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Life expectancy and schooling: new insights from cross-country data

Moshe Hazan

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Abstract I argue that the relationship between life expectancy and schooling crucially depends on which measure of life expectancy one uses. In particular, I show that while the change in life expectancy at birth between 1960 and 1990 is positively correlated with percentage change in schooling, the change in life expectancy at age 5 is, at best, uncorrelated with percentage change in schooling. This evidence suggests that increasing life horizon beyond the early crucial childhood years for formal acquisition of human capital is not as quantitatively important as previously thought.

Keywords Life expectancy · Human capital · Economic growth

JEL Classification J24 · O11

1 Introduction

Conventional wisdom suggests that longer life increases the horizon over which the returns to education can be reaped off and induced higher investment in human capital. This hypothesis dates back to Ben-Porath (1967), and the link to economic growth has been made by Kalemli-Ozcan et al. (2000)

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M. Hazan (✉)
Department of Economics, The Hebrew University of Jerusalem,
Mt. Scopus, Jerusalem 91905, Israel
e-mail: hazan.moshe@gmail.com

and Boucekkine et al. (2002) among others. Hazan and Zoabi (2006) criticized this literature, arguing that in a setting where parents choose fertility and the education of their children, a rise in the life expectancy of the children, increases not only the returns to quality but also the returns to quantity, mitigating the incentive to invest more in the children's education.[1] More broadly, reduction in mortality might have positive effects on human capital and growth via other channels, some of which have been analyzed in Zhang et al. (2001), Kalemli-Ozcan (2002), Zhang et al. (2003), and Bar and Leukhina (2010).

On the empirical side, the evidence on the effect of falling mortality rates on investment in human capital is mixed. Jayachandran and Lleras-Muney (2009) examined declines in maternal mortality in Sri Lanka and estimated that the time in school rises 0.11 year/1 year of additional expected adult life. In contrast, Acemoglu and Johnson (2006) and Lorentzen et al. (2008) found no effect of life expectancy on school enrollment in cross-section data. Hazan (2009) showed theoretically that the Ben–Porath mechanism suggests that as individuals live longer, they invest more in human capital, if and only if, their lifetime labor supply increases. He then showed that this condition does not hold for American men between 1840 and 1970 and concluded that greater longevity cannot account for any of the substantial observed increase in educational attainment in the USA during the nineteenth and twentieth centuries.

Soares (2005) argued that changes in life expectancy can be the cause behind the changes in fertility choice and educational attainment over the time period 1960–1995 in cross-country data. This argument is motivated by the facts that while the cross-sectional relationships between income on the one hand, and life expectancy at birth, schooling and fertility on the other hand have shifted between 1960 and 1995, the cross-sectional relationships among life expectancy at birth on the one hand, and total fertility rate and schooling, on the other hand, have remained constant.

Soares concluded that "…there is a dimension of change in life expectancy that is not associated with income, but that is associated with fertility and educational attainment", and that "while fertility and education are direct objects of individual choice, life expectancy has a large exogenous component … This suggests that exogenous reductions in mortality together with a stable behavioral relationship between life expectancy, educational attainment, and fertility, may be behind the observed changes." (p. 585).

The argument put forward in this paper is simple. Since many mechanisms relating life expectancy to schooling may be at work, it is important to look not only at the relationship between life expectancy at birth and education,

[1] See also (Moav 2005).

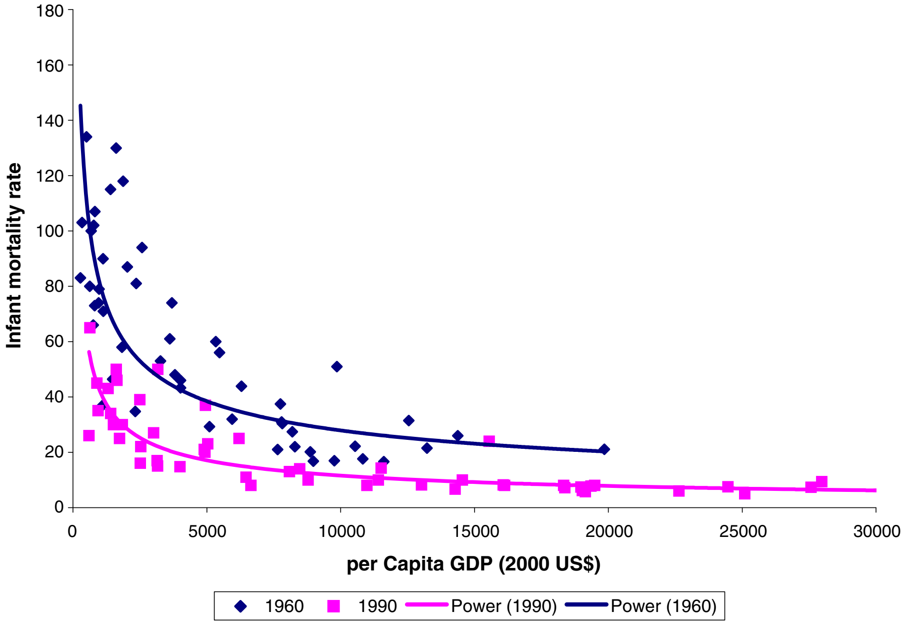

Fig. 1 Relationship between per capita income and infant mortality rate: post-demographic transition countries (1960–1990)

but also at the relationship between life expectancy beyond the crucial early childhood years and education.

It is well known that infant and child mortality rates have been declining sharply at least since 1960 and that these reductions were greater among less developed countries, compared with more developed economies. Figure 1 shows the cross-sectional relationship between income per capita and infant mortality rate in 1960 and 1990, and Fig. 2 shows the cross-sectional relationship between income per capita and child mortality rate in 1960 and 1990. As can be seen, infant and child mortality have declined over time. Moreover, the decline is much more pronounced for poorer countries, suggesting that infant and child mortality rate has been converging over this time period.

The convergence in mortality rates under age 5 suggests that gains in life expectancy at birth are greater for poorer than for richer countries. In 1960, the minimum level of life expectancy at birth in my sample was 52 years and rose to 66 years in 1990, an increase of 14 years. In contrast, the maximum level of life expectancy at birth in my sample was 74 years in 1960 and 79 years in 1990, an increase of 5 years. The sharp reduction in infant and child mortality rates also suggest that gains in life expectancy at age 5 are more modest than at birth. Indeed, in my data, the minimum level has remained

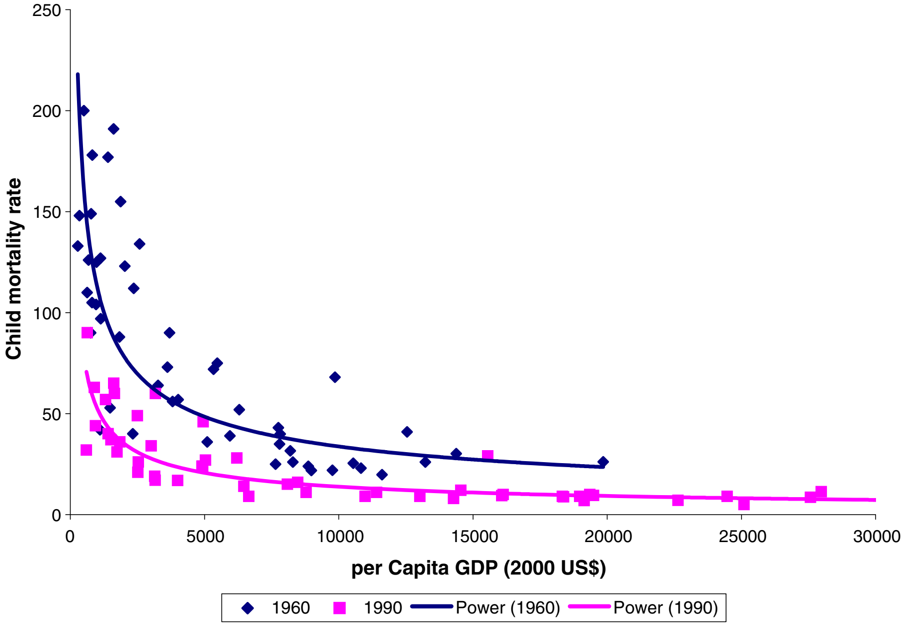

Fig. 2 Relationship between per capita income and child mortality rate: post-demographic transition countries (1960–1990)

60 years while the maximum level has increased slightly by 1 year from 70 to 71 years.[2]

Comparing the distributions of life expectancy at birth and life expectancy at age 5, the following features emerge. First, over this period in which gains in life expectancy at birth have been substantial, gains in life expectancy at age 5 have been quite modest. Second, while the cross-sectional range of life expectancy at birth has declined by more than 40%, from 22 to 13 years, the range of life expectancy at age 5 has been relatively constant: 10 years in 1960 and 11 years in 1990. Finally, following the convergence in mortality rates under age 5, the range of life expectancy at birth and life expectancy at age 5 become similar.[3]

[2]One may find it strange that life expectancy at age 5 plus 5 is less than life expectancy at birth. Indeed, $\forall x > x'$ the following must hold: $x + e_x \geqslant x' + e_{x'}$ where e_x is life expectancy at age x. The reason it happens in my data is that life expectancy at birth is for the total population while life expectancy at age 5 is for males. This does not pose a major problem, however. In 1960, the average life expectancy at birth for the total population was 64.9 years and for males 62.7 years. In 1990, it was 72.9 and 70 years, respectively. However, the correlation between life expectancy at birth for the total population and for males is 0.995 in 1960 and 0.985 in 1990. The reason for using data on males is discussed below.

[3]The coefficient of variation for life expectancy at age 5 has remained constant over the period 1960–1990 at a level of about 0.04 while for life expectancy at birth, it has decreased by half from 0.09 to 0.045 over that period.

The average years of schooling of the population aged 15 and above has also increased over the period 1960–1990. In my sample, the mean average years of schooling has increased from 5.74 to 8.08 while the standard deviation has slightly declined, suggesting a convergence in schooling as well. However, the age at which investment in education begins has remained constant: 5 or 6 years old. I therefore, exploit data on life expectancy at birth and at age 5 on the one hand and school attainment on the other hand, to assess the relationship between life expectancy and school attainment.

In this paper, I provide evidence that illustrates the importance of distinguishing between life expectancy at birth and life expectancy beyond the crucial early childhood years when examining the relationship between life expectancy and schooling. In particular, I look at the correlation between the *change* in life expectancy and *change* in schooling. This correlation provides a first look toward answering the question, did countries that gain more in life expectancy also invested more in schooling? I first show that the absolute change in life expectancy at birth and the percentage increase in schooling are positively correlated and that this correlation is statistically significant. Similar results are obtained if one looks at the correlation between the percentage increase in life expectancy at birth and percentage increase in schooling.[4] However, once life expectancy at birth is replaced with life expectancy at age 5, the correlation becomes *negative* and marginally significant. When I limit the sample by throwing outliers, or countries for which life expectancy at age 5 did not increase, I basically find no correlation among these variables.[5]

How should these results be interpreted? Clearly, the lack of correlation between gains in life expectancy at age 5 and gains in schooling weakens the quantitative importance of increasing life horizon beyond the first few crucial years for formal acquisition of human capital. The results also suggests that reductions in mortality rates before the age at which formal education begins, are perhaps more important than reductions in mortality rates after that age. In Section 4, I discuss a potential hypothesis that may be at work.

The rest of the paper is organized as follows. Section 2 briefly describes data sources. Section 3 presents evidence on the correlation between gains in life expectancy and the rise in average years of schooling. Finally, Section 4 concludes.

2 Data sources

The data come from the World Development Indicators (WDI), except the educational attainment which comes from the Barro and Lee (2000) dataset.

[4] Interestingly, there is no correlation between the absolute gain in life expectancy at birth and *absolute* gain in average years of schooling.

[5] Similarly, Maoz (2008) empirically shows that countries do not seem to share a common dynamic path of fertility and income. This severely weakens the ability to study the relationship between these two variables from cross-section analysis.

Table 1 Summary statistics

	Mean		Standard deviation		Min		Max		Difference
	Full	Small	Full	Small	Full	Small	Full	Small	
LE 0 1960	64.87	66.64	6.58	5.98	51.02	52.06	73.52	73.52	−1.77
LE 0 1990	72.94	74.04	3.89	3.50	64.09	66.09	78.86	78.86	−1.10
LE 5 1960	NA	65.92	NA	2.54	NA	60.27	NA	70.49	NA
LE 5 1990	NA	67.45	NA	2.84	NA	60.27	NA	71.42	NA
AYS 1960	5.33	5.74	2.15	2.14	1.35	1.86	9.73	9.73	−0.29
AYS 1990	7.65	8.08	2.06	2.03	4.02	4.15	11.74	11.74	−0.43

The full sample contains 61 countries, the Small contains 37 countries. Life expectancy at age 5 for the year 2000 is available for only 24 countries. Correspondingly, "AYS 2000" refers to these 24 countries

LE 0 life expectancy at birth, *LE 5* life expectancy at age 5 for males, *AYS* average years of schooling of the population aged 15 and above, *Difference* is the difference in means between the full and small samples. None of these differences is significant at 10% or lower level

The WDI dataset, however, does not contain data on life expectancy at age 5. Hence, data for this variable are from the Historical supplement of the Demographic Yearbook, Table 9a, published by the United Nations in 1997, and from the Human Mortality Database.[6] In terms of country selection, Similar to Soares (2005) I confine the analysis to countries that had life expectancy at birth above 50 years in 1960. Soares referred to these countries as "Post Demographic Transition Countries".

Data on life expectancy at age 5, however, are not available for all the countries in the sample that Soares (2005) uses. Nevertheless, my sample of countries for which I have data on life expectancy at age 5 is not substantially different from the data that meets the criterion of Soares (2005). Table 1 shows summary statistics for the data that meet this criterion, referred to as the "Full" sample and for the subset of countries for which I have data on life expectancy at age 5, referred to as "Small" sample. Fortunately, the subsample, is quite comparable to the full sample: the difference in means of each variable is not statistically different from zero at any conventional significant level.

3 Gains in life expectancy and the rise in schooling

In this section I examine the correlation between gains in life expectancy and gain in average years of schooling between 1960 and 1990. This correlation provides a first look toward answering the question, did countries that gain more in life expectancy also invested more in schooling? Figure 3 shows no correlation between the absolute gains in life expectancy at birth between 1960

[6]The expectation of life at age 5 from the Demographic Yearbook is available only for each gender separately. I use data on the expectation of life at age 5 for males because there are more observations for males than for females.

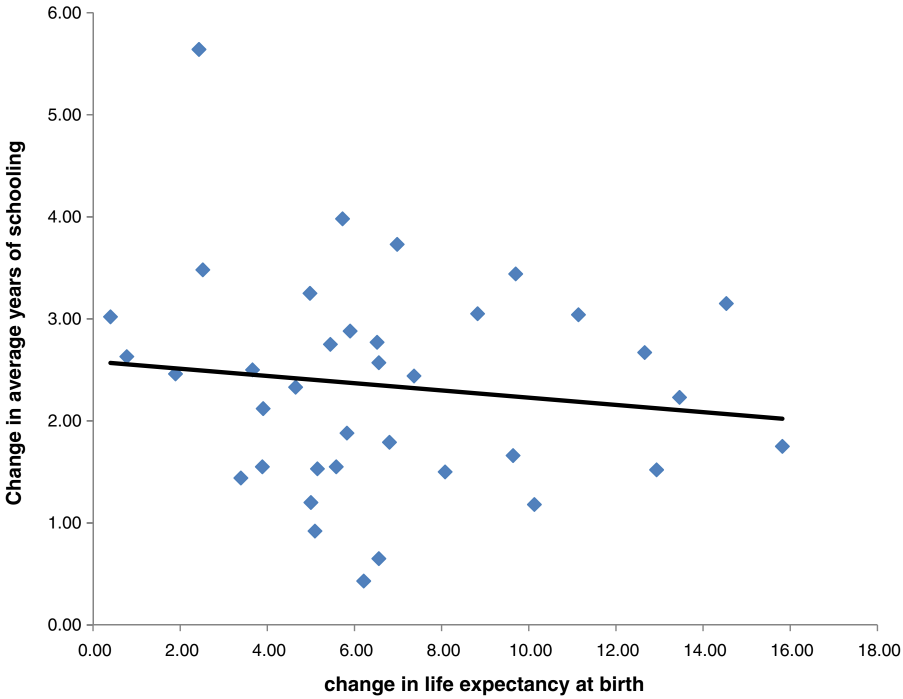

Fig. 3 Absolute gains in life expectancy at birth and gains in average years of schooling: post-demographic transition countries (1960–1990)

and 1990 and the absolute gains in average years of schooling over the same period.[7] But there is no reason a priori for a linear relationship between gains in life expectancy and gains in average years of schooling. In Fig. 4, I look at the correlation between the absolute gains in life expectancy at birth between 1960 and 1990 and the difference between the log of average years of schooling of the population aged 15 and above in 1990 and 1960. As can be seen, there is a positive and significant correlation between these two variables. That is, countries that gain more years in life expectancy at birth have increased their average years of schooling by more, in percentage term. The OLS estimate on gains in life expectancy equals 0.021 and has a p value of 0.03. This suggests that a gain of one extra year in life expectancy at birth is associated with an increase in average years of schooling of 2% over a period of 30 years. With a mean gain in life expectancy at birth of 7.39 years, this implies that at the mean, gains in life expectancy are associated with an increase of average years of schooling of 15.2% over the period 1960 and 1990. Since the average increase in years of schooling is about 39%, gains in life expectancy at birth may explain up to 40% of the increase in schooling.

[7]The OLS estimate is negative, −0.027, but highly insignificant with a p value of 0.51.

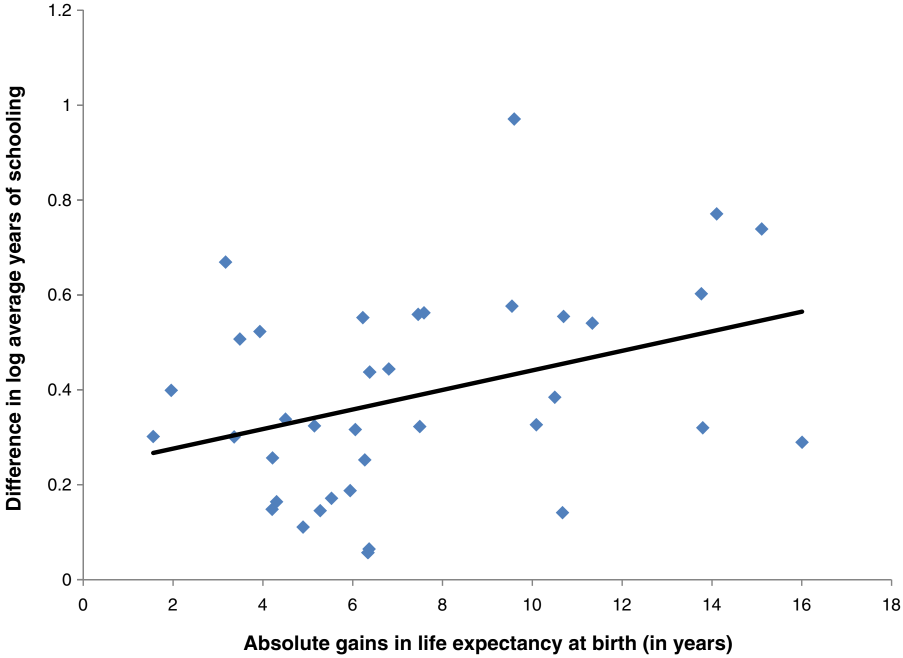

Fig. 4 Absolute gains in life expectancy at birth and the difference in log average years of schooling: post-demographic transition countries (1960–1990)

Figure 5 repeats the exercise shown in Fig. 4 but now life expectancy at age 5 is used, instead of life expectancy at birth. As can be seen from the figure, the correlation is now negative. The OLS estimate on gains in life expectancy equals −0.034 and has a *p* value of 0.09.[8] Looking at Fig. 5, however, shows that this negative correlation may be driven by particular countries. For example, life expectancy at age 5 remained constant in Portugal between 1960 and 1990, but average years of schooling increased substantially (a log difference of almost 1). Omitting Portugal, the OLS estimate is now −0.027 and the *p* value increases to 0.14. Another concern might be that in two countries life expectancy at age 5 actually declined (Bulgaria and Poland) and that in few other countries life expectancy at age 5 remained constant (Argentina, Belgium, Colombia, Cyprus, Czech Republic, Malaysia, Mauritius, Norway, Paraguay, Philippines, Portugal, Singapore, Trinidad and Tobago, and Turkey). Without this set of countries, the OLS estimate is now positive (0.018) but highly insignificant (a *p* value of 0.543). Thus, gains in

[8]A very similar picture emerges if one looks at the correlation between the absolute gains in life expectancy at age 5 and the absolute gains in average years of schooling.

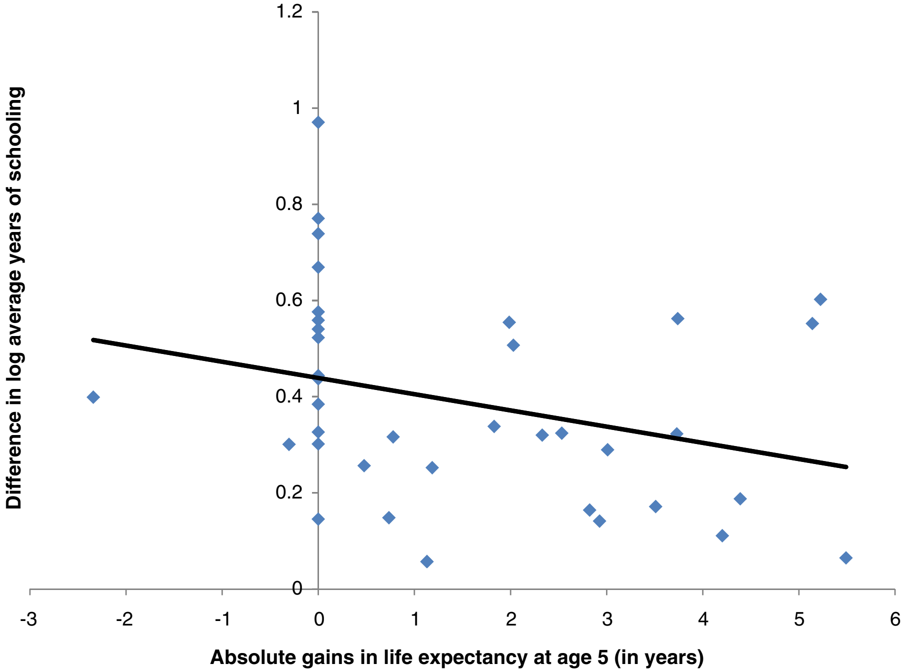

Fig. 5 Absolute gains in life expectancy at age 5, and the difference in log average years of schooling: post-demographic transition countries (1960–1990)

life expectancy at age 5 are, at best, uncorrelated with percentage change in schooling. The lack of a positive correlation among these two variables weakens the quantitative importance of increasing life horizon beyond age 5 for formal acquisition of human capital during the period 1960 and 1990.

3.1 Robustness of these results

Several concerns regarding the findings presented above can be raised. For one thing, even though I argued that there is no statistically significant difference in the mean of any of the variables between the "Full" and the "Small" sample, one may be worried that the correlations reported above when life expectancy at birth is used may change in the "Full" sample. It turns out that the relationships shown in Figs. 3 and 4 are remarkably similar if one used the "Full" sample.

A second concern can be related to the choice of the years, 1960 and 1990. Above I argued that the choice of 1990 is due to availability of data on life expectancy at age 5. Nevertheless, as a robustness check I redid Fig. 3 through Fig. 5 using data for 2000. Data on life expectancy at birth are available for all 37 countries while life expectancy at age 5 is now available for only 24 countries. Nevertheless, using gains in life expectancy and schooling over the period 1960 to 2000 makes no qualitative change, compared to the period 1960 to 1990. First, there is no correlation between the absolute gains in life expectancy at birth between 1960 and 2000 and the absolute gains in average years of schooling over the same period. The OLS estimate equals 0.002 with a p value of 0.945. Second, the correlation between the absolute gains in life expectancy at birth between 1960 and 2000 and the difference between the log of average years of schooling of the population aged 15 and above in 2000 and 1960 is positive and significant. The OLS coefficient equals to 0.024 with a p value of 0.01. Finally, when I use life expectancy at age 5, the correlation between absolute gain in life expectancy and log of average years of schooling of the population aged 15 and above is negative, though not significant. The OLS estimate equals to -0.02 with a p value of 0.18.

Finally, I argued above that a priori there is no reason for a specific functional form between gains in life expectancy and gains in average years of schooling. One can then wonder what is the correlation between the difference between the log of life expectancy and the difference between the log average years of schooling of the population aged 15 and above. It turns out that such a specification yields very similar result to the one reported in Figs. 4 and 5. That is, when life expectancy at birth is used, there is a positive and significant correlation while using life expectancy at age 5 results in no correlation with the difference between the log average years of schooling of the population aged 15 and above.

4 Concluding remarks

I argue that the relationship between life expectancy and schooling crucially depends on which measure of life expectancy one uses. In particular, I show that while the change in life expectancy at birth between 1960 and 1990 is positively correlated with percentage change in schooling, the change in life expectancy at age 5 is, at best, uncorrelated with percentage change in schooling. This evidence suggests that increasing life horizon beyond the early crucial childhood years for formal acquisition of human capital is not as quantitatively important as previously thought.

But what can account for the positive relationship between gains in life expectancy at birth and percentage change in average years of schooling? One may suggest, that a reduction in infant and child mortality may lead to a reduction in fertility and an increase in the investment in human capital of the surviving children along the quantity–quality tradeoff. In fact, Kalemli-Ozcan (2002) formalized this argument. She showed that if the marginal utility of a surviving child is convex, then there is a precautionary demand for children, an effect that is also known as the “hoarding effect”. Under this setup, a decline in child mortality rate also reduces the uncertainty with respect to the number of surviving children and, therefore, the demand for children decreases. Furthermore, she showed that lower mortality encourages educational investment in children.[9]

Doepke (2005) studied the effect of a reduction in child mortality on fertility. Doepke allowed for sequential fertility, which introduces on top of the hoarding effect a "replacement" effect: parents may condition their fertility decisions on the survival of children that were born previously, and in the occurrence of a death they can "replace" the deceased child by having an extra birth. He showed that once sequential fertility choice is allowed for, hoarding behavior does not arise even if parents are highly risk averse.[10]

Interestingly, without the hoarding effect, the intuition that as a result of a reduction in child mortality, parents waste less resources on children who do not survive to age 5, and this will lead to higher investment in the children who survived to age 5 may be misleading. Incorporating child mortality into a standard setup such as the one of Galor and Weil (2000), shows that the larger the saving on wasteful resources, the larger is the *increase* in net fertility and the reduction in human capital investment. This is simply due to a standard substitution effect: a reduction in child mortality lowers the cost of a survivor child and increase the cost of educating all of the surviving children. Thus, through a substitution effect net fertility *increases* and the investment in the human capital of each child declines. In fact, Doepke (2005) showed that this is precisely the effect of a reduction in child mortality on fertility and education in the Barro and Becker (1989) framework as well. The on-line Appendix shows this formally.

Given the inconclusiveness of the theoretical literature on this issue, assessing empirically the link between infant and child mortality on the one hand and fertility and education on the other hand, is highly desirable. Nevertheless, this is beyond the scope of the current paper and is left for future research.

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[9]Using cross-country data, Angeles (2010) showed that mortality plays a significant role in fertility reductions.

[10]Galor (2011) provides a thorough discussion of the necessary conditions which must meet for a reduction in child mortality to have a negative effect on the number of surviving children. He then looked at the evidence for currently advanced economies and concludes that it is highly unlikely that declines in mortality rates caused the observed decline in net fertility.

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