Equitable and Efficient Public Pension Schemes
- A Microsimulation Analysis of the Trade-off

Kyrre Stensnes and Nils Martin Stølen
Statistics Norway

Preliminary version - July 2007

Abstract

Any contribution to a pay-as-you-go pension system may be considered mandatory savings to the extent that it gives a claim to a future benefit. Contributors to the economic literature have argued that an increase in this savings component will lower implicit marginal tax rates, thereby reducing distortions in the labour market. However, the efficiency gain created by increasing the actuarial component of pensions may come at the cost of increased inequality in pension benefits. While the notions of efficiency and equity are simple in theory, they are not easy to quantify in actual public pension schemes whose benefit functions intrinsically exhibit non-linear characteristics. This paper develops a framework to quantify the efficiency and equity dimensions in a fully specified pension system using micro-simulation modelling. The methodology is then applied to five different pension schemes within a dynamic microsimulation model of the Norwegian economy. As expected, we find a negative correlation between efficiency and equality. Surprisingly, we cannot identify any pension scheme that improves the trade-off between these two concerns.

Keywords: Pension reform, social security, equity, labour supply
JEL classification: H53, H55, D31, J22

Address: Research Departement, Statistics Norway, PO Box 8131 Dep., N-0033, Oslo, Norway
Email: kyrre.stensnes@ssb.no and nils.martin.stolen@ssb.no

1. Introduction[1]

Are labour taxes levied to finance pay-as-you-go pension benefits different from other taxes? Specifically, are contributions to the actuarial dimension of the pension system only mandatory savings that do not distort labour supply? Disney (2004) argues that contributions to public pension programmes may differ from other taxes levied on households because these contributions also involve a claim to future benefits. A part of the contribution rate is thus equal to a savings rate. To the extent that a policy change can increase the savings part of pension contributions, distortions in the labour market can be reduced – a view outlined in the economic literature by among others Lindbeck and Persson (2003), Disney (2004) and Lindbeck (2006).

Recent pension reforms in Norway, Sweden, Finland, Italy, Lativa, and Poland, aiming to lower implicit tax rates on labour income, have tightened the link between earnings and pension entitlements,. As long as the average contribution rate to the pension system remains unchanged, this offers a partial positive substitution effect on labour supply without any counteracting income effect. However, as is well know from the economic literature, efficiency improvements may come at the cost of increased inequality.

While the notions of efficiency and equity are simple in theory, they are not easy to quantify in actual public pension schemes. Most pension systems involve complex rules and introduce non-linear features in the accumulation of entitlements. For instance, many countries calculate benefits on the basis of the *n* last years or *m* years with highest labour income. While such a rule is clearly non-actuarial, its redistributive effect is far from obvious. If such a rule were to be replaced by a more linear accumulation of entitlements, does it necessarily imply a less egalitarian distribution? Is it also possible that the change can represent a shift in the equity-efficiency trade-off rather than a movement along this curve, thereby enabling the realisation of Pareto improvement as suggested by the literature? Answers to such questions obviously depend on the specific features of the pension scheme in place.

This paper develops a framework to quantify the efficiency and equity dimensions in a fully specified pension system using micro-simulation modelling. This methodology allows us to combine necessary population heterogeneity with an exact replication of the detailed pension system rules. We apply the framework to quantify the equity and efficiency dimensions of five different pension schemes applied in a Norwegian context. Norway is a particularly interesting case since it recently approved a pension reform that aims to improve efficiency and maintain an egalitarian distribution of pension benefits

[1] We thank Pål Knudsen for excellent technical assistance with the microsimulation model.

while ensuring fiscal sustainability in the face of an ageing population. The analysis thereby allows us to shed some empirical light on the questions raised by the theoretical literature. Furthermore, we can identify whether a particular move towards a more actuarial pension system simply improves efficiency at the expense of equality, or actually allows Pareto improvements through change in the trade-off.

The paper is organised as follows. Section 2 looks more in detail at the theoretical aspects by using a simple model of overlapping generations. Section 3 briefly presents the microsimulation model employed, while section 4 presents the pension schemes under scrutiny. Section 5 and 6 present simulation results for efficiency and equity respectively. Section 7 concludes.

2. Theoretical background

Lindbeck and Persson (2003) classify pension systems along two separate dimensions: the degree of funding, and the degree of actuarial fairness. In this article, we discuss the implications changes in the actuarial properties of the pension system. While the starting point of our discussion is a pay-as-you go pension system, the analysis and results are equally relevant to any system with funded elements. Changes in the actuarial properties will have implications for both the efficiency and equity aspects of the pension system.

Efficiency

The efficiency dimension of a pay-as-you-go pension system can be analysed by simple a two-period overlapping generations model, such as in Lindbeck and Persson (2003)[2], where the first period can be thought of as working age and the second period retirement. The representative individual of generation t supplies labour l_t at wage rate w_t to obtain income y_t in period 1. A contribution rate τ_t levied on labour income is paid to the government, and the individual receives a benefit b_t in period 2. For simplicity we assume that labour is not supplied in period 2 and that the representative individual holds no initial wealth. The return on pension contributions paid to government is then:

(1) $$1 + return = \frac{b_t}{\tau_t w_t l_t}$$

[2] The discussion of efficiency is inspired by Lindbeck and Persson (2003) with equations *1, *2 and 3* drawing directly on this source.

A continuously balanced budget would require $n_t b_t = n_{t+1} w_{t+1} l_{t+1} \tau_{t+1}$ where n_t is the number of individuals in generation t. Inserting the balance requirement into (1) gives us:

$$(2)\quad 1 + return = \frac{\tau_{t+1} n_{t+1} w_{t+1} l_{t+1}}{\tau_t n_t w_t l_t} \equiv \frac{\tau_{t+1}}{\tau_t}(1 + G_{t+1})$$

where G_{t+1} represents the growth rate of the aggregate wage sum. If τ is constant across generations, it also denotes the return on the pay-as-you go assets. For now, we will drop subscripts on τ and G and assume they are constant over time. The consumption possibilities of the representative individual given by the intertemporal budget constraint:

$$(3)\quad c_t^2 = \left[y_t(1-\tau) - c_t^1\right](1+R) + b_t$$

where R is the real interest rate. Subscripts denote generation whereas superscipts denote period, so that c_t^1 and c_t^2 denote consumption of generation t in periods 1 and 2 respectively. The pension benefit b_t paid to each individual will depend on the specific characteristics of the pension system in place. Most systems will in practice contain both a redistributive first-tier benefit and an earnings-based insurance benefit. In the general case, the benefit can be described as a function (ψ) of earnings (y_t), the contribution rate (τ), return (G) and the actuarial characteristics of the system (α):

$$(4)\quad b_t = \psi(y_t, G, \alpha, \tau)$$

ψ can for now be given the very simple functional form, where $\alpha = 0$ denotes a non-actuarial system and $\alpha = 1$ a fully quasi-actuarial system:

$$(5)\quad \psi(y_t, G, \alpha) = (1-\alpha)\bar{b} + \alpha\tau(1+G)y_t$$

$\bar{b}$ represents a flat benefit set exogenously to keep the total benefit level at a constant fraction of the total economy. By substituting (4) and (5) into (3) we attain:

$$(6)\quad c_t^2 = \left[y_t\left(1 - \tau + \alpha\tau\frac{1+G}{1+R}\right) - c_t^1\right](1+R) + (1-\alpha)\bar{b}$$

From this expression we clearly see how the marginal tax on labour income depends on the actuarial properties of the pension system. In the case where $\alpha = 0$, the tax wedge in the labour market is simply τ. When $\alpha = 1$ the marginal tax rate is $\tau(R-G)/1+R$. In a fully quasi-actuarial system, a tax is imposed only by forcing the individual to save at a different (and normally lower) rate of return than the market interest rate. A more actuarial system clearly reduces the tax wedge and distortions in the labour market. Although the marginal tax rate depends the actuarial properties of the system, it is worth noting that the average tax rate is $\tau(R-G)/(1+R)$ for all α. A more actuarial system will therefore improve work incentives through the substitution effect without any counteracting income effect, unambiguously increasing labour supply. Finally, we note that the general case where (4) does not have a defined functional form, the marginal tax rate is expressed by:

(7) $\tau - \frac{\psi'(y_t)}{1+R}$

Equity

Reaping efficiency gains by making the system more actuarial may come at an equity cost since tightening the link between earnings and benefits limits the scope for intra-generational redistribution. This trade-off can relatively simply be illustrated by introducing some heterogeneity in a population faced with a pension system as specified by equation (5). We assume that the population is equally between two types. In this much stylised case, only the type one individuals have labour income in period 1. The consumption of the type two individuals only comes through the flat pension benefit $\bar{b}$, financed by the contribution of the type one individuals in generation t+1. Starting at $\alpha = 0$ and incrementing its value by 0.1 until $\alpha = 1$, combined with plausible parameter values[3], gives an equity-efficiency trade-off as illustrated by figure 1. The horizontal axis contains the implicit reduction in the marginal contribution rate represented by the expression $\alpha\tau(1+G)/(1+R)$. This is equivalent to the second term of equation (7). Note that the does not completely outweigh the contribution rate even when $\alpha = 1$ since we assume $R > G$. The vertical axis illustrates the GINI coefficient of inequality for pension benefits. For a population with only two types of individuals, its maximum value is 0.5.

[3] I assume $\tau = 0.25$ and a net interest rate of $(1+R)/(1+G)-1 = 1.5\%$

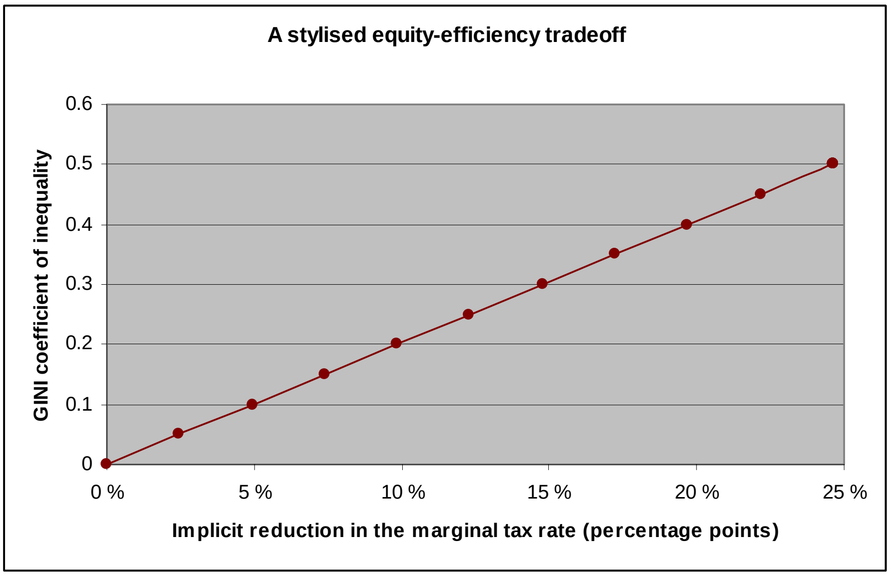

Figure 1: A stylised equity-efficiency tradeoff.

It is worth noting that a reduction in α does not automatically imply more equity. Many OECD pension systems contain non-actuarial elements that turn out to be regressive. For instance, the present Norwegian system calculates benefits on the basis of the 20 best income years of each individual. One intention of this rule was to increase benefits for women with low labour supply in periods with childcare responsibilities. In practice, however, the rule works even more to the advantage of career-oriented men with steep age-earning profiles. Accordingly, pension reform is not limited to movements along the EE-curve. The curve itself may shift, depending on the specific benefit function in place (i.e. the functional form of equation 4).

Unrealistically, in this framework labour supply is not affected in the trade-off illustrated by figure 1. If labour supply were made endogenous, the curve is not likely to maintain its linear shape. As rule of thumb, the distortion is proportional to the square of the tax rate. Exogenous labour supply is, however, an intended shortcoming of this analytical framework. The purpose with this paper is only to describe the incentives created by pension system design. An evaluation of responses should be undertaken as a study in optimal taxation, since it also would be necessary to consider the level of other taxes in the economy.

3. Methodology

Despite the straightforward underlying theory, actually estimating the equity-efficiency trade-off in a real-world pension scheme is an intimidating task. A fully specified pension system is typically involves detailed and complicated benefit rules. The main challenge therefore lies in specifying the pension function ψ. The following three examples illustrate characteristic non-linear elements:

1. Public pension schemes that combine redistributive and insurance benefits usually apply means-testing to target benefits. Even a simple means-test would make the specification in equation (7) discontinuous. In fully specified systems, the interplay between earnings-dependent benefits and guaranteed benefits is quite complex.

2. The simple overlapping generations model above treats all period 1 labour income equally. In practice, the timing of income during the life cycle is important because benefits are typically calculated on the basis of annual income. Rules that place a cap on accumulation years, calculations based on best or most recent income years, and annual ceilings for pension-eligible income introduce non-linearites in the function.

3. Public pension schemes may also impute pension entitlements for military service, childcare responsibility, disability periods, employment benefits etc. Such non-income based entitlements further complicate the benefit structure.

These non-linearities inhibit a specification of ψ as a continuous and differentiable function. For a fully specified pension system, our analysis of the equity-efficiency trade-off is therefore limited to numerical point estimates. Specifically, to approximate the implicit reduction in the tax rate given by the second term of equation (7), we investigate the impact on b_t of a marginal increase in y_t Such estimates require a detailed modelling of the pension system rules. In addition, the estimation framework must capture population heterogeneity as different parts of the population may face different rules, and there may be substantial problems of aggregation in calculating the total effect on government budgets of changes in tax or pension systems. To overcome these problems microsimulation models, as advocated among others by Orcutt *et al*. (1986), have become increasingly used in the last few decades for analysing the effects of different social and financial policies. The basic idea in microsimulation modelling is to represent a socio-economic system by a sample of decision units (e.g. persons), and then model the behaviour of these primary units. Contrary to what is possible in a macroeconomic approach, the detailed and complicated tax and benefit rules may be exactly reproduced.

In our analysis of the National Insurance System in Norway, we employ the dynamic microsimulation model MOSART. It is especially designed to analyse the *direct* effects on individual pension entitlements, benefits and government pension expenditures of changes in the pension system. By direct effects we mean effects ignoring behavioural responses and general equilibrium effects. The model simulates the life courses of a representative cross-section of the Norwegian population, emphasizing what is relevant for individuals' accumulation of public pension entitlements. It captures the following events: migration, deaths, births, marriages, divorces, educational activities, retirement and labour force participation. Transitions between states over the life course depend on individual characteristics, and the transition probabilities have been estimated from observations in a recent period.[4] The model includes an accurate description of the pension rules and captures all relevant details of the population dynamics, as well as the heterogeneity of individual age-earnings profiles and individual public pension entitlements. For a detailed model documentation, see Fredriksen (1998).

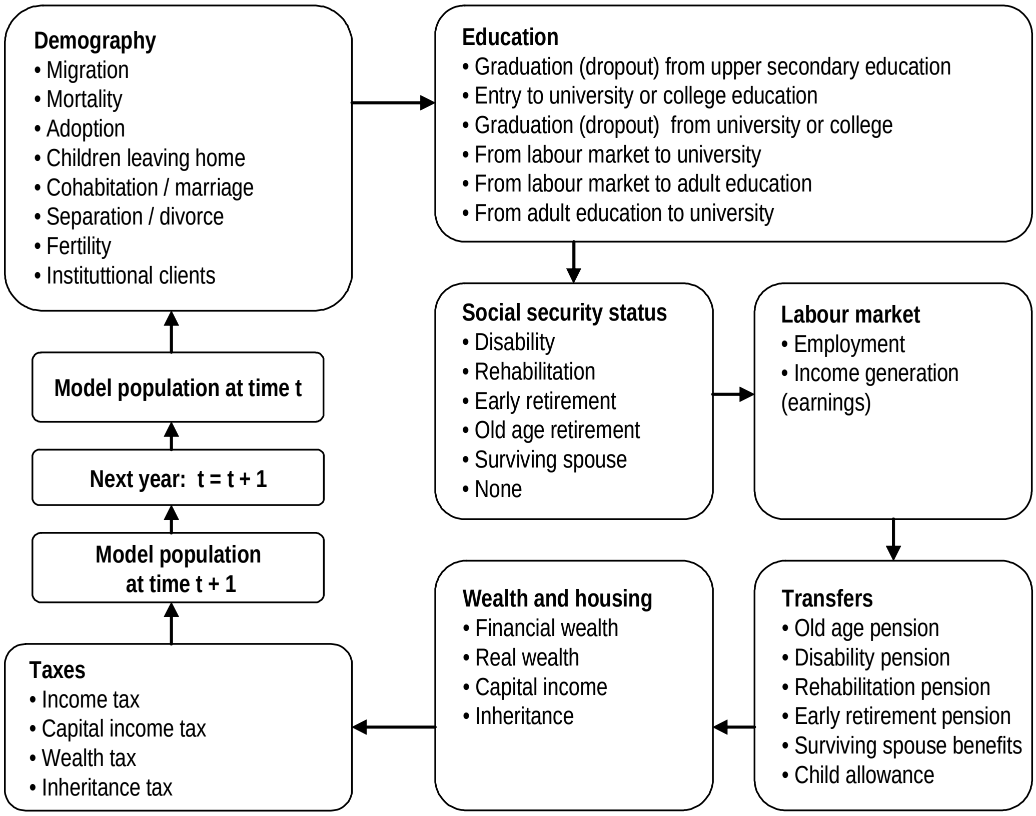

Figure 2: Structure of the dynamic microsimulation model MOSART

[4] The analyses in this paper are based on a representative sample from 1993 that is mainly calibrated to the situation in 2001. The demographic assumptions are based on Statistics Norway's demographic projections from December 2005. A total fertility rate of 1.8 and a net immigration of 16,000 persons each year imply that the size of the different cohorts stabilizes towards 2050. The aggregate population may however increase as a result of a further increase in life expectancy at birth of about 7-8 years in the same period, and then a further increase towards 2100. Assumptions about participation in the labour force and working hours are based on 2001-obervations, while the necessary information about distribution of incomes between individuals over the life cycle is based on observations from a longer period. Our exogenous assumptions are fully in line with those described in detail by Stensnes, Stølen, and Texmon (2007).

4. The pension schemes to be evaluated

We choose to estimate the equity-efficiency trade-off in five different pension schemes applied in the Norwegian context. In line with Scandinavian welfare state traditions, Norway has a pay-as-you-go public pension system with relatively generous replacement rates. However, ageing combined the increase in average benefits that come with a maturing pension scheme, will put severe pressure on public financed in the decades to come. The Norwegian parliament therefore approved in April 2007 a pension reform that aims to correct the projected fiscal imbalance, improve efficiency while maintaining an egalitarian distribution of pension benefits. This makes Norway a case of particular interest. If the reform succeeds with these three intentions, it would seem that policy makers have actually been able to accomplish a pareto improvement by shifting the EE-curve of figure 1 outwards. In addition to evaluating the present and reformed system, we analyse three rejected proposals that were heavily debated in the pension reform process. The proposals differ in their emphasis on the redistributive versus insurance-based pension components, universal as opposed to means-tested benefits, and the specific accrual scheme for entitlements in place.[5]

The present scheme

Old age pension benefits in NIS are based on entitlements each person earns through his or her working career. NIS has it own measuring unit called the *Basic Pension Unit* (BPU).[6] The BPU is used to calculate pension entitlements and adjust pension benefits according to inflation and general economic growth. Pension benefits (PB) are composed of a *Basic Pension* (BP) and the maximum of a *Special Supplement* (SS) and a *Earnings-based Pension* (EP).

(8) $\quad PB = BP + Max\,(SS, EP)$

The sum of BP and SS is the Minimum Pension Benefit all pensioners are guaranteed.[7] The *Earnings-based Pension* is based on previous labour market earnings. Each year when the person is in the interval 17 to 69 years old, the labour market earnings are translated into *Pension Points* (PP) by using the BPU of the year income (Y) was earned:

---

[5] The proposals are also different with respect to retirement incentives. The present system provides heavy subsidies to early retirement. In contrast, the reform proposals all aimed to align the social and private costs of retirement through an actuarial mechanism that keeps the present value of expected pension benefits independent of retirement age. I leave these feature aside in this paper since I only aim to analyse the implicit tax rates on the intensive margin.

[6] In 2006, 1 BPU equals NOK 62 161, or approximately 7500 euros, as a yearly average.

[7] A pensioner married to another pensioner receives a Basic Pension of 85 per cent of BPU, while single pensioners receive 1 BPU. The Special Supplement for single pensioners is 79.33 per cent of BPU in 2006.

$$(9) \qquad PP = \begin{cases} 0 & If\ : Y < BPU \\ (Y - BPU)/BPU & If\ : BPU \le Y < 6\ BPU \\ 5 + (Y - 6\ BPU)/3\ BPU & If\ : 6\ BPU \le Y < 12\ BPU \\ 7 & If\ : Y \ge 12\ BPU \end{cases}$$

The *Final Pension Point* (FPP) is calculated as the average of the 20 largest positive PPs, while *Pension Point Years* (PPY) is the number of years with labour market earnings above BPU. The Earnings-based Pension is calculated when using the BPU at the time pension benefit is received:

$$(10) \qquad EP = SPR \text{ x } \frac{\min(PPY, 40)}{40} \text{ x BPU x FPP}$$

SPR represents a marginal *benefit-wage ratio*, and its present value is 42 per cent. The Special Supplement, a weight of 1/3 for earnings between 6 and 12 BPU and no pension entitlements from earnings above 12 BPU, weaken the connection between earnings and accumulation of pension entitlements. In addition the maximum possible number of years with accumulation of pension points limited to 40, and the calculation of the Final Pension Point as the average of the 20 largest Pension Points, make the marginal effect on pension entitlements from an extra unit of labour income unclear.

Given the political intention of wage indexation of both pension entitlements and individual benefits, the NIS benefits imply a pre-tax replacement ratio equal to about 50 per cent for a person with 40 years of labour market earnings and a steady and normal income level. Special tax rules for pensioners raises the average after-tax replacement ratio of NIS benefits to about 65 per cent. The formal retirement age in the NIS is 67 years.

Principles for pension reform

The pension reform approved in the Norwegian parliament is based on the following main principles for old age pensions in NIS:

- The minimum pension benefit is keep at the present level, but entirely transformed into a means-tested guarantee. More emphasis is to be put on the earnings-dependent pension benefit.
- There is to be a tighter link between earnings and pension benefits, thus improving work incentives. Lifelong accumulation of entitlement replaces the present cap on accrual years and the principle of calculating benefits on the basis on the best 20 years.
- At the same time, the old age pension system should have a social profile, and contribute to smoothing differences in incomes.

- To prevent pension expenditures from increasing if life expectancy improves, an actuarial mechanism is introduced to reduce annual benefits as the expected length of retirement spells increases. It is possible for each individual to counteract lower benefits by postponing retirement.
- Entitlements are indexed by wage growth, as in the present system, but by the average of wage and price growth in payment.
- Mandatory occupational pensions (second pillar) are to be introduced.

The accumulation of entitlements for the earnings-dependent part of the pension benefit is according to the principles above is given by:

(11) $$B_A = \beta \cdot \sum_{t=0}^{A-1} I_t \cdot (1+i)^{A-t}$$ up to a maximum I_t of 7.1 BPU.

Here

B_A = Calculated yearly pension entitlement at retirement age A,

β = Accrual coefficient reflecting the earnings of yearly basic pension entitlements as a share of the relevant income, set to 1.35 percent,

i = Nominal rate of wage growth.

The accrual scheme in the new system thus means that annual labour incomes below a threshold of 7.1 BPU is accumulated as fictitious capital up to retirement age A. The entitlements are to be indexed by average wage growth and converted into an annuity at retirement. The calibration of β to 1.35 percent is chosen to give about equal average benefits as with the present system (before adjusting for growth in life expectancy and indexation of benefits after retirement).

From the accumulated entitlements the pension benefits will be calculated by adjustments for increasing life expectancy and by indexing of benefits after retirement as an average of wage and price growth. The nominal yearly pension benefits at age x for a person from cohort K retiring at age A ($NB_{K,A,x}$), may then be calculated by:

(12) $$NB_{K,A,x} = B_A \cdot (1+w-u)^{x-A} / \delta_{K,A} \quad .$$

where w is the nominal rate of wage growth and u the deviation from wage indexation in percentage points.

$\delta_{K,A}$ is a divisor for a person from cohort K who retires at age A. For a given level of entitlements, the present value of total pension benefits is then independent of retirement age.[8] This is one implementation of what Lindbeck (2006) identifies as an "automatic rule mimicking the functioning of actuarially fair private income insurance systems". The divisor is further outlined and discussed in another paper by Stensnes and Stølen (2007) presenting an overview of the Norwegian pension reform. The new system is calibrated such that those from the 1943-cohort, who retire at the present statutory retirement age of 67 in 2010, will receive the same pension benefit in 2010 as in the existing system. However, lower indexation in payment and the life expectancy adjustment imply that over time retirees receive lower annual benefits than in the present system, unless retirement is postponed.

Alternative accrual schemes for pension reform

All the alternative proposals seek to preserve both the social security and income replacement dimensions of the present system, building on the modifying principles described in the previous section. The accrual schemes all include a contribution-based pension component described by equation (12), whereby annual labour income below a threshold is accumulated as fictitious capital, wage indexed and converted into an annuity at retirement. Common for the schemes is also a minimum pension at 1.79 BPU[9], continued from the present system. However, the different alternatives are based on a different mix of universal benefits, means testing and the income pension that follows from accumulated entitlements. Table 1 summarises the model proposals.

The **Pension Commission proposal** suggests that the minimum pension should be given as a targeted guarantee, and reduced against the income-based pension. For pension benefits above 1 BPU, the Commission recommended that the reduction rate be softened to 60 percent to ensure that also individuals with low income receive pensions in excess of the guaranteed level. The **approved reform** adapts the principles of a targeted guarantee and a uniform accrual rate from the Pension Commission proposal, but narrows the benefit range in both ends. At the lower end of the scale, tapering of the guaranteed benefit starts already at the first unit of income-earned pensions. Only individuals with no accumulated entitlements will therefore become minimum pensioners. At the other end of the scale, the annual income ceiling is lowered to 7.1 BPU, allowing for an increase in the accrual coefficient at the expense of high-income earners. Compared to the Pension Commission and Government

[8] However, special rules imply deviations from an exact actuarial adjustment. For instance, the annual benefits and pension premium are independent of gender and other observable characteristics correlated with life expectancy.

[9] In 2006, the amount is equivalent to NOK 111 473.

proposals, the **basic pension scheme** introduces more equity by way of a universal, minimum pension benefit of 1.79 BPU. There is no means-testing and accumulated income-based pension benefits will always supplement the minimum pension. The **breakpoint model** is another approach to a more egalitarian distribution of pension incomes. A breakpoint is introduced in the accrual coefficient for income pensions, so that the accumulation of entitlements is more weighted towards the lower end of the income scale. The targeted, guaranteed minimum pension with soft means-testing is adopted from the Pension Commission.

	Approved reform	**Pension commission proposal**	**Basic pension scheme**	**Breakpoint model**
Accrual coefficient for income pension	1.35 %	1.25 %	0.85 %	For annual income in BPU-interval: 0-3: 1.7 % 3-8: 0.8 %
Floor *Ceiling*	0 BPU 7.1 BPU	0 BPU 8 BPU	1,79 BPU 8 BPU	0 BPU 8 BPU
Basic pension *Guaranteed pension* } [10] *Minimum pension*	- 1.79 BPU 1.79 BPU	- 1.79 BPU 1.79 BPU	1.79 BPU - 1.79 BPU	- 1,79 BPU 1,79 BPU
Reduction of guaranteed pension against income-based pension	80 % reduction starting at 0 BPU	100 % reduction until 1 BPU. 60 % reduction above BPU.	-	100 % reduction until 1 BPU. 60 % reduction above 1 BPU.

Table 1. Alternative models for accruing pension entitlements.

5. Efficiency

Estimating the implicit reduction in the marginal tax rate was simple in the two-period model outlined in section 2. As indicated by equation (7), it was merely a matter of differentiating the benefit function with respect to earnings and then discounting by the real interest rate. Fully specified pension schemes, including the ones analysed here, contain non-linear elements that make the benefit function non-differentiable and discontinuous. We therefore employ microsimulation to compute numerical

[10] The benefits are differentiated according to martial status, as in the present system. The rates indicated in the table and discussed in the text apply to singles. They will be somewhat lower for married and cohabiting couples. Furthermore, Parliament has agreed to adjust the minimum pension level for changes in life expectancy through the divisor described in the previous section. Greater longevity will thus reduce rates.

solutions. Specifically, we expose a cross-section of the model population to a small and transitory income shock in one specific period (when t=j).[11] This shock is marginal in the sense that is implemented as an addition of one unit to already existing labour income. Once implemented, we run the model to let the individual life courses take place keeping all individual characteristics *as if* the income shock had not taken place. This special model feature thereby permits a *ceteris paribus* evaluation of the income shock's effect on future benefits. Each year of retirement, for every individual in the model population, we calculate public pension benefits b_t and $b_t^{'}$ in parallel. These respectively represent the retirement benefit in *absence* and *presence* of the transitory income shock that the individuals were exposed to during working age. The marginal tax rate given by equation (7) is then approximated as follows:

$$(13)\ \tau - \frac{1}{N}\sum_{i=1}^{N}\sum_{t=j+1}^{\infty}\left(\frac{1+W}{1+R}\right)^{t}\left(b_t^{'} - b_t\right)$$

N is the number of individuals in the model population who participate in the labour force at time *j*.[12] W here indicates the growth rate of wages. The discount factor $(1+W)/(1+R)$ is set by choosing the net interest rate equal to 1.5 per cent. Choosing a higher discount factor would partially increase the marginal tax rate. Using the microsimulation model, we have then provided estimates for the second term of equation (13) for each of the five pension schemes under scrutiny. The implicit reductions in the marginal tax rates are given by table 2.

Approved reform	12.4 %
Present system	10.0 %
Basic pension scheme	6.2 %
Breakpoint model	10.6 %
Pension Commission proposal	12.4 %

Table 2: Implicit reduction in marginal tax rates.

[11] For convenience, we choose to give the marginal income shock by setting j=2050. Choosing a date so far into the future ensures that our results are not affected by the pension reform transition rules. Simulations are then carried out to 2150. The income shock is set as large as NOK 10 000 to avoid errors in rounding numbers.

[12] Labour force participation is negatively defined as not being a recipient of any benefit from the National Insurance Scheme. Such benefits are provided for disability, rehabilitation, work-qualifying training and old age. When the model is run on a sample of 1% of the Norwegian population, N is approximately equal to 40 000.

We observe that the approved reform and the Pension Commission proposal give the largest reduction in the marginal tax rate. The Breakpoint model and the Pension Commission proposal follow suit, whereas the Basic pension model provide the least reductions. To a large extent, the rates follow the magnitude of the accrual coefficient for income pensions that the average income earner faces. Figure 2 gives an illustration of the incentives faced at different income intervals for the very stylised individual with a constant BPU-income for 43 years. A unit increase in annual income in all 43 years, will for different income intervals give an annual increase in pension as indicated by the vertical axis. For instance, a marginal income increase each of the 43 years will, starting 5 BPU under the Approved Reform, give an increase of the annual pension benefit with 0.58 per income unit.

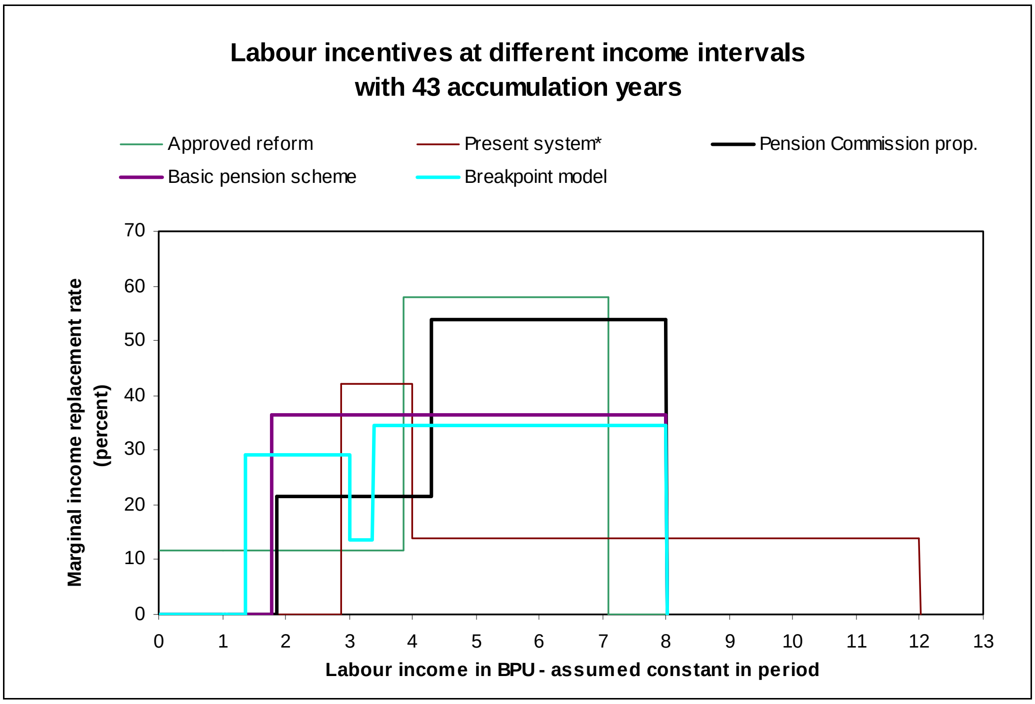

Figure 2: Labour incentives at different income intervals.

6. Distributional consequences

Our evaluation of distributional consequences is based on three important qualifications. First, we consider only pension benefits and not taxes and pension premiums, although the possible tax rate may be designed to have distributional consequences. With Norwegian old age pensions being fully integrated into the general state budget, it is not possible to identify specific contributions to the system. Second, we analyse only the direct effects of pension reform for a given labour supply, both at the intensive and extensive margins. Neglecting indirect income effects caused by behavioural changes can be justified when focusing on changes in utility level; according to the envelope theorem, the utility of marginal income increases from increased labour supply is neutralized by the utility loss of reduced leisure, as long as the individual is free to choose hours worked. Third, we report the distributional effects measured as annual benefits in a cross-section of pensioners without accounting for indexation and the actuarial adjustment through the flexible pension scheme. This scheme effectively replaces a fixed retirement age with an individual retirement choice above 62 years, and the retirement decision will influence both retirement age and length. If we included the actuarial implications of this choice, annual benefits would be a poor approximation for pension wealth because they would indicate both (relevant) changes in pension wealth and (for our purpose irrelevant) changes in retirement spells.

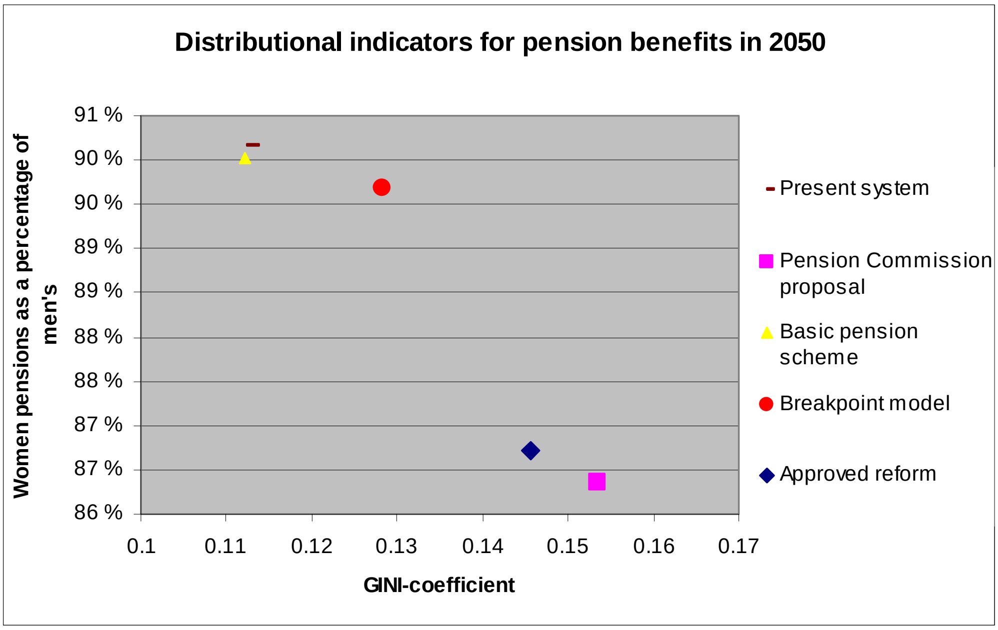

Figure 3: Distributional indicators.

Figure 3 gives a first impression of how different accrual schemes distribute income between individuals at system maturity in 2050. The horizontal axis measures the GINI-coefficient of inequality and the vertical axis shows women’s pensions as a share of men’s, on average. Along the two dimensions, the upper left quadrant would therefore indicate more equality and lower right more inequality. We observe that there is greater inequality in labour incomes than pension benefits in the schemes we consider. The public old age pension scheme is redistributive, due to components such as a minimum benefit and the annual income ceiling on accumulating pension entitlements. Income replacement ratios are therefore higher at the lower end of the income scale.

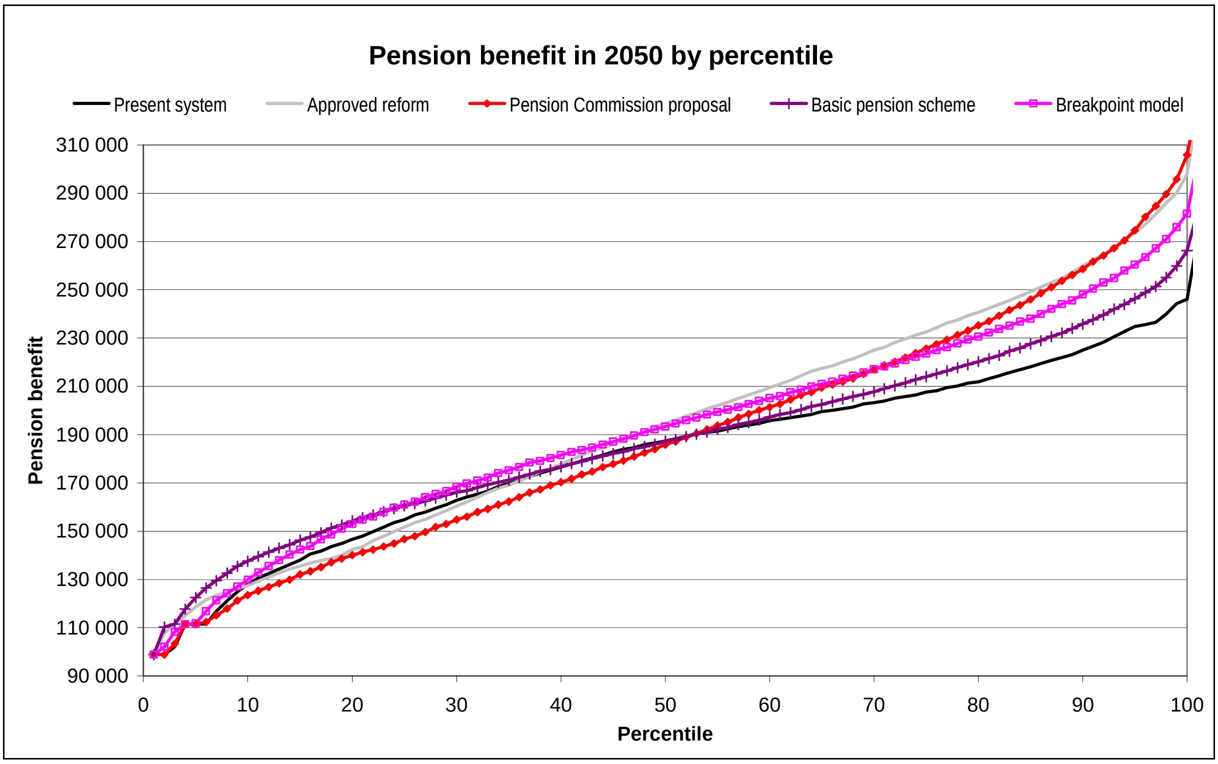

Figure 4: Pension benefits in 2050 for different accrual schemes by pension benefit percentile. Real 2006-wages in Norwegian kroner serve as a numeraire for the wage-indexed benefits.

We will now look more in detail at the distributional consequences of the different accrual scheme alternatives. Figure 4 shows the income profiles of the proposed accrual schemes. For the **lowest 25 percentiles**, pension benefits will be decided in a complex interplay of minimum benefits and means-testing, combined with the accrual coefficient that links lifetime earnings to the income pension benefit. Since the different elements in this mix counteract, the curves can be somewhat intractable. For the **middle percentiles**, this interplay of different elements will influence the curves' intersection with the vertical axis whereas the further developments should be more transparent. On the whole, the slope is proportionately determined by the accrual coefficient. In the breakpoint model, the curve reaches an inflection point around the 37th percentile as higher incomes are exposed to a reduced accrual coefficient.

The annual income ceiling for pension entitlements will, in combination with the accrual coefficient, determine pension benefits for the **highest 25 percentiles**. The basic pension scheme and the breakpoint model have the smallest accrual coefficient, and accordingly the lowest pension benefits for this group. The Pension Commission proposal and the Approved reform are the most generous, with the former coming out on top. Because the Government has a lower annual income ceiling for the accumulation of entitlements than the Pension Commission proposal, the curves cross at the 87th

percentile. For all schemes the curves are convex for the uppermost deciles, because they exhibit an increasing gap between the average incomes.

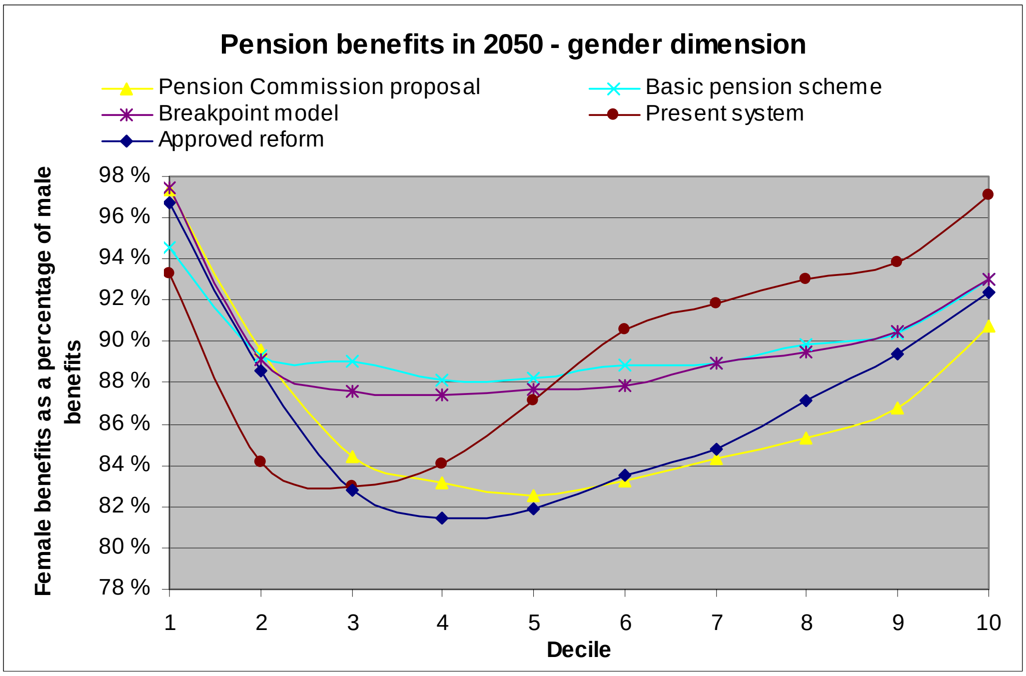

Figure 5: Gender differences in pension benefits in 2050.

Figure 5 illustrates the gender equality dimension in the different accrual schemes, by dividing average female benefits in each income decile on the corresponding male benefit. For all models, gender differences are the smallest for individuals receiving the minimum benefit and greatest between the 3rd and 7th deciles. The basic pension scheme and the breakpoint model have clearly a better gender equality profile than the other two models under consideration.

7. Conclusions

We have used a microsimulation framework to quantify the efficiency and equity dimensions of five fully specified pension schemes, applied in a Norwegian context. While all combine a redistributive first-tier benefit with and an earnings-based insurance benefit, the schemes place different emphasis on these components and differ with respect to the specific accrual scheme in place. Keeping the contribution rate constant, a move towards a quasi-actuarial pension system will permit a reduction in the implicit marginal tax rate because contributions involve a claim to future benefits. Efficiency is evaluated by estimating the average size of this claim for a marginal increase in labour income, discounted to present value. Equity is represented by the GINI-coefficient calculated on the basis of pension benefits. Figure 6 summarises the results.

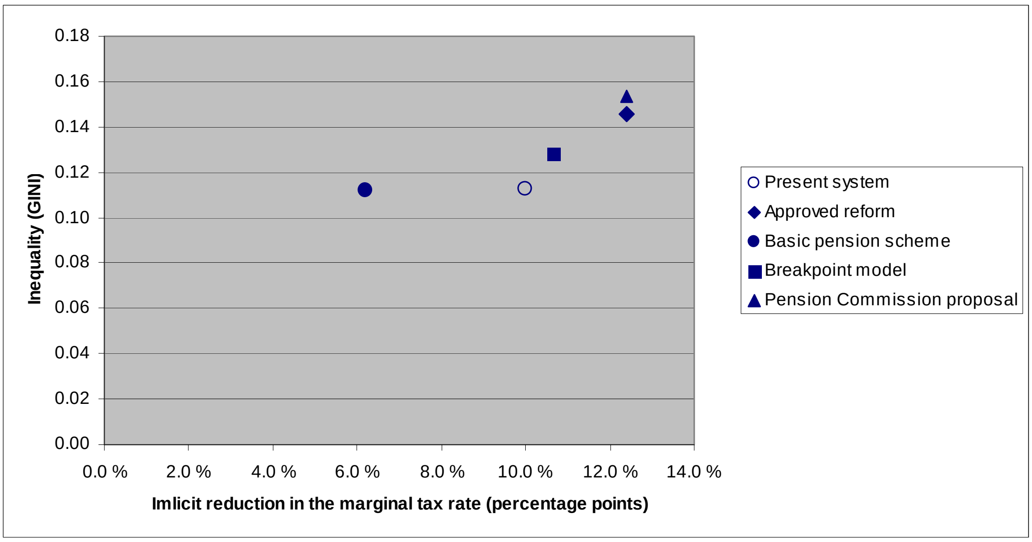

Figure 6: The equity-efficiency (EE) trade-off in five pension schemes

The estimates verify the expected correlation between inequality and inefficiency: A more towards a more actuarial pension scheme limits the scope for intra-generational redistribution. The literature also argues that such reforms can create Pareto improvements in the sense that the EE-curve can shift outwards. Surprisingly, we are unable to find support for this claim in our estimates. Even though extreme caution should be exercised in extrapolating any curve from our point estimates, it would seem that most schemes represent movements along the implicit EE-curve. The Basic pension scheme is nevertheless an exception to this general rule.

Even though we have identified the marginal tax rate reductions in different pension schemes, the consequences for labour market distortions remain contingent on a number of factors. First, labour supply will depend on the other taxes in the economy and need to be addressed in an optimal taxation framework. To some extent, this analysis needs to address relevant heterogeneity in marginal tax rates and labour supply elasticities. Second, actuarial pension contributions represent a claim on a future asset subject to individual survival and political risk. Uncertainty may therefore be an important element in future analyses. Third, one fundamental justification for public pensions in old age is to provide income support to individuals whose myopic behaviour would cause too little savings in absence of a pension system. Accordingly, it may seem inconsistent to evaluate efficiency with traditional discount rates in a rational agent environment. More scientific work is needed before the theoretical labour supply effects can be quantified with confidence.

References

Disney, R. (2004): Are Contributions to Public Pension Programmes a Tax on Employment? *Economic Policy,* July 2004, 267-311.

Fredriksen, D. (1998*): Projections of Population, Education, Labour Supply and Public Pension Benefits - Analyses with the Dynamic Microsimulation Model MOSART.* Social and Economic Studies 101, Statistics Norway.

Lindbeck, A. and M. Persson (2003): The Gains from Pension Reform. *Journal of Economic Literature,* Vol 41, pp. 74-112.

Lindbeck, A. (2006): Sustainable Social Spending. *International Tax and Public Finance,* 13, No 4, 303-324.

NOU 2004:1: *Modernisert folketrygd. Bærekraftig pensjon for framtida. (A Modernised National Insurance Scheme - Sustainable Pension Expenditures in the Future)*. The Ministry of Finance and Ministry of Social Affaires, Oslo.

Orcutt, G.H., J. Merz and H. Quinke (eds.) (1986): *Microanalytic Simulation Models to Support Social and Financial Policy.* North Holland, New York.

St. meld. no. 12 (2004-2005): *Pensjonsreform – trygghet for pensjonene (A Pension Reform – Safety for Future Pension Benefits).* The Ministry of Finance, Oslo.

St. meld. no. 5 (2006-2007): *Opptjening og uttak av alderspensjon i folketrygden.* The Ministry of Labour and Social Inclusion, Oslo.

Stensnes, K. and N.M. Stølen (2007): *Norwegian Pension Reform: Effects on Fiscal Sustainability, Labour Supply and Equity.* Statistics Norway's Discussion Paper (forthcoming).

Stensnes, K., N.M. Stølen and I. Texmon (2007): *Pensjonsreformen: Virkninger på statsfinanser, effektivitet og fordeling (Norwegian Pension Reform: Consequences for Public Finances, Efficiency and Income Distribution).* Reports 2007/11. Statistics Norway. (In Norwegian).