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# Education choices, longevity and optimal policy in a Ben-Porath economy☆

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## HIGHLIGHTS

- According to Ben-Porath (1967), a rise in longevity increases education investment.
- We use an OLG model to examine conditions under which a Ben-Porath effect exists.
- Under exogenous longevity, a Ben-Porath effect requires a change in old-age labor.
- Under endogenous longevity, a Ben-Porath effect exists even if labor time is fixed.
- The Ben-Porath effect may not be robust to variations in production factor prices.

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## ABSTRACT

We develop a 3-period overlapping generations (OLG) model where individuals borrow at the young age in order to finance their education. Education does not only increase future wages, but also raises the duration of life, which, in turn, can affect education, in line with Ben-Porath (1967). We examine the conditions under which the Ben-Porath effect prevails. Although the existence of a positive Ben-Porath effect requires, under exogenous longevity, a change in lifetime hours of work, we find, under endogenous longevity, that a positive Ben-Porath effect arises even when old-age labor is fixed. It is also shown that the Ben-Porath effect may not be robust to allowing for adjustments in production factor prices. On the policy side, we show that the social optimum can be decentralized provided the capital stock is set to the Modified Golden Rule level. Finally, we introduce intracohort heterogeneity in learning ability, and we show that, under asymmetric information, the second-best optimal non-linear tax scheme involves a downward distortion in the education of less able types, which reinforces the longevity gap in comparison with the first-best.



## 1. Introduction

In a seminal contribution, Ben-Porath (1967) highlighted a major channel through which demography affects economic development. According to Ben-Porath, a rise in life expectancy increases lifetime returns from educational investment without increasing the cost of education, and, hence, encourages investments in education. Improvements in survival conditions can thus increase education and favor human capital accumulation and growth. The so-called "Ben-Porath effect" has become increasingly studied by growth theorists, when considering the impact of exogenous changes in mortality on education and development (see Ehrlich and Lui, 1991, Boucekkine et al., 2002, Ludwig and Vogel, 2010), or when examining, in models with endogenous mortality, how development and longevity reinforce each other (see Blackburn and Cipriani, 2002, Chakraborty, 2004, Cervellati and Sunde, 2005, Soares, 2005).

On the empirical side, several studies tested whether life expectancy improvements affect economic growth. This impact may

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not be due to the Ben-Porath effect, since life expectancy may affect growth through other channels (e.g. saving). But the Ben-Porath effect could explain, in theory, a positive impact of life expectancy growth on economic growth. Bloom et al. (2004) show that a 5-year increase in life expectancy generates a 21% rise of the growth rate.[1] Acemoglu and Johnson (2007) found that, once adequate instruments are used to avoid endogeneity biases, life expectancy does not seem to affect economic growth. Hazan (2009) argued that the Ben-Porath effect can only arise provided additional life-years are years of occupation, which has not been observed. On the contrary, de la Croix et al. (2009) find, for Sweden, that the longevity increase accounts for 20% of the rise in education over the last two centuries. Bloom et al. (2014) criticized Acemoglu and Johnson's approach, on the ground that they neglect the impact of initial conditions. Cervellati and Sunde (2011) argued also against Acemoglu and Johnson (2007) that, once we take into account fertility differences between countries, life expectancy increases economic growth in countries having accomplished their demographic transition.

Those mixed empirical results suggest that, although the Ben-Porath effect is theoretically plausible, that effect is far from being universally observed. On the contrary, its size depends on various kinds of factors. In particular, Hazan's (2009) criticism suggests that the plausibility of the Ben-Porath effect should be assessed in a theoretical model where the retirement age is not exogenous, but rather where individuals decide when they retire.

The goal of this paper is precisely to reexamine the Ben-Porath effect in a dynamic economy where individuals choose not only their education, but, also, the age at which they retire, and where the duration of their life depends on the amount of education.[2] In other words, this paper proposes to examine, by means of a dynamic general equilibrium OLG model where education, saving and retirement are chosen by individuals, the conditions under which a rise in lifetime horizon contributes to increase education investment. Following Boucekkine et al. (2002), who emphasized that the Ben-Porath effect depends on the depreciation of human capital, we assume that there exists some decay of human capital, which may affect education decisions. We use that OLG model to identify the various determinants of the Ben-Porath effect.

Moreover, besides this positive goal, we would like also to explore some policy implications of the Ben-Porath effect. Actually, whereas the Ben-Porath effect has been widely studied at the theoretical and empirical levels, little emphasis has been laid, so far, on its policy implications. It is widely acknowledged that education constitutes a major vector of inequalities, and that inequalities in life expectancy and in education are strongly related (see Elo and Preston, 1996, Deboosere et al., 2009, Zarulli et al., 2012). This connection between education and life expectancy is consistent with the Ben-Porath effect. But few attempts were made to derive the optimal public intervention in an economy where education and life expectancy are correlated. For that purpose, we use our model to study the design of the optimal public policy in a Ben-Porath economy. We first consider the decentralization of the social optimum in an economy composed of homogeneous agents. Then, we introduce heterogeneity in individual learning ability, and we study the optimal public intervention in a second-best setting where learning ability is not observed by the government.

Anticipating our results, we first identify conditions that guarantee the existence of a stationary equilibrium with perfect foresight, and we compare those conditions in the cases of exogenous longevity (i.e. longevity is fixed to a constant) and endogenous longevity (i.e. longevity depends on education choices). Then, we reexamine the conditions under which the Ben-Porath effect prevails. We first follow the existing literature, which generally abstracts from changes in production factor prices. When examining the Ben-Porath effect in a small open economy (where the wage and the interest rate are fixed), we show that the distinction between cases where longevity is exogenous or endogenous matters, especially concerning the impact of old-age labor on the Ben-Porath effect. Under exogenous longevity, the existence of a positive Ben-Porath effect requires a change in lifetime hours of work, in line with Hazan (2009). However, under endogenous longevity, a positive Ben-Porath effect can be found even in the absence of old-age labor, and even when old-age labor is fixed. As such, this study completes the recent work by Cervellati and Sunde (2013) on the link between life expectancy and education. Turning then to the closed economy, we show that a rise in longevity does not necessarily increase steady-state education, because longevity variations affect wages and interest rates. This general-equilibrium effect has remained so far largely unnoticed in the literature.

On the policy side, we compare the laissez-faire with the social optimum, and show that the latter can be decentralized provided the laissez-faire capital stock corresponds to the one satisfying the Modified Golden Rule. In a second stage, introducing intracohort heterogeneity in the learning ability allows us to show that, under asymmetric information, the second-best optimal non-linear tax scheme involves a downward distortion in the level of education of less able types, which reinforces the longevity gap in comparison with the first-best.

The rest of the paper is organized as follows. Section 2 presents the model. The temporary equilibrium is characterized in Section 3. Section 4 studies the conditions under which a stationary equilibrium with perfect foresight exists. Section 5 examines, at the stationary equilibrium with perfect foresight, the determinants of the Ben-Porath effect. The social optimum is characterized in Section 6. Section 7 examines the second-best problem when the population is heterogeneous in terms of learning capacity. Section 8 concludes.

## 2. The model

Let us consider a three-period OLG model. Period 1 is childhood, during which children borrow in order to invest an amount $e$ in their higher education. During period 2, individuals work, pay back the cost of their education, consume and save. Period 3 is the old age. Whereas the durations of periods 1 and 2 are normalized to unity, the duration of period 3 is equal to $\ell$ $(0 < \ell < 1)$.[3] During period 3, individuals work some fraction $z \leq \ell$ and consume their saving. We consider, as a baseline, a closed economy.[4] Moreover, we consider, for the sake of simplicity, an economy composed of identical individuals.[5]

**Demography**. Fertility is exogenous, and equal to its replacement level. There is no risk about the duration of life. Survival curves are perfectly rectangular. However, the duration of the old age varies over time, as a function of the educational level enjoyed during childhood, according to the function:

$$\ell_{t+1} = \ell\,(e_{t-1}) \tag{1}$$

where $\ell\,(0) = \ell > 0$.

[1] Similar effects are found in Bloom and Sachs (1998), Bloom and Williamson (1998), and Gallup and Sachs (2001).

[2] Assuming that longevity depends on education is in line with the empirical literature on the increasing (but non-linear) relationship between education and longevity (see Everett et al., 2013).

[3] Alternatively, we could here consider survival probabilities dependent on education. This would imply introducing an annuity market. Further, it would face Bommier's critique of risk neutrality with respect to the length of life (see Bommier, 2007).

[4] When examining the conditions under which the Ben-Porath effect prevails, Section 5 will also consider, in addition, the case of a small open economy (see Section 5.1).

[5] The case of heterogeneous individuals is discussed in Section 7.

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