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The Norwegian Pension Reform in 2011: The Long Term Impact on Take-up of Pension and Labor Supply

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The Norwegian Pension Reform in 2011: The Long Term Impact on Take-up of Pension and Labor Supply

Abstract

We investigate the impact on pension take-up and labour supply of a broad Norwegian pension reform. Focussing on the long term impact, we use a structural discrete choice model estimated on data for first groups to become eligible for the new pension, accounting for the opportunity cost of retiring early. A majority of the individuals combine take-up of pension with working. This is particular the case for individuals with lower education. The estimated model explains observed behaviour rather precisely, in particular for those who retire entirely and for all choices made by individuals with higher education. The estimated model is applied in an out of sample prediction for the cohort born in 1950. Again, the model predicts rather accurately the fraction that retires entirely and the choices made by the higher educated. Two policy simulations, an increase in longevity and tax on pension income equal to tax on labour income, implies lower take up of pensions and more people working. The response to the longevity adjustment compensates less than half of the reduction of the annual pension level in the adjustment, which is designed to mimic the increase in the longevity over the next 20 years.

JEL-Codes: D100, H550, J260.

Keywords: pension reform, labor supply.

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1. Introduction

The Norwegian pension reform of 2011 represents a unique social experiment. It radically changed most – but not all – elderly workers’ labor supply incentives from one day to another. The first experiences from the reform show a significant increase in the labor supply of the elderly (Dahl and Lien, 2013, Hernæs et al., 2016 and Bjørnstad, 2018). A key element on the reform is an automatic longevity adjustment on cohort level, reducing the annual pension in step with increases in cohort longevity. This is linked with the option of working longer to compensate, via flexible and actuarially neutral pension claiming and abolishment of the earnings test.

This paper explores the long term consequences with special focus on the extent to which people work longer to compensate as the adjustment kicks in. The longevity adjustment does not fully neutralize all effects of ageing, and we also simulate the impact of a tax increase on pensions to cover increased public pension expenditure. This can be done with a structural model which can simulate counterfactual situations.

Three elements make the Norwegian pension reform particular and interesting, both for research and policy. The first is the delinking of earnings and pension take-up in the private sector, via a complete removal of the earnings test. Such earnings tests, present in many countries, represent an implicit tax on earnings from pension take-up and are found to reduce labor supply significantly (Brinch et al., 2017 and Hernæs and Jia, 2013). Consequently, from age 62, those private sector workers who before the reform had access to early retirement pension (AFP) now face much stronger incentives to work and continued to work longer (Hernæs et al., 2016)

Second, the institutionalized linking of annual benefits to expected length of life (longevity adjustment) makes the pension system more robust to population aging. For a constant labor supply and increasing longevity, this implies a cut in benefits. Such cuts are consistently found to increase labor supply among elderly, from the seminal studies initiated by the NBER, see Gruber and Wise (1999, 2004), and onwards, including Liebman et al. (2009), Blau and Goldstein (2010) and Laun and Wallenius (2017).

Third, the “hardship” imposed by strengthened incentives to work and the longevity adjustment are “balanced” by improved options for continuing work to increase entitlement and compensate the longevity adjustment. Three elements contribute to do this: reduction of the eligibility age from 67 to 62, actuarially neutral pension claiming, both in the NIS and in private sector occupational pensions, and the abolishment of the earnings tests. The flexible pension claiming covers the whole private sector, also workers previously not entitled to early retirement pension, but subject to a minimum level of accrued pension rights. An increase in the eligibility age has been found to generally increase labor supply (Gruber and Wise, 2004), albeit sometimes partly compensated by increased receipt of e.g. unemployment benefit (Staubli and Zweimüller, 2011). A reduction in the eligibility age in combination with the option of actuarially adjusted take-up of pensions, have been found to reduce labor supply (Hernæs et al. 2019). We are not aware of estimation based studies of long-term consequences of longevity adjustments.

Together these elements provide Norwegians today with stronger work-incentives and more flexibility than before in choosing their preferred combination of work and pension take-up after age 62. However, utilization of this flexibility is determined not only by individual preferences, but also by factors such as health and productivity, labor demand, employers' willingness to accommodate older workers, and family situation. In many respects, the pension reform enacted in Sweden from 1999 resembles the Norwegian pension reform in that both reforms change accrual from a selection of earnings years to all earnings years. However, in Sweden there was already flexible take-up before the reform, whereas in Norway there was either no pension before 67 or an early retirement system (AFP) with very rigid choice between pension and earnings and no adjustment of future pension from deferred take-up. A recent study (Laun and Wallenius, 2015) using a calibrated simulation model, predicts a long term increase in working life of more than two years following the Swedish reform, caused by the strengthened work-incentives.

A likely consequence of the combination of increased flexibility and strengthened work incentives is a selection among elderly workers. The most productive workers, whether because of health or human capital, may use the flexibility to remain employed and increase their future pension entitlements. The least productive, with poor health or with employers unwilling to accommodate them as they get older, may, however, use in a disproportional way the flexibility to retire earlier and take-up their pension entitlements from age 62. This selection will have productivity effects for the economy, but will also challenge the egalitarian ambitions of Norwegian policymakers, as it may be an important new source of inequality of elderly in Norway. However, aside from egalitarian considerations, the welfare effects will most likely be positive. The options are the same as before the reform, including the disability benefit for those who are eligible. There are indications that increased flexibility leads to fewer workers entering disability (Hernæs et al., 2016). This is obviously a choice and indicates a welfare improvement. It could be caused by some workers preferring a pension to disability, as a more "dignified" exit from the labor market.

In this paper, we use a structural model to investigate the long term impact of the pension reform on pension take-up and labor supply. The model is based on those who were the first to start with the new pension system. The eligibility age in the new pension system is 62, which means that the birth cohort from 1949, which we study, is the first to become eligible, in 2011, under the new system. All of them are working in the private sector, with or without having the pension related to the existing early retirement program (AFP). With the new pension system the choices are a take up of public pension, with or without AFP, combined with working or not, and working without taking up public pension. We assume that workers take into account the opportunity cost of taking up public pension early, following actuarial adjustment. The pension wealth is given and is equal to the discounted annual pension the individual has earned the right to receive, discounted over the expected remaining life time, with an annual real rate of interest equal to 2%.

In a model with strict assumptions on interest rates, subjective discounting and perfect credit markets, pension claiming would be undetermined. However, we do not believe such assumptions to be realistic. Brinch et al. (2017) find very little impact on work behavior or incentives in the form of a shift in the future pension stream. In contrast, there is a momentary response to a repeal of the earnings test, which increases the immediate return to work. In our approach, we let the annual utility be a function of disposable income and leisure each year. We assume that the agents maximize the discounted sum of these utilities by choosing the transition year from full time work to one of three alternative weekly hours' groups, including not working at all, with the additional option of claiming their pension. By observing their status across the choice alternatives two years after they became eligible, at age 62, we estimate the parameters of the utility function.

Our discrete choice model predicts rather well the observed behavior two years after the reform was introduced, in particular the fraction that retire completely without combining the take up of pension with working (around 24-25 % in the private sector with AFP and 12-13 % in the private sector without AFP). In particular, the model predicts rather precisely all choices made by the higher educated workers.

The model was estimated on data from the 1949 cohort and tested by predicting the behavior of the 1950 cohort two years after they became eligible for taking up pension. The predictions of the fraction that stop working, are right on target in the private sector without AFP (11 per cent observed and predicted) and close on target in the private sector with AFP (20 per cent observed, 22 per cent predicted). Therefore, the predictions of the fraction who are working are quite precise, but we under-predict the fraction in the total population who combine working with claiming the public pension, by 3-5 percentage points. In the population of the higher educated workers our predictions are rather precise, an under prediction of 1-2 percentage points.

The reduction from the 1949 to the 1950 cohort in the percentage who has stopped working at age 64 is fairly well predicted: among those with AFP the observed percentage is 4.5 percentage points lower, while the predicted reduction is 3.0 percentage points. Among those without AFP, the observed reduction is 2.5 percentages and the predicted reduction 2.9. The differences between predictions and observed in the population of higher educated workers are minor.

We thus underestimate, but only to a minor extent, the tendency to combine work and claiming the pension, more so in the sector with AFP, and more so among workers with low and middle education compared to the workers with high education. This is perhaps not so surprising, since claiming is observed to be so widespread. About 3/4 of the sample claims the pension, the majority in combination with work. This is a result of the reform that has taken many by surprise. Later we will come back to this issue and discuss possible explanations.

With continued increase in longevity, the longevity adjustment will reduce the annual pension correspondingly. Interesting questions are the extent to which workers will work longer to compensate, and the impact of changes in incentives intended to delay retirement. To shed light on this, we perform a policy simulation increasing the expected remaining length of life,

conditional on being 62 years old in 2011, from 87 to 89 years. Consequently, the opportunity cost of taking up pension early increases. The results are that

Although the automatic longevity adjustment is important in the light of the ageing in the following years, it only “neutralizes” the impact of longevity at the individual level, and even that may be incomplete. For each cohort, expected longevity is calculated at age 61, and further increases will not be compensated. Furthermore, changes in relative cohort size, which might increase the financial burden, are not taken into account of (Kudrna, 2017). Tax increases could therefore be a future policy option. As an exercise to reduce public expenditure, we simulate an increase in the tax on pension, so that is equal to the tax on earnings. The result is that the individuals increase their labor supply and fewer take up pension. The main effect is a shift from combining work and pension to work only.

The remainder of the paper proceeds as follows. Section two gives some background information. Section 3 discusses the model and estimation strategy. Section 4 describes data. Section 5 and 6 give the estimates of the model and an out of sample prediction. Section 7 presents the results of the policy simulations and Section 8 concludes.

2. Institutional background and sample

The 2011 pension reform in Norway affected workers in different ways. In the private sector workers could claim the new pension from 62 without any earnings test and actuarially adjusted, if they had a certain level of pension entitlements, which about 80 % had. A previously negotiated early retirement pension (AFP) was transformed into a life-long supplement and could be claimed on the same terms, by those eligible. To this end, we call this pension the public pension.

We estimate our model on a sample of workers in the private sector from the 1949 cohort and eligible for the new pension from age 62, with and without AFP. We restrict the sample to those private sector workers who earned at least 1G⁴, a basic amount in the pension system, in 2011. We observe them in the month they became 64 years, that is in 2013. The reason for the 2-years period after the reform is that we assume that workers need some time to adjust to a quite new pension system. Of course, this may imply that some of the individuals in the sample had made their choice of pension take-up and working during the period 2011-2013. We require that none of individuals were on disability in 2013.

Our sample is a particular cross-section data set, since the individuals are included in the sample in the month in 2013 they became two years older than in 2011. The point of observation, denoted τ , varies across individuals and months in 2013.

The new pension system is designed to be actuarially fair, and to include an automatic longevity adjustment. The individuals in our sample have earned pension rights in the old

⁴ In 2011, 1 G was NOK 75 000-80 000. As of April 2019 1 USD is around NOK 8.6

system⁵, in which the entitlement is first set to an annual level from age 67, based on the earnings history. Then there is a longevity adjustment according to the expected remaining longevity of the cohort at age 61, relative to that of the 1943 cohort. Finally, there is flexible take-up with actuarial adjustment in the age range 62-75, based on the conditional expected longevity at age 61, which in our sample is set to 87 years, and an annual real rate of interest of two percent. Both of these adjustment are captured by a set numbers (Appendix B) by which the initial pension level is divided. Given the discount rate and the longevity, the expected pension wealth is then independent of the timing of the pension claiming. There is thus an institutionalized linking of annual public pension to the expected length of life. If the take-up of annual pension is early, it is divided by a factor above 1, and below 1 if the take-up is later. To this end, we call this factor the longevity and actuarial adjustment factor, LAAF. It decreases until the age of 75. Thus until right before turning 75 the individuals can increase their annual benefit by postponing the take-up. It is also possible to increase the future pension by working at the same time as claiming a pension.

In Appendix B, we show the LAAF for people born in 1943-1950. From Table B.1 we observe that individuals, born in 1949, have a LAAF equal to around 1 six months after they become 67. From Table B.2 we observe that the annual loss in pension at a take-up of public pension at the age of 62, compared to a full annual pension is 24.2 percent. We also observe that due to the expected increase in expected length of life the full-pension, LAAF equal to 1, occurs at the age of 74 and 11 months for the cohort born in 2020. For that cohort the annual loss of taking up pension at the age of 62 is 41.7 percent.

The tax on pension differs from the tax on labor income and also on the sum of labor income and pension. Tax rules are set out in Appendix A. The tax on pension is zero up to a level of NOK 174 025, while the tax on labor income becomes above zero at a much lower level of income; NOK 39 996. We observe from the tables in Appendix A that the tax function is a step-wise linear function of income. We also observe that the marginal tax rates are not uniformly increasing with income. This is particular the case with the tax on pensions. This implies that the budget sets are not convex, which means that standard marginal approaches to labor supply are not feasible, or at least becomes very complicated. In our discrete choice framework this is not a problem, see Dagsvik and Strøm (2006) for further details.

3. The model

To analyze the effects of the pension reform on the labor supply and the take-up of pension, we employ a simple model estimated on a single cross-section sample. However, the model has a structural interpretation in terms of intertemporal decision⁶. The intertemporal part of the model shows up in the opportunity cost of an early take-up of public pension. The longevity and actuarial adjustment factor, LAAF, mentioned in the preceding section, represents the

⁵ A new, notionally defined contribution system will be gradually phased in over the birth cohorts 1954-1962.

⁶ A similar model, but only with two choices, is applied in Colombino et al (2011). The data used in that paper was not due to an implemented pension reform.

opportunity cost. The model implies that the comparison of utilities related to the possible choices yields the optimal choice of the individuals.

In the deterministic part of the utility function, we use leisure and disposable income. There are several reason why we use income instead of consumption. Consumption requires modelling of saving or borrowing, and we believe these options vary a lot between individuals. Some may be able to borrow with a low interest rate, while others might not be able to borrow at all, or at a very high rate. Secondly, the subjective discount rate may vary considerably. Thirdly, the impact on the annual disposable income may be of policy interest. After the reform, the majority of those eligible chose to claim most of their pension, often while continuing to work. This is not likely to be consistent with maximizing the present value of income in the setting of a perfect capital market, since many will be exposed to a high marginal tax rate and the implicit interest rate when delaying pension claiming is quite high.

The individual factors affecting preference are not fully observed. We assume that these unobserved and alternative specific attributes make the utilities random and extreme value distributed. Our endogenous variables are therefore the probabilities of working certain hours and the take-up of pensions, rather than hours worked and take-up of pensions. We thus estimate a discrete choice model, extended to deal with the opportunity cost of an early take-up of pension, on monthly data. Each observation relates to the month of birth exactly two years after the reform in 2011. In the model, we account for taxes. To capture the fact that taxes are progressive we calculate the tax for each choice alternative on an annual basis and then divide by 12 to get the monthly tax.

Let $U_s(C_s(w_s h), h)$ be the utility for an individual working h hours with an hourly wage of w_s , and having a disposable income of $C_s(\cdot)$ at time s . For the moment we suppress the superscript for individual i . Let $U_s(C_s(w_s h, R_s(\tau)), h)$ be the utility when the individual combines working h hours with a take up of pension, $R_s(\tau)$, at time $\tau \leq s$. Let $U_s(C_s(R_s(\tau)), 0)$ be the utility of retiring with pension $R_s(\tau)$.

Furthermore, T_i is the month in 1949 when individual i was born. T_{i0} is the time when he or she started to work, which affect her pension wealth in the social security system. This relationship is accounted for, but not shown explicitly, here. L_i is the expected length of life, conditional of being 64 years of age in 2013. We assume that all born in 1949, and alive in 2013, has an equal expected remaining length of life. According to Statistics Norway, as of 2013 the expected length of life, conditional of being 64 years of age in 2013, is 86 for men and 88 for women. Thus, to simplify we set $L_i=87$. We simplify notation below by setting $T_{i0}=T_i=0$.

Let $V_i(\tau)$ be the value of the discounted future instantaneous utilities for individual i :

$$(1) V_i(\tau) = \int_0^{\tau} U_{it}(C_{it}(w_{it}h), h) e^{-rt} dt + (1 - D_i) \int_{\tau}^{L_i} U_{it}(C_{it}(w_{it}h, R_{it}(\tau)), h) e^{-r(t-\tau)} dt + D_i \int_{\tau}^{L_i} U_{it}(C_{it}(R_{it}(\tau)), 0) e^{-r(t-\tau)} dt$$

If the individual at time τ decides to retire, then $D_i=1$. If the individual at time τ decides to continue working, but with a take-up of pension, then $D_i=0$. The rate of discount is r .

We assume that the individual maximize $V_i(\tau)$ with respect to τ , that is the time for the take-up of public pension. There are then two possibilities: $D_i=0$ and $D_i=1$.

First order condition, at time τ , given $D_i=1$, is

$$(2) U_{it}(C_{it}(w_{it}h), h) \geq U_{it}(C_{it}(R_{it}(\tau)), h) - \int_{\tau}^{L_i} \frac{\partial U_{it}(C_{it}(R_{it}(\tau)), 0)}{\partial \tau} e^{-rt} dt$$

First order condition, at time τ , given $D_i=0$, is

$$(3) U_{it}(C_{it}(w_{it}h), h) \geq U_{it}(C_{it}(w_{it}h, R_{it}(\tau)), h) - \int_{\tau}^{L_i} \frac{\partial U_{it}(C_{it}(w_{it}h, R_{it}(\tau)), h)}{\partial \tau} e^{-rt} dt$$

The expressions to the right in (2) and (3) are the opportunity cost of retiring early. In the new actuarial pension system in the Norwegian private sectors, implemented in 2011,

$$\frac{\partial R_{it}(\tau)}{\partial \tau} \geq 0, \text{ are given by the LAAF, set out in Appendix B.}$$

As mentioned above, we will assume that the utility functions are random. Let $v_{ij\tau}$ be the deterministic part of the utility function in alternative j , $j=1, 2, \dots, J$, and let $\varepsilon_{ij\tau}$ be the random term in the utility function i.i.d extreme value distributed. We then have,

$$(4) U_{ij\tau} = v_{ij\tau} + \varepsilon_{ij\tau}; \quad j=1, 2, \dots, J.$$

It follows from well-known results that for a utility maximizing individual, the probability of choosing alternative j , is the following logit probability

$$(5) \phi_{ij\tau} = \frac{\exp(v_{ij\tau})}{\sum_{j \in J} \exp(v_{jk\tau})}; \quad j=1, 2, \dots, J$$

The alternatives are the following seven:

- 1) Working; three alternative hours of work per month (midpoint in discrete intervals; 18, 56 and 121 hours of work per month)
- 2) Working; the three alternative hours of work per month, combined with take-up of public pension
- 3) Retiring; take-up of public pension.

The deterministic part of the utility function depends on disposable income, C , and leisure, $M-h$, where M is time for rest and sleep. In order to proceed we have to assume a functional form for the deterministic part of the utility function. We assume that it is a Box-Cox

transformation of disposable income and leisure; see Dagsvik and Strøm (2006) for an axiomatic justification for this functional form assumption. The seven deterministic parts are:

$$(6) \quad v_{ij\tau} = \alpha_0 \frac{C(W_{it}h_j)^{\alpha_1} - 1}{\alpha_1} + Z_{it}\beta \frac{(M - h_j)^{\alpha_2} - 1}{\alpha_2}; \quad j = 1, 2, 3$$

(7)

$$v_{ij\tau} = \alpha_0 \frac{C(W_{it}h_j, R_{it})^{\alpha_1} - 1}{\alpha_1} + Z_{it}\beta \frac{(M - h_j)^{\alpha_2} - 1}{\alpha_2} - \int_{\tau}^{L_i} \frac{\partial U_{it}(C_{it}(w_{it}h_j, R_{it}(\tau)), h_j)}{\partial \tau} e^{-rt} dt; \quad j = 3, 4, 5$$

$$(8) \quad v_{ij\tau} = \alpha_0 \frac{C(R_{it})^{\alpha_1} - 1}{\alpha_1} + Z_{it}\beta \frac{(M)^{\alpha_2} - 1}{\alpha_2} - \int_{\tau}^{L_i} \frac{\partial U_{it}(C_{it}(R_{it}(\tau)), h)}{\partial \tau} e^{-rt} dt; \quad j = 7$$

The deterministic part of the utility function is strictly concave if α_1 and α_2 are less than 1. If these coefficients equal zero, the deterministic parts of the utility functions become log-functions. The deterministic parts of the utility functions are cardinal functions, while one does not need to assume the same with the utility functions in (4). They can be ordinal functions. The reason is that the probability $Pr(U_{ij\tau} \geq U_{ik\tau})$, for all $k \neq j$ does not change when there is a monotonic increasing transformations of the utility function.

Let S_H be the tax when the individual works, without taking up pension, let S_{HR} be the tax when the individual combine work and public pension, and let S_R denote the tax when the individual retires. In Appendix A, we observe that the tax structure differs across these three alternatives. We account for these taxation differences in the estimation of the model. Moreover, let K_{it} be other net income after tax. The disposable incomes in the seven alternatives are then:

$$(9) \quad C(W_{it}h_j) = W_{it}h_j - S_H(W_{it}h_j) + K_{it}; \quad j = 1, 2, 3$$

$$(10) \quad C(W_{it}h_j) = W_{it}h_j + R_{it} - S_{HR}(W_{it}h_j, R_{it}) + K_{it}; \quad j = 4, 5, 6$$

$$(11) \quad C(R_{it}) = R_{it} - S_R(R_{it}) + K_{it}, \quad j = 7$$

The Z-vector contains the following variables: Married/cohabiting equal 1, otherwise zero; woman equal 1, otherwise zero; absolute value of age difference between spouses; spouse has taken up pension equal 1, otherwise zero, level of education (low, middle, high, with middle as the reference category)

Because we condition on the individuals be working in 2011, their monthly wage rate is observed. We use these observed wage rates in the calculation of disposable income and of the opportunity costs related to delayed take-up of pension. The latter means that we assume a constant real wage over time. To calculate the opportunity costs we observe that:

$$(12) \quad \int_{\tau}^{L_i} \frac{\partial U_{it}(C_{it}(w_{it}h_j, R_{it}(\tau)), h_j)}{\partial \tau} e^{-rt} dt = \alpha_0 C_{it}(w_{it}h_j, R_{it}(\tau))^{\alpha_1 - 1} \left(1 - \frac{\partial S_{HR}(w_{it}h_j, R_{it}(\tau))}{\partial R_{it}(\tau)}\right) \sum_{t=\tau}^L \left(\frac{R_{67,t}}{a_{\tau+1}} - \frac{R_{67,t}}{a_{\tau}}\right) \left(1 + \frac{r}{12}\right)^{-t}; \quad j = 4, 5, 6$$

The last part in (12) is a discrete approximation. $\frac{R_{67,i}}{a_\tau}$ equals the pension at the take-up time τ .

$R_{67,i}$ is the month in the year when LAAF=1. For individuals born in 1949, it is the year when they are 67 years of age. Dividing $R_{67,i}$ by the LAAF, a_τ , we get the pension at time τ . $\frac{R_{67,i}}{a_{\tau+1}}$ is the

pension one gets by delaying the take-up, here the delay is 12 months later; $a_{\tau+1} < a_\tau$. The annual rate of interest is r , set to 0.02 in the estimation of the model. An annual interest rate of 2% accords with what the social security system uses. We leave for further research an individual specific interest rate, random to the econometrician.

In the case of retiring, alternative $j=7$, we have

$$(13) \quad \int_{\tau}^{L_j} \frac{\partial U_{it}(C_{it}(R_{it}(\tau)), 0)}{\partial \tau} e^{-rt} dt = \alpha_0 C_{it}(R_{it}(\tau))^{\alpha_1-1} \left(1 - \frac{\partial S_R(R_{it}(\tau))}{\partial R_{it}(\tau)}\right) \sum_{t=\tau}^L \left(\frac{R_{67,i}}{a_{\tau+1}} - \frac{R_{67,i}}{a_\tau}\right) \left(1 + \frac{r}{12}\right)^{-t}; j = 7$$

Now let $N_{H\tau}$, $N_{HR\tau}$ and $N_{R\tau}$ be the number of individuals observed at time τ in the states of working, working with take-up of pension and retirement, respectively. Let

$\theta = (\alpha_0, \alpha_{00}, \alpha_1, \alpha_2, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6)$ be a vector of the 10 unknown coefficients that we want to estimate. The reason why we include α_{00} among the unknown coefficients is that we replace α_0 in front of opportunity cost term by α_{00} . We thus allow that the marginal effects related to disposable income differs from the marginal effects related to the opportunity costs. Let the vector $Y_{it} = (W_{it}, R_{it}, K_{it}, Z_{it}, a_\tau, a_{\tau+1}, L, r)$ represent observed variables. In addition, we also observe tax rules.

The joint likelihood of our sample is then:

$$(14) \quad \Omega = \prod_{i \in N_{H\tau}} \prod_{j=1,2,3} \varphi_j(\theta, Y_{it}) \prod_{i \in N_{HR\tau}} \prod_{j=4,5,6} \varphi_j(\theta, Y_{it}) \prod_{i \in N_{R\tau}} \prod_{j=7} \varphi_j(\theta, Y_{it})$$

To estimate the unknown coefficients, we maximize this likelihood with respect to the coefficients. We make separate estimation for private workers with and without AFP.

4. Data

In Tables 1 and two we report summary statistics for the individuals working in the private sector, with and without AFP, respectively. We observe them in the month two years after they became eligible to take up public pension, at 62. All money values are in NOK 2013. We observe that in both sectors a majority, above 50 percent, combines take-up of pension with

work. As expected, the fraction that retires completely is substantially higher in the sector with AFP than in the sector without AFP.

Table 1. Summary statistics, private sectors with AFP. Cohort born in 1949, observed in 2013, two years after the Norwegian pension reform. Monthly data.

Variables	Mean	St.dev	Min	MAX
W_{it}	34874	24751	29	699268
R_{it}	15928	3002	855	19612
K_{it}	25484	23362	-35708	1155295
Z_{1it} (married)	0.713	0.444	0	1
Z_{2it} (woman)	0.272	0.453	0	1
Z_{3it}	0.328	0.353	0	3.8
abs(agediff/10)				
Z_{4it} (spouse w/pension)	0.316	0.465	0	1
Z_{5it} Primary Edu	0.170	0.370	0	1
Z_{6it} High Edu	0.186	0.389	0	1
Working	0.163	0.370	0	1
Work +Pension	0.591	0.492	0	1
Retired	0.246	0.431	0	1
No of observations:	7 743			

Table 2. Summary statistics, private sectors without AFP. Cohort born in 1949, observed in 2013, two years after the Norwegian pension reform. Monthly data.

Variables	Mean	St.dev	Min	MAX
W_{it}	35728	32965	105	1145256
R_{it}	15558	3591	420	19613
K_{it}	29192	34219	-73974	1464943
Z_{1it} (married)	0.734	0.442	0	1
Z_{2it} (woman)	0.318	0.466	0	1
Z_{3it} (agediff/10)	0.343	0.381	0	3.6
Z_{4it} (spouse w/pension)	0.337	0.473	0	1
Z_{5it} Primary Edu	0.149	0.474	0	1

$Z_{6\text{ it}}$ High Edu	0.279	0.449	0	1
Working	0.339	0.474	0	1
Work +Pension	0.526	0.500	0	1
Retired	0.135	0.342	0	1
No of observations	7085			

5. Estimates

Tables 3 and 4 give the results of the estimation. Estimates are precise and significantly different from zero, with one exception (spouse with pension, private sector with AFP). The estimates of the coefficient for the exponents related to disposable income and leisure are less than one. The deterministic parts of the utility functions are thus strictly concave. The estimates of the constants in front of the utility function and the opportunity costs are slightly, but not statistically, different.

Married individuals and women put a higher weight on leisure than unmarried and men. This implies that married individuals and women require a higher compensation for being willing to work longer. The larger the age difference is between spouses, the more important is leisure. Of special interest is that for the higher educated leisure has a minor effect on utility than among the lower educated.

McFaddens rho is 0.53-0.56. This indicates that our model explains data 53 to 56 percent better than as if all choices were made at random. This indicates that our model fits data rather well.

Table 3. Estimates, private sector with AFP.

Coefficients	Estimates	Standard deviation	t-values
Constant, utility function, α_0	0.4325	0.0294	14.69
Constant, opportunity costs, α_{00}	0.3538	0.0249	14.21
Exponent disp. income, α_1	0.7928	0.0182	43.46
Exponent leisure, α_2	-0.1684	0.0092	-18.26
Married, β_1	0.0437	0.0195	2.24
Woman, β_2	0.1522	0.0208	7.32
Abs. age diff. spouses/10, β_3	0.0106	0.0016	6.54
Spouse w/ pension, β_4	-0.0148	0.0214	-0.69
Primary education, β_5	0.0756	0.0220	3.43
Higher education, β_6	-0.2144	0.0272	-7.89
Log likelihood		-8040.163	
McFaddens Rho		0.5336	
No. of observations		7 743	

Table 4. Estimates, private sector without AFP

Coefficients	Estimates	Standard deviation	t-values
Constant, utility function α_0	0.6995	0.0485	14.41
Constant, opportunity costs, α_{00}	0.7587	0.0548	13.84
Exponent disp. income, α_1	0.6636	0.0185	35.83
Exponent leisure, α_2	-0.2382	0.0140	-17.03
Married, β_1	0.0751	0.0293	2.56
Woman, β_2	0.1160	0.0318	3.64
Abs. age diff. spouses/10, β_3	0.0164	0.0018	9.05
Spouse w/ pension, β_4	0.0661	0.0318	2.08
Primary education, β_5	0.1262	0.0361	3.5
Higher education, β_6	-0.0946	0.0338	-2.8
Log likelihood		-7764.72	
McFaddens Rho		0.5632	
No. of observations		7 085	

In Table 5, we compare observed and predicted shares (predicted average probabilities). First, we observe that the model predicts very accurately the shares of the cohort that retire completely and therefore also the fraction that work. Second, few work part-time. Third, among those who work, the majority also takes up the pension, and slightly more do so among those with (private) AFP.

While the model predicts quite well the fraction who work, it under-predicts by 3-4 percentage points the fraction who combine work and pension. Although the difference between observed and predicted shares is relatively small, the economic incentives in our model fail to account fully for the behavior of the agents in this matter.

When we split the predictions according to the three groups of education (Tables 6-8) the model predicts rather precisely the choices made by the higher educated working in the private sector without AFP. For the two other groups of education, working in the same sector, the difference between observed and predicted is a bit larger. In the private sector with AFP we under-predict the share that combine work and take-up of pension. However, the predicted and observed share that retires completely is almost equal.

The observed choices indicate a myopic behavior and it is surprising that so many combine work and a take up of public pension, given the fact that an early take-up of pension will reduce the annual pension in coming years. The information of the consequences of the reform was widely spread through media, i.e newspapers and television. The possible reasons for the high take-up of pension combined with continued working may be the following:

- Liquidity problems.
- The agents believe that the expected remaining length of life at the age of 62-64 is shorter than reported in official statistics.
- Risk aversion: The loss of a pension not taken out in the case of an early death, weighs heavily. One reason could be the reduction children's inheritance.
- The agents may think that they are able to invest a take-up of pension that yield a higher real rate of return than the official two percent.

The latter reason is an interesting case. By taking up a pension, one can easily cover loan expenses needed to buy a small apartment, and rent it out. For the moment, the Norwegian rental market for small flats is rather profitable. Selling it in the future, one can cover the loss in lower pension due to an early take-up of pension. To investigate this, we need data concerning saving and investments portfolios and with a market valuation of the assets, including houses. For the moment, we do not have such data. Given that we are able to get access to such data, we leave this discussion for future research.

Table 5. Observed and predicted (average probabilities) shares. Cohort born in 1949, observed in 2013, two years after the Norwegian pension reform. Monthly data.

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
<i>Working:</i>	<i>0.1632</i>	<i>0.1971</i>	<i>0.3392</i>	<i>0.3712</i>
Low part time	0.0014	0.0043	0.0047	0.0091
Part time	0.0080	0.0166	0.0271	0.0334
Full time	0.1538	0.1762	0.3074	0.3286
<i>Work+Pension:</i>	<i>0.5912</i>	<i>0.5523</i>	<i>0.5259</i>	<i>0.4897</i>
Low part time	0.0080	0.0138	0.0088	0.0150
Part time	0.0504	0.0503	0.0452	0.0496
Full time	0.5328	0.4882	0.4719	0.4251
<i>Retired</i>	<i>0.2456</i>	<i>0.2507</i>	<i>0.1349</i>	<i>0.1392</i>

Table 6. Observed and predicted shares for people with low education. Cohort born in 1949, observed in 2013, two years after the Norwegian pension reform. Monthly data.

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
<i>Working:</i>	<i>0.1452</i>	<i>0.1924</i>	<i>0.3225</i>	<i>0.3522</i>
Low part time	0.0030	0.0063	0.0047	0.0127
Part time	0.0076	0.0213	0.0408	0.0404
Full time	0.1346	0.1648	0.277	0.2991
<i>Work+Pension:</i>	<i>0.5909</i>	<i>0.5367</i>	<i>0.5351</i>	<i>0.5000</i>
Low part time	0.0076	0.0190	0.0133	0.0212
Part time	0.0586	0.0617	0.0541	0.0620
Full time	0.5247	0.4559	0.4677	0.4168
<i>Retired</i>	<i>0.2639</i>	<i>0.2709</i>	<i>0.1423</i>	<i>0.1478</i>

Table 7. Observed and predicted shares for people with middle education. Cohort born in 1949, observed in 2013, two years after the Norwegian pension reform. Monthly data.

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
<i>Working:</i>	<i>0.1358</i>	<i>0.1882</i>	<i>0.3072</i>	<i>0.3548</i>
Low part time	0.001	0.0045	0.0059	0.0097
Part time	0.0088	0.0172	0.0274	0.0347
Full time	0.126	0.1665	0.2739	0.3103
<i>Work+Pension:</i>	<i>0.6086</i>	<i>0.5515</i>	<i>0.5468</i>	<i>0.4948</i>
Low part time	0.0096	0.0148	0.0072	0.0160
Part time	0.0521	0.0533	0.0479	0.0527
Full time	0.5469	0.4833	0.4917	0.4261
<i>Retired</i>	<i>0.2556</i>	<i>0.2604</i>	<i>0.1461</i>	<i>0.1504</i>

Table 8. Observed and predicted shares for people with high education. Cohort born in 1949, observed in 2013, two years after the Norwegian pension reform. Monthly data.

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
<i>Working:</i>	<i>0.2751</i>	<i>0.2321</i>	<i>0.4135</i>	<i>0.4148</i>
Low part time	0.0014	0.0018	0.002	0.0061
Part time	0.0056	0.0102	0.0192	0.0270
Full time	0.2681	0.2201	0.3923	0.3817
<i>Work+Pension:</i>	<i>0.5306</i>	<i>0.5693</i>	<i>0.4783</i>	<i>0.4735</i>
Low part time	0.0028	0.0056	0.0096	0.0095
Part time	0.0369	0.0291	0.0349	0.0365
Full time	0.4909	0.5346	0.4338	0.4275
<i>Retired</i>	<i>0.1943</i>	<i>0.1986</i>	<i>0.1082</i>	<i>0.1117</i>

6. Out of sample prediction

Because of our model is structural we can use the estimated model to predict the choices made by a different group of individuals. To perform an out of sample prediction we have selected the cohort born in 1950. Our prediction concerns the behavior of this cohort exactly two years after they became eligible for taking up pension, at age 62. The prediction thus relates to 2014 when they became 64 years of age. Tables 9 and 10 give the summary statistics. Comparing these two tables with Tables 1 and 2, we observe that fewer retire completely in the 1950 cohort than in the 1949 cohort and that a higher fraction in the 1950 cohort combine work and take up of pension.

Table 9. Summary statistics, private sectors with AFP. Cohort born in 1950, observed in 2014, two years after eligibility age (62). Monthly data.

Variables	Mean	St.dev	Min	MAX
W _{it}	36005	21888	15	271232
R _{it}	14804	2948	529	18526
K _{it}	25765	22848	-655217	1127624
Z1 _{it} (married)	0.700	0.458	0	1
Z2 _{it} (woman)	0.275	0.446	0	1
Z3 _{it}				
abs(agediff/10)	0.378	0.392	0	3.4
Z4 _{it} (spouse w/pension)	0.265	0.441	0	1
Z _{5 it} Primary Edu	0.181	0.385	0	1
Z _{6 it} High Edu	0.175	0.380	0	1
Working	0.186	0.389	0	1
Work +Pension	0.614	0.487	0	1
Retired	0.200	0.400	0	1

Table 10. Summary statistics, private sectors without AFP. Cohort born in 1950, observed in 2014, two years after eligibility age (62). Monthly data.

Variables	Mean	St.dev	Min	MAX
W _{it}	38322	30490	16	729266
R _{it}	14378	3541	252	18542
K _{it}	30115	33138	-39547	1094644
Z1 _{it} (married)	0.724	0.447	0	1
Z2 _{it} (woman)	0.325	0.469	0	1
Z3 _{it}				3.8
abs(agediff/10)	0.377	0.417	0	
Z4 _{it} (spouse w/pension)	0.280	0.449	0	1
Z _{5 it} Primary Edu	0.142	0.349	0	1
Z _{6 it} High Edu	0.283	0.451	0	1
Working	0.409	0.492	0	1
Work +Pension	0.482	0.500	0	1
Retired	0.110	0.313	0	1

Table 11 gives the out of sample prediction for the cohort born in 1950, based on the model estimated on data for the 1949 cohort. The predictions are on target for the fraction that retire completely in the private sector without AFP, and close on target in the private sector with

AFP. Hence, we predict rather accurately the fraction that work. However, we over-predict the fraction that work without take-up of pension and consequently we under-predict the fraction that combine work and take-up of pension. The latter is particular the case in the private sector with AFP.

Tables 12-14 give the out of sample prediction by education level. For all three groups we predict retirement rather accurately, but generally under-predict the fraction that combine work and pension. The one exception is for those with higher education and no AFP. This might be because the fraction that combines work and pension is lower.

Table 11. Out of sample prediction, 1950 cohort, observed and predicted shares

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
Working	0.1864	0.2396	0.4084	0.4400
Work+pension	0.6142	0.5421	0.4816	0.4496
Retired	0.1995	0.2183	0.1099	0.1104
Sum	1.0000	1.0000	1.0000	1.0000

Table 12. Out of sample prediction, 1950 cohort, observed and predicted shares. Low education

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
Working	0.1595	0.2316	0.3631	0.4211
Work+pension	0.5964	0.5214	0.5088	0.4657
Retired	0.2441	0.2470	0.1281	0.1132
Sum	1.0000	1.0000	1.0000	1.0000

Table 13. Out of sample prediction, 1950 cohort, observed and predicted shares. Middle education

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
Working	0.1644	0.2312	0.3771	0.4202
Work+pension	0.6316	0.5449	0.5060	0.4557
Retired	0.2041	0.2239	0.1168	0.1241
Sum	1.0000	1.0000	1.0000	1.0000

Table 14. Out of sample prediction, 1950 cohort, observed and predicted shares. High education

States	Private sector with AFP		Private sector without AFP	
	Observed	Predicted	Observed	Predicted
Working	0.2949	0.2789	0.4948	0.4895
Work+pension	0.5688	0.5534	0.4186	0.4291
Retired	0.1363	0.1678	0.0867	0.0814
Sum	1.0000	1.0000	1.0000	1.0000

7. Policy simulations

We have performed two policy simulations for those born in 1949:

- 1) We increase the expected remaining length of life from 87 to 89 years. Accordingly, the LAAF (Longevity and actuarial adjustment factor) for our cohort increases by 10.5 percent.
- 2) The tax on pension income is increased to the same level as the tax on labor income.

For many years, longevity has been increasing and this might well continue. The longevity adjustment will then reduce the annual pension level, and we will use the out of sample prediction with increased longevity to see to what extent people will work longer to compensate. While this is not a forecast, since we use our sample, it will illustrate consequences of the estimated model. The results are shown for the whole sample in Table 15 and split by education in Tables 16-18, in columns denoted Higher LAAF vs Predicted (with the sample). While the fraction who retires is modelled to go down by only 0.86 percentage points for those with AFP and 0.79 percentage points without AFP, the fraction combining work and pension goes down by 2.29 and 3.36 percentage points, respectively. Hence, the main impact is to delay pension take up. The fraction claiming the pension at 64 is therefore modelled to go down by 3.13 and 4.13 percentage points, respectively.

This result is not directly comparable to the longevity adjustment, since it is a prediction at one specific age. However, a rough assessment of the impact is possible. Empirical overviews indicate that the reform shifts claiming curves without altering the shape to a large degree (Hernæs, 2017). The increase in claiming from age 63 to age 64 is approximately 5 percentage points. If the curve shifts upwards by 3.5 percentage points at age 64, it will have reached the same claiming level $3,5/5=0.7$ years later. According the values of the LAAF in Appendix B, Table B.1, a claiming delay of 0.7 years, about 8 months, increases the annual pension level by about 3.4 per cent. Since the 10.5 per cent increase in the LAAF gives a reduction in the annual pension level of 9 per cent, an 8 months deferral changes the reduction to 6.5 per cent. Hence, the delay in pension claiming compensates about 1/3 of the longevity adjustment.

The longevity compensating impact from continued work is more difficult to assess, since we need the shift in the LFP curve until retirement to assess the earnings increase. However, even if upward shift of approximately 1 percentage point were to continue up to 70, the impact on cohort level would be about 6 per cent of annual earnings. Spread out over the expected lifetime and related to a pension level of one quarter of earnings (Table 2), this would increase retirement income by 2-3 per cent. This would further compensate the longevity adjustment from 6.5 to 4 per cent.

In total, prolonged work and delayed claiming would reduce the fall in annual retirement income from 9 to 4 per cent. Still, the compensation is less half of the longevity adjustment. The effects are very similar for the three educational groups, although the levels of work and pension claiming are different.

The low degree of compensating deferral of pension claiming could be related to the result we found previously, with a surprisingly high overall claiming. People claim early, and even when the longevity adjustment starts to bite, they do not defer to fully compensate.

The longevity adjustment does not fully compensate for ageing. At the individual level, a steady increase in longevity beyond age 61, when the longevity adjustment is determined in the pension system, will not be captured. Furthermore, at the aggregate level, neither will relative cohort size variations be captured. Hence, the historically lower tax on pensions than on labor income, may come on the political agenda. Table 15 reports the results of increasing the tax on pensions to the level of the tax on earnings (Same tax vs Predicted) for the whole sample, while Tables 16-18 give the results according to educational level. This shifts labor supply from work combined with pension to work without take-up of pension, but also from retirement to work. It is interesting to note that the same tax scenario has a stronger impact on behavior than a higher LAAF. The tax increase implies a reduction in total income, given retirement, since the after tax pension becomes lower. It follows readily from the tables that workers with low education are more affected by the same tax scenario than the two other groups. The reason is that when pension and work income are taxed jointly by the work income schedule, the lower paid workers gets a higher income and is more severely hit by now being exposed to higher marginal tax rates. The two other groups have both higher pensions and work income and are exposed to higher marginal tax rates before the same tax scenario is implemented.

It might be that the stronger effect of the same tax scenario than the increase in LAAF accommodates the myopic tendency in the observed behavior. In the total population, a 10.5 increase in LAAF implies an increase of 3.4 percent and 5.7 percent in individuals working in the private sector with and without AFP, respectively. The corresponding changes induced by the same tax scenario are 6.9 percent and 10.9 percent.

Table 15. Impact of higher longevity adjustment factor on shares, LAAF (longer expected remaining length of life) and same tax on pension and labor income. Cohort born in 1949

States	Private sector with AFP			Private sector without AFP		
	Predicted	Higher LAAF	Same tax	Predicted	Higher LAAF	Same tax
Working	0.1971	0.2284	0.2544	0.3712	0.4125	0.4440
Work+pension	0.5523	0.5294	0.5123	0.4897	0.4561	0.4318
Retired	0.2507	0.2421	0.2334	0.1392	0.1313	0.1241

Table 16. Impact of higher longevity adjustment factor on shares, LAAF (longer expected remaining length of life) and same tax on pension and labor income. Cohort born in 1949. Low education

States	Private sector with AFP			Private sector without AFP		
	Predicted	Higher LAAF	Same tax	Predicted	Higher LAAF	Same tax
Working	0.1924	0.2234	0.2508	0.3522	0.3937	0.4279
Work+pension	0.5367	0.5154	0.4981	0.5000	0.4668	0.4409
Retired	0.2709	0.2612	0.2510	0.1478	0.1395	0.1312

Table 17. Impact of higher longevity adjustment factor on shares, LAAF (longer expected remaining length of life) and same tax on pension and labor income. Cohort born in 1949. Middle education

States	Private sector with AFP			Private sector without AFP		
	Predicted	Higher LAAF	Same tax	Predicted	Higher LAAF	Same tax
Working	0.1882	0.2192	0.2460	0.3548	0.3967	0.4279
Work+pension	0.5515	0.5293	0.5119	0.4948	0.4615	0.4364
Retired	0.2604	0.2515	0.2422	0.1504	0.1418	0.1339

Table 18. Impact of higher longevity adjustment factor on shares, LAAF (longer expected remaining length of life) and same tax on pension and labor income. Cohort born in 1949. High education

States	Private sector with AFP			Private sector without AFP		
	Predicted	Higher LAAF	Same tax	Predicted	Higher LAAF	Same tax
Working	0.2321	0.2653	0.2869	0.4148	0.4550	0.4819
Work+pension	0.5693	0.5426	0.5266	0.4735	0.4395	0.4176
Retired	0.1986	0.1920	0.1866	0.1117	0.1055	0.1004

8. Conclusion

The Norwegian pension reform of 2011 changed the labor supply incentives for the elderly people eligible for a public pension to a great extent. The government expected a significant increase in the labor supply of the elderly. This expectation was met according to the observations after the reform. Fewer retired completely, but the majority combined continued working after the age of 62 with a take up of public pension.

Our structural discrete choice model estimated on household data for the 1949 cohort is able to predict this behavior, both based on a within-sample prediction (cohort born in 1949) and an out-of- sample prediction (cohort born in 1950). The strength of applying a structural model, with a detailed specification of choice sets and economic incentives related to pension and tax rules, is that the estimated model can be used in counterfactual simulation as well as in out-of-sample prediction. The model predicts rather accurately the fraction of individuals that retire completely. Therefore, the fraction that continues working after they became eligible for a take up of public pension is accurately predicted out of sample in the 1950 cohort. However, for the total population the model under-predicts the fraction that combines continued working with claiming the public pension. For the higher educated workers all choices are rather accurately predicted.

Out of sample predictions simulating increased longevity and increase tax on pensions, to the level of tax on earnings, both would have as main effect deferred pension claiming. The impact on longer work is much smaller. In the case of increased longevity, deferral and prolonged work compensates for less than half of the longevity adjustment. This result is in line with high degree for claiming early, much earlier than maximizing present value of pensions.

In order to probe deeper into this behavior we need at least good data for household saving and composition of their wealth, assessed at market values, and changes in this composition before and after the reform. It could also be that the individuals have expectations of a shorter expected lifetime than implied by the pension rules. Higher individual specific interest rates than the official one are also candidates to explain the unexpected take-up of pension combined with continued work. These issues we leave for further research.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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Appendix A. Tax functions 2013

Table A. 1 Tax on labor income, NOK

Labor income= Y	Tax
0 - 39 996	0
39 997 – 58 929	$0.25 \cdot Y - 9\,900$
58 929 – 85 614	$0.082 \cdot Y$
85 614 – 195 698	$0.236 \cdot Y - 13\,176$
195 698 – 527 400	$0.352 \cdot Y - 35\,897$
527 400 – 857 300	$0.442 \cdot Y - 83\,363$
857 300 -	$0.472 \cdot Y - 109\,082$

Tabell A.2 Tax on pension, NOK

Pension = P	Tax
0 – 174 025	0
174 026 – 260 741	$0,401 \cdot P - 10\,692$
260 742 – 266 900	$0,474 \cdot P - 13\,176$
266 901 – 527 400	$0,381 \cdot P - 32\,184$
527 401 – 857 300	$0,411 \cdot P - 79\,650$
857 301 -	$0,441 \cdot P - 105\,369$

Table A.3 Tax on pension and labor income, NOK

Combined income= P+Y	Tax
0 – 174 025	0
174 026 – 260 741	$0,401(P+Y) - 10\,692$
260 742 – 266 900	$0,474 \cdot P + 0,236 \cdot Y - 13\,176$
266 901 – 527 400	$0,381 \cdot P + 0,352 \cdot Y - 32\,184$
527 401 – 857 300	$0,411 \cdot P + 0,442 \cdot Y - 79\,650$
857 301 -	$0,441 \cdot P + 0,472 \cdot Y - 105\,369$

Appendix B. Longevity adjustment factors, LAAF.

Table B.1 Longevity adjustments factors, LAAF, for cohorts born 1943–1950, month zero is the month the individuals become say, 62.

Age at take-up		Cohort							
Year	Month	1943	1944	1945	1946	1947	1948	1949	1950
62	0						1,316	1,319	1,323
62	1						1,311	1,314	1,319
62	2						1,306	1,309	1,314
62	3						1,301	1,305	1,309
62	4						1,296	1,300	1,304
62	5						1,291	1,295	1,299
62	6						1,287	1,290	1,294
62	7						1,282	1,285	1,290
62	8						1,277	1,280	1,285
62	9						1,272	1,275	1,280
62	10						1,267	1,271	1,275
62	11						1,262	1,266	1,270
63	0					1,253	1,257	1,261	1,265
63	1					1,248	1,252	1,256	1,261
63	2					1,243	1,248	1,251	1,256
63	3					1,239	1,243	1,246	1,251
63	4					1,234	1,238	1,242	1,246
63	5					1,229	1,233	1,237	1,241
63	6					1,224	1,228	1,232	1,237
63	7					1,219	1,223	1,227	1,232
63	8					1,214	1,218	1,222	1,227
63	9					1,209	1,213	1,217	1,222
63	10					1,204	1,209	1,213	1,217
63	11					1,199	1,204	1,208	1,213
64	0				1,190	1,195	1,199	1,203	1,208
64	1				1,185	1,190	1,194	1,198	1,203
64	2				1,180	1,185	1,189	1,193	1,198
64	3				1,176	1,180	1,184	1,188	1,193
64	4				1,171	1,175	1,179	1,184	1,189
64	5				1,166	1,170	1,175	1,179	1,184
64	6				1,161	1,165	1,170	1,174	1,179
64	7				1,156	1,160	1,165	1,169	1,174
64	8				1,151	1,156	1,160	1,164	1,169
64	9				1,146	1,151	1,155	1,160	1,165
64	10				1,141	1,146	1,150	1,155	1,160
64	11				1,136	1,141	1,145	1,150	1,155
65	0			1,127	1,132	1,136	1,141	1,145	1,150
65	1			1,122	1,127	1,131	1,136	1,140	1,145
65	2			1,117	1,122	1,126	1,131	1,135	1,141
65	3			1,112	1,117	1,122	1,126	1,131	1,136
65	4			1,107	1,112	1,117	1,121	1,126	1,131
65	5			1,103	1,107	1,112	1,117	1,121	1,126
65	6			1,098	1,102	1,107	1,112	1,116	1,122

65	7		1,093	1,097	1,102	1,107	1,112	1,117
65	8		1,088	1,093	1,097	1,102	1,107	1,112
65	9		1,083	1,088	1,092	1,097	1,102	1,107
65	10		1,078	1,083	1,088	1,092	1,097	1,102
65	11		1,073	1,078	1,083	1,088	1,092	1,098
66	0	1,064	1,068	1,073	1,078	1,083	1,088	1,093
66	1	1,059	1,063	1,068	1,073	1,078	1,083	1,088
66	2	1,054	1,059	1,063	1,068	1,073	1,078	1,083
66	3	1,049	1,054	1,059	1,063	1,068	1,073	1,079
66	4	1,044	1,049	1,054	1,059	1,064	1,068	1,074
66	5	1,039	1,044	1,049	1,054	1,059	1,064	1,069
66	6	1,034	1,039	1,044	1,049	1,054	1,059	1,064
66	7	1,029	1,034	1,039	1,044	1,049	1,054	1,060
66	8	1,025	1,029	1,034	1,039	1,044	1,049	1,055
66	9	1,020	1,025	1,030	1,035	1,040	1,045	1,050
66	10	1,015	1,020	1,025	1,030	1,035	1,040	1,045
66	11	1,010	1,015	1,020	1,025	1,030	1,035	1,041
67	0	1,000	1,005	1,010	1,015	1,020	1,025	1,030
67	1	0,995	1,000	1,005	1,010	1,015	1,020	1,026
67	2	0,990	0,995	1,000	1,005	1,011	1,016	1,021
67	3	0,985	0,990	0,996	1,001	1,006	1,011	1,016
67	4	0,981	0,986	0,991	0,996	1,001	1,006	1,011
67	5	0,976	0,981	0,986	0,991	0,996	1,001	1,007
67	6	0,971	0,976	0,981	0,986	0,992	0,997	1,002
67	7	0,966	0,971	0,976	0,982	0,987	0,992	0,997
67	8	0,961	0,966	0,972	0,977	0,982	0,987	0,993
67	9	0,956	0,961	0,967	0,972	0,977	0,982	0,988
67	10	0,951	0,957	0,962	0,967	0,972	0,978	0,983
67	11	0,947	0,952	0,957	0,962	0,968	0,973	0,978
68	0	0,942	0,947	0,952	0,958	0,963	0,968	0,974
68	1	0,937	0,942	0,947	0,953	0,958	0,963	0,969
68	2	0,932	0,937	0,943	0,948	0,953	0,959	0,964
68	3	0,927	0,933	0,938	0,943	0,949	0,954	0,960
68	4	0,922	0,928	0,933	0,939	0,944	0,949	0,955
68	5	0,918	0,923	0,928	0,934	0,939	0,945	0,950
68	6	0,913	0,918	0,924	0,929	0,934	0,940	0,946
68	7	0,908	0,913	0,919	0,924	0,930	0,935	0,941
68	8	0,903	0,909	0,914	0,920	0,925	0,931	0,936
68	9	0,898	0,904	0,909	0,915	0,920	0,926	0,931
68	10	0,894	0,899	0,905	0,910	0,916	0,921	0,927
68	11	0,889	0,894	0,900	0,905	0,911	0,916	0,922
69	0	0,884	0,889	0,895	0,901	0,906	0,912	0,917
69	1	0,879	0,885	0,890	0,896	0,901	0,907	0,913
69	2	0,875	0,880	0,886	0,891	0,897	0,902	0,908
69	3	0,870	0,875	0,881	0,887	0,892	0,898	0,903
69	4	0,865	0,871	0,876	0,882	0,887	0,893	0,905

69	5	0,860	0,866	0,872	0,877	0,883	0,888	0,894	0,900
69	6	0,856	0,861	0,867	0,872	0,878	0,884	0,890	0,896
69	7	0,851	0,856	0,862	0,868	0,873	0,879	0,885	0,891
69	8	0,846	0,852	0,857	0,863	0,869	0,874	0,880	0,886
69	9	0,841	0,847	0,853	0,858	0,864	0,870	0,876	0,882
69	10	0,837	0,842	0,848	0,854	0,859	0,865	0,871	0,877
69	11	0,832	0,837	0,843	0,849	0,855	0,860	0,866	0,872
70	0	0,827	0,833	0,839	0,844	0,850	0,856	0,862	0,868
70	1	0,823	0,828	0,834	0,840	0,845	0,851	0,857	0,863
70	2	0,818	0,823	0,829	0,835	0,841	0,847	0,853	0,859
70	3	0,813	0,819	0,825	0,830	0,836	0,842	0,848	0,854
70	4	0,809	0,814	0,820	0,826	0,832	0,837	0,843	0,850
70	5	0,804	0,809	0,815	0,821	0,827	0,833	0,839	0,845
70	6	0,799	0,805	0,811	0,817	0,822	0,828	0,834	0,840
70	7	0,795	0,800	0,806	0,812	0,818	0,824	0,830	0,836
70	8	0,790	0,796	0,801	0,807	0,813	0,819	0,825	0,831
70	9	0,785	0,791	0,797	0,803	0,808	0,814	0,820	0,827
70	10	0,781	0,786	0,792	0,798	0,804	0,810	0,816	0,822
70	11	0,776	0,782	0,788	0,793	0,799	0,805	0,811	0,818
71	0	0,771	0,777	0,783	0,789	0,795	0,800	0,807	0,813
71	1	0,767	0,772	0,778	0,784	0,790	0,796	0,802	0,808
71	2	0,762	0,768	0,774	0,780	0,786	0,791	0,798	0,804
71	3	0,757	0,763	0,769	0,775	0,781	0,787	0,793	0,799
71	4	0,753	0,759	0,765	0,771	0,776	0,782	0,789	0,795
71	5	0,748	0,754	0,760	0,766	0,772	0,778	0,784	0,790
71	6	0,744	0,749	0,756	0,761	0,767	0,773	0,780	0,786
71	7	0,739	0,745	0,751	0,757	0,763	0,769	0,775	0,781
71	8	0,735	0,740	0,746	0,752	0,758	0,764	0,771	0,777
71	9	0,730	0,736	0,742	0,748	0,754	0,760	0,766	0,772
71	10	0,725	0,731	0,737	0,743	0,749	0,755	0,761	0,768
71	11	0,721	0,727	0,733	0,739	0,745	0,751	0,757	0,763
72	0	0,716	0,722	0,728	0,734	0,740	0,746	0,752	0,759
72	1	0,712	0,717	0,724	0,730	0,736	0,742	0,748	0,754
72	2	0,707	0,713	0,719	0,725	0,731	0,737	0,744	0,750
72	3	0,703	0,709	0,715	0,721	0,727	0,733	0,739	0,745
72	4	0,698	0,704	0,710	0,716	0,722	0,728	0,735	0,741
72	5	0,694	0,700	0,706	0,712	0,718	0,724	0,730	0,737
72	6	0,689	0,695	0,701	0,707	0,713	0,719	0,726	0,732
72	7	0,685	0,691	0,697	0,703	0,709	0,715	0,721	0,728
72	8	0,680	0,686	0,692	0,698	0,704	0,710	0,717	0,723
72	9	0,676	0,682	0,688	0,694	0,700	0,706	0,712	0,719
72	10	0,671	0,677	0,683	0,689	0,695	0,701	0,708	0,714
72	11	0,667	0,673	0,679	0,685	0,691	0,697	0,703	0,710
73	0	0,662	0,668	0,674	0,680	0,686	0,693	0,699	0,706
73	1	0,658	0,664	0,670	0,676	0,682	0,688	0,695	0,701
73	2	0,654	0,659	0,666	0,672	0,678	0,684	0,690	0,697

73	3	0,649	0,655	0,661	0,667	0,673	0,679	0,686	0,692
73	4	0,645	0,651	0,657	0,663	0,669	0,675	0,682	0,688
73	5	0,640	0,646	0,653	0,659	0,665	0,671	0,677	0,684
73	6	0,636	0,642	0,648	0,654	0,660	0,666	0,673	0,679
73	7	0,632	0,637	0,644	0,650	0,656	0,662	0,668	0,675
73	8	0,627	0,633	0,639	0,645	0,651	0,658	0,664	0,671
73	9	0,623	0,629	0,635	0,641	0,647	0,653	0,660	0,666
73	10	0,619	0,624	0,631	0,637	0,643	0,649	0,655	0,662
73	11	0,614	0,620	0,626	0,632	0,638	0,644	0,651	0,658
74	0	0,610	0,616	0,622	0,628	0,634	0,640	0,647	0,653
74	1	0,605	0,611	0,618	0,624	0,630	0,636	0,642	0,649
74	2	0,601	0,607	0,613	0,619	0,625	0,631	0,638	0,645
74	3	0,597	0,603	0,609	0,615	0,621	0,627	0,634	0,640
74	4	0,593	0,598	0,605	0,611	0,617	0,623	0,630	0,636
74	5	0,588	0,594	0,601	0,607	0,613	0,619	0,625	0,632
74	6	0,584	0,590	0,596	0,602	0,608	0,614	0,621	0,628
74	7	0,580	0,586	0,592	0,598	0,604	0,610	0,617	0,623
74	8	0,576	0,581	0,588	0,594	0,600	0,606	0,612	0,619
74	9	0,571	0,577	0,583	0,589	0,596	0,602	0,608	0,615
74	10	0,567	0,573	0,579	0,585	0,591	0,597	0,604	0,610
74	11	0,563	0,569	0,575	0,581	0,587	0,593	0,600	0,606
75	0	0,559	0,564	0,571	0,577	0,583	0,589	0,595	0,602

Table B.2 Consequences of LAAF in the Norwegian pension system.

Year of birth	Annual loss in public pension if uptake of public pension at earliest age 62, percent of full public pension	Age when the annual public pension is not reduced
1949	24.18	67 and 6 months
1950	24.41	67 and 8 months
1960	27.75	68 and 10 months
1970	30.75	69 and 11 months
1980	33.51	71
1990	35.94	72 and 1 month
2000	38.12	73 and 1 month
2010	40.01	74
2020	41.72	74 and 11 months