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# Longevity, age-structure, and optimal schooling

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ABSTRACT

The mechanism stating that longer life implies larger investment in human capital, is premised on the view that individual decision-making governs the relationship between longevity and education. This relationship is revisited here from the perspective of optimal period school life expectancy, obtained from the utility maximization of the whole population characterized by its age structure and its age-specific fertility and mortality. Realistic life tables such as model life tables are mandatory, because the age distribution of mortality matters, notably at infant and juvenile ages. Optimal period school life expectancy varies with life expectancy and fertility. The application to French historical data from 1806 to nowadays shows that the population age structure has indeed modified the relationship between longevity and optimal schooling.



## 1. Introduction

Ben-Porath (1967) suggested a "mechanism" according to which longer life spans imply larger investment in human capital. This mechanism is central to several growth theories in the field of unified growth theory. For example, Boucekkine et al. 2002) and Boucekkine et al. (2004) argued that early increases in life expectancy, mediated by the Ben-Porath mechanism, are at the origin of modern growth: longer lives would induce longer schooling and higher rates of human capital accumulation, giving rise to a new growth regime which allows the escape from the Malthusian trap.

French historical data are accurate enough to give us an insight into the relationship between longevity and education, at the moment of both the schooling and the mortality transitions. From the accurate estimates of female life expectancy at birth by French *départements* from 1806–1810 to 1901–1905 of Bonneuil (1997a) and from French schooling rates in 1837,

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1850, 1867, and 1876 (Bonneuil, 2014), we regressed the time series of the growth rate of female life expectancy (tested to be stationary) on the growth rate of the female schooling rate (also tested to be stationary) in 1837–1850, 1850–1867, and 1867–1876. On 82 French *départements*, these regressions yield 11 positive correlations (for *départements* located erratically on the territory), 6 negative, and 65 non-significant. Then, in spite of the scarcity in time, the absence of clear correlation raises doubts that the relationship between longevity and schooling would be unequivocal.

In a quantity–quality trade-off model *à la* Becker (1991), Hazan and Zoabi (2006) show that the Ben-Porath mechanism may not always work because an increase in longevity affects not only the return to schooling (quality of children), but also the return to quantity or the optimal total number of children. The latter effect mitigates the Ben Porath mechanism and can in principle negate it. Under homothetic preferences, Hazan and Zoabi (2006) find that when fertility is endogenous, an exogenous increase in children's longevity has no effect on schooling. Hazan (2010) questions the Ben-Porath mechanism explicitly. He starts from the cohort model of Boucekkine et al. (2002): all individuals of all cohorts are identical and make decisions about their lifetime consumption, schooling, and work time. Attending school for a longer time has a cost in terms of foregone labor income but this schooling time also induces a gain because longer schooling means higher wages in the labor market. In the case of a perfectly rectangular survival function, increased longer longevity leads to longer schooling only if the total expected number of hours spent at work during one's lifetime also rises. Hazan (2010) tested this property on US data for consecutive 10-year cohorts born between 1840 and 1970, to find that the total number of hours worked did not increase, and to conclude that the Ben-Porath mechanism was not relevant for the US during this period. Cervellati and Sunde (2013a), however, argued that the connection between the total number of hours spent at work during an individual's lifetime and the Ben-Porath mechanism does not hold for non-perfectly rectangular survival functions.

All the studies referred to so far are based on individual decision-making where agents decide about their optimal consumption stream and their lifetime accumulation of human capital over lifetime for a given ad-hoc survival function. Hazan (2010) and Cervellati and Sunde (2013a) used a continuous time (homogeneous) cohort model, incorporating a schooling time decision model like in Boucekkine et al. (2002). Cervelatti and Sunde (2013b) illustrated their argument on a discrete-time version of their cohort model. Boucekkine et al. (2007) introduced within-cohort heterogeneity into this model, which adds formidable complications. However, decisions relative to education are not individual; on the contrary, at least in continental Europe, education is run mainly by the State. For example, control over education in France dates back at least to 1837, when the government started to invest substantial human and material resources in schooling. It withdrew university degrees from private education in 1880, made primary schooling free in 1881, and education became non-clerical and mandatory in 1882. The State finances schools and teachers, with individuals who send their children to state-run schools, which constitute the large majority of teaching establishments, having practically nothing to pay. State schools have been organized in this way until now in most European countries. Nineteenth century France offers an exemplary case, and Ben Porath's hypothesis that governments would respond to increasing longevity by lengthening schooling time can be tested in the context of a rapidly changing demography and deliberate State policies to increase schooling time for boys and girls.

We innovate by relying on the alternative criterion of optimal period schooling, which is the only one so far to involve the whole age structure, in contrast to individual follow-up. The State's expenditures depend on the ratio of schooled children to tax-payers, and this ratio is a function of the age structure. For an equivalent mortality level and population size, at each date, a population in a low fertility regime has comparatively more contributors and fewer schooled children than a population in a higher fertility regime.

A basic formulation of the optimal period schooling equivalent could be the following: given the age structure of the population, its current fertility and mortality levels, would a planner seeking to maximize social welfare (say with respect to the Benthamite criterion) lengthen schooling in response to rising life expectancy? In contrast to the individual-cohort perspective adopted in the related literature, the key component of the period schooling optimum problem is that the decisions have to be taken on the basis of the overall demographic structure. Therefore, the current age structure of the population determines schooling decisions, whereas it is ignored in the literature on individual schooling decisions. Put simply, the main reason supporting the argument that longer life implies longer education is that the proportion of people above the maximum school completion age increases as mortality decreases. But this holds true only if the proportion of people under that age does not increase faster. Following a cohort, as did Hazan (2010) or Cervellati and Sunde (2013a,b), is equivalent to fixing fertility at a constant value over time. The conditions of the moment however vary with fertility, so that if the proportion of people in school increases, compared to the proportion out of school, greater longevity may not be enough to offset higher fertility, leading to *a decrease* in schooling, at the optimum. The relationship between length of life and schooling will thus depend on the balance between the additional young from higher fertility and the additional old from improved survival.