Discussion Papers

Statistics Norway
Research department

No. 859

May 2017

Statistics Norway

Christian N. Brinch, Dennis Fredriksen,
and Ola L. Vestad

Life expectancy and claiming behavior in a flexible pension system

Statistisk sentralbyrå

Discussion Papers No. 859, May 2017
Statistics Norway, Research Department

Christian N. Brinch, Dennis Fredriksen, and Ola L. Vestad

Life expectancy and claiming behavior in a flexible pension system

Abstract:
We study the relationship between early claiming of pensions and incentives in the highly flexible Norwegian public pension system, measuring incentives to claim based on an estimated model for expected longevity. Despite a strong correlation between incentives and claiming decisions, the additional costs to public budgets arising from this selection turn out to be modest. Based on analyses exploiting only variation in expected pensions generated by variation in parental longevities and only claiming of pensions not in conjunction with retirement, we conclude that part of the selection is active: Some individuals claim pensions early because they gain from doing so.

Keywords: social security; pension benefits; retirement; annuity

JEL classification: H55; J14; J26

Acknowledgements: We are grateful for valuable comments from Giovanni Mastrobuoni and Josef Zweimüller, from seminar participants at the Frisch Centre, the University of Bergen, BI Norwegian Business School, the EEA-ESEM 2014 conference, and the EALE 2014 conference, and from anonymous referees. The project received financial support from the Norwegian Ministry of Labour and Social Affairs, and from the Norwegian Research Council through the Statistics Norway project "Push and Pull Factors in Early Retirement" (project # 227020) and the Frisch Centre project "Working life after the Norwegian pension reform" (project # 220746). While carrying out this research, Brinch has been associated with the centre of Equality, Social Organization, and Performance (ESOP) at the Department of Economics at the University of Oslo, and Statistics Norway, Research Department. ESOP is supported by the Research Council of Norway.

Address: Christian N. Brinch, BI Norwegian Business School. E-mail: christian.brinch@bi.no.

Dennis Fredriksen, Statistics Norway, Research Department. E-mail: dff@ssb.no.

Ola L. Vestad, University of Chicago and Statistics Norway. E-mail: vestad@uchicago.edu.

Discussion Papers comprise research papers intended for international journals or books. A preprint of a Discussion Paper may be longer and more elaborate than a standard journal article, as it may include intermediate calculations and background material etc.

Abstracts with downloadable Discussion Papers
in PDF are available on the Internet:
http://www.ssb.no/en/forskning/discussion-papers
http://ideas.repec.org/s/ssb/dispap.html

ISSN 1892-753X (electronic)

Sammendrag

Etter pensjonsreformen i 2011 er uttak av pensjon og avgang fra arbeidsstyrken i stor grad frikoplet: Uttak av alderspensjon fra folketrygden kan startes når som helst mellom alder 62 og 75, hvor årlige ytelser justeres i henhold til gjennomsnittlig forventet gjenstående levetid ved uttakstidspunktet. Personer som lever kortere enn gjennomsnittet vil, alt annet likt, tjene på å ta ut alderspensjon så tidlig som mulig. Hovedformålet med denne artikkelen er å besvare følgende spørsmål: Hvordan og i hvilken grad er uttak av alderspensjon fra folketrygden forbundet med individuelle variasjoner i forventet levealder? Vi tilnærmer oss dette spørsmålet i to trinn. Først måler vi den generelle sammenhengen mellom uttak av pensjon ved alder 62 og individuell forventet levealder i det fleksible norske pensjonssystemet. Deretter studerer vi i hvilken grad personer tar ut pensjon så tidlig som mulig som følge av kort forventet levetid. Etter å ha beskrevet sammenhengen mellom forventet levealder og tidlig uttak av pensjon er vi også i stand til å beregne ekstrakostnadene av et pensjonssystem med fleksibel uttaksalder, relativt til et system med fast uttaksalder.

Hvorvidt enkeltpersoner tar egne levealdersforventninger i betraktning når de bestemmer seg for når de skal ta ut alderspensjon er et åpent spørsmål, som kun kan besvares empirisk. Kunnskap om sammenhengen mellom tidspunkt for uttak av alderspensjon og forventet levealder er også av praktisk relevans: dels på grunn av at en sammenheng mellom tidspunkt for uttak av pensjon og forventet levealder kan ha implikasjoner for fordeling av pensjonsinntekt, men også fordi slik kunnskap kan være nyttig for å forutsi atferd under andre pensjonssystemer.

Vi finner at personer som velger tidlig uttak av pensjon i stor grad er de som har mest å tjene på tidlig uttak, som følge av kort forventet levetid. Videre viser vi, ved å bruke foreldres levetid som instrumenter for egen forventet levealder, at deler av denne sammenhengen er kausal: en betydelig andel av de som velger tidlig uttak av pensjon ser ut til å gjøre dette fordi det resulterer i høyere forventede pensjonsutbetalinger. Til tross for en sterk negativ sammenheng mellom forventet levealder og tidlig uttak av pensjon finner vi at ekstrakostnadene for pensjonssystemet som følger av denne sammenhengen er heller beskjedne. Dermed bør kostnader som følge av individuelle tilpasninger til levealdersjustering av pensjoner ikke tillegges betydelig vekt i utformingen av offentlige pensjonssystemer.

1 Introduction

The design of old age pension systems is an issue that is currently of considerable interest, as most OECD countries are facing challenges due to a combination of graying populations and strained public finances. In addition to the fiscal challenges, a key challenge is how to design systems that minimize labor supply distortions and at the same time provide sufficient insurance against productivity shocks occurring at late stages of the career. The Norwegian old age pension system offers one promising solution to this challenge, in decoupling the claiming of old age pensions and the decision to retire from the labor force: Individuals can decide to claim old age pensions at any age between 62 and 75; benefits are not earnings tested; and annual benefits are subject to actuarial adjustments based on longevity measures specific to each birth cohort. Hence, the system provides no disincentives to work in terms of implicit taxes on continued work past the pension eligible age (Gruber and Wise, 1999) - an important feature in light of the substantial behavioral responses to earnings testing documented by recent studies (e.g. Song and Manchester, 2007; Haider and Loughran, 2008; Gelber et al., 2013; Hernæs et al., 2016; Brinch et al., 2017).

The main purpose of this paper is to provide an answer to the following question: How, and to what extent, is early claiming of public pensions associated with short expected longevity? We approach this question in two steps. First, we measure the overall association between claiming at age 62 and expected longevity in the Norwegian pension system. Any association between expected longevity and pension claiming might affect both the distribution of individual pension entitlements and the total outlays of pension systems, both of which would be important components in assessments of the performance and effects of old age pension systems. Second, we study the extent to which individuals claim pensions early in part because they act on information about their expected longevity. When faced with a pension system with flexible claiming and without earnings testing, potential claimants may take into account that their expected longevities may differ from the average in their birth cohort, and exploit this difference to increase expected pension payouts, compared to claiming pensions in conjunction with retirement from the labor force. Such behavior would be an example of adverse selection.

Delaying claiming is equivalent to buying an annuity: Current pension benefits are given up in return for a higher future income stream from old age pensions. Empirical evidence of adverse selection in private markets for annuities is provided by Finkelstein and Poterba (2002, 2004). Although the universal coverage provided by the pension system and the absence of endogenous pricing exclude any concern for missing markets, there are reasons to suspect adverse selection to take place also in the context of public pension claiming behavior. However, recent literature has shown that the usual assumption of fully optimizing individuals may not hold in the context of complex tax and benefit systems (see e.g. Chetty et al., 2009; Brinch et al., 2017). Another strand of literature studies to what extent financial literacy affects individual behavior (e.g. Lusardi and Mitchell, 2007). Whether and to what extent individuals are taking longevity expectations into account when deciding when to start claiming pensions is of direct relevance to both these strands of literature. Knowledge about the extent to which individuals act on information about their expected longevity in claiming behavior might also be useful for predicting behavior under different potential social security schemes.

Our paper is closely related to a literature on claiming behavior and life expectancy in the US. Empirical analyses of mortality and pension claiming date back to Wolfe (1983), who finds that those who claim their social security pension at age 62 have higher mortality than those who claim at age 65. Coile et al. (2002) show that it would be beneficial for many to delay claiming but that few actually do. Hurd et al. (2004) study the effects of subjective survival on retirement and Social Security claiming, and find that those with very low subjective probabilities of survival both retired earlier and claimed earlier than others. Hurd and Panis (2006) find no evidence of adverse selection associated with cash-out of pension rights in the event of job separation or retirement.

Also related to our paper are some studies of annuitization decisions (e.g. Brown, 2001; Hagen, 2015) and of labor supply effects of removing earnings testing. Engelhardt and Kumar (2009) and Disney and Smith (2002) study the repeal of earnings tests with a deferral mechanism (in the US and in the UK, respectively), and both find that labor supply responses are concentrated mostly in groups of individuals who are likely to find the earnings test particularly disadvantageous; those with high mortality risks and those facing liquidity constraints.

Unlike earlier studies of claiming behavior, our paper addresses the relationship between expected longevity and claiming behavior in a system in which claiming and retirement decisions are largely decoupled: We study the first birth cohort to enter the recently reformed Norwegian pension system at age 62. We simulate expected longevities and expected present values of pensions conditional on claiming at age 62, the minimum pensionable age, and age 67, the normal retirement age in the system. We then construct the relative money's worth of the two annuities characterized by claiming pensions at age 62 and age 67, respectively, defined as the ratio of the expected present value of the two benefit streams. We find that a one percent increase in the relative money's worth is associated with a 4 percentage points (12 percent) reduction in claiming at age 62. Although the measured selection amounts to as much as one third of the full potential for our expected longevity measure, the costs to public funds are rather moderate: Compared to a situation in which there is no difference between early and late claimers in terms of expected longevity, the observed selection in early claiming increases the expected present value of the outlays of public pensions for early claimers by a modest 0.8 percent.

Following Finkelstein and Poterba (2002), we further distinguish active selection from the overall association between the relative money's worth and claiming. Active selection is in our setting driven by individuals making claiming decisions based in part on their knowledge of their prospective mortality. Our first step towards an estimate of the amount of active selection is to control for a wide range of potential predictors of claiming behavior. To this end, we make use of a 2SLS framework in which parental longevities are used as instruments for the relative money's worth. This approach gives us an estimate of the association between the relative money's worth and early claiming that is identified based on variation in parental longevities only, and not by variation in the other covariates contained in the set of controls, most of which are also used in the estimation of expected longevity.

Secondly, we take into account that retirement and claiming decisions might be jointly determined by studying the effects of the relative money's worth on all combinations of the two outcomes. Acknowledging the possibility that the variables capturing parental longevities may be correlated with claiming outcomes not only through the relative money's worth, we interpret the association between the relative money's worth and early claiming as evidence of active selection only to the extent that there is an effect of the relative money's worth on the joint outcome "Claiming and not retired". We find active selection to be statistically significant at the one percent level, with a one percent increase in the relative money's worth reducing claiming at age 62 by one percentage point (three percent). This point estimate represents a lower bound on the part of the overall association between the relative money's worth and early claiming that can be attributed to active selection.

We challenge the robustness of our results on active selection in several ways. First, we investigate the impacts of excluding net wealth and a proxy for health conditions, respectively, from the set of controls. These exclusions do not substantially alter the estimated effect of the relative money's worth, suggesting that our results on active selection are not likely to be driven by liquidity constraints or a correlation between parental longevities and health conditions. We also perform a placebo test based on an older cohort making claiming and retirement decisions within the context of the pre-reform pension system; that is, absent any mechanisms that would generate incentives for active selection. We find no evidence of active selection for the placebo cohort, indicating that the active selection effects that we do find are indeed particular to the cohorts facing incentives for claiming that depend on expected longevity.

The paper proceeds as follows: Section 2 describes the institutional setting, the data and our estimation sample. Section 3 relates claiming behavior to the theory of annuity demand and spells out the details regarding our operationalization of expected longevity and the relative money's worth (our measure of incentives for early claiming). Section 4 presents results in terms of the overall association between the relative money's worth and claiming behavior, and discusses the implication of these results for the additional costs to public funds arising from selection in early claiming. Section 5 describes our approach for estimating active selection effects, and presents the empirical results followed by the results from a number of robustness checks. Section 6 concludes.

2 Institutional setting and data

2.1 Institutional setting

The Norwegian old age pension system is based on the National Insurance Scheme (NIS), a public pay-as-you-go defined benefit plan with universal coverage. As of January 2011, the NIS old age pension system offers a fair amount of flexibility by being characterized by the following three main features: (i) Pensions can be claimed at any age between 62 and 75, (ii) yearly benefits are subject to actuarial adjustments based on mean expected longevity for each cohort, and (iii) pension benefits are not earnings or means tested.

For an individual to be eligible for early claiming, her accumulated pension wealth must be high enough to ensure a mandated minimum level of pension benefits from age 67. Eligible individuals may choose whether to draw the entire pension or only a fraction of it; 20, 40, 50, 60, 80 or 100%. After the initial choice, however, the fraction of benefits claimed can only be changed to a number other than 0 or 100% after 12 months and only once every year, but it can be set to 0 or 100% at any time. The calibration of the deferral mechanism is specific to each birth cohort; for individuals born in 1949, claiming full pensions from age 62 rather than from age 67 reduces annual benefits by 22%. Early claiming is therefore slightly less costly than in the current U.S. Social Security system, in which annual benefits are 25% lower for individuals claiming at age 62 rather than at the normal retirement age of 66. Pensions under payment are regulated according to the average wage growth in the economy, minus 0.75 percent, and benefits are paid until a person dies.

For cohorts born before 1953, pension entitlements are accumulated as specified by the old pension scheme, in which the pension benefits are based on a two tier system, consisting of a basic pension and a supplementary earnings based pension. A full basic pension is approximately equal to one Basic Amount[1] per year, and an additional minimum pension is granted to individuals not qualifying for the earnings based pension. The supplementary earnings based

[1] The Basic Amount (BA) is a central feature of the public pension system in Norway. It is adjusted every year, with a nominal rate of growth varying between 2 and 13% since its introduction in 1967, and from the late nineties and onwards in accordance with the average wage growth in the economy. The average BA for 2011 is 78,024 NOK, which at the time of writing corresponds to about 9,000 USD or 8,500 EUR.

pension is determined by labor income earned between ages 17 and 69, and full supplementary pensions can be obtained after 40 years of contributions. The main determinant of the supplementary pension is an average point score, which is calculated on the basis of the individual's 20 highest annual incomes measured in units of the Basic Amount (see e.g. Brinch et al. (2017) for details).

Another important institution, besides the NIS, is the contractual early retirement scheme AFP, which covers all public sector workers and approximately half of the private sector workers. As of 2011, the private sector AFP scheme is fully integrated with the NIS: It is an actuarially adjusted, non-earnings tested lifelong supplementary benefit available to workers in affiliated firms who fulfill a set of individual requirements related to past earnings and tenure in AFP affiliated firms. Benefits can be claimed at any age between 62 and 75, in combination with the NIS old age pension, and conditional on employment in an affiliated firm at the time of claiming. In contrast, the public sector AFP scheme is rather rigid, in the sense that benefits are earnings tested and foregone benefits are not compensated by means of higher future benefits. Benefits are available from age 62 and until age 67, when recipients are transfered to the NIS, and public sector AFP benefits can not be combined with NIS old age pensions. For a public sector employee who wishes to retire at age 62, the AFP scheme is clearly the most attractive option, since pension benefits are calculated as if she had continued working until the normal retirement age of 67. Public sector employees who wish to combine pension benefits with full time labor earnings would be better off by taking the new and more flexible NIS old age pension.

When the new pension system was implemented in January 2011, a large number of individuals aged 62-66 immediately became eligible for the flexible old age pension. Our focus, however, is on those who became eligible throughout 2011 by reaching age 62. The reason for focusing on the 62-year-olds, as opposed to the larger 62-66-years sample, is that the latter sample is self-selected in a very complicated manner. Not only had a large subgroup of these individuals the opportunity to claim the AFP early retirement benefits under the old regime; they also had the opportunity to evaluate whether it would be beneficial for them to claim pensions under the old regime, or wait until January 2011 to benefit from the new and more flexible pension regime. Our sample of 62-year-olds have never been exposed to the pre-reform early retirement scheme, which simplifies matters with regards to self-selection. In this respect, they are also similar to later cohorts, which makes our analysis of 62-year-olds a good starting point for understanding the behavior of later cohorts.

With our approach we expect to capture most of the selection in the direction of early claiming, as we expect the results of optimizing behavior to be either to claim pensions as early as possible, to claim pensions when retiring from the labor force, or to delay claiming for as long as possible. Our analysis will not capture the effects of selection in the direction of claiming pensions as late as possible; it will be hard to say much about this until a decade or so has passed. We do observe, however, whether individuals choose to delay claiming even though they retire from the labor market.

2.2 Data, sample, and descriptive statistics

The data used in this paper combines several administrative registers linked by unique personal identification numbers. One is the Register of Employers and Employees, which contains both firm and individual specific information for all job spells and covers the entire Norwegian working age population. The data also contains detailed demographic information for all residents, including birth and death dates, gender, level of education, and information on parental longevities. We can identify recipients of AFP, disability and old age pensions, and we have access to individual pensionable earnings data dating back to 1967 (the year in which the NIS was introduced), which allows us to identify eligibility for early take-up of NIS pension benefits.

We start out with all Norwegian citizens born between January and November 1949, who were alive and resident by the end of 2010; 52,991 individuals.[2] Individuals are classified as working if their pensionable income in 2010 exceeds 1 BA, and if they did not receive disability or survivor pension benefits in the same year. Among those classified as working, individuals

[2]Individuals born in December 1949 are left out, as they are not eligible for claiming pensions until January 2012.

Table 1: The Norwegian 1949 birth cohort, their status in 2010 and eligibility for early claiming

	Public pension eligibility at age 62			
	Not eligible		**Eligible**	
Working				
In private sector AFP affiliated firm	1,814	(6.13)	7,029	(30.03)
In private sector non-affiliated firm	1,774	(6.00)	4,897	(20.92)
In public sector firm	5,228	(17.67)	8,492	(36.28)
Self employed and other	895	(3.03)	1,723	(7.36)
Non-working				
On disability pension rolls	18,110	(61.22)	845	(3.61)
Outside disability	1,761	(5.95)	423	(1.81)
N	29,582		23,409	

Percentages of the total number of individuals not eligible and eligible, respectively, in parentheses.

with at least one active record in the employment registry at the end of the year and with wage income above 1 BA are classified as employed in one out of three different sectors, according to the sector affiliation of their main employer: private sector with AFP coverage, private sector without AFP coverage, or public sector.[3] The residual category "self employed and other" includes, in addition to the self employed, unemployment benefit recipients and other individuals having pensionable income above 1 BA, but no active employment relationship at the end of the year.

Table 1 describes the labor market status by the end of 2010 for all individuals in the cohort, separately for those eligible and those not eligible to start receiving public pension benefits from age 62. Starting with the non-eligible, we note that a vast majority (67 percent) is classified as non-working, and that most of the non-working and non-eligible are receiving disability pensions or survivor pension benefits. 95 percent of the 23,409 individuals who were eligible for claiming public pension benefits from age 62 are classified as working, and 66 percent are working in a public or private sector AFP affiliated firm.

Our analysis is focused on individuals who are eligible for claiming NIS pensions at age 62 and not receiving disability pension benefits in 2010; a sample of 22,564 individuals, for which

[3]To identify the AFP affiliation of private sector firms, we make use of the fact that all workers in an AFP affiliated firm are automatically covered by the scheme: We track the previous employment of all individuals observed to be receiving early retirement pensions, and classify a firm as AFP affiliated if it has at least one previous employee who later received AFP pension benefits.

descriptive statistics are provided in Table A1 in the Appendix Section A.3. We note that 76% of our sample are men, compared to 51% in the full cohort (Table A2 in the Appendix Section A.3); that very few have a history of disability benefits receipt; and that the individuals in our sample are relatively well educated.

3 Annuity demand and the money's worth

3.1 Annuity demand

Postponed claiming of pension benefits is equivalent to the purchase of additional Social Security annuities, with the foregone current benefits being the price an individual pays in order to receive higher benefits for the remaining life span in return (Coile et al., 2002). As is clear from the theory of annuity demand, there are two distinct motives for buying annuities: an income maximization and an insurance motive.

Let the *money's worth* of an annuity be defined as the expected present value of the annuity divided by its price. In the absence of any insurance motive, a risk neutral income maximizing individual will be better off by buying an annuity for which the money's worth is larger than unity. An individual faced with a risk of outliving her resources may want to buy an annuity even if the expected present value of the annuity is lower than its price.[4] In this study we put more emphasis on the income maximization motive than on the insurance motive, mainly because the risk of outliving one's resources does not seem particularly relevant for the population under study. All Norwegian citizens have access to a public pension system that provides a basic annuity, and most individuals will not even be close to spending all their resources before they die.[5] Moreover, as the prices of the different annuities in the Norwegian public pension system are given exogenously, the market will exist even in the absence of insurance motives. This stands in contrast to the case of private annuity markets, where noone would sell annuities

[4]Yaari (1965) originally pointed out how life annuities can increase welfare by insuring individuals against the risk of outliving one's resources.

[5]Although data on savings is not of the highest quality, there are clear indications that the average pensioner in Norway saves money every year rather than drawing down on her wealth; see Halvorsen (2011).

if the only buyers would be those who would gain, in expected terms, from buying the annuity.

3.2 The relative money's worth of implicit annuities

The money's worth is a useful way of characterizing individual incentives for buying annuities. In the context of a Social Security system with flexible claiming dates, individuals can choose from a menu of implicit annuities characterized by the age at claiming. Rather than working with the full menu of annuities, we focus on those resulting from delaying claiming until age 67, the normal retirement age, relative to claiming at age 62, the minimum pensionable age.

Let A_a^c denote the annual gross pensions received at age a by an individual who first claims pensions at age c. The money's worth of the additional annuity associated with delaying claiming from age 62 to age 67 is now

$$MW = \frac{\sum_{a=67}^{\infty} \frac{s_a}{(1+r)^{a-62}} A_a^{67} - \sum_{a=67}^{\infty} \frac{s_a}{(1+r)^{a-62}} A_a^{62}}{\sum_{a=62}^{66} \frac{s_a}{(1+r)^{a-62}} A_a^{62}},$$

where s_a is the probability of survival to age a. Actuarial neutrality requires that $MW = 1$. When this condition holds, there are no expected gains associated with delaying claiming. If $MW > 1$, however, delayed claiming will increase expected lifetime income. In the following, we will use an easily interpretable incentive measure that we term the *relative money's worth (RMW)*; the ratio of the present value of gross pensions resulting from claiming at age 67 to the present value of gross pensions resulting from claiming at age 62:

$$RMW = \frac{\sum_{a=67}^{\infty} \frac{s_a}{(1+r)^{a-62}} A_a^{67}}{\sum_{a=62}^{\infty} \frac{s_a}{(1+r)^{a-62}} A_a^{62}}.$$

RMW measures the relative increase in expected pensions resulting from delaying claiming from age 62 to 67.[6] One may think of *RMW* as being a function of expected longevity, with short expected lifetimes being associated with low values of *RMW*.

We see from the expressions for *MW* and *RMW* above that, besides the individual survival

[6] Note that $MW > 1$ if and only if $RMW > 1$, and that the two measures capture essentially the same information.

probabilities, the choice of discount rate (r) will be important for distinguishing between those who will gain and those who will lose from claiming pensions at age 62 compared to at age 67. Note, however, that the discount rate primarily affects the level of MW or RMW, while what we exploit for estimation purposes is the variation in RMW between individuals. The choice of discount rate is therefore not crucial to our estimation results.[7] Note further that the focus on claiming at age 62 compared to claiming at age 67 is not of crucial importance for the purpose of estimation; RMW is approximately 5 times the gain from delaying claiming from age 62 to age 63.

3.3 Mortality models and expected longevity at age 62

We do not observe subjective longevity expectations, but instead make use of a wide range of observable characteristics to estimate expected longevities based on observed mortality for the entire Norwegian population over the years 2001-2010.[8] The basis for our measure of expected longevity is a logit model for the mortality probability of age group a in time t and county g, which is estimated separately for men and women:

$$Pr(M|x,a,t,g) = \frac{\exp(\tau_t + \lambda_g + \theta_a + x'\beta)}{1 + \exp(\tau_t + \lambda_g + \theta_a + x'\beta)},$$

where τ_t, λ_g, and θ_a are parameters specifying year, county, and age fixed effects. x contains a set of individual background characteristics: educational attainment, disability history, and civil status (single, married/cohabiting, with or without children). These enter as three groups of dummies, each interacted with functions of age to produce explanatory variable specific age

[7]We set the discount rate r equal to the interest rate implicit in the NIS, i.e. to the average nominal wage growth. Since future benefits are indexed by average nominal wage growth, through the Basic Amount, this means that 1 Basic Amount of pensions has the same value to the individual irrespective of which year it is received. To verify that our results are indeed robust to the choice of discount rate we have done analyses based on a substantially (two percentage points) higher interest rate. The alternative RMW measure is strongly correlated with our baseline measure (correlation coefficient = 0.9856), and results do not change substantially.

[8]Studies using data from the Health and Retirement Study (HRS) have found that subjective probabilities of survival are generally close to their objective counterparts, as measured by estimated probabilities using actual mortality realizations on HRS respondents over a 10-year period (Khwaja, Sloan and Chung, 2007) and by survival probabilities calculated from life tables (Hurd and McGarry, 1995, 2002).

profiles. The age profiles are specified as quadratic splines, i.e. we specify subvectors of x as

$$(ax_j, a^2x_j, \mathbb{1}\{a > k_{j1}\}(a-k_{j1})^2x_j, \ldots, \mathbb{1}\{a > k_{jm}\}(a-k_{jm})^2x_j),$$

where x_j is a given background characteristic dummy, e.g. for low educational attainment, and the knots $k_{j1}, \ldots, k_{jm}$ are chosen by visual inspection of more complex models in which age specific dummies are estimated for each covariate group.[9]

Also contained in x is information on the longevity of parents.[10] For individuals whose parents are still alive in a given year we impute parental longevities based on expected longevities, as a function of gender, year and cohort, taken from official mortality tables. As the effects of parental longevities are found to be highly nonlinear, we define the following covariates: mother/father unknown, mother/father emigrated, and mother/father dead before age 50 (dummies). In addition, we include separate linear terms in mother's/father's longevities if between 50 and 65 or above 65, respectively. Information about parental longevities is included in the mortality model for individuals of age 56 or older. Summary statistics for the mortality estimation are provided in Tables A3 and A4 in the Appendix Section A.3.

To predict expected longevities and calculate the *RMW* for each individual in the sample, we use estimated coefficients from the mortality models[11] along with detailed pension accumulation histories within the framework of the MOSART microsimulation model.[12] We start out with the full 1949 birth cohort in 2010 and run the model forward year-by-year, to simulate survival and present values of future pension benefits. We run the simulation 900 times, and approximate expected longevity at age 62 by taking the average over these 900 predictions.

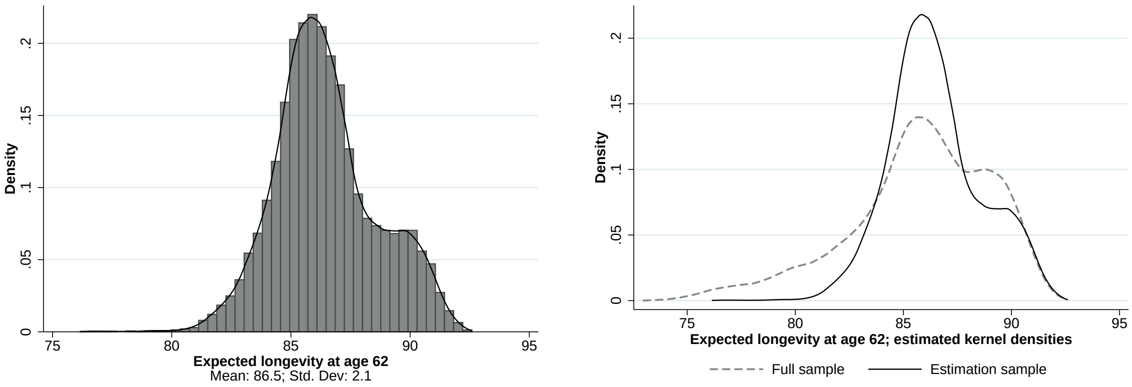
[9] The reason for estimating models with quadratic splines is simply to obtain unrestrictive prediction models for age-specific mortality without undue overfitting.

[10] We know the parents' identities for all cohorts born in 1964 or later. For older cohorts, we make use of nationwide censuses conducted from 1960 and onwards to link children with their parents based on surnames and place of residence. With this procedure we are not able to identify the parents of those not living with their parents in 1960, and therefore we only use information on parents for cohorts born after 1935.

[11] Coefficients for year effects beyond 2010 are calibrated so that the average mortality for each cohort correspond to official Norwegian population forecasts. Our analysis is not sensitive to this calibration since these parameters primarily affect the level of expected longevity for a cohort, while our study uses the variation in expected longevity within a cohort.

[12] While the MOSART model is built to simulate a wide range of outcomes for the full population, we single out only the parts that are of direct use for our purpose. See e.g. Fredriksen (1998) and Fredriksen and Stølen (2011) for details on the MOSART model.

Figure 1: Histogram and density plot of expected longevity at age 62



(a) Estimation sample

(b) Full sample vs estimation sample

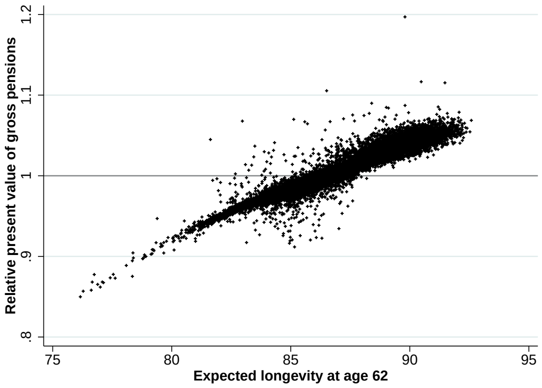
Notes: The estimation sample consists of individuals who are eligible for public pension take-up at age 62 and not receiving DI pensions in 2010.

Figure 1 (a) shows how the model spans out expected longevity for individuals eligible for claiming pensions at age 62. The distribution ranges from 76 to 93 years with an average of 86.4, and is bimodal, owing mainly to the difference in average expected longevity between men and women. Figure 1 (b) highlights the difference in expected longevities according to eligibility for early claiming. The distribution for the full cohort has a much heavier left tail and slightly more mass to the right of the leftmost mode than that for eligible individuals only. These differences are due to individuals on disability insurance rolls and women with insufficient pension accumulations, respectively.[13] For the full cohort, the standard deviation of expected longevity at age 62 is 3.3 years. This is well in line with Hosseini (2015), who estimates a standard deviation of subjective expected longevities of approximately four years based on data from the HRS.

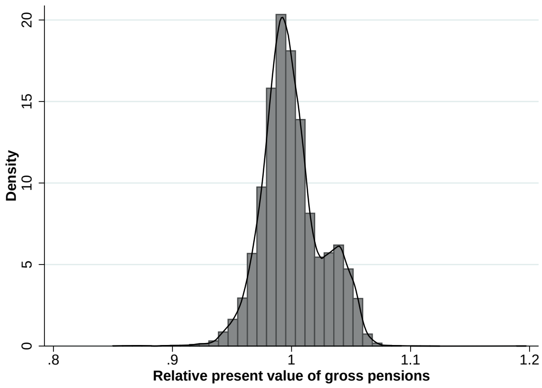
Figure 2 (a) shows a scatterplot of expected longevity against the relative money's worth for individuals eligible to claim pensions at age 62. The figure shows a strong association between the relative expected value of gross pensions and expected longevity, with a correlation of 0.96 and only a small number of outliers. These outliers arise from different idiosyncrasies in the

[13]To summarize the magnitude of the effects of different covariates on expected longevity generated by this complex nonlinear model, we report the results of a linear regression of expected longevity on all the covariates used in the mortality models, for the full 1949 cohort, in Table A5 in the Appendix Section A.3.

Figure 2: The relative money's worth and expected longevity



(a) *RMW* and expected longevity



(b) *RMW*

Notes: The sample consists of individuals who are eligible for public pension take-up at age 62 and not receiving DI pensions in 2010.

pension system.[14] Note that we have normalized our *RMW* measure so that it equals 1 for individuals with expected longevity corresponding to the full sample average of 86 years.[15] By focusing on the deviations from the mean of the cohort, our approach is orthogonal to recent work on US data studying how the attractiveness of delaying claiming varies between cohorts (Shoven and Slavov, 2012, 2013).

While there is considerable variation in both expected longevity and in the relative money's worth across individuals in our sample, it should also be noted that the effect of expected longevity on the relative money's worth is of a modest magnitude: One additional year of expected longevity translates into slightly more than a 0.01 unit increase in the relative money's worth. Hence, an individual expecting to live for one year longer than the cohort average will increase his expected lifetime pensions by about one percent by postponing claiming of pension benefits by five years. This moderate effect is not a consequence of very high discount rates, although discount rates will have some impact on our incentive measure - it simply follows from the fact that the gains from postponing claiming are small. We elaborate further on this in

[14]Survivor pension benefits, for instance, will tend to make it very profitable to postpone the claiming of own pensions for individuals whose deceased spouse had relatively high pension accumulations.

[15]Since the Norwegian deferral mechanism is based on actuarially neutral rates for an individual with average longevity, the *RMW* measure would be fairly close to 1 for an average individual also without the normalization.

the Appendix Section A.1 by means of a simple numerical example.

4 Early claiming of flexible old age pensions

4.1 Early claiming and the relative money's worth

In this section, we first describe the aggregate claiming behavior of our estimation sample, before moving on to an assessment of the relationship between early claiming and the relative money's worth. Column (2) of Table 2 shows that 34 percent of the full estimation sample are early claimers, i.e. they have chosen to start receiving (a fraction of) their public pension in 2011.[16] The same table also shows the fraction of early claimers by sex and educational attainment, which gives a first indication of selection in claiming behavior: Early claiming is considerably more common among groups of workers whose average expected longevity is known to be relatively low; men, and individuals with low educational attainment. When dividing the sample into three groups according to individuals' firm affiliation at age 61 (leaving out the 423 eligible individuals who are not classified as working in 2010), we see that early claiming is most common among workers in private sector AFP affiliated firms, followed by workers in private sector non-affiliated firms and the self-employed, while early claiming is relatively uncommon among workers in the public sector. These differences are probably partly due to the fact that the groups differ according to their occupational pension coverage, as described in Section 2.1, but they might also reflect the high shares of women and highly educated workers in the public sector (see Table A6 in the Appendix Section A.3).

For a more precise assessment of the extent to which claiming decisions are related to individual life expectancies, we proceed by measuring the overall association between the relative money's worth and early claiming. To this end, we first estimate easily interpretable linear probability models of the following form:

$$Y = \alpha + \rho RMW + \varepsilon, \tag{1}$$

[16] We make no distinction between claiming the full pension and claiming only a fraction of it. More than 90 percent of early claimers are claiming a full pension.

Table 2: Effects of *RMW* on early claiming

	N	Dep. Mean	OLS		2SLS[a]	
	(1)	(2)	(3)	(4)	(5)	(6)
Sample						
Full estimation sample	22564	34.1	-4.07***	(0.12)	-1.20***	(0.33)
Men	17051	38.8	-3.92***	(0.22)	-1.16***	(0.38)
Women	5513	19.3	-2.78***	(0.32)	-1.31*	(0.67)
Educational attainment						
Primary/missing education	8092	45.3	-2.55***	(0.23)	-1.36**	(0.57)
High school	7655	35.8	-3.37***	(0.21)	-0.96*	(0.57)
Higher education	6817	18.8	-2.82***	(0.19)	-1.27**	(0.56)
Individuals working in 2010, by firm affiliation						
Private sector, no AFP[b]	6620	35.4	-2.69***	(0.24)	-1.22**	(0.59)
Private sector, with AFP	7029	55.0	-2.80***	(0.27)	-0.81	(0.69)
Public sector	8492	15.1	-2.00***	(0.14)	-1.48***	(0.46)

Heteroskedasticity robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
The full estimation sample includes all individuals eligible for early claiming and not receiving disability pensions in 2010.

[a] The set of controls includes dummies for AFP affiliation (2010), sex, receipt of disability benefits prior to the age of 62, educational attainment (three categories), civil status (four categories), dummies for the number of months on sickness leave at age 61, dummies for net wealth quartiles (measured in 2010), and dummies for labor income quartiles and employment status (measured in 2010). Information on parental longevities is used to form instrumental variables in the 2SLS estimations.

[b] Includes workers in private sector firms not affiliated with AFP, and the group “Self employed and other”.

where Y is an indicator for the outcome *claiming NIS pensions in 2011*. Estimates of ρ from equation (1) estimated for the full estimation sample and separately for each of the above mentioned sub-groups are provided in Column (3) of Table 2. Starting with the full estimation sample, the point estimate of -4.07 indicates that a one percent increase in the expected gains from claiming pensions at age 67 relative to age 62 is associated with a 4 percentage points (12 percent) decrease in the probability of early claiming. An increase in the relative money's worth of one standard deviation (0.025) is associated with a 30 percent decrease in the probability of claiming.

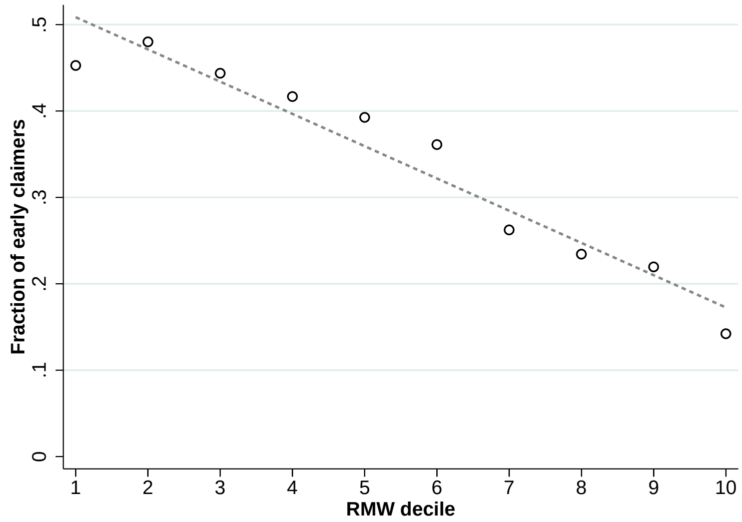
Turning to the different sub-groups, we first note that the estimated associations between the relative money's worth and early claiming are negative and significant at the one percent level in all eight cases. When evaluated relative to the respective sample means, the magnitude of the association is higher for women than for men, and it is increasing with educational attainment. The association appears to be considerably stronger among workers in public sector firms than among the two groups of private sector workers.

Figure 3 shows the fraction of early claimers at each decile of the RMW distribution. We see that except for at the first decile, moving up from one decile to the next is associated with a lower propensity for early claiming. The relationship between the fraction of early claimers and RMW is close to linear, and the slope of the fitted regression line is -0.037, meaning that the average difference in the propensity for early claiming between two subsequent deciles is 3.7 percentage points.

4.2 The cost of selection in early claiming to public funds

To illustrate the cost to public funds of selection in early claiming, we contrast the amount of selection that we do observe with the following two polar cases: no selection, and the maximum amount of selection that one could observe, given our measure of expected longevity. The case of no selection corresponds to claiming behavior being orthogonal to the relative money's worth, and hence its average value should equal 1 for both early and late claimers. At the other extreme, "full" selection would correspond to the case in which the 34 percent of early claimers

Figure 3: The fraction of early claimers by deciles of the RMW distribution.



in our estimation sample all belong to the lower tail of the *RMW* distribution. The average relative money's worth for individuals at the 34th percentile and below equals 0.975, which means that "full" selection would increase the expected cost of pension outlays to early claimers by 2.5 percent, relative to a situation with no selection. The average relative money's worth for those who are in fact observed as early claimers equals 0.992, meaning that while the observed selection corresponds to about 32 percent of the maximum potential, given our measure of expected longevity, it only increases the cost to public funds by a modest 0.8 percent.[17]

5 Active selection

5.1 Controlling for observables

We take the results presented so far as evidence of a considerable amount of selection in early claiming: There is a clear tendency that individuals who have more to gain by claiming early are more likely to be the ones who are claiming early. With this being established, note that

[17] Since we have normalized the relative money's worth to equal 1 for individuals with expected longevity corresponding to the sample average, this cost should not be interpreted as a measure of the total costs or benefits associated with early claiming. It is rather a measure of the extra costs associated with selection in early claiming compared to a situation in which claiming is orthogonal to the relative money's worth.

the overall association between the relative money's worth and claiming behavior captured by the simple OLS estimates can be thought of as arising from two different types of selection: (i) active selection, represented by individuals claiming early in part because they expect to gain in terms of the expected present value of pension benefits, and (ii) passive selection, defined residually from other mechanisms generating a correlation between expected longevity and claiming. One example of such a mechanism may be that claiming and retirement decisions are to some extent coordinated, and that people with characteristics predictive of early retirement, e.g. low educational attainment, will typically also have short expected longevities. We address this issue in Section 5.2 below. Other mechanisms may be that individuals with characteristics predicting short expected longevity for some other reason claim pensions early to a greater extent than others - maybe because of issues related to financial literacy, or by men behaving differently from women in financial decision making.

We take a first step towards an estimate of the amount of active selection by conditioning on characteristics that may be correlated with early claiming without directly reflecting incentives for early claiming. The relative money's worth is by construction a nonlinear function of many of the variables that would naturally belong in the set of controls. We therefore apply a two stage least squares (2SLS) regression framework, using information on parental longevities as instruments for the relative money's worth. The first and second stage regressions can be described as follows:

$$RMW = \alpha_1 + X'\beta_1 + Z'\gamma + \varepsilon_1 \tag{2}$$

$$Y = \alpha_2 + X'\beta_2 + \rho_2\widehat{RMW} + \varepsilon_2, \tag{3}$$

where equation (2) is the first stage regression, and where the actual values of RMW are replaced by predicted values from equation (2) in the second stage regression, equation (3). X is a vector of observable characteristics, containing dummies for sex, receipt of disability benefits prior to the age of 62, educational attainment (three categories), and civil status (four categories). Dummies for the number of months on sickness leave at age 61 are included to control for health conditions. In addition, we control for net wealth, labor income and employment status in 2010, by including dummy variables specifying the quartiles in the income and wealth distributions, and dummies for the group "self employed and other" and for individuals not working in 2010. Z is a vector containing information on parental longevities, specified as described in Section 3.3.

Our 2SLS framework has a slightly different motivation from standard uses of instrumental variable techniques. Our variable of interest, RMW, is a nonlinear function of a subset of the observables contained in X, because it is based in part on estimated age specific mortality rates, as described in Section 3.3. To avoid multicollinearity we therefore need an exclusion restriction. One could control linearly for X in a multivariate OLS setup. However, the effect of RMW would then be identified not only from variation in RMW generated by the excluded variables (parental longevities), but also from the nonlinear relationship between variables in X and RMW. The 2SLS framework ensures that the estimated association between RMW and the outcomes are identified based on variation in parental longevities only.

2SLS estimates of ρ_2 are provided in Column (5) of Table 2, for the full sample and for each of the eight sub-groups. As expected, the 2SLS point estimates are quite a bit smaller in magnitude than the corresponding simple OLS estimates in Column (3). While the full sample coefficient is significant at the one percent level, some of the subgroup point estimates are not statistically distinguishable from zero. This lack of precision appears to a large extent to be driven by small sample sizes.

Our regression analysis also serves the purpose of identifying other predictors of early claiming. To this end, we report the full set of estimates from the second stage regression in Table 3. First, note that the differences in early claiming between the groups in Table 2 are present also conditional on other characteristics, although they are smaller than what appears from the unadjusted means: Men are more likely than women to claim early; those with low educational attainment are more likely early claimers than those with high educational attainment; and early claiming is least common in the public sector, and most common among workers in private sector firms with AFP coverage. Other important predictors of early claiming are labor income and net wealth; those with lower income and those with lower net wealth prior to eligibility for early claiming are more likely to be claiming early than are their counterparts with higher income or higher net wealth.

5.2 Joint analysis of retirement and claiming

Although claiming and retirement decisions are notionally decoupled in the new flexible system, there are features such as taxes on wage and pension income and capital market imperfections that prevent them from being perfectly decoupled. One might therefore suspect the established association between the relative money's worth (or equivalently, expected longevity) and claiming decisions to be driven by expected longevity influencing retirement behavior, which in turn causes claiming behavior. In this section, we estimate a lower bound on the magnitude of the direct effect of the relative money's worth on early claiming, i.e. on the part of the effect that is not driven by a relationship between expected longevity and the retirement decision. The key ingredients of this exercise are theoretical predictions for the effects of the relative money's worth on each of the four possible combinations of early claiming and retirement outcomes, and their empirical counterparts represented by estimates obtained within our 2SLS regression framework.[18]

5.2.1 Theoretical predictions

In Appendix Section A.1 we set up a simple model of claiming and retirement behavior, in which the pension system has the same main features as the NIS; no earnings testing, and actuarial adjustments for early or late claiming. The main purpose of this model is to show that with such a decoupled claiming/retirement system, and absent capital market imperfections, distortive taxes and other regulations or interventions, individuals will choose when to start claiming pensions without regards to the retirement decision, and vice versa. The relative money's worth matters only for the claiming decision and not for the retirement decision. More

[18]Since both retirement and claiming are outcomes, it is not a prudent empirical strategy to condition on one of them, such as e.g. studying claiming behavior conditional on retirement.

Table 3: Second stage regression; full estimation sample

Dependent variable: Claiming at age 62		
RMW	-1.1953***	(0.3290)
Male	0.0693***	(0.0161)
Educational attainment (ref: higher education)		
Primary/missing	0.1066***	(0.0097)
High school	0.0729***	(0.0077)
Receipt of disability benefits (ref: never received)		
Received prior to age 62	-0.0843*	(0.0481)
Civil status (ref: married/cohabiting, at least one child)		
Married, no children	-0.0434***	(0.0155)
Single, at least one child	-0.0246	(0.0461)
Single/cohabiting, no children	-0.0370***	(0.0086)
Working in public sector	-0.1414***	(0.0084)
Working in private sector with AFP	0.1919***	(0.0090)
Labor income quartiles and employment status (ref: first quartile)		
Q2	-0.0081	(0.0088)
Q3	-0.0401***	(0.0089)
Q4	-0.0661***	(0.0096)
Self employed and other	-0.0029	(0.0142)
Not working	0.0796***	(0.0261)
Net wealth quartiles (ref: first quartile)		
Q2	-0.0289***	(0.0083)
Q3	-0.0463***	(0.0083)
Q4	-0.0748***	(0.0085)
Number of months on sickness leave at age 61 (ref: zero)		
One	0.0242	(0.0175)
Two	0.0070	(0.0134)
Three	0.0208	(0.0160)
Four	0.0295	(0.0202)
Five	-0.0042	(0.0218)
Six	-0.0314	(0.0260)
Seven	-0.0186	(0.0296)
Eight	-0.0395	(0.0342)
Nine	-0.0920***	(0.0348)
Ten	-0.0574	(0.0375)
Eleven	-0.1688***	(0.0393)
Twelve	-0.1853***	(0.0441)
Constant	1.5349***	(0.3577)
R^2	0.1566	
N	22564	

Heteroskedasticity robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sample: Individuals eligible for pension take-up and not receiving disability pensions in 2010.

generally, a change in the factors affecting claiming will not affect retirement, and a change in the factors affecting retirement will not affect claiming. In reality, however, different types of imperfections, regulations and interventions tend to make coordinated claiming and retirement outcomes (claiming and retiring; not claiming and not retiring) more attractive than the non-coordinated ones (claiming and not retiring; not claiming and retiring), relative to what would be the case in a perfectly decoupled system.

In the following, we refer to a coupled system as one in which a penalty applies for not coordinating claiming and retirement behavior, or one in which a bonus applies if decisions are coordinated. One example of a coupled system is the current US system, for individuals below the normal retirement age. Since their pension benefits are earnings tested, combining early claiming with continued work is simply not feasible. Another example is a system which is notionally decoupled, but not accompanied by a perfect capital market, so that individuals wanting to borrow in order to finance early retirement without claiming pensions will have to pay an interest rate strictly higher than the market interest rate. In this example, the maximum utility resulting from the outcome "not claiming and retiring" will be lower than in a perfectly decoupled system, since some resources are lost through a higher interest rate. A third example of a coupled system is one that is decoupled at the gross pension level, but not at the net pension level, due to progressive taxation. This applies to the Norwegian system. Progressive taxation discriminates slightly against not coordinating claiming and retirement, as coordination of claiming and retirement decisions amounts to income smoothing and therefore leads to higher net income.

While in a perfectly decoupled system, an improvement in the incentives for early claiming may induce individuals to claim without affecting their retirement decision, this need not be the case in a coupled system: Improving the incentives for early claiming may induce individuals to claim *and* to retire, and improving the incentives to retire may lead individuals to both retire and claim pensions. However, an improvement in the incentives for early claiming and an improvement in the incentives to retire will have different implications in terms of changes in the joint outcomes of retirement and early claiming, which can be summarized as follows: In a coupled system, an improvement in the incentives for early claiming may lead individuals

1. from *not claiming pensions* and not retiring to *claiming pensions* and not retiring,

2. from *not claiming pensions* and retiring to *claiming pensions* and retiring, and

3. from *not claiming pensions and not retiring* to *claiming pensions and retiring*.

An improvement in the incentives to retire may lead individuals

1. from not claiming pensions and *not retiring* to not claiming pensions and *retiring*,

2. from claiming pensions and *not retiring* to claiming pensions and *retiring*, and

3. from *not claiming pensions and not retiring* to *claiming pensions and retiring*.

That is, while improvements in the incentives for early claiming and improvements in the incentives to retire will have the same implications in terms of effects on coordinated outcomes, they have conflicting implications for the non-coordinated outcomes. This is illustrated in Table 4 below, where the signs are switched relative to the preceding discussion to reflect the fact that an increase in the relative money's worth represents reduced rather than improved incentives for early claiming.

Table 4: The effects on joint outcomes of reduced incentives for ...

	retirement		claiming	
	$Retire = 1$	$Retire = 0$	$Retire = 1$	$Retire = 0$
$Claim = 1$	÷ (a)	+ (b)	÷ (a)	÷ (b)
$Claim = 0$	÷ (c)	+ (d)	+ (c)	+ (d)

5.2.2 Empirical evidence

To allow for a straightforward operationalization of retirement from the labor force we restrict attention to individuals registered as working full time at the end of 2010, and classify individuals as retired in 2011 if they have no active employment record at the end of the year. Column

Table 5: Effects of *RMW* on early claiming and retirement outcomes

	Dep. Mean	OLS		2SLS[a]	
	(1)	(2)	(3)	(4)	(5)
Outcome					
Claiming	33.8	-4.27***	(0.13)	-1.24***	(0.36)
Retired	15.1	-0.80***	(0.11)	-0.67**	(0.29)
Claiming and retired	7.5	-1.24***	(0.07)	-0.21	(0.21)
Claiming and not retired	26.3	-3.03***	(0.12)	-1.03***	(0.36)
Retired and not claiming	7.6	0.45***	(0.08)	-0.45**	(0.21)
Not retired and not claiming	58.6	3.82***	(0.14)	1.69***	(0.39)
N		18546			
First stage F-statistic		1866.42			

Heteroskedasticity robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The sample includes individuals eligible for early claiming, not receiving disability pensions in 2010, and registered as full time employed at the end of 2010. Individuals are classified as *retired* in 2011 if they have no active employment record at the end of the year.

[a] The set of controls includes dummies for AFP affiliation (2010), sex, receipt of disability benefits prior to the age of 62, educational attainment (three categories), civil status (four categories), dummies for the number of months on sickness leave at age 61, and dummies for net wealth and labor income quartiles (both measured in 2010). Information on parental longevities is used to form instrumental variables in the 2SLS estimations.

(1) of Table 5 summarizes the claiming and retirement behavior for this sample of 18,546 individuals, by listing the dependent means for the two combined outcomes *claiming* and *retired*, and for each of the four joint claiming and retirement outcomes. We note that the restricted sample is very close to the full estimation sample in terms of the fraction of early claimers (33.8 vs 34.1 percent), and that 15 percent are classified as retired in 2011. The fact that as many as 26 percent claim their NIS pensions without at the same time retiring from the labor market is a clear indication that individuals are indeed making separate decisions of whether to retire from the labor market and whether to start claiming pensions.[19]

Going further, we estimate equations (1)-(3) with each of the six claiming and retirement outcomes on the left hand side of equations (1) and (3). In Column (2) of Table 5 we present

[19] The extent to which individuals in the "claiming and not retired" group are combining receipt of NIS pensions with reductions in hours worked appears to be very limited. Average earnings in 2011 and 2010 are at the same level, and only two percent (one half percent) have a reduction in earnings of more than 50 (20) percent from 2010 to 2011. Only seven percent are claiming less than a full pension.

the simple linear regression estimates. A higher *RMW* decreases the probability of both joint outcomes involving claiming, and increases the probability of *retired and not claiming* and *not retired and not claiming*. Our main focus is on the 2SLS estimates in Column (4), where we use only the variation in *RMW* that is generated by variation in parental longevities. We see that higher values of *RMW* appear to be moving individuals to the *not retired and not claiming* outcome from the three joint outcomes involving early claiming and/or retirement. *RMW* having a negative effect on both non-coordinated outcomes means that one of the estimated coefficients coincides with the predicted effect of reduced incentives for claiming (*claiming and not retired*), while the other coincides with the predicted effect of reduced incentives for retirement (*retired and not claiming*), cf. Table 4. Now, given that *RMW* is closely related to expected longevity, with a correlation of 0.96, it is natural to think of the effect of *RMW* on early retirement as an effect of expected longevity rather than an effect of claiming incentives as such.[20] Variation in expected longevity driven by parental longevities is likely to also be correlated with health, and both high expected longevity and good health may keep individuals from retiring early.

We show in Appendix Section A.1 that, under reasonable assumptions, the effect of *RMW* on the joint outcome *claiming and not retired* can be interpreted as a lower bound for the amount of selection that can be attributed to *RMW* affecting claiming decisions directly, and not operating through a correlation between *RMW* (or expected longevity) and retirement decisions.[21] The point estimate for this lower bound is a statistically significant -1.00, which suggests that at least 83% $(1.03/1.24)$ of the effect of *RMW* on early claiming can be explained by the relative money's worth influencing claiming behavior directly. The remaining 17% could be explained by either claiming or retirement behavior.

[20]Replacing *RMW* with expected longevity in the regressions makes very little impact on the results, besides changing the scale of the point estimates.

[21]This test result still holds when it is taken into account that the effect of *RMW* on the joint outcome *retired and not claiming* must be positive for the estimate of the effect of *RMW* on the joint outcome *claiming and retired* to be interpreted as a lower bound on the amount of selection in early claiming that can be attributed to *RMW* affecting claiming decisions directly, as detailed in Appendix Section A.1.

5.3 Threats to validity and robustness analysis

The preceding section established that expected longevity influencing retirement behavior has, at most, only a moderate impact on the estimated association between the relative money's worth and claiming decisions. We now turn to a discussion of other potential threats to the exclusion restriction, i.e. the assumption that effects of parental longevities on claiming decisions are operating only through the relative money's worth. We focus on heterogeneity in time preferences and health conditions. These are traits that might be correlated with expected longevity, and transmitted from parents to their children. We present descriptive evidence showing that heterogeneity in time preferences is unlikely to be driving our results because our agents are unlikely to be liquidity constrained, and we demonstrate that including/excluding controls for net wealth and health conditions has very little impact on our parameter of interest. Finally, we perform a placebo test using data on claiming behavior for an older cohort making claiming and retirement decisions within the context of a pension system absent any mechanisms that would generate incentives for active selection. We find no evidence of active selection for the placebo cohort, suggesting that the active selection effects that we do find are indeed particular to the cohorts facing differential incentives for claiming depending on expected longevity.

In a model without a credit market, individual time preference rates would be key components of claiming behavior: Individuals with high discount rates could obtain a higher level of current consumption by claiming pensions at the earliest possible age. If time preference rates are passed on from parents to their children and access to credit is limited, a new link is opened between parental longevities and claiming behavior. Individuals from families with high discount rates are less likely to invest in future health, leading to worse health and shorter lifespans, and they are more likely to claim their pensions early. The presence of a well-functioning credit market breaks the link between heterogeneity in time preference rates and claiming behavior. Individuals can use the credit market to adjust their consumption over time to the desired levels and as a consequence the marginal rate of substitution between consumption today and consumption tomorrow will be the same for all individuals and equal to the market rate. Heterogeneity in intergenerationally transmittable time preference rates is there-

Table 6: Descriptive statistics - Wealth of analysis cohort

	Full cohort	Eligible individuals			
	Mean (1)	Mean (2)	1st quartile (3)	Median (4)	3rd quartile (5)
Variable					
Net Wealth	1,577,718	2,246,605	528,076	1,582,295	2,793,050
Housing wealth	984,000	1,488,000	0	1,487,598	2,311,340
Debt	492,840	728,448	9,205	311,744	971,238
Homeownership	0.591	0.740			
N	59,291	22,564			

fore not likely to pose a threat to the exclusion restriction if the subjects of our study have access to credit at reasonable interest rates.

Table 6 describes the wealth holdings of our analysis cohort, in terms of net wealth and some of its components. Column (1) reports means for the full cohort, while Columns (2)-(5) focus on our estimation sample, consisting of individuals eligible for early claiming and not receiving DI pensions in 2010. Average net wealth for individuals in our estimation sample amounts to about 2.2 million Norwegian kroner (NOK), which at the time of writing corresponds to about 250,000 US Dollars. Although the mean is influenced by a relatively small number of very wealthy individuals, we note that even the first quartile of the distribution is above NOK 500,000. Most of the individuals in our estimation sample are therefore likely to have easy access to credit. Note that 74% of the estimation sample are homeowners. These are particularly unlikely to be credit constrained, since they can typically refinance their mortgage at low cost, using their home as collateral.[22]

Individual net wealth is highly relevant to the discussion above, both because myopic individuals are unlikely to have high net wealth and because individuals with high net wealth are unlikely to be liquidity constrained. In the presence of heterogeneity in time preference rates and liquidity constraints, our estimated coefficient of interest could have an omitted variable bias if individuals with low relative money's worth were more likely to have high discount rates and be credit constrained. However, we would then expect the estimated coefficient of

[22]Most homes are worth far more than the associated mortgages - due to downpayments, and to substantial increases in housing prices.

interest to be sensitive to whether net wealth is included as part of the set of controls. Table 7 shows how the 2SLS estimate of the effect of *RMW* on the outcome *Claiming and not retired* is not substantially altered by the inclusion/exclusion of dummies for net wealth quartiles. Further, restricting the estimation sample to include homeowners only gives a point estimate very similar to the one estimated on the full sample.

Expected longevity is very likely to be correlated with individual health, and health, in turn, is likely to be partly determined by both genetic and social factors transmitted from parents to their children. The perhaps most evident way in which health might affect claiming behavior is through retirement decisions, together with claiming and retirement decisions being jointly determined. We found above that expected longevity influencing retirement behavior has little impact on the estimated association between the relative money's worth and claiming decisions, but we cannot a priori rule out any other mechanism through which health conditions might have an influence on claiming decisions. However, if our estimated coefficient on the relative money's worth has an omitted variable bias because health is correlated with early claiming and with the relative money's worth, one would expect the coefficient to be sensitive to whether a health proxy is included as part of the set of controls. Table 7 shows that including/excluding dummies for the number of months on sickness leave at age 61 has very little impact on the coefficient of interest.

Finally, we perform a placebo test of the relationship between expected longevity and early claiming of pensions. This test is based on a simple comparison of claiming behavior under two widely different pension regimes: the flexible pension system introduced in 2011, and the much less flexible system that existed prior to 2011. In the old system, there were no mechanisms that would generate incentives for active selection. The only way to claim pensions prior to age 67 was through the old AFP early retirement program, a system with strict earnings testing and without a deferral mechanism.[23] Hence, there were no differences in the incentives for early claiming generated by differences in expected longevities, besides those operating on the retirement dimension. If we were to find an "active selection effect" also in the old

[23] See e.g. Vestad (2013) for details.

Table 7: Effects of *RMW* on *Claiming and not retired* - robustness

Claiming and not retired	2SLS	
All covariates included	-1.029***	(0.356)
Controls for sickness leave excluded	-1.000***	(0.356)
Controls for financial wealth excluded	-1.190***	(0.358)
Both sickness leave and wealth excluded	-1.163***	(0.358)
Homeowners only (n=16,688)	-1.039***	(0.383)

Heteroskedasticity robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The sample includes individuals eligible for early claiming, not receiving disability pensions in 2010, and registered as full time employed at the end of 2010. Individuals are classified as *retired* in 2011 if they have no active employment record at the end of the year.

The full set of controls includes dummies for AFP affiliation (2010), sex, receipt of disability benefits prior to the age of 62, educational attainment (three categories), civil status (four categories), dummies for the number of months on sickness leave at age 61, and dummies for net wealth and labor income quartiles (both measured in 2010). Information on parental longevities is used to form instrumental variables in the 2SLS estimations.

system, this would necessarily be generated by other mechanisms than a direct link between expected longevity and early claiming, which would not reflect well on the credibility of our main analysis.

We perform our placebo analysis on the claiming behavior of the 1945 cohort in 2007, chosen to be reasonably close in time to our main analysis, but with some spacing to minimize issues with behavior in the anticipation of the new pension system. To make sure that we can run comparable analyses for the 1949 and 1945 cohorts, we make some minor adjustments to our baseline framework. First, we use expected longevity rather than the relative money's worth as the regressor of interest. This change has very little impact on the results for the 1949 cohort, given the close to perfect correlation between expected longevity and the relative money's worth. Second, we restrict attention to workers in AFP affiliated firms for both cohorts, i.e. to the groups of workers at risk for early claiming under both the old and the new pension regimes. Third, we require eligibility for early claiming according to the rules in the new pension system also for the 1945 cohort, to make the sample selection resemble the one we use for the 1949 cohort. And fourth, we exclude net wealth from the set of controls, as it is very

Table 8: Effects of expected longevity on early claiming for the 1945 and 1949 cohorts

	N	Dep. Mean	OLS		2SLS[a]	
Sample						
1949 cohort	15521	33.2	-0.0497***	(0.0016)	-0.0134***	(0.0039)
1945 cohort	12610	27.8	-0.0094***	(0.0021)	0.0013	(0.0041)
First stage F-statistics:						
	1949 cohort		3108.33			
	1945 cohort		2786.06			

Heteroskedasticity robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
The two samples include workers in public and private sector firms affiliated with AFP, eligible for early claiming, and not receiving disability pensions in 2010/2006.
[a] The set of controls includes dummies for public sector (2010/2006), sex, receipt of disability benefits prior to the age of 62, educational attainment (three categories), civil status (four categories), and dummies for labor income quartiles (measured in 2010/2006). Information on parental longevities is used to form instrumental variables in the 2SLS estimations.

hard to construct comparable measures of net wealth for the two years.[24]

OLS and 2SLS estimates for each of the two cohorts are presented in Table 8. The results for the 1949 cohort are well in line with the baseline results presented in Section 5.1: In terms of total selection, a one year increase in expected longevity is associated with a 5.0 percentage points decrease in early claiming, while magnitude of the 2SLS coefficient amounts to 27% of the total selection estimate. As for the 1945 cohort, we estimate a much lower amount of total selection than for the 1949 cohort, with a one year increase in expected longevity being associated with a 0.9 percentage points decrease in early claiming. Note that statistically significant total selection for the 1945 cohort is not at odds with the theory: In the old system, early claiming was in practice the same as early retirement, and hence a correlation between early claiming and expected longevity comes as no big surprise. The 2SLS coefficient, however, is small and statistically insignificant. This supports our interpretation of the active selection effect that we do find for the 1949 cohort as one being particular to the cohort facing the flexible pension system with incentives for active selection.

[24] This difficulty arises from a highly unsystematic relationship between tax assessments and market values of real estate for years prior to 2010.

6 Conclusion

In this paper, we have studied the extent to which early claiming of public pensions is associated with expected gains from early claiming in the context of a public pension system with flexible claiming age. We have made use of a mortality model with a wide range of background characteristics for the entire Norwegian population to estimate individual expected longevity at age 62. We have further operationalized a measure of the incentives for early claiming, the relative money's worth, defined as the ratio of the expected present value of pension benefits associated with claiming at age 67 to the expected present value of pension benefits associated with claiming at age 62.

By using parental longevities as instruments for expected longevity in a 2SLS framework, we have distinguished between two types of selection: (i) active selection, represented by individuals claiming early in part because they expect to gain from doing so in terms of the expected present value of pension benefits, and (ii) passive selection, resulting from other mechanisms generating a correlation between expected gains from claiming and actual claiming, such as coordinated timing of retirement and claiming and a negative correlation between retirement age and longevity. In terms of the overall selection, our results indicate that a one percent increase in the gains from postponing claiming from age 62 to 67 is associated with a 4 percentage points (12 percent) reduction in claiming at age 62. Although the observed selection in early claiming amounts to as much as one third of the full potential, given our measure of expected longevity, the costs to public funds are rather moderate: Selection in early claiming increases the public cost of pensions for early claimers by a modest 0.8 percent.

In terms of active selection, or the extent to which individuals claim pensions early in part because they act on information about their expected longevity, we find that a one percent increase in the relative money's worth reduces claiming at age 62 by at least one percentage point (three percent). In our view, the finding that active selection is present in this context is of inherent interest, as it should not be taken for granted that agents act on complicated incentives in public benefit schemes. Our analysis suggests that allowing for more flexibility in pension systems, for instance by removing earnings testing, is likely to lead to adverse selection in early claiming; some individuals will claim pensions early to take advantage of the associated increase in social security wealth. Our results also suggest, however, that the resulting increase in the costs to public budgets will be rather moderate. Hence, adverse selection should not be considered a major disadvantage of flexible systems when considering the design of public pension systems.

References

Brinch, Christian N., Erik Hernæs, and Zhiyang Jia (2017) "Salience and Social Security Benefits," *Journal of Labor Economics*, Vol. 35, No. 1, pp. 265–297.

Brown, Jeffrey R. (2001) "Private pensions, mortality risk, and the decision to annuitize," *Journal of Public Economics*, Vol. 82, No. 1, pp. 29–62.

Chetty, Raj, A. Looney, and K. Kroft (2009) "Salience and Taxation: Theory and Evidence," *American Economic Review*, Vol. 99, No. 4, pp. 1145–1177.

Coile, Courtney, Peter Diamond, Jonathan Gruber, and Alain Jousten (2002) "Delays in claiming social security benefits," *Journal of Public Economics*, Vol. 84, No. 3, pp. 357–385.

Disney, Richard and Sarah Smith (2002) "The labour supply effect of the abolition of the earnings rule for older workers in the United Kingdom," *The Economic Journal*, Vol. 112, No. 478, pp. C136–C152.

Engelhardt, Gary V. and Anil Kumar (2009) "The repeal of the retirement earnings test and the labor supply of older men," *Journal of Pension Economics and Finance*, Vol. 8, No. 04, pp. 429–450.

Finkelstein, Amy and James Poterba (2002) "Selection effects in the United Kingdom individual annuities market," *The Economic Journal*, Vol. 112, No. 476, pp. 28–50.

——— (2004) "Adverse selection in insurance markets: Policyholder evidence from the UK annuity market," *Journal of Political Economy*, Vol. 112, No. 1, pp. 183–208.

Fredriksen, Dennis (1998) "Projections of population, education, labour supply and public pension benefits. Analyses with the dynamic microsimulation model MOSART." Social and economic studies 101, Statistics Norway.

Fredriksen, Dennis and Nils Martin Stølen (2011) "Norwegian pension reform - Defined benefit versus defined contribution." Discussion paper 669, Statistics Norway.

Gelber, Alexander M., Damon Jones, and Daniel W. Sacks (2013) “Earnings Adjustment Frictions: Evidence from the Social Security Earnings Test,” Working Paper 19491, National Bureau of Economic Research.

Gruber, Jonathan and David A. Wise (1999) “Introduction to ”Social Security and Retirement around the World”,” in *Social Security and Retirement around the World*: University of Chicago Press, pp. 1–35.

Hagen, Johannes (2015) “The determinants of annuitization: evidence from Sweden,” *International Tax and Public Finance*, pp. 1–30.

Haider, Steven J. and David S. Loughran (2008) “The Effect of the Social Security Earnings Test on Male Labor Supply: New Evidence from Survey and Administrative Data,” *Journal of Human Resources*, Vol. 43, No. 1, pp. 57–87.

Halvorsen, Elin (2011) “Norske husholdningers sparing,” *Økonomiske analyser*, Vol. 3, pp. 32–35.

Hernæs, Erik, Simen Markussen, John Piggott, and Knut Røed (2016) “Pension reform and labor supply,” *Journal of Public Economics*, Vol. 142, pp. 39 – 55.

Hosseini, Roozbeh (2015) “Adverse Selection in the Annuity Market and the Role for Social Security,” *Journal of Political Economy*, Vol. 123, No. 4, pp. 941–984.

Hurd, Michael D. and Kathleen McGarry (1995) “Evaluation of the subjective probabilities of survival in the health and retirement study,” *Journal of Human resources*, pp. 268–292.

——— (2002) “The Predictive Validity of Subjective Probabilities of Survival,” *The Economic Journal*, Vol. 112, No. 482, pp. 966–985.

Hurd, Michael D. and Constantijn Panis (2006) “The choice to cash out pension rights at job change or retirement,” *Journal of Public Economics*, Vol. 90, No. 12, pp. 2213–2227.

Hurd, M.D., James P. Smith, and Julie M. Zissimopoulos (2004) “The effects of subjective survival on retirement and social security claiming,” *Journal of Applied Econometrics*, Vol. 19, No. 6, pp. 761–775.

Khwaja, Ahmed, Frank Sloan, and Sukyung Chung (2007) “The relationship between individual expectations and behaviors: Mortality expectations and smoking decisions,” *Journal of Risk and Uncertainty*, Vol. 35, No. 2, pp. 179–201.

Lusardi, Annamaria and Olivia S Mitchell (2007) “Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth,” *Journal of Monetary Economics*, Vol. 54, No. 1, pp. 205–224.

Romano, Joseph P, Azeem M. Shaikh, and Michael Wolf (2010) “Hypothesis testing in econometrics,” *Annu. Rev. Econ.*, Vol. 2, No. 1, pp. 75–104.

Shoven, John B. and Sita Nataraj Slavov (2012) “The Decision to Delay Social Security Benefits: Theory and Evidence,” Working Paper 17866, National Bureau of Economic Research.

——— (2013) “Recent Changes in the Gains from Delaying Social Security,” Working Paper 19370, National Bureau of Economic Research.

Song, Jae G. and Joyce Manchester (2007) “New evidence on earnings and benefit claims following changes in the retirement earnings test in 2000,” *Journal of Public Economics*, Vol. 91, No. 3-4, pp. 669–700.

Vestad, Ola Lotherington (2013) “Labour supply effects of early retirement provision,” *Labour Economics*, Vol. 25, pp. 98–109.

Wolfe, John R. (1983) “Perceived longevity and early retirement,” *The Review of Economics and Statistics*, pp. 544–551.

Yaari, Menahem E. (1965) “Uncertain Lifetime, Life Insurance, and the Theory of the Consumer,” *The Review of Economic Studies*, Vol. 32, No. 2, pp. pp. 137–150.

A Appendix

This appendix consists of three parts. Section A.1 presents a simple model of the joint decisions of claiming and retirement. Section A.2 presents a short numerical illustration of the costs of early claiming to public finances to demonstrate that these costs can be expected to be modest. Section A.3 provides supplementary tables.

A.1 A simple model of claiming and retirement

In this section we present a simple model of claiming and retirement. This model serves three purposes: First, it highlights the simultaneous nature of the claiming and the retirement decisions. Second, it shows how some factors might affect the claiming decision without affecting the retirement decision, and vise versa. Third, it delivers predictions for retirement and claiming outcomes that can be used to rule out the possibility that the relationship between financial incentives and claiming behavior that we observe in the data is entirely driven by the retirement decision.

We model the decisions of an agent facing two periods: a first period involving early retirement and claiming decisions, followed by an old age retirement period. Our agent starts out with initial wealth W. He makes a dichotomous decision of whether to retire early, $R \in \{0,1\}$, earning $(1-R)$ from work in period 1, and a separate decision of whether to claim pensions early, $C \in \{0,1\}$. The pension system is modelled as follows: If $C = 1$, the agent receives ω_1 in period 1 and ω_2 in period 2. If pensions are deferred, the individual receives $\omega_2 + \tau\omega_1$ in the second period, where τ is an actuarial adjustment factor. Besides through the pension system, the agent can transfer money between the two periods by saving, which pays a market interest rate r. A binary random variable ξ takes the value 1 if the agent is alive in period 2, and 0 otherwise, and p denotes the survival probability. The agent only receives pensions if alive, while any remaining wealth is bequeathed upon death. The pension system offers a compensation for the mortality risk, which means that $\tau > (1+r)$. In the following, we will write $\tau = (1+r)/q$ and interpret q as the survival probability that is implicit in the actuarial adjustment in the pension system.

Individuals are assumed to maximize expected lifetime utility, based on the utility function

$$U = u(X_1, R) + \delta(X_2 + b), \tag{A1}$$

where X_1 and X_2 represent first and second period consumption, respectively, b denotes bequests, δ is the individual discount factor, and $u(\cdot)$ is strictly increasing and concave in X_1 and strictly increasing in R. To abstract from the insurance motive in annuity demand and from bequest motives, we specify second period utility simply as the sum of own consumption and bequests. Each agent's problem amounts to choosing first period consumption, to decide whether to retire or not and whether to claim pensions or not in period 1, so as to maximize lifetime utility. Private transfers S from period 1 to period 2 can be expressed as follows:

$$S = W + (1 - R) + C\omega_1 - X_1. \tag{A2}$$

No choices of substance are made in the second period; the individuals who die after period 1 simply bequeath their wealth, while those who survive will choose any combination (X_2, b) of own consumption and bequests from their wealth and pensions, such that

$$X_2 + b = (1 + r)S + \xi\left(\omega_2 + (1 - C)\tau\omega_1\right). \tag{A3}$$

Combining (A2) and (A3), inserting for $X_2 + b$ into equation (A1) and taking expectations (over survival) leaves us with

$$E(U) = u(X_1, R) + \delta\left((1 + r)(W + (1 - R) + C\omega_1 - X_1) + p\left(\omega_2 + (1 - C)\tau\omega_1\right)\right), \tag{A4}$$

which can be rearranged so as to highlight the decoupling of the retirement and claiming decisions:

$$E(U) = u(X_1, R) + \delta(1+r)(W + (1-R) - X_1)$$
$$+ \delta\left[p\omega_2 + \omega_1(C(1+r) + p(1-C)\tau)\right]. \tag{A5}$$

In a *perfectly decoupled* retirement/claiming system, and in the absence of capital market imperfections, the choice of C and R is best studied by examining

$$U_{R,C} = \max_{X_1} E(U|R,C), \tag{A6}$$

i.e. by comparing the utilities in the four possible combinations of R and C, given the optimal choice of first period consumption. It is clear from equation (A5) that one may write $U_{R,C} = U_R^r + U_C^c$, where

$$U_R^r = \max_{X_1}\{u(X_1, R) + \delta(1+r)(W + (1-R) - X_1)\} \tag{A7}$$

and

$$U_C^c = \delta p\omega_2 + \delta(1+r)\omega_1\left[C + \frac{p}{q}(1-C)\right], \tag{A8}$$

where we have used that $\tau = (1+r)/q$.

Postponing claiming, choosing $C = 0$, can be thought of as buying an annuity. The price of the annuity in this system is ω_1, the foregone period 1 pension benefits, while the present value of the increase in second period pensions is $\xi\tau\omega_1/(1+r)$. The moneys' worth of the implicit Social Security annuity is then

$$MW = \frac{E\left(\frac{1}{1+r}\xi\tau\omega_1\right)}{\omega_1} = \frac{p}{q}, \tag{A9}$$

i.e. the ratio of the subjective survival probability to the survival probability in the pension system. From equation (A8) it follows directly that the agent will choose to claim pensions early ($C = 1$) if and only if $p/q < 1$, i.e. if the money's worth of the implicit annuity is less than one. Importantly, the money's worth does not affect the retirement decision, as it only appears in the expression for U_C^c. We can use this property to define a perfectly decoupled retirement/claiming system in a more general manner: In such a system, a change in the factors affecting claiming will not affect retirement, and a change in the factors affecting retirement will not affect claiming.

We will now discuss the implications of introducing different imperfections to the system. Define a retirement/claiming system as a *coupled* system if taxes, benefits, regulations or credit markets lead to reduced utility or infeasibility of the non-coordinated combinations of claiming and retirement. More formally, define a coupled system as one in which $U_{R,C} \geq U_R^r + U_C^c$ if $C = R$, and where $U_{R,C} \leq U_R^r + U_C^c$ if $C \neq R$. Unlike in the model above, some penalty may apply for not coordinating claiming and retirement behavior, or some bonus may apply if decisions are coordinated.

One example of a coupled system is the current US system for individuals below the normal retirement age. Since their pension benefits are earnings tested, choosing $C = 1$ and $R = 0$ is simply not feasible, which is equivalent to assigning $U_{0,1}$ a sufficiently low value. Another example of a coupled system is a system that is notionally decoupled, but not accompanied by a perfect capital market. Assume that an agent faces liquidity constraints, in the sense that any borrowing must be at an interest rate higher than the market rate r. With sensible parameters in the model above, the only reason our agent would want to borrow would be to finance early retirement without claiming pensions; $R = 1$, $C = 0$. In this example, $U_{1,0}$ will be lower than in a perfectly decoupled system, since some resources are lost through a higher interest rate. A third example of a coupled system is a system that is decoupled at the gross pension level, but not at the net pension level, due to progressive taxation. This applies to the Norwegian system. Progressive taxation discriminates slightly against not coordinating claiming and retirement, as coordination of claiming and retirement decisions amounts to income smoothing and therefore leads to higher net income.

In the following, we will say that a change in parameters improves the incentives for early claiming if U_1^c increases relative to U_0^c. We will say that a change in parameters improves the incentives to retire if U_1^r increases relative to U_0^r. In a perfectly decoupled system, a change in parameters that improves the incentives for early claiming may induce agents to claim while leaving their retirement decision unaffected, unless the same parameters also affect the incentives to retire. In a coupled system, on the other hand, improving the incentives for early claiming may induce individuals to claim *and* to retire, and improving the incentives to retire may lead individuals to both retire and claim pensions. However, an improvement in the incentives for early claiming and an improvement in the incentives to retire will have different implications in terms of changes in the joint outcomes of retirement and early claiming, which can be summarized as follows: In a coupled system, an improvement in the incentives for early claiming may lead individuals

1. from choosing $R = 0, C = 0$ to choosing $R = 0, C = 1$,
2. from choosing $R = 1, C = 0$ to choosing $R = 1, C = 1$, and
3. from choosing $R = 0, C = 0$ to choosing $R = 1, C = 1$.

An improvement in the incentives to retire may lead individuals

1. from choosing $R = 0, C = 0$ to choosing $R = 1, C = 0$,
2. from choosing $R = 0, C = 1$ to choosing $R = 1, C = 1$, and
3. from choosing $R = 0, C = 0$ to choosing $R = 1, C = 1$.

That is, while improvements in the incentives for early claiming and improvements in the incentives to retire will have the same implications in terms of effects on coordinated outcomes, they have conflicting implications for the non-coordinated outcomes.

Let π_c be a continuous variable measuring the incentives for early claiming, and π_r be a continuous variable measuring the incentives to retire. Think about these variables as imperfect predictors of claiming and retirement, and let the probability of each of the possible combinations of retirement and claiming be continuously differentiable functions of π_c and π_r. Let π be some variable potentially affecting π_c and π_r, e.g. the relative money's worth, and assume that π_c and π_r are both continuously differentiable functions of π. We now have

$$\frac{\partial P(R=a\cap C=b)}{\partial \pi}=\frac{\partial P(R=a\cap C=b)}{\partial \pi_c}\frac{\partial \pi_c}{\partial \pi}+\frac{\partial P(R=a\cap C=b)}{\partial \pi_r}\frac{\partial \pi_r}{\partial \pi} \tag{A10}$$

for $a,b\in\{0,1\}$. The signs of the partial derivatives with respect to π_c and π_r follow from the list above and are illustrated in Table 4 (in which the signs are switched relative to the preceding discussion to reflect the fact that an increase in the relative money's worth represents reduced rather than improved incentives for early claiming). Under assumptions about the signs of $\partial\pi_r/\partial\pi$ and $\partial\pi_c/\partial\pi$, it is possible to bound the two objects $(\partial P(R=0\cap C=1)/\partial\pi_c)(\partial\pi_c/\partial\pi)$ and $(\partial P(C=1)/\partial\pi_c)(\partial\pi_c/\partial\pi)$.

Assume that $\partial\pi_c/\partial\pi<0$ and $\partial\pi_r/\partial\pi<0$, i.e. an increase in the relative money's worth/expected longevity lowers the incentives for early claiming/retirement. These assumptions, along with the theoretical predictions for the effects of improvements in the incentives for early claiming/retirement, gives us that

$$\frac{\partial P(R=0\cap C=1)}{\partial \pi_r}\frac{\partial \pi_r}{\partial \pi}\geq 0. \tag{A11}$$

From equation (A10), with $R=0$ and $C=1$, it now follows that

$$\frac{\partial P(R=0\cap C=1)}{\partial \pi}\geq\frac{\partial P(R=0\cap C=1)}{\partial \pi_c}\frac{\partial \pi_c}{\partial \pi}. \tag{A12}$$

The estimated effect $\partial P(R=0\cap C=1)/\partial\pi$ is also an estimated lower bound on the full magnitude of the direct effect of increased incentives for early claiming, as

$$\frac{\partial P(C=1)}{\partial \pi_c}=\frac{\partial P(R=0\cap C=1)}{\partial \pi_c}+\frac{\partial P(R=1\cap C=1)}{\partial \pi_c} \tag{A13}$$

together with equation (A12) implies

$$\frac{\partial P(R=0\cap C=1)}{\partial \pi}\geq\frac{\partial P(R=0\cap C=1)}{\partial \pi_c}\frac{\partial \pi_c}{\partial \pi}\geq\frac{\partial P(C=1)}{\partial \pi_c}\frac{\partial \pi_c}{\partial \pi}. \tag{A14}$$

Thus, the effect of RMW on $P(R = 0 \cap C = 1)$ in Table 5 can be interpreted as an upper bound (or a lower bound on the magnitude) for the effect of RMW on early claiming that is operating through claiming decisions, and not mediated by retirement decisions. For valid statistical inference, it is necessary to take into account the uncertainty in the sign assumptions used for deriving the bounds. A simple approach is to state that we have a significant upper bound to the effects in equation (A14) as long as $\partial P(R = 0 \cap C = 1)/\partial \pi < 0$ and $\partial P(R = 1 \cap C = 0)/\partial \pi < 0$.[25] Using the Bonferroni method (see e.g. Romano et al., 2010), we can compute (an upper bound to) the p-value for such a joint test as twice the maximum p-value of the two components' tests.

[25] If π is a variable that affects claiming negatively, but retirement positively, the bound derived here is not valid, because a lower π leads to a higher $P(R = 0 \cap C = 1)$ through both the claiming and the retirement mechanism. The bound is based on the notion that a lower π leads to a higher $P(R = 0 \cap C = 1)$ only through the claiming mechanism, as the retirement mechanism works in the opposite direction.

A.2 A note on the costs of selection in pension claiming to public funds

The combination of significant selection in early claiming and very moderate costs to public funds may appear as a somewhat puzzling result. It is not a consequence of particularly high discount rates, nor does it relate to insufficient variation in expected longevity in our sample (see Section 3.3) - it simply follows from the fact that the gain from strategically choosing the time of claiming is rather modest.

A brief numerical example elucidates this mechanism. Consider a pension system that pays a benefit stream whose present value is independent of the age at which pension claiming begins, for an individual with average expected longevity. For simplicity, assume that an individual can claim at age 62 or age 67, and that the system is calibrated to a longevity of 25 years at age 62, so that claiming at age 62 leads to a 20 percent reduction in annual benefits compared to claiming at age 67.

An individual expecting to live another 24 years at age 62 might choose to claim early to capture the gains. By claiming at age 62 he will receive 24 years of pensions at 80 percent of the ordinary rate, compared to 19 years at the full rate. The full gain from claiming 5 years earlier is then only about 1.0 percent ($(24*0.8-19)/19$).

The effect of expected longevity on the relative money's worth is slightly non-linear, but an individual with a life expectancy of 20 years at age 62 would by similar calculations gain 6.7 percent from claiming early (i.e. $(20*0.8-15)/15$).

A.3 Additional tables

Table A1: Summary statistics; estimation sample

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Expected longevity	86.4607	2.1525	76.163	92.587
Relative money's worth	1.0002	0.0254	0.8499	1.1970
Income in 2010 (in 100000 NOK)	4.6653	2.9927	0	109.8312
Net wealth in 2010 (in 100000 NOK)	22.4660	58.3468	-328.2402	3037.14
Male	0.7557	0.4297	0	1
Birth month	5.8537	3.0650	1	11
Number of children	2.0745	1.1340	0	13
Civil status				
Married/cohabiting, at least one child	0.6940	0.4608	0	1
Married, no children	0.0366	0.1878	0	1
Single, at least one child	0.0044	0.0664	0	1
Single/cohabiting, no children	0.2650	0.4413	0	1
Receipt of disability benefits				
Never received	0.9953	0.0687	0	1
Received prior to age 62	0.0047	0.0687	0	1
Educational attainment				
Primary/missing	0.3586	0.4796	0	1
High school	0.3393	0.4735	0	1
Higher education/in education	0.3021	0.4592	0	1
Parents' longevity				
Mother unknown	0.0349	0.1835	0	1
Mother emigrated	0.0009	0.0298	0	1
Father unknown	0.0632	0.2434	0	1
Father emigrated	0.0005	0.0231	0	1
Mother dead before age 50	0.0114	0.1061	0	1
Mother's (expected) longevity[1]	83.2278	10.8111	50	104.26
max(Mother's (expected) longevity − 65, 0)	18.1058	9.9837	0	39.2600
Father dead before age 50	0.0180	0.1329	0	1
Father's (expected) longevity[1]	77.3338	11.2622	50	105.22
max(Father's (expected) longevity − 65, 0)	9.7956	10.3062	0	40.22
N		22,564		

[1] For the subsample of individuals whose mothers/fathers are not unknown, not emigrated, and did not die prior to age 50.

Table A2: Summary statistics; 1949 cohort

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Expected longevity	85.7478	3.3141	73.2400	92.718
Male	0.5072	0.5	0	1
Birth month	5.8533	3.0697	1	11
Number of children	2.1011	1.1994	0	14
Civil status				
Married/cohabiting, at least one child	0.6383	0.4805	0	1
Married, no children	0.0353	0.1846	0	1
Single, at least one child	0.0067	0.0817	0	1
Single/cohabiting, no children	0.3197	0.4664	0	1
Receipt of disability benefits				
Never received	0.6810	0.4661	0	1
Received in 1967	0.0118	0.1078	0	1
Received before age 50	0.1306	0.3370	0	1
Received between age 50 and 61	0.1766	0.3813	0	1
Educational attainment				
Primary/missing	0.5045	0.5000	0	1
High school	0.2991	0.4579	0	1
Higher education/in education	0.1964	0.3973	0	1
Parents' longevity				
Mother unknown	0.0812	0.2731	0	1
Mother emigrated	0.0008	0.0281	0	1
Father unknown	0.1115	0.3148	0	1
Father emigrated	0.0004	0.0199	0	1
Mother dead before age 50	0.0121	0.1093	0	1
Mother's (expected) longevity[1]	82.6692	10.9513	50	106.26
$\max($Mother's (expected) longevity $- 65, 0)$	16.7667	10.4782	0	41.26
Father dead before age 50	0.0186	0.1351	0	1
Father's (expected) longevity[1]	76.6768	11.3217	50	105.22
$\max($Father's (expected) longevity $- 65, 0)$	8.9540	10.0581	0	40.22
N		52,991		

[1] For the subsample of individuals whose mothers/fathers are not unknown, not emigrated, and did not die prior to age 50.

Table A3: Summary statistics for longevity estimation

Variable	Mean	Std. Dev.	Min.	Max.
Male	0.49	0.50	0	1
Age	47.29	18.78	17	94
Above age 56	0.33	0.47	0	1
Year	2006.59	2.88	2002	2011
No. of children	1.6	1.42	0	18
Survive	0.99	0.1	0	1
Receipt of disability benefits				
Never received	0.8595686	0.3474341	0	1
Received in 1967	0.0018619	0.0431091	0	1
Received before age 50	0.0529078	0.2238494	0	1
Received between age 50 and 61	0.0589444	0.2355206	0	1
Received after age 62	0.0267174	0.1612562	0	1
Educational attainment				
Primary/missing	0.4094713	0.4917363	0	1
High school	0.2873144	0.4525095	0	1
Higher education/in education	0.3032143	0.459647	0	1
Civil status				
Married/cohabiting, at least one child	0.4876253	0.4998468	0	1
Married, no children	0.0372666	0.1894144	0	1
Single, at least one child	0.1929423	0.3946081	0	1
Single/cohabiting, no children	0.2821658	0.4500536	0	1
County				
Østfold	0.0565932	0.2310636	0	1
Akershus (Asker and Bærum)	0.0327908	0.1780886	0	1
Akershus (excl. Asker and Bærum)	0.0732115	0.2604833	0	1
Oslo West	0.0276363	0.1639284	0	1
Oslo (excl. Oslo West)	0.0925232	0.2897632	0	1
Hedmark	0.0413802	0.199168	0	1
Oppland	0.0400961	0.1961847	0	1
Buskerud	0.0534495	0.2249281	0	1
Vestfold	0.0481229	0.2140259	0	1
Telemark	0.0361931	0.1867704	0	1
Aust-Agder	0.0224486	0.1481373	0	1
Vest-Agder	0.0344703	0.1824338	0	1
Rogaland	0.0836963	0.2769318	0	1
Hordaland	0.0965672	0.2953675	0	1
Sogn og Fjordane	0.0225099	0.1483347	0	1
Møre og Romsdal	0.0525532	0.2231397	0	1
Sør-Trøndelag	0.0594736	0.2365089	0	1
Nord-Trøndelag	0.0274072	0.1632669	0	1
Nordland	0.0506338	0.2192488	0	1
Troms	0.0328167	0.1781567	0	1
Finnmark	0.0154264	0.1232414	0	1
N		36897516		

Table A4: Summary statistics; individuals of age 56 and older

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Survive	0.971	0.169	0	1	12230460
Mother unknown	0.453	0.498	0	1	12230460
Mother emigrated	0.001	0.024	0	1	12230460
Father unknown	0.484	0.500	0	1	12230460
Father emigrated	0.001	0.026	0	1	12230460
For sub-sample with known parents:					
Mother dead before age 50	0.009	0.094	0	1	6680768
Father dead before age 50	0.013	0.113	0	1	6296877
For sub-sample with parents living past age 50:					
Mother's (expected) longevity	82.97	9.92	51	111	6621289
Father's (expected) longevity	77.83	10.24	51	111	6214686

Table A5: Longevity regression; 1949 cohort

Dependent variable: Expected longevity		
Male	-4.00***	(0.01)
Educational attainment (ref: higher education)		
Primary/missing	-1.63***	(0.01)
High school	-0.81***	(0.01)
Receipt of disability benefits (ref: never received)		
Received in 1967	-7.70***	(0.04)
Received before age 50	-5.21***	(0.01)
Received between age 50 and 61	-2.99***	(0.01)
Civil status (ref: married/cohabiting, at least one child)		
Married, no children	-1.05***	(0.02)
Single, at least one child	-1.33***	(0.05)
Single/cohabiting, no children	-1.39***	(0.01)
County (ref: Østfold)		
Akershus (Asker and Bærum)	0.53***	(0.03)
Akershus (excl. Asker and Bærum)	-0.01	(0.02)
Oslo West	0.36***	(0.03)
Oslo (excl. Oslo West)	-0.24***	(0.02)
Hedmark	-0.01	(0.02)
Oppland	0.00	(0.02)
Buskerud	0.07***	(0.02)
Vestfold	0.18***	(0.02)
Telemark	0.12***	(0.03)
Aust-Agder	-0.02	(0.03)
Vest-Agder	0.27***	(0.03)
Rogaland	0.31***	(0.02)
Hordaland	0.56***	(0.02)
Sogn og Fjordane	0.72***	(0.03)
Møre og Romsdal	0.79***	(0.02)
Sør-Trøndelag	0.29***	(0.02)
Nord-Trøndelag	0.45***	(0.03)
Nordland	0.57***	(0.02)
Troms	0.45***	(0.03)
Finnmark	-0.16***	(0.03)
Parents' longevity		
Mother unknown	-1.08***	(0.17)
Mother emigrated	-0.61***	(0.22)
Father unknown	0.03	(0.12)
Father emigrated	0.93***	(0.24)
Mother dead before age 50	-0.83***	(0.05)
Mother's (expected) longevity	-0.04***	(0.00)
max(Mother's (expected) longevity − 65, 0)	0.11***	(0.00)
Father dead before age 50	0.02	(0.04)
Father's (expected) longevity	-0.01***	(0.00)
max(Father's (expected) longevity − 65, 0)	0.08***	(0.00)
R^2	0.917	
N	52,991	

Table A6: The composition of workers in different sectors

	Private		Public
	with AFP	no AFP	
Men	0.83	0.84	0.58
Educational attainment			
Primary/missing	0.45	0.42	0.18
High school	0.37	0.34	0.32
Higher education	0.18	0.24	0.50

Sample: Individuals eligible for pension take-up, not receiving disability pensions in 2010 and with registered labour income above 1BA in 2010.

Table A7: First stage regression; full estimation sample

Dependent variable: Relative money's worth		
Parents' longevity		
Mother unknown	-0.0045*	(0.0025)
Mother emigrated	-0.0012	(0.0027)
Father unknown	-0.0037**	(0.0018)
Father emigrated	0.0043	(0.0026)
Mother dead before age 50	-0.0063***	(0.0008)
Mother's (expected) longevity	-0.0003***	(0.0000)
max(Mother's (expected) longevity − 65, 0)	0.0010***	(0.0000)
Father dead before age 50	-0.0009	(0.0006)
Father's (expected) longevity	-0.0002***	(0.0000)
max(Father's (expected) longevity − 65, 0)	0.0008***	(0.0000)
Male	-0.0441***	(0.0002)
Educational attainment (ref: higher education)		
Primary/missing	-0.0146***	(0.0002)
High school	-0.0076***	(0.0001)
Receipt of disability benefits (ref: never received)		
Received prior to age 62	-0.0582***	(0.0023)
Civil status (ref: married/cohabiting, at least one child)		
Married, no children	-0.0080***	(0.0003)
Single, at least one child	-0.0184***	(0.0006)
Single/cohabiting, no children	-0.0166***	(0.0002)
Working in public sector	0.0009***	(0.0002)
Working in private sector with AFP	-0.0031***	(0.0002)
Labor income quartiles and employment status (ref: first quartile)		
Q2	0.0001	(0.0002)
Q3	-0.0002	(0.0002)
Q4	-0.0000	(0.0002)
Self employed and other	-0.0007**	(0.0003)
Not working	-0.0006	(0.0008)
Net wealth quartiles (ref: first quartile)		
Q2	-0.0004**	(0.0002)
Q3	-0.0007***	(0.0002)
Q4	-0.0005***	(0.0002)
Number of months on sickness leave at 61 (ref: zero)		
One	0.0005	(0.0004)
Two	-0.0001	(0.0003)
Three	0.0006*	(0.0003)
Four	0.0000	(0.0004)
Five	-0.0006	(0.0005)
Six	-0.0001	(0.0006)
Seven	-0.0008	(0.0007)
Eight	-0.0000	(0.0007)
Nine	0.0015*	(0.0008)
Ten	-0.0014*	(0.0008)
Eleven	0.0003	(0.0008)
Twelve	0.0002	(0.0009)
Constant	1.0920***	(0.0030)
R^2	0.88	
First stage F-statistic	2204.91	
N	22,564	

Heteroskedasticity robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sample: Individuals eligible for pension take-up and not receiving disability pensions in 2010.

Statistics Norway

Postal address:
PO Box 8131 Dept
NO-0033 Oslo

Office address:
Akersveien 26, Oslo
Oterveien 23, Kongsvinger

E-mail: ssb@ssb.no
Internet: www.ssb.no
Telephone: + 47 62 88 50 00

ISSN: 1892-753X

Design: Siri Boquist

Statistisk sentralbyrå
Statistics Norway