Norway's new public pension system: Is it robust against unexpected life expectancy developments?

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Abstract

Norway introduced a new system for public old age pensions in January 2011. The new system leads to lower pension expenditures than the old system, because annual pension benefits under the new system are inversely proportional to the remaining life expectancy of those who retire. We can expect public pension expenditures equal to 170 billion Norwegian crowns (NOK) in 2030 and 288 billion NOK in 2050. But expenditures will be larger if retirees live longer than expected. We cannot be certain about the pace of mortality decline in the future. Therefore we have computed a probabilistic population forecast for Norway to 2050 and analysed the consequences of population growth for public old age pension expenditures. A new insight is that the new system is much less robust against unexpected longevity shocks than what was assumed earlier, in spite of the longevity adjustment. The reason is that annual pension benefits are determined when a person retires. After retirement, a retiree's annual benefits remain the same, even when mortality changes.

1. A new pension system

A new system for public old-age pension in Norway was introduced on 1 January 2011. The old system, which was of the Pay As You Go-type and which had been in use since 1967, proved not to be sustainable in the long term. Increasing life expectancy, a rapidly growing number of retirees, and little or no growth in the number of people of working age would result in sharply rising pension costs in future decades. Action was required, and after a public debate which lasted about ten years, a new pension system was in place in 2010. Analyses

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conducted by Statistics Norway (SN) show that the new public pension system is expected to reduce expenditures by around 30 billion Norwegian Kroner[2] (NOK) in 2030 and approximately 50 billion NOK in 2050, compared to the old system (Fredriksen and Stølen 2011a, 32). The main reason for this is that the new system encourages people to work longer. As a result, they start to take up public pension benefits later in life. This has been achieved by introducing a flexible retirement age (between 62 and 75 years) and pension benefits based on actuarial priciples. The details are complicated (see Fredriksen and Stølen 2011a), but the main idea is as follows.

In the new system pension entitlements are accumulated through income from work or through other types of pension earning, between the ages of 13 and 75 years. The individual will each year increase his or her pension entitlements corresponding to 18.1% of the pensionable income, up to a ceiling. The public pension scheme allows for flexible retirement for the age group 62-75 years based on actuarial neutrality. It is possible to combine work and pension fully or partly from the age of 62 without an earnings test. Also, the new system contains a life expectancy adjustment of the pension for new old-age pensioners. The life expectancy divisors are determined for each cohort, based mainly on remaining life expectancy. They are determined when the cohort reaches 61 years, and will not be adjusted later (Fredriksen and Stølen, 2011a, 21). Each cohort will receive a set of separate life expectancy divisors from the age of 62 until the age of 75. They do not differ by sex. At the time of retirement, a person’s annual pension is calculated by dividing the accumulated pension entitlements by the life expectancy divisor of the person’s birth cohort. Those who postpone retirement will have a lower divisor and hence higher annual pension benefits compared to those who retire early. In addition, later retirement will often imply higher pension entitlements.

Because of the general decline in mortality in the population, younger cohorts have lower mortality than older ones. Since the divisor reflects the remaining life expectancy at a given

[2] 1 € corresponds with 8.2 NOK (exchange rate as of early May 2014).

age (62, 63, 64, ... , 75), younger cohorts have higher divisors than older cohorts. Mortality decline and increasing life expectancy lead to increasing pension costs (other things being the same), but the divisor helps to counteract this effect.

Analyses of the costs of the new pension system have been implemented using SN's micro simulation model MOSART (Fredriksen 1998). The current version of the model starts with a representative sample of the population in 2007 and simulates the further life course of each individual with respect to migration, death, births, household formation and dissolution, schooling, education, employment, and income. MOSART computes annual pension benefits based on the simulated life course of each person. It is a comprehensive model, which is capable of providing highly detailed results.

The purpose of our analysis was to build a simple macro model to predict future pension expenditures. Using this model (see Section 2 for details) we were able to simulate future pension expenses with stochastic population growth. In this way we answer the question: "How robust is the new pension system for unexpected developments in mortality and population's life expectancy?" In other words, what are the consequences for pension costs and other pension variables if life expectancy suddenly increases faster (or slower) than assumed in MOSART analyses? This is an important question, because mortality and life expectancy are demographic variables that are difficult to predict in the long term. To illustrate: compared with numbers that were observed later, Statistics Norway's population projections published between 1969 and 1990 underpredicted 15 years-ahead life expectancy at birth by no less than two years on average (Keilman et al. 2002). As a result, projected numbers of elderly (aged 85 +) 15 years into the future were around 10-15 per cent too low. Norway is not alone in this - in many Western countries, life expectancy has increased much faster than demographers and other social scientists thought.

Because the future of mortality (and other demographic factors) is very uncertain, we used a so-called probability forecast (stochastic forecast) of future population growth, so that we can provide an estimate of the chances of future pension expenditures in a given year being 200 billion NOK, 250 billion NOK, 300 billion NOK, ... and so on. In other words, we have quantified the demographic uncertainty in our projections for pension expenditures.

One method that is often used as an alternative for stochastic forecasting is the scenario method. In this approach one formulates a few, typically three different values for one or more key model parameters. One example is SN's population projection, which provides alternative paths for the future development of the population under a *high* population growth scenario (high life expectancy combined with high fertility and a high level of immigration) and the *low* population growth scenario (low life expectancy combined with low fertility and low immigration) - in addition to a medium scenario; see Statistics Norway (2012a). The disadvantage of this method is that it does not quantify prediction uncertainty. We do not know whether the interval between population sizes under the high and the low scenario will cover the real number with 30 per cent, 60 per cent or 90 per cent probability. Another disadvantage is that this method is inconsistent from a statistical standpoint. Exemplified by the high scenario of SN's population projection, the problem is that every year when mortality is high, also fertility and immigration are high (and *vice versa* for the low scenario). Such a perfect correlation between the three demographic components is unrealistic. Moreover, when life expectancy (fertility, immigration) is high in a particular year, it is also high in all the other years. In reality these components fluctuate over time.

2. A simple macro model for simulation of pension expenses

The starting point for modelling future expenditures on public old-age pensions was a macro model introduced by Bongaarts (2004). The key variable in the model is the public pension expenditure ratio (*per*), defined as the share of total gross labour income that is spent on public old-age pensions in a given year. In the rest of the paper, we use "pension" in the sense of "public old-age pension."

In a "pay as you go" pension system (PAYG), where workers finance the ongoing pension obligations through taxes, the pension expenditure ratio reflects the tax rate required to finance the pension system (Bongaarts, 2004, 5). We assume that, for a certain year in the future, the product of the pension expenditure ratio and the total gross income from labour provides an estimate of the pension expenditures in that year.

Bongaarts' model implies a decomposition of *per*. First we define the concepts of old age dependency ratio (*odr*), pensioners ratio (*pr*) and employment ratio (*er*). Write the number of persons aged x at a given time as $K_{x.}$ The number of pensioners is denoted as P, while W is the number of employed persons ("workers") in the age group 20-64. Define

$$odr = K_{65+} / K_{20\text{-}64}$$

$$pr = P / K_{65+}$$

$$er = W / K_{20\text{-}64.}$$

Furthermore, we define the benefit ratio *br* as the average public pension (per pensioner) divided by the average earnings (per worker, full-time equivalents).[3]

Thus, the pension expenditure ratio is equal to

(1) $$per = br.\frac{P}{W} = br.odr.\frac{pr}{er}.$$

For 2010, we found a *per*-value of 11.9 per cent and a benefit ratio equal to 44.1 per cent.[4]

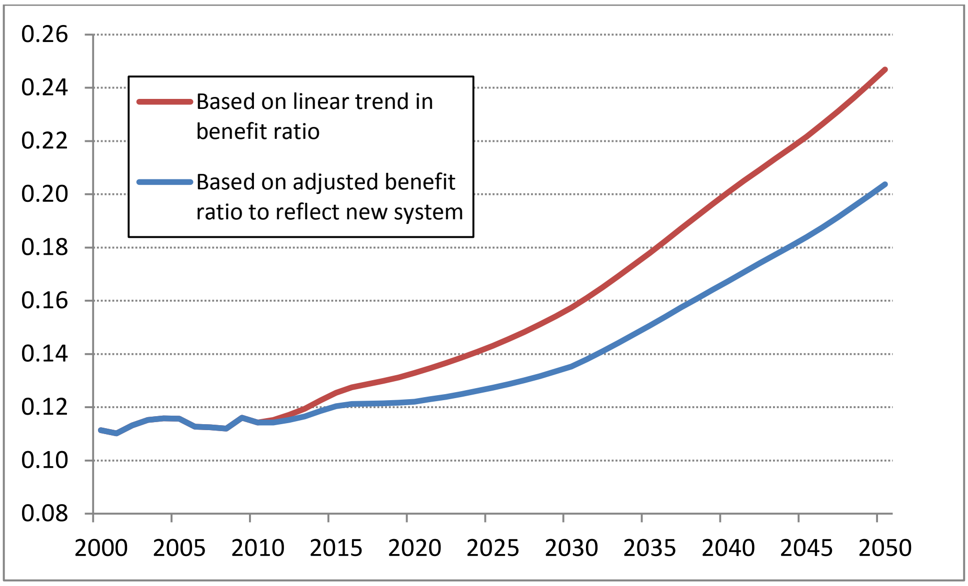
We calculated a simple deterministic forecast to 2050 for *per*, based on predictions of future values for *br*, *P*, and *W*. Results from MOSART simulations include annual predictions to

[3] The benefit ratio, being the ratio of two averages, is closely linked to the replacement ratio, which is the average ratio of pension benefits over earnings. The benefit ratio includes earnings of both full-time and part-time workers. Part-time earnings recalculated as full-time equivalents.

[4] Data sources: Statistics Norway's data bank (SN 2012b-e), OECD (2012), and other sources detailed in Keller (2012, 11-13 and 20-21).

2050 of the number of pensioners and the number of persons in the labour force. We reduced the latter number by 3 per cent each year to reflect unemployment. This gave us predictions for the number of employed persons each year in the future. For the benefit ratio *br* we assumed initially that the more or less linear trend that is visible in historical figures as of 1984 (SN 2011) would continue in the future. The assumption behind such a linear trend extrapolation is that the old pension system would continue. Next, we adjusted the trend in *br* based on MOSART-estimates of reduced pension expenditures in the new system, compared to the old one (Fredriksen and Stølen 2011a). For example, in 2050 the predicted reduction equals NOK 50.3 billion, which corresponds to 17.4 per cent of the pension expenditures under the old system. Similar numbers are available for the years 2020, 2030 and 2040. We used these percentages to scale down *br* predictions initially obtained by linear extrapolation, and interpreted the results as *br* predictions under the new system. Linear interpolation gave us *br*-values for intermediate years. The result is an increasing benefit ratio from 44 per cent in 2010 to 49 per cent in 2050. The first equality in expression (1) gave us predictions for *per* (Figure 1).

Figure 1. Public pension expenditure ratio (*per*) 2000-2050



Due to an increasing number of pensioners, the new pension system will not be able to stabilize the pension expenditure ratio in the long run. By 2050, the tax rate would have to be increased by 8 percentage points if it would cover increased pension expenditures.

According to these simple calculation, pension expenditures are expected to increase from 117.5 billion NOK in 2010 to 171 billion NOK in 2030 and further to 274 billion NOK in 2050 NOK, with Norwegian kroner measured as constant wage kroner as of 2010. MOSART results (converted to constant wage kroner as of 2010) show pension expenditures equal to 174 billion NOK in 2030 and 246 billion NOK in 2050 (Fredriksen and Stølen 2011a). Our simple macro model agrees pretty well with MOSART results for 2030 and it results in expected expenditures for 2050 that are about 10 per cent higher.

However, we will not be able to use such a simple calculation to analyze the impact of random variations in mortality. When mortality differs from its expected value (which underlies the results shown in Figure 1), we can no longer use expected numbers of pensioners from MOSART. This is because the life expectancy divisor leads to lower annual pension benefits when mortality falls, and *vice versa*. But a prospective pensioner may compensate for lower annual pension benefits by postponing retirement.

The new scheme gives people the option to take up pension[5] at any age between 62 (under certain minimum conditions regarding accumulated pension entitlements) and 75. A reduction in mortality can have two different effects. 1) The age at which one takes up pension remains unchanged, and benefits are reduced in line with the life expectancy divisor as determined by lower mortality. 2) Pension benefits remain unchanged. This is achieved by postponing the time (age) at which one takes up pension, which counteracts the effect of the higher life expectancy divisor. A numerical example shows that one year higher life expectancy at age 62

[5] From now on we will use the term “to take up pension” rather than “to retire” or “to withdraw from the labour market”. The latter two terms have become imprecise, because under the new system one is free to combine full-time or part-time labour with receiving a pension, without any cuts in the benefits.

will result in about 8 months later pension take up, if the aim is to keep benefits constant (Fredriksen and Stølen, 2011b, 42).

We have created two models to analyze the impact of random life expectancy shocks on pension expenditures. Assume that life expectancy is higher than expected. The first model simulates a situtation in which everyone follows Option 1: unchanged take up age and reduced pension benefits. The second model simulates a situation in which all workers follow Option 2: unchanged benefits and later pension take up. The two models in which we allow a change only in take up age (Option 1) or only in take up age (Option 2) cover the range of possibilities for what will happen in the future. Reality will lie somewhere inbetween these two extremes. Therefore, we calculated a weighted average of the pension costs that result from the two options.

All variables are defined for a particular calendar year (2011, 2012, ..., 2050). In a model with stochastic variables both the benefit ratio (*br*), the number of pensioners (*P*), and the number of persons in employment (*W*) in the first equality of expression (1) are perceived as stochastic. Benefits are paid to persons aged 62 years or more. The main reason why the future number of persons in this age group is uncertain is because future mortality is uncertain. The fact that we do not know the future level of migration in this age group is less important, because most migrants are younger than 40 years of age at the time of migration. Both mortality and migration are stochastic in our population projection; see Section 3

When mortality is stochastic also the remaining life expectancy at certain ages is stochastic. The life expectancy divisor, which reflects the remaining life expectancy at take up age, reduces the benefit ratio *br* when mortality is lower than expected. We use a highly simplified model for the relationship between *br* and mortality. It is based on average values for a number of variables that in reality vary with age, for instance average pension benefits for new and old retirees, similar to Bongaarts' model. Furthermore, our model is a macro model, which simulates the average person. In reality there are major variations between individuals.

The stochastic population forecast gives us simulated probability distributions of future values of the population by age and of the life expectancy at birth. The total number of pensioners (*P*) is the product of the pensioner ratio *pr* and the population K_{65+} [6]. They have an average pension benefit equal to *Y*. *P* consists of new pensioners *NP* and existing or "old" pensioners *OP* (*P* = *NP* + *OP*). The latter group consists of the survivors of those who took up pension in earlier years. We write the proportion of new pensioners compared to all persons aged 62-75 as *k*. The average pension benefits for new pensioners is written as Y^{np}, while the old pensioners receive on average Y^{op}. Together with the definitions of the pensioners ratio *pr* and the employment ratio *er* we have the following expressions:

(2) The number of pensioners $P = pr \, . \, K_{65+}$.

(3) The number of new pensioners $NP = k \, . \, K_{62\text{-}75}$.

(4) Average pension for all pensioners $Y = (Y^{np} \, . \, NP + Y^{op} \, . \, OP)/P$

(5) The number of persons employed $W = er \, . \, K_{20\text{-}64}$.

The number of existing pensioners *OP* is a stochastic variable. We assume that the relative volatility in this variable (due to stochastic mortality and migration) is the same as that in the population aged 65+ (K_{65+}). Thus we can write

(6) $OP/\mathrm{E}[OP] = K_{65+}/\mathrm{E}[K_{65+}]$, so that $OP = \mathrm{E}[OP] \, . \, K_{65+}/\mathrm{E}[K_{65+}]$,

where $\mathrm{E}[OP]$ and $\mathrm{E}[K_{65+}]$ are expected values of the random variables *OP* and K_{65+} , respectively.

Finally, we assume that the ratio of average pensions for old and for new pensioners equals a given number α, i.e.

[6] Under the new pension system one can take up pension starting from age 62. It would be more natural to used K_{62+} as a basis for computing *P*. However, the fact that we use age 65+ is consistent with our choice of age 65 as the border line age between workers and non-workers. See the definitions of *br* and *er* above.

(7) $Y^{np} / Y^{op} = \alpha$.

It is reasonable to assume that the new pensioners have a longer work history than the exisitng pensioners and therefore have accumulated larger pension entitlements. We expect that $\alpha > 1$.

The total gross labour income is the product of employment and average labour income. When employment is a random variable, the total gross labour income is random, too.

Option 1: Unchanged take up age. The age at which the average worker starts to take up pension benefits is fixed under this option, while the life expectancy divisor determines the level of pension benefits. Changes in mortality only affect pension benefits for *new* retirees, since the life expectancy divisor for a certain birth cohort is determined in the year when the cohort members reach the age of 61 (Fredriksen and Stølen, 2011a, 21), and does not change afterwards. The life expectancy divisors differ by take up age and by birth cohort. We prefer to see the divisor as a function of remaining life expectancy at age 62 (e_{62}), in addition to take up age (t). Write the life expectancy divisor as $D(t,e_{62})$. It is a random variable with mean $E[D(t,e_{62})] = D(t, E[e_{62}])$, $E[e_{62}]$ is the expected value of the random variable e_{62}. Take up age t is not stochastic under this option. The average pension for new retirees Y^{np} has expectation $E[Y^{np}]$. We assume that the relative volatility in average pension benefits for new pensioners (Y^{np}) equals the relative volatility in the life expectancy divisor:

(8) $Y^{np}/ E[Y^{np}] = D(t,e_{62})]/D(t, E[e_{62}])$ or $Y^{np} = E[Y^{np}] \,.\, D(t,e_{62})]/D(t, E[e_{62}])$.

When the remaining life expectancy e_{62} is larger than expected ($E[e_{62}]$), the division number D is larger than expected ($E[D]$) and benefits for new pensioners Y^{np} are reduced proportionally. Benefits Y^{gp} for old pensioners remain unchanged. The life expectancy divisor D is calculated based on an average value from life tables for the past ten years (Fredriksen and Stølen 2011a, 22). Therefore, we assume that only 10 per cent of the mortality shock in e_{62} affects the new divisor D in a particular year. The model consists of expressions (1) - (8).

Option 2: Unchanged benefits. Under Option 2, a future retiree aims at receiving the same level of benefit as in the reference situation, and he or she adjusts the time of pension take up to achieve this. The consequence of a random change in mortality is that the numbers of new retirees and employees vary with changes in take up age. Following calculations mady by Fredriksen and Stølen (2011b, 42), we assume that a one-year increase in e_{62} implies an increase by eight months in take up age. Changes in e_{62} larger or smaller than one year lead to proportional changes in take up age. The take up age t is a random variable under this option. When the take up age t increases the share k of new pensioners among the population aged 62-75 will fall. We assume a linear relationship between the share k and the take up age t:

(9) $k = a + b.t, b < 0$

The number of employed persons (W) plus the number of pensioners (P) is the same with or without a mortality shock:

(10) $W + P = \mathrm{E}[W] + \mathrm{E}[P].$

Under this option, the model consists of expressions (1), (3), (6), (9), and (10).

3. Stochastic population projection

The stochastic population forecast has been calculated by means of the Program for Error Propagation (PEP). PEP simulates the so-called Scaled Model for Error (Alho and Spencer 2005). This is, in a fact, a cohort-component model. But the model assumes that fertility and mortality rates are normally distributed in the log scale, and that numbers of net migrants are normally distributed in the original scale (Alders et al., 2007, 65). The normal distribution requires that one specifies an expected value and a standard deviation. The standard deviation reflects the uncertainty.

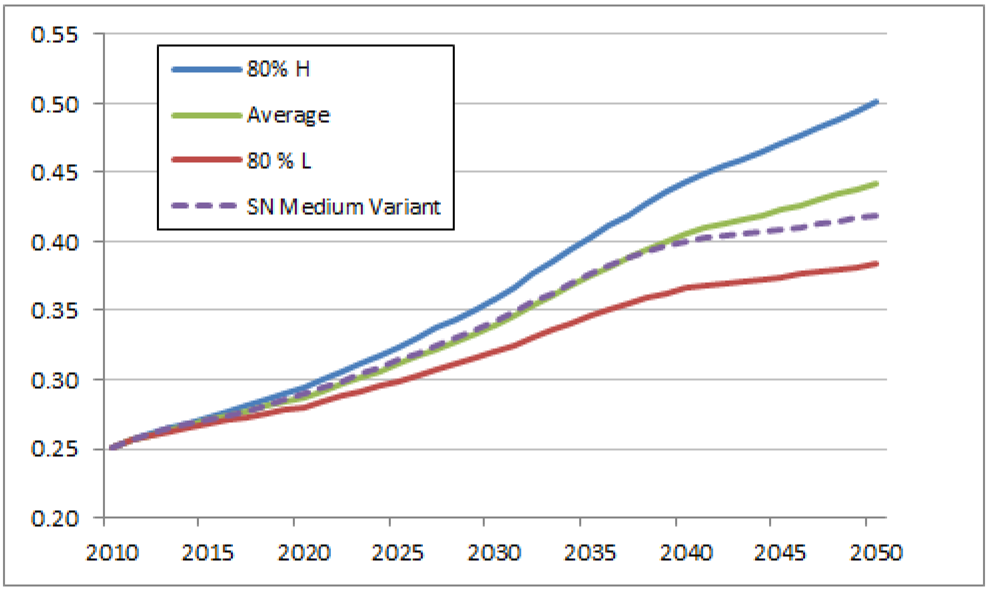
Foss (2012) used PEP to simulate 3000 possible paths for the future population development in Norway for each year from 2012 to 2060. Simulations were based on randomly selected values for fertility and mortality rates broken down by (mother's) age and sex, and numbers of net migrants (specific for age and sex). Uncertainty parameters were chosen so that the volatility in the parameters is the same as in the past (see Alders et al., 2007 and Alho et al., 2008). Expected values for all projection parameters were set equal to the corresponding values in the 2011-based projections from Statistics Norway (Brunborg and Texmon 2011). PEP computed 3000 trajectories for annual population numbers broken down by age and sex to 2060. We repeated Foss' calculations and used simulation results for all ages at five-year intervals: 2015, 2020, ..., 2050. For each variable of interest we computed average values and upper and lower limits of 80 per cent prediction intervals.

The average of the simulation numbers for the population aged 20-64 in 2050 amounts to 3,557,000 persons. Upper and lower limits of the 80 per cent prediction interval shows that the number of persons aged 20-64 years with 80 per cent probability will be between 3,241,000 and 3 877 000. There is an 80 per cent chance that the number of elderly (65+) in 2050 will lay between 1,378,000 and 1,748,000 persons.

The 80 per cent prediction interval for the old-age dependency ratio *odr* in Figure 2 shows, as expected, that uncertainty increases further out in the projection period. We see that odds are four to one for the old age dependency ratio to be in the range between 0.38 and 0.50 in 2050.

The average value of a certain variable in the stochastic population forecast should be equal to the corresponding variable in the Medium Variant of Statistics Norway's population projection of 2011. Figure 2 shows a small difference towards the end of the time period: PEP computes the forecast a little bit different than Statistics Norway does.

Figure 2: 80 per cent prediction interval for the old age dependency ratio. The curve labeled "SN Medium variant" gives results from Statistics Norway's population projection of 2011



4. Empirical specifications and results

First, we compute a deterministic forecast of the number of old pensioners and the number of pensioners in total (*OP* and *P*), the benefit level Y^{np} for new retirees, the life expectancy divisor $D(t,e_{62})$, the life expectancy $e_{62,}$ the number of persons who are employed *S* and the number of persons aged 65+ $K_{65+.}$ We interpret the results of this deterministic forecast as estimates of the expected values of the relevant stochastic variables. At a certain time or in a particular calendar year, the stochastic variables differ from this expectation. The input data required for the deterministic forecast come partly from the stochastic population forecast (expectations of K_{65+} and $K_{62\text{-}75}$) and partly from a deterministic MOSART calculation by Fredriksen and Stølen (2011a). In other words, we calibrated our macro model to selected MOSART results.

The expected value of the take up age *t* should be higher in Option 2 than in Option 1; we write Δt for this difference in E[*t*]. We have used a weight λ for computing a weighted average of pension expenditures in the two options. For *k*, α, Δt, and λ we need estimates; cf. below.

An empirical analysis of the relationship between life expectancy e_{62} and life expectancy divisors gave us the expected value of $e_{62.}$ Dennis Fredriksen of Statistics Norway provided us with a table of divisors D broken down by take up age (t = 62, 63, ..., 75) and e_{62} (with values between 0 and 50 years). A regression analysis showed that the life expectancy divisor is an almost perfect linear function of these two variables:

$$D(t,e_{62}) = 48.5458 - 0.7956t + 0.9055e_{62},$$

R^2 = 0.9993, n = 714, and absolute t values larger than 200 for all three parameters.

When it comes to longevity, PEP gives stochastic values not for $e_{62,}$ but only for the life expectancy at birth $e_{0.}$ We used SN's data base with values for e_x for all ages x and for all years from 2010 to 2100, based on the 2011 forecast. For the Medium Variant of that forecast we found the following relationship between e_0 and e_{62} (both sexes combined):

$$e_{62} = -43.7071 + 0.8089e_0,$$

R^2 = 0.9998, n = 91, and absolute t values larger than 300 for both parameters.

By combining these two empirical expressions we find that

$$D(t,e_0) = 8.9690 - 0.7956t + 0.7325e_0.$$

Assuming that 90 per cent of the shock in e_{62} is restrained by the smoothing of mortality over a ten-year period, it is easy to show that

$$D(t,e_0) = 8.9690 - 0.7956t + 0.7325(0.1e_0 + 0.9\mathrm{E}[e_0]).$$

For k (the share of new retirees among the population aged 62-75 years) we assumed a value of 7 per cent. Statistics from the Norwegian Labour and Welfare Service (NAV 2012) show a slight increase from 7.0 to 7.8 per cent in the period 2002-2010. In 2011, the value is 14.4 percent, a high value related to the introduction of the new pension system. That year, people aged 62-66 years had the right to take up pension for the first time. MOSART figures for the period 2008-2100 give a largely constant number around 7 per cent.

For α (the ratio of average pensions for new compared to old retirees), we chose 1.05. Figures for 2011 from NAV (2012) suggest a value of 0.98 in 2011, but we expect that the latter value will not be representative of later calendar years. It is reasonable to assume that new retirees have a longer employment history than old pensioners, when the new pension system has been in use for some years.

For the linear relationship between k and t, we have assumed $k = 0.4 – 000.5t$. This choice results in a k-value around 6 per cent for t equal to 67.5 years and 68.6 years respectively in 2030 and 2050; cf. Table 1. When everyone takes up pension at age 65 (approximately the current value), k equals 7.5 per cent (roughly today's value). The difference in the age of pension take up between Options 1 and 2 (Δt) is set equal to one year. Finally, we chose the weight λ equal to ½. The consequences of choosing other values of k, α, Δt, and λ are discussed later in this section.

We focus on results for 2030 and 2050. The employment ratio *er*, the pensioner ratio *pr*, and the benefit ratio *br* in these years are derived from the simple forecast described in Section 2. The life expectancy at birth is given by the average value of the 3000 simulated values calculated by the PEP program. The values for withdrawal ages are taken from MOSART. In accordance with the assumptions that underlie MOSART we assumed that the total gross labour income of the population will increase with the expected growth in employment. This means that the average labour income per employed is constant and equal to the 2010 level. All future expenditures are expressed in constant wage kroner as of 2010. Overall gross labour income is expected to increase from 1,028.5 billion NOK in 2010 to 1266.5 billion NOK in 2030 and 1,343.3 billion NOK in 2050 (SN 2011f).

Table 1 Parameter values deterministic prediction

	2030	2050
Employment ratio (*er*)	0.8431	0.8452
Pensioner ratio (*pr*)	0.7517	0.8329
Benefit ratio (*br*)	0.4433	0.4935
Take up age (*t*)	67.5	68.6
Life expectancy at birth (e_0), both sexes	84.0	86.4

Expected values of the pension expenditure ratio *per* turn out to be 13.4 per cent in 2030 and 21.4 per cent in 2050.[7] Pension expenditures are estimated at 169.7 billion in 2030; they increase to 287.9 billion in 2050.

Table 2 gives selected results in 2050 under two options with stochastic population. The average pensioner will receive around 49% of average labour income. The prediction interval for this benefit ratio is extremely narrow under Option 1, because random changes in the life expectancy divisor only affect new pensioners, while pensions for existing pensioners remain unchanged. The proportion of new retirees is low (around 7 per cent), and hence variations in this proportion have little impact on the overall benefits and the benefit ratio. Because future population growth is uncertain, tax rates on labour income will have to increase, with 80 per cent chance, by between 6 and 12 percentage points by 2050, compared with the observed level of 12 per cent in 2010. The 3000 simulations of take up age under Option 2 show that this age with 80 per cent probability will be in the range from 66.7 to 72.6 years in 2050. We weigh the results of the two options equally, and find that the average of the two options results in pension expenditures in 2050 that will vary between 254 and 317 billion NOK with 80 per cent chance.

[7] This *per* result for 2050 is slightly higher than in Figure 1. It is based on population numbers from the stochastic simulation using PEP. Population numbers underlying Figure 1 come from SN's official population projections. In Section 3 we argued that these numbers were computed according slightly different methods, in particular after 2040. The same explanation holds for the slightly higher estimate of pension expenditures (288 billion, against 274 billion in Section 2).

Table 2. Pension expenditure ratio, benefit ratio and take up age in 2050. Average values, lower and upper limits of 80 per cent prediction intervals based on 3000 simulations

	Option 1: unchanged take up age			Option 2: unchanged benefits		
	average	80% L	80% H	average	80% L	80% H
Pension expenditure ratio (*per*)	0.215	0.188	0.243	0.211	0.179	0.243
Benefit ratio (*br*)	0.494	0.493	0.494	0.495		
Take up age (*t*)	68.6			69.6	66.7	72.6

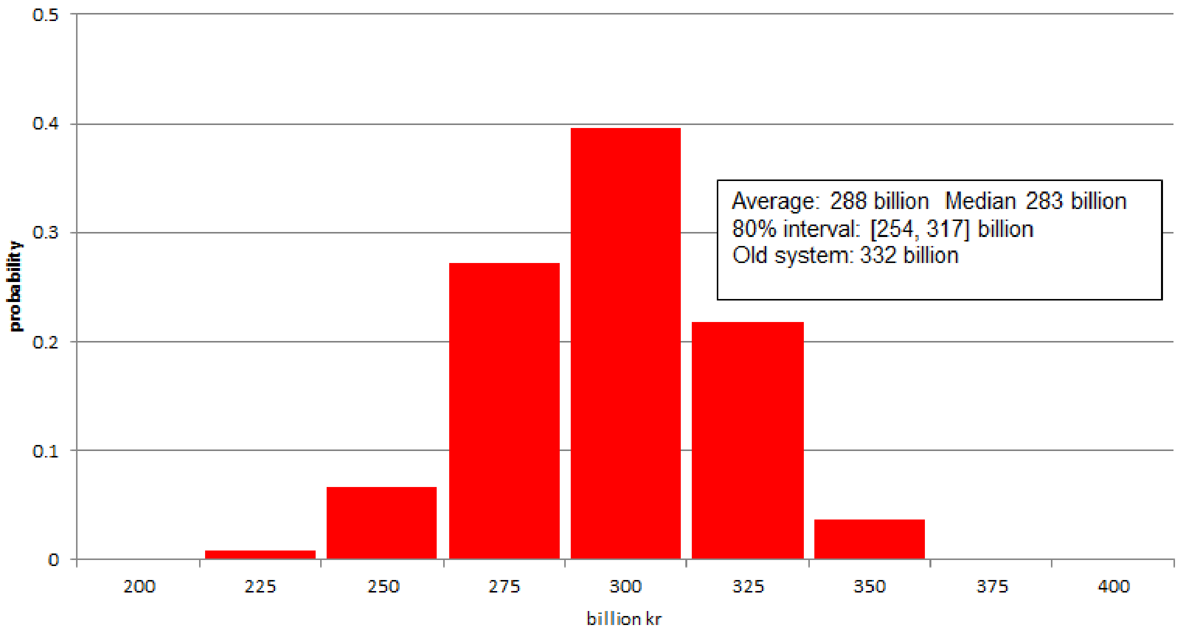
By way of comparison, calculations for 2030 show that *per*, which can be interpreted as the tax rate required to finance the pension system, is only one percentage point higher in 2030 than in 2010. Option 1 provides an 80 per cent interval for *per* in that year which is 1.4 percentage points wide. Option 2 shows that to achieve the desired benefit ratio, the take up age in 2030 will be with 80 per cent chance between 66.8 and 70.2 years. The 80 per cent prediction interval for pension expenditures ranges from 161 to 176 billion NOK in 2030.

We conducted a number of sensitivity calculations and varied the take up age t (between 67 and 70 years), the proportion of new retirees k (2 - 12 per cent), the ratio between benefits for new and old pensioners α (0.95 to 1.15), and the difference in take up age Δt in Option 2 compared to Option 1 (0-3 years). The results in terms of coefficients of variation for pension expenditure in 2050 show that the large spread in these parameters provides little or no change in uncertainty (mean values vary, of course). For Option 1 we find that a k-value which is 5 percentage points higher (lower) than the reference value at 7 per cent has a small effect on uncertainty: a lower proportion k goes along with greater uncertainty, because there are fewer new retirees and thus the group of pensioners as a whole is older, on average, than in a situation with a high k-value. For this option we assumed a linear relationship between k and t. In the reference situation the take up age t is 68.6 years, and k equals 5.7 percent. When we change the linear relationship between k and t such that the mean value of k varies between 0.02 and 0.12, we find only a modest change in the coefficient of variation for pension expenses: respectively from 0.0846 to 0.0802. Finally, we found that the uncertainty in pension expenditure was insensitive to the weight λ. Weight values of 0 and 1 represent Options 1 and 2, respectively. The coefficients of variation for the expenditures in 2050 are equal to 0.091 and 0.083, respectively.

5. Predicted probability distribution of pension expenditures

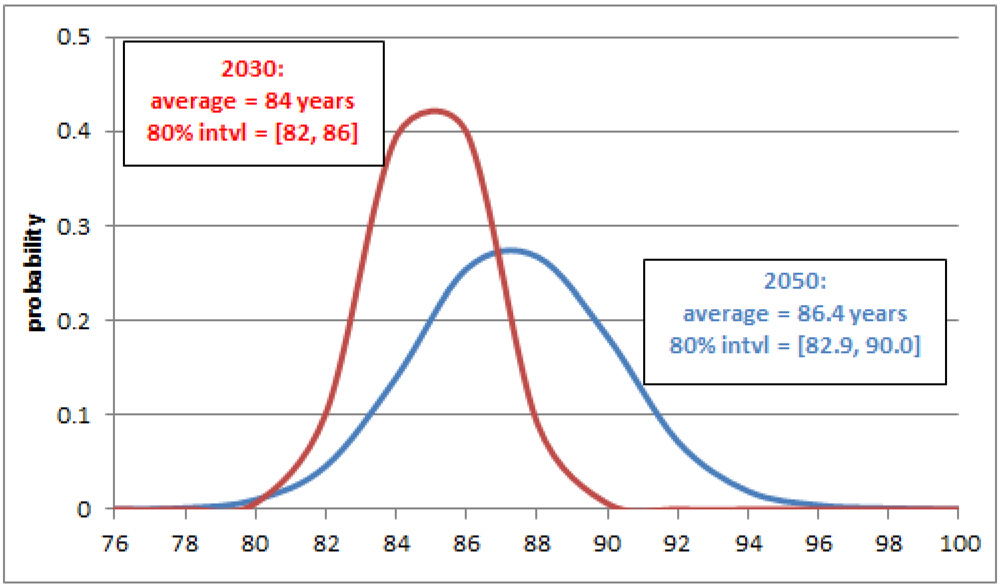
As mentioned, our calculations show that pension expenditures in 2050 will vary between 254 and 317 billion NOK with 80 per cent chance - an uncertainty margin of 63 billion NOK. This margin is wider than the amount of savings of 50 billion NOK one may expect from the new pension system, compared to the old one (measured at constant wage kroner as of 2010). We have calculated the predictive distribution for pension expenditures in 2030 and 2050. Figure 3 shows the results for 2050, with λ equal to ½.

Figure 3 Probability distribution for pension expenditures in 2050 (in constant wage kroner as of 2010)



Expenditures equal to 288 billion NOK in 2050 are far from certain. Chances are 26 per cent that the expenditures will exceed 300 billion NOK. For 2030, expected expenditures amount to 170 billion NOK, with an 80 per cent interval equal to [161, 176] billion NOK. There is much less prediction uncertainty for pension expenditures in 2030 than in 2050, because the old age dependency ratio (see Figure 2) and the life expectancy (Figure 4) are much more certain in 2030 than in 2050. We also found little impact on the likelihood of a particular level of pension expenditures in case many retirees prefer to receive a pension early (λ close to or equal to one) or rather wait a while (λ close to or equal to zero). The largest impact on uncertainty in pension expenditures stems from uncertainty associated with the development in the number of elderly.

Figure 4 Predictive distribution of the life expectancy at birth, 2030 and 2050



6 Summary and conclusion

We have used a simple macro model to simulate future expenditures for the new system for public old-age pensions of Norway, which was introduced on 1 January 2011. In the simulations, we took into account random variations in future population growth. In this way we were able to analyze the likelihood that the new system will result in a lower or higher level of pension expenditures than expected when the system was introduced.

Expenditures are expected to be 288 billion NOK in 2050. But this number is far from certain. Our calculations show that pension expenditures in 2050 will vary between 254 and 317 billion NOK with 80 per cent chance - an uncertainty margin of 63 billion NOK. Chances are 26 per cent that the expenditures will exceed 300 billion NOK. For 2030, expected expenditures amount to 170 billion NOK. Odds are four to one that they will be in the range between 161 and 176 billion NOK. There is much less prediction uncertainty for pension expenditures in 2030 than in 2050, because the old age dependency ratio and the life expectancy are much more certain in 2030 than in 2050.

The new system provides future pensioners the opportunity to take up public pension (to “retire”) as early as 62 years of age; they may also wait until they turn 75. Early retirement means lower annual pension payments. In addition, the annual pension is dependent on mortality in terms of the expected number of years as a pensioner. Other things being equal, a cohort of 62 year olds who have a higher life expectancy than previous cohorts receive lower pension benefits, but they can compensate this by postponing pension take up and by remaining in gainful employment longer. A numerical example shows that the cut in pension benefits as a result of one year higher life expectancy can be compensated for by postponing pension take up by eight months. When life expectancy increases, some older workers prefer to retire early and accept a lower pension, while others want to work longer and thus avoid such cuts. We have simulated two alternative possibilities that may result when a random shock in mortality occurs. In the first option all new pensioners accept that their pension will be reduced when life expectancy goes up - they take up their pension at the same age as retirees from earlier cohorts did. In the other option, prospective pensioners aim at the same benefit level as without mortality shock, and they adapt the take up age to accomplish this. The approach with changes only in pension benefits (Option 1), or only in take up age (Option 2) provides a system that covers the range of possibilities of what actually will happen in the future. The real situation will lie somewhere inbetween these two extremes. Therefore, we also simulated the benefits of an "average pensioner", by weighting the results for Options 1 and 2.

A major uncertainty is how the individual worker will react to the flexible retirement age in the future. When a similar system was introduced in Sweden, it had an immediate effect on employment for the first cohort that could benefit from the new pension system (Dahl and Lien, 2011, 36). At the same time findings from Finland show that life expectancy adjustment of benefits can lower the retirement age (Lassila and Valkonen, 2008, 157). A worker who can expect lower benefits in the future may prefer to work more when young, build up larger pension entitlements, and still retire early.

We have used a stochastic population forecast to 2050 similar to the one that Foss (2012) has calculated. It is based on the expected values of parameters for future fertility, mortality, and migration as in Statistics Norway’s population projection published in 2011 (Brunborg and Texmon, 2011). Foss used a stochastic forecasting model that simulated random demographic variations based on the assumption that volatility in today's demographic trends is the same as one can expect for the future. Such an assumption is reasonable, because an analysis of forecast accuracy in a number of European countries has shown that forecast errors have not become smaller over the past 25 years (Keilman, 2008).

We have combined Foss' stochastic population model with a deterministic model that simulates pension expenditures. We find that expenditures, which were 117 billion NOK in 2010, are expected to increase to 170 billion NOK in 2030 and further to 288 billion NOK in 2050, expressed as constant wage kroner as of 2010. In particular, the increasing elderly ratio, i.e. the ratio between the numbers of elderly and persons of working ages, will push expenses up between 2030 and 2050. Expressed as a share of total gross labour income, expenditures will increase from 12 per cent in 2010 to 13 per cent in 2030 and further to 21 per cent in 2050. This share can be interpreted as the tax rate necessary to cover the public expenditures on old-age pensions.

We cannot be certain about population developments in the future. Therefore, future pension costs are uncertain, too. We have calculated prediction intervals for different model variables, which reflect expected variability in future values. We find a likelihood of 80 per cent that the costs will be between 254 and 317 billion NOK in 2050. Here we have assumed that there are as many retirees who prefer Option 1 (unchanged take up age and reduced pension when life expectancy increases) as Option 2 (unchanged pension by postponing pension take up). Intuitively, one would perhaps have expected less uncertainty and a narrower prediction interval, because the feedback mechanism of the new pension system reduces pension expenditure as soon as life expectancy increases. That is correct, but the adjustment applies only to mortality among new retirees. Pensions for existing pensioners remain unchanged. New retirees make up only between 3 and 7 per cent of all pensioners in the period 2030-2050, and it is highly uncertain how mortality will affect numbers of elderly in the long term. The life expectancy divisor for existing pensioners remains unchanged once it has been determined; this is an intentional feature of the new pension system. It would have been unreasonable to reduce the pension benefits of existing pensioners (due to sudden lower mortality than expected) after they have retired. At that time very few would have the possibility to adapt to changes in the pension system, for example by working longer.

As mentioned above, the tax rate necessary to finance the new pension system will have to increase by 6 to 12 percentage points by 2050 with 80 per cent probability. If employment is higher than expected, the increase will be more moderate. A higher employment rate will still not be sufficient to avoid a higher tax rate, since the number of pensioners will increase stronger in the years ahead.

The pension model has some parameters that cannot be estimated, because an empirical basis for these is lacking. We have used parameter estimates we think are reasonable, but these can be criticized. Therefore, we conducted a series of sensitivity analyses based on widely varying values for these parameters. We found that our estimate of the uncertainty about future pension costs does not change much.

We have quantified the effects of demographic change on pension expenditures. This is possible, because the age structure of a population evolves slowly, with a relatively high degree of predictability. At the same time sustainability analyses for old age pensions require a long time horizon, preferably up to 40 years or more. In the long term population trends are also difficult to predict, but demographers and statisticians have developed methods to provide estimates of forecast uncertainty. In addition to demographic variables, our simple model contains a number of economic variables. These too, are uncertain. In principle we should also quantify prediction uncertainty in labor market variables and pension variables. Methods to calculate meaningful prediction intervals with a forecast horizon of 40 years for future retirees or the number of persons who are employed are not known of. We also see that the percentage of people in Norway who participate in the labour market is at a more or less constant high level; some variations are visible due to cyclical fluctuations. We assume that the latter portion does not have large prediction uncertainty. The number of people who are gainfully employed can vary greatly due to unexpected changes in immigration levels, but such variations are included in the stochastic population forecast.

In our opinion, the uncertainty in the pension variables is huge, especially in the age at which workers start to take up their pensions. Therefore, we modeled two alternative situations (cf. above) and performed a number of sensitivity analyzes. We hope in this way to have covered most of the wide range of future levels of pension costs.

Is the new pension system robust with respect to unexpected changes in life expectancy? We have assumed the same increase in life expectancy as Statistics Norway did in its population projections from 2011, and we allowed random variations around this level, which reflect prediction uncertainty in life expectancy forecasts. We found that the expenditures in 2050 can be much higher (with lower mortality than expected) or much lower (with a less favorable life expectancy development) than expected. Differences in expenditures may very well be 10 billion NOK or more, just for one year. Compared with the total expenditure for public old-age pensions (200 or 300 billion per year), this difference is not large, but if the payments for public old-age pensions are 10 billion NOK higher than expected in a number of years, such an amount is of great significance. Then policy measures could be necessary. Demographers have often underestimated the increase in future life expectancy. Therefore it is good practice to account for pension costs that increase faster than expected. A buffer fund may protect the Norwegian state against sudden increases in pension costs. It is too early to propose changes in the new pension system, partly because we have little knowledge of retirement behavior under changing life conditions. Therefore it is necessary to monitor demographic trends closely.

References

Alho, J., H. Cruijsen and N. Keilman (2008). Empirically based specification of forecast uncertainty. In: Alho, J., SH Jensen og J. Lassila: *Uncertain Demographics and Fiscal Sustainability*. New York: Cambridge University Press, 34 – 54.

Alho, J. and B. Spencer (2005). *Statistical Demography and Forecasting*. New York: Springer.

Alders, M., N. Keilman og H. Cruijsen (2007). Assumptions for long-term stochastic population forecasts in 18 European countries. *European Journal of Population*, 33-69.

Bongaarts, J. (2004). Population aging and the rising cost of public pensions. *Population and Development Review*, March 2004, 1-23.

Brunborg, H. and I. Texmon (2011). Befolkningsframskrivning 2011-2100: Modell og forutsetninger. *Økonomiske Analyser* 4/2011, 33-45.

Dahl, E. and O. Lien (2011). Pensjonsreformen: effekter på sysselsettingen. *Arbeid og Velferd* 4, 35-42.

Foss, A. (2012). Stokastiske befolkningsprognoser for Norge 2012-2060. *Økonomiske Analyser* 2/2012, 30-34.

Fredriksen, D. (1998). Projections of Population, Education, Labor Supply and Public Pension Benefits. Oslo: Statistics Norway.

Fredriksen, D. and N.-M. Stølen (2011a). Utforming av alderspensjon i folketrygden, Rapporter 22/2011. Oslo: Statistics Norway.

Fredriksen, D. and N.-M. Stølen (2011b). Pensjonsreformen - økte utgifter til alderspensjon motvirkes av sterkere vekst i arbeidsstyrken. *Økonomiske Analyser* 6/2011, 38-44.

Keilman, N., D.Q. Pham and A. Hetland (2002). Why population forecasts should be probabilistic - illustrated by the case of Norway. *Demographic Research* 6-15, 409-454.

Keilman, N. (2008). European demographic forecasts have not become more accurate during the past 25 years. *Population and Development Review* 34(1), 137-153.

Keller, L. (2012). *Demografisk usikkerhet og utgifter til alderspensjon i folketrygden – En empirisk analyse.* Masteroppgave, Universitetet i Oslo.

Lassila, J. and T. Valkonen (2008). Longevity adjustment of pension benefits. In: Alho, J., S. Jensen and J. Lassila: *Uncertain Demographics and Fiscal Sustainability*. New York: Cambridge University Press, 137-160.

NAV-statistikk 2012. Arkiv-Alderspensjon pr. 31. desember 2011. http://www.nav.no/Om+NAV/Tall+og+analyse/Pensjon/Alderspensjon

Statistics Norway – SN (2011). *7 Trygd, sosialhjelp og barnevern.* http://www.ssb.no/samfunnsspeilet/utg/201105/tabeller/tab-2011-12-05-07.html

Statistics Norway - SN (2012).

a. Befolkningsframskrivninger. Nasjonale og regionale tall, 2012-2100. Rask utvikling mot 6 millioner innbyggere. http://www.ssb.no/folkfram/
b. Tabell 06913: Folkemengde 1. januar og endringer i kalenderåret (K). http://statbank.ssb.no/statistikkbanken/
c. Tabell 03781: Sysselsatte, etter kjønn og alder. http://statbank.ssb.no/statistikkbanken/
d. Tabell 08054: Gjennomsnittlig månedslønn for heltidsekvivalenter, etter kjønn, sektor og desiler. http://statbank.ssb.no/statistikkbanken/
e. Tabellene 05798 og 08564: Oversiktstall fra skattelikningen for alle personer. http://statbank.ssb.no/statistikkbanken/
f. Tabell 07482: Offentlig forvaltning. Inntekter og utgifter, etter art (mill. kr). http://statbank.ssb.no/statistikkbanken/

OECD (2012). Average annual wages. http://stats.oecd.org/Index.aspx?DatasetCode=AV_AN_WAGE

Rikstrygdeverket (2000). Tabell 153: Folketrygden. Alderspensjon, etter fylke. 31. desember 2000. http://www.ssb.no/aarbok/2001/tab/t-030430-153.html