Saving after Retirement and Preferences for Residual Wealth

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Abstract

We use administrative data for Norway to estimate an incomplete-market life-cycle model of retired singles and couples with a bequest motive, and uncertain longevity and health. We allow the parameters of the bequest utility to differ between households with and without offspring. Our estimates imply a very strong utility of residual wealth (bequest motive), in line with the estimates by Lockwood (2018). The bequest motive accounts for approximately three-quarters of aggregate wealth at age 85. More surprisingly, we estimate similar utility of residual wealth for households with and without offspring. We interpret this as, *prima facie*, evidence that the utility of residual wealth represents forces beyond an altruistic bequest motive.

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1 Introduction

The average retired household dissaves at a much lower rate than predicted by the standard life-cycle model.[1] Furthermore, richer retirees, both in terms of wealth and income, dissave at lower rates than poorer ones, to an extent that cannot be accounted for by their lower mortality rates.

The potential explanations for these patterns fall into two main categories (De Nardi, French and Jones, 2016*b*). The first emphasises the risks of medical and long-term care expenses late in life and their interaction with differences in mortality risk between richer and poorer retirees. The low dissaving would be the result of precautionary asset accumulation to self-insure against such risks (Palumbo, 1999; De Nardi, French and Jones, 2010; French and Jones, 2011; Kopecky and Koreshkova, 2014; Nakajima and Telyukova, 2024). This saving motive is stronger for richer individuals because they are less likely to be covered by means-tested government-provided insurance of medical and long-term care expenses (e.g., Medicaid in the U.S., De Nardi, French and Jones, 2016*a*), and because they have longer expected lifetimes.

The second class of explanations emphasises bequest motives. Specifically, individuals may derive utility from accumulating or donating their wealth, possibly, but not necessarily, at the time of death. This implies an additional incentive to accumulate wealth, resulting in higher wealth levels at death over and above any accidental bequests stemming from the inability to annuitise longevity risk. To the extent that the utility from bequests is non-homothetic, in the sense that bequests are a luxury good, the bequest motive can also account for the differential saving patterns between poorer and richer retirees.

The two motives have similar implications for wealth accumulation late in life.[2] For this reason, a consensus on their relative importance has not yet been reached. As shown by Dynan, Skinner and Zeldes (2002) and elaborated in De Nardi et al. (2010), the problem is one of identification. Adding a luxury bequest motive to a model featuring medical and long-term care expense risk does not change saving patterns significantly. For this reason, a number of papers have instead focused on other data moments beyond saving to separately identify the two motives. Ameriks, Caplin, Laufer and Van Nieuwerburgh

[1] Nakajima and Telyukova (2015) document that the pattern for the *median* retired wealth holder displays substantial variation across countries.

[2] A preference for owner-occupied housing is a third saving motive often emphasised in explaining savings behaviour after retirement (Nakajima and Telyukova, 2015, 2017, 2020; McGee, 2021; French, Jones and McGee, 2023). Barczyk, Fahle and Kredler (2023) point to an additional role for owner-occupied housing as a device to commit to strategically reward children for the provision of informal care. We abstract from housing in the current paper because we observe similar wealth profiles for homeowners and renters in our data.

(2011) and Ameriks, Briggs, Caplin, Shapiro and Tonetti (2020) use strategic survey questions to identify the bequest utility parameters. Lockwood (2018) targets long-term care insurance decisions to separately identify the precautionary saving and bequest motive. Kværner (2023) exploits the response of inter-vivos transfers to negative life expectancy news.

This paper follows a third approach. It estimates a life-cycle model of retirees' savings using population wealth data from Norway. Because medical and nursing home expenses are effectively fully insured in Norway, this leaves only longevity risk as a driver of precautionary saving. Moreover, our administrative dataset has four main advantages compared to prior studies. First, it has universal coverage and is highly accurate since wealth is third-party reported for tax purposes. As a result, we can document and exploit for our estimation, life-cycle profiles of wealth at various percentiles of the distribution, for singles and couples, for households with and without offspring and conditional on health status. Second, because inheritances were taxed over the sample period, we observe all inter-vivos transfers, including from parents to offspring. These transfers are substantial and quantitatively relevant when estimating wealth age profiles for retirees. Third, we directly observe individuals moving into long-term care, allowing us to precisely account for how a deterioration in health and accession to nursing homes affect wealth accumulation. Finally, the relatively long panel dimension of the data allows us to precisely estimate the relevant wealth age profiles, dealing properly with time, age, and cohort effects.

Equipped with precisely estimated wealth profiles from age 70 to 90 for 20 groups, we build an incomplete-markets life-cycle model of retired singles and couples with a bequest motive. Specifically, our model incorporates state-dependent health and mortality risks, returns risk, and key components of the tax and transfer system in Norway, including wealth and income taxes, as well as user payments for long-term care. Importantly, and contrary to most of the literature, we allow the parameters of the bequest utility to differ between households with and without offspring.

Our main result is that our estimates imply a very strong utility of residual wealth (bequest motive), in line with the estimates by Lockwood (2018). The "bequest motive" accounts for three-quarters of aggregate wealth at age 85. More surprisingly, our estimate of the utility of residual wealth is very similar for households with offspring as those without. We interpret this as strong, *prima facie*, evidence that the utility of residual wealth is driven by forces beyond an actual bequest motive.

Finally, we use the model to assess the wealth response of the elderly population to changes in wealth and estate taxes. The model implies an elasticity of taxable wealth with respect to the after-wealth-tax rate of about 4.2, which is in the ballpark of comparable empirical estimates (Brülhart, Gruber, Krapf and Schmidheiny, 2022; Jakobsen, Jakobsen, Kleven and Zucman, 2020). The response is mostly due to the (mechanical) impact of the change in the after-tax return of wealth accumulation with little change in saving. For the same reason, the model implies that the abolition of estate taxation would reduce tax revenue with hardly any effect on wealth accumulation.

Related literature. Our paper has two main aims. The first one is to identify the role of the utility of residual wealth in accounting for the low rates of dissaving of the elderly relatively to the prediction of the life-cycle model (the retirement saving puzzle). De Nardi et al. (2016*b*) provide a recent survey of the literature on the puzzle.[3] Our approach is similar to Christensen, Kallestrup-Lamb and Kennan (2022) in that we address this identification problem by focusing on a country where long-term care expense risk is negligible, thus allowing us to identify the bequest motive.[4] However, while Christensen et al. (2022) restrict their focus to a very small and selected sample of single individuals not owning homes in Denmark, we estimate the bequest motive on *all* types of households in Norway. In common with Braun, Kopecky and Koreshkova (2016), Nakajima and Telyukova (2020) and De Nardi, French, Jones and McGee (2025) we model couples in addition to single households. The distinction is important due to the differences in wealth at retirement, health and life expectancy by marital status, sex and age in the data, as well as for the additional income risk associated with spousal death.[5]

The second goal of the paper is to understand the extent to which the utility of residual wealth captures, in a reduced form fashion, other forces beyond an actual bequest motive. We make progress in this direction by estimating separately the utility of residual wealth for households with and without offspring. This follows the early contribution of Hurd (1987, 1989) who posited that differences in wealth accumulation between households with and without offspring provide a measure of the strength of the bequest motive. Contrary to us, Hurd assumes that only individuals with offspring have a bequest motive and, on the basis of similar rates of wealth growth for the two populations, concludes that the bequest motive is economically negligible.

[3]A related yet different literature attempts to use saving behaviour also before retirement to identify bequest motives (Pashchenko and Porapakkarm, 2023).

[4]Similarly, Van Ooijen, Alessie and Kalwij (2015) presents wealth patterns by age in the Netherlands, a country where long-term care expense risk is also negligible, consistent with the patterns in our current paper.

[5]A less directly related paper, although it uses the same dataset, is Halvorsen, Hubmer, Ozkan and Salgado (2021), which estimates a life-cycle model over the whole working life augmented with a common to-all bequest motive. They use the model to assess the relative contribution of various forces, namely heterogeneity in lifetime income and returns, as well as a bequest motive, to wealth concentration.

Kopczuk and Lupton (2007) show that the findings in Hurd (1987, 1989) are due to the assumption of zero bequest motive among households without offspring. They instead assume a *common* strength of the bequest motive in the two populations but allow for its presence to reflect unobserved heterogeneity. They estimate the motive to be economically meaningful and its incidence higher for households with offspring, although the difference is only marginally statistically significant. Our approach assumes that the bequest motive affects both populations, but we allow its strength to differ. We find that the bequest motives for households with and without offspring are very similar, almost indistinguishable, suggesting that the utility from residual wealth is driven by forces beyond an altruistic bequest motive.

Road map. The paper is organised as follows. Section 2 describes the data and the institutional setting. Section 3 introduces our structural model. Section 4 discusses the estimation methodology, while Section 5 presents the parameter estimates. Section 6 uses the model to assess the contribution of the bequest motive on the wealth accumulation of the elderly, as well as the response of the latter to estate taxation. Section 7 concludes.

2 Data and institutional setting

This section is organised as follows. We first present the relevant institutional setting for our analysis. Next, we introduce the data sources, variable definitions, sample restrictions, and summary statistics applied to the administrative data from Norway. Lastly, we discuss the estimation targets: wealth profiles by age for different household subsets and the wealth drop upon nursing home accession.

2.1 Institutional setting

Our analysis relies on the argument that long-term care and, in general, health-related expenditure risks are not important drivers of post-retirement saving in Norway. In what follows, we introduce the relevant aspects of the Norwegian long-term care and healthcare system.

Long-term care. The near totality of long-term care is publicly financed in Norway.[6] In practice, individuals can choose among nursing homes, both private and public, all

[6] The Hospital Act of 1970 made local counties (municipalities from 1988) responsible for running nursing homes for those who need care, including long-term care for the elderly.

financed within the public system. Within the context of the publicly-funded system, many municipalities allow individuals to choose from a list of public and approved private nursing homes. The latter account for around 11.6 percent of long-term care provision (Førland, Ambugo, Døhl, Folkestad, Rostad and Sundsbø, 2020).[7] There exists only a very limited number of private self-pay alternatives.[8] These fully private alternatives are very expensive and relevant only for a selected few households in the top 1 percent of the wealth distribution, which is excluded from our analysis below. The relevant long-term care option for the rest of the population is the publicly funded system, which is financed through a progressive system of user fees detailed in Section 4.

Health care. Norway has an effectively Beveridgean public health care system where the government provides health care for its citizens, financed by taxes. All approved treatments are covered by the public system, and there is limited user payment. According to the 2012 Norwegian survey of consumer expenditure, the average share of total medical expenses out of personal income for individuals older than 70 years was around 5 percent. It was mainly accounted for by dental services and auxiliary equipment (3 percentage points) and out-of-pocket drug expenses (1 percentage point). These shares reflect the fact that, while there exist private alternatives—e.g., for relatively uncomplicated emergency room tasks or general practitioners—individuals tend to be treated in the public health care system whenever the treatment is expensive. This motivates us to abstract from health spending and health spending risk in the model presented in Section 3, with the exception that we do include a reduction in wealth upon nursing home accession, due to the evidence in Section 2.3.2.

2.2 Data

We use administrative data from Norway. The data contain information from tax records on the wealth and income of all individuals with tax residence in Norway. Because Norway levies a wealth tax, the tax data contain detailed household portfolio information by broad asset classes. Prior to 2014, there was also an inheritance tax. We therefore restrict our sample to the years from 2005 to 2013 because we use inheritance tax data to measure the extent of inter-vivos transfers and transfers at death. The data are matched to population data with information on individual characteristics such as birth year, sex,

[7]This includes both institutions run by religious or humanitarian organisations and private companies.

[8]There is no official statistic on the extent of fully-private nursing homes. However, occasionally, newspaper articles present luxury versions of nursing homes with prices of around NOK 1 million (around $100,000) per year, see, e.g., tv2.no and a-magasinet.

marital status, and number of children. Finally, we combine the address registry and the population censuses to observe whether individuals move into long-term care. We additionally use the administrative data on deaths to compute expected mortality rates within subgroups of the population.

Variable definitions. Our model features households who consume and save out of their income and who differ by age, sex, health and marital status. Beyond these traits, we use data on income and wealth to estimate our model.

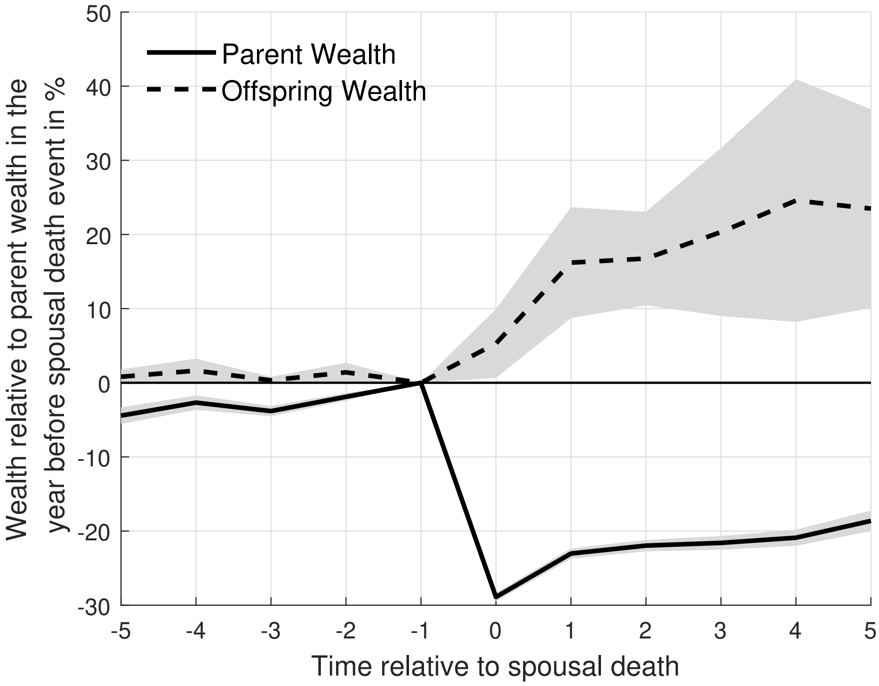
Permanent income. Permanent income at retirement captures in a parsimonious way households' ex-ante heterogeneity (e.g. De Nardi et al., 2016*a*). Households with different permanent income ranks not only receive different flows of retirement income but also face different processes for health and mortality. We use gross pension income as our measure of *gross* permanent income. Pension income includes recurring income from social security, as well as private and public occupational pensions.

Although there is some flexibility in when an individual receives a pension, from the age of 70, almost all individuals are retired, and there is limited time variation in annual pension income, except for annual indexation. We therefore use pension income at age 70 within the cohort to define an individual's position in the gross permanent income distribution.

While permanent income, as captured by gross pension income, is invariant over the lifetime, the mapping from gross pension income to disposable income reflects two additional sources of heterogeneity. The first is that the total tax burden depends on taxes other than that on pension income, such as capital income and wealth. The second is that we need to consider user payments for long-term care, as discussed in Section 4.

Wealth. The second main variable is household wealth. We define wealth as the sum of net worth (housing equity + stocks + stock funds + bonds + deposits + private business wealth + ownership of private loans - debt) and the net present value of inheritances given. For most wealth variables, the data contain market values. A notable exception is housing equity, for which we use the estimated valuations from Fagereng, Holm and Torstensen (2020) because the tax values are imprecise prior to 2010. The other exception is private business wealth which is valued according to a criterion close to book value (see the discussion in Fagereng, Holm, Moll and Natvik, 2021). We sidestep this issue by restricting our sample to the bottom 99 per cent of wealth holders for whom the portfolio share of private business wealth is negligible.

One issue that needs addressing is the value of inheritances given (inter-vivos transfers). The average cumulated value of these inheritances is sizeable and, conceptually,



Notes: The figure shows the estimated response of parent and offspring wealth relative to parent wealth in t-1, estimated using equation (1) and (2), respectively. Offspring wealth is defined as the sum of all household wealth of all households where offspring belong. The parent sample contains households with offspring. The regressions are weighted by parent wealth and relative parent wealth at $t-1$ to ensure that the results resemble a population average. The shaded areas represent the 95% confidence bands.

Figure 1: Wealth drop around spousal death.

is akin to end-of-life bequests. One way to account for these inheritances is to allow for such transfers within the model. However, this complicates the model significantly. Instead, we choose to keep the model relatively simple by only allowing for end-of-life bequests and account for inheritances given as part of these. To this effect, we carry over the observed inter-vivos inheritances given by our retired households from the estate tax registry to the end of life, compounding them at the average real return in our sample in the years thereafter (1.72 percent).

A complication is that even after we correct for observed transfers from the estate tax registry, there is a large wealth drop when a member of a couple dies. To estimate the size of this drop in wealth, we estimate the following event-study model for parents

$$\frac{\text{wealth}_{i,t+k} - \text{wealth}_{i,t-1}}{\text{wealth}_{i,t-1}} = \sum_{k=-5}^{5} \beta_k D_{t+k} + \varepsilon_{i,t} \tag{1}$$

where $\text{wealth}_{i,t+k}$ is the wealth of household i and D_{t+k} is a dummy equal to one in year

$t + k$ relative to the spousal death event at time t. The coefficients β_k thus estimate the percent change in wealth relative to wealth in the year before the spousal death event. For offspring, we estimate the following adjusted event-study model

$$\frac{\text{offspring wealth}_{i,t+k} - \text{offspring wealth}_{i,t-1}}{\text{wealth}_{i,t-1}} = \sum_{k=-5}^{5} \beta_{k,o} \cdot D_{t+k} + \varepsilon_{i,t} \tag{2}$$

where offspring wealth$_{i,t+k}$ is the total wealth held by *all* households featuring an offspring of household i. The coefficients $\beta_{k,o}$ thus estimate the change in offspring wealth relative to parental household wealth in the year before the parent dies.

Figure 1 shows parent and offspring wealth around a parent death event where there is a surviving spouse. Parental wealth drops by about 28.9% and offspring wealth increases by a comparable amount in the aftermath of the spousal death event.[9] We interpret this as a transfer from parents to offspring and include it as part of inter-vivos transfers.[10] Because we cannot precisely observe this wealth drop at the individual level, we impute inter-vivos transfers when a member of the couple dies, as 28.9 percent of household wealth in the previous year. These imputed inter-vivos transfers are thus included as part of the wealth in the surviving household.

Sample restrictions. We restrict attention to households whose head is between 70 and 90 years old in order to abstract from labour supply decisions. Among these households, we drop: (1) households with negative net wealth (2.4 percent) to enable estimation of log wealth profiles; (2) households in the top 1 percent of the wealth distribution of their cohort at age 70; (3) households for whom the annual growth rate of wealth is greater than 100 percent in absolute value (2.7 percent); and (4) households whose gross pension income is below the minimum threshold (approximately \$10,000 per year) in the Norwegian social security system (0.08 percent of the population).[11] The final sample consists of 2,393,863 household-year observations between 2005 and 2013, approximately 265,000 households per year.

Descriptive statistics. Table 1 presents descriptive statistics for our sample of households. We highlight four observations. First, 63 percent of retired households between

[9] In Figure A.1, we also document that this wealth drop is smaller for households with no offspring but that, conditional on having children, it does not vary much with the number of children.

[10] This is a pattern of transfers similar to what has been documented for the U.S. (French, De Nardi, Jones, Baker and Doctor, 2006; Poterba, Venti and Wise, 2011; De Nardi, French, Jones and McGee, 2023; French et al., 2023).

[11] Additionally, we exclude households residing in the counties of Troms and Finnmark (5 percent of the population) because of preferential tax treatment.

	Mean	S.D.	P10	P50	P90
Panel A: Demographics					
Age	78.75	5.73	71	78	87
Singles	0.63	0.48			
Male	0.38	0.48			
With children	0.86	0.35			
Homeowner	0.88	0.32			
In nursing home	0.05	0.22			
Panel B: Wealth and Income ($1'000)					
Household net worth	869.4	1,594.7	190.3	675.1	1,673.1
Household net worth excl. inter-vivos transfers	773.1	1,535.7	121.2	598.9	1,519.7
Individual pension income	42.3	18.6	23.4	38.4	65.5

Notes: Descriptive statistics for our sample of individuals aged 70 to 90 in 2005 to 2013 expressed in 2011 UxcS dollars. The average PPP ratio exchange rate over the sample period is 11.35 Kr/$.

Table 1: Descriptive statistics.

age 70 and 90 are single households. Second, the vast majority, 86 percent, have children. However, childless households still account for a significant portion of our sample, allowing us to differentiate between households with and without offspring. Third, by comparing wealth with and without the net present value of inter-vivos inheritances given, about 11% of wealth consists of the net present value of inheritances given, suggesting that it is important to account for inter-vivos transfers when studying bequest motives. Fourth, home ownership is widespread: 88 percent of households in our sample own homes. It is even higher, at 96 percent, if we restrict attention to households at age 70 because individuals tend to move into nursing homes with age.[12]

2.3 Estimation targets

2.3.1 Wealth age profiles

The main estimation targets for our model are the profiles of average wealth by age. A challenge in computing them is that one needs to distinguish between time, age, and cohort effects. Because time, age, and cohort dummies are perfectly collinear, identifying these effects relies on structural assumptions. We follow Deaton and Paxson (1994) and

[12]Homeownership is very persistent among the retired households in our data. 98.54% of homeowners in year t are homeowners also in year $t + 1$. Of the 1.46% who transition into non-homeownership, we observe that 27.4% of these enter nursing homes.

assume that the time effect is orthogonal to a linear time trend such that any linear time trend can be decomposed into a cohort and an age effect.

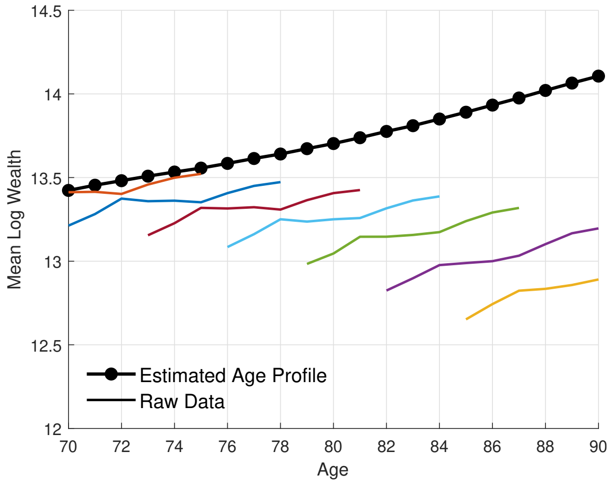
To illustrate how the time-age-cohort decomposition operates, Figure 2a shows estimated age profiles of wealth and raw data for selected cohorts. In the raw data, some movements are similar across all cohorts (all raw data profiles start in the same year in Figure 2a). These movements are interpreted as time effects and are taken out. Moreover, moving between cohorts, the wealth profiles shift. These shifts are interpreted as cohort effects and are also taken out. What is left is the average growth rate by age after taking out the time and cohort effects, the black circled line in Figure 2a, which starts from the average value at age 70 for the cohort born in 1935.

The rest of Figure 2 displays age profiles of wealth within groups. For our purpose of motivating and estimating a household model, we highlight four key facts in Figure 2. First, wealth is approximately flat or monotonically increasing in age, both in the aggregate (2a) and within all population subgroups. This holds by percentiles of initial wealth with (2c) or without (2d) offspring, by marital status (2b), by initial homeownership (2e), and by health as measured by admission to a nursing home (2f). A standard life-cycle model without a bequest motive cannot explain these features without large medical expenses or long-term care risks, which are structurally absent in Norway. Hence, the data point toward the importance of a bequest motive.

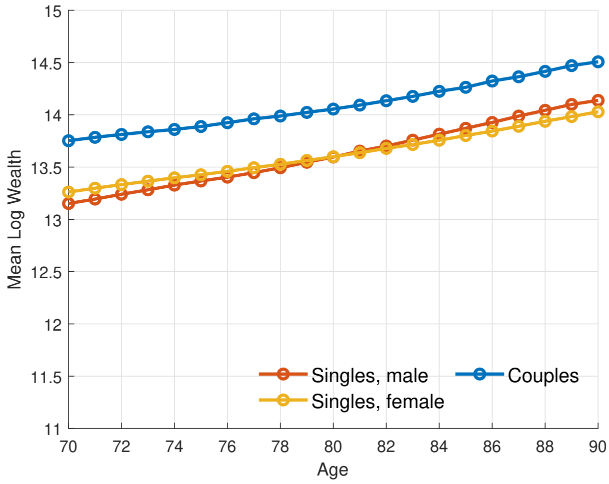
Second, the wealth profiles by age are steeper for poorer households. This also holds when we exclude the net present value of inter-vivos transfers from wealth in Figure A.3. The effect is driven by the poorest groups, whose wealth at 70 is relatively low.

Third, the average age profiles are relatively similar between households with and without offspring. Panels 2c and 2d reveal that childless households have a steeper wealth profile among low-wealth households, but relatively similar wealth profiles among wealthier households.

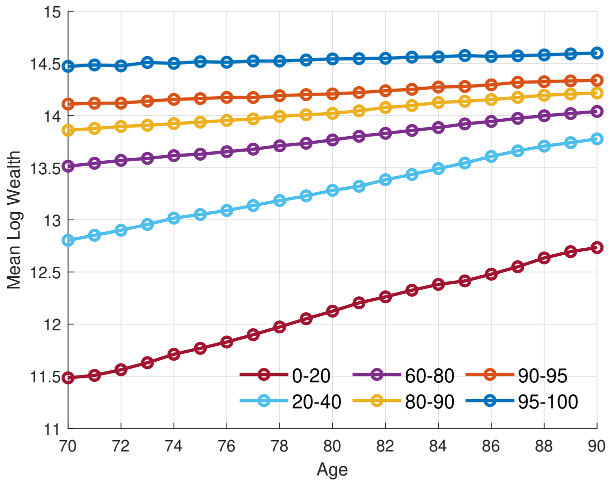
Fourth, wealth is increasing with age, both for homeowners and renters. This finding contrasts with the results for the U.S. in Nakajima and Telyukova (2020), who find that wealth declines with age for renters but is flat for homeowners. Given the relative similarity in growth rates once the level differences are controlled for, this motivates our choice of abstracting from separately modelling housing. As further support for this assumption, in Figure A.2 in Appendix A, we present wealth profiles by age, decomposed into housing wealth, financial wealth, and the net present value of inter-vivos transfers, showing that wealth increases with age also within each asset class. Hence, the wealth pattern we observe is not due to the accumulation of only one major asset, but rather an increase in all assets.



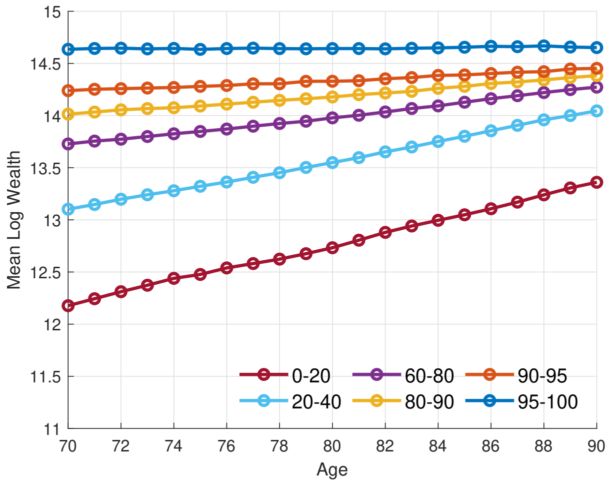
(a) Average log wealth by age.



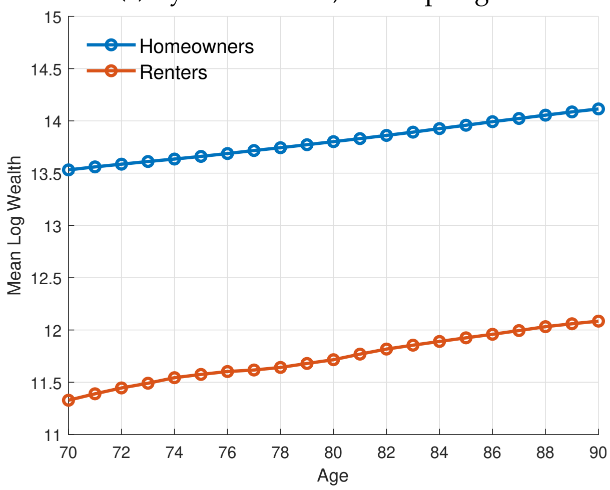
(b) By marital status.



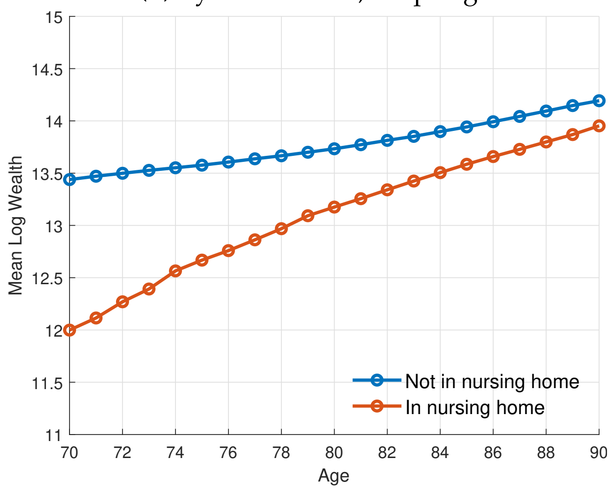
(c) By wealth at 70, no offspring.



(d) By wealth at 70, offspring.



(e) By homeownership at 70.



(f) By nursing home status.

Notes: In Figures 2c, 2d, and 2e, the groups are defined at age 70, while the groups change over time in Figures 2b and 2f.

Figure 2: Average log wealth by age.

The reported profiles in Figure 2 are not corrected for survivor bias. Within a cohort, it is well-documented that wealthier households tend to live longer (Smith, 1999; Attanasio and Hoynes, 2000), and that this composition effect biases the cross-sectional wealth profiles (De Nardi et al., 2010). Appendix A shows that the wealth profiles for differential mortality rates by age, permanent income, sex, wealth, and health are flatter than the unadjusted ones. Yet, this does not change the fact that they are at odds with a standard life-cycle model. Since our structural model will explicitly include differential mortality rates by age, permanent income, sex, wealth and health, we target the unadjusted wealth profiles in Figure 2 and demonstrate that the individual wealth profiles in the model also align with the untargeted mortality-adjusted wealth profiles in the data.

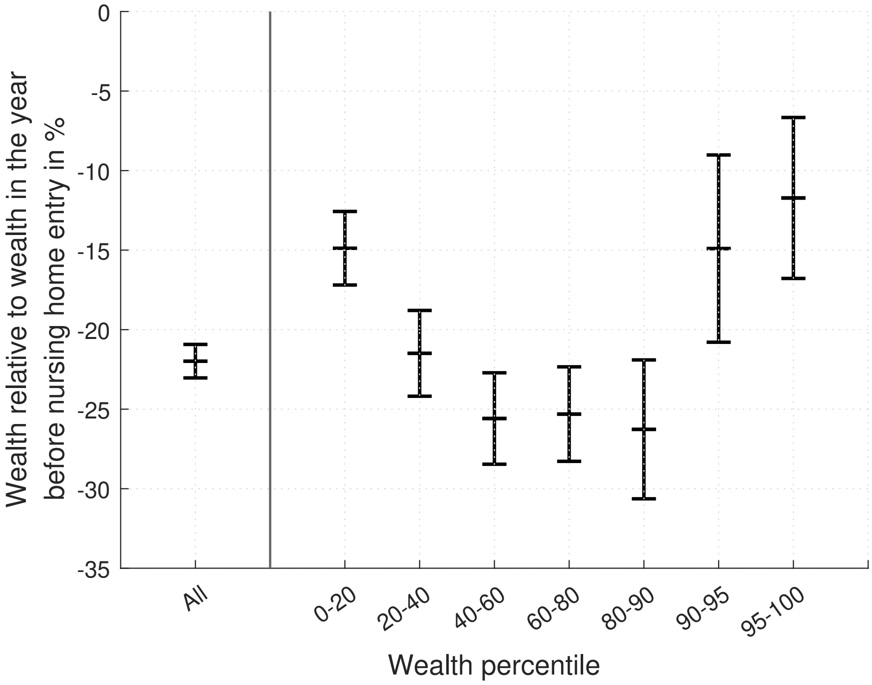
2.3.2 Wealth drop around nursing home entry

In the data, we observe an unusually large year-on-year reduction in household wealth associated with nursing home accession. We estimate this wealth drop with the following event-study model

$$\log \text{wealth}_{i,t+k} - \log \text{wealth}_{i,t-1} = \sum_{k=-5}^{0} \beta_{k,n} D_{t+k} + \varepsilon_{i,t+k} \tag{3}$$

where $\text{wealth}_{i,t+k}$ is the wealth of household i in year $t+k$ and D_{t+k} is a dummy equal to one in year $t+k$ with t being the year of entry into nursing home. The coefficients $\beta_{k,n}$ thus estimates the growth rate of wealth around the nursing home entry event.

Figure 3 reports estimates of $\beta_{0,n}$, the year-on-year percentage change in wealth following nursing home entry. Wealth drops significantly, by between 15% and 25% depending on the wealth percentile range, with an overall average of approximately 22%. Our interpretation is that the drop is most likely due to home care and other costs associated with negative health shocks, leading to nursing home admission. Given its quantitative importance, we explicitly account for it in the model in the form of an anticipated proportional wealth loss upon transition into nursing home (ξ) and include the average wealth drop of 22% as an explicit target in the model estimation.



Notes: The figure displays estimates of $\beta_{0,n}$ estimated using equation (3) for the sample of all households and across the wealth percentiles. The regression is weighted by log wealth at t-1 to ensure that the results resemble a population average. The bars show 95% confidence bands.

Figure 3: Wealth drop upon nursing home entry.

3 The model

3.1 Environment

Time is discrete and the horizon is finite. Households start at age 70 and live at most 105 years. They may be composed of a single individual, of gender $g = f, m$, or a couple, husband and wife. They are heterogeneous in wealth $a \in [0, \infty)$, the pension income $y_g \in \{y_1, y_2, , \dots, y_N\}$ of each household member, age t, marital status ("paired" or single) $j \in \{p, s\}$, whether they do not or do have offspring $o \in \{0, 1\}$ and health status $s_g \in \{h, n, d\}$ of each household member. The three health states are healthy ($s_g = h$), in long-term nursing home care, NHC in what follows, ($s_g = n$) and dead ($s_g = d$).

Households derive utility from consumption and the bequests they leave at the end of their life. They are subject to two sources of uncertainty: health and death, and the realisation of the rate of return on their savings. In every period, they choose consumption expenditure c and savings a', taking as given their members' constant pension income and the one-period rate of return on their savings. They cannot borrow.

3.2 Preferences

Preferences are time separable and households discount the future with inter-temporal discount factor β. Individuals value consumption according to a standard CRRA felicity function

$$u(c) = \frac{(c/\nu_j)^{1-\sigma}}{1-\sigma}, \quad \sigma > 0, \tag{4}$$

where ν_j is a consumption equivalence factor which depends on marital status j. We assume that couples maximise utility in a unitary fashion, which implies that their felicity function is the sum of the individual utilities.

Upon the death of a household's last surviving member, any outstanding wealth is distributed as a bequest. Agents value, net-of-tax, bequests b according to a warm-glow utility function

$$v_o(b) = \theta_o \frac{(\kappa_o + b)^{1-\sigma}}{1-\sigma}, \tag{5}$$

where θ is the bequest loading and κ is a Stone-Geary shifter. Both parameters depend on whether the household has children or not ($o = 0, 1$).

3.3 Uncertainty

Households are exposed to two sources of uncertainty. First, at the beginning of each period, they draw a household-specific, i.i.d. realisation of the one-period rate of return on their saving. This assumption allows for the possibility that some of their wealth accumulation is determined by luck. Our timing assumption, together with the one-period maturity, implies that the one-period rate of return is known with certainty (i.e., risk-free) at the time of investment. However, households face uncertainty over subsequent periods. The rate of return process follows a stationary, first-order Markov process with transition probabilities $\pi(r)$.

The second source of uncertainty concerns individuals' health status. Individuals may be hit by a negative health shock and either irreversibly enter a nursing home or die according to a first-order Markov process with transition probabilities $\pi(s'_g|s_g, t, g, j)$ that depend on current health, age, gender and family composition as well as permanent income and wealth at age 70 (y_g and $a_{t=0}$).[13] We assume that the transition to NHC, but not death, is perfectly correlated for members of a married couple.[14] As discussed in

[13]The assumption of irreversible health states is innocuous. In the data, only 2.6% of individuals living in nursing home in year t move out in year $t+1$. Of these, 47% re-enter nursing home or die the next year.

[14]In our data, both members of a couple enter nursing home within the same year in 54% of nursing home accessions by non-singles.

Section 2.1 and 2.3.2, we assume that nursing home accession is associated with losing a fraction—denoted by ξ— of wealth. Furthermore, health status affects the mapping from individual pension income y_g to disposable income $\phi(y_g; s_g)$, in a way we describe below.

3.4 Government

The government taxes individual income, wealth, and bequests and provides an income floor $\underline{y}$ for individuals in NHC ($s_g = n$). Disposable income $\phi(y_g; s_g)$ is a function not only of pre-tax income y_g but also of health status to capture the fact that in Norway individuals in NHC are taxed at a higher rate than individuals with the same income but not in NHC. Wealth above the exemption level is taxed at rate $\tau(a)$. Finally, household wealth transfers to the surviving spouse are tax-exempt, but bequests originating from the death of the last surviving member of a household are subject to taxation. After-tax bequests are related to end-of-life wealth a through the tax schedule $b(a)$.

3.5 The individual problem

Let $z_s = (a, r, y_g, a_{t=0}, t, g, s_g, o)$ and $z_p = (a, r, y_f, y_m, a_{t=0}, t, s_f, s_m, o)$ denote the vectors of states respectively for singles and couples. The household optimisation problem in recursive form for singles alive in the previous period can be written as

$$
\begin{aligned}
V^s(z_s) &= (1 - \mathbf{1}_d)\{\max_{c,a'} u(c) + \beta E_{r',s'_g} V^s(z'_s)\} + \mathbf{1}_d\{v_o(b(a))\} \\
\text{s.t. } a' &= (1 - \xi \mathbf{1}_n)[(1 + r)(1 - \tau(a))a + \phi(y_g, s_g) - c] \geq 0.
\end{aligned}
$$

The indicator functions $\mathbf{1}_d$ and $\mathbf{1}_n$ take the value one, respectively, in the case of death and in the period when the household enters a nursing home. They equal zero otherwise.

The right hand side of the Bellman equation has two main components. The first one, which applies if the individual is alive in the current period ($s_g \neq d$) is the current utility plus the expected continuation value next period. The expectation is taken with respect to the rate of return and the individual health status next period. The second main sub-component is the warm glow bequest utility in case the individual has died at the beginning of the current period ($s_g = d$). The dynamic budget constraint reflects the fact that the transition from living at home to a nursing home entails losing a fraction ξ of wealth.

The recursive problem for couples is

$$V^p(z_p) = (1 - \mathbf{1}_d)\{\max_{c,a'} 2u(c/\nu) + \beta E_{r',s'_f,h'_m} V^{j'}(z'_j)\} + \mathbf{1}_d\{v_o(b(a))\}$$
$$\text{s.t. } a' = (1 - \xi\mathbf{1}_n)[(1 + r)(1 - \tau(a))a + \phi(y_f, s_f) + \phi(y_m, s_m) - c] \geq 0,$$

where in this case $\mathbf{1}_d$ takes value one if *both* members of the household die at the beginning of the current period ($s_f = s_m = d$).

If the couple is alive in the current period, it pools income and maximises the sum of the spouses' utility plus the continuation value. The expectation reflects the possibility that a health shock may hit either spouse. In the case in which one spouse dies, the continuation value function is that of the surviving member being single.

4 Estimation methodology

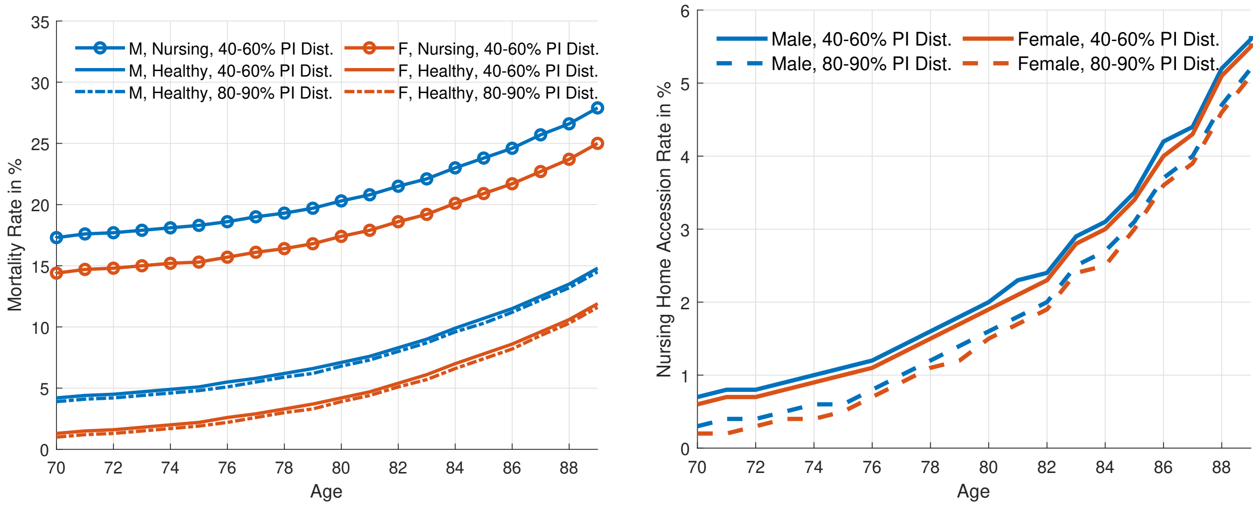
We adopt a two-stage strategy to estimate the model. In the first stage, we select a first set of parameters which can be identified outside the model. In the second stage, we estimate the remaining parameters by the method of simulated moments (MSM), taking as given the parameters from the first stage.

4.1 External estimates

This section presents the external estimates: the mortality and nursing home accession rates, preferences, the return process, and the tax schedules.

Demographics. We obtain demographic information from a number of sources described in Section 2. Our model starts out with the initial distribution of 70-year-old households by sex, health, children, wealth, and permanent income in Norway. Transitions between the three health states (healthy, nursing home, and dead) follow an estimated Markov process where the transition probabilities depend on current health, age, sex, wealth at age 70 and permanent income.

Figure 4 displays a subset of these average rates. The mortality and nursing home accession rates are higher for males and poorer individuals, while being in long-term care raises the mortality rate. Men have, on average, about 3.5 percentage points higher mortality rates and around 0.05 percentage points higher nursing home accession rates than women. Higher permanent income is associated with reduced mortality and lower nursing home accession rates, but the effect is modest. Going from the median to the



(a) Mortality rate.

(b) Nursing home accession rate.

Figure 4: Selected mortality and nursing home accession rates for singles by age.

80-90th percentiles in the permanent income distribution reduces mortality by around 0.3 percentage points and nursing accession rates by around 0.45 percentage points. Wealth at age 70 has a similar effect to permanent income, but is approximately twice as strong: going from the 40-60 percentile group to the 80-100 percentile group decreases mortality by approximately 0.9 percentage points. Mortality rates for individuals in long-term care are around eight percentage points higher than for those who do not receive long-term care.

Preferences. We set the curvature of preferences over consumption and bequests σ to 3, a standard value (e.g., Kaplan and Violante, 2010), and the discount factor β to 0.97. It would be inappropriate to identify those parameters from post-retirement saving behaviour alone.

As our model does not target consumption moments, we refer to the many external estimates for the value of the equivalence factor for couples ν, which controls the strength of economies of scale in household consumption. We set ν to 1.5, well within the typical range—1.06-1.7—documented in the literature (e.g. Fernandez-Villaverde and Krueger, 2007, and references therein). This implies that a couple living together has to spend, on average, \$1.5 to achieve the same level of utility as each member spending \$1 if living alone.

Returns to wealth. We estimate returns to wealth, defined as the sum of capital income and capital gains as a share of net wealth, from the data. In Appendix B.1, we compare the data distribution with a normal distribution, provide evidence of low dependence of returns on wealth in our sample, and illustrate the low persistence of returns. The combined evidence suggests that assuming returns are normally distributed with a mean of 0.068 and a standard deviation of 0.086 is a reasonable approximation for our sample of elderly households for whom housing is the primary asset. Our assumption of i.i.d. normally distributed returns aligns with the evidence in Fagereng, Guiso, Malacrino and Pistaferri (2020) using Norwegian data on returns to wealth.

Taxes. Households are subject to five types of taxes: a tax on pension income, a capital income tax, a wealth tax, an inheritance tax, and a user payment if in a nursing home.

We estimate the pension income tax schedule on pension income using data on taxes and pension income for individuals for whom pension income constitutes the bulk of their gross income (see Appendix B.2 for details). The estimated pension income tax schedule involves a lump-sum tax of $1,400 and a constant marginal tax rate of 36 percent for pension income above $25,000.

The capital income tax in our sample period is 28 percent on all capital returns in excess of the risk-free rate (equal to 1.72 percent on average in our sample period).

The wealth tax is 1.1 percent for taxable wealth above $125,000. Various asset classes have different discounts when computing taxable wealth in Norway, the most important being that housing is valued at 25 percent of its estimated market value. In the model, we approximate the wealth tax by estimating the wealth tax as a linear function of net wealth in the data (see Appendix B.2 for details). This results in the following wealth tax formula

$$\text{wealth tax} = \tau_w \max\{\text{adjustment factor} \cdot \text{wealth} - \bar{\tau}, 0\},$$

with τ_w equal to 0.011, $\bar{\tau}$ equal to $\$159,000$, and the adjustment factor equal to 0.35.

The inheritance tax is 6 percent for inheritances above $81,500 and 10 percent above $138,500. We do not model inter-vivos transfers, but, as explained in Section 2, we include inter-vivos transfers in net wealth to account for them as part of the relevant end-of-life bequest motive. Hence, the inheritance tax is only applied at the end of life and relevant for the bequest motive.

The user payment schedule for nursing homes is progressive. The costs are 75 percent of net income above a minimum threshold of $1,350 and 85 percent above $14,600. The maximum annual cost is capped at $137,800.

4.2 Internal estimates

We estimate the remaining five parameters. These are the bequest parameters (θ_i, κ_i), $i = 0, 1$ for households with and without offspring and the wealth loss upon nursing home entry ξ. We use the method of simulated moments to estimate these, meaning that we find the parameter values that minimise the weighted squared deviations[15] between model-simulated life-cycle profiles and their data counterparts. We apply a global minimisation algorithm that selects parameter values to minimise these deviations.[16]

The moments we target in our estimation are the age profiles, between age 70 and 90, of the logarithm of: (i) unconditional average wealth holdings, (ii) average wealth holdings for those in selected percentile ranges (0-20, 20-40, 40-60, 60-80, 80-90, 90-95, 95-99) of the wealth distribution at age 70 among households with and without offspring, (iii) average wealth holdings of couples as well as singles by gender, (iv) average wealth holdings by nursing home status, and (v) the average percentage wealth loss between the year before and the year immediately after nursing home entry in Figure 3. In terms of the model, this represents the average of $\log a' - \log a$ among nursing-home entrants. In total, we are targeting 421 moments, 20 moments for each of the 21 years in the 70-90 age range plus (v). All parameters are estimated jointly.

5 Parameter estimates

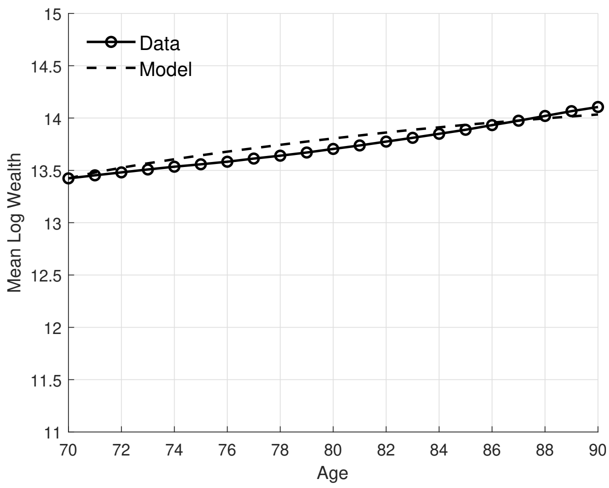
This section presents the parameter estimates of the model and the model fit. We first show how the model fits the targeted moments. Next, we discuss the parameter estimates and their implications. Third, we present the model fit of some untargeted moments.

5.1 Model fit

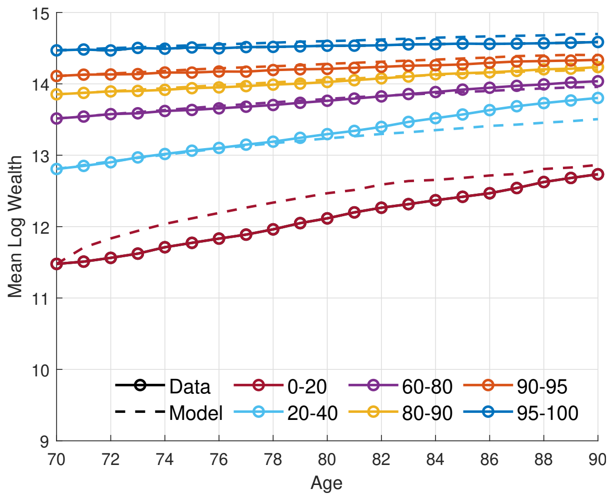
Before discussing the parameter estimates, Figure 5 shows the model's fit of the targeted moments. Overall, the model fits well the age profiles of average wealth holdings both in the aggregate and within the selected groups. The model overestimates somewhat the growth rate for the wealthiest 5 percent, slightly underestimates the growth rates for the 20-40 percent wealth group and overestimates the initial growth rate for the bottom 5 percent. The model underestimates growth rate after age 80 for the poorest households without offspring, but matches very well all other moments. Finally, the model estimate

[15]The weighting matrix is diagonal with non-zero entries given by the variances of the data moments.

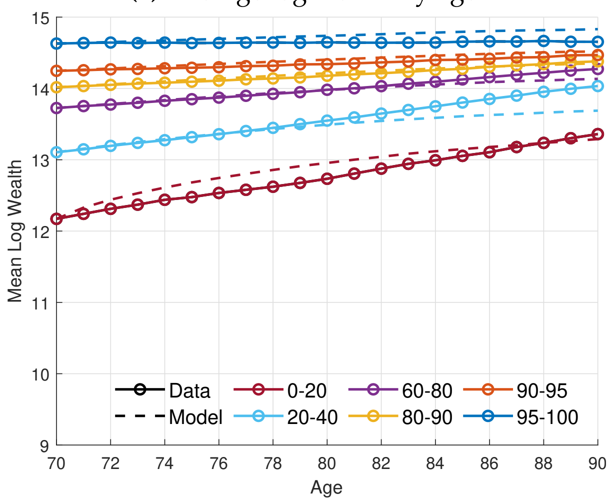
[16]Our preferred method for robustness is to quasi-randomly sample the parameter space, then select a set of best-fitting points upon which to apply a root-finding algorithm to each and select the best-fit solution resulting from the multiple local minimises.



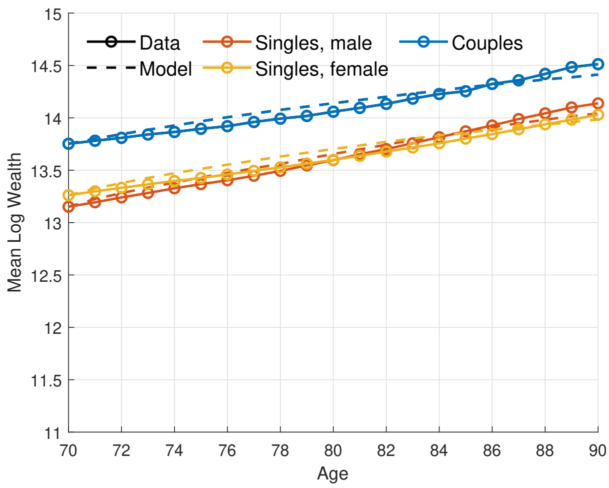
(a) Average log wealth by age.



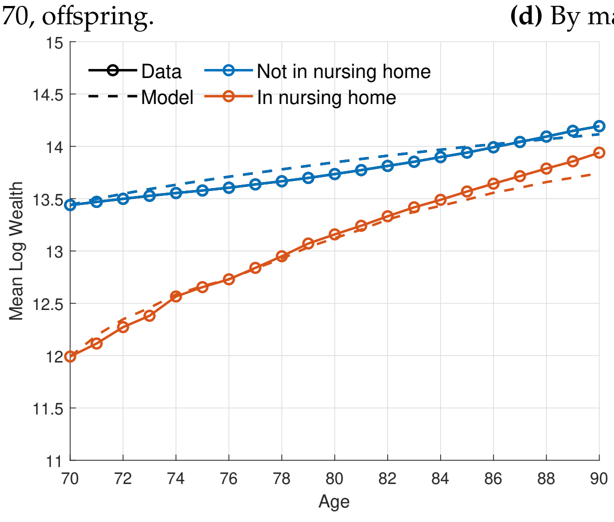
(b) By wealth at 70, no offspring.



(c) By wealth at 70, offspring.



(d) By marital status.



(e) By health.

Figure 5: Average log wealth by age. Data vs. model. Benchmark estimation.

of the wealth loss upon nursing home accession is 18 per cent against 22 per cent in the data. To understand the discrepancy, remember that ξ is estimated jointly with the other parameters rather than targeting only moment (v), the wealth loss upon nursing home accession. The estimate reflects the trade-off between fitting this moment and fitting the age-wealth profile for households in nursing home in Figure 5e.

Overall, we argue that the model does a remarkable job, considering the small number of parameters (5) relative to the targeted moments (421).

5.2 Parameter estimates

θ_0 :	Bequest loading – no offspring ('000,000)	853.7 (29.43)
κ_0 :	Stone-Geary shifter – no offspring	290.2 (6.85)
θ_1 :	Bequest loading – with offspring ('000,000)	24.1 (5.14)
κ_1 :	Stone-Geary shifter – with offspring	82.6 (8.11)
ξ :	Wealth shock upon nursing home entry	0.155 (0.006)

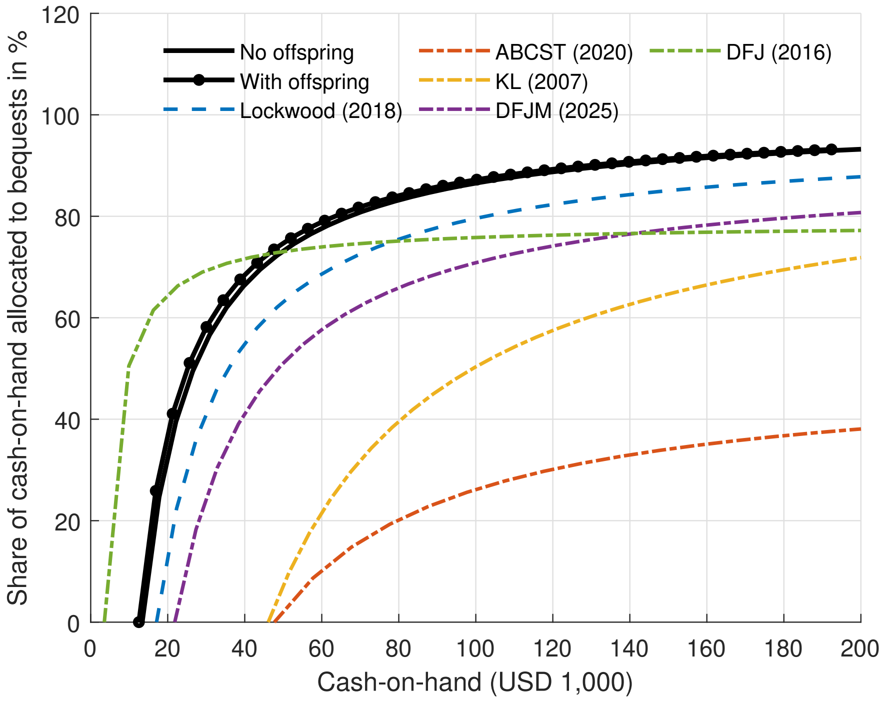
Notes: Standard errors in parentheses.

Table 2: Parameter estimates.

Table 2 reports the parameter estimates in the baseline model. The values of (θ_i, κ_i) for $i = 0, 1$ capture the strength of the bequest motive. The estimates imply a strong bequest motive not only for households with offspring but also for those without. This suggests that the bequest motive is capturing, in a reduced-form fashion, a reason to save which is not necessarily associated with a desire to bequeath. While it is reasonable that individuals may derive utility from bequeathing to relatives other than their own children, it seems unlikely that this motive is as strong as that towards one's offspring. The Norwegian inheritance registry provides some evidence supporting this view. In 2013, children and grandchildren received 82.6% of total inheritances (in dollars) from single individuals with offspring.[17]

[17]Moreover, Fahle (2023) provides further evidence on the basis of the Health and Retirement Survey

Our finding that the strength of the bequest motive is similar for households with and without children is in line with results in Hurd (1987, 1989), and Kopczuk and Lupton (2007). For example, Hurd (1989) identifies the constant, in his setup, marginal utility of bequests by assuming that only households with children have a bequest motive. He estimates the (differential) motive to be economically negligible. Similarly, Kopczuk and Lupton (2007) also assume constant marginal utility of bequests but allow for unobserved heterogeneity in the presence of a bequest motive. They find it to be sizeable[18] and its incidence to be higher among households with children. However, the difference in incidence is only marginally statistically significant. Compared to those two papers, we do not impose either (a) the absence of a bequest motive for households without offspring; or (b) we do not impose constant marginal utility of bequests.[19]



Notes: The figure compares our result for households with and without offspring with Kopczuk and Lupton (2007), De Nardi et al. (2016*a*), Lockwood (2018), Ameriks et al. (2020) and singles in De Nardi et al. (2025)

Figure 6: Estimated bequest motive compared with results in the literature.

(HRS) data. At the extensive margin, the likelihood of receiving a bequest upon the death of a single individual with children is more than 10 times larger for those with children than for any other group (over 90, against at most 8). At the intensive margin, the median share of the estate bequeathed to children is 3 to 4 times larger (100 against at most 33) than to relatives or friends and 25 times larger than to charities.

[18] They find that half of the bequeathed wealth is accounted for by an operative bequest motive.

[19] Constant marginal utility of bequests implies that consumption is independent of income and wealth for agents who leave positive bequests at the terminal date.

Figure 6 illustrates the strength of the bequest motive for both types of households, as well as that implied by the estimates in Kopczuk and Lupton (2007), De Nardi et al. (2016*a*), De Nardi et al. (2025), Lockwood (2018), and Ameriks et al. (2020).[20] It does so by plotting the share of cash at hand allocated to bequests that solves the one-period problem of a single who dies with certainty at the end of the period.

$$\max_{b} \frac{(z-a')^{1-\sigma}}{1-\sigma} + \theta_j \frac{(\kappa_j + b(a'))^{1-\sigma}}{1-\sigma} \quad \text{s.t. } a' \geq 0. \tag{6}$$

The figure[21] makes clear that households' propensity to leave bequests is basically the same, independently of whether the household has offspring. The estimates by Lockwood (2018) for the U.S. imply a bequest motive whose strength is very similar to ours. On the other hand, Ameriks et al. (2020) and even more so Kopczuk and Lupton (2007), estimate a substantially weaker bequest motive and with a substantially larger luxury-good feature.

5.3 Untargeted moments

In this section, we show how the model fits two set of moments not explicitly targeted at the estimation stage: the mortality-adjusted wealth profile and empirical estimates of the wealth elasticity to the wealth-tax rate.

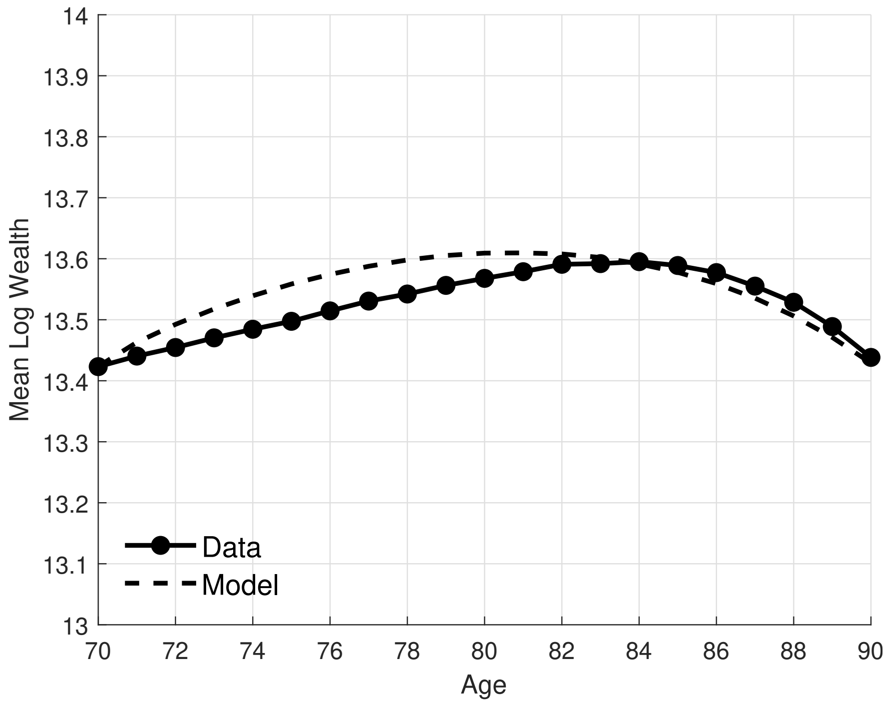
5.3.1 Mortality-adjusted wealth profile

As discussed in more detail in Appendix A.4, there are several alternative ways of estimating wealth profiles. In the body of the paper, we present average wealth profiles by age, correcting for time and cohort effects. However, because wealthy individuals tend to live longer, these average wealth profiles grow more than what one individual should expect, due to selection on mortality by wealth (Attanasio and Hoynes, 2000); namely, the sample of households at older ages disproportionately include households that were richer when young. The model deals with such selection by using estimated mortality rates that depend on state variables. This approach controls for the selection on wealth only to the extent that the estimated mortality rates precisely reflect the selection in the data.

To verify that this is the case, Figure 7 presents the mortality-adjusted wealth profiles in the data, following the approach in Attanasio and Hoynes (2000), together with the

[20] As most of the literature, e.g. De Nardi et al. (2010), De Nardi et al. (2025) and Lockwood (2018) estimate the bequest motive on the whole population without distinguishing between households with and without children.

[21] The figure assumes $b(a') = a'$ for comparability with the cited papers.



Notes: The figure compares the estimated mortality-adjusted average log wealth by age profile with the model counterpart. Appendix A.4 details how we mortality-adjust the wealth profiles in the data.

Figure 7: Mortality-adjusted mean log wealth.

mortality-adjusted wealth profiles in the model, using the same approach. In the data, we adjust for mortality by estimating how the mortality rates depend on wealth and age. We then use the inverse of the implied cumulative survival probabilities as weights when we compute the wealth profiles. Similarly, in the model, we use the employed mortality rates to compute survival probabilities and the inverse of these survival probabilities as weights to compute wealth profiles. The two approaches differ because we do not allow the mortality rates in the model to depend on *current* wealth because wealth is an endogenous state variable, and it would affect behaviour. Instead, mortality rates in the model depend on initial wealth at age 70, permanent income, health, age, and marital status. Figure 7 shows that the resulting mortality-adjusted wealth profiles in the model and data are similar. They first increase until the mid-80s before they start decreasing. We take this as reassuring evidence that the mortality rates we use in the model estimation reasonably approximate the mortality rates in the data.

5.3.2 Wealth tax elasticity

A more direct way to assess the performance of the model is to compare its response to tax changes to empirical estimates. In particular, since the main margin in the model is saving and because Norway does have a wealth tax, it seems natural to look at the response of wealth accumulation to changes in wealth taxation.

There is a burgeoning, and by now sizeable, empirical literature[22] that estimates wealth tax elasticities. The relevant empirical benchmark for the wealth tax elasticities in the model are empirical estimates that (a) are not local to kinks in the tax schedule, unlike those relying on bunching techniques; and (b) attempt to isolate the pure saving response from changes in wealth due to tax avoidance.Two studies that best meet these two requirements are Jakobsen et al. (2020), for Denmark, and Brülhart et al. (2022), for Switzerland.[23] Both follow a difference-in-difference approach. The setup is Jakobsen et al. (2020) is closest to our model setup and we try to stay as close to their approach as possible in the experiment that follows.

The experiment consists in increasing the marginal rate of tax on wealth above the exemption threshold[24] by 1 percentage point and compute the associated aggregate wealth elasticity in the model.

Panel (a) in Figure 8 plots the percentage change in wealth for the whole simulated population. Wealth falls by 0.6% ($5,851 per household) in the first year and is 5.59% lower by the tenth year. This corresponds to an elasticity with respect to the net-of-tax rate on wealth of approximately 0.60 and 5.53 respectively.[25] A large proportion of the effect of the tax increase is 'mechanical,' namely due to the change in the after-tax rate of return on wealth accumulation at unchanged saving function. By contrast, the 'behavioural' effect is the change in wealth growth due to the change in the saving function induced by the lower after-tax rate of return. In the first year, the behavioural effect is 3.3% of the total wealth response, but by the tenth year, this proportion is negligible as the income effect offsets the substitution and wealth effects.

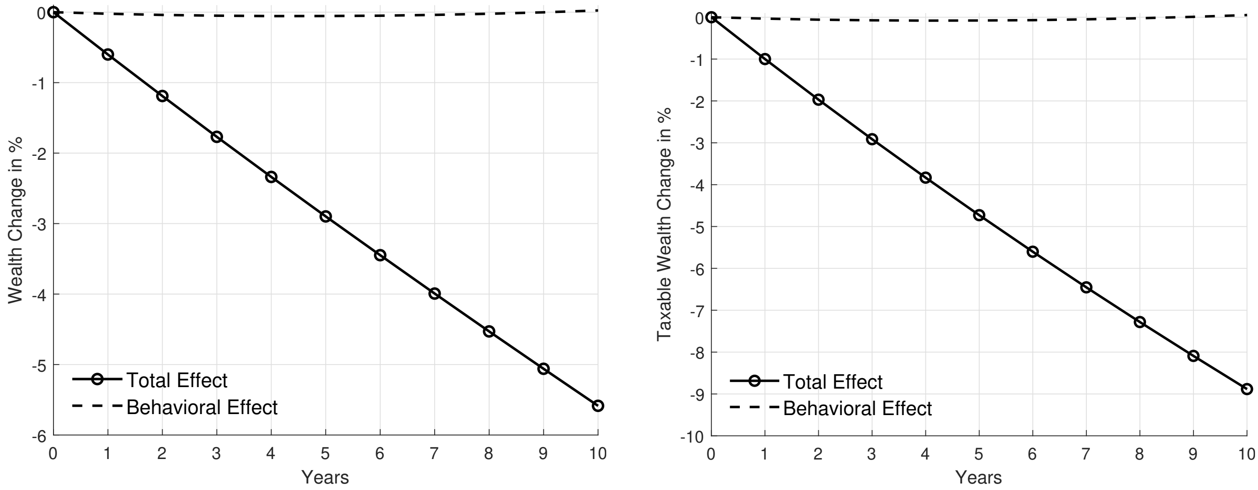
The change in aggregate wealth discussed above is the relevant quantity from the

[22]See Saez and Zucman (2019) and Advani and Tarrant (2021) for comprehensive surveys on the topic and the issues involved.

[23]Similarly to Norway, wealth taxation in Denmark is broad-based and relies on third-party reporting. For this reason, estimated elasticities are less likely to be biased upward by strategic asset reallocation and avoidance. This is not the case in Switzerland, but Brülhart et al. (2022) make an effort to identify the pure saving response net of the response due to multiple channels of tax avoidance.

[24]Since 35% of a household's wealth is taxed, this requires a raise in the headline tax rate from 1.10% to 3.86%. Note that approximately 70% of the simulated population in the 2013 baseline year have wealth above the threshold.

[25]Given a pre-reform marginal tax rate of 1 per cent, the elasticity is approximately equal to the percentage change in wealth.



(a) Wealth response. **(b)** Taxable wealth response.

Figure 8: Response of aggregate wealth and wealth above the wealth-tax threshold to a one percentage point wealth tax increase.

perspective of assessing the implications of changes in wealth taxation for the supply of capital in the economy. To compare the tax elasticity in the model to the available empirical estimates, though, we need to look at changes in total *taxable* wealth, namely wealth above the exemption threshold. This is because most difference-in-difference estimates exploit differences in post-reform saving behaviour between (treated) agents whose wealth is above the exemption threshold (thus subject to tax) after the reform and a (control) group of agents with wealth below the threshold. For this reason, panel (b) in Figure 8 reports the change in total taxable wealth, namely wealth above the exemption threshold, over time. This corresponds to the treatment-on-the-treated effect in difference-in-difference studies. The average reduction in wealth above the threshold is almost exactly 1% ($5,797 per affected household) in the first year, 3.3% of which is due to the aggregated behavioural effect. By year ten, taxable wealth has fallen by 8.88%, with the behavioural effect turning marginally positive, as the size of the (positive) wealth effect associated with the fall in the net-of-tax rate of return falls with the remaining expected lifetime.

As discussed above the closest empirical studies to our experiment are Jakobsen et al. (2020), for Denmark, and Brülhart et al. (2022), for Switzerland. Jakobsen et al. (2020) estimate an (eight-year) average elasticity of taxable wealth to the net-of-tax rate of 5.1 and of 8.9 for moderately wealthy couples.[26] The two values are obtained by comparing the response of (treated) couples benefiting from a doubling of the couple exemption threshold to, respectively, that of two alternative control groups: (a) couples below the

[26] Formally, couples with wealth between percentiles 97.6 and 99.3 of the household wealth distribution. This is the most comparable group to our sample which excludes the top 1% of the wealth distribution.

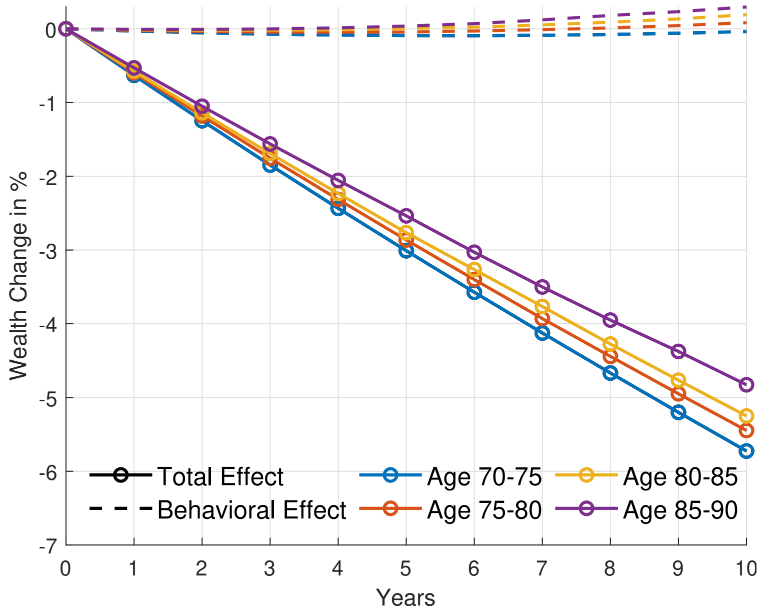


Figure 9: Wealth response by age to a one percentage point increase in the tax rate.

post-reform threshold and (b) singles with the same average, pre-reform household wealth as the treated couples.[27] The average elasticity over the first eight years in our model is 4.2. The corresponding estimate by Brülhart et al. (2022) is 6.9.

To sum up, the wealth tax elasticity in the model is in the ballpark, if at the low (in absolute value) end, of comparable empirical estimates. This is reassuring given that it is an untargeted moment in the model estimation. Furthermore, part of the difference can be accounted for by the higher average age in our sample. We estimate our model on individuals aged more than 70 compared to more than 60 in Jakobsen et al. (2020) and the whole population in Brülhart et al. (2022). Empirical estimates of wealth elasticities are larger for younger individuals (see the Online Appendix of Jakobsen et al., 2020; Brülhart et al., 2022). Figure 9 shows that this is true also in the model, as one would expect given that the tax change affects younger households over a longer horizon.

6 Model implications

In this section we use the model to understand the role of the bequest motive in accounting for the life-cycle wealth patterns of retirees and their responsiveness to estate taxation.

[27]Therefore, the average per-capita wealth of singles in the second control group is double that of the treated couples.

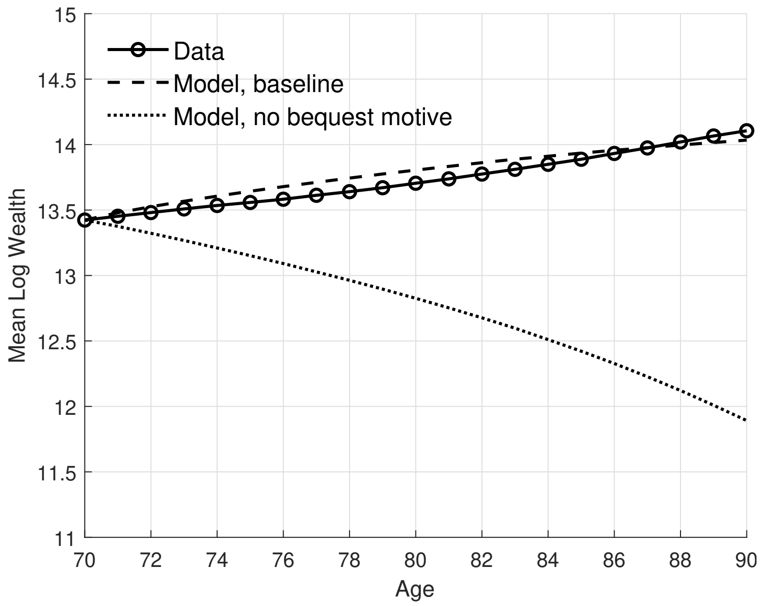


Figure 10: Average log wealth by age, baseline model vs. model with no bequest motive.

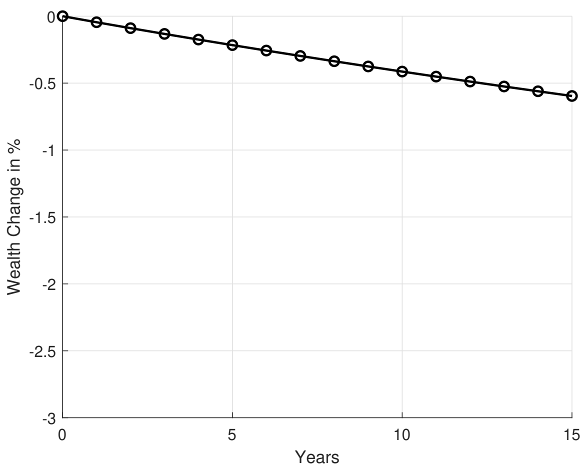
6.1 Drivers of saving

To assess the importance of the bequest motive, we re-estimate the model by setting to zero the parameters of the utility from leaving bequests; $\theta_0 = \theta_1 = 0$. The resulting economy features only accidental bequests due to the lack of markets to annuitise survival risk. We leave the value ξ, the parameter controlling the size of the wealth loss upon nursing home accession, at its baseline value as its effect on aggregate wealth accumulation is negligible.

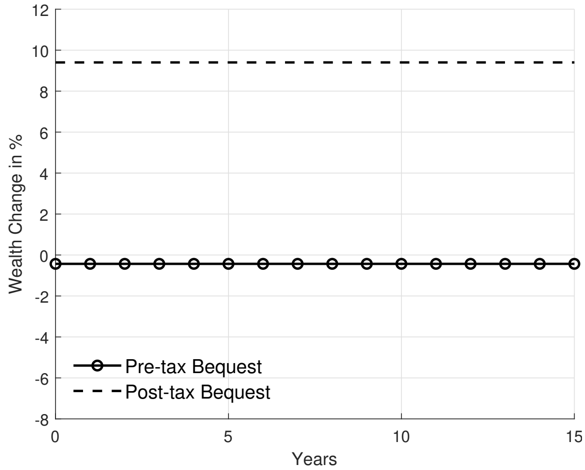
Figure 10 compares the the age profiles of average wealth in the two models (Figure C.1 in Appendix C reports all the moments in Figure 5) for the economy without bequest motive. In the aggregate, in the absence of a bequest motive, average wealth at age 85 is less than 25 percent (approximately \$300,000 against \$1,300,000) of its data counterpart. Generally, the model without a bequest motive implies strongly declining wealth-age profiles, inconsistent with the flat or upward-sloping profiles in the data.

6.2 Removal of estate taxation

The fact that the model economy displays a wealth-tax elasticity broadly in line with empirical estimates gives us confidence in using it to evaluate the implications of estate taxation for wealth accumulation. Until 2014, inherited wealth in Norway was subject to progressive taxation as in our baseline economy described in Section 4.1. The estate tax was eliminated in 2014. Since our baseline model is estimated on the pre-2014 period, it seems quite natural to use it to evaluate the implications of the 2014 reform.



(a) Aggregate wealth response.



(b) Bequest response.

Figure 11: Aggregate wealth and bequest responses to abolishing the bequest tax.

Figure 11a plots the response of aggregate wealth among those alive. Aggregate wealth *falls* by a negligible 0.6 percent ($5,844 per household) after 15 years, in response to the elimination of the estate tax. This corresponds to a negligible aggregate wealth elasticity with respect to the net-of-estate-tax rate of about -0.05.

To understand the sign and magnitude of the response of wealth to estate taxation, it is helpful to inspect the (interior) optimum of the two-period problem in equation (6) under the simplifying assumption that the estate tax is proportional; i.e. $b(a') = (1-\tau)a'$. The optimal pre-tax bequest satisfies

$$a' = \frac{z - \theta_j^{-\frac{1}{\sigma}}(1-\tau)^{-\frac{1}{\sigma}}\kappa_j}{1 + \theta_j^{-\frac{1}{\sigma}}(1-\tau)^{\frac{\sigma-1}{\sigma}}}. \tag{7}$$

If preferences are homothetic—$\kappa_j = 0$— the pre-tax bequest a' is decreasing in the net-of-tax rate $1-\tau$ if and only if $\sigma > 1$—the positive income effect on consumption more than offsets the negative substitution effect.[28] This is indeed the case in our parameterisation, which features $\sigma = 3$. When $\kappa_j > 0$, preferences are non-homothetic and bequests are a luxury good. An increase in $1-\tau$ reduces the numerator on the right hand side of equation (7), reinforcing the substitution effect. Our parameter estimates, though, imply that the income effect more than offsets the other two and pre-tax bequests respond negatively to an increase in the net-of-tax rate.[29]

[28]Similarly, Ring (2023) shows that the elasticity of the intertemporal substitution drives the sign of the response of wealth to the wealth tax rate in an economy without a bequest motive.

[29]Note that, if anything, our chosen value for the CRRA coefficient is conservative in the light of the meta study by Havránek (2015) and the findings in Best, Cloyne, Ilzetzki and Kleven (2019). Also, although the

Equation (7) also implies that the magnitude of the response of pre-tax bequests to $1-\tau$ is decreasing in θ_j, the bequest loading. Given our estimates for θ_j, the coefficients of $(1-\tau)$ in the above expression are very close to zero and so is the response of a' to estate taxes. Effectively, the economy behaves as if the average retired household is close to satiated in consumption. Figure 11b illustrates this by plotting the change in pre- and post-tax bequeathed wealth. Total *pre-tax, bequeathed* wealth falls by \$4,329 per household (or 0.43% of aggregate bequests) for the whole cohort, but the *post-tax, bequeathed* amount would rise by \$85,872 per household (9.4% of aggregate bequests). As a result, government revenue falls by \$90,201 per household relative to the baseline.

There is very little empirical work on the response of wealth to estate taxation. For the U.S., Kopczuk and Slemrod (2001) estimate an elasticity of *reported* bequests to (one minus) the tax rate of 0.16, while Joulfaian (2006) a value of 0.09. Goupille-Lebret and Infante (2018) find elasticities between 0.25 and 0.35. These numbers are not trivial, given estate tax rates of 0.4-0.5 in France and the U.S. The elasticity implied by our experiment is negative, reflecting the optimal response, but an order of magnitude smaller in absolute value. It has to be kept in mind, though, that while empirical estimates may reflect changes in estate planning or reporting, our model captures the pure behavioural, saving response.

7 Conclusion

In this paper, we use rich, high-quality administrative data to study quantitatively the importance of a bequest motive in shaping late-in-life saving. We document the presence of widespread, large and positive saving post-retirement in an institutional environment with little-to-no medical and nursing-home expenditure risk. Importantly, this is the case across households that differ by health, couple status, existence of offspring, age, sex, wealth, and income. The poorest households and childless households tend to increase their wealth the fastest. These patterns are unlike many documented, e.g., for the U.S.A., which usually exclude inter-vivos transfers.

To account for these facts, we build and estimate a heterogeneous agent model with a bequest motive in the form of utility from residual wealth, as well as realistic income, morbidity, mortality processes, and idiosyncratic returns. We find that the model matches the data well and that strong and non-homothetic bequest motive is important for explaining saving patterns in the population. The estimated model indicates that around

sign of the wealth response does depend on σ, quantitatively the size of its absolute value is small if θ_j is large.

three-quarters of bequeathed wealth is attributable to the bequest motive. It is particularly striking that childless households have a bequest motive quantitatively comparable to households with offspring. This suggests that the utility from residual wealth in the model is capturing other positive drivers of late-in-life saving beyond altruism or strategic bequeathing.

We use the model to assess the wealth response of the elderly to wealth and estate taxes. Reassuringly, the model implies an elasticity of taxable wealth with respect to the after-wealth-tax rate broadly in line with existing comparable empirical estimates (Brülhart et al., 2022; Jakobsen et al., 2020). The response is mostly due to the (mechanical) impact of the change in the after-tax return of wealth accumulation with little change in saving. For the same reason, the abolition of estate taxation would reduce tax revenue with hardly any effect on wealth accumulation.

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Online Appendix

A Appendix to Section 2

A.1 Institutional setting

Pensions. The pension system in Norway builds on three pillars: the social security system, occupational pensions, and private pension savings. The social security system provides defined benefit pensions to all Norwegian citizens. While working, individuals accumulate pension rights above a minimum as a function of gross income. These pension rights are converted to pension claims after retirement. Annual pension payments are indexed to average wage growth and adjusted for average life expectancy at retirement. After retirement, there is no uncertainty about future pension payments except for annual wage growth indexation. This social security pension system is the main pension income of most households in our sample of data.

Occupational pensions vary depending on employers. In the public sector, individuals accumulate a state occupational pension. In our sample, a former public sector employee with full pension contributions (at least 30 years of public employment) receives 66 percent of their last salary. Private occupational pensions vary, depending on the employer and type of contract.

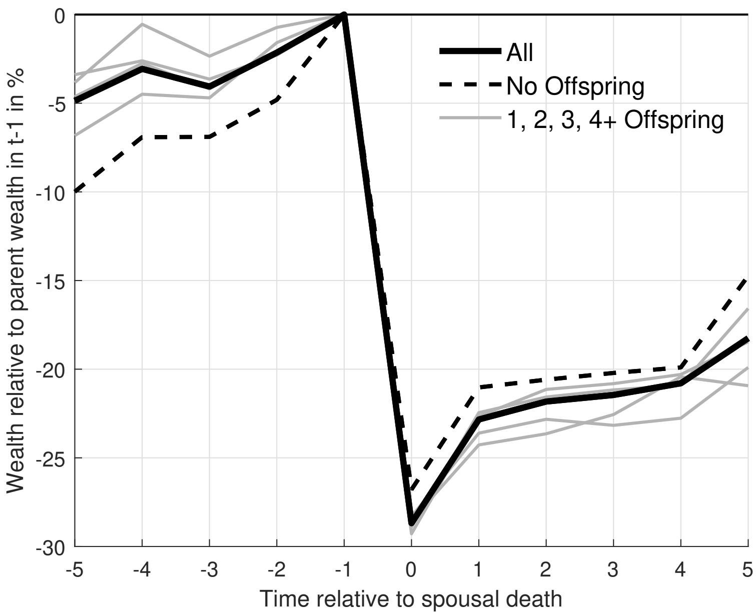
The inheritance law. During our sample period, the inheritance law states that when an individual in a couple (either married or registered partner with joint children) dies, the nearest relatives inherit their wealth. The nearest relatives are defined in the following order: (i) offspring, (ii) parents, (iii) children of parent (sibling), (iv) grandparents, and (v) grandchildren of grandparents (cousins). Unless there is a will, the wealth is distributed equally among individuals in the first group that contains individuals. For example, if the deceased individual has children, the wealth is distributed equally among the children. And if the deceased has no (living) offspring or parent, the wealth is distributed equally among the siblings. In the sample of deceased individuals with no offspring in our data, 7.3 percent of inheritances go to siblings, while 4.3 percent of inheritances go to cousins. The rest goes to individuals or entities outside the family.

One complication is that a surviving spouse of the deceased is entitled to a minimum of the wealth.[30] This minimum threshold introduces a kinked scheme in which all wealth

[30]This minimum was computed as the maximum of one-quarter of the wealth and four times the minimum in the social security system (approximately $40,000). This minimum was approximately $60,000

goes to the spouse if wealth is sufficiently low while it goes to other relatives if wealth is large. Another complication is that the law allows the surviving spouse to keep the estate undivided, that is, postponing dealing with the inheritance of the deceased until the surviving spouse's death. However, if the deceased has offspring that are not the surviving spouse's offspring, the children of the deceased have to consent that the estate stays undivided.

A.2 Spousal death event plot

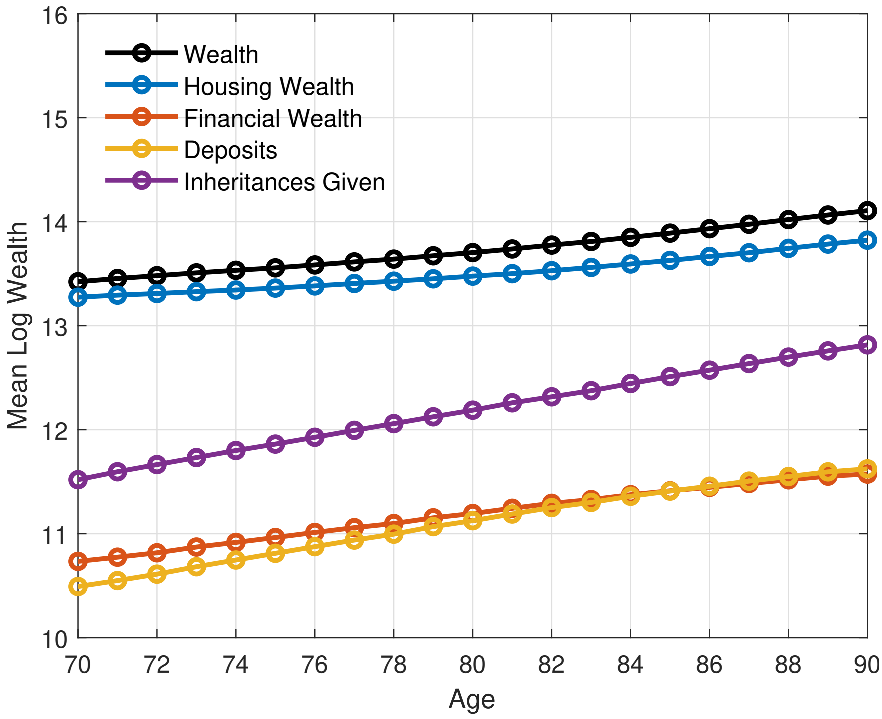


Notes: The figure shows average wealth relative to wealth in t-1 computed as $w_{t+h}/w_{t-1} - 1$ for each group.

Figure A.1: Wealth around spousal death event by the number of kids.

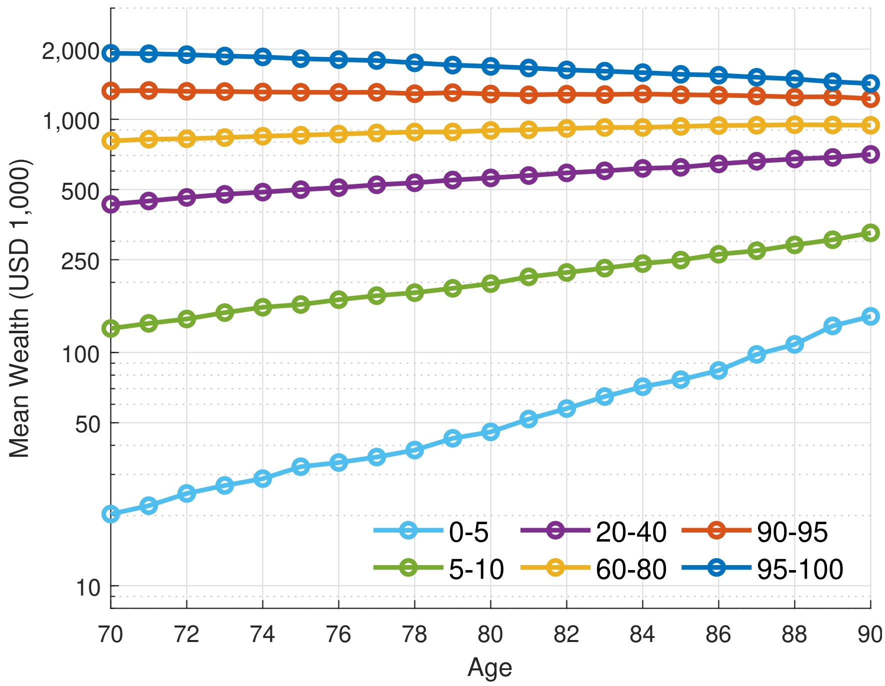
A.3 Additional wealth profiles

when the closest relative was not an offspring.



Notes: Wealth in the figure is the sum of housing wealth (housing wealth net of debt), financial wealth, deposits, and the net present value of inheritances given.

Figure A.2: Log wealth by age, decomposed.



Notes: The figure shows estimated wealth profiles by groups of wealth defined at age 70. Wealth is defined as wealth excluding the net present value of inheritances given.

Figure A.3: Log wealth by age, excluding inter-vivos transfers, by wealth at 70.

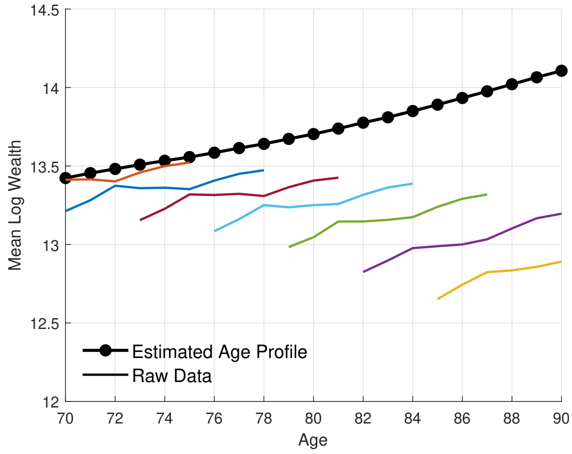
A.4 Adjusted wealth profiles

A major challenge in understanding the wealth accumulation of the elderly is constructing relevant wealth profiles by age. There are two issues. First, we are interested in age profiles, which are contaminated by cohort and time effects in cross-sectional data. For example, when wealth grows over time, the cross-sectional age profile of wealth may be downward sloping partly because older households belong to older cohorts with lower wealth. Second, within a cohort, wealthier households tend to live longer (Attanasio and Hoynes, 2000). This composition effect biases the cross-sectional wealth profiles even within a cohort.

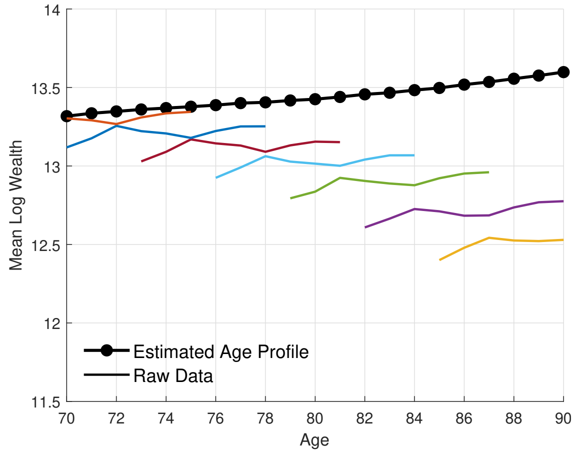
Figure A.4 illustrates how some central assumptions matter for estimating wealth profiles by age. First, Figure A.4a is the same as Figure 2a in the body of the paper and illustrates how our benchmark time-age-cohort decomposition works. Second, Figure A.4b displays the estimated wealth profiles when we exclude inter-vivos transfers from the wealth definition. The main difference is that the growth rate of wealth is lower compared with the benchmark case, where we include inter-vivos transfers. Wealth still, however, monotonically increases with age. Third, Figure A.4c shows how a mortality adjustment affects the wealth profiles. We follow Attanasio and Hoynes (2000) and weigh the estimated wealth profile by the inverse of the cumulative survival probability. Because the survival probability is positively correlated with wealth, the mortality adjustment tends to reduce the growth rate of wealth. As a result, wealth is first increasing with age, then decreasing. Fourth, Figure A.4d shows the estimated wealth profile when we both exclude inter-vivos transfers and mortality adjust. Wealth now decreases for age for all age groups.

When comparing our estimated wealth profiles with the model, they correspond to different objects. Because the model includes mortality rates that are correlated with permanent income, and thus wealth, the population-averaged wealth profiles from the model should be compared with Figure A.4a as in the body of the paper. An alternative approach, however, is to use Figure A.4c. In a model, Figure A.4c corresponds to the expected wealth profile of an individual, more closely mapping into the *savings policy function*. In Section 5.3, we therefore compare the saving policy functions in the model with the wealth profile in Figure A.4c as an untargeted moment.

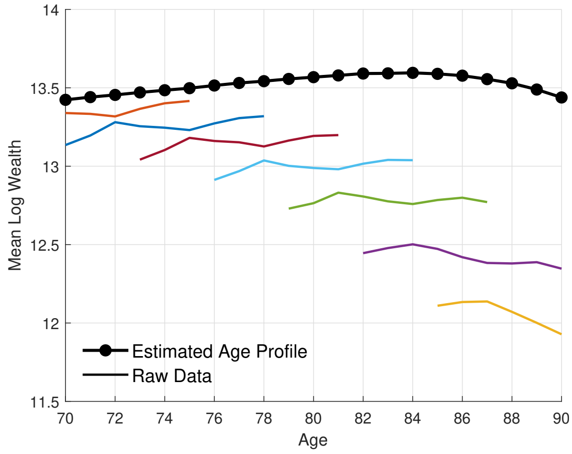
An alternative is to estimate wealth profiles for medians rather than mean log wealth. Figure A.4e and A.4f display the estimated median wealth profiles and raw data from some selected cohorts. The median wealth profiles are very similar to the mean wealth profiles. We therefore use mean wealth profiles because they more naturally map into wealth profiles in simulated data.



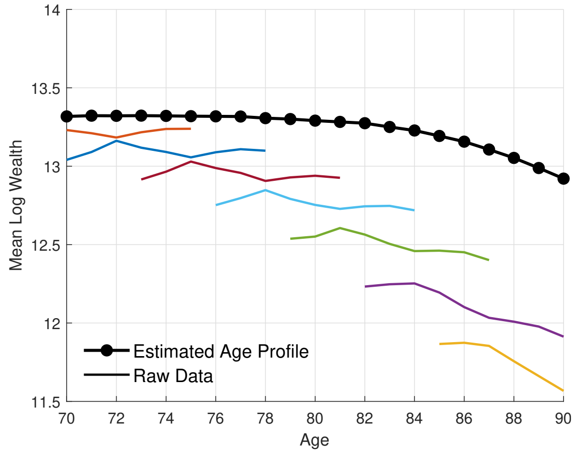
(a) Mean log wealth.



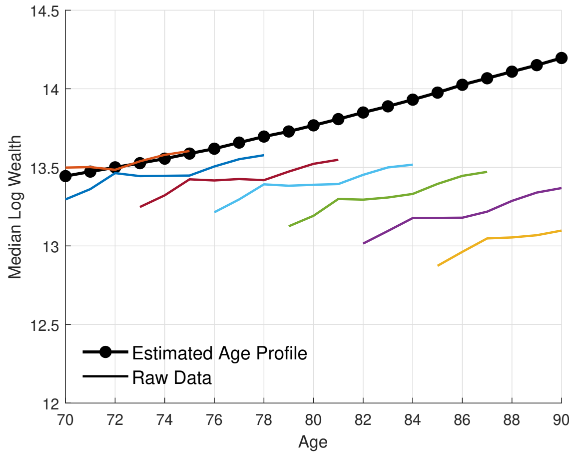
(b) Mean log wealth ex. inter-vivos transfers.



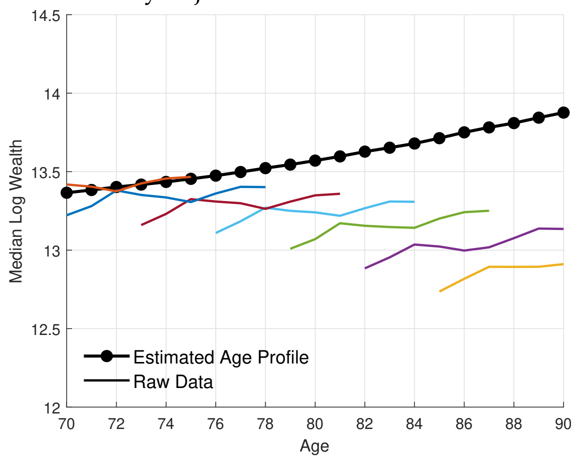
(c) Mean log wealth, mortality adjusted.



(d) Mean log wealth ex. inter-vivos transfers, mortality adjusted.



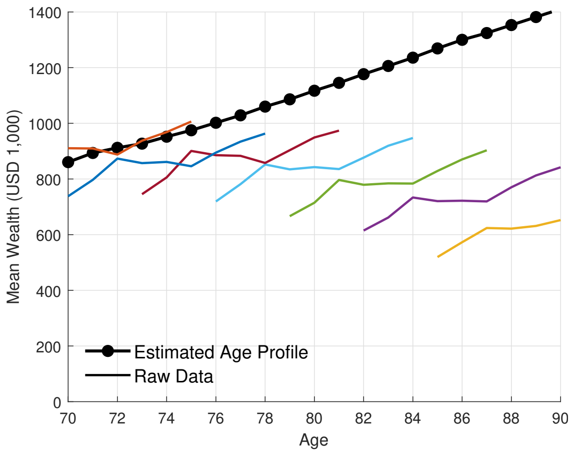
(e) Median log wealth.



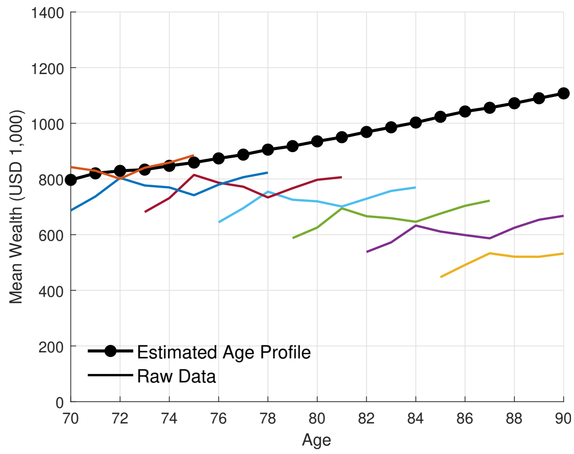
(f) Median log wealth ex. inter-vivos transfers.

Figure A.4: Log wealth by age. Raw data and estimated age profiles.

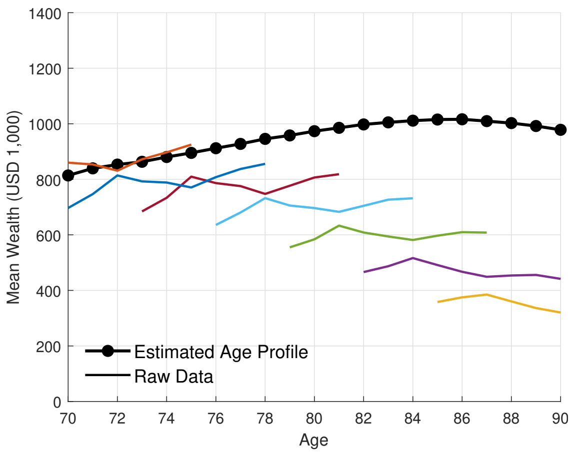
Another alternative is to estimate wealth profiles in levels rather than in logs. Figure



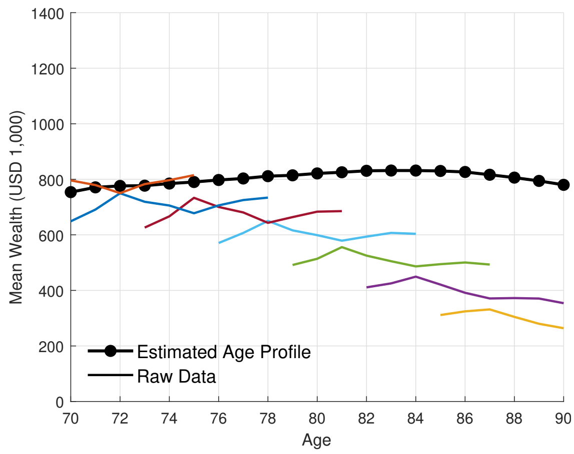
(a) Mean wealth.



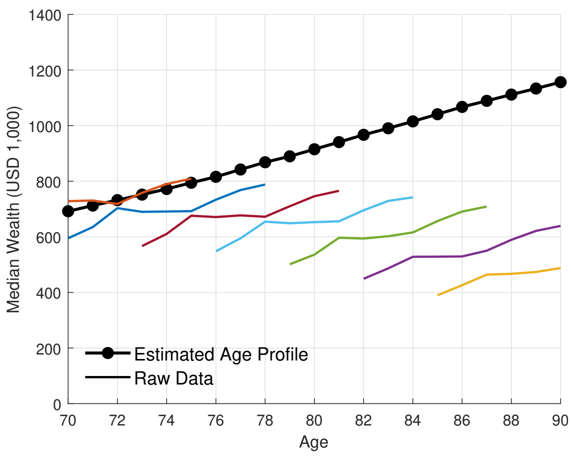
(b) Mean wealth ex. inter-vivos transfers.



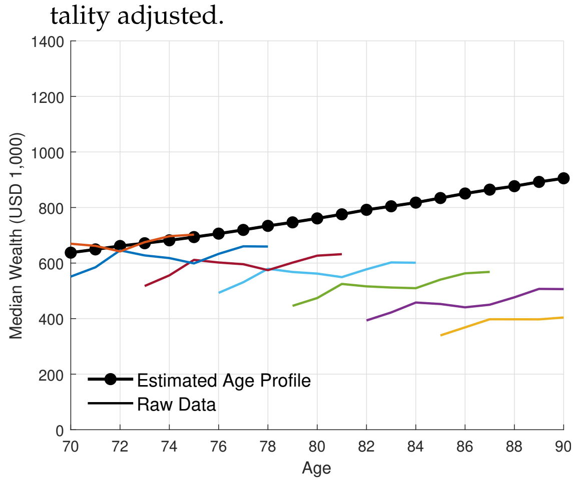
(c) Mean wealth, mortality adjusted.



(d) Mean wealth ex. inter-vivos transfers, mortality adjusted.



(e) Median wealth.



(f) Median wealth ex. inter-vivos transfers.

Figure A.5: Wealth by age. Raw data and estimated age profile.

A.5 presents raw data and estimated age profiles of mean wealth. The estimated wealth profiles are still increasing in wealth. Estimated mean wealth increases from around $800,000 to $1,400,000, an increase of approximately 50 percent, similar to what we find when we estimate wealth profiles using log wealth. The patterns as we exclude inter-vivos transfers, adjust for mortality, or compute median wealth profiles are also very similar.

B Appendix to Section 4

B.1 Returns to Net Wealth

This appendix contains details on how we compute returns to net wealth. We define returns as the sum of capital income and capital gains as a share of net wealth, where net wealth excludes inter-vivos transfers relative to its definition in the paper. Capital income includes capital income and housing service flows. Capital gains covers both realised and unrealised capital gains. When we divide by wealth, we take the average of wealth at Dec 31 the previous and current year. We focus on individuals with positive net wealth. In addition, because the returns are volatile for some individuals, for example due to large changes in net wealth, we trim at the top and bottom 5 percent (-25 percent and + 37 percent) of the returns distribution.

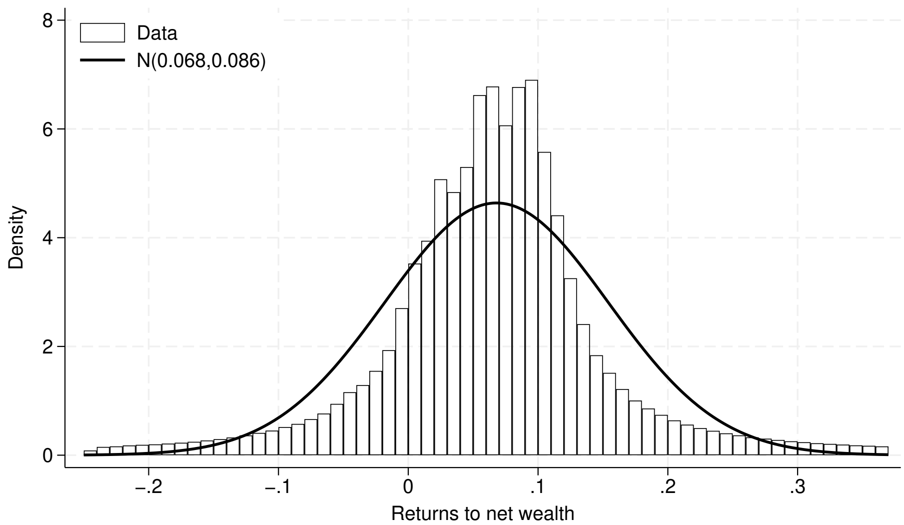
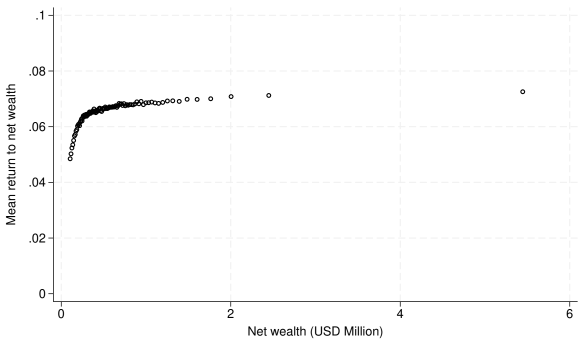


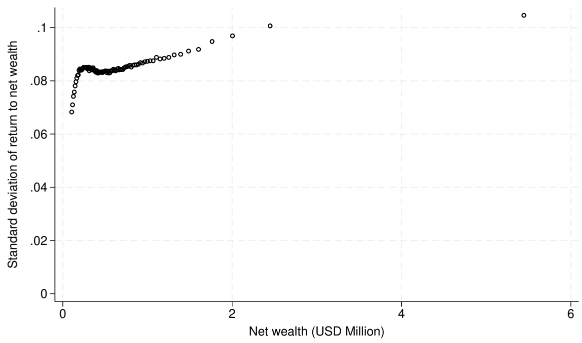
Figure B.1: The distribution of returns to net wealth.

Figure B.1 shows the cross-sectional distribution of returns to net wealth. In our sample, average returns is 0.068 with a standard deviation of 0.086. In the model, we assume that returns are i.i.d. normal with the same mean and standard deviation. Figure B.1 includes the normal distribution on top of the data distribution. While the data distribution is more kurtotic than the normal distribution, the normal distribution seems to be a reasonable approximation of the returns distribution for our purpose.

A further assumption we make is that expected returns are independent of wealth. Figure B.2 plots the mean and standard deviation of returns against percentiles of the net wealth distribution. In our sample of older households, mean returns is independent of wealth above a threshold. Similarly, the standard deviation of returns can also be reasonably well approximated as independent of wealth.



(a) Mean.



(b) Standard deviation.

Figure B.2: Mean and standard deviation of returns to net wealth by wealth percentile.

The third assumption is to say that returns are i.i.d., i.e., there is no persistence in returns among individuals. Table B.1 tests this assumption by running a regression of current returns on previous period returns. If returns are to a large extent individual-specific, current returns should be predicted by past returns when we include no controls. Instead, the coefficient on past returns is negative, suggesting mean-reversion of returns. This result also holds when we add individual- and time-fixed effects.

B.2 Approximated Income and Wealth Tax Schedules

Income tax. We set the income tax schedule in the model to match Norway by estimating an approximate tax schedule in the data.[31] For each individual, we observe both their

[31] Alternatively, we could directly impose the tax laws in Norway. However, because the tax system includes a set of deductions for variables which we have no information, we instead estimate a simplified tax schedule.

Dependent variable: returns to net wealth$_t$	(1)	(2)	(3)	(4)
Returns to net wealth$_{t-1}$	-0.043	-0.119	-0.178	-0.243
	(0.001)	(0.001)	(0.001)	(0.001)
Time-fixed effects	No	Yes	No	Yes
Individual-fixed effects	No	No	Yes	Yes
Observations	3,818,237	3,818,237	3,818,237	3,818,237

Notes: The table shows the coefficients of a regression of returns on lagged returns. Standard errors are clustered at the individual level.

Table B.1: Returns to net wealth.

pension income and their total taxes paid that year. These observable taxes include all income taxes, including taxes on capital income, capital gains realisations, and other similar posts. To estimate the tax schedule, we focus on a subset of the population that has less than $1,000 in combined capital and earned income. Among these individuals, pension income is their primary and almost only source of income. Hence, for these individuals, the taxes we observe reflect almost exclusively income taxes on pension income.

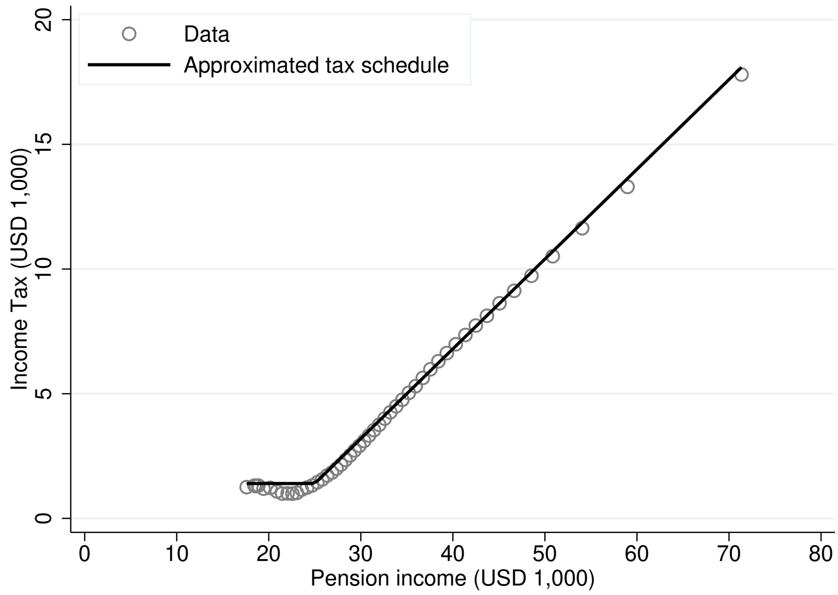


Figure B.3: Pension income and taxes.

Figure B.3 displays the taxes and pension income in data together with the approximated tax schedule. The tax schedule is kinked in which taxes when income is below \$25,000 is approximately constant at \$1,400. From \$25,000, the marginal tax rate is constant at 36 percent. Figure B.3 shows that our approximated tax schedule matches the data well in our sample of individuals where income primarily comes from pension income.

Wealth tax. For the wealth tax, we also estimate an approximate tax schedule from the data. During our sample period, the wealth tax changed from year to year. We use the tax schedule from 2010, which is in the middle of our main sample years, to approximate a tax schedule. In 2010, the wealth tax was 1.1 percent on taxable wealth above a threshold of NOK 700,000 (approximately \$125,000) for singles and NOK 1,400,000 (approximately \$250,000) for couples. Taxable wealth is wealth after imposing a discount where housing wealth is valued at 25 percent of the market price. We approximate the wealth tax as a function of the market value of net wealth and housing, appropriately discounted. We first compute the wealth tax directly in the data from a measure of taxable wealth, after calculating an estimate for the empirically observed discount for total wealth, which is 65%. The functional form we assume is

$$\text{wealth tax} = \tau_w \max\{0.35 \cdot \text{net wealth} - \bar{\tau}, 0\},$$

where τ_w is an approximate marginal tax above the threshold and $\bar{\tau}$ is an approximate threshold. Figure B.4 displays the wealth and the wealth tax in data together with the approximated tax schedule. We compute $\bar{\tau}$ to be \$159, 000 and τ_w to be 0.011 by minimising the squared distance between the data and the approximated tax schedule. Figure B.4 shows that our approximated tax schedule matches the data reasonably well.

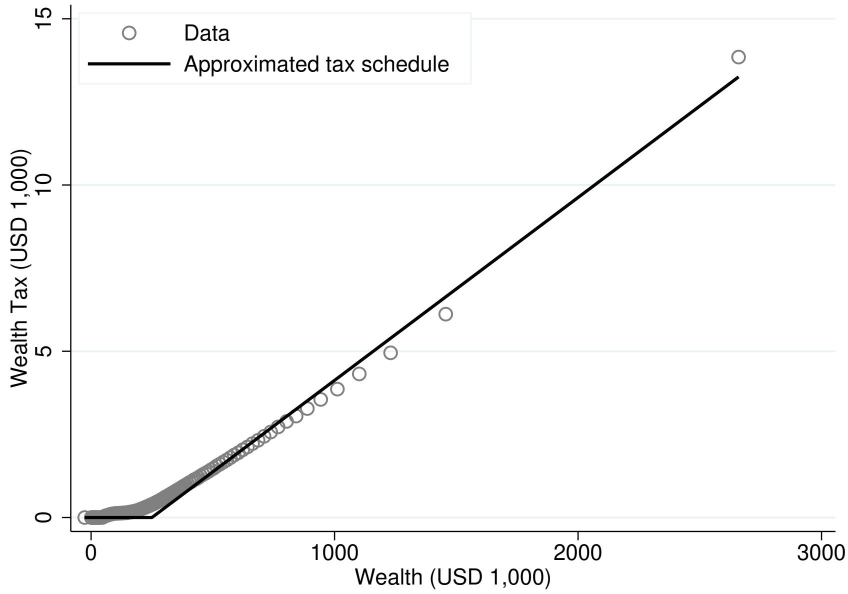
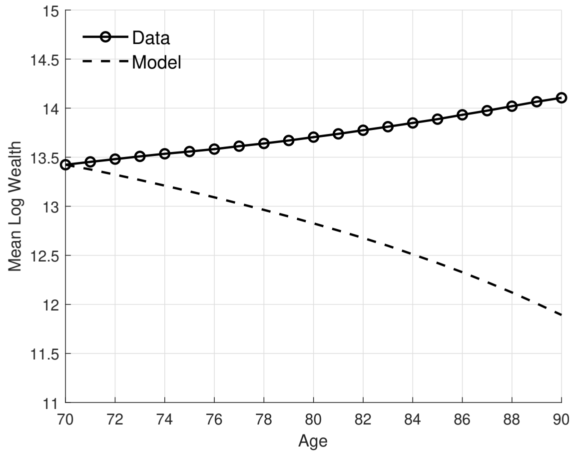


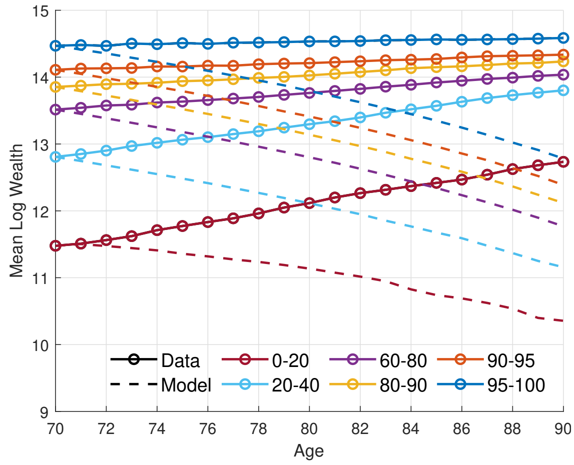
Figure B.4: Wealth and wealth taxes.

C Appendix to Section 6

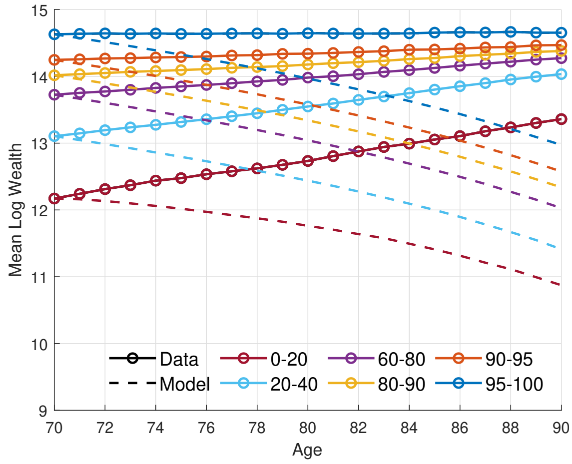
C.1 Estimation results with no bequest motive



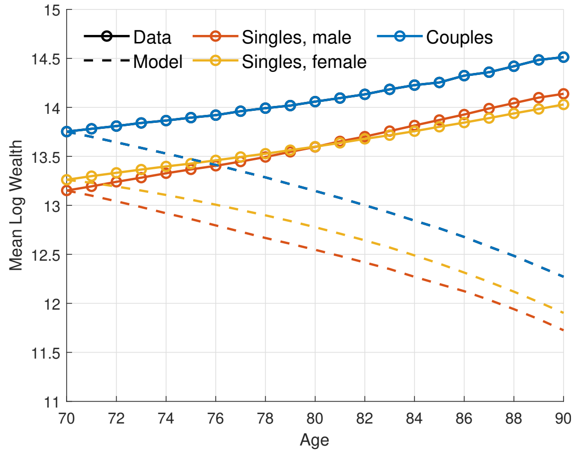
(a) Average log wealth by age.



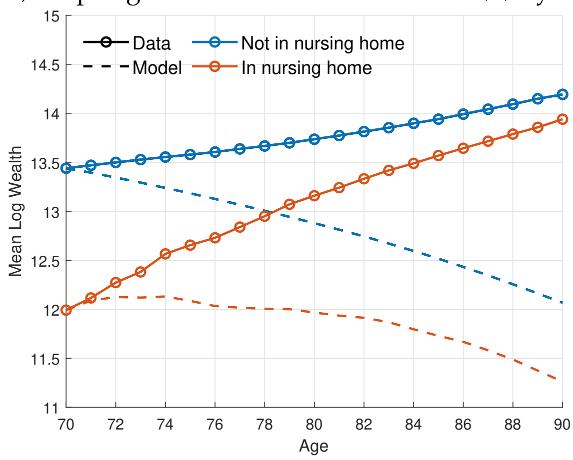
(b) By wealth at 70, no offspring.



(c) By wealth at 70, offspring.



(d) By marital status.



(e) By health.

Figure C.1: Average log wealth by age. Data vs. model. Calibration with no bequest motive.

C.2 Change in the wealth tax threshold

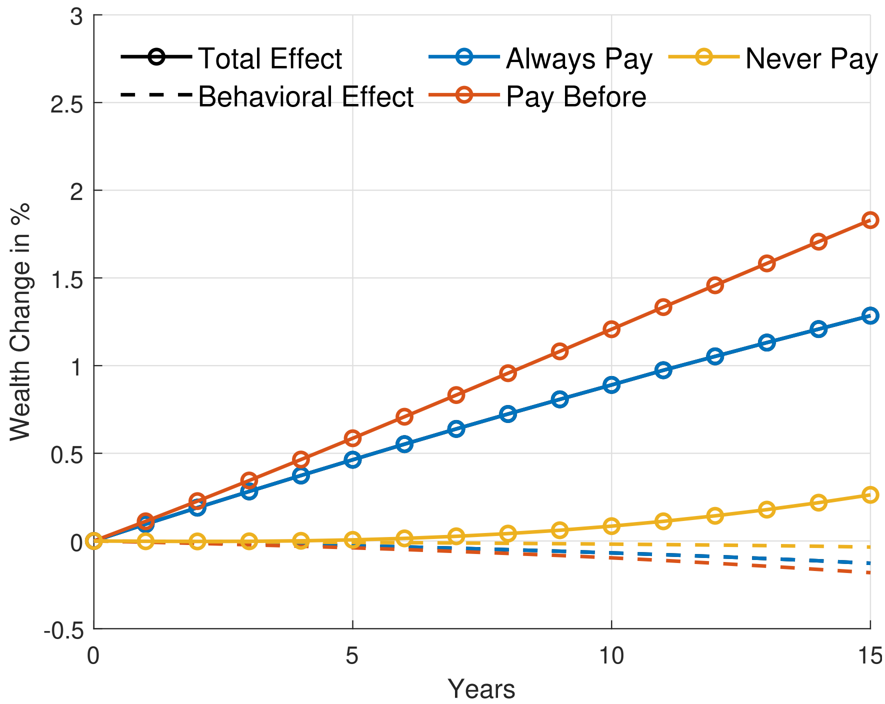


Figure C.2: Response of aggregate wealth to an increase of the wealth tax threshold from \$159,000 to \$318,000 by wealth relative to the thresholds at time 0.

An alternative wealth tax change is to modify the threshold at which the tax is paid. The estimated limit covers around two-thirds of the population in 2013. We consider doubling the limit from \$159,000 to \$318,000, leaving the tax to cover only 37% of the 2013 population. In Figure C.2 we group the households by their position relative to the wealth tax thresholds in 2013: those below the old (\$159,000) threshold, those above the old threshold but below the new threshold (\$159,000-318,000) and those above the new (\$318,000) threshold.[32] Those below the old threshold are not affected immediately or to a large degree, as they benefit from the threshold increase only if their wealth rises above the old threshold, and relatively few do. Those above the old threshold benefit from the tax relief on the previously taxed wealth. This forms an overall large, positive wealth response, most of which is mechanical, and for which they compensate with a negative behavioural response to the change. Those already above the new threshold gain a very small amount initially (since they receive the full benefit of the tax reprieve

[32] Due to wealth growth as households age, and faster death of older, poorer cohorts, for clarity we group households by tax threshold status at time 0.

on \$318,000) but the response is very similar. This response, despite halving the taxable population, has a relatively small effect compared to the change in the marginal rate of tax. This is due to the latter's proportional effect across the wealth distribution compared to the small impact on the wealthy of a threshold change. Importantly, both tax changes demonstrate that the behavioural effect of the wealth tax changes is very small compared to the mechanical effect, i.e. given the bequest motive estimated from the data, wealth taxes have limited distortionary effects on saving.