Mathematical Social Sciences 93 (2018) 22–36

Contents lists available at ScienceDirect

Mathematical Social Sciences

journal homepage: www.elsevier.com/locate/mss

Longevity and welfare in general equilibrium

Laurent Brembilla

EPEE, Univ Evry, Université Paris-Saclay, 91 025, Evry, France

HIGHLIGHTS

- Impact of longevity on welfare in a Diamond model.
- A longevity increase can reduce welfare.
- Costly longevity improvements also studied.
- Numerical illustrations are provided.

ARTICLE INFO

Article history:
Received 22 September 2016
Received in revised form 14 February 2017
Accepted 2 January 2018
Available online 3 February 2018

ABSTRACT

Life expectancy is on the rise across the world. This paper analytically studies how it affects welfare in general equilibrium. First, we examine the exogenous impact of a longevity increase on welfare in a canonical Diamond model. We find that a longevity increase does not necessarily increase welfare. Second, we study the impact of a longevity increase on welfare when longevity improvements are costly. We show the existence of economies in which welfare is maximized when longevity is at its minimal level. We provide numerical illustrations of our results. They highlight that the age at which longevity improves and the cost of such improvements are important to determine the welfare impact of a longevity increase.

1. Introduction

One of the great achievements of the second half of the XXth century is the life expectancy increase across the world. This can be observed from the evolution of the world average life expectancy, which increased from 54.4 years in 1960 to 71.5 years in 2014.[1] Becker et al. (2005) argue that this produced important welfare gains across countries. In this paper, we underline that this conclusion is sensitive to the age at which survival conditions improve and to the cost of such improvements. Particularly, we focus on a longevity increase at old age. Fig. 1 shows that life expectancy at age 60 has also remarkably increased in each region of the world over the previous fifty years and that these trends should pursue. While improved survival conditions at any age are generally seen as positive for population well-being, we determine here if economic theory is in line with this view. To do this, we study the impact of longevity at old age on welfare in a standard general equilibrium model.

The framework we use is motivated by two features that these future life expectancy gains will likely have. First, they will be the result of both exogenous improvements and costly health programs. Indeed, Acemoglu and Johnson (2007) argue that the overall life expectancy increase is the result of the diffusion of medical technology and knowledge, which can be classified as exogenous longevity improvements. This type of longevity improvements will continue, however they will not be sufficient to sustain continuous mortality declines. As highlighted by Cutler et al. (2006), domestic health expenditures will be required. Second, the retirement age is unlikely to change by much. Prettner and Canning (2013) and Bloom et al. (2007) observe that the previous life expectancy gains have not implied an increase of the retirement legal age in OECD countries. For example, Fig. 2 shows the evolution of the US average retirement age over the period 1840–2000. It only fluctuates between 60.5 and 63.5 years. Prettner and Canning (2013) set up a dynamic general equilibrium model with endogenous retirement and they show that for realistic parameter values, the retirement age increases with life expectancy contrary to what Fig. 2 suggests. This allows them to conclude that political constraints impede the adjustment of the retirement age with longevity.[2] Thus, in this paper, we take as given the relative invariance of the retirement age with respect to longevity by considering a Diamond model, in which we examine the impact on welfare of both types of longevity improvements in retirement period.

E-mail address: laurent.brembilla@univ-evry.fr.

[1] Source: World Bank database.

[2] On the link between retirement age and life expectancy, see also the partial equilibrium findings of Cervellati and Sunde (2013) and d' Albis et al. (2016).

https://doi.org/10.1016/j.mathsocsci.2018.01.003

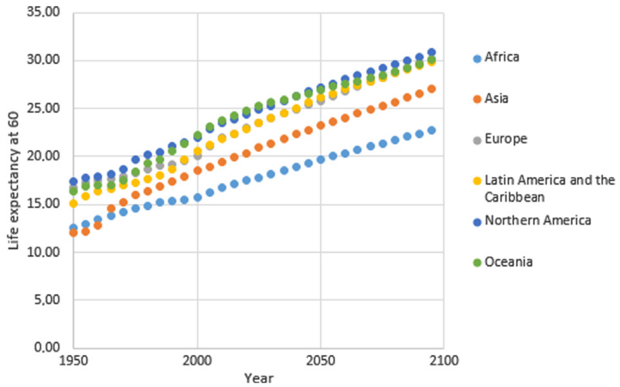

Fig. 1. Life expectancy at 60 evolution by region.
Source: UN population estimates.

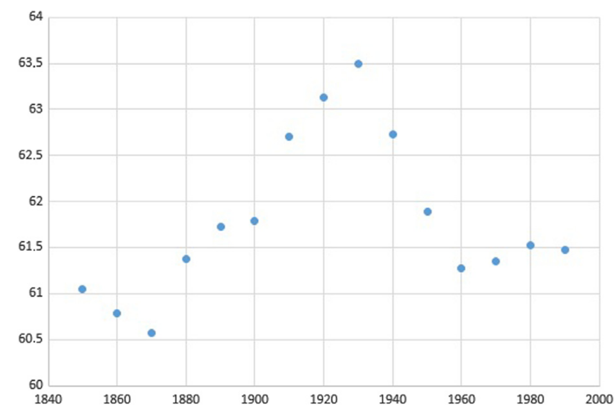

Fig. 2. Retirement age for cohort US American males.
Source: Lee (2001).

More precisely, in the first part, we determine the variation of the steady-state welfare level with respect to the longevity parameter in a canonical Diamond model. In the second part, to examine the impact on welfare of a costly longevity improvement, we use the framework of Chakraborty (2004). This is a Diamond model with a longevity in retirement period that depends on the level of public health expenditures, whose financing tax rate is an exogenous parameter. Here we interpret an increase of this tax rate as a costly longevity improvement and we study how it influences the steady-state welfare level. In the third part, we provide numerical illustrations of our theoretical results.

Doing this, the paper complements two strands of the literature. The first one is empirical and studies the welfare gains due to previous life expectancy increases. Becker et al. (2005), Weil (2014), Jones and Klenow (2016) and Cordoba and Ripoll (2017) all find a positive effect on welfare from life expectancy increases across countries. Murphy and Topel (2006) also measure a positive welfare effect of medical innovation in US. Our paper differs from these ones with respect to three aspects that suggest that the welfare gains due to life expectancy increase are not automatic. First, we consider a longevity improvement at old age, which forces individuals to reduce their consumption expenditures. Second, we consider costly longevity improvements that reduce the disposable income of individuals. Third, we incorporate general equilibrium effects of longevity that may be potentially important. A numerical illustration of our results suggests that these differences lead to different conclusions about the welfare impact of longevity improvements in low-income countries.

The second strand of the literature that we complement is a large theoretical literature that studies the role of longevity in dynamic general equilibrium models. This literature has clarified the exogenous impact of longevity on income in growth models with human capital, (de la Croix and Licandro, 1999; Boucekkine et al., 2002), physical capital, (Bloom et al., 2003), and R&D, (Prettner, 2013). Our contribution is to add results on welfare. We do this in a simple framework, a canonical Diamond model, that allows to shed light on the channels of transmission and to give complete analytical results.

We also complement the literature that incorporates an endogenous lifetime in economic growth models by giving additional results on the influential model of Chakraborty (2004). In a previous work, (Brembilla, 2016), we examine the impact of the tax rate on the steady-state income level in this framework. Here to analyze the welfare impact of a costly longevity improvement, we provide results on the tax rate that maximizes the steady-state welfare level. Other works incorporate health expenditures, particularly to discuss the decentralization of social optimum in economies with health related externalities. For example, Jouvet et al. (2010) and Ponthiere (2016) examine the decentralization of social optimum in economies in which pollution exerts negative externalities on the longevity of individuals. However, to the best of our knowledge, the literature has not discussed the possibility for health expenditures to be detrimental to welfare.

The rest of the paper proceeds as follows. Section 2 studies the variation of welfare with respect to longevity in a canonical Diamond model. Section 3 outlines the model of Chakraborty (2004) to study the impact of costly longevity improvements on welfare. Section 4 provides a numerical illustration of the results. Section 5 concludes.

2. Welfare effect of an exogenous longevity shock

2.1. Logarithmic utility

We consider first the canonical Diamond model, hence the utility per period is logarithmic and the production function is Cobb–Douglas. We will discuss the robustness of our results with respect to these functional forms and we will consider an alternative functional form for the utility function in the next subsection.[3] Despite the popularity of the Diamond model, the variation of welfare with respect to longevity has not yet been investigated in this framework. We first briefly outline the model to introduce the notations.

There is a single good which is consumed or invested in physical capital. It is produced with capital and labor. Note Y_t, K_t, L_t respectively the output, the capital stock and the laborforce at time t. Then, under the Cobb–Douglas assumption, $Y_t = AK_t^{\alpha}L_t^{1-\alpha}$, with $\alpha \in (0, 1)$ and $A > 0$. Production factors are paid at their marginal productivity. Capital fully depreciates each period.

Individuals live for two periods. The size of each new cohort is constant and normalized to 1. Individuals work during the first period, whose length is 1, and retire in second period, whose length is equal to p, with $p \in [0, 1]$.[4] Each cohort-t member maximizes the following lifetime utility function: $U_t = \ln(c_t) + p\ln(d_{t+1})$,

[3] In a one-sector Diamond model with general utility and production functions, there does not exist conditions that insure the existence of an inter-temporal equilibrium. Functional forms or conditions on endogenous variables must be imposed (see Galor and Ryder, 1989).

[4] We do not consider human capital investments. If we assume that agents can acquire human capital through schooling during their first period to get a higher labor income, then their schooling period does not depend on the longevity parameter, which leaves unaffected our results. This is consistent with the findings of Cervellati and Sunde (2013) according to which the Ben-Porath effect mainly results from an increase of survival probabilities in working age.