Demographic Changes and Social Discounting

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Abstract

This paper studies social discounting in the context of demographic transitions. We show how changes in population growth and age structure affect the social discount rate, giving rise to a *demographic premium*: the spread between the discount rate during a transition and that in a stationary environment. The premium is sizable and robust across a range of plausible assumptions about how consumption growth responds to demographic change. It is also larger for less developed and low-income countries, suggesting that long-term policy decisions requiring international cooperation are especially prone to tension and disagreement.

1 Introduction

Demographic projections for the next century predict low population growth and significant population aging. At what rate should policymakers discount future consumption during these demographic transitions? Addressing this question is crucial for long-term economic issues such as climate policy, healthcare reforms, and pension system design. This paper provides an answer using an overlapping generations framework with stochastic lifespans and a focus on non-stationary environments.

We characterize the social discount rate using the marginal rate of substitution between aggregate consumption today and in the future for a planner that cares about all generations. Our analysis centers on the demographic premium: the difference between the discount rate during a transition and that in a stationary environment. We show that while greater concern for the future lowers discounting, it also raises this premium when the demographic transition involves population aging. This occurs because stronger concern for the future also implies placing greater weight on younger cohorts, who become relatively fewer in an aging society, thereby raising the discount rate.

We quantify the demographic premium using United Nations and Social Affairs (2024) demographic data, and provide bounds that capture the uncertainty about how aggregate consumption growth tracks population growth along demographic transitions. We show that under current demographic trends, this premium is positive, large, and persistent. Moreover, it is larger for low-income and less-developed countries, reflecting the fact that they are expected to experience more drastic demographic transitions.

Our paper contributes to the literature on intergenerational social discounting, including Eden (2023), Quiggin (2012), Fleurbaey and Zuber (2015), and Schneider et al. (2012). Building on the insight of Eden (2023) that greater concern for the future increases the weight on younger cohorts, we show how population aging alters the social discount rate in an overlapping generations framework. Fleurbaey and Zuber (2015) analyze the social discount rate under a broad class of social evaluation functions but in a stationary setting. By focusing on non-stationary environments, we isolate a demographic component directly tied to observable population dynamics, while retaining the simplicity and transparency of the discounted utilitarian framework. This perspective complements risk-based explanations for horizon-dependent discounting (Weitzman, 1998; Gollier, 2002), while our perfect-foresight benchmark leaves open the treatment of demographic uncertainty. By focusing on a tractable, data-driven channel, we stay on the sidelines of the debate between descriptive and prescriptive approaches to long-term discounting, exemplified by Nordhaus (2007) and Stern (2008).

2 Conceptual Framework

Consider an infinite-horizon economy in which a new cohort is born every period. Each cohort is composed of a continuum of identical agents. Total population in period t is denoted by $\mathcal{P}_t$ and evolves over time as follows:

$$\mathcal{P}_{t+1} = (1 + n_{t+1})\mathcal{P}_t, \tag{1}$$

where n_{t+1} is the rate of population growth between t and $t+1$. We use h to denote the age of an individual. Agents are born with $h = 0$ and live for a maximum of $H + 1$ periods. The probability that an agent born in period t survives to age h is denoted $S_{h,t}$, with the convention that $S_{0,t} = 1$ for any t and $S_{h,t} = 0$ for any $h > H$.

We use $\mathcal{P}_{h,t}$ to denote the mass of population aged h in period t. The share of agents born in period t still alive at age h is exactly $S_{h,t}$, which implies:

$$\mathcal{P}_{h,t+h} = S_{h,t}\mathcal{P}_{0,t}, \tag{2}$$

for all h and t.

The share of population aged h in period t is:

$$\omega_{h,t} = \frac{\mathcal{P}_{h,t}}{\mathcal{P}_t} = \frac{S_{h,t-h}\mathcal{P}_{0,t-h}}{\mathcal{P}_t}. \tag{3}$$

and the vector $(\omega_{1,t}, \omega_{1,t}, ..., \omega_{H,t})$ represents the age distribution in period t.

We use $\mathbf{c} = \{c_{0,t}, c_{1,t}, ..., c_{H,t}\}_{t=0}^{\infty}$ to denote a consumption plan, which specifies consumption for each member of the age group h in every period t.

The expected lifetime utility that an agent born in period τ derives from $\mathbf{c}$ is:

$$U_\tau(\mathbf{c}) = \sum_{h=0}^{H} \beta^h S_{h,\tau} u(c_{h,\tau+h}), \tag{4}$$

where β denotes the private discount factor. We assume that $u(c) = c^{1-\gamma}/(1-\gamma)$.

3 Social Welfare

We consider a discounted utilitarian social welfare function, in the spirit of Calvo and Obstfeld (1988) and Arrow et al. (2004). The planner assigns cohort-specific Pareto weights according to:

$$W(\mathbf{c}) = \sum_{\tau=-H}^{\infty} \alpha_\tau U_\tau(\mathbf{c}), \tag{5}$$

with Pareto weights given by

$$\alpha_\tau = \frac{\delta^\tau \mathcal{P}_{0,\tau}}{\sum_{s=-H}^{\infty} \delta^s \mathcal{P}_{0,s}}, \tag{6}$$

where τ indexes a generation and $\tau \geq -H$. The generational discount factor, δ, represents how much society cares about the well-being of future generations and does not need to be the same as the private discount factor β. We assume that $\delta > \beta$ throughout.

This social welfare function can also be expressed in an alternative form, where the planner places weights directly on the members of different cohorts at each period :

$$W(\mathbf{c}) = \sum_{t=-\infty}^{\infty} \delta^t \mathcal{P}_t \sum_{h=0}^{H} \left(\frac{\beta}{\delta}\right)^h \omega_{h,t} u(c_{h,t}). \tag{7}$$

Therefore, assigning weights by birth date according to (6) is equivalent to treating individuals at different points in their lifetime as distinct selves. When $\delta > \beta$, the planner favors younger cohorts in the cross-section, and this bias increases with δ. Thus, greater concern for the future (higher δ) also implies greater concern for the young, as in Eden (2023).

4 Social Discounting

To study social discounting, we must first make explicit how aggregate consumption enters social preferences. Let $\mathbf{C} = \{C_t\}_{t=0}^{\infty}$ denote an aggregate consumption plan, and $\mathbf{b} = \{b_{0,t}, b_{1,t}, ..., b_{H,t}\}_{t=0}^{\infty}$ a generic cross-sectional allocation rule that satisfies $\sum_{h=0}^{H} \omega_{h,t} b_{h,t} = 1$

for all t. Any consumption plan $\mathbf{c}$ maps into a pair $\{\mathbf{C}, \mathbf{b}\}$ as follows:

$$C_t = \sum_{h=0}^{H} \mathcal{P}_{h,t} c_{h,t}, \tag{8}$$

$$b_{h,t} = \frac{c_{h,t}}{C_t / \mathcal{P}_t}. \tag{9}$$

for all h and t. Therefore, we can rewrite (7) as

$$W(\mathbf{C}, \mathbf{b}) = \sum_{t=-\infty}^{\infty} \delta^t \mathcal{P}_t \sum_{h=0}^{H} \left(\frac{\beta}{\delta}\right)^h \omega_{h,t} u\left(\frac{b_{h,t} C_t}{\mathcal{P}_t}\right). \tag{10}$$

We can use this representation to define the social discount rate. Consider a small investment in period t that increases aggregate consumption in $t+T$ by $(1+r_t(T))^T$ units. The planner is indifferent between undertaking the project or not if and only if

$$\left(1 + r_t(T)\right)^T = \frac{\partial W(\mathbf{C}, \mathbf{b}) / \partial C_t}{\partial W(\mathbf{C}, \mathbf{b}) / \partial C_{t+T}}. \tag{11}$$

This expression defines $r_t(T)$ as the social discount rate between periods t and $t+T$. Using (10), the indifference condition (11) yields

$$\left(1 + r_t(T)\right)^T = \frac{1}{\delta^T} \left(\frac{C_{t+T}}{C_t}\right)^{\gamma} \left(\frac{\mathcal{P}_{t+T}}{\mathcal{P}_t}\right)^{-\gamma} \frac{\Phi_t(\mathbf{b})}{\Phi_{t+T}(\mathbf{b})}, \tag{12}$$

where

$$\Phi_t(\mathbf{b}) \equiv \sum_{h=0}^{H} \left(\frac{\beta}{\delta}\right)^h \omega_{h,t} b_{h,t}^{1-\gamma}. \tag{13}$$

Demographic variables affect social discounting in two ways. First, positive population growth makes the planner less willing to discount the future. Intuitively, a larger population implies lower consumption per capita for future generations and, thus, a higher marginal utility of consumption. This creates an incentive to substitute current for future consumption, an idea that dates back to Ramsey (1928).

Second, demographic change operates through the term $\Phi_t(\mathbf{b})$, which captures the evolution of the age distribution over time. According to (12), a decline in this term raises the social discount rate, making the planner less willing to substitute current for future consumption. For illustration, consider the case $H = 1$, in which

$$\Phi_t(\mathbf{b}) = (1 - \omega_{1,t})\, b_{0,t}^{1-\gamma} + \omega_{1,t} \left(\frac{\beta}{\delta}\right) b_{1,t}^{1-\gamma}.$$

This expression shows that the evolution of $\Phi_t(\mathbf{b})$ hinges on both the cross-sectional allocation rule and the relative weight placed on younger cohorts through δ. In this case, aging makes Φ_t decline over time whenever

$$\delta > \left(\frac{b_{1,t}}{b_{0,t}}\right)^{1-\gamma} \beta.$$

That is, when the planner places sufficiently high weight on younger cohorts relative to older ones. As populations age, the relative size of younger cohorts declines, raising their consumption per capita and increasing the incentive to discount the future. This effect arises as long as the cross-sectional allocation rule is not excessively tilted toward older cohorts. The general case can be summarized as follows.

Proposition 1 (Aging and Social Discounting) *If $\delta > (b_{h+1,t}/b_{h,t})^{1-\gamma}\beta$ for all h and t, then a persistent rise in the share of older individuals increases the social discount rate.*

When $\delta > \beta$, it is easy to check that the condition in Proposition 1 is satisfied if resources are allocated optimally in the cross section.[1] A tractable alternative is the uniform allocation rule, $b_{h,t} = 1$ for all h and t, which also satisfies the condition. For the remainder of the paper, however, we focus on the special case of logarithmic preferences (corresponding to the limit as $\gamma \to 1$), which delivers the following result.

Proposition 2 (Log Preferences) *When preferences are logarithmic, the social discount rate is independent of the cross-sectional allocation rule.*

Thus, under log utility, the intertemporal trade-off depends only on aggregate consumption and demographic variables.

5 The Demographic Premium

We assess the quantitative importance of demographic change on social discounting by comparing the social discount rate implied by (12) with its stationary counterpart. Formally, we define the *demographic premium* between t and $t+T$ as $\varrho_t(T) \equiv r_t(T) - r^\star(T)$, where both $r_t(T)$ and $r^\star(T)$ are computed as in (12), with the latter assuming constant population growth and a stable age distribution. Log linearizing this expression yields

$$\varrho_t(T) \approx (g_t(T) - g^{ss}) - (\eta_t(T) - \eta^{ss}) - \mu_t(T), \tag{14}$$

where $g_t(T)$, $\eta_t(T)$, and $\mu_t(T)$ are the average growth rates of C_t, $\mathcal{P}_t$, and Φ_t between t and $t+T$, and g^{ss} and η^{ss} are the corresponding stationary growth rates.

Along a transition that involves population aging, Φ_t declines, so μ_t is negative, which increases the demographic premium and makes the planner discount the future more

[1] Under the welfare-maximizing allocation, $b_{h,t} = (\beta/\delta)^{h/\gamma} \,/\, \sum_{j=0}^{H} (\beta/\delta)^{j/\gamma} \omega_{j,t}$. This is the case studied in Eden (2023). For $\delta > \beta$, this rule tilts consumption toward younger cohorts.

heavily relative to a stationary environment. The next result establishes the main comparative statics of this premium.

Proposition 3 (Comparative statics on δ) *The demographic premium increases with δ when the transition involves population aging, and this effect is stronger the more drastic the aging process.*

In other words, while greater concern for the future normally reduces discounting, it also raises the demographic premium, since it entails more concern for younger cohorts, whose relative weight declines in an aging population.

To quantify this premium, one must take a stand on how aggregate consumption growth relates to population growth during demographic transitions. Establishing bounds grounded in economic theory helps capture the uncertainty surrounding this link and provides a robust and transparent range for the premium.

To formalize these bounds, we assume that the terms in (12) are consistent with the neoclassical growth model without productivity growth. For the lower bound, note that in steady state aggregate consumption growth equals population growth, $g^{ss} = \eta^{ss}$, while during a transition $g_t > \eta_t$ because consumption per capita rises as population growth declines. It follows that

$$\varrho_t(T) \geq -\mu_t(T) \equiv \underline{\varrho}_t(T).$$

For the upper bound, note that declining population growth also implies $g_t < g^{ss}$, so that

$$\varrho_t(T) \leq \left(\eta^{ss} - \eta_t(T) - \mu_t(T)\right) \equiv \bar{\varrho}_t(T).$$

These bounds provide a benchmark for how large the demographic premium can be, and we use them in the next section to assess the implications of ongoing demographic trends.

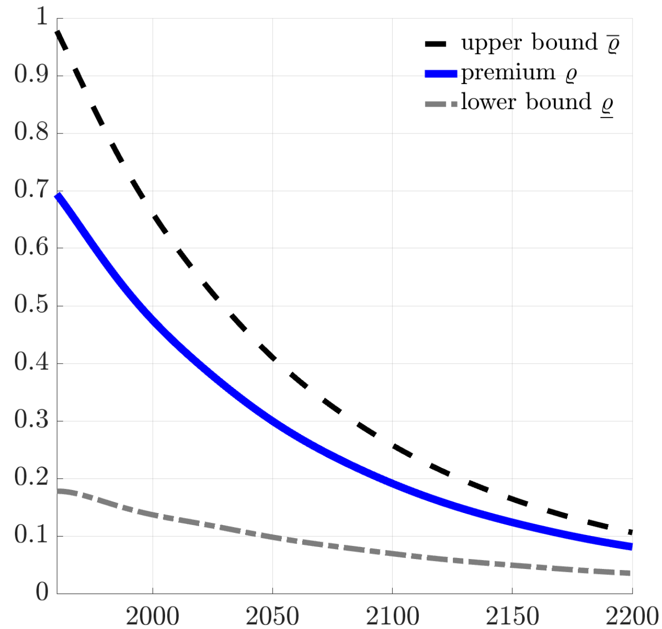
6 Implications of Current Demographic Trends

We now examine how observed demographic patterns translate into the demographic premium. Using data from United Nations and Social Affairs (2024), we parameterize demographic trends under the assumption that the first data point corresponds to a demographic steady state, while subsequent data describe a perfect-foresight transition. The details of our parameterization are provided in D.

We begin by setting $\beta = 0.96$ and $\delta = 0.985$, using standard values (see, e.g., Eden (2023) for a discussion), and adopting logarithmic preferences, in line with Proposition 2. We then use our parametrization of the transition to compute η_t and μ_t, and set $\eta^{ss} = n_t$, since averaging over a longer period would otherwise yield a smaller upper bound. These choices allow us to evaluate the bounds on the demographic premium.

Figure 1 displays the bounds corresponding to the 100-years-ahead social discount rates using global demographic data. It also includes the demographic premium calculated using (14) and assuming that g_t tracks the 30-year moving average of n_t. All series

Figure 1: Global Demographic Premium

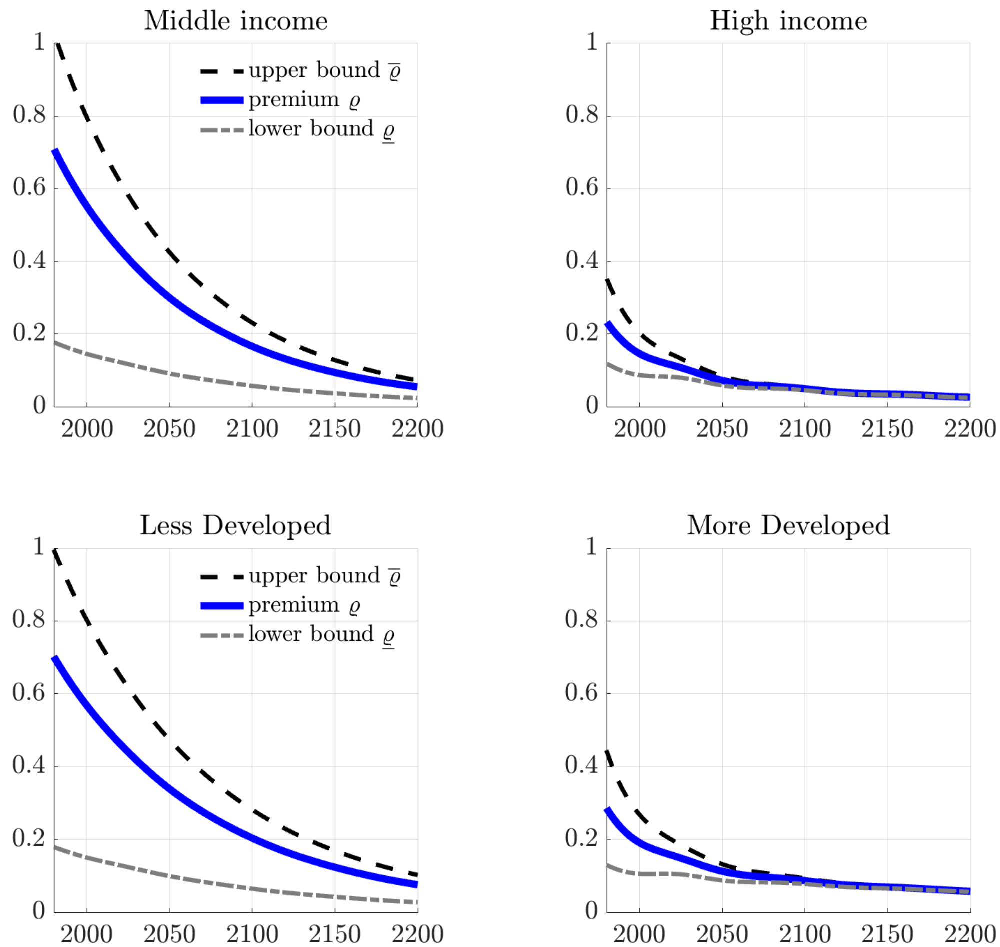


Notes: We set $\delta = 0.985$ and $\beta = 0.96$. We compute the bounds and the demographic premium using 100-years-ahead social discount rates. For the premium we assume that g_t tracks the 30-year moving average of n_t.

change discretely as the transition unfolds, and they converge back to zero in the long run as population growth stabilizes and the age distribution becomes stationary. During the transition, however, deviations from zero can be large and persistent. Since the lower bound isolates the contribution of aging, its size relative to the upper bound provides a measure of the importance of changes in the age distribution. According to the figure, these changes account for no less than 20% of the overall premium during the demographic transition.

Although the decline in the population growth rate and the increase in life expectancy appear to be global phenomena, the timing and pace of these changes vary substantially between countries. To assess the implications of these differences, in Figure 2 we show the bounds and the demographic premium classifying countries according to their income level and development stage. The premium decreases with development and income, reflecting the fact that more drastic demographic changes are expected in less developed and low-income countries. These economies are likely to discount the future more, considering current trends.

Figure 2: Regional Demographic Premium



Notes: We compute the demographic premium according to (14), using 100 years ahead social discount rates. In all cases, we set $\delta = 0.985$ and$\beta = 0.96$.

7 Conclusions

This paper shows that demographic change has a direct impact on social discounting and that the age distribution becomes relevant during demographic transitions. In particular, while greater concern for the future normally lowers discounting, demographic transitions involving population aging offset this effect through a positive and persistent demographic premium. This premium is larger in less developed and low-income countries, suggesting that during these transitions, policy decisions involving long-horizon investments and requiring international cooperation are especially prone to tension and disagreement.

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Appendix

A Proof of Proposition 1

First, note that $\delta > (b_{h+1,t}/b_{h,t})^{1-\gamma}\beta$ implies

$$\left(\frac{\beta}{\delta}\right)^{h} b_{h,t}^{1-\gamma} > \left(\frac{\beta}{\delta}\right)^{h+1} b_{h+1,t}^{1-\gamma}, \tag{15}$$

for all h and t. Then we can write

$$\Phi_t(\mathbf{b}) = \omega_{0,t} b_{0,t}^{1-\gamma} + \left(\frac{\beta}{\delta}\right) b_{1,t}^{1-\gamma}\omega_{1,t} + \cdots + \left(\frac{\beta}{\delta}\right)^{H} b_{H,t}^{1-\gamma}\omega_{H,t}.$$

Since the sequence in (15) is strictly decreasing in h, any reallocation of weight $\omega_{h,t}$ from younger to older cohorts strictly lowers $\Phi_t(\mathbf{b})$. Thus, for any cutoff age $\hat{H}$ defining older individuals, a persistent increase in their share reduces $\Phi_t(\mathbf{b})$ and raises the social discount rate.

B Proof of Proposition 2

With log preferences, the representation in (10) can be written as

$$W(\mathbf{C}, \mathbf{b}) = \sum_{t=-\infty}^{\infty} \delta^t \mathcal{P}_t \sum_{h=0}^{H} \left(\frac{\beta}{\delta}\right)^{h} \omega_{h,t} \left\{\log b_{h,t} + \log C_t - \log \mathcal{P}_t\right\}. \tag{16}$$

Rearranging terms yields

$$W(\mathbf{C}, \mathbf{b}) = \sum_{t=-\infty}^{\infty} \delta^t \mathcal{P}_t \Phi_t \log C_t + O, \tag{17}$$

where

$$\Phi_t = \sum_{h} \left(\frac{\beta}{\delta}\right)^{h} \omega_{h,t},$$

is independent of the cross-sectional allocation rule and O groups all the other terms. Thus, the intertemporal trade-off in (12) is independent of $\mathbf{b}$, which proves Proposition 2.

C Proof of Proposition 3

First note that the premium depends on δ only through μ_t. Therefore, differentiating $\varrho_t(T)$ with respect to δ yields

$$\frac{\partial \varrho_t(T)}{\partial \delta} = -\frac{\partial \mu_t(T)}{\partial \delta} = -\frac{1}{\delta T}\left(\frac{\sum_h \left(\frac{\beta}{\delta}\right)^h \omega_{h,t} h}{\Phi_t} - \frac{\sum_h \left(\frac{\beta}{\delta}\right)^h \omega_{h,t+T} h}{\Phi_{t+T}}\right) \tag{18}$$

Recall that $\Phi_t = \sum_h \left(\frac{\beta}{\delta}\right)^h \omega_{h,t}$. Each of the terms between parentheses can be interpreted as the *modified* mean age of the population at t and $t+T$, weighted by $(\beta/\delta)^h$. Because population aging implies a higher mean age in the future, the expression in parentheses is negative, so the effect of δ is positive. Moreover, a faster pace of aging increases the gap in modified mean ages, thereby amplifying the derivative and strengthening the effect.

D Parametrization of Demographic Transitions

We consider demographic transitions that involve both a change in the growth rate of the population and a shift in the survival probability profile that extends life expectancy. United Nations and Social Affairs (2024) contains data on both variables for the period 1950-2021 and projections for the period 2022-2100. We use 10-year moving averages for all series. To parameterize these transitions, we make assumptions about the evolution of these variables over time.

In the case of the growth rate of population, we postulate an auto-regressive process. Specifically, we assume that the population growth rate is initially stationary and equal to $\overline{\eta}$. Then, a demographic transition unfolds and the law of motion for the population's growth rate is:

$$\eta_{t+1} = (1-\rho_\eta)\eta^\star + \rho_\eta \eta_t, \tag{19}$$

for all t, with $\eta_0 = \overline{\eta}$ and where ρ_n measures the speed of the transition. We choose $\{\overline{\eta}, \eta^\star, \rho_\eta\}$ to minimize the sum of squared errors between the data and the process described in (19).

For the survival probability profile, we proceed in three steps. First, we approximate the data using a Weibull distribution. Specifically, we assume that:

$$S_{h,t} = 1 - F_t(h; \lambda, \kappa) \tag{20}$$

for all h and t, where:

$$F_t(h; \lambda, \kappa) = 1 - e^{-\left(\frac{h}{\lambda}\right)^\kappa}. \tag{21}$$

For each period, we choose λ and κ to minimize the sum of squared errors between the data and the profile described in (20). This delivers two time series for the two parameters of the Weibull distribution. We then postulate the following laws of motion:

$$\lambda_t = a_0 + a_1 t, \qquad \lambda_0 = \overline{\lambda} \tag{22}$$

$$\kappa_t = b_0 + b_1 t, \qquad \kappa_0 = \overline{\kappa} \tag{23}$$

for all t, We then choose a_0, a_1, b_0, and b_1 to minimize the sum of squared errors between the data and the time series for the two series generated in the previous step.

Finally, we implement the Lee–Carter procedure (see Lee and Carter (1992)) using mortality rates derived from the parametric survival profiles. The method projects age-specific mortality rates over time by combining a fixed age profile with a time-varying mortality index. We then convert the projected mortality rates back into survival probabilities, which we use in the main analysis.