The Care Wave: Macroeconomic Impact of Prevention and Provision

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Abstract

This paper develops an overlapping generations (OLG) model to assess the macroeconomic and social impacts of Europe's demographic transition, focusing on the retirement of the baby boomer generation and the rising demand for long-term care (LTC). As aging accelerates, two policy approaches are evaluated: preventive health measures aimed at reducing future LTC needs and expanding LTC insurance coverage to meet the immediate care demands. The model, calibrated to EU5 countries, explores the effects of these strategies on economic growth, inequality, and fiscal sustainability. The findings highlight the trade-offs between healthier aging, increased public spending, and the burden on younger generations, providing insights into balancing economic growth and equity as Europe faces the challenges of an aging population.

Keywords: Economic Growth, Income Inequality, Long-Term Care, Health
JEL Codes: I11 · I12 · I13 · I14 · J11.

1 Introduction

The onset of the 21st century marks an important demographic transition in Europe, characterized predominantly by the retirement of the 'baby boomer' generation. As this cohort gradually moves into retirement, with most individuals ceasing work between 60 and 65 years and self-assessing their health positively, a significant transformation is underway. This 'pension wave' has been the focal point of numerous studies analyzing retirement decisions and the ensuing transformation of pension systems in Europe's aging societies. However, a second, less explored transformation appears on the horizon: the 'care wave'. By the mid-2030s, the deteriorating health of the baby boomers will escalate the need for long-term care (LTC), impacting not only this generation but their children as well, and consequently influencing labor supply, saving behavior, economic growth, and social inclusiveness. The importance of understanding the 'care wave' stems from a sharp rise over the next decades in the population share of individuals aged 85 and older in the EU27 (Eurostat, 2021b). Hence, more older people will demand long-term care while fewer younger people can supply it. The 'care wave' comes from the gap or imbalance between the demand and supply of long-term care.

Two additional aspects reinforce this demographic change problem. First is that there are indications that the trend toward better health is stalling or even reversing, although with great heterogeneity within the European population (Börsch-Supan, Ferrari, & Salerno, 2021). This might threaten to increase even more the care needs in the future. Second, is that the female labor supply is still rising in all major European countries (Eurostat, 2021a). Furthermore, there is evidence that the gender pay gap (and, also, the gender pension gap) is decreasing (OECD, 2021). Pressures to supply more care may endanger this progress especially as women generally provide more frequent and longer hours of informal care than men ((Schmid et al., 2012), (Verbakel et al., 2017)). As the 'care wave' approaches, it becomes crucial to explore policies that address both the increasing care demands and the socioeconomic inequalities that may emerge.

In response to these demographic and social challenges, this research aims to assess the economic and social consequences of the 'care wave' and to evaluate two policy approaches designed to mitigate its impact: prevention of health deficiencies and provision of long-term care through insurance expansion. These policy strategies are modeled using an overlapping generations (OLG) framework, which builds upon existing models of population aging and economic impacts ((Auerbach et al., 1983), (Auerbach & Kotlikoff, 1987)), while extending the analysis to focus explicitly on health deficiencies, LTC needs, informal care provision and their macroeconomic effects, as outlined in Börsch-Supan et al. (2023).

The first strategy, health prevention, focuses on reducing future healthcare and LTC needs by improving health outcomes earlier in life, primarily through preventive health measures. By reducing the prevalence of chronic diseases and disabilities, preventive policies aim to lower the economic burden of aging, alleviate pressures on public health systems, and promote healthier, more independent aging. This strategy seeks to address the root causes of LTC needs, thereby delaying or reducing the costs associated with providing care in later life. The second strategy, provision of LTC, involves expanding LTC insurance coverage to address the immediate and growing care needs of the elderly population. This policy focuses on improving access to formal care services, reducing the out-of-pocket financial burden on households, and ensuring a more equitable distribution of care costs across the population. While expanding LTC insurance can improve access to care and reduce economic disparities, it also requires higher public expenditures, raising concerns about fiscal sustainability and the tax burden on younger generations.

The main innovation of this OLG model is its detailed examination of the trade-offs between financial sustainability, economic growth, and equality across generations characterized by significant heterogeneity. This heterogeneity includes variations in age, productivity, health deficiencies, life expectancy, and preferences for consumption and leisure. The model will be calibrated to reflect a mix of France, Germany, Italy, Sweden, and Poland (EU5), allowing for a detailed exploration of the impending care wave's effects in Europe. It seeks to answer critical questions: Can prevention policies mitigate the economic burden of rising LTC needs? What are the trade-offs between economic growth and equity? How do prevention and LTC provision policies impact economic inequality across and within generations, and implicit tax rates?

This research explores several critical hypotheses related to Europe's aging population, the rising demand for LTC, and the macroeconomic and social impacts of the care wave: The first hypothesis posits that increasing LTC needs, driven by an aging population, will decelerate economic growth across OECD countries. This slowdown could result from higher social spending on healthcare and LTC services (Connolly & Li, 2016), reduced labor force participation due to caregiving responsibilities (Lee & Shin, 2021), and a heavier financial burden on younger generations (Kitao, 2014) in the form of higher taxes and social security contributions. Additionally, expanding LTC insurance coverage could impose significant fiscal pressures, leading to increased government deficits if not managed carefully ((Beqiraj, Fedeli, & Forte, 2018), (Alinaghi & Reed, 2021)). However, health prevention policies may mitigate this slowdown by improving labor productivity, reducing healthcare costs, and delaying LTC needs, thus sustaining higher economic growth for a longer period.

The second hypothesis suggests that escalating LTC expenditures will disproportionately impact lower-income households in Europe, exacerbating economic inequality. Higher LTC costs, if not addressed through expanded public coverage, could deepen the socioeconomic gradient in healthcare access ((Devaux & De Looper, 2012), (Thomson, Cylus, & Evetovits, 2019)), with wealthier households better positioned to afford private care (Carrieri, Di Novi, & Orso, 2017). Meanwhile, lower-income groups may rely more heavily on informal care, which can limit their participation in the labor market ((García-Gómez, Hernández-Quevedo, Jiménez-Rubio, & Oliva-Moreno, 2015), (Rodrigues, Ilinca, & Schmidt, 2018), (Tenand, Bakx, & Van Doorslaer, 2020)). Expanding LTC insurance coverage may reduce these inequalities by providing greater public support to vulnerable populations, but it risks shifting the financial burden to younger generations through higher taxes, increasing intergenerational inequality. On the other hand, health prevention policies may alleviate these disparities by promoting healthier aging across socioeconomic groups, reducing the overall demand for care, and fostering greater equality in health outcomes.

The third hypothesis examines the trade-offs between the fiscal sustainability of LTC systems and the implicit tax rate borne by younger generations. The PAYG-DB pension system, already strained by demographic shifts, may face additional challenges as LTC needs rise. Expanding LTC insurance could increase public expenditures and push the implicit tax rate higher, burdening younger generations with the cost of supporting an aging population. However, preventive health measures could offer a more fiscally sustainable alternative by reducing LTC needs and healthcare costs, potentially stabilizing or even lowering the implicit tax rate over time.

There is a growing literature exploring the rising demand for LTC in areas such as saving behavior ((Lockwood, 2018), (Bueren, 2023)), formal and informal care ((Carrino, Orso, & Pasini, 2018), (Barczyk & Kredler, 2019), (Perdrix & Roquebert, 2022)), the effects of informal care on labor market outcomes (Løken, Lundberg, & Riise, 2017) and the importance of informal care (Barczyk & Kredler, 2018).[1] However, current models may not fully capture the complexities of behavioral responses to changing care needs and especially the different aspects of its macroeconomic implications.

This OLG model will give us a clear way to understand the macroeconomic impact of Europe's aging population, particularly in terms of healthcare and long-term care. A major benefit of this model is to show the financial impact of healthcare and LTC for people of different ages. This means that rising LTC costs might require higher taxes for working people or less money for retirees to spend. Furthermore, it is especially useful in understanding how caregiving responsibilities can affect labor supply and the economy. Without these extensions, the model would miss key elements like the escalating healthcare and LTC costs, leading to incomplete and potentially misleading economic forecasts. This model stands out from others by integrating these critical aspects, offering a more comprehensive picture of the economic impact of the Care Wave. The remainder of the document is structured as follows: Section 2 details the model and its components. The policy simulations are presented in section 3 and the conclusion in section 4.

2 Model

This overlapping generations model extends the Auerbach and Kotlikoff (1987) type, building on Börsch-Supan et al. (2023). It enhances the social security system to include detailed public pension, health, and long-term care pillars. Integrating health and long-term care is crucial, recognizing that aging leads to declining health and increased care needs. This model adapts to reflect the interplay between aging, health, and economic support systems, influencing individual decision-making. Like Börsch-Supan et al. (2023),

[1] Klimaviciute and Pestieau (2023) provides an overview of the economics of long-term care.

it includes a discrete endogenous retirement choice alongside continuous leisure/work and consumption/saving trade-offs.

2.1 Households

Within each cohort, there are K different types of perfectly foresighted households at every point in time t with age j. These households exhibit ex-ante heterogeneity, meaning initial differences in their productivity, consumption/leisure preferences, survival probabilities, and health deficiencies.[2] The households receive utility from consumption $c_{t,j}^k$ and leisure $l_{t,j}^k$. The utility function is twice continuously differentiable, strictly increasing in consumption and leisure, and strictly concave and is given by:

$$u(c_{t,j}^k, l_{t,j}^k) = \frac{1}{1-\theta}\Big[\big(c_{t,j}^k\big)^{\phi_j^k}\big(l_{t,j}^k\big)^{1-\phi_j^k}\Big]^{1-\theta} \quad (1)$$

where ϕ_j^k captures the individual's intra-temporal preference between consumption and leisure at age j for a type k individual. It dictates how the individual trades between consumption and leisure when maximizing their utility. If ϕ_j^k is high, the individual strongly prefers consumption over leisure. This parameter will dictate how the individual allocates time between labor and leisure at each age, given their wage rate, health status, and time providing informal care. θ determines the inverse of the individual's intertemporal elasticity of substitution. This determines how willing the individual is to substitute consumption over different periods, or in other words, how the individual is willing to smooth consumption over time.

The households are subject to different constraints: monetary and time constraints. The monetary or budget constraint is given by

$$a_{t+1,j+1}^k = a_{t,j}^k\,(1+r_t) + h_{t,j}^k\,w_{t,j}^k(1-\tau_t) + p_{t,j}^k - c_{t,j}^k - (1-\eta^m)\,m_{t,j}^k - (1-\eta_j^n)\,n_{t,j}^k \quad (2)$$

where $a_{t,j}^k$ denotes assets. Wages depend on age and household type, $w_{t,j}^k = w_t\,\epsilon_j^k$ where ϵ_j^k generates age and type-specific wage profiles. $p_{t,j}^k$ are pension benefits. Furthermore, $m_{t,j}^k$ and $n_{t,j}^k$ are the total health and LTC medical expenses obtained from the health status, and η^m and η_j^n are the shares of the medical expenses covered by the health and LTC public insurance respectively. This means that $(1-\eta^m)$ and $(1-\eta_j^n)$ are the shares of the medical costs that the individual pays. From labor income, τ_t is the contribution rate of the social security system which combines public pension, health, and long-term care systems $\tau_t = \tau_t^p + \tau_t^h + \tau_t^{ltc}$. The time endowment per period is normalized to one. Leisure $l_{t,j}^k$ is equal to time endowment minus hours worked $h_{t,j}^k$, minus the share of time spent in providing care Λ_j^k. The time constraint is expressed as:

$$l_{t,j}^k = 1 - h_{t,j}^k - \Lambda_j^k \quad (3)$$

[2]The different types of household profiles are detailed in the Appendix A.4.

2.1.1 Health Deficiency

At the core of this OLG model lies a crucial component: the health deficiency process. Health is a key determinant of an individual's quality of life and economic decisions, especially in later years. It is modeled here as the lack of health with detailed attention to health deterioration over time. A deterministic health deficiency profile χ_j^k is determined by:

$$\chi_j^k = \beta_0^k + \beta_1^k e^{\beta_2^k age_j^k} \tag{4}$$

This model portrays the aging process and non-linear health deficiency evolution. Key parameters include β_1^k and β_2^k, representing the scale and acceleration of health decline, respectively, while β_0^k indicates baseline health influenced by genetics and environmental factors. A lower β_0^k suggests a healthier start. Using health deficiencies as a stock χ_j^k helps understand LTC needs, reflecting the cumulative nature of health changes. This approach facilitates projecting health and LTC expenditures, as each marginal increase in χ_j^k correlates with higher costs. This stock-based approach aligns with the model's focus on LTC needs linking to chronic illnesses and gradual health deterioration, enhancing its predictive power. The need for long-term care services arises in later life when an individual's health deficiency χ_j^k meets or exceeds a specified threshold $\bar{x}$. This threshold is reached at varying ages due to differences in health profiles; individuals with poorer health cross the LTC threshold earlier than those with better health.

2.1.2 Health and LTC Expenditures

In the OLG model, health (m_j^k) and long-term care (n_j^k) expenditures reflect the financial implications of an individual's health deficiency. Health expenditures are always present in the budget constraint, while LTC expenditures appear only if $\chi_j^k \geq \bar{x}$. These terms are included in the individual's budget constraint, equation 2, and are quantified as follows:

$$m_j^k = \theta_0^m + \theta_1^m \cdot \chi_j^k \tag{5}$$

$$n_j^k = \theta_0^n + \theta_1^n \cdot \chi_j^k \quad \text{if} \;\; \chi_{t,j}^k > \bar{x}, \; 0 \text{ otherwise} \tag{6}$$

The health deficiency status χ_j^k for individuals of type k and age j is used to calculate health and LTC costs via the cost functions 5 and 6. Parameters θ_0^m and θ_0^n represent the base cost, covering minimum expenses even when health deficiencies are zero, such as preventive care and check-ups. Parameters θ_1^m and θ_1^n capture direct cost increases as health declines. The inclusion of quadratic terms is crucial for depicting the progressive nature of health and LTC costs. As individuals age, the diagnosis of multimorbidities in chronic diseases increases ((McPhail, 2016), (Barnett et al., 2012)), complicating treatments and raising costs ((Cortaredona & Ventelou, 2017), (Buja et al., 2020)). These multimorbidities are linked to higher healthcare utilization and social care costs among older adults (Picco et al., 2016). This non-linear behavior is implicitly included with the health deficiency index, enhancing the model's ability to capture the nuances of health deterioration and its impact on LTC expenses over time.

2.1.3 Provision of Informal Care

The provision of informal care to parents depends on the health deficiency profile of the parent, denoted by $\chi^k_{j+d,p}$. This profile reflects the health condition of the parent when the child is at age j and the parent is d years older than the child. The amount of care provided by the child, represented by Λ^k_j, indicates the average hours that a person devotes to caring for their parents. The care provision by a child at age j for a parent in household type k is given by:

$$\Lambda^k_j = \theta^c_0 + \theta^c_1 \cdot \chi^k_{j+d,p} \quad if\ \chi^k_{j+d,p} \geq \bar{x},\ 0 \text{ otherwise} \tag{7}$$

where, θ^c_0 represents the base level of care provided regardless of health status, reflecting social norms or obligatory care levels. θ^c_1 captures the linear increase in care hours as parental health deteriorates. Additionally, as the model is based on the parental health deficiency profile, nonlinear behavior is also included. This model realistically represents caregiving behavior, considering caregiver capacity limits or shifts to professional care at advanced health deterioration stages.

Since informal care Λ^k_j depends on the parental health deficiency profile, there are three different informal care profiles derived from equation 7. For example, individuals with parents in excellent health will start providing care later than those with parents in poor health. The model assumes household heterogeneity, or type k, is consistent across generations, maintaining characteristics like high productivity in descendants, contributing to the model's dynastic nature.

2.1.4 Household Recursive Problem

Figure 1 presents a simplified guide to the household life cycle, showing different stages. Households are divided into working and retirement stages. From age 20 to R, depending on their endogenous decisions for retirement R, individuals work and, thereafter, receive retirement pensions. They also provide care to the previous generation. Based on the deterministic health deficiency process, care needs arise when $\chi^k_j \geq \bar{x}$. This threshold is set to match the prevalence rates of LTC needs rising exponentially after 80 years of age ((Fuino & Wagner, 2018a), (Fuino & Wagner, 2018b)). Consequently, individuals start providing care to parents around the age of 50 and continue until their parents are out of the model, around the children's age of 70. After that, individuals await their own care needs.

A different way to understand these dynamics and the life cycle of individuals is by detailing their recursive problem. At time t, an individual of type k of age j solves a dynamic programming problem. The state space at the beginning of age j is $a^k_{t,j}$ and the value function is given by $V(a^k_{t,j})$. From 20 to around 50 years of age, the agent only works, and the remaining time is spent on leisure activities. Moreover, the agents are

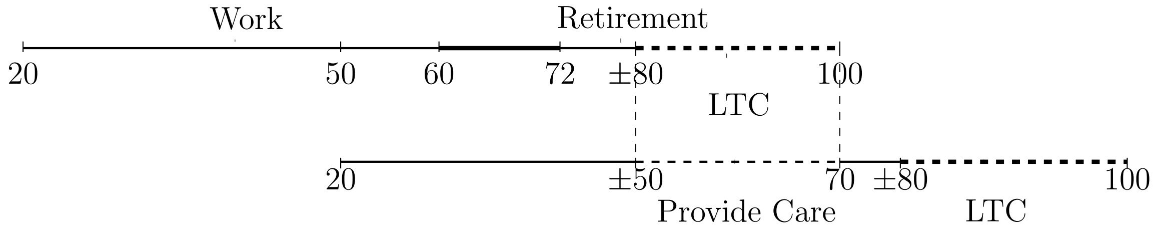


Figure 1: The Life Cycle of an Individual

not expected to provide care, as the previous generation is still young and does not need care. For individuals in this period, the Bellman equation is:

$$V^k_{t,j}(a^k_{t,j}) = \max_{c^k_{t,j},l^k_{t,j}} \left\{ u(c^k_{t,j}, l^k_{t,j}) + \beta \pi^k_{t+1,j+1} V^k_{t+1,j+1}(a^k_{t+1,j+1}) \right\} \tag{8}$$

where β represents the discount factor, which measures the individual's preference for consuming goods and enjoying leisure today rather than in the future, and $\pi^k_{t+j,j}$ the survival probabilities. This Bellman equation is constrained by

$$l^k_{t,j} = 1 - h^k_{t,j} \tag{9}$$

$$a^k_{t+1,j+1} \; = \; a^k_{t,j}\,(1 + r_t) \; + \; h^k_{t,j}\, w^k_{t,j}(1 - \tau_t) \; - \; c^k_{t,j} \; - \; (1 - \eta^m)\, m^k_{t,j} \tag{10}$$

From when parents need care, around 50 years of age of the child, until their retirement decision R is endogenously made, individuals are still in their working stage, so they receive labor income. Their time is divided between working and leisure and providing care to their parents. The Bellman equation for individuals in this stage is:

$$V^k_{t,j}(a^k_{t,j}) = \max_{c^k_{t,j},l^k_{t,j}} \left\{ u(c^k_{t,j}, l^k_{t,j}) + \beta \pi^k_{t+1,j+1} V^k_{t+1,j+1}(a^k_{t+1,j+1}) \right\} \tag{11}$$

subject to

$$l^k_{t,j} = 1 - h^k_{t,j} - \Lambda^k_j \tag{12}$$

$$a^k_{t+1,j+1} \; = \; a^k_{t,j}\,(1 + r_t) \; + \; h^k_{t,j}\, w^k_{t,j}(1 - \tau_t) \; - \; c^k_{t,j} \; - \; (1 - \eta^m)\, m^k_{t,j} \tag{13}$$

A Feature of this model is the endogenous retirement decision R^k_t. Households choose to retire within a "window of retirement" denoted by $R_E \leq R^k_t \leq R_L$, where R_E is the earliest eligibility age for retirement and R_L is the latest. The retirement age chosen by the household is a by-product of the main optimization routine. From the age of the decision R^k_t to when $\chi^k_j < \bar{x}$, the retirement period starts for individuals. They no longer receive labor income but retirement pensions. Their time is spent now in leisure activities and in providing care to their parents. In this stage, individuals do not spend time working as they are retired. Their Bellman equation in this stage is:

$$V^k_{t,j}(a^k_{t,j}) = \max_{c^k_{t,j},l^k_{t,j}} \left\{ u(c^k_{t,j}, l^k_{t,j}) + \beta \pi^k_{t+1,j+1} V^k_{t+1,j+1}(a^k_{t+1,j+1}) \right\} \tag{14}$$

subject to

$$l_{t,j}^k = 1 - \Lambda_j^k \tag{15}$$

$$a_{t+1,j+1}^k \;=\; a_{t,j}^k\,(1+r_t) \;+\; p_{t,j}^k \;-\; c_{t,j}^k \;-\; (1-\eta^m)\,m_{t,j}^k \tag{16}$$

Individuals after retirement, from when $\chi_j^k \geq \bar{x}$ to 100 years of age, need LTC services. Thus their budget constraint includes the term $n_{t,j}^k$ to pay for $1-\eta^m$ of the care services. Additionally, their time endowment is fully spent on leisure activities. The Bellman equation at this final stage is:

$$V_{t,j}^k(a_{t,j}^k) = \max_{c_{t,j}^k,l_{t,j}^k} \left\{ u(c_{t,j}^k, l_{t,j}^k) + \beta\pi_{t+1,j+1}^k V_{t+1,j+1}^k(a_{t+1,j+1}^k) \right\} \tag{17}$$

subject to

$$l_{t,j}^k = 1 \tag{18}$$

$$a_{t+1,j+1}^k \;=\; a_{t,j}^k\,(1+r_t) \;+\; p_{t,j}^k \;-\; c_{t,j}^k \;-\; (1-\eta^m)\,m_{t,j}^k \;-\; (1-\eta_j^n)\,n_{t,j}^k \tag{19}$$

2.2 Government

The model abstracts from a reserve fund and debt such that the budget equation is assumed to be balanced in each year:

$$\tau_t w_t \sum_{k=1}^{K}\sum_{j=1}^{R_t^k} \epsilon_j^k h_{t,j}^k N_{t,j}^k = \underbrace{\sum_{k=1}^{K}\sum_{R_t^k+1}^{J} p_{t,j}^k N_{t,j}^k}_{Pension} + \underbrace{\sum_{k=1}^{K}\sum_{j=1}^{J} \eta^m m_{t,j}^k N_{t,j}^k}_{Health} + \underbrace{\sum_{k=1}^{K}\sum_{j=1}^{J} \eta_j^n n_{t,j}^k N_{t,j}^k}_{LTC} \tag{20}$$

where τ_t is the sum of contribution rates of all the branches of the social security system $\tau_t = \tau_t^p + \tau_t^h + \tau_t^{ltc}$ and $N_{t,j}^k$ represents the number of people aged j at time t and in household-type k. Additionally $m_{t,j}^k$ and $n_{t,j}^k$ are the health and LTC medical expenses, and η^m and η_j^n are the shares of the medical expenses covered by the health and LTC insurance respectively. If the government's budget is not balanced, the τ_t might need to be adjusted, cut benefits, or consider other sources of revenue or borrowing.

The pension system is a defined benefit (DB) pay-as-you-go (PAYG) pension system and follows Börsch-Supan et al. (2023). DB means that a cohort of retirees is promised a pension benefit $p_{t,j}^k$, which is defined by a replacement rate b_t that is set by the pension policy and not necessarily dependent on the demographic and macroeconomic environment. The contribution rate to the system is then adjusted to keep the PAYG system balanced. Individual pension benefits $p_{t,j}^k$ are given by:

$$p_{t,j}^k = \gamma_{R_t^k}^k \cdot b_t \cdot w_t \bar{h}_t \cdot \frac{s_{t,R_t^k}^k}{R_t^k} \tag{21}$$

where $w_t\bar{h}_t$ denotes average earnings. The earnings points $s_{t,j}^k$ represent the pension claims that are accumulated in a career average plan, and $s_{t,R_t^k}^k/R_t^k$ is the number of pension points at retirement age R_t^k, averaged over the working life. $\gamma_{R_t^k}^k$ adjusts pension benefits to the chosen retirement age. These adjustment factors counterbalance a longer or shorter duration of receiving pension benefits if households retire before or after the full pensionable age. $\gamma^k_{R^k_t}$ equals 1 if the household retires at the full pensionable age. If the household decides to retire earlier, there is a deduction of pension benefits for every year of earlier retirement. For each year of delayed retirement, there is a premium. A detailed description of this public pension system is found in Börsch-Supan et al. (2023).

2.3 Firms

The production sector consists of a representative firm. Production is given by a Cobb-Douglas production function using capital stock, K_t, and aggregate labor, L_t, as inputs.

$$Y_t = K_t^\alpha \, (A_t \, L_t)^{1-\alpha} \tag{22}$$

A_t is technology (growing at a time-varying rate g_t). α is the capital share in the economy. Since factors earn their marginal product, wage, and rates of return for capital are given by

$$r_t = \alpha k_t^{\alpha-1} - \delta \tag{23}$$

$$w_t = A_t(1-\alpha)k_t^\alpha \tag{24}$$

where k_t denotes the capital stock per efficient unit of labor, $k_t = \frac{K_t}{(A_t L_t)}$, and δ is the depreciation rate. Equilibrium is reached when supply equals demand in all relevant markets.

2.4 Model Parameters and Calibration

In this model, there are k different types of perfectly foresighted households at every point in time t with age j. This means, that the model considers a combinatorial product of heterogeneities across the four different dimensions. The initial total number of unique household types would amount to 81. These different profiles and their connections are summarized in Figure 2. To make the process more efficient, the best approach to solve the model is to select a specific mix of household types out of the 81 possibilities. This selection is designed to capture the most important correlations effectively without overly complicating the computational process. This would mean that in the model, the final number of household types is to be reduced from 81 to only 24 possibilities. The shares of each household type are obtained using SHARE data. The household types excluded from the computation of the model are the ones with a small sample share. This allows a comprehensive mix of ex-ante heterogeneity that encapsulates a wide spectrum of household k to ensure a more detailed analysis.

Households enter the model and the labor market at age 20, with a maximum lifespan of 100 years. Parents have children at age 30, linking generations through informal care. Thus, when a child enters the model at age 20, their parents are 50. Demographic

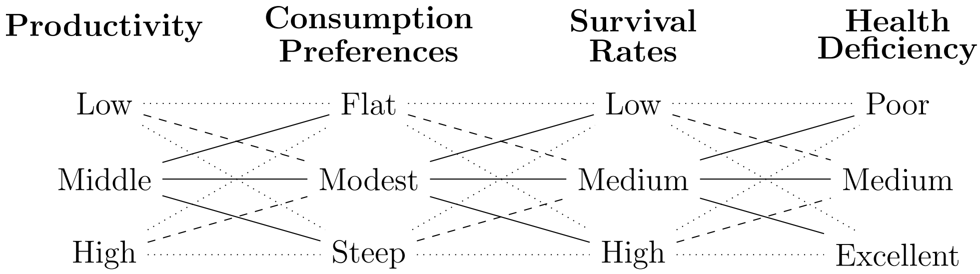


Figure 2: Household Types

factors are exogenous, defined by cohort population size, survival rates, and net migration changes. The population size at age j in period t is given by $N_{t+1,j+1} = N_{t,j} \cdot \psi_{t,j}$, where $\psi_{t,j}$ is the age-specific survival rate. The initial cohort size $N_{c,0}$ depends on the fertility of women aged k at time $c = t - j$, expressed as $N_{c,0} = \sum_{k=0}^{\infty} f_{c,k} N_{c,k}$. The model captures population aging through three components: longevity increases (ψ), the transition from baby-boom to baby-bust (changes in $f_{c,k}$), and current/future low fertility levels ($f_{c,k}$). Population data, age distributions, and projections for fertility, mortality, and migration rates are sourced from the (Human Mortality Database, 2016) for the EU5.

On the side of individual preferences, the intra-temporal elasticity parameter between consumption and leisure, which defines the preferences for consumption ϕ_j^k and its decline, as seen in Figure A3, is calibrated to match pension expenditures. The discount rate, ρ, is calibrated to match the consumption-output ratio (Frederick, Loewenstein, & O'donoghue, 2002). Lastly, the inverse of the intertemporal elasticity of substitution (IES) parameter, θ, is set to 2 (Conesa et al., 2009).

The age for early retirement, $R_E = 60$, is selected due to the earlier legal retirement age for women in several European countries (Organisation for Economic Co-operation and Development (OECD), 2019). While there is no legal upper bound for late retirement, it is set $R_L = 70$ as the latest retirement age for computational ease. Due to the weighted average value of current adjustment rates in the EU5 countries, $\omega = 3.2\%$ is assumed. On the firm side, the capital share, α, in the economy is assumed to be 0.33 (King & Rebelo, 1999). The annual productivity growth is set to its actual average values before 2017 using data from the Penn-World tables and set to 1.5% after 2017 (Feenstra et al., 2015). Lastly, the depreciation rate of capital is calibrated to match the capital-output ratio (Christiano et al., 2005).

2.4.1 Health and LTC Coverage

Based on the details in section A.1, LTC eligibility in the model is approximated by covering individuals when $\chi_j^k \geq \bar{x}$. The parameter $\bar{x}$ determines the LTC necessity and it is set to match the exponential rise in LTC prevalence after age 80 ((Fuino & Wagner, 2018a), (Fuino & Wagner, 2018b)), resulting in $\bar{x} = 0.19$.

To translate the LTC benefits of the EU5 into the OLG model, eligibility is based on care dependency levels. A simple framework with categories of mild, moderate, and severe dependency is created to provide variation in dependency levels. Mild dependency involves assistance with some daily activities like housekeeping or transportation. Moderate dependency requires more substantial help with personal care and possibly some medical monitoring. Severe dependency involves extensive or total care, often for individuals who are bed-bound or have significant impairments. Thresholds for dependency levels are set using χ_j^k: mild starts at $L1 = 0.19$, moderate at $L2 = 0.29$, and severe at $L3 = 0.39$. These categories are illustrated in Figure 3.

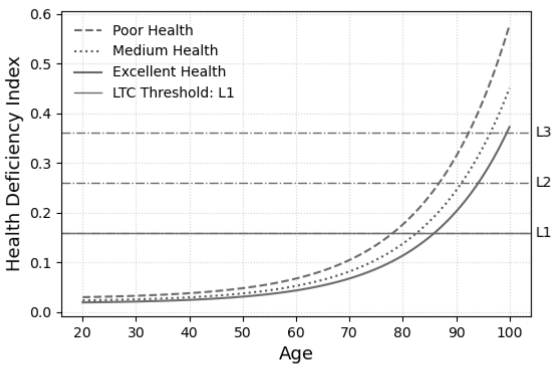


Figure 3: Health Deficiency Profiles with Levels of Care Dependency

Source: Author's calculations.

According to Figure 3, individuals will reach different levels of care dependency at varying ages. The share of LTC services covered by public insurance, η_j^n, is determined by the care dependency level, with three distinct values. Based on Rothgang (2010), in 2007, the average co-payment share for LTC in Germany was 22% for mild, 26% for moderate, and 33% for severe dependency. Thus, η_j^n values are 0.78 for mild (L1), 0.74 for moderate (L2), and 0.67 for severe (L3). The share of health expenses covered by public insurance, η^m, is constant at 88%, reflecting the average inpatient costs covered by government or compulsory insurance across the EU (OECD & Union, 2020).

2.4.2 Health and LTC Costs

Health and LTC expenditure parameters from equations 5 and 6 are derived using wave 6 of SHARE data. Health expenditures are based on the question: "How much did you pay yourself for doctor visits, medication, hospital stays, and dental care in the last twelve months without reimbursement?". The information related to LTC expenditures is extracted from: "How much did you pay for at-home care or nursing home stays in the last twelve months without reimbursement?". These questions capture only out-of-pocket expenses. Using this out-of-pocket health (OOP^m) and LTC (OOP^n) expenditure data, the total expenditure values are calculated:

$$m_j^k = \frac{OOP_j^m}{(1 - \eta^m)} \tag{25}$$

$$n_j^k = \frac{OOP_j^n}{(1-\eta_j^n)} \tag{26}$$

This approach assumes a linear relationship between out-of-pocket costs and total costs, proportional to insurance coverage rates η^m and η_j^n. This transformation facilitates the estimation of parameters from equations 5 and 6. Parameter values are obtained by regressing total health or LTC expenditures on the health deficiency index, ensuring empirical foundations. The parameters for total health expenditures are $\theta_0^m = 0.08$ and $\theta_1^m = 0.005$, and for total LTC expenditures are $\theta_0^n = 0.561$ and $\theta_1^n = 0.016$. The results are summarized in Table 1.

Table 1: Summary of Estimation: Health and LTC Expenditures

	Health	LTC
Health Deficiency Index	0.005**	0.016**
	(0.002)	(0.007)
Constant	0.083***	0.561**
	(0.014)	(0.228)
Observations	45945	1909

Note: Standard errors in parentheses. Significance levels are denoted as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The data uses sampling weights. Standard errors are heteroskedastic robust. Control variables include: income, age, and country effects. Additional control variables for LTC include: age squared and number of siblings. Control variables are not reported for brevity.

2.4.3 Informal Care Parameters

Regarding the informal care profile presented in equation 7, the parameters θ_0^c and θ_1^c, can be estimated using data from the time expenditure, demographics, and networks modules in wave 8 of SHARE. The hours of informal care are derived from the question: "How much time did you spend yesterday helping your parents or parents-in-law?" This includes tasks like administrative chores, washing, dressing, and medical visits. Parental health information comes from: "How would you describe the health of your mother/father?". The estimation of these parameters is presented in table 2 and the values are $\theta_0^c = 0.32$ and $\theta_1^c = 0.20$.

The transformed total cost of LTC in equation 26 represents the 'Formal Care' component in the model, which, when combined with the 'Informal Care' provided by children, gives us the total 'Care Received' for individuals with LTC needs at each time period t. The total 'Care Received' balances the provision of care with the total needs for LTC of the older generation. The adjustment needed to properly add formal and informal care is to transform the total formal care into hours. To accurately represent the 'Formal Care' component in terms of hours within our model, the total LTC expenditures (formal care costs) are converted into an equivalent number of care hours. The transformation

Table 2: Summary of Estimation: Informal Provision of Care

	Informal Care
Parental Health	0.208***
	(0.026)
Constant	0.322**
	(0.129)
Observations	4125

Note: Standard errors in parentheses. Significance levels are denoted as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The data uses sampling weights. Standard errors are heteroskedastic robust. Control variables include: income, and country effects. Control variables are not reported for brevity.

of formal care costs into care hours is accomplished by dividing the total formal LTC expenditure by the average hourly rate for formal caregiving services. This rate should reflect the average cost of hiring a professional caregiver in the EU5. This hourly rate is taken as the minimum wage for workers in the LTC sector and it is average between non-medical and medical care providers. This value sets in 13.97 euros per hour (Geyer et al., 2023). This approach ensures that both formal and informal care components are expressed in a common unit (hours), facilitating to obtain the balance between the care provided formally and informally, and the care received by the parents.

2.5 Main Calibration Targets

The structural parameters of this model are calibrated to match the most important simulated moments of the model to their empirical counterparts for the year 2017. A prototypical country is considered in this model, a synthetic aggregation of the population data from the five largest continental European countries (France, Germany, Italy, Sweden and Poland) called EU5. The model calculates different weighted average moments as targets for calibration. For instance, the capital-output ratio, consumption-output ratio, average hours worked, and the pension system's expenditures with pension payments as a percentage of GDP. Two additional targets related to the social security pillars will be added: health and LTC expenditures as a percentage of GDP. Lastly, to evaluate the informal care outcomes of the model, it is included the time provision of care as percentage of time in a year.

An overview of the values of the parameters obtained from the literature is presented in Table A5 in the Appendix. Based on these parameters and estimation procedures, Table 3 is presented to show how well the model matches the main moments of the data. The comparison between the model outcomes and real-world data from 2017 shows how closely the model approximates key macroeconomic indicators, specifically for the EU5 countries.

Table 3: Calibration Targets

	2017 Data	**Model**
Capital-output ratio	3.10	3.47
Consumption-output ratio	0.75	0.79
Average hours worked	0.64	0.65
Pension expenditure (% of GDP)	13.2	15.0
Health expenditure (% of GDP)	9.74	8.97
Long-term care expenditure (% of GDP)	1.61	2.43
Time providing care (% of Year)	2.10	2.17

Note: Author's calculations.

2.6 Baseline Results

This section examining baseline macroeconomic indicators and inequality measures. The figures present the evolution of GDP growth, inter and intra generational inequality, and the implicit tax rate.

2.6.1 GDP Growth

Figure 4 presents the evolution of the GDP growth rate from the 1950s until the projected future in 2050. The GDP growth rate follows a cyclical pattern, peaking at around 2.5% in the early 1980s before declining sharply, reaching a low point around 2010. This trend reflects major economic disruptions during this period, such as the global financial crisis. The recovery after 2020 is notable, though the growth rate remains below the historical peak, stabilizing at around 1.5% in the long run. These results suggest a slowing economy over time, driven in part by demographic shifts and an aging population that contributes to slower labor force growth and productivity gains.

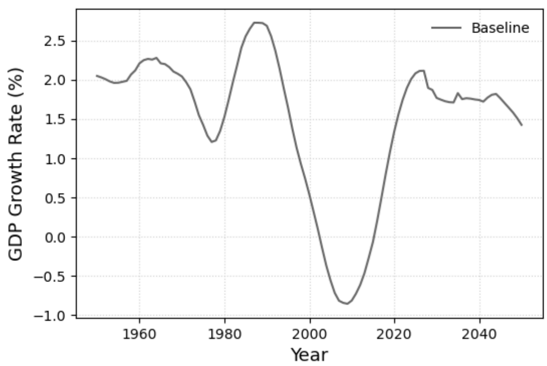


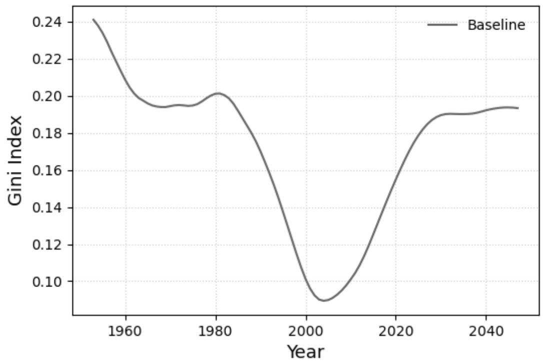
Figure 4: Baseline Result: GDP Growth

Note: Author's calculations.

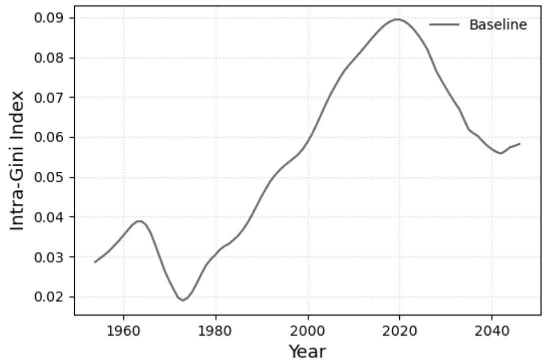
The projections of the model start around 2020, and it can be observed that the growing provision of care may contribute to the reduction in GDP growth. This aligns with the hypothesis that increasing LTC needs are decelerating economic growth. The rising demand for healthcare and LTC services, coupled with reduced labor force participation due to caregiving responsibilities, likely contributes to this slowdown. Additionally, the financial burden on younger generations, who face higher taxes and social security contributions, might exacerbate the economic deceleration. These factors suggest that the provision of care is having a tangible impact on the trajectory of GDP growth.

2.6.2 Income Inequality

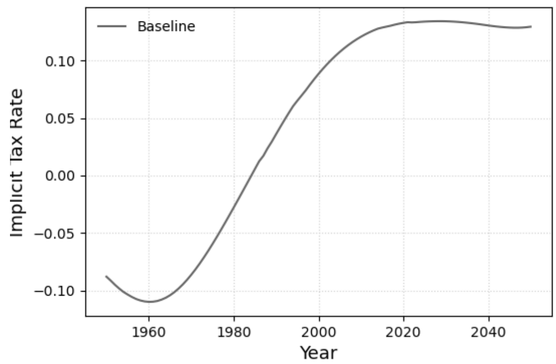
Figure 5 illustrates different dimensions of income inequality to provide a general view. Figure 5a shows intergenerational inequality as measured by the Gini index across age cohorts. After 2020, intergenerational inequality steadily increases. This reflects the growing economic divide between younger and older generations, with older generations benefiting from accumulated wealth and social security, while younger cohorts face increasing financial pressures. These pressures are likely exacerbated by rising long-term care LTC needs, as higher public spending on healthcare and pensions diverts resources away from younger generations.



(a) Inter-Income Inequality



(b) Intra-Income Inequality



(c) Implicit Tax Rate

Figure 5: Baseline Results: Income Inequality

Note: Author's calculations.

Figure 5b shows the trend in intra-generational inequality, as measured by the intra-Gini index. This measure reflects inequality within each generation, capturing disparities in income and wealth among individuals of the same age cohort. The intra-Gini index steadily increases from the 1950s through the early 2020s. This suggests that inequality within generations has been worsening over time. After peaking, the index begins to decline, but it remains elevated, indicating that despite some improvements, significant intra-generational inequality persists. The reason for the reduction might be attributed to several demographic changes. As the population ages and more individuals retire, income disparities narrow due to more uniform retirement incomes. Additionally, declining birth rates and smaller younger cohorts reduce competition for jobs and resources, contributing to more balanced outcomes. Improved longevity and health allow for longer working lives, helping individuals accumulate wealth more evenly. Lastly, shifts in family structures and the redistribution of wealth through generational transfers may further reduce disparities within age cohorts.

Figure 5c shows the evolution of the implicit tax rate, which is central to understanding the dynamics of the PAYG-DB pension system. The sharp increase in the implicit tax rate from the 1950s to the early 2000s reflects the growing financial strain on the system, largely driven by demographic shifts, such as an aging population and increasing life expectancy. The implicit tax rate represents the balance between contributions made during individuals' working years and the benefits they can expect to receive upon retirement. A negative rate in earlier decades indicated that individuals were receiving more in benefits than they contributed, creating a net gain. However, the transition to a positive implicit tax rate suggests that newer generations are now contributing more than they will receive, effectively bearing a higher burden of supporting the system. This shift highlights the increasing financial pressure on the working population to sustain the pension benefits of retirees. The stabilization of the rate in recent decades indicates that the system may have reached a new, less generous equilibrium, where contributors face a higher implicit "tax" on their labor compared to previous generations. This stabilization reflects efforts to manage the system's sustainability in response to demographic and policy changes, though it continues to impose a significant fiscal load on current workers.

3 Prevention versus Provision of Care

As demographic changes increase the demand for long-term care (LTC), two policy approaches are considered to address this challenge. The first focuses on improving population health through preventive measures, while the second explores expanding LTC insurance coverage to enhance access to care. Both strategies aim to mitigate the financial and social impact of aging populations on healthcare systems, but they tackle the problem from different angles.

3.1 Increasing Health Preventive Measures

An approach to addressing the rising demand for LTC is to focus on preventive health measures, which aim to reduce the need for costly treatments and care services by addressing health issues earlier in life. Unlike increasing LTC insurance coverage, which deals with the financial burden of care, preventive health efforts target the root causes of future healthcare needs by promoting healthier aging. In this model, preventive health measures primarily relate to cost savings. By preventing or delaying the onset of chronic diseases and disabilities, these measures reduce the overall burden on the healthcare system, leading to more efficient resource use. This approach helps alleviate the pressure on public spending by decreasing the need for expensive treatments and extended LTC services in later stages of life.

Beyond cost savings, preventive health measures aim to improve health outcomes for the population. By fostering healthier lifestyles and reducing the prevalence of preventable conditions, such as obesity, diabetes, and hypertension, these interventions can extend life expectancy and improve the quality of life for older individuals. Healthier aging might reduce reliance on LTC and promote independence, helping to mitigate the strain on healthcare systems in aging societies. Moreover, by addressing health disparities and improving access to preventive care for underserved populations, preventive measures contribute to a more equitable healthcare system. A healthier population is also more productive. Although the broader economic benefits of health prevention—such as reduced absenteeism and greater workforce stability—are acknowledged, this research focuses specifically on the effects of preventive measures during old age, particularly their impact on LTC needs.

In the simulations conducted, the model explores how reducing health deficiencies could mitigate LTC needs across different household types. Simulation 1 applies a uniform reduction in health deficiencies, decreasing each household type's health deficiency profile by 5%. This assumes a generalized improvement in preventive care outcomes, reducing frailty and LTC dependency uniformly across the population. Simulation 2, on the other hand, applies differentiated reductions to reflect targeted interventions for individuals with varying health statuses. Specifically, household types with poor, medium, and excellent health reduce their health deficiencies by 7%, 4%, and 1%, respectively. These simulated improvements demonstrate the potential impact of various health prevention policies aimed at different groups. By lowering health problems as people age, these preventive efforts highlight the potential for healthier aging and reduced LTC costs across diverse household profiles.

3.1.1 GDP Growth under Health Prevention

Figure 6 illustrates the projected GDP growth rate under the baseline scenario, as well as the two simulations aimed at reducing health deficiencies. The baseline model indicates a sharp and immediate reduction in GDP growth following the demographic shifts after 2020, as the population ages and the demand for long-term care increases. This decline reflects the economic burden of an aging population, reduced labor force participation, and increased social spending on healthcare and pensions.

However, the two simulations present a different trajectory. Both simulations, which introduce health preventive measures that reduce health deficiencies, show an initial boost

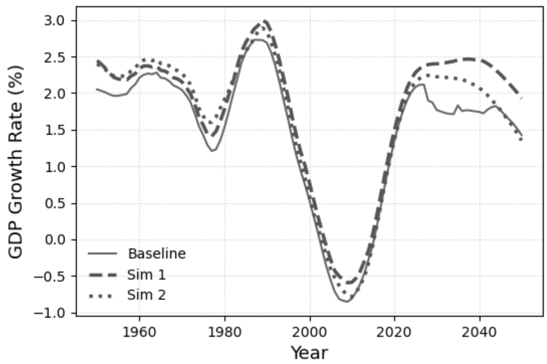


Figure 6: Health Prevention: GDP Growth

Note: Author's calculations.

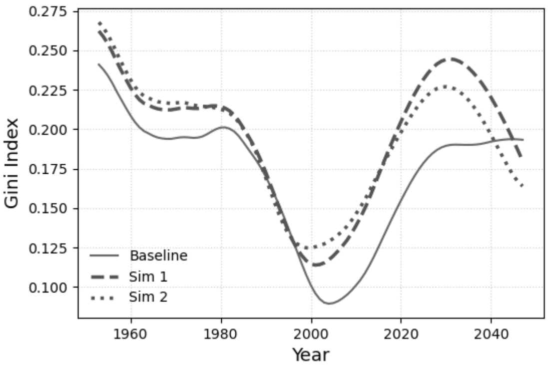
in GDP growth compared to the baseline. Under simulation 1, GDP growth remains higher for an extended period, sustaining a notable advantage over the baseline until the late 2030s. In simulation 2, which applies targeted reductions in health deficiencies, the impact on GDP growth is more nuanced but still positive. Similar to simulation 1, GDP growth remains elevated compared to the baseline, although the improvement is slightly more modest. The targeted interventions still contribute to healthier aging, and the economic benefits persist into the mid-2030s. The long-term benefits of a healthier aging population manifest in greater productivity and reduced pressure on healthcare systems, which delay the economic slowdown caused by an aging society.

3.1.2 Income Inequality under Health Prevention

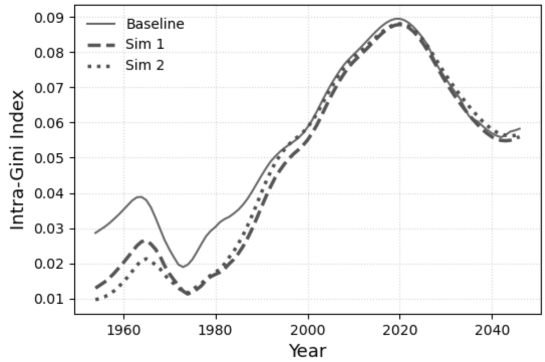
Figure 7a shows the evolution of the intergenerational inequality. Under the baseline, intergenerational inequality is projected to increase steadily after 2020, reflecting the growing wealth disparity between older and younger generations as the population ages. However, both simulations, which introduce health preventive measures, show a permanent reduction in the Gini coefficient compared to the baseline. This suggests that preventive health policies, by improving overall health and reducing the need for long-term care, help redistribute resources more evenly across generations.

Figure 7b presents the intra-Gini index, which measures inequality within generations. While both simulations initially show a reduction in intragenerational inequality, the results indicate that by the mid-2030s, all scenarios, including the baseline, begin to converge toward similar levels of inequality. This outcome suggests that while preventive health policies can reduce disparities within generations in the short term, these effects may diminish over time. As the population ages and long-term care needs become more prevalent, the pressures of caregiving and healthcare costs appear to balance out, causing the convergence seen across the baseline and simulated scenarios.

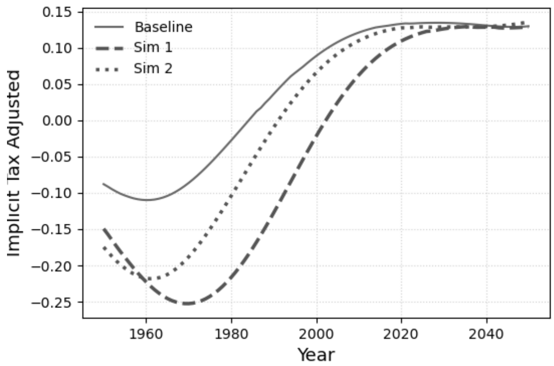
Finally, Figure 7c illustrates the evolution of the implicit tax rate. Initially, previous generations benefit significantly from the PAYG-DB system, as indicated by the more negative implicit tax rates in simulations 1 and 2 compared to the baseline. This reflects the short-term advantage provided by preventive health policies, which delay the financial strain of the aging population and allow younger generations to contribute less relative to the benefits they receive. However, by the mid-2040s, all scenarios converge, showing that while preventive health policies can provide short-term relief, the long-term fiscal pressures of the PAYG-DB system persist. This convergence underscores the broader challenge of sustaining pension and healthcare systems in the face of demographic change, despite the temporary advantages introduced by preventive health measures.



(a) Inter-Income Inequality



(b) Intra-Income Inequality



(c) Implicit Tax Rate

Figure 7: Health Prevention: Income Inequality

Note: Author's calculations.

3.2 Mechanisms under Health Prevention

The results observed in GDP growth and income inequality under Simulations 1 and 2 can be better understood by examining the underlying mechanisms driving these outcomes, as shown in Table 4. Both simulations, which introduce preventive health measures, lead to a notable improvement in economic performance and a reduction in inequality, relative to the baseline. The changes in key indicators such as the capital-output ratio, health expenditure, long-term care expenditure, and time spent providing care illustrate how preventive health policies affect the economy's productive capacity, labor participation, and the distribution of resources.

The capital-output ratio increases in both simulations. The reduction in health deficiencies allows individuals to remain healthier for longer. As a result, fewer resources are needed for healthcare and LTC, freeing up more capital for productive investments. This boosts the economy's long-term growth potential, leading to higher GDP growth compared to the baseline.

These dynamics also help explain the changes in consumption-output ratios. Both simulations show a decrease in the consumption-output ratio, as healthier populations require less spending on healthcare and LTC, allowing for more savings and investment. In Simulation 1, this shift is more pronounced, leading to a greater reduction in consumption relative to output. In Simulation 2, the targeted approach results in smaller reductions in health expenditures, contributing to a slightly higher consumption-output ratio than in Simulation 1. This difference in resource allocation helps explain why GDP growth under Simulation 1 is more sustained over time compared to Simulation 2.

The effects of preventive health measures also extend to labor market outcomes, with both simulations showing a slight increase in average hours worked. As individuals maintain better health, they can stay in the workforce for longer, contributing more hours to the economy. This increase in labor participation boosts overall productivity, which further sustains GDP growth, particularly in Simulation 1, where the health improvements are more evenly distributed. The additional labor force participation also plays a key role in reducing income inequality. Healthier individuals, especially those in lower-income groups, are able to continue working and earning income for a longer period, narrowing the income gap within and across generations.

Table 4: Calibration Targets: Health Prevention

	Baseline	**Simulation 1**	**Simulation 2**
Capital-output ratio	3.47	4.05	3.79
Consumption-output ratio	0.79	0.76	0.77
Average hours worked	0.65	0.66	0.66
Pension expenditure (% of GDP)	15.0	14.7	17.2
Health expenditure (% of GDP)	8.97	8.31	8.75
Long-term care expenditure (% of GDP)	2.43	1.90	2.01
Time providing care (% of Year)	2.17	1.80	1.80

Note: Author's calculations.

At the same time, the changes in pension and LTC expenditures highlight important trade-offs. In Simulation 1, pension expenditures decrease slightly as healthier individuals delay retirement, reducing the financial burden on the pension system. This alleviates some of the pressure on younger generations, helping to lower intergenerational inequality. In Simulation 2, however, pension expenditures increase, particularly for individuals with poorer health who benefit from targeted longevity gains. While this helps reduce intragenerational inequality by allowing these individuals to remain in the pension system for longer, it also increases the long-term fiscal burden.

The reductions in health and LTC expenditures are another key driver of the improved outcomes in both simulations. By lowering the demand for expensive care services, preventive health measures free up resources for other productive uses, which contributes to higher GDP growth. This reduction in healthcare and LTC costs disproportionately benefits lower-income households, who tend to rely more on public services and face higher out-of-pocket expenses. As a result, the preventive health measures help narrow both intergenerational and intragenerational income disparities, particularly in Simulation 1, where the reductions in health deficiencies are more uniform. In Simulation 2, the targeted improvements result in smaller reductions in expenditures, leading to less pronounced improvements in inequality.

Finally, the reduction in time spent providing care in both simulations further supports higher GDP growth and reduced inequality. As individuals require less caregiving due to improved health, more family members—particularly women—are able to remain in the workforce. This increases overall productivity and helps to reduce both intergenerational and intragenerational disparities, as lower-income households, which often rely on informal caregiving, are able to retain more of their income. The reduction in caregiving burdens also allows younger generations to contribute less to the pension and healthcare systems, thereby reducing the implicit tax rate and alleviating financial pressures on the working population.

3.3 Increasing LTC Insurance Coverage

An additional approach to deal with the risind demand of LTC is the provision of care through increased coverage of LTC costs by public insurance. Although government expenditures on LTC will rise due to demographic changes regardless of coverage rates, expanding LTC insurance is a potential solution to address the growing needs of an aging population. One reason for increasing LTC insurance coverage is to close existing gaps in care. Many individuals currently face unmet LTC needs, and expanding coverage would ensure that more people receive the necessary services, reducing these unmet needs. The quality of LTC services can also be enhanced. With broader insurance, higher standards of care can be maintained, leading to better health outcomes and potentially reducing the severity and duration of care needs.

In Simulation 3, the model explores the impact of expanding LTC insurance coverage by increasing coverage rates across all levels of care (L1, L2, and L3) by 5%. This simulation reflects a policy shift where governments take on a larger share of LTC costs, addressing unmet care needs and improving the quality of care. By expanding LTC insurance, the government increases public spending on care services, ensuring that more individuals across the three levels of care have access to the necessary support. While the increase in public insurance coverage alleviates the financial strain on households, particularly for those with lower incomes, it shifts the burden to taxpayers through higher contributions to the system.

3.3.1 GDP Growth under Care Provision

Figure 8 illustrates the projected GDP growth rate under the baseline scenario and Simulation 3, which simulates the impact of increasing LTC insurance coverage by 5%. The expanded coverage initially leads to a higher GDP growth rate compared to the baseline, reflecting the economic benefits of improved access to formal care services and the resulting reduction in informal caregiving burdens. However, as the projection moves into the later stages, GDP growth in Simulation 3 begins to converge with the baseline. This suggests that while increased LTC coverage can provide short-term economic benefits by enhancing labor productivity and reducing caregiving burdens, the additional fiscal strain from higher government expenditures and increased taxes begins to weigh on growth over time. The need for higher taxes to finance the expanded LTC coverage moderates the initial economic gains, leading to a more tempered long-term GDP growth trajectory.

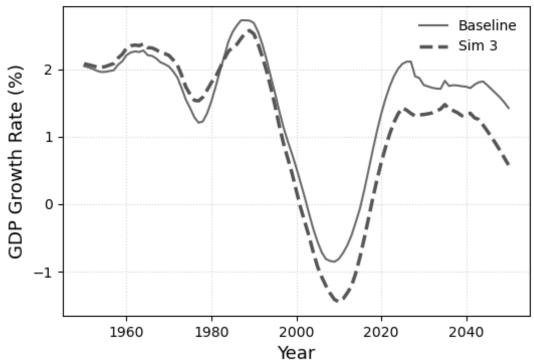


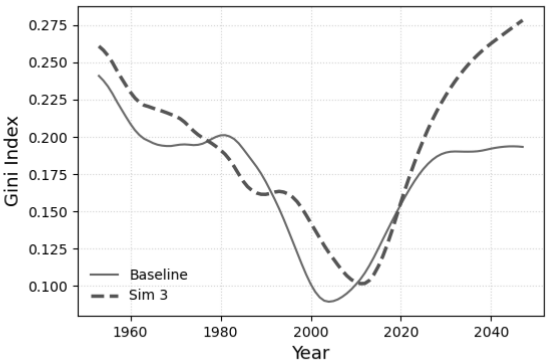
Figure 8: Provision of Care: GDP Growth

Note: Author's calculations.

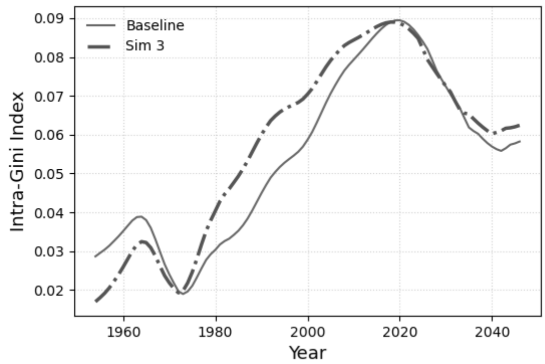
3.3.2 Income Inequality under Care Provision

Figure 9a shows the evolution of intergenerational inequality, as measured by the Gini index. In Simulation 3, where LTC insurance coverage is expanded, we observe a marked increase in intergenerational inequality over time. This rise in inequality is largely driven by the higher tax rates required to finance the increased public spending on LTC services. As younger generations shoulder the heavier tax burden to fund the system, their ability to accumulate wealth is reduced, resulting in a widening gap between older and younger generations. This outcome highlights a key trade-off in Simulation 3: while expanded LTC coverage provides greater support for the elderly and reduces out-of-pocket costs for care, it comes at the cost of greater financial strain on younger working populations, leading to increased intergenerational inequality.

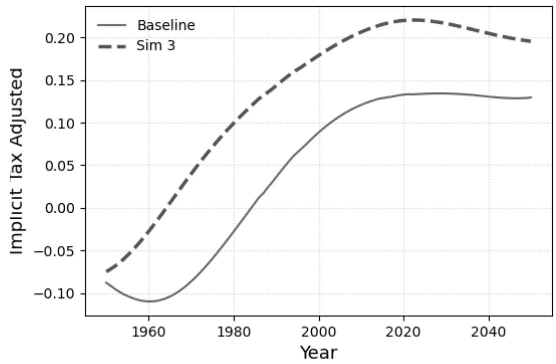
Figure 9b presents the evolution of intragenerational inequality. Both scenarios show a steady increase in intragenerational inequality through the early 2020s, as disparities in income and wealth accumulation continue to grow within generations. Under Simulation 3, where LTC coverage is expanded, intragenerational inequality follows a similar upward



(a) Inter-Income Inequality



(b) Intra-Income Inequality



(c) Implicit Tax Rate

Figure 9: Health Provision: Income Inequality

Note: Author's calculations.

trend, though the difference between the baseline and Simulation 3 is more pronounced in the earlier years. This indicates that the expanded LTC insurance helps alleviate some of the financial burden on lower-income households, particularly by reducing their out-of-pocket expenses for care. However, as the simulation progresses, intragenerational inequality begins to converge with the baseline, suggesting that while the increased insurance coverage reduces disparities initially, other factors—such as wage stagnation or differing access to high-quality jobs—continue to drive inequality within generations over the long term. By the mid-2040s, intragenerational inequality in both scenarios stabilizes at similar levels, reflecting the persistence of these structural inequalities.

Figure 9c shows the evolution of the implicit tax rate. Under Simulation 3, the implicit tax rate rises sharply compared to the baseline, reflecting the higher tax burden required to fund the expanded LTC insurance coverage. While earlier generations benefit from the expanded coverage without experiencing the full increase in tax rates, younger generations—particularly those entering the workforce after 2020—face significantly higher taxes to sustain the system. This shift is particularly evident in the steep divergence between the baseline and Simulation 3 after 2020. Although expanded LTC coverage reduces out-of-pocket costs for care, it ultimately shifts the financial burden to taxpayers, leading to a higher implicit tax rate for future generations. Over time, this heavier tax burden may place additional pressure on younger generations, contributing to the rise in intergenerational inequality observed in Simulation 3.

3.4 Mechanisms under Provision of Care

The results of Simulation 3, which models increased provision of LTC through expanded insurance coverage, can be better understood by examining the changes in key economic indicators as outlined in Table 5. The adjustments in the capital-output ratio, consumption-output ratio, pension expenditure, and LTC expenditure all reflect the broader economic shifts caused by the increased government involvement in LTC, influencing both GDP growth and income inequality.

The capital-output ratio decreases under Simulation 3, indicating that more resources are being allocated toward consumption and public expenditures, particularly in healthcare and LTC services, rather than capital investment. This reduction in the capital-output ratio suggests that the expansion of public LTC coverage diverts resources from productive investments into care services, contributing to the slightly lower GDP growth observed in the long run. For income inequality, this lower capital accumulation may exacerbate wealth disparities, particularly as wealthier households are better able to save and invest, while lower-income households, who benefit more from public LTC coverage, see fewer opportunities for wealth growth through capital.

The increase in the consumption-output ratio reflects higher overall consumption as a share of output, driven by increased public spending on LTC services and higher household consumption of healthcare-related goods and services. While this increase in consumption supports short-term GDP growth by boosting demand, it may also reduce long-term growth potential as fewer resources are available for investment. For inequality, the higher consumption-output ratio suggests that households, particularly those in lower-income brackets, are consuming more relative to their income, potentially as a result of reduced out-of-pocket healthcare and LTC costs. This can help reduce disparities in immediate living standards, but the long-term effects on wealth inequality may be less favorable if households are not able to save and invest as much as wealthier households.

Table 5: Calibration Targets: Provision of Care

	Baseline	**Model 3**
Capital-output ratio	3.47	3.08
Consumption-output ratio	0.79	0.82
Average hours worked	0.65	0.64
Pension expenditure (% of GDP)	15.0	12.4
Health expenditure (% of GDP)	8.97	10.1
Long-term care expenditure (% of GDP)	2.43	2.76
Time providing care (% of Year)	2.17	2.17

Note: Author's calculations.

The slight reduction in average hours worked reflects the trade-off between expanded public LTC coverage and labor market participation. As the government takes on a greater share of LTC costs, some individuals, particularly informal caregivers, may reduce their labor market participation as they shift toward providing care or benefiting from publicly funded services. For GDP growth, this slight reduction in average hours worked translates into lower overall productivity, contributing to the convergence in GDP growth observed in the long run. For inequality, this reduction in hours worked may not have a substantial immediate effect, but over time, lower workforce participation—especially among lower-income households—could contribute to wider income disparities, particularly within generations.

Pension expenditure as a percentage of GDP decreases significantly in Simulation 3, as the expansion of LTC services may delay retirement for some individuals and reduce the financial burden on the pension system. This reduction in pension expenditures helps ease some of the fiscal pressures on younger generations, potentially reducing intergenerational inequality by limiting the need for higher taxes to fund pensions. For GDP growth, the reduced pension expenditure frees up government resources for other uses, which could support broader public investments or reduce the need for higher taxes, although these effects are tempered by the increased spending on LTC services.

Both health and LTC expenditures rise significantly under Simulation 3, with health expenditure increasing to 10.1% of GDP and LTC expenditure rising to 2.76% of GDP. These increases reflect the higher cost of providing broader public LTC coverage. While these expenditures improve access to care and reduce financial strain on households, particularly lower-income ones, they also increase the overall fiscal burden on the government, necessitating higher taxes to finance these services. For GDP growth, the increased public spending supports short-term demand but may weigh on long-term growth due to the need for higher taxation. For inequality, the expansion of public services helps reduce disparities by providing greater support to lower-income households, reducing out-of-pocket expenses for healthcare and LTC. However, the fiscal pressure created by these higher expenditures could lead to rising taxes on the working population, which may contribute to greater intergenerational inequality over time.

4 Conclusions

The demographic shift in Europe, marked by the growing 'care wave,' presents significant challenges for economic growth, fiscal sustainability, and social equity. This research explores two policy responses to the rising demand for long-term care: health prevention and LTC insurance expansion. Both approaches aim to mitigate the economic strain caused by aging populations but have different implications for economic growth, and income inequality.

Health prevention measures show potential to ease the economic burden of an aging population by improving population health and delaying the need for long-term care. By reducing health deficiencies, these policies encourage healthier aging, which leads to higher labor force participation and productivity, resulting in stronger GDP growth and lower healthcare and LTC expenditures. The simulations show that while older generations benefit more from these measures, reflected in a more negative implicit tax rate for older cohorts, younger generations face a similar tax burden as in the baseline scenario. This implies that the primary fiscal relief from prevention efforts is enjoyed by the older population, while younger generations do not see a significant reduction in their tax burden. Health prevention, however, reduces both intergenerational and intragenerational inequality by promoting healthier aging across all socioeconomic groups, which helps reduce reliance on informal care and contributes to more equitable outcomes.

While expanding LTC insurance improves access to care and reduces out-of-pocket expenses for vulnerable populations, the simulations reveal important trade-offs. The immediate boost to GDP growth is tempered by the long-term fiscal strain caused by higher public spending on LTC. The simulations show a steep increase in the implicit tax rate compared to the baseline, indicating that younger cohorts bear a greater financial burden to support expanded public LTC services. The expanded insurance coverage increases taxes, leading to higher intergenerational inequality over time. Though intragenerational inequality initially declines as low-income households benefit from better access to care, this effect diminishes in the long run, leading to a higher intragenerational Gini coefficient.

The findings suggest that health prevention policies offer a more balanced approach to managing the 'care wave.' They delay the need for care, sustain economic growth, and reduce inequality without overly burdening future generations. In contrast, LTC insurance expansion, though crucial for closing current care gaps, risks increasing fiscal strain and inequality if not carefully managed. Policymakers should prioritize preventive health measures to reduce future care demands while considering targeted LTC insurance reforms to ensure broad access without destabilizing public finances. Ultimately, a combination of prevention and strategic care provision offers the most sustainable path forward in addressing Europe's aging population.

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Online Appendix

A.1 Institutional Background

This subsection provides an overview of the institutional background surrounding LTC in five European Union countries: France, Germany, Italy, Sweden, and Poland. Each country has a distinct approach to LTC insurance and provision, shaped by its unique social and economic structures (Carrera et al., 2013), highlighting the diversity in eligibility criteria, benefits, and funding sources across the EU.[3]

In France, LTC insurance is integrated into the broader health insurance system through the Personalized Allowance for Autonomy (APA), aimed at supporting individuals over 60 with expenses related to loss of independence (Joël et al., 2010). Eligibility is determined by assessing ten physical and mental activity variables and seven domestic and social activity variables, categorizing dependency into six levels, with only the first four eligible for APA. In 2019, APA benefits ranged from 674 Euros per month for level four to 1742 Euros for level one, adjusted based on income. Those earning below 800 Euros per month receive full coverage, while those with over 2948 Euros per month co-pay up to 90%. On average, APA covers about 80% of care plan costs, financed by payroll taxes and retirement pension contributions ((Joël et al., 2010), (Barber et al., 2021)).

Germany has a dualistic LTC insurance model, mandatory for all citizens, either integrated with statutory health insurance or sourced from private providers. Eligibility and benefits are based on care levels, assessed by mobility, cognitive capabilities, and daily activities. Since 2017, there have been five care dependency levels (Pflegegrade), ranging from slight impairment (level 1) to full hardship (level 5). The assessment covers mobility, cognitive and communication skills, behavior, self-care, coping mechanisms, and social contact. Individuals can choose between in-kind benefits (services) and cash benefits, with cash benefits typically valued at half the in-kind services. For example, maximum in-kind home care benefits range from 689 Euros per month for level two to 1995 Euros for level five. This system is financed through a shared payroll tax between employers and employees. Those with private health insurance must secure private LTC insurance ((Schulz, 2010), (Barber et al., 2021), (Geyer et al., 2023)).

Italy's LTC approach is decentralized and region-centric, involving Municipalities, Local Health Authorities (ASL), Nursing Homes (RSA), the National Institute of Social Security (INPS), the central State, Regions, and Provinces. LTC provisions are embedded within existing health and social care frameworks. Eligibility is not linked to social security contributions, means tests, or age restrictions, and beneficiaries must be assessed and not reside in publicly funded institutions. Assessment criteria and generosity vary by region, leading to different numbers of recipients and varying types and amounts of aid. Benefits include cash (indennità di accompagnamento), means-tested care benefits (assegni di cura), and in-kind services (assistenza domiciliare integrata, Presidi sociosanitari, and Centri diurni). LTC is primarily funded through general taxation and region-specific

[3] Barczyk and Kredler (2019) presents an overview of the LTC programs in Europe.

household co-payments ((Tediosi & Gabriele, 2010), (Colombo et al., 2011), (Barber et al., 2021)).

In Sweden's long-term care (LTC) system, eligibility for services is determined by a needs assessment rather than financial means, ensuring equitable access for all citizens in need. There are no national regulations on eligibility; instead, local municipalities establish their criteria, service levels, and range of services. Benefits include highly subsidized health and social care services, with public funding covering 95% of costs. Users pay minimal fees, capped at 2,068 SEK per month, which includes care, rent, and meals. Additionally, there are two types of municipal cash benefits for family carers: attendance allowance, a cash payment given to the care recipient to pay for family help, and carers allowance, where the municipality employs a family member to provide care. However, these benefits play a residual role, with priority given to services in kind. The system is funded through taxation, with county councils and municipalities financing around 90% of the costs, supplemented by national taxes covering about 5

Poland's LTC system heavily relies on family caregiving, with 70-90% of care provided informally. However, with a significantly aging population projected by 2060, the government has introduced policy documents to address LTC needs. Services are organized locally, divided between health and social assistance sectors, and include residential services, community care, daycare, and nursing home care. In 2018, the 'Care 75+' program was launched to support elderly care in rural areas and small towns, with financial contributions from local authorities. Eligibility varies: medical care requires a physician's referral and a low Barthel scale score, while social assistance is based on income, family situation, and social worker assessments. LTC services are funded through obligatory social health insurance and general taxes, with local government cost-sharing. Patients in long-term care units pay up to 70% of their monthly income for accommodation and nutrition, with no financial obligation on their families. Social assistance homes have similar cost-sharing limits, and local governments support low-income residents. Private full-time care facilities exist but are often unaffordable. Cash benefits include a nursing supplement for individuals aged 75+ and allowances for carers of disabled adults, with more support available for parents of disabled children.

A.2 F.O.C. of Working Households

The household in the working stage maximizes the following lifetime utility:

$$\max \sum_{j=0}^{J} \beta^j \pi^k_{t+j,j} u(c^k_{t+j,j}, l^k_{t+j,j})$$

subject to the:

$$a^k_{t+1,j+1} = a^k_{t,j}(1+r_t) + h^k_{t,j} w^k_{t,j}(1-\tau_t) + p^k_{t,j} - c^k_{t,j} - (1-\eta^m)m^k_{t,j} - (1-\eta^n_j)n^k_{t,j}$$

$$l^k_{t,j} = 1 - h^k_{t,j} - \Lambda^k_j$$

We construct the Lagrangian by incorporating the constraints with associated Lagrange multipliers, λ and μ, which correspond to the budget and time constraints, respectively.

$$\mathcal{L} = \sum_{j=0}^{J} \beta^j \pi^k_{t+j,j} u(c^k_{t+j,j}, l^k_{t+j,j}) +$$

$$\lambda^k_{t+j,j}\Big[a^k_{t+1,j+1} - a^k_{t,j}(1+r_t) - h^k_{t,j} w^k_{t,j}(1-\tau_t) - p^k_{t,j} + c^k_{t,j} + (1-\eta^m)m^k_{t,j} + (1-\eta^n_j)n^k_{t,j}\Big] +$$

$$\mu^k_{t+j,j}\Big[l^k_{t,j} - 1 + h^k_{t,j} + \Lambda^k_j\Big]$$

Taking derivatives of the Lagrangian with respect to consumption ($c^k_{t+j,j}$), and labor supply ($h^k_{t+j,j}$) and setting them equal to zero gives us the FOCs.

Lagrangian with respect to consumption ($c^k_{t+j,j}$):

$$\frac{\partial \mathcal{L}}{\partial c^k_{t+j,j}} = \beta^j \pi^k_{t+j,j} \frac{\partial u(c^k_{t+j,j}, l^k_{t+j,j})}{\partial c^k_{t,j}} = \lambda^k_{t+j,j}$$

$$\frac{\partial u}{\partial c^k_{t,j}} = \left[\left(c^k_{t,j}\right)^{\phi^k_j}\left(l^k_{t,j}\right)^{1-\phi^k_j}\right]^{-\theta} \cdot \left(c^k_{t,j}\right)^{\phi^k_j - 1} \cdot \phi^k_j \cdot \left(l^k_{t,j}\right)^{1-\phi^k_j}$$

$$\frac{\partial \mathcal{L}}{\partial c^k_{t+j,j}} = \beta^j \pi^k_{t+j,j}\left[\left(c^k_{t,j}\right)^{\phi^k_j}\left(l^k_{t,j}\right)^{1-\phi^k_j}\right]^{-\theta} \cdot \left(c^k_{t,j}\right)^{\phi^k_j - 1} \cdot \phi^k_j \cdot \left(l^k_{t,j}\right)^{1-\phi^k_j} = \lambda^k_{t+j,j}$$

Lagrangian with respect to labor supply ($h^k_{t+j,j}$):

$$\frac{\partial \mathcal{L}}{\partial h^k_{t+j,j}} = \beta^j \pi^k_{t+j,j} \frac{\partial u(c^k_{t+j,j}, l^k_{t+j,j})}{\partial l^k_{t+j,j}} \frac{\partial l^k_{t+j,j}}{\partial h^k_{t,j}} = -\lambda^k_{t+j,j} w^k_{t,j}(1-\tau_t) + \mu^k_{t+j,j}$$

$$\frac{\partial u}{\partial l^k_{t,j}} = (1-\phi^k_j)\left[\left(c^k_{t,j}\right)^{\phi^k_j}\left(l^k_{t,j}\right)^{1-\phi^k_j}\right]^{-\theta} \cdot \left(l^k_{t,j}\right)^{-\phi^k_j}$$

$$\frac{\partial \mathcal{L}}{\partial h^k_{t+j,j}} = \beta^j \pi^k_{t+j,j}(1-\phi^k_j)\left[\left(c^k_{t,j}\right)^{\phi^k_j}\left(l^k_{t,j}\right)^{1-\phi^k_j}\right]^{-\theta} \cdot (-1) \cdot \left(l^k_{t,j}\right)^{-\phi^k_j} = -\lambda^k_{t+j,j} w^k_{t,j}(1-\tau_t) + \mu^k_{t+j,j}$$

These FOCs characterize the optimal decision rules for consumption, labor supply, and asset holdings in the OLG model.

A.3 F.O.C. of Retired Households

The retired household maximizes the following lifetime utility:

$$\max \sum_{j=0}^{J} \beta^j \pi_{t+j,j}^k u(c_{t+j,j}^k, l_{t+j,j}^k)$$

subject to the:

$$a_{t+1,j+1}^k = a_{t,j}^k(1+r_t) + p_{t,j}^k - c_{t,j}^k - (1-\eta^m)m_{t,j}^k - (1-\eta_j^n)n_{t,j}^k$$

$$l_{t,j}^k = 1 - \Lambda_j^k$$

We construct the Lagrangian by incorporating the constraints with associated Lagrange multipliers, λ and μ, which correspond to the budget and time constraints, respectively.

$$\mathcal{L} = \sum_{j=0}^{J} \beta^j \pi_{t+j,j}^k u(c_{t+j,j}^k, l_{t+j,j}^k) +$$
$$\lambda_{t+j,j}^k \left[a_{t+1,j+1}^k - a_{t,j}^k(1+r_t) - p_{t,j}^k + c_{t,j}^k + (1-\eta^m)m_{t,j}^k + (1-\eta_j^n)n_{t,j}^k \right] +$$
$$\mu_{t+j,j}^k \left[l_{t,j}^k - 1 + \Lambda_j^k \right]$$

Taking derivatives of the Lagrangian with respect to consumption ($c_{t+j,j}^k$), and leisure ($l_{t+j,j}^k$) and setting them equal to zero gives us the FOCs.

Lagrangian with respect to consumption ($c_{t+j,j}^k$):

$$\frac{\partial \mathcal{L}}{\partial c_{t+j,j}^k} = \beta^j \pi_{t+j,j}^k \frac{\partial u(c_{t+j,j}^k, l_{t+j,j}^k)}{\partial c_{t,j}^k} = \lambda_{t+j,j}^k$$

$$\frac{\partial u}{\partial c_{t,j}^k} = \left[\left(c_{t,j}^k\right)^{\phi_j^k} \left(l_{t,j}^k\right)^{1-\phi_j^k} \right]^{-\theta} \cdot \left(c_{t,j}^k\right)^{\phi_j^k - 1} \cdot \phi_j^k \cdot \left(l_{t,j}^k\right)^{1-\phi_j^k}$$

$$\frac{\partial \mathcal{L}}{\partial c_{t+j,j}^k} = \beta^j \pi_{t+j,j}^k \left[\left(c_{t,j}^k\right)^{\phi_j^k} \left(l_{t,j}^k\right)^{1-\phi_j^k} \right]^{-\theta} \cdot \left(c_{t,j}^k\right)^{\phi_j^k - 1} \cdot \phi_j^k \cdot \left(l_{t,j}^k\right)^{1-\phi_j^k} = \lambda_{t+j,j}^k$$

Lagrangian with respect to labor supply ($l_{t+j,j}^k$):

$$\frac{\partial \mathcal{L}}{\partial l_{t+j,j}^k} = \beta^j \pi_{t+j,j}^k \frac{\partial u(c_{t+j,j}^k, l_{t+j,j}^k)}{\partial l_{t+j,j}^k} \frac{\partial l_{t+j,j}^k}{\partial h_{t,j}^k} = \mu_{t+j,j}^k$$

$$\frac{\partial u}{\partial l_{t,j}^k} = (1-\phi_j^k) \left[\left(c_{t,j}^k\right)^{\phi_j^k} \left(l_{t,j}^k\right)^{1-\phi_j^k} \right]^{-\theta} \cdot \left(l_{t,j}^k\right)^{-\phi_j^k}$$

$$\frac{\partial \mathcal{L}}{\partial l_{t+j,j}^k} = \beta^j \pi_{t+j,j}^k (1-\phi_j^k) \left[\left(c_{t,j}^k\right)^{\phi_j^k} \left(l_{t,j}^k\right)^{1-\phi_j^k} \right]^{-\theta} \cdot (-1) \cdot \left(l_{t,j}^k\right)^{-\phi_j^k} = \mu_{t+j,j}^k$$

These FOCs characterize the optimal decision rules for consumption, labor supply, and asset holdings in the OLG model.

Table A1: Health Deficiency Index: Variables

Ever Diagnosed by a Doctor:	
Stomach or duodenal ulcer, peptic ulcer	Heart attack
Alzheimer's disease, dementia, senility	Stroke
Hip fracture or femoral fracture	Arthritis
High blood pressure or hypertension	Chronic lung disease
Osteoarthritis/other rheumatism	Cancer
Rheumatoid arthritis	Cataracts
Parkinson's disease	High blood cholesterol
Diabetes or high blood pressure	
Difficulties with the following activities:	
Reaching or extending arms above shoulder	Walking 100 meters
Getting in or out of bed	Sitting for two hours
Lifting or carrying weights over 5 kilos	Eating, cutting up food
Pulling or pushing large objects	Climbing one flight of stairs
Using the toilet, including getting up or down	Walking across a room
Dressing, including shoes and socks	Climbing several flights of stairs
Picking up a small coin from a table	Stooping, kneeling, crouching
Using a map in a strange place	Bathing or showering
Shopping for groceries	Preparing a hot meal
Taking medications	Telephone calls
Doing work around the house or garden	
Memory:	
Can't recall current day of the month	Can't recall current year
Can't recall current day of the week	Can't recall current month
Eyesight/hearing:	
Eyesight is poor for seeing things at a distance	Uses hearing aid
Eyesight is poor for reading	

A.4 Life-Cycle Profiles

This model introduces several dimensions of ex-ante household heterogeneity: health deficiencies, productivity levels, consumption and leisure preferences, and life expectancy. These elements are essential for capturing the varied impacts of social security reforms on different household types.

A.4.1 Health Deficiency Profile

The health deficiency profile χ_j^k is based on the health deficiency index by Börsch-Supan et al. (2021) and calculated using questions on physical and cognitive health across different waves of SHARE data. It is based on 44 binary variables related to various health dimensions. χ_j^k is defined as the number of these binary variables reported by an individual divided by the maximum possible number of variables. Thus, ranging from 0 to 1 where 0 represents optimal health or maximum health, and 1 denotes the poorest health or minimum health, capturing the spectrum of health conditions in this model. The deterministic health deficiency profile in this model is a function of age and stratified by three initial health status. These profiles are poor, medium, and excellent health. As shown in Figure A1 health deteriorates more rapidly for individuals in the poor health deficiency profile as suggested by equation 4.

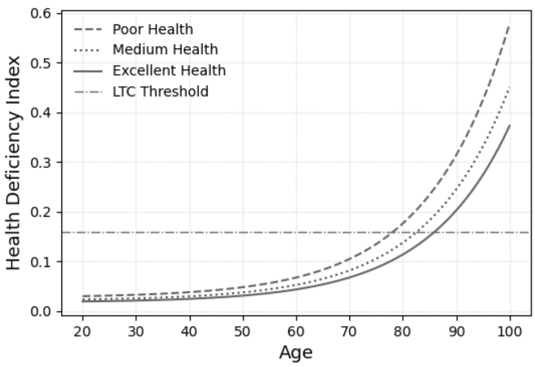

Figure A1: Health Deficiency Profiles

Source: Author's calculations.

A.4.2 Productivity Profile

The model varies in productivity levels ϵ_j^k, reflecting the diverse economic contributions of individuals throughout their life cycle. These profiles provide insights into how productivity first increases when young, later reaches a peak in middle age, and decreases again as a consequence of the aging process ((Altig et al., 2001), (French, 2005) and (Huggett et al., 2011)). These productivity profiles are separated into three income groups, as depicted in Figure A2. The resulting productivity profiles increase with age at a steeper rate for higher-income groups and decrease slightly after the peak. These profiles calculate cohort-corrected wage profiles for men aged 50 or over, containing their average earnings from ages 20 to 49 using SHARE data and the job episodes panel ((Börsch-Supan et al., 2013); (Brugiavini et al., 2019)). The income groups are calculated for the upper productivity profile for the highest income category, the lower productivity profile for the lowest income category, and the middle profile for a combination of the lower and the upper middle class.

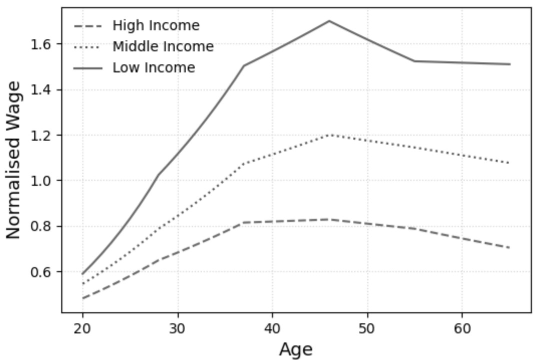

Figure A2: Productivity Profiles

Source: Author's calculations.

A.4.3 Consumption Profile

The consumption profiles for each household type ϕ_j^k measure how willing an individual is to substitute consumption with leisure. These profiles represent the aging process, during which the preference for leisure increases, thereby reducing labor supply and eventually inducing retirement. The consumption preferences are also separated into three different profiles as shown in Figure A3. To obtain these consumption profiles a parametric approach is implemented. It assumes the same starting value for all the groups. For the individuals in the first group, there is no decline. There is a modest decline for the second group and a steep decline for the last group.

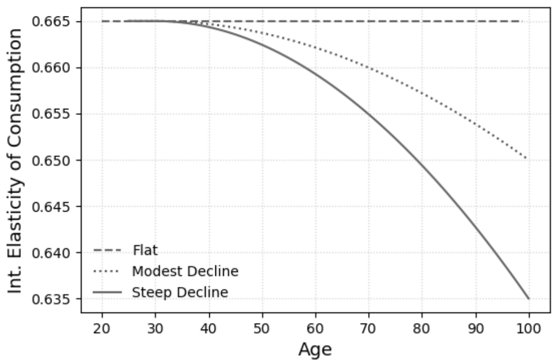

Figure A3: Consumption Profiles

Source: Author's calculations.

A.4.4 Mortality Risk Profile

The final life-cycle profile shows the heterogeneity in mortality risk π_j^k, which increases with age. The unconditional survival rates are calculated by cohort and individual-specific, for the three different household types using the Human Mortality Database (2016). These estimated unconditional survival rates are used to determine the conditional survival rates for the three household types. The conditional survival rates are shown in Figure A4.

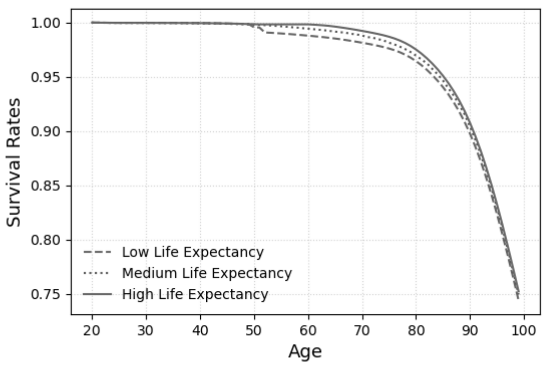

Figure A4: Mortality Risk Profiles

Source: Author's calculations.

A.5 Estimation of Health Expenditure Parameters

Table A2: Health Expenditures

	(1)	(2)
HDI	0.005**	0.025***
	(0.002)	(0.007)
Income	0.004***	0.004***
	(0.001)	(0.001)
Age	0.000	0.000
	(0.000)	(0.000)
HDI Sq.		0.004**
		(0.002)
Constant	0.083***	0.108***
	(0.014)	(0.016)
Observations	45945	45945
R-squared	0.029	0.03
AIC	-47122	-47161

Standard errors in parentheses

* $p < .1$, ** $p < .05$, *** $p < .01$

A.6 Estimation of LTC Expenditure Parameters

Table A3: Long Term Care Expenditures

	(1)	(2)
HDI	0.016**	0.072***
	(0.007)	(0.027)
Age	-0.015**	-0.014**
	(0.007)	(0.006)
Age Sq.	0.000**	0.000**
	(0.000)	(0.000)
Income	0.020***	0.019***
	(0.005)	(0.005)
Number of Siblings	-0.002	-0.002
	(0.002)	(0.002)
HDI Sq.		0.016***
		(0.006)
Constant	0.561**	0.561**
	(0.228)	(0.224)
Observations	1909	1909
R-squared	0.096	0.11
AIC	-2660	-2676

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

A.7 Estimation of Informal Care Provision Parameters

Table A4: Informal Care: Parental Health

	(1)	(2)	(3)
Mother's Health	0.208***		0.092
	(0.026)		(0.062)
Income Classification	-0.035**	-0.145***	-0.020
	(0.017)	(0.033)	(0.035)
Father's Health		-0.021	0.106*
		(0.051)	(0.059)
Constant	0.322**	0.610**	0.010
	(0.129)	(0.247)	(0.285)
Observations	4125	1443	886
R-squared	0.033	0.047	0.033
AIC	12609	4796	2652

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

A.8 Summary of Parameters

Table A5: Parameters

Parameter	Description	Value
Preferences		
ϕ_j^k	Intra-temporal elasticity	0.6685
-	Modest decline of ϕ	0.0085
-	Steep decline of ϕ	0.017
ρ	Discount factor	0.0101
θ	Inverse of IES	2
Health Exp.		
η^m	Share of health coverage	0.88
θ_0^m	Minimum health cost	0.08
θ_1^m	Direct effects of healthcare usage	0.005
LTC Exp.		
η^n	Share of LTC coverage	-
θ_0^n	Minimum LTC cost	0.561
θ_1^n	Direct effects of long-term care usage	0.016
$\bar{x}$	Threshold for LTC	0.19
Informal Care		
θ_0^c	Minimum informal care	0.32
θ_1^c	Direct effects of parental health	0.20
Pension		
R_E	Earliest retirement age	60
R_L	Latest retirement age	70
b	Initial steady-state replacement rate	0.6
ω	Adjustment rate	0.032
Firms		
α	Capital share in production	0.33
δ	Depreciation rate of capital	0.05
g	Growth rate of labor productivity	0.015