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Discussion Papers no. 115 • Statistics Norway, April 1994

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Abstract:
The microsimulation model MOSART is used to analyse the long run development in disability and old-age pensions covered by the Norwegian National Insurance System. The number of pensioners will increase relative to the number of workers, leading to a growing tax burden on future generations. It is found that among those born before the year 2000, early generations possess a larger pension wealth (the discounted value of payments and received benefits) as a per cent of life time labour income than later generations. The paper discusses changes in the rules for determining pension benefits and the consequences of going from a pay-as-you-go system to a funded system.

Keywords: Disability, demography, microsimulation, pension benefits.

JEL classification: H5, J1

Acknowledgement: We are grateful to Marie W. Arneberg for valuable comments and to the National Insurance Administration for letting us use their registers on pension entitlements. Financial support from Norges Råd for Anvendt Forskning (NORAS) is acknowledged.

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1. Introduction

In many countries there is an ongoing debate about the modern welfare state. In a welfare state the government takes explicit responsibility for creating social justice, reducing poverty and creating a stable economic environment. This usually entails active government intervention in the economy, a large government sector providing goods and services and comprehensive redistributive programs. To some extent the welfare states developed in the Scandinavian countries have achieved these aims. However, the recent past has also revealed some of the negative effects of a comprehensive welfare state. It necessitates relatively high taxes (and/or large public sector deficits) and leads to negative supply effects. It has also been argued that the total redistribution effects of the welfare state are in reality fairly small.

An effect of the welfare state is to divide the population into receivers and contributors of government funds. If the number of receivers or the value of the transfers to the receivers grows rapidly, the tax-burden on the contributors can become politically unacceptable. In particular, social security systems in countries facing low fertility rates and an ageing population represent a growing burden on government budgets.

This paper analyzes the future burden of public pension benefits in Norway. It focuses on the public pensions received by the disabled and the retired in relation to the contributions to the social security system from those in the labour force. The pension system is formally a pay-as-you-go system, where pensions are determined by legal rules based on each individual's income history. The pension system also has some built-in indexation.

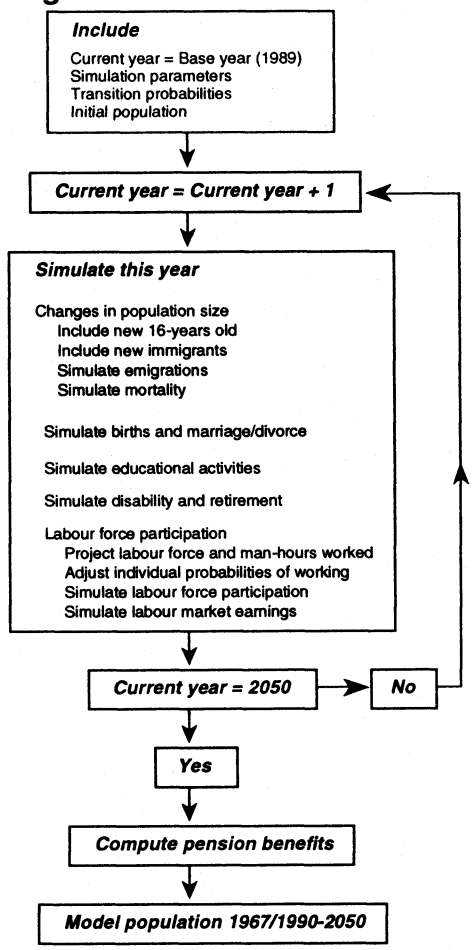
The analysis is based on the microsimulation model MOSART[1]. One of the advantages of using a microsimulation model in the present context is that it produces individual life histories which are important when calculating pension benefits and entitlements. The paper discusses how different immigration rates, labour force participation rates and disability propensities in the long run influence the labour force and the social security system. The paper also considers how the social security system redistributes income across generations (cohorts).

1. MOSART is a Norwegian acronym for Model for Microsimulation of Schooling, Labour Supply and Pensions (MOdell for mikrosimulering av Skolegang, ARbeidstilbud og Trygd).

2. Model description

The MOSART model is a dynamic cross-sectional stochastic microsimulation model which projects population size and composition, labour force, educational level and future pension benefits. It includes the events immigration and emigration, death, births, marriage, divorce, education, disability, retirement, labour force participation and labour market earnings. An overview of the MOSART model is given in figure 1, while table 1 lists the events which are simulated along with the variables that each event depends on.

Figure 1. Simulation model



The present version of the model simulates life histories for a 1 per cent sample of the Norwegian population 16 years and older. This gives us a model population of 30 000-35 000 individuals in each simulation year. It is possible to simulate a larger sample, but we have chosen this level to achieve acceptable computing times (a total of about 4.5 hours of CPU-time). This version of the model is an expanded version of the model presented in Andreassen (1993) and Andreassen et al. (1993).

The MOSART model is a discrete time model, with one year intervals and has a recursive structure. The simulation proceeds one year at a time, simulating all events which occur for all individuals during that year. This procedure enables us to keep track of the link between spouses and to set constraints on some aggregate totals for each year. As can be seen from figure 1 and table 1, the simulation is sequential with later events to a large degree depending on earlier events. Transition probabilities are estimated as conditional probabilities, dependent on the events which are simulated earlier. This enables us, to a certain degree, to take into account competing risk.

For each year the model first supplements the model population with new 16-years-old and immigrants, and simulates emigration and mortality. Then births are simulated, followed by marriage and divorce. After the above demographic events are simulated, the model simulates educational activity, disability and retirement. Finally labour force participation and labour incomes are simulated depending on most of the events simulated earlier that year.

The simulation in the present version of the model goes from 1990 to 2050, with historical data going back to 1967. This results in a very large output which is sorted and organized ontor indvidual life histories after the simulation is finished. These post-

Table 1: Processes represented in the MOSART model

Process or Event	Conditional Upon
Death	Age, sex, disability
Fertility (women)	Age, parity, age of youngest child,
Marriage (female dominant)	Women's age and marital status (unmarried, divorced or widow) and whether the woman has children
Matching with a husband	Husband's age depends upon woman's age
Divorce (female dominant)	Wife's age
Education	Age, sex, educational attainment, current educational activity
Entry into disability	Age, sex, educational attainment, marital status, labour force participation in the preceding year
Retirement	Happens at age 67 for all individuals (approximately)
Labour force participation Labour market earnings	Age, sex, educational attainment, whether an individual is a student, disability, labour force status in the preceding year, labour force attachment (a measure of the stability of labour force participation in the preceding years), marital status. In addition for women: the number of children and age of youngest child

simulation routines also include calculation of pension benefits and production of tables with aggregate figures.

The MOSART model is mainly a demographic model where educational transition probabilities, the transition into disability, labour force participation rates and labour market earnings only depend on demographic variables. An important feature of the model is the large initial population with no synthetically generated (simulated) variables.

A model which has many similarities with the MOSART model is the Dutch dynamic cross-sectional model NEDYMAS, described in Nelissen and Vossen (1989) and Nelissen (1991).

2.1. The initial population

The initial population is a 1 per cent random sample of the Norwegian population 16 years and older in the base year 1989, and includes about 33 000 individuals. The sample is drawn stratified by age, sex and marital status. Married couples are drawn together and are linked together during the simulation. We have produced ten disjunct initial populations each covering 1 per cent of the total population. We thus have access to a 10 per cent sample when we estimate transition probabilities. To avoid estimation bias, this sample includes 10 per cent of all individuals who have died or emigrated since 1967.

The initial population and the larger 10 per cent sample are the result of merging different data registers. From the Central Population Register we get female birth histories and information on each individual's sex, age, marital status, and for immigrants year of entry into Norway. From the Educational Register in Statistics Norway we get

educational attainment and activities since 1985. Data from registers in the National Insurance Administration show whether a person is a recipient of old age-, disability- or widow pension for each year since 1985 and also existing pension entitlements based on annual labour market earnings since 1967 (first year of the National Insurance System).

2.2. Demographic transitions

The number of new 16-year-olds added to the model population each simulation year can be determined in two ways. One can use the number of births simulated in the model, and thus make an endogenous population projection. Or one can use an exogenous number of new 16-year-olds, for example from the official population projection from Statistics Norway. New 16-year-olds are assigned the starting-values of unmarried, childless, non-disabled, non-working and just left primary school.

The total number of net immigrants is specified exogenously in the model and divided into groups by age and sex. We also simulate womens birth histories and marriage among immigrants using probabilities which characterize the Norwegian population as a whole. This reflects the fact that immigrants in the model are assumed to exhibit behaviour with the same probability structure as non-immigrants. This is done for simplicities sake, since data on immigrants at present is limited. The educational attainment for immigrants is set to "unknown", as in the educational statistics. If we are faced with net emigration in some age groups, the model draw individuals from the sample who then are assumed to emigrate.

Mortality is simulated dependent on age and sex. If a married person dies, the surviving spouse is made a widow or widower. Disability pensioners have substantially higher mortality rates than others, and we have as an option the possibility of increasing their mortality by a fixed per cent. The mortality of non-disabled is in this case reduced endogenously to make aggregate mortality unchanged. Mortality is in the present version independent of marital status and educational attainment, assumptions that are open for improvements.

After mortality and migration, the model simulates births and changes in marital status. Giving birth is simulated using probabilities which depend on the women's age, the number of children and the age of the youngest child. These fertility probabilities are mainly independent of marital status, but unwed mothers are exposed to increased probabilities of marrying. This assumption is to some extent a reflection of the large proportion of couples cohabitating without being married.

Simulation of marriage and divorce is female dominated based on marriage and divorce probabilities for females. Marriage is simulated with probabilities that depend on the woman's age, whether she recently has born a child and on her marital status (unmarried, divorced or widow). If a woman marries, the model draws the age of her spouse with probabilities depending on the woman's own age and then randomly draws a spouse among all unmarried males of this age. This implies that the marriage probability of a man will be the same whether he is unmarried, divorced or widower. If a woman is

drawn to divorce, her husband will also be divorced. We assume that it is only possible to change marital status once a year.

2.3. Education

The MOSART model simulates for each individual year by year educational activities and the resulting influence on educational attainment. The transition probabilities through the educational system depend only on age, sex, educational attainment and educational activity in the previous year. Education is described by level and subject. Educational level is divided into one-year steps and educational subjects are gathered in relatively large groups, where we separate between health subjects, technical subjects and administrative subjects at all levels. The transition probabilities have been estimated on all educational transitions in Norway between the school years 1986/87 and 1987/88. The number of pupils and students in Norway has increased dramatically since 1988, perhaps related to the rise in unemployment. To take this into account we have adjusted the estimated probabilities so that the model simulates the observed number of pupils and students in 1991.

About 90 per cent of those leaving primary school continue directly into secondary school, with 40 per cent choosing gymnasium. The flow through the educational system is seemingly slow, characterized by movements across subjects and fairly low progression. This is especially the case for higher education and vocational training. Low progression in vocational training is caused by a combination of good capacity in basic courses and low capacity in final courses. On the basis of estimated transition probabilities for education from 1987, about 40 per cent of all individuals experiencing these probabilities will attain an higher education (post-secondary) during their lifetime, and about 40 per cent will end up with a three-year vocational training. The increase in the number of pupils and students since 1987 will probably lead to a substantially higher proportion of the population attaining higher education.

2.4. Old age and disability pensions

Public old age pensions, disability pensions and pensions for widows and widowers are in Norway organized through the ***National Insurance System***. This version of the MOSART model simulates the number of recipients under these three programmes and also calculates the corresponding pension benefits. The intention of these programmes is both to secure a minimum level of income and ensure pensions which are related to previous labour market earnings. The calculation of these benefits is rather complex and is presented in more detail in appendix A.

The key to understanding the National Insurance System is the socalled ***basic pension unit*** (BPU), an amount of nominal Norwegian Krone. The BPU is increased every year to compensate for inflation and to some degree real income growth. The BPU is also used to calculate the upper limit for earning pension entitlements.

The main features of the pension system are that all pensioners are guaranteed a ***minimum pension***, which is about one-third of average full time labour market earnings. Most pensioners also receive an ***additional pension*** depending on average labour market

earnings during their working years. These pension entitlements are roughly calculated by dividing labour income each year by the BPU that year. As pensioners, the additional pension is calculated by multiplying a predetermined fraction of the current pension entitlements by the current BPU.

The after tax pension/wage-ratio decreases with income, and is with stable labour market earnings around 80 per cent with an income of 100 000 Nkr and 50 per cent with an income of 300 000 Nkr. The National Insurance System was established in 1967 and it is only earnings obtained after this year which qualify for the additional pension. This implies that average entitlements will keep on growing well into the next century. People 70 years and older receive old age pensions independent of other sources of income, while people of age from 67 to 69 have their pensions means-tested against labour market earnings. The fact that 90 per cent retire at the age of 67 simplifies the simulation of retirement[2]. Widow pensions cover mainly widows with low labour market earnings[3]. The simulation of such pensions is therefore closely connected with the simulation of marital status and labour force participation.

Disability pensions are granted to all people with a permanently reduced working ability of at least 50 per cent caused by disease or accident. Once a person is granted disability pension, it is common to remain a disability pensioner until she or he reaches the age of 67 (and is transferred to old age pension) or dies. Working ability is measured relative to a person's opportunities in the labour market. At the end of the eighties the medical claims had become rather open and included more or less any kind of long term problems in the labour market. This included problems such as alcoholism, stress syndromes and long term unemployment. In many cases disability pension has been (mis)used to enable elderly workers to retire earlier than the official retirement age of 67. In 1990 about 8.5 per cent of the population in the age group of 16 to 66 years received a disability pension, and by the age of 65 to 66 years about 45 per cent received a disability pension. During the very last years there has been a tightening of the criteria for being disabled and a reduction in the number of new disability pensioners. It is too early to see the long term effects of this, since there has been an increase in the number of persons in situations which commonly lead to disability pension (for example work rehabilitation and long term unemployment).

The transitions into disability depend on sex, age, educational attainment, marital status and labour force participation. The probabilities are represented by a logit function and are estimated on the same 10 per cent sample of the population as the initial population is based on. Data on transitions into disability pensioner is here available for the years 1986 to 1989.

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2. Certain occupational groups have a lower retirement age, but not through the National Insurance System. During the last years there has been established a scheme for general retirement at 64 for members of the main labour market organisations.
3. In principle men can also receive this type of pension, but few men become widowers before the age of 67. Additionally the widow and widowers pension is means-tested, and most men earn more than the maximum limit.

2.5. Labour force participation

Simulation of yearly labour force participation is intended to both give a projection of the labour force and of the pension entitlements earned in the future. Lack of good data covering both the labour force and labour market earnings has lead us to use two different types of simulation of labour force participation based on two different definitions of labour force participation. One definition is the one usually used by labour force surveys, namely the yearly average number of persons in the labour force. The other definition is the total number of persons who have been in the labour force at any point of time during the year. This last definition corresponds to the data we have for labour income[4] in the data registers of the National Insurance System.

These two definitions of labour force participation are related by the probability that a person with labour income during the year also will be a part of the labour force at any given time during that same year[5]. This probability can be interpreted as the share of the year a person works. The two definitions vary in the extent to which they capture pupils, students and pensioners participating only in seasonal work during holidays and vacations.

The first type of simulation is based on data from the Norwegian Labour Force Surveys. The model computes the expected labour force participation rate and working hours of each individual. By adding across all individuals in the model population, the model produces a projection of the labour force and man-hours worked. The labour force participation rates and average working hours are estimated from the Labour Force Surveys in 1991, and depend on sex, age, educational activities and attainments, disability, marital status, number of children and age of youngest child. Labour force participation rates are in the present version assumed constant throughout the simulation period. The projection thus shows the effect on the labour force of changes in the size and composition of the population.

The second type of simulation simulates exits from and entries into the state of having positive labour income during the year. These transition probabilities are dependent on age, sex, educational activities and attainments, disability, stability of labour force participation in preceding years, marital status, number of children and age of youngest child. They are estimated using a logit function on our 10 per cent sample of the Norwegian population for the years 1985-1988. Consistency between the two types of simulation is ensured by letting the first type determine the level of the total labour force and man-hours worked, while the second type determines the distribution of labour force participation across the population. The transition probabilities used in the second simulation are adjusted to make the expected number of individuals with labour income consistent with the projected labour force of the first simulation. This is done using an algorithm ensuring that the individual differences in the probability of having labour income during the year are maintained.

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4. This is the sum of wages, income of the self-employed, sick leave benefits, unemployment benefits and maternity leave benefits during each year.
5. We have excluded the possibility of a person without labour income being a part of the labour force, for example young unemployed without previous work experience and therefore no unemployment benefits.

Distribution of labour income

Simulation of labour income is based on the distribution of income among individuals and is estimated by using OLS on our 10 per cent sample of the Norwegian population during the years 1985-1988. Our estimates are based only on persons with positive labour income during the year (i.e. more than 1 000 Nkr). The model can be written:

$$\log Y_{it} = X_{it}\beta + U_{it}, \qquad (1)$$

where Y_{it} represents labour income during year t for individual i and U_{it} is a disturbance term. The vector of explanatory variables, X_{it}, includes age, sex, educational activity and attainment, disability, whether an individual the same year has entered or left[6] the state of having labour income, stability of labour force participation in the preceding years, marital status, number of children and the age of the youngest child. Labour income is simulated by using (1) and an adjustment term k in the following manner:

$$Y^s_{it} = k \cdot EXP(X_{it}\hat{\beta} + \varepsilon_i), \qquad (2)$$

where ε_i is a fixed residual spesific for each individual and $\hat{\beta}$ is the OLS estimate from equation (1). ε_i does not vary over time, but has the same distribution across individuals as the disturbance term U_{it}. The chosen specification of the residual ε_i gives an income distribution similar to the observed income distrubution in our 10 per cent sample of the Norwegian population over the years 1967-1989. The adjustment term k is set so that the following condition is satisfied:

$$\Sigma_i Y^s{}_{it} = W_t \cdot H_t \qquad (3)$$

where W_t is an exogenous given wage level and H_t is projected man-hours from the simulation. This implies that (2) only gives a description of the income distribution, and that the average full-time labour income is set outside the model.

3. The National Insurance System in the long run

In our analysis we use a base line projection together with several alternative projections. These alternative projections are simulations using different levels of the most important transition rates and of other exogenous variables such as net immigration. This gives an indication of how sensitive our results are to changes in current behaviour.

3.1. The base line projection

In table 2 we have summarized the main assumptions underlying the base line projection. The most important demographic assumptions concern immigration, death, and fertility.

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6. We assume that an individual leaves the state of having labour income in the year before labour income become zero.

Table 2: The main assumptions in the base line projection

Process or Event	
Net immigration	5 000 per year
Death rates	1988/1989 data, with death rates decreasing to 2010 at a rate equal to that observed in the period 1965-1988
Fertility	1989 data (period fertility) implying a total fertility rate of 1.89
Marriage	1984 data
Education	Data from the school years 1986/1987 and 1987/1988, with an ad hoc adjustment so that the model simulates the observed number of pupils and students in 1991.
Disability	1989 level (a historically high level)
Labour force participation	1991 level (a relatively low level compared with the preceding 5 years)
Labour market earnings	0.75 per cent growth in real wages
Social security benefits	The basic pension unit BPU (which determines individual pension benefits) increases at the same rate as wages

Net immigration is assumed be 5 000 persons per year during the whole projection period (the total population in Norway is just above 4 000 000 people). Since 1985 actual net immigration has varied from -1 500 (in 1989) to 14 000 (in 1987). Death rates are at the outset assumed to be equal to those observed in 1989, and then decrease until 2010 at a rate equal to that observed in the period 1965-1988. After 2010 the death rates are assumed to be constant. This will lead to an increase of expected life time at birth of 1-2 years. Fertility rates are assumed to be equal to the period fertility rates observed for 1989, implying a total fertility rate of 1.89. In comparison, the fertility rate for the period 1981-1985 was 1.68, while in 1991 it was 1.92. In 1967, when the National Insurance System was established, the total fertility rate was well above 2.5.

Transitions into disability in the base line alternative are from the year 1989, when they where at a historically high level. They were much ower in 1986 having increased by 60 per cent in the period until 1989. Labour force participation rates are set at the 1991 level when 68.5 per cent of the population 16-74 years old was in the labour force. In comparison, 71.3 per cent of the population aged 16 to 74 years old were in the labour force in 1987 (highest observed level in post-war Norway).

In the base line alternative the BPU, and thus the additional pensions, increase in line with wages. Real wage growth is assumed to be 0.75 per cent a year, although this growth rate is by itself not very interesting in our model. It is the difference between the growth in benefits and in wages which is of interest, and which is the main focus of our paper.

Figure 2. Population projections under different demographic assumptions

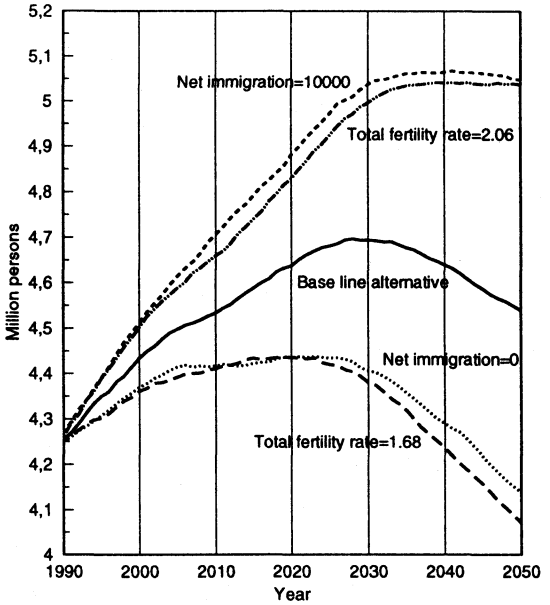
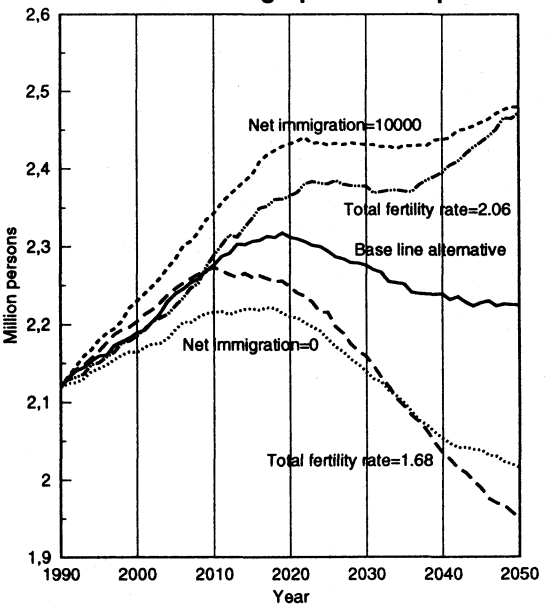


Figure 3. Labour force projections under different demographic assumptions



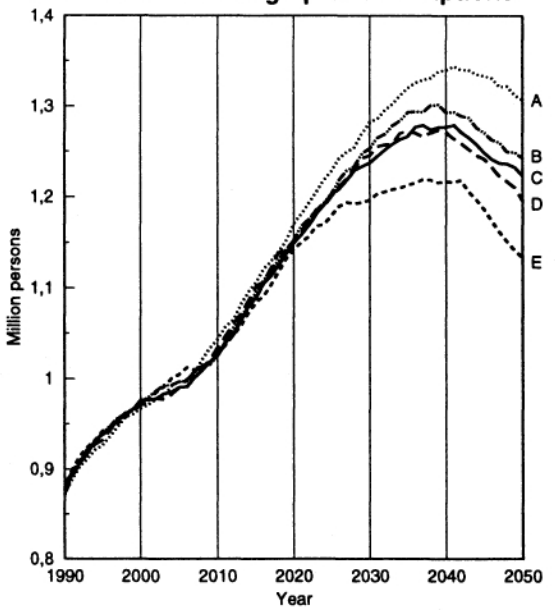
3.2. Population, labour force and the number of pensioners

Figure 2 shows five different projections illustrating how sensitive the base line projection is to changes in immigration and fertility. As mentioned earlier, the base line alternative assumes a total fertility rate of 1.89 and a net immigration of 5 000 persons. The figure shows that in the base line alternative the population starts declining just before 2030, while with a net immigration of 10 000 or a total fertility rate of 2.06 (approximately the replacement level of fertility) the population levels off at about 5 million persons. A drop in net immigration to zero or a fall in the total fertility rate to 1.68 will lead to a significantly smaller population, approaching 4 million in 2050. This illustrates the fairly dramatic consequences arising from changes in immigration or fertility, but it also illustrates how it is possible to compensate for a fall in fertility by increasing immigration.

In figure 3 developments in the labour force is similar to the population developments shown in figure 2. High net immigration or high fertility level leads to an increasing labour force during the whole period. Figure 3 also illustrates that changes in immigration and in fertility have different effects on the age profile of the population. Increased immigration feeds directly into the labour force because immigrants are mainly adults under the age of 40, while increased fertility can first affect the labour force when the newborn reach maturity. This explains why a net immigration of 10 000 individuals a year in the short run increases the labour force more than a total fertility rate of 2.06, but have about the same effect in the year 2050.

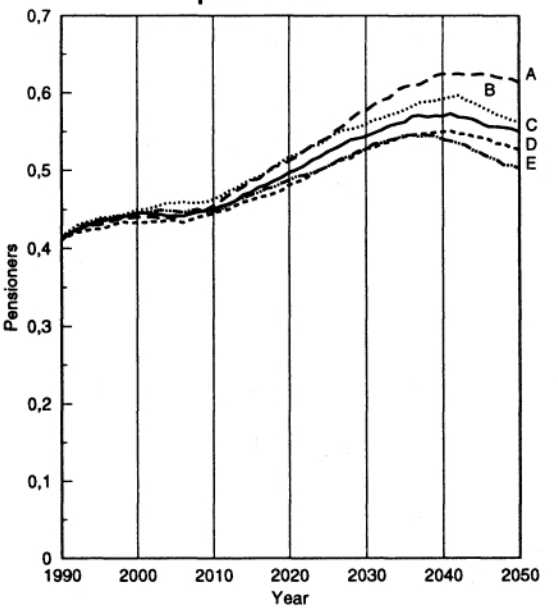
Figure 4 illustrates the increase in the number of pensioners implied by the different demographic assumptions. It includes pensioners on both public disability and old-age pensions. The base line alternative shows a peak in 2040. As expected, the effects from a shift in assumptions are not as dramatic for the number of pensioners as for the popu-

Figure 4. The number of pensioners under different demographic assumptions



A. Net immigration = 10000
B. Total fertility rate = 2.06
C. Base line alternative
D. Total fertility rate = 1.68
E. Net immigration = 0

Figure 5. The number of pensioners per worker



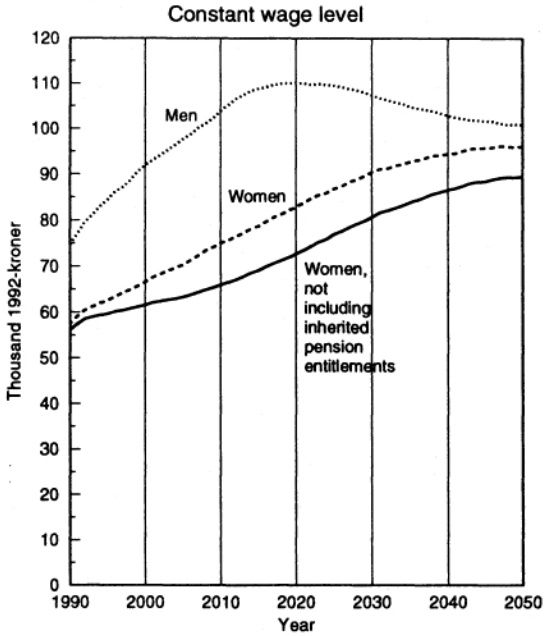
A. Total fertility rate = 1.68
B. Net immigration = 0
C. Base line alternative
D. Net immigration = 10000
E. Total fertility rate = 2.06

lation as a whole. This is in large part because of fertility assumptions to a very limited degree will affect the number of pensioners before the year 2050. Changes in immigration have larger consequences, because, as mentioned earlier, most immigrants arrive in the country as adults. In 2050 the difference between the alternative with high and low immigration is almost 200 000 persons.

One of the main determinants of the burden of pension benefits is the number of pensioners compared with the number of workers. Figure 5 gives the number of pensioners per person in the labour force under different assumptions and shows little change in this dependency ratio until the year 2010. It then starts increasing about 2010 and reaches a peak around 2040. In the case of a total fertility rate of 1.68 it peaks at a level 51 per cent higher than in 1990, in the base line alternative it is 39 per cent higher, and in the case with high participation rates and low disability rates it is 23 per cent higher. If we disregard the two most extreme cases, we see that this dependency ratio in 2040 lies between 43 per cent (if we have a net immigration of 0) and 31 per cent (with a total fertility rate of 2.06) higher than in 1990. It is therefore a fairly robust conclusion that in the first half of the next century Norway will experience a very large increase in the number of pensioners in relationship to the number of workers.

We also see from figure 5 that changes in fertility have a greater effect on the dependency ratio than immigration, because fertility mainly affects the labour force and not the number of pensioners in the period until 2050. Toward the end of the period increased immigration will ***both have*** increased the labour force and the number of pensioners leading to a relatively small decrease in the number of pensioners per worker. During the later part of the century increased fertility will also lead to an increasing number of pensioners.

Figure 6. Average old age pensions



3.3. Pension benefits

Figure 6 shows the growth in average old age pensions when wages and the BPU are held constant. The figure thus shows the growth in average pension benefits relative to the average wage level. This gives basically the same results as letting wages and the BPU grow at the same rate. The growth in average old age pensions for men until the year 2020 is due to the increase in average entitlements as more and more people earn full pension rights (see 2.4 or appendix A). Average pension benefits for men reach a maximum just before 2020, when most male pensioners will have received pension entitlements from their full working careers. In 1992 the possibility of earning pension entitlements was reduced for high incomes, not affecting already earned pension entitlements. This reform will reduce male old age pension benefits after 2020, as seen from the figure. A stronger growth in the educational level for women than for men, will give a reduction in male/female differences in labour income in the simulation. This will also contribute to the reduction in male pensions (related to average wage level).

Old age pensions for women continue to grow for the next 60 years, and end up close to the pension level for men. The main reason for this long-lasting growth is a strong increase in female labour participation rates throughout the last 25 years in Norway. Only female cohorts born after 1970 will have these high labour participation rates throughout their full working careers. Even though average labour income for women born after 1970 in the simulation is about 70 per cent of that of men in the same generations, the differences in male/female pensions is small. Two important reasons for this are that the pension/wage ratio decreases with income and that persons without labour income receives pension entitlements if they have extensive family care obligations (mothers with young children). Another important contribution comes from the fact that women on average live longer than men. As widows they both receives higher basic pensions as singles and inherit pension entitlements from their late husbands, the magnitude of the latter is shown in figure 6.

3.4. Contribution rates

An indicator of the burden of public pension benefits is the ratio between total pensions and total income. This ratio can be thought of as a general tax rate or as the required contribution rate to the social security system. When discussing contribution rates and income distribution we are incorporating economic variables which are not explicitly modeled in MOSART. One way of interpreting this is to think of MOSART as representing a closed economy producing a non-durable commodity. This means that there is no saving or investment and that future pension payments cannot be based on foreign

capital income. Labour is the only production factor and labour income is the only source of income. Total income in the model will then be equal to the sum of labour income while consumption will be equal to yearly output. This leads to an interpretation of the MOSART model close to the overlapping generations model in Samuelson (1958).

The elderly are in this type of model completely dependent on sharing a part of the workers income. Old-age pensions represent an implicit contract where those in the labour force (the young) care for the elderly in return for being cared for by the next generation when they themselves become old. If we assume that the government is only concerned with this type of redistribution, the government budget constraint will be

$$\Sigma_i p_i = t \Sigma_i w_i h_i, \tag{4}$$

where p_i is the pension, w_i is the wage, and h_i is the number of hours worked by individual i. The variable t is the contribution rate (tax rate) which is necessary for the social security system to be able to honor its obligations. If pensions are also taxed this relationship becomes

$$\Sigma_i p_i = t \Sigma_i (w_i h_i + p_i). \tag{5}$$

This budget balance can be interpreted as an implicit social contract. The contribution rate t will vary over time depending on variations in average income, the size of the labour force, and the number of old-age and disability pensioners. The future developments in the number of pensioners per worker shown earlier in figure 5 and in average

Figure 7. Contribution rates

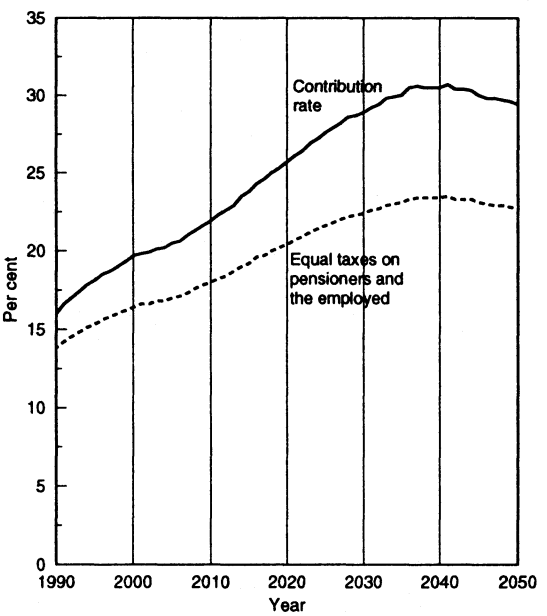
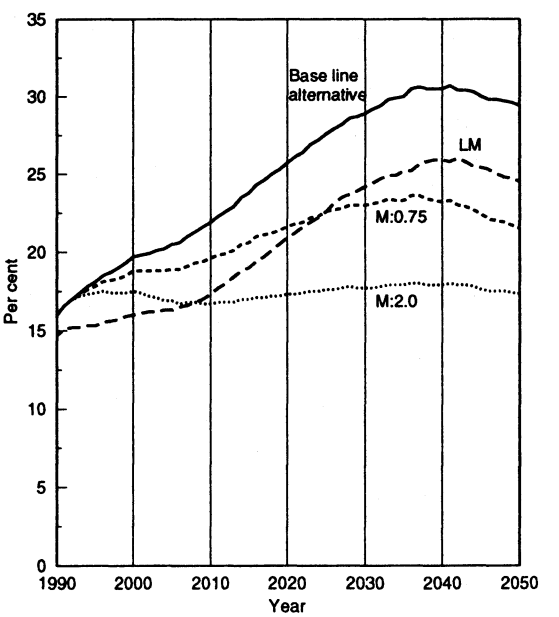


Figure 8. Contribution rates



LM: Entry into disability pension reduced by one-third, 1987 labour force participation rates.

M:0.75,M:2.0: BPU increases at a rate which is 0.75 and 2.0 % lower than that of wages.

old-age pensions in figure 6 are thereby important factors in determining the contribution rate. Figure 7 shows that the contribution rate in the base line alternative will grow dramatically for the next 50 years. From a level of 17-18 per cent today, the contribution level will stabilize at a level just below 30 per cent.

The growth in the contribution rate during the first 20 years is caused by the maturing of the National Insurance system and a major increase in the number of disability pensioners. In this period we expect an increase in the labour force and a (slight) reduction in the number of people older than 67 years. These sosio-demographic changes will isolated reduce the contribution rate. Just after 2010 the first cohorts of the post-war baby-boom reach retirement age, and this will lead to a strong growth in the contribution rate.

Pensioners in Norway pay a premium into the National Insurance System, but at a much lower rate than the employed[7]. This difference has to some degree been reduced since 1967. Figure 7 shows the effect of equal taxation of labour income and pension benefits. This tax rate is estimated as the ratio between total pensions and the sum of total pensions and total wages each year. The reduction related to the contribution rate is large, especially after 2010 when pension benefit expenses increase fast.

The contribution rate is sensitive to changes in the underlying assumptions, and we can only outline the effect of changes in a few of these assumptions. Historically, the basic pension unit (BPU) has been increased at a lower rate than the increase in wages. The BPU, and thus the additional pensions, have mainly been increased with the general inflation rate, while the minimum pension has increased at a slightly higher rate than wage growth. Figure 8 shows the development in the contribution rate if this policy is continued. The BPU is increased at a rate respectively 0.75 and 2 per cent lower than wage growth, while minimum pensions are held constant relative to the wage level. With a real income growth of 0.75 per cent, the first alternative is quite realistic since all pensioners at least maintain their purchasing power. Compared to the base line alternative, where additional pensions are increased at the same rate as wages, the impact on the contribution rate is considerable.

The number of new disability pensioners has been reduced since 1989, probably because the government has made it more difficult to be diagnosed as disabled. Compared with the base line alternative this shows the effect if the entry rate of new disabled is held at this lower level combined with an increase in labour participation rates to the 1987-level. Decreased entry into disability may be regarded as a policy option, and shows another possibility of substantially reducing the growth in the contribution rate. The number of disability pensioners is reduced by one-third in the long run, showing what large variation there has been in the entry of new disability pensioners over the last years.

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7. The differences in the direct social security tax is low, but employers also pay a tax directly into the National Insurance System that is related to wage expenses.

3.5. Income transfers between generations

Social justice is one of the basic ideas behind the welfare state. Social justice concerns both income distribution and legal principles about fair and equal treatment by the government.

The welfare state consists of a complex set of rules and laws that cover the concerns of a very heterogeneous population. Some of the effects of welfare state institutions are visible immediately, but others have to be judged in a life cycle perspective. In a social insurance system we have to use a life cycle perspective to compare the contributions paid with the transfers gained. Such comparisons can be made for different socio-demographic groups by comparing high versus low income, male versus female or different birth cohorts. Comparing the contributions and gains of different birth cohorts is to some extent also the aim of the generational accounting approach such as the study done for Norway in Auerbach et al. (1993).

The complexity of the welfare state and the heterogeneity of the population makes dynamic microsimulation a very effective tool for analyzing how different population groups are treated by the welfare state. The microsimulation approach allows us to take into account in great detail the socio-demographic structure of the population and use an almost precise description of the laws and rules which apply. The weak point in our present model is the modeling of economic behaviour.

In the following we try to analyse how life cycle income is influenced by a transfer system, such as the National Insurance System, based on a pay-as-you-go social contract. We also look at whether the present system has any redistributive effects across generations.

In the closed economy interpretation of MOSART discussed earlier, we have that net income y_i for individual i in a given year will be

$$y_i = w_i h_i + p_i - t(w_i h_i + p_i). \qquad (6)$$

For most people either p_i or $w_i h_i$ equals zero. The distribution of net income over each individuals life time depends on gross income, the tax structure and of course the rules which apply in the pension system.

In the simple economy with only a non-durable good, life time income can be seen as simply the sum of yearly incomes. This is similar assumption to that used in calculating life-cycle earnings in Wolfsen (1988). If we leave the this simple interpretation of MOSART and assume that there are financial markets, where it is possible to save at a given interest rate, it is natural to discount income. A certain income earned today is of greater value than income earned later. The interest rate is an exogenous variable in MOSART in the same manner as average wages. These variables were in the base-line projection determined in a separate macroeconomic model.

In the following we try to analyse the effect the National Insurance System has on the distribution of income both between generations and within each generation. The key concept is individual pension wealth calculated as the difference between the discounted value of pension benefits and payments into the National Insurance System (pension premiums) over the life course:

$$\text{Pension wealth} = \Sigma_t(\text{pension benefit} - \text{pension premium})\cdot(1+r)^{-t}, \qquad (7)$$

where

t - the number of years since this person was 16 years old,

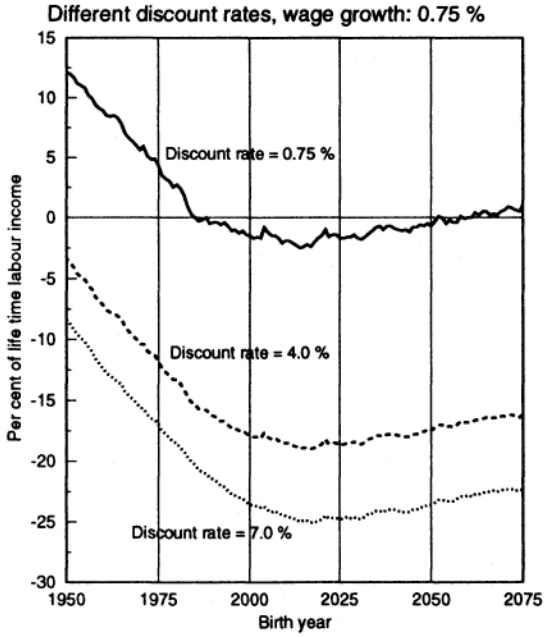
r - the discount rate.

We assume that the discount rate is equal to the real interest rate. We further assume that the pension premium is the estimated contribution rate discussed earlier multiplied by each individuals labour income. This probably gives a reasonable representation of how the National Insurance System actually has been financed. We only have full life time income series for persons born after 1950, making it difficult compare the pension wealth of those born before 1950 with those born after this year. An extra complication is the fact that there was some public pension schemes prior to 1967.

The premiums paid into the National Insurance System may be considered as an alternative to saving (bank deposits, private pension funds). The size of these premiums depends on the number of persons who contribute to the insurance system and the size of the total pensions being paid out. Figure 9 shows the development in pension wealth using different interest rates (discount rates) and assuming that wages grow by 0.75 per

Figure 9. Pension wealth

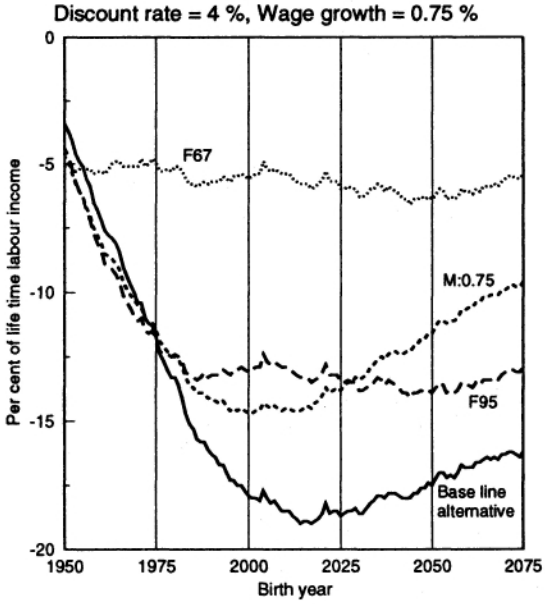
Different discount rates, wage growth: 0.75 %



Smoothed time series

Figure 10. Pension wealth

Discount rate = 4 %, Wage growth = 0.75 %

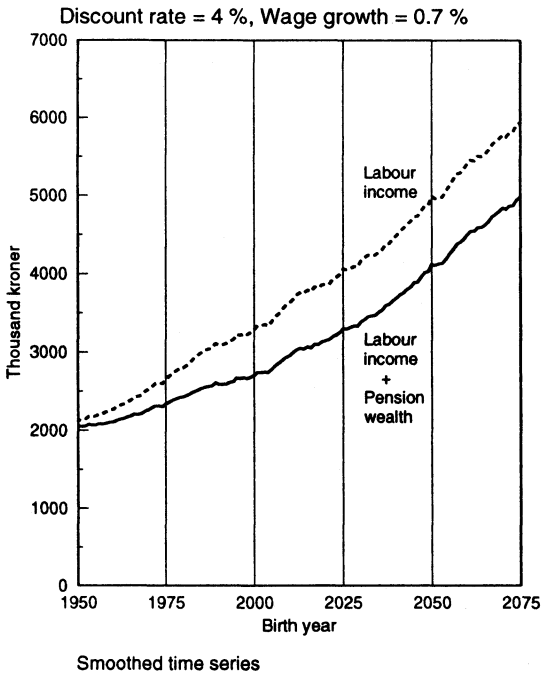


F67,F95: Funded, with a constant contribution rate from 1967 and 1995 respectively.

M:0.75: BPU increases at a rate which is 0.75 % lower than that of wages.

Smoothed time series.

Figure 11. Life time income



cent a year. As before, the basic pension unit BPU (which determines individual pension benefits) increases at the same rate as wages. It is only the difference between the interest rate and the growth rate of wages which matters in our model. If these are equal, we see from figure 9 that individuals born after 1980 receive a return on their pensions which is about equal to what they could have received by saving privately. Those born before 1980 receive more than they otherwise could achieve, because there were relatively few pensioners when they paid their premiums and their pension benefits have increased faster than wages. Because of the increase in additional pensions, average pension benefits will continue to increase faster than wages until the year 2020.

If the discount rate is higher than wage growth, future generations may lose a substantial part of their potential life time incomes (what they could acheive by saving privately instead of being a member of the National Insurance System). In this case the National Insurance System gives a lower return than the market. Another interpretation is that current pension premiums are too low to cover the pension entitlements that are earned today, and that the the interest on the accumulated "deficit" will inflict a loss on all future generations. This redistribution is not necessarily unjust, because future generations may still achieve higher incomes than current generations, as can be seen from figure 11. With a high discount rate figure 9 shows that only generations born long before 1950 will gain, actually only those generations which had no or short working careers after 1967.

We have also looked at other ways of financing the National Insurance System, and figure 10 gives three important alternatives. Two of these alternatives show the effect of holding the pension premium rate constant since 1967 and 1995 respectively, while at the same time requiring the insurance system to be self-financing. The first is the starting year of the National Insurance system, the latter is a present a policy option. Both alternatives imply building large funds under the National Insurance System[8]. If properly funded since the beginning in 1967, the pension premium rate could have been 17.5 per cent assuming a discount rate of 4 per cent and a wage growth of 0.75 per cent. Related to a long run contribution rate of 29 per cent, this would have reduced the loss of future generations substantially. The remaining loss of about 5 per cent, as shown in figure 10,

8. This was the intention when the National Insurance System was established in 1967, but was abandoned in the seventies. The size of these funds is today far too small to meet the increase in the contribution rate after 2010. But total public wealth, mainly future taxes on petroleum production, may change this conclusion.

is mainly a result of paying the pensions of generations that in 1967 had few or no years left of their working careers.

If the National Insurance System were to be funded starting in 1995, the pension premium rate would have to be 25 per cent. Related to a current contribution rate of just below 20 per cent, this only leads to small reductions in future losses. Another alternative is to reduce future benefits by letting the BPU, and thus the additional pensions, be increased at a lower rate than wage growth, without changing the minimum pension. Letting additional pensions grow 0.75 per cent less than wages will slightly reduce the pension wealth of generations born before 1975, and increase that of all future generations.

3.6. Further distribution analysis

Income distribution within generations is a more complicated matter, since the redistributive effects of pension wealth depend both on differences in purely actuarial elements (how long one lives and the probability of being disabled) and on income inequalities. It would be most appropriate to measure expected pension wealth, while the model generates actual pension wealth. With this reservation in mind, we have looked at the latter, and found that the redistributive effects are large. Gini-coefficients for discounted life time income for a syntethic generation, is reduced by 15 per cent in the base line alternative. High discount rates reduce the redistributive effects, because pension benefits are received late in life. The present system with additional pensions has more redistributive effect than a system with an equal pension to everyone (at todays low level of the minimum pension). The reason for this is that additional pensions increase the average pension, and this is more important than the differences in pension benefits. Looking at pension wealth, the National Insurance System benefits women (at the cost of men). One important reason is that women receive higher pensions related to previous income. Two other important aspects are that women become pensioners at a lower age (through disability pension) and live longer.

Appendix A: Calculating pension benefits

Old age, disability and widow pensions from the National Insurance System are based on entitlements each individual achieves through his or her working years. These entitlements are guaranteed by the government and cannot be abandoned, even though their worth can be changed through adjustments of the basic pension unit (see below). For this reason existing pension benefit rules will have an impact on the Norwegian economy well into the next century. The rules for calculating benefits have been slightly changed over the years and since existing entitlements cannot be reduced, this has produced complicated transition rules. In the following, we only discuss the rules used today. We also omit discussing residency requirements which apply when calculating benefits. The National Insurance System was established in 1967, and labour income previous to 1967 are not included in the calculation of benefits. The transition rules which apply to people born too early to achieve full pension entitlements are not discussed in detail.

Measuring unit

The main key to understanding the National Insurance System is the so-called ***Basic Pension Unit*** (BPU), a certain amount of nominal Norwegian kroner (Nkr). BPU is used in both computing new pension entitlements and current benefits. We will later outline how BPU may be increased according to inflation and income growth and what effect this has on the National Insurance System. In 1992 BPU had an average value of 36 200 Nkr (approximately 5 000 Usd[9]).

Pension entitlements

Pension entitlements are calculated using two variables measuring respectively average labour incomes during the working years with highest income, ***Final Pension Point*** (FPP) and number of working years, ***Pension Point Years*** (PPY). Labour income includes wages, income of the self-employed, sick leave benefits, unemployment benefits and maternity leave benefits. For the ages 17 to 69, labour income of each tax-year is translated into ***Pension Points*** as follows:

$$\text{Pension Point} = (\text{Income-BPU})/\text{BPU} \qquad (8)$$

Incomes above 6 BPU are divided by tree times BPU, and incomes above 12 BPU are not included into the calculation of the pension point. Thus small incomes give no pension entitlements while high incomes give progressively less pension entitlements. Some people are granted pension points for other reasons than own labour income. Disability pensioners are granted a ***Computed Pension Point*** (CPP) for each year this person is disabled until he or she is transferred to old age pension. CPP can be computed in several ways, but is normally the average of the last three Pension Points before disability occurred. In this sense CPP is a replacement of the pension entitlements the individual would have achieved if he or she had not become disabled. People who are disabled before the age of 24, are granted a CPP of minimum 3.3. After 1991 women (and men) with children below 7 years, or other extensive family-care obligations, are

9. We have used the exchange rate of june 1993, approximately 7.20 Nkr for each US Dollar.

granted a Pension Point of minimum 3. This is also the average Pension Point of non-skilled females working full-time.

Pension Point Years is the number of positive Pension Points, or the number of years with labour income above one BPU. If the number of Pension Point Years is larger than 40, the Pension Point Year is set to 40. The Final Pension Point is the average of the 20 best positive Pension Points.

Pension benefits

Old age, disability and widow/widower pensions under the National insurance system are mainly composed of three components, a ***Basic Pension***, a ***Spesial Allowance*** and an ***Additional Pension***. The total pension can be written as:

$$\text{Total Pension} = \text{Basic Pension} + \text{Max}(\text{Special Allowance}, \text{Additional Pension}) \quad (9)$$

Pensioners married to another pensioner are granted a Basic Pension of 0.75 BPU and a Special Allowance of 0.55 BPU (in 1992). Other pensioners are granted a Basic Pension of 1 BPU and a Special Allowance of 0.61 BPU (in 1992). The Basic Pension plus the Special Allowance constitute the ***Minimum Pension*** that every pensioner is guaranteed. By increasing the Special Allowance, the government is able to increase the income of those with Minimum Pension, without increasing the income of those with (high) Additional Pensions. The Additional Pension is computed as:

$$\text{Additional Pension} = \text{BPU} \times \text{APR} \times \text{FPP} \times (\text{PPY}/\text{MaxPPY}), \quad (10)$$

where

APR: Additional Pension Rate, with a value of 42 per cent in 1992.
FPP: Final Pension Point, defined above.
PPY: Pension Point Years, defined above.
MaxPPY: Maximum number of Pension Point Years.

For people born after 1936, the maximum number of Pension Point Years (MaxPPY) is 40. People born before 1937 cannot achieve 40 Pension Point Years from the year the National Insurance System was established (1967) until the year they become 70 years old. People born before 1937 are for this reason given a lower MaxPPY, but not fully compensating for the lack of sufficient Pension Point Years. Widow/widower pensioners receive 55 per cent of the Additional Pension the late spouse would have received[10]. Old age pensioners who are widows/widowers receive either their own Additional Pension or 55 per cent of the sum of their own Additional Pension and the Additional Pension the late spouse would have received.
If BPU follows income growth, the level of pension benefits can be divided into three groups. The first group consists of persons with low incomes during their working years

10. If the late spouse died before he (or she) reached the age of 67, the pension is calculated as if the late spouse had become a disability pensioner the same year he (or she) died.

or "few" working years. These persons will only receive the Minimum Pension, in 1992 worth 58 000 Nkr for single pensioners (8 000 Usd). Tax rules for pensioners are quite favourable and especially pensioners living only on a Minimum Pension do not pay taxes. An average full-time labour income in manufacturing was in 1992 about 180 000 Nkr and after tax 100-150 000 Nkr. The second group consists of persons with long working careers and normal incomes, roughly between 100 000 and 300 000 Nkr (15 000-45 000 Usd). These persons will after tax receive approximately 50-80 per cent of average labour income during their 20 best working years. The third group consists of persons with incomes above 12 BPU, in 1992 above 435 000 Nkr (60 000 Usd). These persons will receive the Maximum Pension of about 4 BPU, in 1992 worth 145 000 Nkr (20 000 Usd). If BPU had been adjusted according to income growth since 1967, and the calculation rules had been the same today as in 1967, the Maximum Pension would have been worth about 210 000 Nkr in 1992 (29 000 Usd).

Adjustments of the BPU

Due to inflation and real income growth it is necessary to adjust the BPU and the Special Allowances, if the National Insurance System is to keep up with the income level of society in general. Adjustment of BPU has an effect both on new pension entitlements and current pension benefits. Additionally, BPU is used to determine several other public and non-public benefits. For example private insurance companies often write insurance contracts based on BPU. For these reasons adjustment of BPU is an important part of the income negotiations[11] between government and pensioners under the National Insurance System. Two possible political strategies for adjusting BPU are worthwhile mentioning:

(i) BPU is increased with the income growth rate and the Special Allowance is held constant (measured in BPU).

(ii) BPU is increased with the general inflation rate and the Special Allowance is increased so as to keep growth in the Minimum Pensions in line with general income growth.

Strategy (i) maintains the intentions of the National Insurance System in the sense that the level of the Additional Pensions are fixed relative to the income level of society in general. Each existing pensioner will with this strategy receive an income growth in line with the rest of society. Strategy (ii) maintains the purchasing power[12] of all existing pensioners and lets pensioners with a Minimum Pension participate in the general income growth.

Strategy (ii) will in the long run change the contents of the National Insurance System. In the short run the benefits will be reduced, but this reduction will to some degree be neutralized by higher pension entitlements in the future. However, the pension/wage ratio decreases with income level (measured in BPU), and this aspect will become more apparent if strategy (ii) is followed for several decades. With sufficient real income

11. The BPU is set unilaterally by Parliament, but the result from the negotiations are normally respected.
12. This will be the case given that the general inflation rate reflects the prices of the goods and services older people buy.

growth, for instance 2 per cent per year for 45 years, the Maximum Pension will be as small as the Minimum Pension. At this stage the Additional Pensions of the National Insurance System will in practice have ceased to exist. Historically BPU has increased mainly in accordance with the inflation rate and the Minimum Pension with the income growth.

Future pensions

The Additional Pensions are determined by labour income earned after 1967, implying that average benefits will continue to grow for several decades ahead. New pensioners will gradually have more Pension Point Years and more Pension Points to choose from when computing the Final Pension Point. These effects will be strong until the year of 2007, when we get the first new pensioners who had the possibility of earning a full set of Pension Point Years (40 years). Average pensions will keep on growing until 2020, when we get the first new pensioners who had the opportunity to earn pension entitlements throughout their whole working life (they were 17 years old in 1967). Additionally the historically under-adjustment of BPU will generate a growth in Additional Pensions for several decades if BPU suddenly is adjusted in accordance with income growth. Another important effect is the increase in female labour force participation over the two last decades which will contribute to increased average female pensions as late as 2030-2040.

Appendix B: The computer programmes

Merging files, estimating probabilities and drawing the initial population is done using SAS on an IBM-compatible mainframe. The simulation program itself is written in SIMULA which is an object oriented language developed in Norway in the sixties. The model is now run on a SUN SparcII work station 10 model 20, and requires approximately 1 Gigabyte free hard-disk. Using an object oriented language makes it fairly easy to take into account interdependencies between individuals. An object oriented language defines objects and links them through the use of pointers. Two married individuals in our model are thereby two objects with pointers directed at each other. When something happens to one spouse, the other spouse can immediately be updated. Such linkages are especially important when simulating complex interdependencies between individuals such as those encountered in household dynamics. We are at present working on a household model based on two types of objects, individuals and households, where interdependencies are modeled through the use of a large set of pointers. The use of an object oriented language is one of the main features which distinguishes the MOSART model from other models. A more detailed description of the use of an object oriented language to model household formation is given in Andreassen, Spurkland and Vogt (1992).

A simulation of 1 per cent of the population from 1990 to 2050 takes just below 2 hours of CPU-time. This includes the preparation of a few aggregate output tables which can be directly used in a spread sheet. During a simulation the model writes out all events to a sequential log file. After a simulation is done this file is sorted so that all records for each individual are grouped chronologically. The sorted file is read by a SAS program which produces a SAS data set of life histories. The sorting of the log file and production of the life histories takes about 40 minutes of CPU-time. Another SAS-program computes pension benefits from this data set of life histories requiring 1 hour of CPU-time. From the SAS data set of life histories it is easy to produce detailed output tables. A standard set of tables covering all important aspects of the model takes about 1 hour of CPU-time. Summing the above together we get that a simulation and preparation of output uses about 4.5 hours of CPU-time.

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