

Socioeconomic Status and the Effects of Pension Reforms on Lifetime Benefits in Denmark*

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Abstract

We examine the impact of Danish pension reforms from 1990 to 2022 on retirement behavior and lifetime benefit inequality across socioeconomic groups. Using administrative data and an affluence-based measure of socioeconomic status, we estimate retirement responses to Social Security wealth, implicit tax rates, and earnings, while accounting for group-specific differences in life expectancy. Counterfactual simulations highlight substantial, progressive gains for lower socioeconomic groups during an early reform period, but reveal increasingly regressive outcomes in later reforms. Our results underscore that mechanical changes in pension rules drive inequality more than behavioral adjustments, indicating the need for targeted policy measures.

Keywords: Pension Reform, Socioeconomic Inequality, Retirement Behavior, Social Security Wealth

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*Some footnote

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1 Introduction

Starting from the introduction of the Post Employment Wage (PEW) program in 1979, Denmark experienced a decrease in the retirement age over the next two decades. However, since 1999, Denmark, like many other OECD countries, has witnessed a trend reversal (Bingley et al., 2020). After reaching a minimum in 1999, there has been a sustained rise in the labor force participation rate at older ages. Survey evidence corroborates that this increasing propensity to remain in the labor market at older ages is observed among both women and men, as well as across educational groups (VIVE, 2023). Reforms enacted over the past three decades have contributed to tightening eligibility requirements, eliminating certain early pension and transitional benefit pathways, increasing the statutory retirement age, and reducing the duration of the PEW. These reforms have increased the incentives for men and, even more so, for women to remain in the labor market, as successive cohorts of women have gained more experience.

The purpose of this chapter is to explore the effects of pension reforms and their inherent incentives on retirement behavior, with particular focus on the inequality in retirement behavior in Denmark. That is, how do reforms interact with affluence and life expectancy to explain socioeconomic differences in retirement behavior? Do we increasingly observe in Denmark that affluent individuals withdraw with generous pensions, supplementing their social security? In contrast, do less affluent workers withdraw early due to health-related reasons with little beyond their social security pension? Do affluent workers, due to their higher life expectancy, enjoy many more years in retirement compared to less affluent workers? Thus, we model retirement age as a function of financial incentives, split by affluence quantiles that correspond to differences in life expectancy. The aim is to map out the sources of inequality in pension benefits and retirement behavior in Denmark and to understand how reforms have affected these inequalities.

The rest of the chapter unfolds as follows: Section 2 describes the institutional setting and major pension reforms over the period 1985-2022; Section 3 presents the data and modeling concepts; and Section 4 presents the model estimates. Section 5 presents counterfactual analyses, and Section 6 concludes the study.

2 Social Security Reforms

Denmark has a generous pension system with a high replacement rate and wide coverage (Pensionskommissionen, 2015). Yet, it carries certain disincentives to saving for some groups. The pension system consists of three pillars. The first pillar is Statutory pension (OAP), which is a universal basic amount plus a pension supplement and a special supplementary amount. All three elements are means-tested. The basic amount is income tested against personal

work income only, and only against work income above a relatively high threshold. The pension supplement and the special supplementary amount are income-tested against all taxable income, including work income, private pensions, and capital income. All Danish citizens who are permanently residing in Denmark are entitled to the basic amount starting from the official OAP age. Depending on their supplementary private income, the individual will receive greater or lesser income-tested supplementary amounts. This weakens the incentive for pension savings, especially for low-income workers.

The second pillar is contribution-based labor market pensions. These are typically contribution-defined, fully funded schemes. Contribution-based labor market pensions have been slowly maturing since the 1980s. By the end of the 1980s, approximately one-third of all employees had a labor-market pension. The remaining 2/3 without any agreement-based labor-market pensions were typically blue- and white-collar workers within the private sector. As part of collective bargaining in the late 1980s and early 1990s, an agreement was reached to expand occupational pensions into the private sector. Accordingly, the coverage of labor market pension schemes during the last 25 years has increased from 30 percent to 90 percent of all workers. Contributions are paid as a percentage of earnings. In 2004, contributions to agreement-based labor market pension schemes were typically 7-10 percent of the wage in the private sector, while they were 12-16 percent of the wage in the public sector. However, in connection with the collective bargaining agreement in 2005, several increases to these contributions were agreed upon. Typically, the employer contributes two-thirds, while the employee contributes one-third.

The third pillar of the Danish pension system consists of voluntary savings-based private pensions. Contributions to private pensions are deductible from personal income tax (up to a ceiling), but returns and benefits are taxed. Private pensions can be paid out as a lump sum, a lifelong annuity, or withdrawn gradually (phased withdrawal).

The major reforms in the 1985-2005 period are: the opening and closing of the temporary benefits program and the reform of PEW and OAP in 1999, implemented from 2004 to 2006. By 1985, the PEW had been in effect for 6 years, and male labor force participation in the 60-64 age group had stabilized to around 50 percent. In comparison, in 1978, the year before PEW was introduced, it had been as high as 80 percent. To add to that, a temporary benefits program was opened in 1994, allowing a PEW-like early retirement among unemployed elderly in their 50s. The Temporary Benefit Program (TBP) was initially introduced for individuals aged 55 – 59 who are long-term unemployed. In 1994, the benefit was also made available to individuals aged 50-54. Initially, the benefit could be claimed for a maximum of 7 years, but over the years 1996-2001, there was a stepwise reduction in the maximum benefit duration from 7 to 4 years.

After witnessing this dramatic and somewhat unintended outflow from the labor market among the young elderly via these programs, the government, from the mid-1990s, enacted a

series of pension reforms, tightening eligibility requirements, closing off certain early retirement pathways, consolidating disability benefits, and shortening the duration of PEW.

In 1996, the entry into the Transitional Benefits Program was discontinued. In 1999, the statutory pension claiming age was advanced from 67 to 65, thereby reducing the duration of the Post-Employment Wage from seven to five years (enacted 2005-2006). Furthermore, the incentives to delay retirement until 63 in the PEW program were strengthened. These reforms significantly reduced the incentives for early retirement. For women, the effect was intensified because successive cohorts gained more labor market experience.

In 2011, the Retirement Reform, following up on the Welfare Agreement from 2006, proposed a major overhaul of both PEW and OAP 2011, which were to be phased in from 2014 and 2019, respectively. This reform is to be implemented in steps, consisting of half-year increases in the early and statutory retirement ages, starting from 2014 and 2019, respectively. These reforms have resulted in the early retirement program being shortened to a 3-year scheme, effective from 2018, and future early and statutory retirement ages will be indexed to life expectancy.

In recent years, there has been a trend towards allowing earlier health-related retirement. In 2014, “senior DI” was introduced as an alternative way to apply for DI for individuals with long and current labor market attachment, with a maximum of 6 years to OAP age. It started in 2017 as a relatively small program, with about 700 participants. However, by 2022 21,000 individuals were receiving “Senior DI” or Senior Pension. Senior DI requires verification of reduced work capacity by medical examiners.

In 2022, a right to an early pension was introduced, 1-3 years before the retirement age, for individuals with a long labor market history. It was named ‘Arne pension’, after Arne Juhl, the construction worker who became the poster child for the right to early retirement of blue-collar workers, worn down after a long career with hard physical work. This pension, unlike Senior DI, does not require medical verification, but only a long labor market history (at least 42 years, from the age of 16 to 61). This effectively means that it is only workers with low education who have been apprenticed from an early age who will qualify for it. In 2022, 6,000 men and 4,000 women retired via the Arne pension.

To summarize, the period from 1985 to 2022 is characterized by multiple reforms, resulting in rich policy variation. Key changes were the reduction in OAP age of first eligibility from 67 to 65 in 2004-6, and its increase from 65 to 67 in 2014-2019. The most significant reforms over the period 1980-2022 are illustrated in Figure 1.

Key reforms affecting retirement of wage-earners

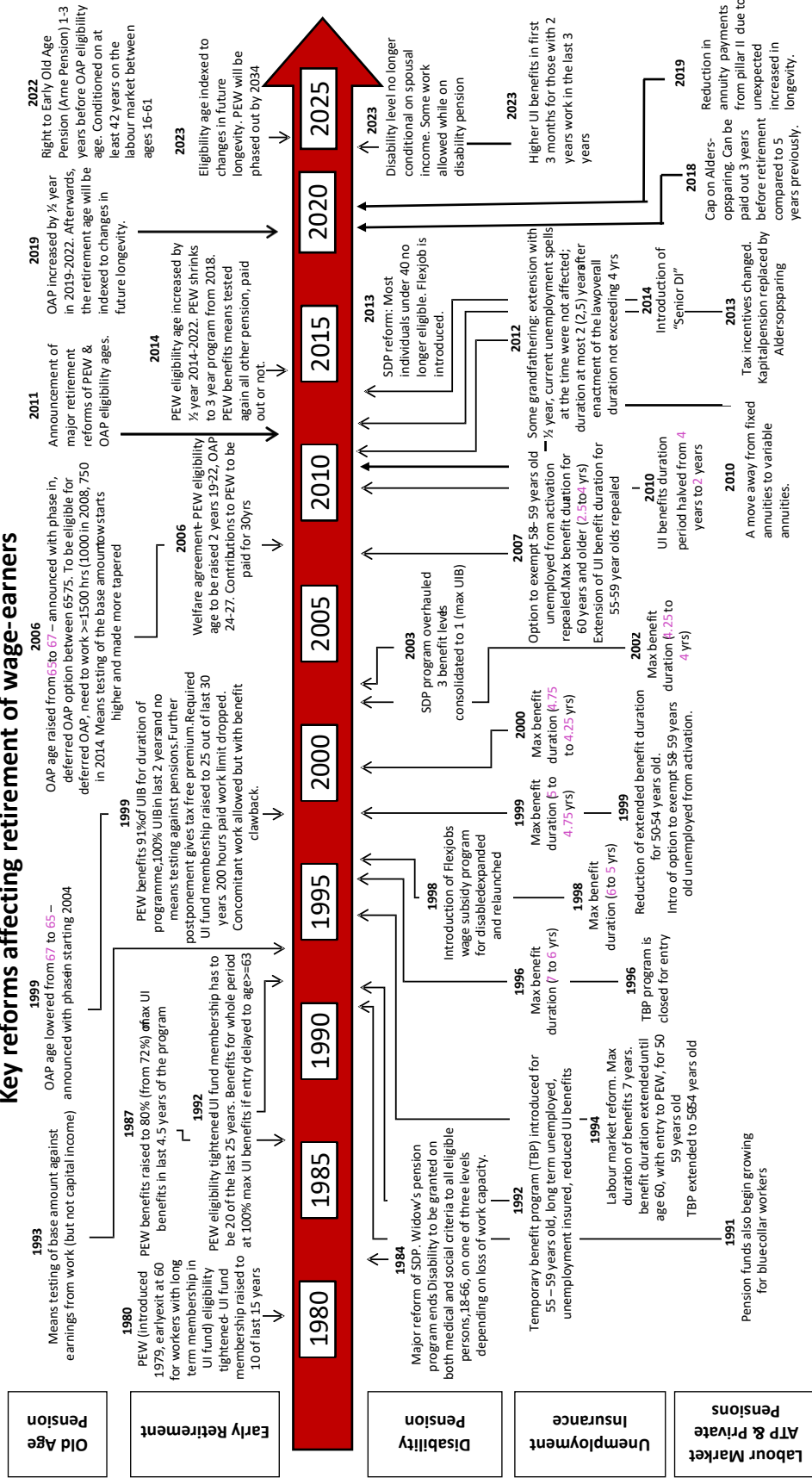


Figure 1: Overview of pension reforms in Denmark.

3 Data, Socioeconomic Status and Pension Benefits

We use data from administrative registries maintained by various governmental agencies. To merge data from multiple registries, researchers or authorized personnel use a pseudonymized version of the CPR number as a common identifier. By linking datasets based on these identifiers, they can create comprehensive datasets that combine information from different sources while preserving the anonymity of individuals. This process enables researchers to analyze complex relationships and patterns across various domains, while also tracking the same individual over consecutive years.

3.1 Socioeconomic Groups

We define socioeconomic groups based on the affluence measure developed by [Cairns et al. \(2019\)](#), which is particularly well-suited for our dataset ([Kallestrup-Lamb et al., 2020](#); [Cairns et al., 2019](#)). This measure takes into account both wealth, represented by tangible assets, and income, indicative of intangible human capital. The inclusion of both income and wealth is crucial, as they are likely to represent adherence to a socioeconomic group; an individual may possess high income, high wealth, or both.

The affluence measure, denoted as $A_{i,x,t}$, combines K times lagged income for individual i aged $x-1$ in year $t-1$, $I_{i,x-1,t-1}$, with lagged wealth, $W_{i,x-1,t-1}$, for each individual in the dataset, formulated as:

$$A_{i,x,t} = K \cdot I_{i,x-1,t-1} + W_{i,x-1,t-1} \quad (1)$$

Using lagged values of income and wealth proves advantageous, especially since income and wealth data may be missing in the year of an individual's death. The affluence measure demonstrates robustness to values of K between 10 and 20; following [Cairns et al. \(2019\)](#), we set K equal to 15. Conceptually, K serves as a capitalization factor employed to approximate the present value of future retirement income, while also balancing the magnitude of income and wealth.

We employ a gender-specific allocation approach to assign individuals to one of five equally-sized socioeconomic groups (SEGs) based on their ranking in the affluence measure. Hence, at each age, time, and gender, the 20 percent least affluent individuals are designated to socioeconomic group 1 (SEG1), the subsequent 20 percent to SEG2, and so forth, until the 20 percent most affluent individuals are allocated to SEG5. Given the limited variation in income at retirement, we adhere to [Cairns et al. \(2019\)](#) and fix the socioeconomic group in that year, specifically at age 67.

We acknowledge the existence of alternative measures of socioeconomic status, such as education, occupational status, income, wealth, and combinations thereof, as suggested by various studies ([Goldman et al., 2018](#); [Kreiner et al., 2018](#); [Fernald et al., 2012](#); [Frederick et al., 2014](#); [Mackenbach et al., 2018](#); [Steptoe and Zaninotto, 2020](#)).

Of particular interest in this project are the population and death registers, as they allow the calculation of the number of individuals who are exposed to death and the number of individuals who die. The population register ([Sortsø et al., 2011](#)) encompasses the entire population from 1985 to 2022 and includes information on sex, age, and cohort. We merge the population register with the death register. The register of deaths holds information on the date of each individual's death for individuals who have passed away. The combined registers allow us to calculate the number of individuals exposed to death and the number of individuals who die by age, gender, time, and socioeconomic status. We calculate mortality rates annually as the number of individuals who die divided by the number of individuals alive at the beginning of the period. As an auxiliary data source for exposures and deaths, we utilize the data from [Human Mortality Database \(2023\)](#) for the entire Danish population before 1985.

Each individual may be assigned to a specific socioeconomic group, allowing for the calculation of deaths within that group. Of particular interest for our socioeconomic measures are income and wealth indicators. The income register contains detailed information about individuals' income, including earnings from employment, self-employment, pensions, benefits, and other sources of income. The wealth register contains detailed information about the value of various types of property and assets owned by individuals and households. The wealth register plays a crucial role in assessing property taxes, determining eligibility for social welfare benefits, and providing valuable data for statistical and research purposes. We define wealth as total assets less liabilities.

Cohort life expectancy is less commonly used than period life expectancy due to its higher data requirements. Calculating cohort life expectancy necessitates data on the age at death of each individual in the population, whereas period life expectancy only requires mortality rate data by age. Having these cohort data is not possible for non-extinct cohorts. Meanwhile, cohort life expectancy may offer more insight than period life expectancy, as cohorts are exposed to the same risk factors at the same age, unlike period life expectancy, which encompasses several different cohorts.

The main challenge related to the data requirements for cohort life expectancy arises in cohorts where not all individuals have died yet, rendering the entire death profile unobserved as the cohort is non-extinct. A recent method proposed by [Rizzi et al. \(2021\)](#) provides a solution for estimating the age-at-death distribution of non-extinct cohorts.

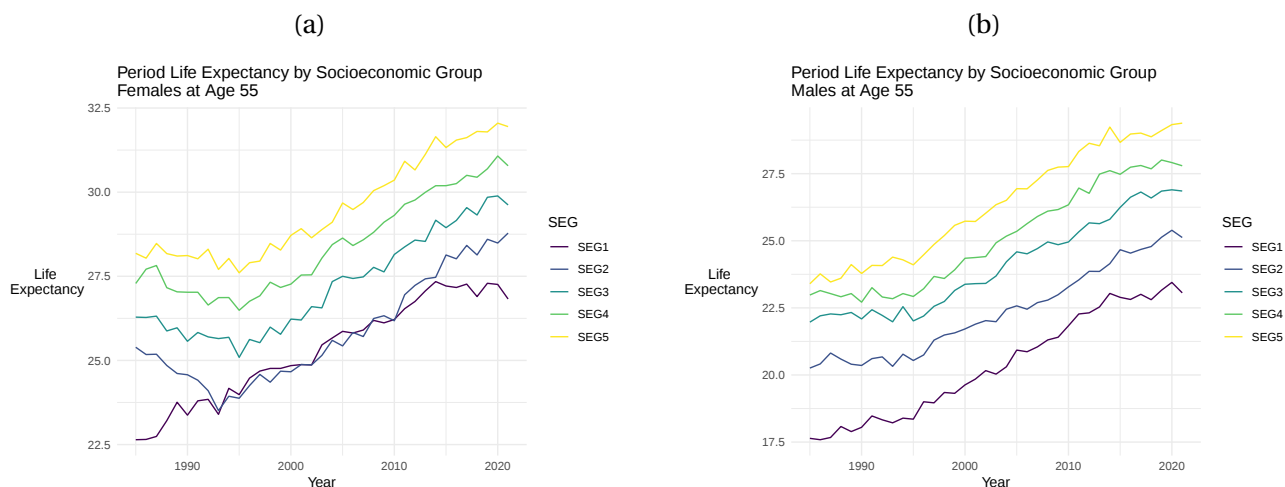
This approach employs an ungrouping method to distribute individuals still alive in the

cohort across remaining ages at death. To make informed statistical decisions about the number of deaths at each age, the method considers the modal age at death, the number of deaths at the mode, and the proportion of deaths occurring after the mode. The modal age at death and the number of deaths at the mode have historically shown an upward trend. For cohorts where the mode is unobserved, these properties are forecasted using historical data and a local-linear trend state space model with ARIMA time-series dynamics (Durbin and Koopman, 2012).

The mortality time series by socioeconomic group spans from 1985 through 2021 in the registers, as discussed in Section 3.1, which is insufficient to forecast the mode, number of deaths at the mode, and the proportion of deaths after the mode. Therefore, we forecast these properties for the entire Danish sample using data from Human Mortality Database (2023) and apply the changes in these values to each socioeconomic group.¹ This implies that all socioeconomic groups exhibit equal improvements in the mode, deaths at the mode, and the proportion of deaths after the mode. The socioeconomic group differences pertain to the cohort data in the registers. After estimating the age-at-death distribution using the method by Rizzi et al. (2021), estimating cohort life expectancy by gender and socioeconomic group is straightforward using standard demographic methods (Preston et al., 2000).

3.2 The Differences in Life Expectancy by Socioeconomic Status

Figure 2: Gender-specific period life expectancy by SEG

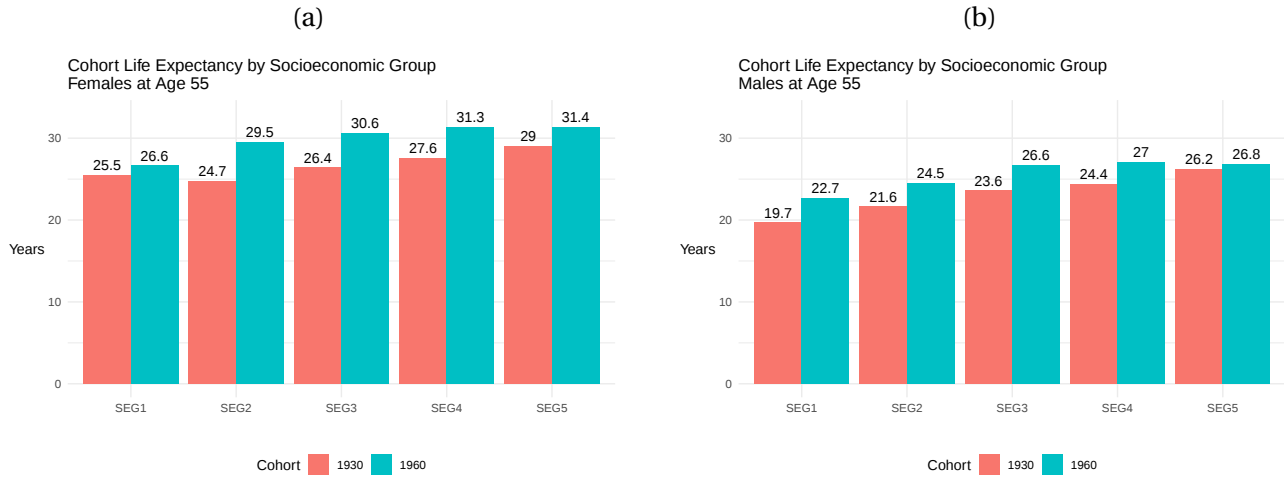


Note:

¹Forecasting these properties with the short time series of socioeconomic group data from the registers results in unsatisfactory forecasts that are highly unstable, volatile, and imprecise.

Figure 2 depicts period life expectancy by socioeconomic group for males and females at age 55. It shows a clear stratification in life expectancy across socioeconomic groups over the past three decades, indicating profound and persistent health disparities associated with socioeconomic status. We observe a consistent gradient, with higher socioeconomic groups experiencing substantially longer life expectancies compared to lower socioeconomic groups. Moreover, we observe progress across all groups from 1990 to 2020, yet the persistent gaps underscore entrenched inequality. Notably, the rate of improvement appears uneven, with some groups exhibiting stagnation or slower growth in life expectancy. Period life expectancy does not account for future changes in mortality trends and thus typically underestimates longevity. Therefore, we plot the period life expectancy in Figure 3.

Figure 3: Gender-specific cohort life expectancy by SEG



Note:

3.3 Benefit Calculation

In our calculation of social security wealth and retirement incentives, we include all major public pension benefits available to Danish residents. The primary component is the Old Age Pension (OAP), which consists of a universal basic amount, a pension supplement, and a special supplementary amount. All three elements are means-tested, with the basic amount tested against labor income above a relatively high threshold, while the supplements are tested against total taxable income, including private pension and capital income. Eligibility for OAP begins at the statutory pension age, and the precise benefit levels depend on the individual's supplementary income and spousal income as set by policy rules in each year of our study period. Alongside OAP, we incorporate the Post-Employment Wage (PEW) program, which

permits earlier retirement contingent on prior labor market attachment and satisfies program-specific eligibility criteria. The value of each benefit is determined as a function of the policy in place in each analyzed year, ensuring that our simulation accounts for institutional changes over time.

We also factor in disability pensions (SDP), early health-related pensions such as Senior DI, and experience-based early pensions (e.g., Arne pension), to the extent that individuals in our sample become eligible for and receive these benefits during the observation window. Each of these programs provides distinct pathways to retirement and is characterized by specific eligibility requirements, duration limits, and benefit formulas. When computing expected pension benefits for any individual, we identify all pension entitlements they would accrue at each age from the first possible age of claim onward, based on their observed work history, earnings, and household attributes. By applying survival probabilities and discounting future benefit streams back to the baseline age using a real interest rate, the calculation yields a present value measure of total expected lifetime pension benefits, integrating across all covered public pension programs. This comprehensive inclusion captures the complexity and breadth of the benefit system, ensuring an accurate and policy-relevant measure of pension incentives faced by individuals in differing socioeconomic contexts.

3.4 Incentive Measures

Social security wealth is calculated as the present discounted value of all future pension benefits an individual is expected to receive upon retirement, taking into account the rules governing benefit eligibility, accrual rates, and the individual's expected longevity. The calculation requires determining, for each prospective retirement age, the annual pension entitlement based on the current policy parameters (such as age of eligibility and benefit formulas) and projecting these payments forward, accounting for possible survival in each future year. Each of these future expected benefits is then discounted back to the present using a three percent discount rate. This approach ensures that social security wealth reflects the full value, in today's terms, of a stream of anticipated retirement benefits conditional on surviving to and beyond each eligible age.

In practice, the calculation begins by specifying the policy-relevant retirement ages, ranging from 50 to 80, and the amount of yearly pension an individual would receive at each of these ages. For each future year from the minimum eligible age onward, the probability that the individual survives to that year is multiplied by the corresponding pension benefit for that year. These expected future payments are then discounted to the present. Summing across all future years yields the individual's social security wealth at a given baseline age. This method can incorporate

heterogeneity in life expectancy—such as differences by socioeconomic status—by applying group-specific mortality rates, thereby yielding more precise and inequity-sensitive measures of social security wealth.

4 Results

This section presents an analysis of how financial incentives and sociodemographic characteristics interact to shape retirement behavior across the population. Drawing on regression estimates for both the pooled sample and stratified subsamples, we examine the effects of social security wealth (SSW), implicit tax rates (ITAX), and labor earnings on the probability of retiring in the subsequent year. Careful attention is paid to the robustness of these effects across alternative model specifications, including controls for age (in both quadratic form and as a set of dummies), as well as stratification by socioeconomic group and gender. This approach enables the assessment of not only the average impact of policy-relevant variables but also the heterogeneity of these effects across key groups.

The results are positioned within the context of major pension reforms and their distributional consequences. By contrasting pooled analyses with those separated by gender, marital status, and socioeconomic status, the section illuminates both universal and group-specific patterns in retirement responsiveness. The findings also set the stage for interpreting the consequences of policy changes, such as variations in pension eligibility age, through a framework that distinguishes between mechanical (direct) and behavioral (indirect) effects. This dual perspective is crucial for understanding the broader implications for equity and policy design in the retirement system.

4.1 Estimating Retirement Probabilities

We closely follow the empirical strategy of Bingley, et. al. (2024) by estimating the following linear probability model:

$$R_{it} = \beta_0 + \beta_1 SSW_{it} + \beta_2 ITAX_{it} + \beta_4 X_{it} + \varepsilon_{it}$$

In this specification, retirement entry (R_{it}) is a binary indicator that equals one in the year the individual transitions to a pension as the primary source of income. The variable SSW_{it} denotes social security wealth, and $ITAX_{it}$ reflects the implicit tax rate on continued work, both capturing the incentive effects embedded in Denmark’s social security system. The vector X_{it} comprises control variables including earnings, dummies for year, sex, marital status, and functions of age. The error term ε_{it} captures unobserved determinants of retirement behavior.

Table 1: OLS Estimates of Retirement Probabilities for the Full Sample

	(1)	(2)	(3)	(4)
	Mean LE	Mean LE	SEG LE	SEG LE
SSW	0.168*** (0.000938)	0.115*** (0.00121)	0.131*** (0.000871)	0.0661*** (0.00105)
ITAX	0.0233*** (0.000343)	0.0106*** (0.000380)	0.0270*** (0.000360)	0.0134*** (0.000405)
Earnings	-0.0356*** (0.000551)	-0.0412*** (0.000479)	-0.0410*** (0.000556)	-0.0434*** (0.000481)
Male	0.0428*** (0.000336)	0.0260*** (0.000422)	0.0303*** (0.000314)	0.00999*** (0.000367)
Married	-0.00313*** (0.000147)	-0.00288*** (0.000143)	-0.00387*** (0.000147)	-0.00329*** (0.000143)
SEG2	0.0164*** (0.000262)	0.0151*** (0.000252)	0.00272*** (0.000284)	0.00877*** (0.000282)
SEG3	0.0127*** (0.000286)	0.0122*** (0.000268)	-0.0163*** (0.000358)	-0.00167*** (0.000364)
SEG4	0.00402*** (0.000324)	0.00405*** (0.000299)	-0.0335*** (0.000425)	-0.0141*** (0.000433)
SEG5	-0.0101*** (0.000443)	-0.00733*** (0.000394)	-0.0548*** (0.000562)	-0.0290*** (0.000540)
Age Dummies	-	X	-	X
Mean Dep. Var.	0.0671	0.0671	0.0671	0.0671
R ²	0.149	0.183	0.148	0.182
Individuals	1,144,799	1,144,799	1,144,799	1,144,799
Observations	12,043,111	12,043,111	12,043,111	12,043,111

Notes: Estimated coefficients from four separate OLS regressions with the dependent variable a binary indicator taking the value of one if an individual retires next year and zero otherwise. Social Security Wealth is discounted by three percent and cohort life expectancy. Columns 1-2 use life expectancy by sex and age, while columns 3-4 use life expectancy by sex, age, and five socioeconomic groups. Columns 1 and 3 include age and age squared, while columns 2 and 4 include age dummies. All specifications include year dummies. Socioeconomic group 1 (the lowest socioeconomic group) is the reference category. Social Security Wealth and Earnings are valued at 100,000 Euros at 2023 prices. The sample comprises a random 40 percent of the population aged 49-80 in the years 1985-2022 who are observed to work in at least one year. Retirement is defined as the first year in which the primary source of income is a pension; individuals are dropped from the sample the year following

retirement. Standard errors are clustered by individual; *** indicates $p < 0.01$.

Table 1 shows that incentive measures have conventional signs across specifications: higher SSW and ITAX increase the likelihood of an individual retiring next year. In contrast, higher earnings decrease the likelihood that an individual will retire next year. The magnitude of the SSW and ITAX coefficients decreases when moving from a quadratic specification for age to a full set of age dummies; however, the coefficient on earnings remains relatively stable across age specifications. While stratifying life expectancy by socioeconomic group reduces the magnitude of the SSW coefficient, it increases the magnitude of the ITAX coefficient; hence, the consequences of longevity stratification on incentive effects remain ambiguous based on these estimates alone.

There is a non-monotonic relationship between the socioeconomic group dummies, with the highest group being less likely to retire at each age than the lowest (omitted) socioeconomic group. Still, the second-lowest socioeconomic group is more likely to retire at each age than the lowest socioeconomic group. Age dummy specifications have the highest goodness-of-fit, but there is no significant difference in the results whether life expectancy is stratified by socioeconomic group..

Table 2: OLS Estimates for Women using Life Expectancy by Socioeconomic Group

	(1) All	(2) SEG 1	(3) SEG 3	(4) SEG 5
SSW	0.170*** (0.00192)	0.291*** (0.00574)	0.200*** (0.00491)	0.101*** (0.00359)
ITAX	0.0127*** (0.000508)	0.00174*** (0.000645)	0.0428*** (0.00163)	0.0317*** (0.00214)
Earnings	-0.0586*** (0.000876)	0.0158*** (0.00226)	-0.0923*** (0.00389)	-0.0628*** (0.000910)
Married	0.00234*** (0.000211)	-0.00592*** (0.000546)	0.00458*** (0.000508)	0.00358*** (0.000378)
Mean Dep. Var.	0.0705	0.0725	0.0771	0.0562
R ²	0.193	0.170	0.219	0.186
Individuals	550,600	120,665	151,323	134,696
Observations	5,658,171	965,171	1,117,943	1,336,357

Notes: Estimated coefficients from four separate OLS regressions with the dependent variable a binary indicator taking the value of one if an individual retires next year and zero otherwise. Social Security Wealth is discounted by three percent, and cohort life expectancy by sex, age, and five socioeconomic groups. All specifications include age, age squared, and year dummies. Column 1 includes dummies for socioeconomic groups. Social Security Wealth and Earnings are valued at 100,000 Euros at 2023 prices. For the estimates in column 1, the sample comprises a random 40 percent of the female population aged 49-80 in the years 1985-2022 who are observed to work in at least one year. Columns 2-4 contain subsamples in socioeconomic groups 1, 3, and 5. Retirement is defined as the first year in which the primary source of income is a pension; individuals are dropped from the sample the year following retirement. Standard errors are clustered by individual; *** indicates $p < 0.01$.

Table 2 presents estimates for women, pooled in Column 1 and split by Socioeconomic group in Columns 2-4. While the effects of SSW on retirement age decline with socioeconomic status, the effects of ITAX and earnings do not exhibit a clear pattern. A 100,000 Euro increase in SSW increases the probability of retirement at each age by three times as much for those in the lowest socioeconomic group compared to those in the highest group (20 percent versus 10 percent). Married women in the lowest socioeconomic group are less likely to retire at each age compared to unmarried women, whereas for higher socioeconomic groups, the difference is reversed.

Table 3: OLS Estimates for Men using Life Expectancy by Socioeconomic Group

	(1)	(2)	(3)	(4)
	All	SEG 1	SEG 3	SEG 5
SSW	0.0484*** (0.00159)	0.143*** (0.00585)	0.172*** (0.00454)	0.00699*** (0.00270)
ITAX	0.00870*** (0.000643)	-0.00211*** (0.000810)	0.0150*** (0.00207)	-0.00876*** (0.00222)
Earnings	-0.0278*** (0.000608)	0.0188*** (0.00171)	-0.0973*** (0.00289)	-0.0402*** (0.000630)
Married	-0.00534*** (0.000198)	-0.0152*** (0.000477)	-0.00342*** (0.000456)	-0.00131*** (0.000392)
Mean Dep. Var.	0.0642	0.0755	0.0704	0.0452
R ²	0.177	0.163	0.204	0.171
Individuals	594,211	135,092	169,011	145,698
Observations	6,384,940	1,066,621	1,264,142	1,528,881

Notes: Estimated coefficients from four separate OLS regressions with the dependent variable a binary indicator taking the value of one if an individual retires next year and zero otherwise. Social Security Wealth is discounted by three percent, and cohort life expectancy by sex, age, and five socioeconomic groups. All specifications include age, age squared, and year dummies. Column 1 includes dummies for socioeconomic groups. Social Security Wealth and Earnings are valued at 100,000 Euros at 2023 prices. For the estimates in column 1, the sample comprises a random 40 percent of the male population aged 49-80 in the years 1985-2022 who are observed to work in at least one year. Columns 2-4 contain subsamples in socioeconomic groups 1, 3, and 5. Retirement is defined as the first year in which the primary source of income is a pension; individuals are dropped from the sample the year following retirement. Standard errors are clustered by individual; *** indicates $p < 0.01$.

Table 3 presents results for men analogous to those presented for women in Table 2. Comparing the pooled samples of men and women in the first Columns of the respective tables, we can see that the male coefficients are significantly smaller in magnitude, indicating that men are less responsive to financial incentives to retire than women. For men, there is no obvious gradient in incentive effects across socioeconomic groups.

Table 4: OLS Estimates for Singles using Life Expectancy by Socioeconomic Group

	(1) All	(2) SEG 1	(3) SEG 3	(4) SEG 5
SSW	0.0261*** (0.00206)	0.0411*** (0.00589)	0.0762*** (0.00579)	0.00673* (0.00379)
ITAX	0.0207*** (0.000761)	0.0119*** (0.000969)	0.0388*** (0.00233)	0.0216*** (0.00270)
Earnings	-0.0401*** (0.000907)	0.00676*** (0.00230)	-0.0742*** (0.00391)	-0.0495*** (0.00104)
Male	0.00244*** (0.000700)	0.0124*** (0.00239)	0.0180*** (0.00181)	-0.00256** (0.00112)
Mean Dep. Var.	0.0679	0.0741	0.0713	0.0547
R ²	0.179	0.161	0.200	0.176
Individuals	410,208	100,146	102,151	97,762
Observations	3,421,452	696,733	645,097	756,384

Notes: Estimated coefficients from four separate OLS regressions with the dependent variable a binary indicator taking the value of one if an individual retires next year and zero otherwise. Social Security Wealth is discounted by three percent, and cohort life expectancy by sex, age, and five socioeconomic groups. All specifications include age, age squared, and year dummies. Column 1 includes dummies for socioeconomic groups. Social Security Wealth and Earnings are valued at 100,000 Euros at 2023 prices. For the estimates in column 1, the sample comprises a random 40 percent of the unmarried population aged 49-80 in the years 1985-2022 who are observed to work in at least one year. Columns 2-4 contain subsamples in socioeconomic groups 1, 3, and 5. Retirement is defined as the first year in which the primary source of income is a pension. Individuals are dropped from the sample the year following retirement or if they change marital status. Standard errors are clustered by individual; *** indicates $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 4 presents estimated coefficients for the sample of unmarried individuals. Those in the middle socioeconomic group have the largest magnitude incentive coefficients, indicating that they are the most responsive to incentives. Single men in the highest socioeconomic group are less likely to retire at any given age than single women in the highest group. For lower socioeconomic groups, this difference is reversed.

Table 5: OLS Estimates for Married Individuals using Life Expectancy by Socioeconomic Group

	(1) All	(2) SEG 1	(3) SEG 3	(4) SEG 5
SSW	0.0771*** (0.00122)	0.186*** (0.00379)	0.163*** (0.00359)	0.0299*** (0.00215)
ITAX	0.0111*** (0.000473)	-0.00207*** (0.000591)	0.0418*** (0.00154)	0.0309*** (0.00198)
Earnings	-0.0430*** (0.000567)	0.0397*** (0.00170)	-0.0866*** (0.00274)	-0.0463*** (0.000600)
Male	0.0110*** (0.000433)	0.0653*** (0.00167)	0.0386*** (0.00117)	-0.00137** (0.000656)
Mean Dep. Var.	0.0669	0.0741	0.0743	0.0488
R ²	0.184	0.169	0.213	0.172
Individuals	883,826	182,119	247,891	219,107
Observations	8,621,659	1,335,059	1,736,989	2,108,854

Notes: Estimated coefficients from four separate OLS regressions with the dependent variable a binary indicator taking the value of one if an individual retires next year and zero otherwise. Social Security Wealth is discounted by three percent, and cohort life expectancy by sex, age, and five socioeconomic groups. All specifications include age, age squared, and year dummies. Column 1 includes dummies for socioeconomic groups. Social Security Wealth and Earnings are valued at 100,000 Euros at 2023 prices. For the estimates in column 1, the sample comprises a random 40 percent of the married population aged 49-80 in the years 1985-2022 who are observed to work in at least one year. Retirement is defined as the first year in which the primary source of income is a pension. Individuals are dropped from the sample the year following retirement or if they change marital status. Standard errors are clustered by individual; *** indicates $p < 0.01$.

Table 5 presents results for married individuals analogous to those presented for singles in Table 4. Pooling socioeconomic groups, comparing the first columns of the respective tables, married individuals are three times as responsive to SSW as unmarried individuals, but they are only half as responsive to ITAX. Similar to single men, married men in the highest socioeconomic group are less likely to retire at any given age than married women in the highest group. For lower socioeconomic groups, this difference is reversed.

5 Counterfactual Analysis of Pension Reforms

To illustrate how the effects of pension reforms on retirement ages and benefit entitlements differ by socioeconomic status, we perform counterfactual simulations based on the estimates in Column 3 of Table 1. These estimates use the pooled sample, incorporate life expectancy

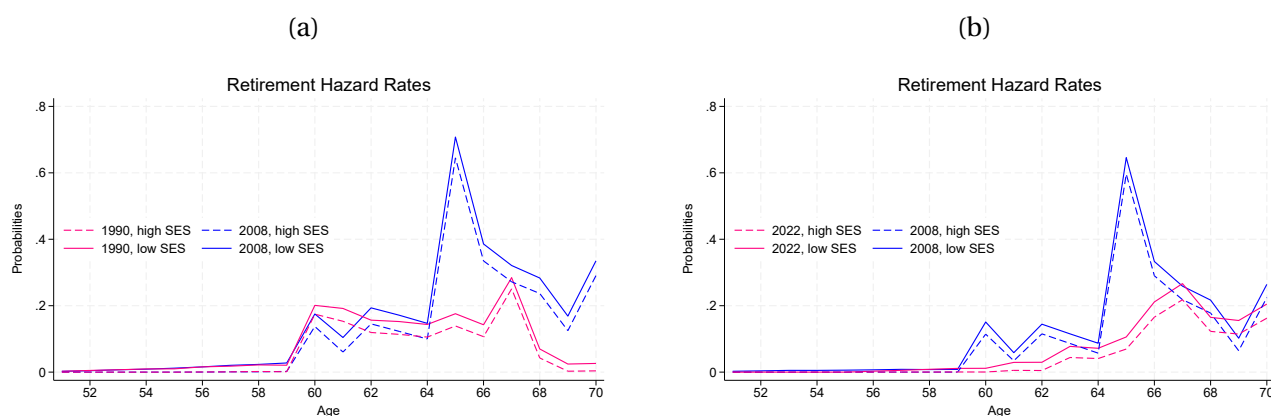
stratified by socioeconomic group, and control for a quadratic function of age.

We characterize two periods of reforms: 1990-2008 and 2008-2022. The first period spans the reduction of the age of first OAP entitlement from 67 to 65, which was announced in 1999 and implemented between 2004 and 2006. The mid-1990s saw the introduction of TBP, with the ages of first eligibility set at 50 and 55. Because the TBP was short-lived but grandfathered, we began the baseline of our first period beforehand to abstract from its effects. The second period spans the increase in the age of first OAP entitlement back to 67.

5.1 Retirement Age Simulations

To simulate the effects of a reform period on retirement ages, we predict retirement probabilities at each age in the base year and the end year of the period. Using the sample observed at baseline, first, we predict using benefit entitlements as implemented or announced at the base year, and second, using the same sample, we predict using benefits as implemented or announced at the end year. The left pane of Figure 4 shows predicted retirement hazards for the first period (1990-2008) and the right pane shows hazards for the second period (2008-2022).

Figure 4: Simulations of Retirement Ages by Socioeconomic Group



Note: Predicted retirement age probabilities for the reform period 1990-2008 (left pane) and 2008-2022 (right pane). Using the base year sample, the probability of retiring at each age is predicted using the estimates in Column 3 of Table 1, with benefits at both the base year and end year, separately by socioeconomic group.

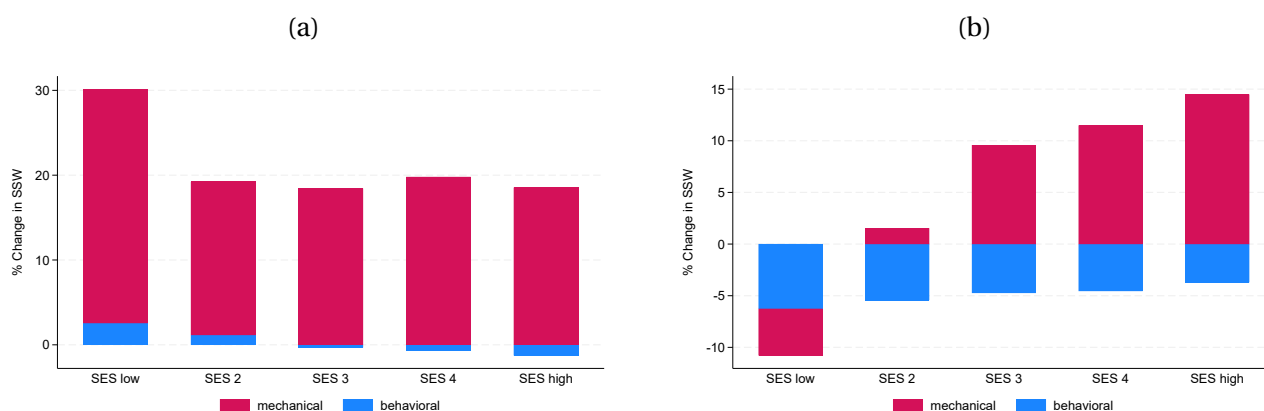
Reforms from 1990 to 2008 shifted the spike in retirement hazard to follow the change in age of first OAP eligibility from 67 to 65. Retirement hazards are approximately 0.03 lower at each age for those in the highest socioeconomic group compared to those in the lowest; a difference that remains constant over the reform period. In contrast, the right pane of Figure 4 shows that reforms from 2008 to 2022 shifted the spike in retirement hazard to follow the change in age of

first OAP eligibility back from 65 to 67. Furthermore, there is no longer a spike in the retirement hazard at age 60 in 2022, corresponding with the delay in the first age of PEW eligibility.

5.2 Mechanical and Behavioral Effects

In this subsection, we seek to differentiate between two distinct effects of social security reforms on the distribution of SSW. First, by holding the distribution of retirement ages constant, we can isolate the direct effect of reforms on the distribution of pension benefits. By aggregating these changes and weighting them according to stratified survival probabilities, we obtain the direct effect of reforms on the distribution of SSW. Second, social security reforms are likely to influence individuals' retirement age decisions by altering the incentives to remain in the labor force. These behavioral responses generate secondary effects, whereby reforms impact inequality through changes in retirement patterns and, consequently, in the distribution of SSW. We denote the direct effects on SSW of changing benefit entitlements while holding retirement ages constant as the mechanical effects of the policy change. We refer to the secondary effects that allow retirement ages to vary as behavioral effects.

Figure 5: Simulation of SSW Decompositions by Socioeconomic Group



Note: Percentage changes in SSW (weighted by predicted ages of retirement) during 1990-2008 (left pane) and 2008-2022 (right pane). Mechanical changes reflect changes in benefit entitlements from the base year to the end year, for the sample in the base year, with retirement ages fixed at the base year. Behavioral changes reflect changes in benefit entitlements due to predicted changes in retirement age probabilities due to changed incentives based on estimates in Column 3 of Table 1 and as illustrated in Figure 4.

The left pane of Figure 5 shows that the mechanical effect of the 1990-2008 reforms was to increase the generosity of expected lifetime benefits by 30 percent for the lowest socioeconomic group and by approximately 18 percent for other groups. Behavioral effects that induce changes in retirement ages cause much smaller increases in SSW, ranging from zero to 2 percent. The

decompositions of SSW changes illustrated in the right pane of Figure 5 for the reform period 2008-2022 are in stark contrast. There is a gradient in the mechanical effects of the reforms, ranging from a 4 percent reduction in SSW for the lowest socioeconomic group to a 14 percent increase for the highest, with groups 2-5 all experiencing an increase in SSW. The behavioral effects of the second period of reforms reduce SSW quite similarly across socioeconomic status, with a much more modest gradient, ranging from a six percent reduction to a three percent reduction.

5.3 Discussion

The magnitude and distribution of the mechanical effects depend on the direction and nature of reform. When the pension eligibility age was reduced (1990–2008), lower SES groups, often more dependent on public pensions, saw outsized increases in their expected pension wealth, relative to higher SES groups. This effect reflects the progressive intent in pension policy: lowering the eligibility age confers proportionally greater gains to those with fewer resources. Yet, in the subsequent period (2008–2022), when the eligibility age rose again, the pattern reversed, and mechanical effects became regressive: the lowest SES group saw a reduction in pension wealth, while higher SES groups experienced gains. This inversion is particularly concerning from an equity perspective, as it suggests that increasing the eligibility age without compensatory adjustments for vulnerable groups can undermine the redistributive objectives of public pensions.

In contrast to the mechanical effects, the *differential* behavioral responses by SES group in both periods were markedly more modest. Individuals did not delay or accelerate retirement differentially. Instead, the observed changes in actual retirement ages, while large on average, were relatively small between SES groups, with only incremental adjustments in social security wealth relative to the mechanical effects. This has significant policy implications, as it demonstrates a limit to the ability of reforms to induce differential labor supply shifts, particularly among those whose choices are constrained by factors such as health status or employment opportunities. SES gradients in retirement behavior, while consistently present, proved stable and resistant to large swings resulting from policy changes.

The interplay between mechanical and behavioral effects thus becomes a site of potential policy conflict or synergy. While policymakers may expect that shifting eligibility ages will generate the desired fiscal or labor market responses, the empirical evidence suggests that such behavioral effects are secondary. The mechanical effects of reform dominate not just the fiscal calculus, but also the distributional outcomes, potentially exacerbating retirement inequalities if not carefully managed. A key discussion point is whether this underlines a broader challenge

facing pension policy: how to ensure reforms designed for sustainability do not inadvertently deepen existing socioeconomic disparities in old age security.

These findings challenge the simplistic assumption that work and retirement are fungible across social groups. Higher SES individuals are better positioned to adjust to less generous entitlements, perhaps due to longer life expectancy, more accumulated private wealth, or jobs that are more amenable to later retirement. In contrast, those at the lower end—who typically face shorter life expectancies and greater dependence on public pensions—are disproportionately harmed when eligibility requirements are tightened. The analysis, by incorporating stratification by SES and controlling for life expectancy, highlights the necessity for targeted policy responses—be it through differentiated eligibility ages, supplementary benefits, or protective carve-outs for vulnerable workers.

6 Conclusion

We provide robust evidence that financial incentives embedded in the pension system, namely social security wealth and implicit tax rates, actively shape the timing of retirement across a range of demographic and socioeconomic profiles. Consistent with prior literature, a greater accumulation of pension wealth and higher implicit taxes on continued work each significantly increase the probability of retirement in the following year. Conversely, higher labor earnings serve to postpone retirement, a pattern that remains stable across model specifications. Yet, the heterogeneity of these effects by gender, marital status, and especially socioeconomic status (SES) highlights the limitations and potential risks of relying solely on universal policy levers to steer retirement behavior.

A key contribution of this analysis lies in its systematic stratification by SES. For both men and women, and among single and married individuals, a clear gradient emerges: those in the lowest socioeconomic groups are consistently more responsive to increases in social security wealth, with the marginal effect of an additional 100,000 Euros on the retirement probability often being two or three times larger for these groups compared to their higher-SES peers. This pronounced sensitivity among vulnerable populations underscores the importance of public pensions for groups with fewer alternative retirement resources. However, the responsiveness to implicit tax rates and earnings is less strongly differentiated by SES, and the gender comparisons reveal an additional layer of complexity, as women's retirement decisions appear more sensitive to financial incentives than those of men.

The counterfactual simulations examining the impact of specific pension reforms reveal both the strengths and pitfalls of policy-driven changes to retirement incentives. The reforms studied—first, a reduction and then a subsequent increase in the age of pension eligibility—produced

marked shifts in the distribution of expected pension wealth across SES groups. Lowering the pensionable age primarily benefited individuals in lower SES groups, enlarging their pension accrual and narrowing inequality. In contrast, raising the eligibility age later reduced pension wealth for the same populations, while increasing it for the highest SES groups due to longer life expectancies and greater capacity to delay retirement. This reversal reflects the regressive consequences that can inadvertently arise when reforms are not carefully calibrated to the needs of diverse groups.

Strikingly, while the direct (“mechanical”) effect of changing pension entitlements exerts a substantial impact on benefit distributions, the observed (“behavioral”) responses in retirement timing are far smaller and vary less across groups. Although policy changes shift retirement ages on average, adaptation among different socioeconomic strata is limited, suggesting that barriers, such as health, job characteristics, and differential labor market opportunities, limit the room for behavioral adjustment. This finding raises questions about the effectiveness of uniform eligibility shifts as a tool for equalizing outcomes and points to the need for complementary measures to protect the most vulnerable.

In summary, the results highlight both the power and the limitations of pension policy reforms as instruments for shaping retirement behavior and managing inequality in old age. Mechanical changes in entitlements remain the dominant driver of outcome disparities, while behavioral changes are modest and unevenly distributed. To safeguard both the adequacy and equity of retirement income, policymakers must look beyond uniform age thresholds and instead consider targeted interventions—such as differentiated eligibility ages, supplements for those with lower life expectancy, and continued monitoring of behavioral responses—to ensure that reforms promote both fiscal sustainability and social fairness in increasingly diverse aging populations.

References

- Cairns, A. J. G., Kallestrup-Lamb, M., Rosenskjold, C., Blake, D., and Dowd, K. (2019). Modelling socio-economic differences in mortality using a new affluence index. *ASTIN Bulletin*, 49(3):555–590. [6](#)
- Durbin, J. and Koopman, S. J. (2012). *Time series analysis by state space methods*, volume 38. OUP Oxford. [8](#)
- Fernald, L. C., Kariger, P., Hidrobo, M., and Gertler, P. J. (2012). Socioeconomic gradients in child development in very young children: Evidence from india, indonesia, peru, and senegal. *Proceedings of the National Academy of Sciences*, 109(Supplement 2):17273–17280. [7](#)
- Frederick, C. B., Snellman, K., and Putnam, R. D. (2014). Increasing socioeconomic disparities in adolescent obesity. *Proceedings of the National Academy of Sciences*, 111(4):1338–1342. [7](#)
- Goldman, N., Gleib, D. A., and Weinstein, M. (2018). Declining mental health among disadvantaged americans. *Proceedings of the National Academy of Sciences*, 115(28):7290–7295. [7](#)
- Human Mortality Database (2023). University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Data downloaded on 10th October, 2023. [7](#), [8](#)
- Kallestrup-Lamb, M., Kjærgaard, S., and Rosenskjold, C. P. (2020). Insight into stagnating adult life expectancy: Analyzing cause of death patterns across socioeconomic groups. *Health Economics*, 29(12):1728–1743. [6](#)
- Kreiner, C. T., Nielsen, T. H., and Serena, B. L. (2018). Role of income mobility for the measurement of inequality in life expectancy. *Proceedings of the National Academy of Sciences*, 115(46):11754–11759. [7](#)
- Mackenbach, J. P., Valverde, J. R., Artnik, B., Bopp, M., Brønnum-Hansen, H., Deboosere, P., Kaleidene, R., Kovács, K., Leinsalu, M., Martikainen, P., et al. (2018). Trends in health inequalities in 27 european countries. *Proceedings of the National Academy of Sciences*, 115(25):6440–6445. [7](#)
- Preston, S., Heuveline, P., and Guillot, M. (2000). *Demography: Measuring and Modeling Population Processes*. Demography: Measuring and Modeling Population Processes. Wiley. [8](#)
- Rizzi, S., Kjærgaard, S., Boucher, M.-P. B., Camarda, C. G., Lindahl-Jacobsen, R., and Vaupel, J. W. (2021). Killing off cohorts: Forecasting mortality of non-extinct cohorts with the penalized composite link model. *International Journal of Forecasting*, 37(1):95–104. [7](#), [8](#)
- Sortsø, C., Thygesen, L. C., and Brønnum-Hansen, H. (2011). Database on Danish population-based registers for public health and welfare research. *Scandinavian Journal of Public Health*, 39(7_suppl):17–19. [7](#)
- Stephens, A. and Zaninotto, P. (2020). Lower socioeconomic status and the acceleration of aging: An outcome-wide analysis. *Proceedings of the National Academy of Sciences*, 117(26):14911–14917. [7](#)