Am I halfway? Life lived = expected life

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Abstract

We have reached halfway in life when our age equals our remaining life expectancy at that age. The trends over time and over populations with historical data are investigated. Period and cohort perspectives show increase in the age where halfway in life is found, however the pace of the increase is different. In a period perspective, when halfway-age is compared with life expectancy at birth, e0, a marked disparity in the tempo of change is observed: over the observed time e0 doubles while halfway increases by 25%. In a cohort perspective, as it is the case with life expectancy, cohort halfway-age is higher than period halfway-age. Our estimates of cohort halfway-age for the most recent birth cohorts result in a halfway-age of about 50 years for females, approximately 10 years older than the observed period halfway-age.

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Introduction

Life is a cycle and the desire of classifying its stages has always accompanied human beings. “All the world's a stage, and all the men and women merely players: they have their exits and their entrances; and one man in his time plays many parts, his acts being seven ages.” (Shakespeare 1599-1600). William Shakespeare, extraordinary interpreter of the deepest turmoils of the human soul, used this metaphor to indicate the parabola of life as a succession of seven stages, from birth to death.

But the desire of classifying the stages of life can be traced further back in time. Hippocrates described seven stages, each of them a multiple of 7 years: young boy until age 7, boy until 14, lad until 21, young man until 28, man until 49, elderly man until 56 and old men after 56, of which the 5th stage (man) represented the “prime of life”, the stage of the leadership (Overstreet 2009).

Stages of life are of interest to individuals, institutions and societies. For individuals life stages are meaningful for those wanting to plan their future, while for institutions and societies they help planning important factors such as retirement, social aid and education policies.

The painting shown as Figure 1 represents the stages of life according to an anonymous German painter, where a summit is reached halfway in life where the person is open-armed showing both the traversed path and the future trajectory. Through childhood, adolescence and the enthusiasm of young adulthood, life heads to its summit at the stage of maturity, before the descent towards death starts. Typically, the peak of this path is considered to be the middle stage, the stage between youth and old age, the prime of life, the age of maturity in a mental rather than biological way. Midlife is the prime of life when “our powers are at the highest point of development,” The New York Times declared in 1881, “and our power of disciplining these powers should be at their best.”

[Figure 1 here]

But what is the age of midlife? In the ancient Greek and Roman worlds, following Hippocrates classification, this stage would be placed approximately between ages 30 and 50. For the anonymous German painting shown in Figure 1 it is at age 50. Today, the literature in psychology, sociology and psychiatrics identifies the mid-life period in the range 40-60 (Golembiewski 1978, Dannefer 1984, Brown 1995, Willis and Reid 1998). Books are published (Cohen 2012), surveys are conducted (Midlife in the United States 2013) and newspapers’ articles are written (Cohen 2012, Cohen 2012) about this phenomenon that draws a lot of attention from the society and around which there seems to be a convergence of opinions around 50 as the starting age.

However, demographically speaking, mid-life means something very specific: it is the age that equals our remaining life expectancy at that age. Literally, it is the age when we are halfway, when we have lived half of our life and we can expect to live as much. Did the ancient societies and the anonymous

painter place this stage at the right point? Is the social perception of mid-life today right? Do people place the middle life at the right point of life, demographically speaking?

It must be pointed out that we don´t intend to confute the categorizations used by other disciplines, as they look at this phenomenon from different perspectives that require other definitions. Our aim is to bring into the midlife debate the demographic perspective as well.

Methods and Data

We refer to halfway in life when our age equals the remaining life expectancy at that age. Formally, this can be represented by the equation

$$x = e_x\,, \qquad (1)$$

where life expectancy is defined in terms of the survival function $\ell(x)$ as:

$$e_x = \frac{\int_x^\omega \ell(a)da}{\ell(x)}. \qquad (2)$$

Remaining life expectancy at age x can be expressed in terms of the mortality beyond this age as

$$e_x = \int_x^\omega e^{-\int_x^a \mu(y)dy} da, \qquad (3)$$

where $\mu(y)$ is the force of mortality at age y. Thus halfway-age is a measure that only focuses on mortality at ages above the halfway age.

The database used in this analysis is the Human Mortality Database (HMD 2014) . Using all the 1x1 life tables (single year and single age) available in the HMD we calculate for each life table the age when remaining life expectancy is equal to its age. Then, for each given year and all available populations, we calculate the mean of all the obtained halfway ages and their standard deviations. This is calculated independently for females and males as well as for period and cohorts life tables. The time span goes from 1816 to 1920 for cohorts (being 1816 the first year for which cohort information is available for at least two populations) and from 1850 to the year of 2010 for periods.

Results

Figure 2 shows the identity function for age and the decreasing function of remaining life expectancy by age for American females in the year 2000. The crossing of the two lines occurs at age 40 when the population has reached its halfway.

[Figure 2 here]

Similar to the halfway-age for American females in 2000, the halfway-ages are calculated for all the available years for USA on both female and male period life tables, as well as for all the countries included in the HMD. For each year, the mean halfway-age and its standard deviation are presented in Figure 3. In the Figure it is observable the increase in halfway-age for both females and males and since the band of standard deviation has remained constant across time we can conclude that all countries have transitioned in a similar way. However, while the female pace of increase seems invariant over the 160 years of observation, the male measure stagnates in the 1950s and, only after the 1970s it moves in a similar pace as their females counterparts.

[Figure 3 here]

Since halfway-age corresponds to a measure that mainly focuses on mortality in the second half of life, its trend over time differs from that of a measure that includes the entire age range as life expectancy at birth. Figure 4 shows the trend of the mean and standard deviations of halfway-age and life expectancy at birth for period life tables from 1850-2010. Life expectancy at birth in 1860 starts in the early forties, 41.7 years for females and 41.5 years for males, and not far below are the first halfway ages found at ages 33.4 and 32.4 respectively. At the end of the studied period, in 2010, life expectancy practically doubled, while halfway-age reached levels around age 41 for females and males (21.7% and 25.1% increase respectively).

[Figure 4 here]

Similar to Figure 3, we present now the combined halfway perspective of period and cohort life tables, as well as the standard deviations around the mean (see Figure 5). If only the last 20 years of each series are observed, there is a rapid increase in halfway-ages in both period and cohort measure, with an annual value of around 0.2%, with the exception of the males, whose period halfway-age shows a more accelerated pace of increase (0.3% annual increase), thus allowing them to catch up with their female counterparts.

[Figure 5 here]

Figures 6 presents the female gaps and lags between period and cohort perspective. As with life expectancy, also for the halfway-age the cohort measure is higher than the period measure in any given year. The linear increasing trend of the gap between cohort and period halfway-age can be extrapolated and used to assert a simplistic prediction on the halfway-age for cohorts born in 2010. In the most recent available years, the difference amounts to approximately 10 years. The mean cohort female halfway-age will be the result of adding to the period halfway-age in 2010 the predicted cohort-period gap. As shown in Figure 7, the predicted halfway-age for the 2010 cohort is 51.8 years.

[Figures 6,7 here]

Discussion

This paper analyzed the trend over time of the age that equals our remaining life expectancy at that age. We called this halfway-age.

The stage of midlife has always been considered an important step in the life of human beings. Classifications of stages of life existed in the ancient societies as well as in modern times. If, on one hand, these classifications share the idea of middle age as the "prime of life", on the other hand there is no agreement on which is the age or age-range that represents the middle phase. Between 30 and 50, 50, or between 40 and 60?

Novak and Palloni (2013) showed that in the USA, even though there are gender and racial differences, subjective survival probabilities in general are close to actual life tables. Do social perceptions of middle age and observed demographic patterns match as well?

In this study we observed that the halfway-age has been increasing over time, in both the period and cohort perspectives. Period halfway-age in 2010 resulted to be slightly above 40 for women and slightly below 40 for men, a value corresponding to lowest low bound of what is today considered as "middle life" by most of the socio-psychological and psychiatric literature (Golembiewski 1978, Dannefer 1984, Brown 1995, Willis and Reid 1998), which places this stage of life somewhere between 40 and 60. In general, the public debate seems to agree on the age 50 as the "division line", showing a tendency to overestimating this age compared to the demographic observation.

However, looking at the phenomenon from a cohort perspective (which represents the true life experience of individuals), we can see that social perceptions might be right. As it is the case with life expectancy, cohort halfway-age is higher than the period one. In fact, female cohorts born today might actually reach the middle point of the journey of life exactly around the age 50. It must be pointed out that this prediction is based on rather simplistic calculations and that this point deserves further analyses and careful investigation. Nevertheless, our results for the first time shed a demographic light on the important and strongly socially perceived concept of middle life.

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Appendix

We refer to halfway in life when our age equals the remaining life expectancy at that age. Formally, this can be represented by the equation $= e_x$, where life expectancy is defined in terms of the survival function as:

$e_x = \frac{\int_x^\omega \ell(a)da}{\ell(x)}$.

A similar function is obtained by rearranging the terms in the equality $x = e_x$ and asking for the age which solves for the maximum in the function

$$x\,\ell(x) - \int_x^\omega \ell(a)da = 0. \qquad \text{(A1)}$$

Although, we don't analyze in the main document any further equation (A1) we include in this appendix additional mathematical relations that derive from this alternative perspective.

Denoting the derivative with respect to age by a dot on top of the variable the maximum is obtained as

$$\ell(x) + x\frac{\dot{\ell}(x)}{\ell(x)}\ell(x) - \ell(a)[_x^\omega = 0, \qquad \text{(A2)}$$

or using the definition of force of mortality, as $\mu(x) = -\frac{\dot{\ell}(x)}{\ell(x)}$, and of the distribution of deaths, as $d(x) = \mu(x)\,\ell(x)$, equation (2) simplifies to

$$2\ell(x) - xd(x) = 0, \qquad \text{(A3)}$$

and the age that maximizes this is found at age $2\frac{\ell(x)}{d(x)} = x$, or the age that is equal to two times the inverse of its probability of death,

$x = \frac{2}{q(x)}$.

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Figure 1. The anonymous German painting of the stages of life.

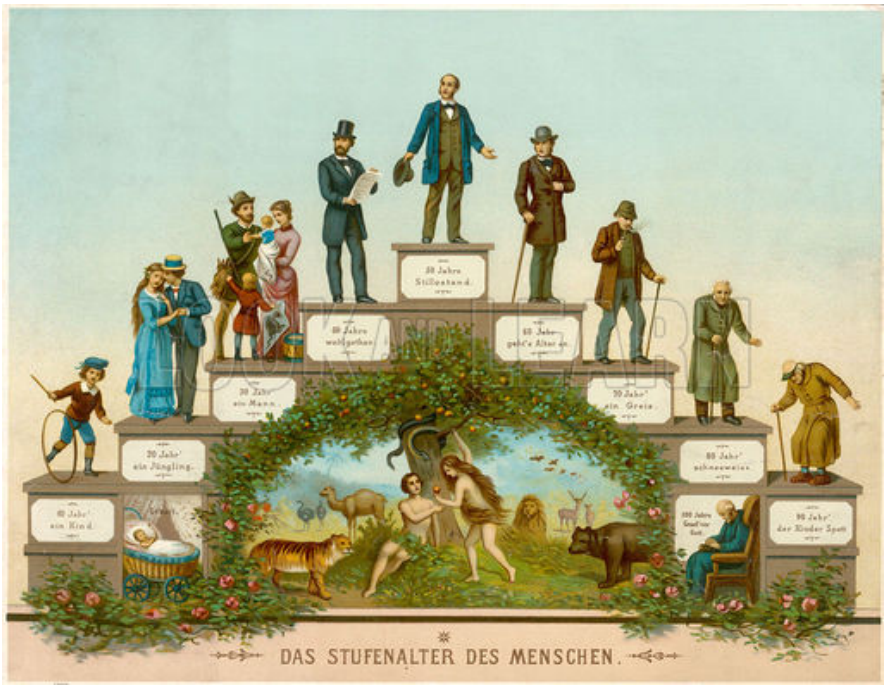


Figure 2. Halfway in life for females in 2000, USA.

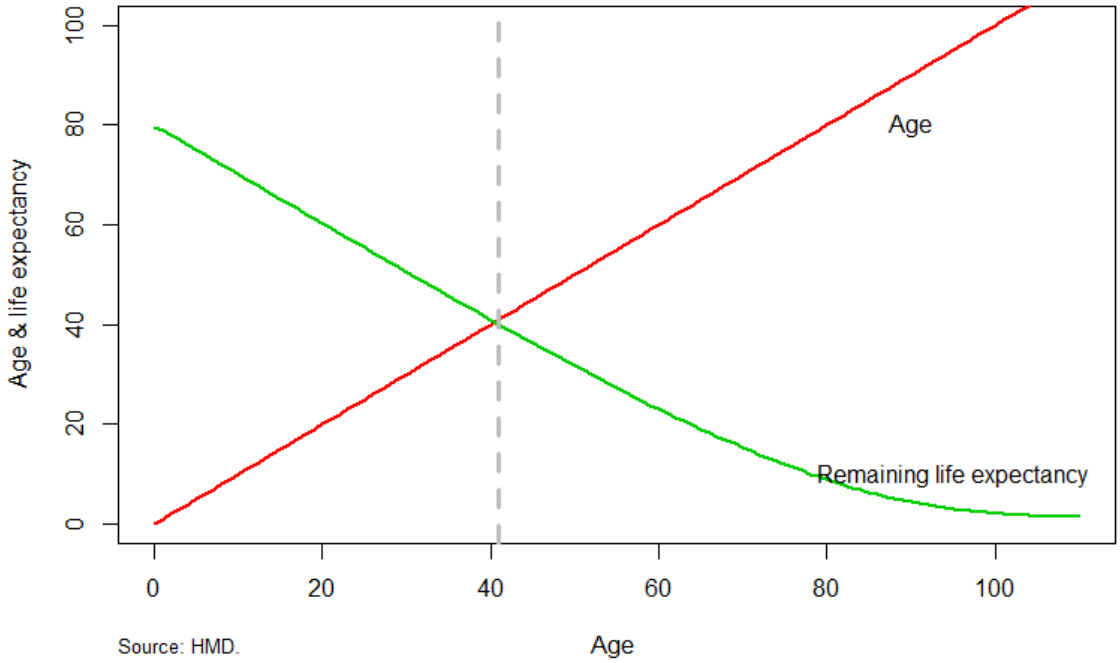


Figure 3. Female and male time trend of ages where life expectancy is the same as the life lived, life tables from HMD 1850-2010.

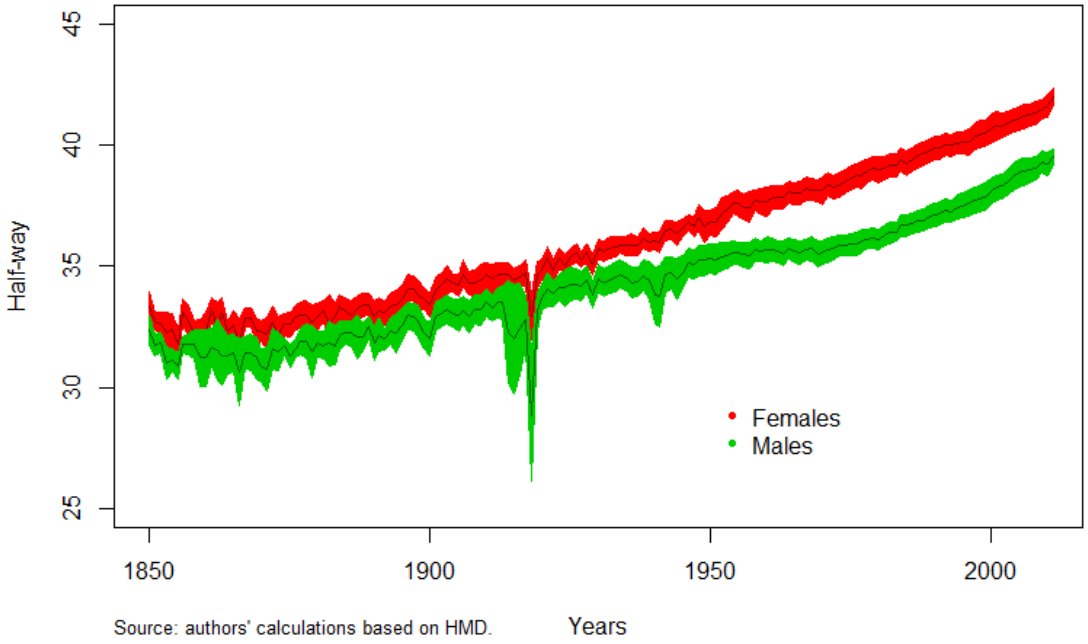


Figure 4. Female and male life expectancy at birth and halfway life, period life tables from HMD 1850-2010.

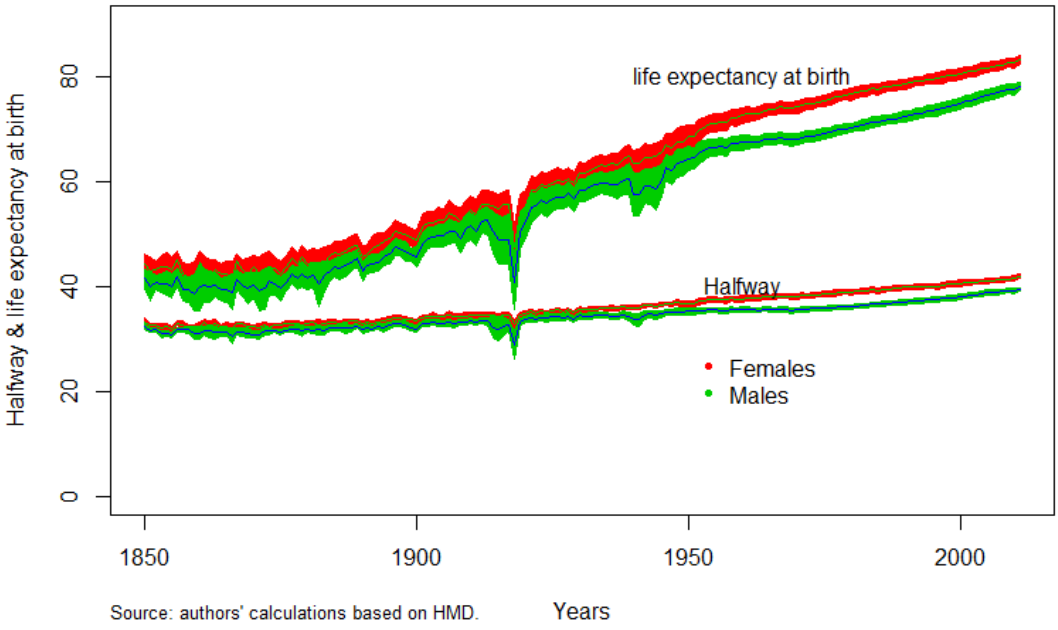
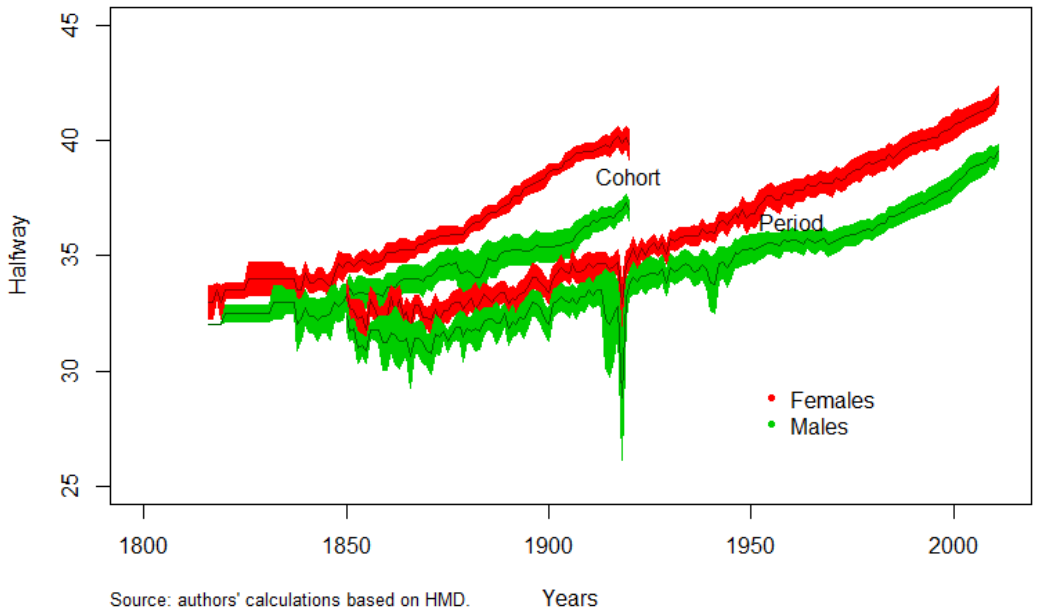
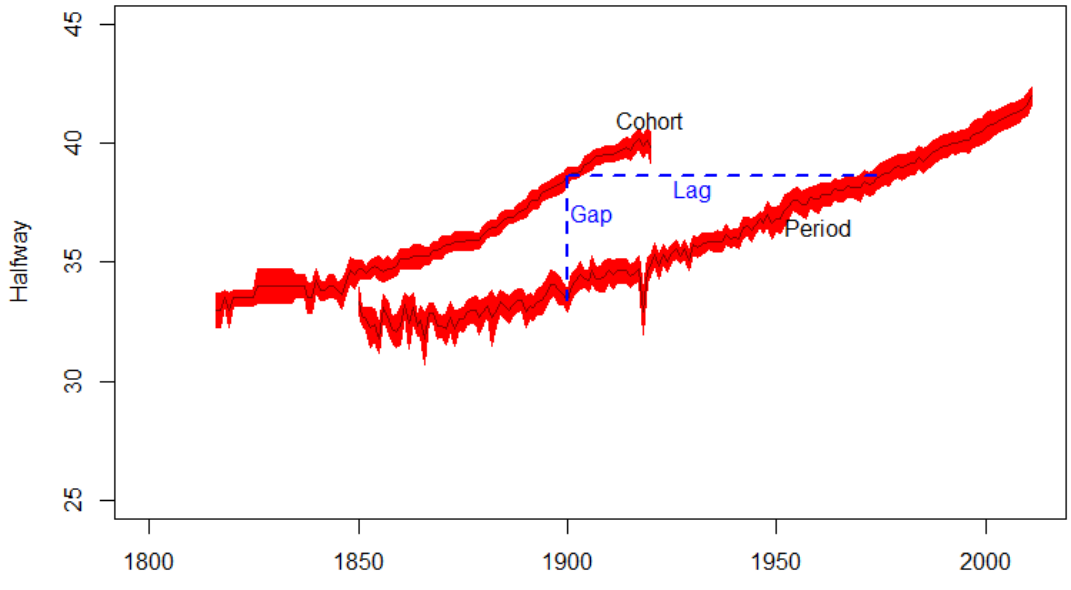


Figure 5. Female and male time trend of ages where life expectancy is the same as the life lived, life tables from HMD 1816-2010.



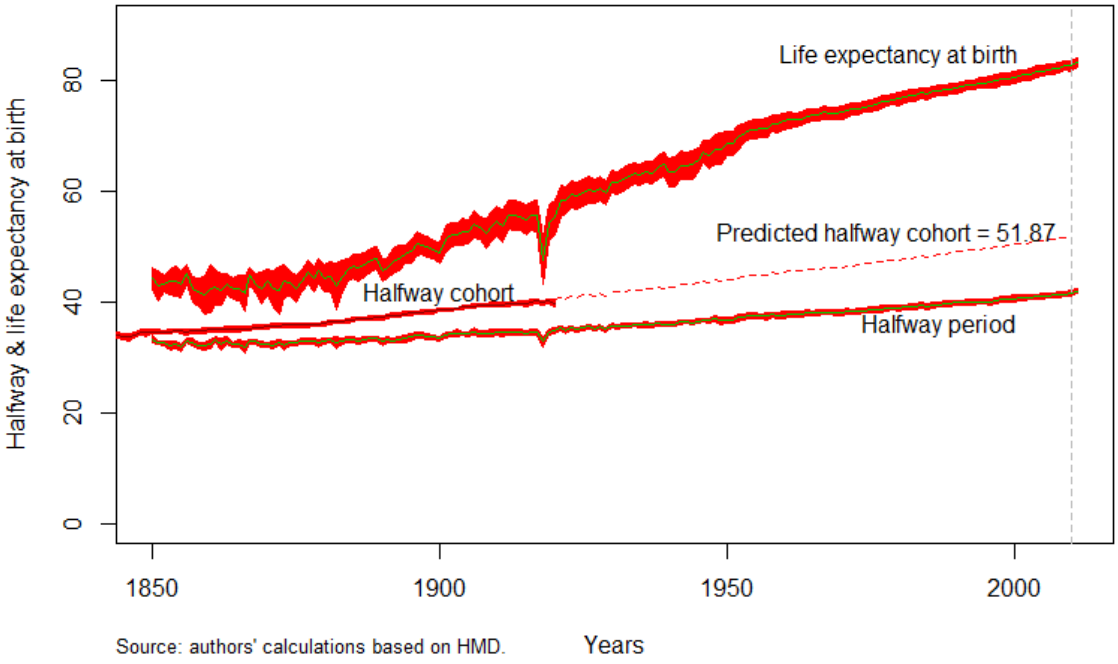
Source: authors' calculations based on HMD.

Figure 6. Female time trend of ages where life expectancy is the same as the life lived, in period and cohort life tables from HMD 1816-2010.



Source: authors' calculations based on HMD.

Figure 7. Female life expectancy at birth, period halfway age, cohort halfway age and predicted cohort halfway age from period and cohort life tables in HMD 1850-2010.



Source: authors' calculations based on HMD.