MEMORANDUM

No 09/2009

Towards an Actuarial Fair Pension System in Norway

Ugo Colombino
Erik Hernæs
Marilena Locatelli
Steinar Strøm

ISSN: 0809-8786

Department of Economics
University of Oslo

This series is published by the
University of Oslo
Department of Economics

P. O.Box 1095 Blindern
N-0317 OSLO Norway
Telephone: + 47 22855127
Fax: + 47 22855035
Internet: http://www.oekonomi.uio.no
e-mail: econdep@econ.uio.no

In co-operation with
The Frisch Centre for Economic Research

Gaustadalleén 21
N-0371 OSLO Norway
Telephone: +47 22 95 88 20
Fax: +47 22 95 88 25
Internet: http://www.frisch.uio.no
e-mail: frisch@frisch.uio.no

Last 10 Memoranda

No 08/09	Kjell Arne Brekke, Karen Evelyn Hauge, Jo Thori Lind and Karine Nyborg *Playing with the Good Guys: A Public Good Game with Endogenous Group Formation*
No 07/09	Benedicte Carlsen and Karine Nyborg *The Gate is Open: Primary Care Physicians as Social Security Gatekeepers*
No 06/09	Alessandro Corsi and Steinar Strøm *The Premium for Organic Wines? Estimating a Hedonic Price Equation from the Producer Side*
No 05/09	Jo Thori Lind, Karl Moene and Fredrik Willumsen *Opium for the Masses? Conflict-induced Narcotics Production in Afghanistan*
No 04/09	Jo Thori Lind and Karl Moene *Misrely Developments*
No 03/09	Steinar Holden and Fredrik Wulfsberg *Wage Rigidity, Institutions, and Inflation*
No 02/09	Nils-Henrik M. von der Fehr and Petter Vegard Hansen *Electricity Retailing in Norway*
No 01/09	Diderik Lund *Rent Taxation for Nonrenewable Resources*
No 30/08	Finn R. Førsund *Good Modelling of Bad Outputs: Pollution and Multiple-Output Production*
No 29/08	Michael Hoel *Bush Meets Hotelling: Effects of Improved Renewable Energy Technology on Greenhouse Gas Emissions*

Previous issues of the memo-series are available in a PDF® format at:
http://www.oekonomi.uio.no/memo/index.html

19 April 2009

Towards an actuarial fair pension system in Norway

Ugo Colombino[1], Erik Hernæs[2], Marilena Locatelli[3] and Steinar Strøm[45]

Abstract

In order to estimate labour supply responses among older people we have employed a very simple model of retirement decisions that can be estimated on a single cross-section sample, and still be given a structural interpretation in terms of inter-temporal decisions. The model is estimated on Norwegian register data from 1996, which covers all Norwegians aged 55-68 in 1996. The empirical model is employed to assess the impact on retirement of moving the Norwegian pension system towards actuarial fairness. Future annual pension benefits are increased if retirement is postponed say, for one year. In one of the simulations future annual benefits are increased by NOK 8,000 (as of April 2009 1 Euro~ NOK 8.7), which is around 5 per cent of the average pension benefit in 1996 and corresponds approximately to the adjustment in the new pension system which comes into effect 1. January 2011. The number of men and women choosing retirement is reduced by around 5 per cent, given that there is no consumption smoothing. When perfect consumption smoothing is assumed the reduction is much larger; 18 per cent in the case of men and 14 per cent in the case of women. These reductions are really sizeable and indicate that pension reforms, combined with removing constraints in the credit market, may be of great importance in giving the individuals incentive to prolong their working life.

---

[1]Department of Economics Cognetti De Martiis, via Po 53, Turin, Italy, e-mail: ugo.colombino@unito.it
[2] The Ragnar Frisch Centre for Economic Research, Gaustadalleen 21, 0349 Oslo, Norway, e-mail: erik.hernas@frisch.uio.no
[3] The Ragnar Frisch Centre for Economic Research and the Department of Economics Cognetti De Martiis, via Po 53, Turin, Italy, e-mail: marilena.locatelli@unito.it
[4] The Ragnar Frisch Centre for Economic Research, Department of Economics Cognetti De Martiis, via Po 53, Turin, Italy and the Department of Economics, University of Oslo, P.O. 1095, Blindern, 0317 Oslo, Norway, e-mail:steinar.strom@econ.uio.no
[5] This article is part of a Strategic programme on retirement, funded by the Norwegian Ministry of Labour and Social Inclusion. Financial support is gratefully acknowledged. The data sets used were received from Statistics Norway, with permission from the Norwegian Data Inspectorate.

JEL Classification: D10, H55, J26.

Keywords: Retirement, inter-temporal interpretation, estimates and policy simulations, Norway

1. Introduction

Today, nearly all industrialized countries are ageing. An increasing number of individuals are becoming eligible for retirement, and the maturing of the pensions system gives increasing pension levels. With the present Norwegian pension system, which is a pay-as-you-go pension benefit system, an increasing burden of work and tax payments will have to be born by a declining number of individuals in the work force over the coming decades. However, pension reforms have been proposed by the Norwegian government, with the intention to induce more people to postpone their retirement age. The reforms, if implemented, will move the pension system towards actuarial fairness. The unions have argued against part of the reforms and pointed to the fact that the reforms would excessively punish people who retire early compared to what happens under the current pension regime. In Norway, there is an early retirement scheme (AFP) that covers all employees in the public sector and a majority of employees in the private sector. The lowest retirement age is 62. If one decides to retire early he or she is not punished in terms of lower annual future pension benefits. What would happen to this early retirement scheme is still not totally clear.

To asses the labour market implication of pension reforms one needs to know how potential retirees respond to the labour supply incentives present in the pension reforms and to changes that moves the pension system towards actuarial fairness, which implies that if one retires at the earliest possible age, annual pensions will be lower than if the retirement age is postponed. This is what this paper tries to answer.

In order to estimate labour supply responses among older people we have employed a very simple model of retirement decisions that can be estimated on a single cross-section sample, and still be given a structural interpretation in terms of inter-temporal decisions. Empirical models of retirement typically use flow data (i.e. containing information on change of status) and adopt some version of the stochastic dynamic programming approach (e.g. Lumsdaine et al. 1992, Rust and Phelan, 1997). Here we follow a much simpler research strategy, developed in Colombino (2003). Like in Burtless and Moffit (1985) and Gustman and Steinmeier (1986) the first order conditions of a standard inter-temporal optimisation problem are employed to yield the optimal retirement age. From an empirical point of view, the advantage is that the model can be estimated on cross-section data, containing only information on current occupational status. To simplify modelling we assume that the individual maximises the intertemporal utility given the expected length of life instead of maximising the expected intertemporal utility (with expectation taken with respect to the probability distribution of life length).

We will estimate the model under two alternative assumptions with respect to constraints in the credit market. In the first alternative we assume that the agents are facing liquidity constraints to the extent that total consumption in each period (year in this study) is equal to current disposable income (no consumption smoothing). In the second alternative we go to the other extreme and assume that the credit markets are perfect (perfect consumption smoothing). In the dataset income as well as savings is observed. In reality the credit markets are neither totally perfect nor totally imperfect. However, it is hard to observe the factual credit constraint that each household is facing and our estimates reported below are only meant to illustrate the empirical importance of the credit constraint assumption.

The model is estimated on Norwegian register data from 1996, which covers all Norwegians aged 55-68 in 1996. In this year we observe the individuals either in a retirement or in an employment modus and we use these observations to estimate the probability of retirement based on a structural model. Two policy reforms are analysed. First, we reduce the pension benefits in the current pension system by 10%. This change has a positive impact in terms of increases in the labour supply of people eligible for early retirement. The number of men and women choosing retirement is reduced by around 9 per cent (women) and 10 (men) per cent, which imply elasticities of the retirement probabilities with respect to pension benefits of around 1. These elasticities are almost identical irrespective of the assumption of consumption smoothing or not.

In the current Norwegian pension system there is no punishment in terms of reduced future pension benefits if one retires early. However, the government has proposed a pension reform that will introduce this type of punishment and hence move the Norwegian pension system towards actuarial fairness. Future pension benefits will increase if retirement is postponed. The reform will start to be implemented in 2011. To assess the impact on retirement of moving the Norwegian pension system towards actuarial fairness, we have increases future annual pension benefits if retirement is postponed one year. In one of the simulations future annual benefits are increased by NOK 8 000 (as of April 2009 1 Euro~ NOK 8.7), which is around 5 per cent of the average pension benefit in 1996. The number of men and women choosing retirement is reduced by around 5 per cent, given that there is no consumption smoothing. When perfect consumption smoothing is assumed the reduction is much larger; 18 per cent in the case of men and 14 per cent in the case of women. These reductions are really sizeable and indicate that pension reforms combined with removing constraints in the credit market may be of great importance in giving the individuals incentive to prolong their working life. The mechanism behind the result is that when the credit market is perfect, it is possible to borrow money today on the premises of future increases in pension benefits, given that one signs a contract of continuing working. In the calculation of the gains if retirement is postponed, we have accounted for expected length of life, which differs across gender, with women living a little longer than men. Despite the latter, when the credit market is perfect, the reduction in the probability of retirement is predicted to be larger among men than women. The explanation is that there are many factors, other than pension benefits and own income, that affect the decision to retire. In the calculation of the future gains, if retirement is postponed, we have assumed a real rate of interest equal to 3 per cent and equal across all individuals. With higher interest rates and/or with a variation in the interest rates across individuals, the gains of postponing retirement would on average be lower and hence the overall reduction in the propensity to retire early would also be lower.

In Appendix 1 we give a brief overview of the institutional settings in Norway. Appendix 2 reports the tax structure.

In Section 2 we present the theoretical models from which we derive the optimal point in time for retirement. Section 3 gives the empirical specification of the models, while Section 4 and 5 present data and estimation results, respectively. In Section 6 we report policy simulations performed on the model. Section 7 concludes.

2. A model of individual retirement decisions

2.1 Imperfect credit markets, no consumption smoothing

We start with the case with no consumption smoothing. Let C denote household consumption, that has to be less than or equal to annual after tax household income. If retired, annual after tax income is denoted R, and if working, annual after tax income is denoted W. Because utility will be assumed to be strictly increasing in consumption and because of the assumption of no saving or borrowing, utility is derived from current disposable income and from other variables that will be introduced later. Annual consumption entering the utility function is replaced by annual disposable income.

Let

(1) $U_{Rt}(R_t(\tau))$ = instantaneous utility of a retired individual receiving a pension $R_t(\tau)$ in year t, given that he retired in year τ, with $\tau \leq$ t.

(2) $U_{Wt}(W_t)$ = instantaneous utility of the individual if working at year t and receiving an income W_t.

The inter-temporal utility, V(.), is the sum of discounted future instantaneous utilities,

$$(3)\quad V(\tau) = \int_0^{\tau} e^{-\delta t} U_{Wt}(W_t)dt + \int_{\tau}^{D} e^{-\delta t} U_{Rt}(R_t(\tau))dt$$

where time is measured since the start of the working career, τ is the point in time of (for simplicity, irreversible) retirement, $e^{-\delta}$ is the discount factor, and D is the expected length of life.

The necessary condition for a maximum of $V(\tau)$ with respect to τ is

$$(4)\quad U_{W\tau}(W_\tau) = U_{R\tau}(R_\tau(\tau)) - \Delta(\tau) \equiv U_{R\tau}(R(\tau)) - \int_{\tau}^{D} e^{-\delta(t-\tau)} \frac{\partial U_{Rt}(R_t(\tau))}{\partial \tau} dt$$

If $V(\tau)$ is single-peaked this condition is also sufficient.

Let

$$\Delta(\tau) = \int_{\tau}^{D} e^{-\delta(t-\tau)} \frac{\partial U_{Rt}(R_t(\tau))}{\partial \tau} dt$$

The individual will then be observed

- in retirement status in year t if and only if

$$(5)\quad U_{Wt}(W_t) \leq U_{Rt}(R_t(t)) - \Delta(t)$$

- in employment status in year t if and only if

$$(6)\quad U_{Wt}(W_t) > U_{Rt}(R_t(t)) - \Delta(t).$$

The term $\Delta(t)$, evaluated at the time of retiring, is the (future) gain in utility by postponing retirement by one more year, which is positive if the future pension level then increases. $\Delta(t)$ is the cost of early retirement. From the definition of $\Delta(\tau)$ we observe that

$$(7)\quad \Delta(\tau) = \int_{\tau}^{D} e^{-\delta(t-\tau)} \frac{\partial U_{Rt}(R_{\tau}(\tau))}{\partial \tau} dt = \int_{\tau}^{D} e^{-\delta(t-\tau)} \frac{\partial U_{Rt}(R_t(\tau))}{\partial R_t(\tau)} \frac{\partial R_t(\tau)}{\partial \tau} dt$$

In an *actuarially fair pension system* $\frac{\partial R_t(\tau)}{\partial \tau} > 0$, which implies that you get a higher future annual pension if retirement is delayed. Hence, there will be a loss if retirement is not postponed. In the Norwegian current pension system, the pre-reform pension system, the future pension benefits are not affected at all by the retirement decision. In fact if an individual retire early, future pension benefits are projected on the basis of the projection of future wage income, as if the individual were still working. Thus, in the current Norwegian case $\frac{\partial R_t(\tau)}{\partial \tau}$ is zero, and hence $\Delta(\tau)$ also equals zero. In the proposed reform the pension system is moved towards an actually fair pension system with $\frac{\partial R_t(\tau)}{\partial \tau}$ being positive. This we will come back to when we discuss policy simulations.

2.2 Perfect credit markets, perfect consumption smoothing

Next we consider the case where perfect credit markets allow the consumer to optimally smooth expenditures across different time periods. The inter-temporal optimisation problem is

$$(8)\quad \max_{\tau,\{C_t\}} V(\tau) = \int_0^{\tau} e^{-\delta t} U_{Wt}(C_t) dt + \int_{\tau}^{D} e^{-\delta t} U_{Rt}(C_t) dt$$

s.t.

$$(9)\quad \int_0^{D} e^{-rt} C_t dt = \int_0^{\tau} e^{-rt} W_t dt + \int_{\tau}^{D} e^{-rt} R_t(\tau) dt$$

where C_t is consumption at time t and e^{-r} is the market discount rate. To this end we assume δ=r.

Let £ be the Lagrange function associated with this problem and μ the Lagrange multiplier:

$$(10)\ £ = \int_0^{\tau} e^{-rt} U_{Wt}(C_t)dt + \int_{\tau}^{D} e^{-rt} U_{Rt}(C_t)dt - \mu\left[\int_0^{D} e^{-rt} C_t dt - \int_0^{\tau} e^{-rt} W_t dt - \int_{\tau}^{D} e^{-rt} R_t(\tau)dt\right]$$

The first order conditions are:

$$(11)\quad e^{-r\tau} U_{W\tau}(C_\tau) - e^{-r\tau} U_{R\tau}(C_\tau) + \mu\left[e^{-r\tau} W_\tau - e^{-r\tau} R_\tau(\tau) + \int_{\tau}^{D} e^{-rt} \frac{\partial R_t(\tau)}{\partial \tau} dt\right] = 0$$

$$(12)\quad \frac{\partial U_{Wt}(C_t)}{\partial C_t} = \mu \quad \text{for} \quad t < \tau$$

$$(13)\quad \frac{\partial U_{Rt}(C_t)}{\partial C_t} = \mu \quad \text{for} \quad t \geq \tau$$

From (12) and (13) we get $C_t = \overline{C}$ for all t, and hence from (11) we get

$$(14)\quad U_{W\tau}(\overline{C}) = U_{R\tau}(\overline{C}) - \Gamma(\tau)$$

where

$$(15)\quad \Gamma(\tau) = \mu\left[W_\tau - R_\tau(\tau) + \int_{\tau}^{D} e^{-r(t-\tau)} \frac{\partial R_t(\tau)}{\partial \tau} dt\right]$$

As mentioned above, in the current Norwegian pension system $\frac{\partial R_t(\tau)}{\partial \tau}$=0. In the section where we discuss policy simulation we will discuss the impact on retirement of introducing an actually fair pension reform, which implies that $\frac{\partial R_t(\tau)}{\partial \tau}$>0.

From (12) and (13) we observe that μ can be calculated from the empirical specification of the utility function. We also observe that μ and hence $\Gamma(\tau)$ depend on the consumption level $\overline{C}$.

As in the no-smoothing case we now observe the individuals in

- retirement status at time t if $U_{Wt}(\bar{C}) \leq U_{Rt}(\bar{C}) - \Gamma(t)$

- employment status at time t if $U_{Wt}(\bar{C}) > U_{Rt}(\bar{C}) - \Gamma(t)$

3. Empirical specification

3.1 Imperfect credit markets, no smoothing of consumption

The instantaneous utilities are specified as follows:

(16) $U_{Wt}(W_t) = \alpha f(W_t + y_t) + \gamma g(L_{Wt}) + \varepsilon_{Wt}$
(17) $U_{Rt}(R_t(\tau)) = \alpha f(R_t(\tau) + y_t) + \gamma g(L_{Rt}) + \varepsilon_{Rt}$

where f(x) is a concave function of x and:

• $R_t(\tau)$ = after-tax pension received in year t if decided to retire in year τ. This will be equal to 0 if the individual exits the employment status but is not eligible to receiving either the old age pension, or early retirement pension. We let $R_t(\tau)$ be the after-tax pension when the pensioner is either on old age pension or on pensions in the early retirement programme (AFP). The pension term in the utility function is given by $R_t(\tau)E_t$, where $E_t=A_t+S_t$, and where $S_t=1$ if the age equals 67 or above (old age pension) and S_t equals 0 otherwise, while $A_t=1$ if $S_t=0$ and the individual is eligible to retire early on AFP, otherwise $A_t=0$.

- W_t = after-tax employment income received in year t, if employed in year t.
- y_t = exogenous (with respect to the individual) income in year t, i.e. the after tax income of the spouse plus the after tax capital income.
- L_{Wt} = leisure if employed in year t.
- L_{Rt} = leisure in year t if retired.

The ε-s are stochastic components, identically and independently standard extreme value distributed with a scale parameter which will be absorbed in the scale coefficients of the utility function (the α and the γ-s)

α and γ are parameters to be estimated. γ is expressed as a linear combination of a set of characteristics Z_t:

(18) $\gamma = Z_t^{'}\beta$

We do not model the choice of hours of work. We therefore choose a convenient normalisation: $g(L_{Wt})=0$ and $g(L_{Rt})=1$. The utility functions[6] are given in (19) and (20):

$$(19) \quad U_{wt} = \alpha \frac{(W_t + y_t)^{\lambda} - 1}{\lambda} + \varepsilon_{Wt}$$

$$(20) \quad U_{Rt} = \alpha \frac{(R_t(\tau) + y_t)^{\lambda} - 1}{\lambda} + Z'\beta + \varepsilon_{Rt}$$

The utility function is strictly concave if λ<1. If λ=1, the utility function is linear in consumption and log-linear if λ=0

Note that according to the conditions (5) and (6) above, the relevant comparison between utilities in the alternative states is done for $\tau = t$.

Let P_{Rt} be the probability of observing the individual in the retirement status at time t. From (5), (19) and (20) we then have

$$(21) \quad P_{Rt} = \Pr(U_{Wt}(W_t) \le U_{Rt}(R_t(t)))$$

Given the distributional assumption made upon the ε, P_{Rt} is

$$(22) \quad P_{Rt} = \frac{\exp\left\{\alpha \frac{\left[R_t(\tau) + y_t\right]^{\lambda} - 1}{\lambda} + Z_t^{'}\beta - \Delta(t)\right\}}{\exp\left\{\alpha \frac{\left[R_t(\tau) + y_t\right]^{\lambda} - 1}{\lambda} + Z_t^{'}\beta - \Delta(t)\right\} + \exp\left\{\alpha \frac{\left[W_t(\tau) + y_t\right]^{\lambda} - 1}{\lambda}\right\}}$$

---

[6] See Aaberge, Dagsvik and Strøm (1995), Aaberge, Colombino and Strøm (1999) and Dagsvik and Strøm (2006) to previous adoptions and justification for this form.

The variables in the Z-vector are given in Table 1 below. In the current Norwegian pension system $\Delta(t)=0$. In order to discuss the impact of a pension reform that moves the system towards an actuarially fair pension system, we will introduce $\Delta(t)$ in the probabilities and show the effect of this.

3.2 Perfect credit markets, perfect smoothing of consumption

In this case the instantaneous random utilities are given by

$$(23) \quad U_{Wt} = \alpha \frac{C_t^{\lambda} - 1}{\lambda} + \varepsilon_{Wt}$$

$$(24) \quad U_{Rt} = \alpha \frac{C_t^{\lambda} - 1}{\lambda} + Z_t^{'}\beta + \varepsilon_{Rt}$$

where C_t is consumption at time t, defined as household disposable income at time t minus household savings at time t.

From (14), (23) and (24) we get the probability that an individual is observed in retirement status at time t, P_{rt}

$$(25) \quad P_{Rt} = \Pr(U_{Wt}(\bar{C})) \leq U_{Rt}(\bar{C}) - \Gamma(t))$$

where $\Gamma(t)$ is given in (15). From (23)-(25) we get

$$(26) \quad P_{Rt} = \frac{\exp\left\{\alpha \frac{\bar{C}^{\lambda} - 1}{\lambda} + Z_t^{'}\beta - \Gamma(t)\right\}}{\exp\left\{\alpha \frac{\bar{C}^{\lambda} - 1}{\lambda} + Z_t^{'}\beta - \Gamma(t)\right\} + \exp\left\{\alpha \frac{\bar{C}^{\lambda} - 1}{\lambda}\right\}}$$

which clearly reduces to

$$(27) \quad P_{Rt} = \frac{\exp[Z_t^{'}\beta - \Gamma(t)]}{\exp[Z_t^{'}\beta - \Gamma(t)] + 1}$$

As alluded to above, since $\Gamma(t)$ is proportional to the Lagrange multiplier μ, $\Gamma(t)$ depends on consumption $\bar{C}$, and it is given by

$$(28) \quad \Gamma(\tau) = \alpha \bar{C}^{\lambda - 1}[W_{\tau} - R_{\tau}(\tau) + \int_{\tau}^{D} e^{-r(t-\tau)} \frac{\partial R_t(\tau)}{\partial \tau} dt]$$

where $\bar{C} = \max(W_t, R_t) + y_t$

Again, in the current Norwegian pension system $\frac{\partial R_t(\tau)}{\partial \tau}$=0, while in the proposed reform of the system $\frac{\partial R_t(\tau)}{\partial \tau}$>0.

4. Data sources and summary statistics

Sample

We base our analysis on administrative data, which are merged administrative registers received from Statistics Norway, with permission from the Norwegian Data Inspectorate. We use demographic data files, old age pension registry and tax return records. A unique personal identification number[7] for each resident in Norway allows linking over time and across registers. From the Norwegian register datasets we have extracted persons aged 55-68 in 1996 (born 1928-41) and who were receiving labour income or pension of at least one G in 1996. G denotes minimum income (see Appendix 1 for further details). The reason why the lowest age is 55 is that in Norway there is no pension available for "young individuals", at least not for individuals in the 40s and early 50s. For the sample used in the analysis, we have included all persons who were either:

1. Retired: Classified as a pensioner in July 1996 in a social benefit database in Statistics Norway (FD-trygd), and receiving an old age pension or an early retirement pension (AFP) of at least one G in 1996, according to the tax files.
2. Working: Not retired and with earnings of at least one G according to the tax files in 1996.

---

[7] This number is encrypted version of the official personal identification number and is only used for internal linking of files at the Frisch Centre.

This means that we have excluded persons who were disabled, were on rehabilitation or were out of the labour force for other reasons, or had too low earnings. The spouse's after-tax income was added to give household income, regardless of the source of the spouse's income.

Potential pension

For all persons in the sample, we impute potential old age public pension for persons aged 67 and above, and early retirement pension for persons aged 64-67, by applying the appropriate formulae to the sequence of pension points, which are observed in our data (see Haugen, 2000 and Hernæs et al., 2001).

Although the public pension system (old age public pension and AFP) is the most important source of income for most retirees, there are also other pension programmes, as mentioned above, which influences the budget constraints of potential retirees. So far we have not been able to impute the size of these occupational pensions, or identify eligibility, which would also require information on accrual within the company. Instead we have represented this pension option by including among the covariates a dummy, called FIRM, which equals 1 if the individual works in a firm with a pension plan (other than AFP) and 0 otherwise. This information is derived by identifying the previous occupation of retirees who were observed receiving occupational pensions.

Potential earnings

In order to smooth out possible fluctuations in income, the potential earnings assigned to each individual is the maximum of observed earnings in 1996, earnings in 1995 and the average of earnings 1991-1995. This means that the longer a person has been retired, the lower the potential earnings will be predicted to be. Individuals, who have not had earnings later than 1990, are all excluded. The after tax wage income of the spouse and household capital income after tax is observed for 1996. In the model these two incomes sum to the variable y_t, but in Table 2 both incomes are reported. To calculate household consumption we deduct household savings from household income after tax. Savings are observed as the value of financial assets at the end of the year 1996 minus the value of financial asset at the end of the previous year, as reported to the tax authorities.

Variable description and summary statistics for the sample used in estimating the models are given in Table 1 and Table 2, respectively.

Table 1. Variable description

Variable	**Description**
R_t	After tax household income1996 if individual is retired, including A*fter tax spouse income* , and *After tax capital income*
W_t	After tax househod income 1996 if working, including *After tax spouse income* and *After tax capital income*
spouse_income	After tax spouse income. Included in R_t (retired) and in W_t (working)
capital_income	After tax household capital income, included in inntekt1 (retired) and in inntek9 (working)
H_C_W	Household consumption96 if the eligible individual is working
H_C_R	Household consumption96 if if the eligible individual is retired
age	Age in 1996 divided by 10
south	dummy = 1 if living in the South of Norway, 0 otherwise
educ	Education in year divideb by 10.
firm	dummy = 1 if current or last job was in a company (either private or public) with an occupational pension
pr_55_59	percentage retired age 55-59
pr_60_67	percentage retired age 60-67
pr_68	percentage retired age equal 68

Table 2. Summary statistics for sample used in estimation, Norway 1996

	Males		Females	
	Mean	Std.	Mean	Std.
R_t	164 470	115 163	194 786	112 837
W_t	308 358	142 758	286 315	131 417
spouse_income	111 975	64 986	167 937	109 319
capital_income	28 546	109 964	9 143	44 622
H_C_W	270 315	235 024	270 771	250 257
H_C_R	126 427	225 221	179 243	246 680
age	6.07	0.41	6.07	0.42
south	0.87	0.34	0.87	0.33
education	1.10	0.32	1.01	0.27
firm	0.60	0.49	0.69	0.46
Number of obs.	140 569		114 277	
Percentage retired:				
age 55-59	0.00		0.00	
age 60-67	15.06		16.07	
age 68	94.32		98.07	

Note: t = 1996. In the estimation income variables are in 10000 NOK

As of April 2009 1Euro~NOK 8.7

5. Estimates

The models are estimated (by Maximum Likelihood), using the cross-section data for Norway in 1996. Let d_{it} =1 if the individual is in the retirement status at time t, and d_{it}=0 if the individual is in the employment status. Then the log-Likelihood function to be maximised with respect to α, β-s and λ, is

$$\ln £ = \sum_i d_{it} \ln P_{Rti} + \sum_i (1-d_{it}) \ln(1-P_{Rti}) .$$

To measure how well our models explain data we have computed a pseudo-R^2 as $1-\frac{\ln £^*}{\ln £^0}$, where £* is the maximised likelihood and $£^0$ is the likelihood when choices of retirement is made at random, that is P_{Rt}=(1-P_{Rt})=0.5. Thus $\ln£^0$= nln0.5, where n is the total number of observations. This pseudo-R^2 measures how much better our structural model explains data relative to pure random draws of the choices.

Table 3 reports the estimates of the no-smoothing model and Table 4 the estimates of the perfect consumption smoothing model. As expected with this huge dataset, the coefficients are sharply determined. The Pseud0-R^2 is rather high in all four cases in Table 3 and 4 and indicates that our models explain data far better than if all choices had been made at random. Of particular interest is the result that the estimates of all coefficients as well as the fit, are the same across the two extreme cases of no and perfect consumption smoothing. This means that the two extreme assumptions on smoothing fit the data equally well. An indicator of e.g. individual specific credit rationing could improve modelling. This is, however, not available in our data, so we use both models in the following, noting reasonably good fit with both.

Both for men and women the deterministic part of the utility function is estimated to be strictly concave, and for both gender the utility function is significantly different from a linear as well as a log-linear function. The estimates of the shape coefficient, λ, indicate that the marginal utility of consumption declines more with consumption among men than among women. For both gender the marginal utility of leisure is increasing with age and almost to the same extent. As expected, both for men and women age has a positive impact on retiring. Living in the south and hence in the most densely populated area of Norway has a positive impact on the utility of leisure and hence on the propensity to retire.

The positive estimates of (β_{firm}) mean that working in a company with a company specific pension programme increases the probability of retiring. This underlines the importance of financial incentives for the retirement decision. The estimates indicate clearly that the firm-pension effect is more important among men than among women.

The estimate related to the impact of education on retirement, $(\beta_{education})$, imply that for females, higher education increases the probability of retirement. For males, the impact is the opposite: the higher the education is, the higher is the propensity to postpone retirement

Table 3. Maximum Likelihood Estimates of α, β and λ. Norway 1996. No consumption smoothing

	Men		Women	
Parameters	**Estimates**	**Asy-t**	**Estimates**	**Asy-t**
λ	0.3860	13.5220	0.6153	18.7790
α	1.6509	11.4340	1.2301	10.0420
$\beta_{constant}$	-75.2594	-90.4640	-87.3448	-72.5640
β_{age}	11.5340	92.2360	13.2498	74.0420
β_{south}	0.1691	3.3490	0.1661	2.4430
β_{firm}	0.7248	18.7460	0.4030	6.8620
$\beta_{education}$	-0.4964	-9.0780	0.4527	5.2230
Mean ln $£^*$	-0.08963		-0.064398	
Mean ln $£^0$	-0.89501		-0.93163	
Pseudo-R^2	0.90		0.93	
Number of observations	140,569		114,277	

Table 4. Maximum Likelihood Estimates of α, β and λ. Norway 1996. Perfect consumption smoothing

	Men		Women	
Parameters	**Estimates**	**Asy-t**	**Estimates**	**Asy-t**
λ	0.4425	16.7240	0.6547	19.4580
α	1.6126	11.2450	1.1550	9.2320
$\beta_{constant}$	-75.8105	-91.2160	-87.6876	-72.8060
β_{age}	11.6144	92.9270	13.2974	74.2540
β_{south}	0.1735	3.4350	0.1685	2.4830
β_{firm}	0.7589	19.6970	0.4063	6.9220
$\beta_{education}$	-0.4425	-8.1270	0.4930	5.6960
Mean ln $£^*$	-0.089904		-0.064563	
Mean ln $£^0$	-2.074650		-2.149290	
Pseudo-R^2	0.96		0.97	
Number of observations	140,569		114,277	

6. Policy simulation

The estimated structural model can be used to simulate the effects of pension reforms. Here we limit ourselves to illustrate the implications of the models by showing the *ceteris paribus* effects of changes in pension benefits and a reform of the pension system that moves it towards actuarial fairness. The simulations must be interpreted as a comparative static exercise: it shows how different the number of retired people would be, as a consequence of a permanent change in some variables or parameters. For each individual we compute the probability of being in retirement status before and after the exogenous change. The individual probabilities are then summed across the sample to get the estimate of the expected number of people in retirement status. The simulations are replicated for each of the estimated model versions. The results are given in Tables 5.

The reduction in pension benefits by 10 per cent has almost the same effect on retirement among men (around 10 per cent less retired men) and women (around 9 per cent less retired women). These numbers imply that the elasticity of retirement wrt to pension benefits is around 1, both for men and women.

To introduce actuarially fairness into the Norwegian pension system implies that $\frac{\partial R_t(\tau)}{\partial \tau}$>0. We show nine examples, ranging from $\frac{\partial R_t(\tau)}{\partial \tau} = 0.2$, which means that pension benefits are increased by NOK 2 000 per year if retirement is postponed by one year, to $\frac{\partial R_t(\tau)}{\partial \tau}$=3.0, which means that pension benefits are increased by NOK 30 000 per year if retirement is postponed by one year. These numbers imply that if retirement is postponed by one year, pension benefits are increased from around 1 per cent to 15 per cent of the average pension in the population. Table 5 gives the results in terms of reduction in number of people choosing retirement in 1996. In the new and proposed flexible pension system, actuarial adjustment implies that the pension level will increase by around 6 per cent if retirement is postponed from 67 to 68 years and around 4,5 % by a postponement from 62 to 63 (Ministry of labour and social inclusion, 2009). At the average pension level for males and females, this corresponds to increases in the range of 7-10 000 NOK (0.7 – 1.0 in Table 5). With $\frac{\partial R_t(\tau)}{\partial \tau}$=0.8, the model without consumption smoothing gives a decrease in the number of retirees by around 5 per cent, a little more for females, since a certain percentage increase in pension correspond to at somewhat higher absolute increase. This result implies that the share of retired individuals between 60 and 67 goes down by around 0.75 percentage point, a little more for women (from 15 per cent for men and 16 per cent for women).

The most striking result from a modelling point of view is that the responses to actuarial adjustments are much stronger when the individuals are able to smooth consumption over the life-cycle. With $\frac{\partial R_t(\tau)}{\partial \tau}$=0.8 the model with consumption smoothing yields a reduction in retirement of close to 18 per cent for men and 14 per cent for women. This implies that the share of retired men between 60 and 67 goes down by more than 3 percentage point (from around 15 per cent), and a little less than 3 percentage point for women between 60 and 67 (from around 16 per cent). This result stresses that the reduction in retirement when pension systems are reformed depends crucially on the credit market. With a perfect credit market, the individuals can borrow money to smooth consumption on the premises of future gains in pension benefits when retirement is postponed.

Instead of increasing future pension benefits if retirement is postponed, the government can reduce the future pension benefits if retirement is taken out early. The impact on retirement is more less the same.

There are some interesting differences across gender. When the credit market is completely imperfect, women tend to respond a little stronger to changes in future pension benefits if retirement is postponed by one year. When credit market is completely perfect, men tend to respond stronger.

Table 5 Simulations

Exogenous change	Percentage variation in the number of individuals in retirement status*			
	Men		Women	
	No smoothing	Perfect smoothing	No smoothing	Perfect smoothing
Pension down 10 per cent	-10.4	-10.4	-9.3	-9.2
$\frac{\partial R_t(\tau)}{\partial \tau} = 0.2$	-1.2	-4.5	-1.4	-3.5
$\frac{\partial R_t(\tau)}{\partial \tau} = 0.4$	-2.4	-8.9	-2.8	-7.0
$\frac{\partial R_t(\tau)}{\partial \tau} = 0.7$	-4.2	-15.6	-4.8	-12.1
$\frac{\partial R_t(\tau)}{\partial \tau} = 0.8$	-4.9	-17.7	-5.5	-13.8
$\frac{\partial R_t(\tau)}{\partial \tau} = 0.9$	-5.5	-19.9	-6.2	-15.5
$\frac{\partial R_t(\tau)}{\partial \tau} = 1.0$	-6.1	-22.1	-6.9	-17.3
$\frac{\partial R_t(\tau)}{\partial \tau} = 2.0$	-12.1	-43.0	-13.6	-37.7
$\frac{\partial R_t(\tau)}{\partial \tau} = 2.5$	- 15.1	-52.9	-17.0	-48.2
$\frac{\partial R_t(\tau)}{\partial \tau} = 3.0$	-18.1	-62.3	-20.5	-60.6

* The point in time of (irreversible) retirement (τ) is 1996.

7. Conclusion

We have employed a very simple model of retirement decisions that can be estimated on a single cross-section sample, and still be given a structural interpretation in terms of inter-temporal decisions. The model is estimated on Norwegian register data from 1996, which covers all Norwegians aged 55-68 in 1996. The empirical model is employed to assess the impact on retirement of moving the Norwegian pension system towards actuarial fairness. Future annual pension benefits are increased if retirement is postponed one year. In one of the simulations future annual benefits are increased by NOK 8,000 (as of April 2009 1 Euro~ NOK 8.7), which is around 5 per cent of the average pension benefit in 1996. This corresponds approximately to the adjustment in the new pension system which comes into effect 1. January 2011. The number of men and women choosing retirement is reduced by around 5 per cent, given that there is no consumption smoothing. When perfect consumption smoothing is assumed, the reduction is much larger; a little les than 18 per cent in the case of men and 14 per cent in the case of women. These reductions are really sizeable and indicate that pension reforms combined with removing constraints in the credit market may be of great importance in giving the individuals incentive to prolong their working life.

Appendix 1. Institutional settings

The description of pension and taxation rules that follows is not only meant to serve as an introduction to the paper. In fact, in the estimation of the retirement models all details of pension programs and taxation are accounted for.

In 1937, the first mandatory public old age pension insurance was implemented. The system was universal in the sense that everyone was included. It was restricted to persons with relatively low income. The age of eligibility was set to 70 years. In 1957 the means testing was lifted and co-ordination with government pensions was introduced. Earnings based component was added to the basic amount in 1967 and the age of eligibility was lowered to 67 years, giving the structure of the National Insurance System (NIS), which is still in operation.

Pensions are financed through taxes levied on employers and employees as percentages of total earnings and on self-employed as a percentages of their income. There exists a central pension fund, but it is not required that this should meet future net expected obligations. The (PAYG) system is based on yearly contributions from the government. In what follows we will briefly describe the Norwegian pension system. If not otherwise stated all information refers to the year of analysis in this paper, 1996. More details can be found in Nordic Social-Statistic Committee (2008).

The public old age pension system

The mandatory public pension system (NIS) has two main components. One component is a minimum pension, paid to all persons who are permanently residing in the country. The pension is reduced proportionally with less than 40 years of residence.

The other main component is earnings based pension. A crucial parameter in the system, used for defining contributions as well as benefits, is the basic amount. The basic amount (G) in 1996 was NOK 40 410. As of April 2009, 1 EURO is approximately NOK 8.7.

The earnings based pension depends on the G and the individual earnings history in several ways. To give pensions points, earnings exceeding the G each year are divided by G. Earnings above 12 times G do not give points, and earnings between 6 and 12 times G (8 and 12 times before 1992) are reduced to one third before calculating pension points. Points calculated each year are then multiplied by a "Supplementary Pension Rate" of 0.45 (points obtained after 1992 are multiplied by a rate of 0.42), and the average yearly points over the 20 best years are calculated. These points multiplied by G give the earnings based component, and adding 1G gives the total public pension. If a person has had less than 40 years with earnings above the G, the earnings based pension is reduced proportionally.

The public pension system also has a number of additional regulations, which we will briefly recount here. First, since we are still in the process of phasing in the public pension system established in 1967, a special "overcompensation" program is in operation for persons born before 1928. Secondly, there is a supplementary pension for those without or with a low earnings based pension component, giving a minimum pension level of 1.605 times the G (1G). Because of the supplementary pension, income below 2.344 times the minimum pension does not contribute to the total public pension. Thirdly, there is a co-ordination of the pensions for married couples, mainly resulting in a reduction (25% in 1996, 20% in 2003) of the couples joint pension compared to the sum for two single persons.

Keeping 1996 regulations constant, the maximum future public old age pension level will be 3.94 times the G. This pension level requires 20 year with earnings of at least 12 G and another 20 years with earnings of at least 1 G.

Government pensions

State and local government employees have occupation-based pensions, coordinated so that benefits as a main rule will be the maximum of the public old age pension and the government pension. The government pension is based on the earnings level immediately prior to retirement and not on the previous earnings history. The pension is 66 per cent of gross income the year prior to retirement up to 8 times G (the same basic amount as in the public system) and 22 per cent of income between 8 and 12 G. In 2000 rules were changed so that pension now is 66 per cent of gross income up to 12 G. As in the public system, income below 1G does not count. In the government sector there are some few groups that can retire early like individuals working in the police and the military.

Private sector (firm specific) occupation based pensions

In the private sector 36 per cent of the work force are covered by occupation based pension, from which benefits are received 'on top' of the public old age pension without any reduction. For employers to receive tax deductions for contributions, there are regulations, implying that the pension should include all employees and that the eligibility age is at least 65.

Earnings testing of pension benefits

Pensioners aged between 67 and 70 in the public old age pension system (previously employed in the private sector), who continue to work in another job than they had when they retired, will have their pension reduced if earnings from work exceed a certain level. The same happens to pensioners in the government sector who start working in other jobs in the government or local government. However, if the government pensioners get a job in the private sector their income does not influence their pension. For pensioners aged 70 years or more there are no reductions in benefits regardless of what system one receives pension benefits from.

Personal savings

Individuals can save for their retirement age. These savings are tax deductible and widespread. In 1996, 167 000 individuals received tax deductions.

Early retirement

Finally, in 1989 employers and unions negotiated an **early retirement scheme** (AFP). Under this scheme, persons working for employers who are participating (in 2001 about 43 % of private employees and all employees of central and local government) and meeting individual requirements can retire at an earlier age than the ordinary 67, for details see Hernæs et al (2001)). The age at which persons become eligible for AFP has been gradually lowered since the first agreement in 1989. Table A.2 gives a summary of this. We observe that in the years before 1996 the eligibility age was lowered from 66 to 64 years.

Table A.1. The age limit for AFP eligibility

Introduced	Age limit
01.01.1989	66 years
01.01.1990	65 years
01.10.1993	64 years
01.10.1997	63 years
01.03.1998	62 years

The pension under the AFP scheme is calculated in much the same way as the ordinary public old age pensions except for some differences due to the age at which one choose to retire and which sector one is working in. Individuals working in the private sector who choose to retire early get the public old age pension as described above and an additional tax-free AFP lump sum of NOK 11 400 a year.

In the government sector, both state and local, the rules are different. First, the occupation-based pension, described above, is part of the AFP scheme from the age of 65. Before that age the public sector retirees get the same pension as those retiring from the private sector. Secondly, the AFP lump sum is different. Retired people between 62 and 65 get a *taxable* AFP lump sum of NOK 20 400 a year, whilst from the age of 65, when they receive the occupation-based pension, they do not get the AFP lump sum. Moreover, early retirement is not penalized in the sense that future AFP-pension is not affected by when the individual retires.

Taxation

In *Appendix 2* we report how different types of income were taxed in 1996. Taxation of wage income is progressive and hence re-distributive. From the tax functions in *Appendix 2* we note that the marginal tax rates on pension income is not uniformly increasing with income and consequently the budget sets for retired individuals are non-convex.

Replacements ratios

Table A.2 reports replacement ratios for Norway in 1996. We show the replacement ratios for Norwegian singles, see Haugen (2000) for married people and for other years. After-tax replacement ratios are defined as the after-tax-pension income divided by the after-tax wage income.

Table A.2. After-tax replacement ratios. Single individuals. Norway 1996

Life time income, stable in terms of basic amount (G)		Old age NIS pension, age 67 and above		Early retirement pension (AFP) age 64-66		
In (G)	In NOK	Public pension	Govern-ment pension	Private sector	Governm ent sector, age 64	Governm ent sector, age 65-66
1 G	40410	1.89	1.89	2.23	2.43	1.89
2 G	80820	1.04	1.04	1.22	1.33	1.04
3 G	121230	0.84	0.95	0.97	0.99	0.95
4 G	161640	0.75	0.85	0.84	0.84	0.85
5 G	202050	0.68	0.82	0.76	0.76	0.80
6 G	242460	0.65	0.81	0.71	0.71	0.79
7 G	282870	0.64	0.82	0.68	0.68	0.80
8 G	323280	0.62	0.83	0.65	0.67	0.81
9 G	363690	0.59	0.78	0.61	0.63	0.76
10 G	404100	0.56	0.74	0.58	0.59	0.72
11 G	444510	0.53	0.70	0.55	0.56	0.68
12 G	484920	0.51	0.67	0.53	0.54	0.65

The Norwegian replacement ratios indicate that incomes after retirement are more evenly distributed than before retirement. The pension system, as well as the tax rules, contributes to this result. For individuals with very low wage income the replacement ratio, like in Italy, is even above 1. In 1996 the average income, among those working, was around 6G, and we observe that at this income level the replacement ratio ranges from 65% for individuals on old age pension to 81% for individuals on government pension. In the private sector the replacement ratios tend to be higher for the early retiree than for the old age pensioners.

Appendix 2. Tax functions, Norway 1996.

Below we give the tax functions for Norwegian individuals in 1996. According to the rules regarding tax deductions and marginal tax rates there are 9 separate tax functions that are of relevance for our study. Individuals on old age pension get tax deduction for high age (67 or above). A single individual gets the same deduction for old age as a married couple where both spouses are above 67. Moreover, individuals on old age pension or who are retired according to the early retirement programme, AFP, do not pay taxes that exceed 55% of gross income before deductions. Taxes vary also with regards to whether the individual is married or not, and they also depend on the source of income for the spouse.

I. Individuals on old age pension, 67 years of age or above.

Table A.3. Single individual on old age pension, 1996

Income=R, NOK	Tax function, NOK
0-80 875	0
80 875- 129 688	0.44R- 35 585
129 688 – 149 000	0.254R- 11 463
149 000- 220 500	0.31R- 19 807
220 500- 248 500	0.405R- 40 755
248 500-	0.447R- 50 472

Table A4. Married individual on old age pension, spouse also on old age pension, 1996.

Income=R, NOK	Tax function, NOK
0-63 063	0
63 063- 100 828	0.44R- 27 748
100 828- 149 000	0.254R-8 994
149 000- 220 500	0.31R- 17 338
220 500- 248 500	0.405R- 38 286
248 500-	0.447R- 48 723

Table A5. Married individual on old age pension, spouse working, 1996.

Income=R, NOK	Tax function, NOK
0-63 063	0
63 063- 87 554	0.44R- 27 748
87 554 – 149 000	0.254R- 11 463
149 000- 220 500	0.31R- 19 807
220 500- 248 500	0.405R- 40 755
248 500-	0.447R- 50 472

Table A.6. Married individual on old age pension, spouse has no income, 1996

Income=R, NOK	Tax function, NOK
0-126 125	0
126 125- 149 000	0.44R- 55 495
149 000- 189 808	0.55R- 71 885
189 808- 267 500	0.31R- 26 331
267 500- 278 500	0.405R- 51 744
278 500-	0.447R- 63 441

II. Individuals on AFP

Table A.7. Single individual on AFP, 1996

Income=R, NOK	Tax function, NOK
0-80 875	0
80 875- 149 000	0.44R- 35 585
149 000-154 612	0.55R- 51 975
154 612- 220 500	0.31R- 14 868
220 500- 248 500	0.405R- 35 816
248 500-	0.447R- 46 253

Table A.8 Married individual on AFP, spouse either on pension benefit, old age pension as well as AFP, or working, 1996

Income=R, NOK	Tax function, NOK
0-63 063	0
63 063- 115 161	0.44R- 27 748
115 161 – 149 000	0.254R- 6 524
149 000- 220 500	0.31R- 14 868
220 500- 248 500	0.405R- 35 816
248 500-	0.447R- 46 253

Table A.9. Married individual on AFP, spouse has no income, 1996

Income=R, NOK	Tax function, NOK
0-126 125	0
126 125- 149 000	0.44R- 55 495
149 000 – 210 388	0.55R- 71 885
210 388- 267 500	0.31R- 21 392
267 500- 278 500	0.405R- 46 805
278 500-	0.447R- 58 502