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The genesis of the golden age: Accounting for the rise in health and leisure ☆

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ABSTRACT

We develop a life cycle model featuring an optimal retirement decision in the presence of physiological aging. In modeling the aging process we draw on recent advances within the fields of biology and medicine. In the model individuals decide on optimal consumption during life, the age of retirement, and (via health investments) the timing of their death. Accordingly, "years in retirement" is fully endogenously determined. Using the model we can account for the evolution of age of retirement and longevity across cohorts born between 1850 and 1940 in the US. Our analysis indicates that 2/3 of the observed increase in longevity can be accounted for by wage growth, whereas the driver behind the observed rising age of retirement appears to have been technological change in health care. Both technology and income contribute to the rise in years in retirement, but the contribution from income is slightly greater.

1. Introduction

A 20 year-old US male who was born in 1850 could expect to live another 43.7 years upon reaching his 20th birthday; in the 1940 cohort the same number had gone up by more than a decade. At the same time the age of retirement only rose by two years, implying an increase in length of retirement by roughly eight years (Lee, 2001).[1] What were the main driving forces behind the impressive increase in longevity? What drove the changes in the age of retirement? Can the observed increase in years in retirement be expected to continue in the years to come? In an era where the global population is aging rapidly, these are all relevant and important issues to resolve; not least because of the fiscal sustainability problems that are created by an aging global population. In this paper we attempt to offer some progress in this regard.

In the present study we develop a life-cycle model where the representative individual is subject to physiological aging. In modeling the aging process as increasing frailty we draw on recent research in the fields of biology and medicine. In our

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[1] It is well known that the labor force participation rate for older individuals has declined monotonically from the 19th century (Costa, 1998; Lee, 2001). From this evidence it is tempting to conclude that the *age of retirement* also must have been monotonically declining. This is not so, as discussed below in the context of our cohort analysis.

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life cycle model aging has three substantive implications: it gradually lowers wage earnings over the life cycle; it works to increase the disutility from work, and it eventually leads to death. Within this framework the individual consumes, saves, and makes deliberate investments in slowing down the aging process thus postponing death. In addition, the individual decides when to optimally retire. In the end, the model allows us to study the impact from income and health technology (broadly defined) on changes in longevity, age of retirement, and thus years in retirement.[2] Formally, the model below extends the framework developed in Dalgaard and Strulik (2014) so as to allow for optimal retirement, disutility from work, and a wage rate that changes over the life cycle due to changes in health.[3]

We proceed to calibrate the model so that it reproduces observed aging, death and health expenditures for the US cohort that was born in 1940. Subsequently, we use the calibrated model to analyze the evolution of longevity and age-of-retirement across cohorts born from 1850 to 1940. We focus on these cohorts as they have all (largely) retired, which means that our model's predictions can be compared to observed rather than estimated age of retirement.

In so doing we establish three main results. First, the increase in life expectancy at age 20 is mainly driven by income, propelling investments in health; 2/3 of the increase in longevity can be accounted for by wage growth. Second, technological progress in health care is responsible for the observed increase in age of retirement for individuals born between 1850 and 1940. Finally, our simulations show that as for years in retirement both income and technological change contributed over the period in question, with the income channel being somewhat stronger. As noted below, various explanations for the rise in the importance of retirement have been put forward in the literature. While income is a familiar explanation for the rise of retirement, we believe this paper is the first to suggest that technological change in health care was a contributor.

Analytically, wage income increases longevity for a simple reason. If an increase in income is solely spent on increasing consumption at the "intensive margin" (i.e., more per period consumption) the utility gains will diminish rapidly. As a result, it is a superior strategy to expand consumption along an "extensive margin" (i.e., by an increasing length of life), which can be attained by making investments that slow down aging. Consequently, rising wages increase longevity.[4] At the same time, we show that wages hold an ambiguous effect on age of retirement. As a result, wage growth is unlikely to have caused the observed path of age of retirement. But it does contribute significantly to an increase in years in retirement, though primarily via longevity.

In contrast, technological change in health care works to increase the age of retirement. The intuition is the following. When technology in health improves, individuals age more slowly; both because of a direct impact from the innovation and because of a behavioral response in the direction of more health investments. As a result, the disutility from work declines, inducing individuals to stay on longer in the labor market. In addition, a lower per period consumption level, prompted by greater health investments, elevates the utility gain from working. Hence, technology promotes both longevity and extends working life. While wage growth accounts for a big part of the observed increase in adult life expectancy, the increase in age of retirement is caused by technology. Since technological change both raises longevity and age of retirement, the net impact on years in retirement is theoretically ambiguous. With the aid of the calibrated model however we find that technological change, like wage growth, has worked to increase years in retirement, on net.[5]

We explore a range of extensions of our baseline model. In particular, we study the consequences of allowing the disutility of labor to depend on health, the influence from (exogenous) increases in education, and we discuss the implications of task-specific structural change. In the latter context we compare the health outcomes between blue collar and white collar occupations; the former is assumed to be more strenuous and less economically rewarding than the latter. The physical aspect of the task is captured by assuming a greater amount of health reducing environmental stress on blue collar workers. Unsurprisingly, we find that white collar workers live longer and experience more years in retirement. What is interesting, is that the model also captures that health differences between the two groups, founded during working life, continue to *diverge* after retirement, consistent with the evidence (Case and Deaton, 2005). Overall, the extensions show that human capital accumulation and structural change (in part by raising average wages) may have played a role in accounting for the rise of "the golden age".

The present paper is related to several strands of literature. Our work is related to the literature which models optimal health investments and longevity (e.g., Grossman, 1972; Ehrlich and Chuma, 1990). Kuhn et al. (2015) are particularly related as the authors develop a life cycle model where retirement is optimally determined, in the presence of life prolonging health investments. The authors explain how annuity markets (motivated by uncertain length of life) might lead to overinvestment in longevity, and discuss policy options to restore the first best. Wolfe (1985) and Galama et al. (2013) discuss the implications of retirement in the context of a Grossman (1972) model. In Wolfe (1985), however, retirement is

[2] Technically, technology improvement in our model means that any dollar amount of investment in health is more effective in slowing down the aging process. As a result, "technology" could be anything from improvements in health institutions to scientific discoveries leading to a better mode of conduct at the individual level (washing hands more often in response to the discovery of the germ theory, for instance) or breakthroughs that are more of the nature of "Big Medicine" (e.g., blood pressure controlling medicine).

[3] Empirically, wages appear to be stimulated by improvements in health. See Jaeckle and Himmler (2010) and Hokayem and Ziliak (2014).

[4] An implication is that rising income inequality will be associated with rising inequality in health and longevity, a prediction which is broadly confirmed in empirical studies (e.g. Pappas et al., 1993; Pijoan-Mas and Rios-Rull, 2014; Chetty et al., 2016).

[5] We also examine the impact of changes in the relative price of health investments. From an empirical standpoint, however, this relative price has – if anything – been on the rise during the period in question, which the model suggests works to lower life expectancy and age of retirement. As a result, the observed rise in age of retirement seems to derive from technological change. Moreover, our analysis suggests that the impact from prices on years in retirement appears to be modest.