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Will the Norwegian pension reform reach its goals?
An integrated micro-macro assessment

Abstract:
The Norwegian pension reform of 2006 intends to (1) improve long run fiscal sustainability by reducing the growth in public old-age expenditures, (2) strengthen labour supply incentives, and (3) maintain the main redistributive features of the present system. We assess to what extent the reform is likely to achieve these three goals, using two empirical models iteratively: We combine a detailed dynamic micro simulation of individual benefits and government pension expenditures with a CGE-model, which captures behavioural effects and equilibrium repercussions. We find that the pension reform improves fiscal balances substantially. Compared to a no-reform scenario, the payroll tax rate can be cut by 10 percentage points in 2050. Increased employment contributes more to the fiscal improvement than the reduction in pension expenditures. However, these changes are basically level effects; the reform has a surprisingly small effect on the growth rate of the necessary tax burden starting in 2020. In particular, the growth rate of public pension expenditures is hardly affected. Stronger government finances and higher employment is obtained at the expense of a significant increase income inequality among old age pensioners.

Keywords: Pension reforms, Fiscal sustainability, Income distribution, Computable general equilibrium model, Dynamic micro simulation

JEL classification: H30, H55, H62, H68, O15

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1. Introduction

Around half of the OECD countries have substantially reformed their pension system over the last decade, see OECD (2007) for an overview. Most of these reforms share three goals. First, they are intended to save costs for the government, at least in the long run. In this respect they are a policy response to population ageing, which will erode the fiscal sustainability of welfare states. Second, most reforms seek to stimulate employment. An efficient stimulus will partially offset the tax burden caused by ageing, improve social efficiency, and allow higher earnings to mitigate unpopular benefit cuts. Third, reforms typically seek to distribute income more evenly than a laissez-faire regime, and this concern influences the design of the pension system.

These three goals have also dominated the design of the pension reform approved by the Norwegian parliament in 2007. The purpose of this paper is to assess as realistically as possible to what extent the Norwegian reform is likely to achieve them. Such an assessment must weigh together empirical estimates of a multitude of effects identified and analysed using stylized models in the theoretical literature on social security and pension reform. Barr and Diamond (2006), Diamond (2002) and Lindbeck and Person (2003) represent just a few of several excellent surveys.

In our view, any profound analysis of pension reform performance must integrate three separate approaches, and is therefore a very demanding modelling task. First, huge amounts of details is required to provide an operational and relevant description of the reform elements, as well as the heterogeneity of individual earning profiles and other aspects of individual life courses. Dynamic Micro Simulation (DMS) models provide such details, which make them frequently used by the authorities to compute effects on individual benefits and public pension expenditures. Adopting the terminology used in Gruber and Wise (2004), we will refer to these effects as *mechanical* in the sense that they ignore behavioural adjustments and general equilibrium repercussions. OECD (2007), Flood (2007), Fredriksen and Stølen (2007), Stølen (2007), Bonin (2001) are but a few examples of studies of mechanical pension reform effects.

Second, realistic estimates should capture that pension reforms indeed intend to affect behaviour, notably labour supply. A vast empirical literature has studied how pension schemes affect labour supply, especially through retirement, see Gruber and Wise (2004) for a comprehensive overview. From 12 comparable microeconometric country studies, Gruber and Wise conclude that the pension system has an "enormous effect on retirement".

Third, the mechanical fiscal effect and the behavioural responses to plausible pension reforms are likely to be strong enough to have significant general equilibrium repercussions. Coile and Gruber (2003) provide a good example of the striking significance of such repercussions: When estimating the fiscal effects of a Social Security reform in the US, they find that delaying retirement raises revenues by expanding tax bases, whereas expenditures are hardly affected because the pension system is close to actuarial. In a previous assessment of the effects of the Norwegian pension reform, Fredriksen, Heide, Holmøy and Solli (2007) find that the expansion of the tax base has a stronger fiscal effect than the reduction in pension expenditures. Recent examples of Computable General Equilibrium (CGE) model simulations of pension reforms are Beetsma, Bettendorf and Broer (2003), Bovenberg and Knaap (2005), Fehr and Habermann (2006), Fehr, Sterkeby and Thøgersen (2003), Fehr (2000), Kotlikoff, Smetters, and Walliser (2001), Lindbeck and Persson (2003), McMorrow and Roeger (2002) and Miles (1999). However, while these studies capture behavioural effects and macroeconomic repercussions, the models neglect many potentially important aspects of agent heterogeneity and details of the pension system. Even a specification of 12 lifetime earning classes in each cohort, as in the model used in Kotlikoff et al. (2001), would imply crude approximations when calibrated to the present and the proposed Norwegian pension systems.

This paper therefore integrates the three above-mentioned approaches by combining a detailed dynamic microsimulation model with a large scale dynamic CGE model. The models are run iteratively to ensure consistency. Methodologically, we thereby extract the strong sides of the different approaches, and our estimates exploit the maximum of available relevant information.[1] Moreover, we seek to avert the "black box" criticism often raised against analyses relying on large models, by quantifying the specific contributions from the most significant behavioural and equilibrium repercussions to the total key effects.

Realistic long run projection of government finances may have greater policy implications in Norway than in most other countries. Contrary to most other OECD economies, the Norwegian government finances look impressively solid, mainly due to large government petroleum revenues and a highly ambitious pre-funding strategy. This does not create a policy climate conducive to cost saving welfare reforms. However, Norway faces a fiscal sustainability problem in the long run. Ageing, combined

[1] The present paper builds on Fredriksen, Heide, Holmøy and Solli (2007). Updates compared to that paper include: 1) The reforms are somewhat different. 2) The demographic projections have been updated. 3) The government petroleum revenues have been more than doubled due to changes in the global energy markets after 2004. 4) We have revised the labour supply incentives at the intensive margin implicit in the present and the new pension system. 5) We have exploited updates and technical improvements in the modelling framework.

with the present public pension system and other relatively generous welfare schemes, imply that fiscal contractions will be necessary in every year after around 2020. Quantitative projections are one of the few means to make the long run less abstract, which is needed to ensure that long run policy issues are given proper priority today.

The paper is organised as follows: Section 2 provides a brief overview of the main elements of the present Norwegian pension system and the proposed reform. Section 3 describes the microsimulation and the CGE models. Section 4 examines the fiscal motivation for a cost saving pension reform by studying a baseline scenario. Section 5 discusses the reform effects on government finances and employment, whereas section 6 discusses the distributional consequences. Section 7 analyses the robustness of the reform effects with respect to the uncertain labour supply responses and the demographic development. Section 8 concludes.

2. The Norwegian public pension reform

2.1. The present system

The present public pension system was established in 1967 as a mandatory, defined benefit, pay-as-you-go pension system. The total benefit combines a flat-rate universal benefit, a means-tested supplement and an earnings-related income benefit according to the formula:

Pension benefit = universal benefit + max(means-tested supplement, income benefit).

The income benefit is based on pension entitlements accrued through labour market earnings after 1967. In addition, imputed pension entitlements are granted to parents caring for young children and recipients of social security benefits compensating for unemployment, sickness, rehabilitation, and disability. Both entitlements and benefits are in principle wage indexed, although practice has tended to fall somewhat short of this intention. In the stylised case where an individual earns the average wage for 40 years, the after-tax replacement ratio of the public old age benefit will be about 65 per cent.[2]

[2] Special tax rules for pension benefits makes the after-tax replacement ratio about 15 percentage points higher than the corresponding pre-tax ratio. Income from private pension schemes and special pension schemes for public employees come in addition to this figure.

The income pension scheme has several non-actuarial elements. Most important is the best-years rule, according to which a full benefit requires that 40 years of covered earnings will only be calculated using the 20 years with highest earnings. On average, the non-linear elements result in a relatively weak income dependency of pension benefits. Simulations on the microsimulation model used in this paper, shows that increasing earnings by 1 NOK raises the average present value of future pension benefits by 0.10 NOK, see Stensnes (2007). Moreover, this income dependency is hard to compute *ex ante*, and varies highly across individuals, which probably weakens the labour supply incentive of the income dependency.

The formal retirement age is 67 years. Roughly 40-50 per cent of the population receives disability benefits at retirement age, and about 60 per cent of the (still) employed are entitled to early retirement from the age of 62. Disability pension and early retirement imply that the present effective retirement age averages about 60 years in Norway. Note that early retirement through these arrangements does not reduce future pension benefits at any point in time, neither because of a shorter period of labour market earnings nor through a longer period as pensioner. Both disability pensioners and early retirees obtain entitlements as if they remained working until the age of 67.

2.2 Main reform elements[3]

The new system is to be gradually phased in from 2010. It continues to be a defined benefit system financed on a pay-as-you-go basis. The reform is designed to stimulate labour supply, maintain most of the distributional properties of the present system, and reduce the long run *growth* in future government pension expenditures – not the compensation level in 2010. The most important reform elements are:

1. The pension benefit continues to include two components, a minimum income guanatee and an earnings-based benefit. The minimum benefit is maintained at the same level as the current minimum benefit. Contrary to the basic benefit in the present system, however, it is means-tested against the income based pension benefit. New indexation rules imply that the minimum benefit over time is reduced relative to the income component.

[3] Since this paper was written, some elements of the pension reform have been modified, and it is likely that further revisions will come when all details are made precise. However, the reform proposal discussed in this paper is still a good approximation to the actual reform as far as it has been clarified.

2. The expenditure risk associated with increases in longevity is shifted from tax payers onto each cohort of pensioners through an actuarial mechanism. With some qualifications with respect to the redistributive guarantee pension, the new system converts the implicit pension wealth of accumulated entitlements into an annuity over the average expected remaining lifetime. An increase in the expected number of retirement years reduces the annual benefit such that the present value of total pension benefits is nearly invariant to changes in current remaining life expectancy and retirement age. This is one implementation of what Lindbeck (2006) identifies as an "automatic rule mimicking the functioning of actuarially fair private income insurance systems".[4]
3. The statutory retirement age and current early retirement arrangements are phased out and replaced with a flexible retirement age from the age of 62 years, available to everyone. The mechanism described in point 2 intends stimulate labour supply by increasing the individual cost of early retirement. If life expectancy increases by one year, an additional eight months of labour market participation will be needed to maintain the annual benefit.
4. Labour supply is also stimulated by a stronger dependency between earnings and pension benefits. The income based benefit is basically 1.35 per cent of lifetime labour market earnings below an annual wage-indexed threshold.[5]
5. The income dependent entitlements are indexed by wage growth only until retirement, and by an average of wages and consumer prices in payment.[6]

The reform strengthens the incentives to retire as a disability pensioner. Changes in the disability pension scheme were presented by a government committee in May 2007, but this is a separate reform process. Our analysis takes as given both the disability scheme and observed rates of transition into disability. We have further assumed that public sector employees are exposed to the retirement incentives outlined above, and that any expenditure increase in the scheme for occupational pensions in the government sector is fully financed by higher premiums and does not imply any additional need for raising taxes. Finally, we have assumed that the state contribution to the present early retirement scheme is phased out from 2010 in line with the proposals put forth by the Pension Commission. (NOU 2004).

[4] 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. See Stølen (2007) for details.

[5] In 2007 the ceiling was approximately 58 000 euro.

[6] In practice, the reform implements the less generous indexation in payment as a fixed annual deduction of 0.75 percentage points relative to wage indexation. This is consistent with an implicit real wage increase of 1.5 percent.

The new system is not intended to give benefit cuts at the time of implementation, that is for those from the 1943-cohort who retire at the present statutory retirement age of 67 in 2010. Instead, expenditure cuts are the result of both the actuarial life expectancy adjustment, for given retirement behaviour, and the less generous indexation of benefits in payment. To the extent that postponed retirement neutralizes the reduction of average annual benefit, the fiscal improvement will instead come from a decline in the number of pensioners and increased tax revenues.

3. Modelling framework

Our ambition of providing realistic estimates of the total fiscal effects of a fully specified pension reform imposes five fundamental requirements on the modelling framework: First, accounting for system complexity requires an accurate description of most elements in the existing and the proposed pension system. Specifically, one must account for the complex interplay between minimum guarantees and earnings-dependent pensions. Second, a detailed description of population heterogeneity with respect to age and income is necessary for accurate calculations of individual and aggregate pension entitlements and benefits. In particular, the increasing trend of female labour supply implies a surge in the future old-age entitlements of women. Third, the simulations should take into account that changes in employment affect most tax bases. Fourth, the fiscal effects should capture expenditure effects caused by changes in relative prices. For example, wage rate adjustment affects pension expenditures and other transfers through indexation of entitlements and benefits, and the relative prices of government consumption. Fifth, analyses of fiscal sustainability and pension reform require a long-run perspective that captures both the stationary reform effects as well as the capacity effects of investments and productivity growth.

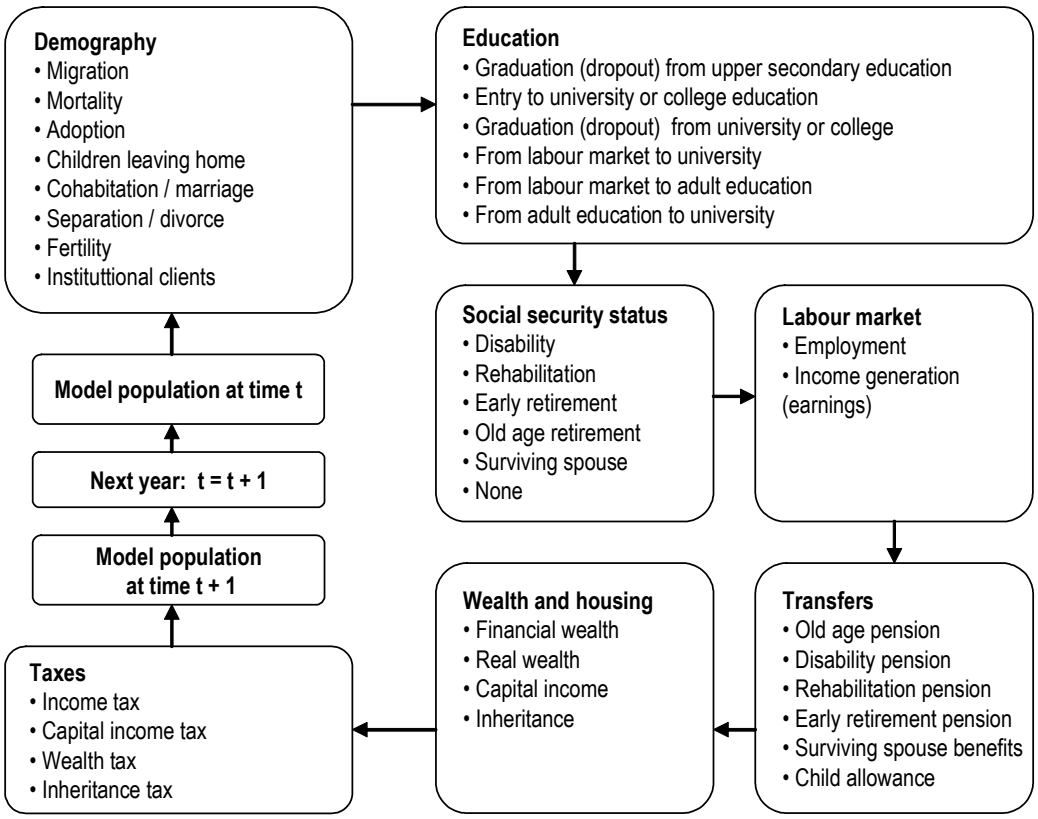
The integrated micro-macro model framework used in this paper is designed to meet these requirements. It enables us to account consistently for the existing relevant knowledge about the pension systems, individual heterogeneity, behavioural effects and general equilibrium repercussions. Admittedly, it is complex and not easily accessible, but a more simple and transparent model framework would necessarily produce less realistic estimates.

3.1 The dynamic microsimulation model

Tax and pension systems are typically detailed and complex, and individuals may face different rules. Accordingly, there are substantial aggregation problems when 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 to support governments with analyses regarding 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 aggregate models, inhabited by one or a few representative agents, the detailed and complicated tax and benefit rules may be exactly reproduced.

Figure 1: Structure of the dynamic microsimulation model MOSART



The dynamic microsimulation model, MOSART, is especially designed to analyse the mechanical effects on individual pension entitlements, benefits, and government pension expenditures of changes in the Norwegian public pension system. [7] The model simulates the life courses of a representative cross-section equal to 1 percent of the Norwegian population, using a set of transition probabilities to determine the occurrence of socio-demographic events, 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

[7] For a detailed model documentation, see Fredriksen (1998).

probabilities have been estimated from observations in a recent period. 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.

3.2 The CGE Model

The CGE model (MSG6[8]) describes the Norwegian economy as small and open; agents face exogenous world prices of exports and imports and an exogenous world interest rate. Goods and factors are perfectly mobile between industries. Flexible relative prices ensure that all markets clear in all periods. Thus, the aggregate consumption possibilities are basically determined from the supply side. Firms are run by managers with perfect foresight, who maximise present net-of-tax cash flow to owners. They are price takers in the export markets, whereas most of them engage in monopolistic competition in most domestic markets. Consumers and producers consider imported products as close but imperfect substitutes for the corresponding domestic products. Industry production functions exhibit decreasing returns to scale and shift over time due to exogenous growth in total factor productivity (TFP). In each period, consumers allocate time to work and leisure according to standard consumer theory. The uncompensated wage elasticity of labour supply equals 0.1, consistent with the econometric results in Aaberge et al. (1995). In addition to the time constraint, aggregate consumption possibilities are restricted by a national budget constraint, which requires that foreign trade is balanced in present value terms, corrected for initial net foreign wealth. The two constraints implied by full employment and balanced trade are met by endogenous adjustments of private consumption and the labour cost per hour. Thus, unit labour cost is basically determined by world prices and productivity in the traded goods sectors. However, decreasing returns to scale implies a relatively small influence from the activity level in the traded goods sector on the labour cost. If the demand for traded goods grows - as it will as an effect of the pension reform - the labour cost must fall in order to maintain balanced trade through profitable expansion of the traded goods sector.

[8] Different version of the MSG model have been developed over many years. Heide, Holmøy, Lerskau and Solli (2004) provides an overview of the structure and the empirical characteristics of the version of MSG6 used in this paper.

The model includes comprehensive and detailed accounts of government revenues and expenditures. All tax bases are endogenous. The growth in real government consumption has been derived from specialised models[9], whereas government pension expenditures result from an iterative use of MOSART and MSG6. Specifically, the equilibrium effects on the wage rate and labour supply have been accounted for in the results produced by the microsimulation model.

3.3 Key Assumptions[10]

The demographic development corresponds to the median alternative in the population projections from 2005 (Statistics Norway, 2005). The ratio of those aged 20-66 to those 67 and older will decrease from 4.7 in 2005 to 2.7 in 2050, basically due to an increase in longevity of approximately 8 years for both newborn men and women over this period. For the effects of the pension reform, it is especially relevant that the conditional remaining expected life expectancy for both men and women aged 62 years, increases by 4 years from reform implementation in 2010 till 2050. Except for the public old age pension system, the present welfare schemes, including wage indexation of most welfare transfers, are prolonged in all scenarios. Resources used in sectors producing public goods remain constant at their 2004 levels. The same holds for resources per user of individual services financed by the government, as well as the age-specific use of these services. The government petroleum revenues are based on the production forecasts in Ministry of Finance (2004) and a real oil price of 50 2004-dollars per barrel. The price of natural gas follows the oil price.

In all scenarios the government obeys the fiscal policy rule introduced in 2001: The government petroleum revenues are saved in the Government Pension Fund (GPF), and the non-petroleum primary deficit equals the expected real rate of return, i.e. 4 percent on the GPF assets.[11] This determines directly the time path of the government budget constraint. We assume that this constraint is met by endogenous pay-as-you-go adjustments of the payroll tax rate, whereas all other tax rates remain constant in real terms. Any choice of budget neutral policy response will be somewhat arbitrary. We have four reasons for choosing the payroll tax. First, adjustments of government spending would not

[9] The projections of government consumption within the sectors of *health care* and *education* have utilised models which decompose changes in the input of labour and intermediate inputs into (a) changes in the number of persons in different age groups; (b) changes in the service standards; and (c) changes in coverage ratios. Thus, the projections capture the fact that ageing, *cet. par.*, increases public health care expenses.

[10] Heide, Holmøy, Solli and Strøm (2006) provide more details on the exogenous assumptions and a survey of related fiscal projections.

[11] Formally, the fiscal policy rule limits the non-petroleum primary deficit, D, to $D_t = (i - \pi)B_{t-1}$, where i is the nominal rate of return, π is the expected international inflation, and B is the value of the accumulated GPF assets. Net financial investments in the GPF becomes $B_t - B_{t-1} = \pi B_{t-1} + P_t$, where P is government net petroleum cash flow. Since i, π and P are exogenous variables in MSG6, the time paths of B and D are effectively exogenous.

be less controversial. Especially, there are obvious objections against a residual determination of the supply of public health services, old age care, education and/or defence each year. If we had chosen a particular public service to be residually determined, that choice would likely distract from the pension reform effects we wanted to analyse. Second, if taxes rather than expenditures adjust, it is rather uncontroversial that the tax burden effectively will be carried by labour in a small open economy. Third, most contributions to mandatory public or private pension schemes are formally paid by the employer as a fixed share of wages. As a matter of fact, the payroll tax was introduced as a social security premium. Fourth, other taxes are more complex than the payroll tax. Touching these would increase the risk that this paper would have to analyse a tax reform in addition to the pension reform.

Table 1 summarizes key exogenous determinants of the macroeconomic performance in the baseline scenario. They imply an average annual growth in real GDP of 1.7 percent. This is relatively slow compared to historical trends, basically due to the low projected growth in the labour force and the drag on aggregate productivity growth caused by the reallocation of resources from private to government sectors.

Table 1. Exogenous assumptions underlying the simulated macroeconomic development. Average annual growth rates 2004-2050 unless otherwise indicated. Percent

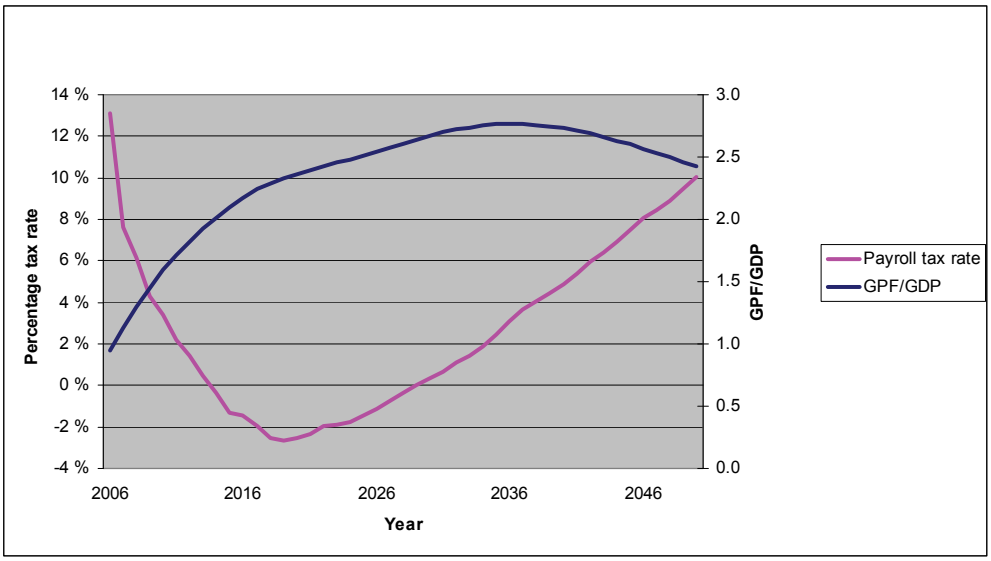
Total Factor Productivity (TFP)	1.3
Labour productivity growth in government sectors	0.5
Nominal interest rate, *level*	5.5
World prices	1.5
Labour force (individuals aged 20-66, net of disabled)	0.3
Number of individuals older than 66	1.6
Real oil price per barrel, 2004-dollars	50

4. The fiscal motivation for pension reform

Would Norway face severe fiscal sustainability problems if the pension system were not reformed? Figure 2, which shows the pay-as-you-go adjustments of the payroll tax rate required to meet the fiscal policy rule, may justify both a “no” and a “yes” to this question. A “no” can be justified by considering the level of the necessary tax rate, which is below today’s level in all years until 2050. Especially, the demographic development until 2020 causes stronger growth in tax bases than in government expenditures, which allows for successive cuts in the payroll tax rate from the present level of 13 percent. Negative payroll tax rates around 2020 means that there is fiscal scope for cutting other taxes as well. Simultaneously, the fiscal policy rule implies an unprecedented accumulation of

financial assets. The GPF/GDP ratio rises from close to 1 in 2007 to a peak at 2.8 in 2036. Thus, judged by the *levels* of government expenditures and tax bases within a 40-50 years perspective, Norway's fiscal future looks bright.[12] In particular, it looks much brighter than it did when the pension reform process was initiated. Then the real oil price was expected to half of the level in our simulations (NOU 2004:1).

Figure 2. No-reform scenario: Necessary payroll tax rate (left axis) and the ratio of the Government Pension Fund to GDP measured in current prices (right axis)



On the other hand, Figure 2 can also serve as a fiscal motivation for the pension reform if one emphasizes the *growth trends* after 2020 rather than the *levels* of government revenues and expenditures within a more or less arbitrarily chosen period. After 2020 ageing raises the ratio of government expenditures to the total tax base. If taxes were cut until 2020 according to Figure 2, even a broad based tax such as the payroll tax rate would have to be raised by 0.42 percentage points in every year. Moreover, no available information suggests that the necessary tax burden would stabilize if the simulation period were extended beyond 2050. On the other hand, Figure 2 can be criticised for underrating the future tax burden, since it relies on no growth in public service standards. The political pressure for improving standards of public health and care services will be strong when private consumption per capita grows by 2-3 percent annually, and the main users will represent a radically

[12] The combination of lower tax rates in 2050 than "today" and the accumulation of substantial government funds, makes Norway an outlier in an international perspective. Taking general equilibrium effects into account, Feldstein (2005) estimate that the payroll tax rate must increase by about 70 per cent from today to 2075 to finance the benefits specified in current law. Kotlikoff et al. (2001) suggest that the payroll tax rate in the U.S. must increase by 77 per cent over the next three decades. The Danish Welfare Commission (2004) projects that pay-as-you-go financing the present welfare schemes would require a 5.1 percent increase in total tax revenue relative to GDP from 2001 to 2050. Projections in OECD (2001) suggest that ageing requires a 7 per cent increase in tax revenues relative to GDP.

larger share of the voters. Thus, the scope for expansionary fiscal policy until 2020 may be used to expand spending instead of tax cuts. The consequence would be that the payroll tax rate would have to be increased from the present level in 2020, and with accelerated growth as increases in the public spending per elderly interacts with the growth in the number of elderly, see Heide *et al.* (2006).

A natural response to the U-shaped time path of the required payroll tax rate in Figure 2 is that the time path of the tax burden should be smoothened through more pre-funding. This would require a tighter fiscal policy rule than the present one. It is beyond the scope of this paper to discuss such a policy change, but we will just mention two points. First, it is questionable if it is politically feasible to increase government savings beyond the ambitious plan implied by the fiscal policy rule. Second, after 2020 the difference between the interest rate and the growth rates of primary fiscal deficit is less than one percentage point. Consequently, the pre-funding needed to reduce the future growth in the tax burden would be very high.

Stronger growth in government expenditures than in the tax base after 2020 will eventually undermine the impressive government finances. Sooner or later sustainable government finances require alignment of the growth rates of, respectively, government expenditures and the tax bases. Since growing public pension expenditures is the dominant source behind the simulated gap in growth rates after 2020, Figure 2 serves as a good motivation for a pension reform designed to reduce the *growth* in public pension expenditures. Measured in per cent of GDP, public pension expenditures grow from 4.5 to 15.8 per cent from 2006 to 2050. The most important reason is that the present pension system lacks any actuarial adjustment to modify the expenditure growth caused by increased longevity, expected to be 8 years in this period. Second, the baby-boom after World War II will replace less populous mid-war cohorts. Third, public pension benefits in payment are indexed to wage growth, and the wage rate grows faster than the GDP deflator. Fourth, maturing of the existing pension system, as well as growth in female labour market earnings, causes a 21 per cent real increase in the average public old age benefit from 2006 to 2050.

5. Reform effects on fiscal sustainability and employment

5.1 Labour supply responses

Responses at the intensive margin

Stensnes (2007) estimates the labour supply incentives at the intensive margin in the present and the proposed pension system. The reform implies that 1 NOK extra labour market earnings raise the present value of future pension benefits from 0.101 NOK to 0.157 NOK, on average. This corresponds to a 5.1 percent increase in the perceived effective wage rate. We consider this estimate as cautious, because it does not take into account that individual income dependency becomes more transparent and more similar between individuals in the new system. Appendix 1 examines to what extent alternative responses affect the total fiscal effects of the reform.

Responses at the extensive margin

Several studies find that labour supply is more elastic on the extensive than on the intensive margin, see e.g. Heckman (1993), Gruber and Wise (2004), and Chan and Stevens (2003).[13] Hernæs et al. (2002) survey Norwegian studies on retirement behaviour. However, estimates on retirement responses to this particular Norwegian pension reform are bound to be highly uncertain. Below we argue why we assume that the reform will increase the average retirement age by 0.6 years for a given life expectancy, and why this reform effect is deepened by an additional by 0.4 years for each year life expectancy improves.

Today about 60 per cent of the labour force has access to the present early retirement scheme, in which early retirement does not reduce benefits in subsequent years. The reform increases the individual cost of early retirement by a close to actuarial cut in the annual pension benefit the earlier one retires. According to the econometric estimate in Brinch et al. (2001) of a hypothetical switch from the present retirement incentives to a *perfectly actuarial* system, the resulting delay in retirement averages 2.4 years, corresponding to a 2 percent rise in aggregate labour supply. Such a response implies that labour market participation rates of the age groups 60-69 stabilise exactly between the present ones to those observed in the early 1980s, when no early retirement schemes had been introduced. However, non-actuarial properties caused by the granted minimum benefit reduce the response estimate. We also believe that changes in social norms pull in the same direction, because the statutory retirement age from 67, eroded by several early retirement schemes, drops to a new universal

[13] On the other hand, Samwick (1998) finds that levels of pension and other wealth are not major determinants of retirement.

limit of 62 years. See Gruber and Wise (2004) on the importance of statutory age limits for retirement norms. As a cautious estimate of the retirement effect of the actual reform, for given life expectancy, we modify the cost effect from 2.4 to 1.2 years.

The remaining 40 percent of the labour force will face access to the new universal early retirement scheme as a new option. Assuming that the average post-reform retirement behaviour will be equal for both groups, they will reduce their retirement age by 0.3 years when the reform is phased in. Consequently, when the reform is fully implemented in 2015, the average retirement age is estimated to have increased by 0.6*1.2 years + 0.4*(-0.3 years) = 0.6 years.

Increasing life expectancy is likely to have only a negligible effect on retirement under the present system, since the annual benefit is independent of the number of pension years. Thus, if consumption initially is completely financed by the benefit, this consumption-leisure combination can be maintained when life expectancy increases. If the initial consumption path is partly financed out of private funds, this path cannot be sustained when life expectancy increases without increasing labour supply. However, from the statutory early retirement age in the present system the individual faces a kinked budget constraint when he decides to work or retire, because delaying retirement by X years, means that he simply loses X times the annual benefit, without earning any additional entitlements. As the resulting effective personal tax rate on the extra income of staying in the labour force is typically as high as 80 percent[14], no significant labour supply response can be expected.

In the more actuarial system, however, increased life expectancy is likely to increase the retirement age through consumption smoothing, see e.g. Bloom, Canning and Moore (2004). In addition, if increased longevity results from improved health, it represents additional income. The optimal response would then be to trade some of the leisure increment for consumption, and postponing retirement is one way of doing this. However, 40 percent of the individuals will be unaffected by the changes in the early retirement incentives, since they have become disabled before the age of 62. Moreover, observed labour market participation rates in 2005 show that about 10 percent of the individuals keep on working after having passed the statutory retirement age of 67 (Brinck and Omholt, 2007). We assume that this share will increase to 20 percent when the pension system becomes more actuarial. Provided that increased longevity reflects improved health among the elderly, it is most plausible that the additional time spent working will, on average for this particular group,

[14] If the relevant tax rates on labour income and pensions are, respectively, 0.35 and 20 percent, and the compensation ratio is 0.55, the effective tax rate becomes 1 – [(1-0.35) – 0.55(1-0.20)] = 0.79.

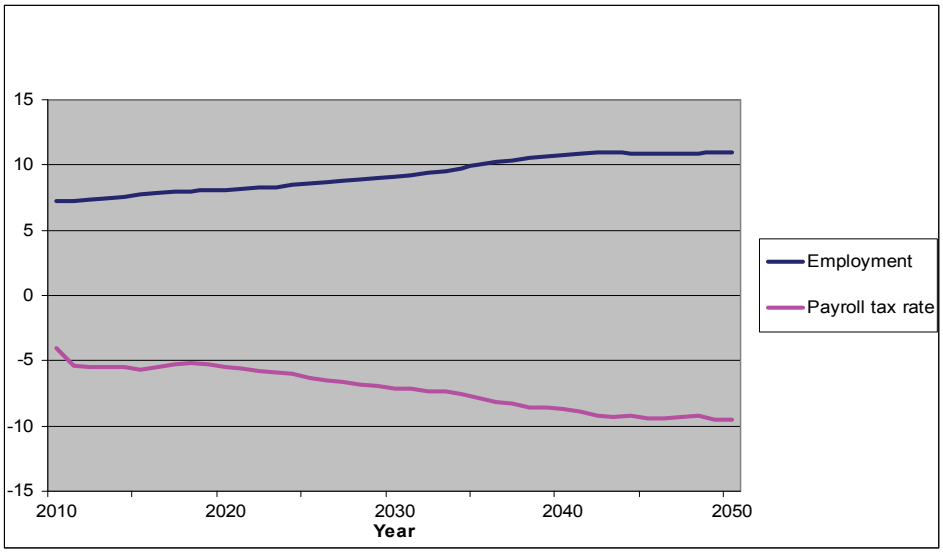
equal the increase in remaining life expectancy. Implicitly, this requires corresponding adjustments of upper age limits. The remaining 40 percent of the individuals are assumed to neutralize the benefit cut that follows directly from to the more actuarial reform, by delaying retirement by 2/3 years per year of increased remaining life expectancy at age 62. Thus the average delay of retirement caused by an increase in expected remaining lifetime of 1 year becomes 0.4*2/3 + 0.2*1 = 0.46 years. In 2050, the conditional remaining life expectancy of individuals of 62 years is expected to be 4 years longer than in 2010. Adding the immediate reform effect of 0.6 years to the gradually magnifying interaction between the reform and increased remaining life expectancy, implies that the reform effect on the average retirement age in 2050 equals 0.6 + 0.46*4 = 2.47 years. This corresponds to a 4.5 percent increase in supplied man hours relative to the projected 2050 level in the no-reform scenario.

5.2 Total effects

Tax burden and employment

Our model simulations suggest that the pension reform is likely to be highly successful in achieving a lower tax burden and stimulating employment. Compared to the no-reform path, the scope for cutting the payroll tax rate increases gradually from 6 percentage points in the first decade after reform implementation, passing as much as 9.5 points in 2050 (Figure 3). Until 2050, the budget neutral tax cut exceeds the complete payroll tax revenue. Towards 2020, the reform boosts employment by 8 percent relative to the no-reform path, rising further to 11 percent in 2050.

Figure 3: Deviation between Reform- and No-reform scenarios for the Payroll tax rate (percentage points) and Employment (percent)



Decomposition of the government budget effect by main budget components

Table 2 shows that the scope for tax rate reductions results from a rather complex mix of changes in government expenditure and revenue components. On the expenditure side, the reform is indeed cost saving for the government: Public old age pension expenditures would be 12.2 percent below the no-reform scenario in 2050. On the other hand, the reform increases other government transfers to households than old age pension expenditures by 6.8 percent in 2050. There are two reasons for this: First, the reform transfers some of the early retirees into disability and sickness schemes, rather than work. This reclassification of beneficiaries raises transfers by 4.7 points. Second, the increase in the pre-tax wage rate accounts for the remaining effect, which reflects that most transfers are indexed to wage growth. In absolute terms, lower labour costs in public service production account for the greatest contribution to lower expenditures, but this is basically a book-keeping effect, reflecting that the government pays less payroll tax to itself.

Table 2. Reform effects on tax bases and government expenditures in 2050. Deviations from the baseline scenario

	Billions NOK	Percent
1. Total revenues	-315	-5.1
a. Given baseline tax rates	262	4.2
b. Including the tax base effect of changed tax rates	399	6.4
c. Residual (= 1 – 1b)	-714	-11.5
2. Total expenditures	-328	-5.9
a. Transfers to households	-113	-3.6
i. Public old age pensions	-210	-12.2
ii. Other transfers	97	6.8
b. Government consumption	-224	-8.7
3. Net financial investment (= 1 – 2) [15]	13	1.9

On the revenue side, the scope for cutting tax rates levied on labour income reflects the reduction in government expenditure, as well as the expansion of most tax bases. The tax base expansion can be decomposed into a pure reform effect and an indirect effect induced by lower tax rates on labour income. We estimate the pure reform effect on the tax base to 4.2 percent in 2050 by simulating the reform scenario while keeping the payroll tax rate at the no-reform path and neglecting the government budget constraint (Table 2, line 1a). This tax base expansion is driven by the stronger labour supply incentives at the intensive and extensive margins (cf. section 5.1 and Table 3 below).

[15] The (relatively small) increase in government net financial investment is caused by the reduction in labour costs, which is explained in footnote 16. Total government net financial investment will be dominated by the investment in the GPF. As explained in footnote 11, the fiscal policy rule implies that this investment equals $B_t - B_{t-1} = \pi B_{t-1} + P_t$. The cut in the payroll tax rate reduces labour costs, which increases the government net petroleum cash flow, P, in every year. The increase in $B_t - B_{t-1}$ will grow over time since previous increments in P are capitalized.

The CGE model captures that higher employment expands almost all tax bases, not only the bases of the payroll tax and the personal income tax. The indirect effect of realizing the scope for tax cuts by reducing the payroll tax rate magnifies the tax base expansion from 4.2 to 6.4 percent through a further expansion of labour supply. The residual in line 1c in Table 2 should be interpreted as the direct and indirect revenue effect of tax rate reduction.

The surge in the pre-tax wage rate contributes to raise both government expenditures and the tax bases. The net budget effect is negative in our simulations, because the (direct and indirect) absolute wage share in government expenditures exceeds the wage share in the tax bases. This pattern reflects that the fiscal policy rule allows parts of the wage dependent expenditures to be financed by the petroleum wealth, which is nearly independent of the wage rate.

Contributions from reform elements

Table 3 decomposes the total reform effects on the tax rate and employment measured in 2050 into partial contributions from key reform elements: delayed retirement, stronger income dependency of benefits, and reduced average old age benefits. We identify these contributions by simulating the effects of each one separately. Accordingly, we estimate the contribution from delayed retirement by simulating the effects of a partial exogenous shift in the time path of retirement corresponding to the direct effects rationalized in Section 5.1. In 2050 delayed retirement corresponds to a 4.5 percent increase in employment. The equilibrium effects of such a shift, including the budget neutral cut in the payroll tax rate, raises the employment effect to 6.6 percent, which accounts for 60 percent of the total surge in employment.

Following the same procedure, we find that stronger income dependency of benefits contributes to, respectively, a cut in the payroll tax rate of 2.8 percentage points, and a rise in employment of 3.8 percent. 2.5 points of the employment effect is a direct response to the stronger link between earnings and benefits (cf. section 5.1).

Table 3. Decomposition of the reform effects in 2050. Deviations from the baseline scenario in percent unless otherwise indicated

	Employment	Payroll tax rate, percentage points	Consumer real wage, incl. stronger income dependency
1. Increased retirement age	6.6	-6.9	3.8
Direct effect	4.5		
2. Stronger income dependency of benefits	3.8	-2.8	5.6
Direct wage effect	2.5		5.1
3. Reduced average benefits	0.4	-1.0	0.8
4. Interaction effects (= 5 - 1 - 2 - 3)	0.2	1.2	-0.7
5. Total effect	11.0	-9.5	9.5

Determinants of changes in average benefit and total public old age pension expenditures

A striking example of the importance of behavioural and equilibrium effects is the finding is that the reform will leave the average benefit unaffected, see Table 4, which reports the contributions from mechanical reform effects and equilibrium repercussions. *Ceteris paribus*, the new entitlement structure raises the compensation by 7 percent, for given earnings histories. Over time, however, increased life expectancy and less generous indexation reduce the average benefit for given earnings and retirement behaviour. In 2050 these pure mechanical effects imply that the average benefit would be reduced to 88.9 percent of the no-reform benefit. However, labour supply responses counteract the mechanical effects, raising the average benefit to 97.6 percent of the no-reform level in 2050. Delayed retirement accounts for most of this rise in employment. The labour supply response at the intensive margin reflects both the new entitlement structure and the increase in the consumer real wage rate, which is mainly caused by the cut in the payroll tax rate. The deviation between the figures in line 3c and 3b in Table 4 shows that the partial effect of indexing entitlements to the endogenous wage growth raises the average benefit in the new system from 97.6 percent to 100.0 percent of the no-reform benefit in 2050.

The labour supply responses shift most of the cost saving effect of the reform from lower annual benefits to fewer old age pensioners and expanded tax bases. In 2050 delayed retirement would reduce the number of old age pensioners by 10.4 percent (from 1.249 to 1.119 millions) compared to the no-reform scenario. Delayed retirement explains why Table 3 attributes a much larger share of the tax cut to increased retirement age rather than reduced average benefits.

Table 4. Reform effects on Public Old Age Pension (POAP) expenditures, average Old Age (OA) benefit, and number of Old Age recipients. Cumulative contributions from different effects in 2050. Indexes, 2050-levels in the no-reform scenario = 1.

	Number of OA-recipients	OA-benefit	POAP-expenditures
1. No-reform scenario	1	1	1
2. Mechanical reform effects			
a. 1 + New entitlement structure	1	1.070	1.070
b. 2a + Actuarial benefit adjustment	1	0.955	0.955
c. 2b + New indexation of benefits	1	0.889	0.889
3. Behavioural and equilibrium effects			
a. 2c + Delayed retirement	0.896	0.963	0.863
b. 3a + Increased labour supply at the intensive margin	0.896	0.976	0.874
c. 3b + indexation of entitlements to new wage rate = **Total effects**	0.896	1.000	0.896

Growth rates of tax bases and government expenditures

Section 4.2 pointed out that the main long run fiscal sustainability problem in Norway lies in stronger growth in government expenditures, especially public pension expenditures, than in the total tax base after 2020. To what extent will the reform solve this problem? The simulated growth rates reported in Table 5 suggest that the problem is diminished, but only slightly: The growth gap between government expenditures and the total tax base is reduced from 0.99 to 0.92 percentage points, and the annual increase in the payroll tax after 2020 drops from 0.42 to 0.29 percentage points. Moreover, the fiscal improvement does not show up as slower expenditure growth. On the contrary, the reform *raises* the growth rate of total expenditures by 0.01 percentage points. The fiscal improvement results from more rapid growth in the tax base. Expenditure growth is most accelerated for government consumption and other transfers than the old age pensions. Stronger wage growth is a common driving force behind accelerated growth in most budget components. As noted above, this is a tax incidence caused by the gradually increasing cut in the payroll tax rate. The growth effect on the tax bases is somewhat reinforced by positive labour supply responses to the faster growth in the consumer real wage rate.

Interestingly, the long run *growth rate* of the public old age pension expenditures after 2020 is practically unaltered by the reform. Thus, the 12.2 percent reduction from the no-reform scenario of this expenditure component in 2050 reflects basically a shift in the expenditure *level*. The decomposition in Table 5 shows that the expenditure effect of slower growth in the number of old age pensioners is nearly completely neutralized by accelerated growth in entitlements. The latter effect is driven by more rapid wage growth, which affects entitlements through both indexation and labour supply.

Table 5. Average growth rates in the period 2020-2050 of government budget components measured in current prices. Percent

	Present system	New system
1. Total government expenditures	4.45	4.46
Government consumption	4.39	4.44
Transfers to households	4.77	4.84
Total public old age pension expenditures	5.57	5.56
Number of old age pensioners	1.47	1.25
Average annual benefit		
- ex ante indexation	0.12	0.21
- indexation with wage growth	3.94	4.06
Total tax base, no-reform tax rates	3.46	3.62
2. Total tax base, tax rates after reform	3.46	3.54
3. Gap between growth in expenditures and tax base (2-1)	0.99	0.92
Gap between growth in public old age pension expenditures and tax bas	2.11	2.02
Memo		
Employment	0.19	0.28
Payroll tax rate, percentage points	0.42	0.29

Appendix 1 shows that the reform effects on the growth rates of the tax base and the government expenditure components, including the old age pensions, are robust to alternative exogenous assumptions on demography and labour supply responses. Consequently, the following rather surprising conclusions can be drawn: The pension reform contributes to reduce the need for successive increments in the tax rates after 2020. However, the contribution is modest, and will come from accelerated growth in tax bases, rather than slower growth in expenditures. Contrary to the explicit goal of the reform, no significant change can be expected in the long run growth rate of public old age pension expenditures after 2020.

The choice of endogenous tax instrument

The general equilibrium repercussions need, however, some qualifications. First, the wage rate adjustments result basically from the choice of the payroll tax rate as the endogenous budget neutral fiscal policy instrument.[16] If the government budget constraint were met by pay-as-you-go adjustments in government consumption, the effects on the government budget components would have looked

[16] The negative effect on unit labour cost can be explained as follows: The pension reform expands the economy, including the demand for traded goods. In order to maintain the long run external balance, the production of traded goods must expand. This expansion commands lower labour costs due to decreasing returns to scale. Despite rather price elastic export supplies and import shares, the fall in the labour cost is as large as 9.6 percent in 2050. This reflects that the traded goods sector that is sensitive to labour costs is reduced by petroleum and interest income, and that the effective cost share of wages is less than fifty per cent in the wage sensitive sectors.

quite different. Specifically, the reform would have reduced the growth in the old age benefits compared to our reform simulations. Adjusting the tax rate levied on personal labour income, instead of the payroll tax rate, is likely to entail that both the level and the indexation of pension benefits would become based on the after-tax wage rate in order to maintain compensation rates. Then a tax rate reduction would be shifted onto the pension benefit just as in the case of payroll tax rate adjustment. Including pension benefits in the tax base would automatically leave the compensation rates invariant to endogenous tax rate adjustments, but the resulting minimum benefits may be in conflict with distributional concerns.

6. Distributional consequences

It should come as no surprise that the present reform, aiming to stimulate labour supply, also will increase inequality in pension outcomes. The question is by how much. We are able to measure changes in the old age pension benefits for 1 percent of the actual population. The resulting evaluation of distributional consequences is subject to three qualifications. First, we disregard possible distributional effects of changes in taxes and pension premiums, as well as equilibrium effects on wage rates and prices. The error resulting from this short-cut is likely to be small when such a broad based tax rate as the payroll tax is adjusted to neutralize the budget effect of the reform. Second, we analyse only the mechanical effects of pension reform for a given labour supply, both at the intensive and extensive margins. It follows from the envelope theorem that the income effects caused by behavioural changes indeed should be disregarded when we seek to capture utility changes, provided the changes are not "too" large". Third, we disregard the effects of changes in indexation and actuarial adjustments of the annual benefit to changes in the expected number of pension years in the new system. Including actuarial adjustments of annual benefits would confuse changes in pension wealth, which is the variable we want to measure, with (for our purpose irrelevant) changes in retirement spells.

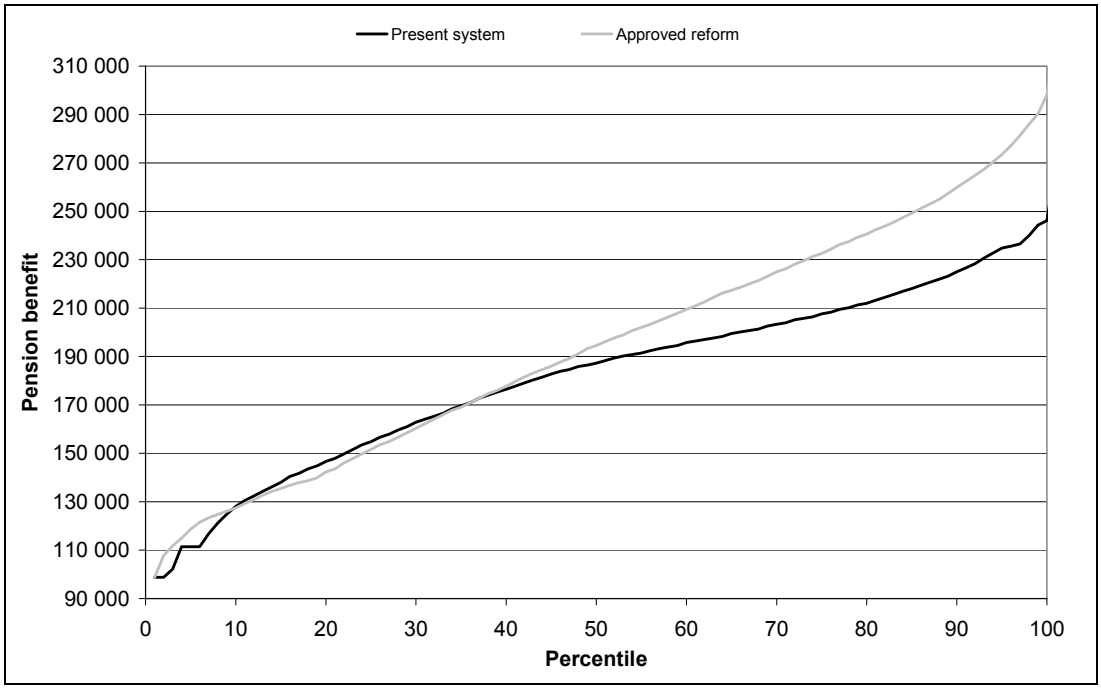
The reform increases the Gini-coefficient (G) of the public old age pension benefits in our cross-section of pensioners from 0.112 to 0.146, i.e. 30 percent, when measured at system maturity in 2050. The intuition provided by Aaberge (1997) helps to judge whether this is much. He proves that the 30 percent increase in G corresponds to introducing an equal-sized lump-sum tax of 30 percent of the mean benefit, and redistributing the collected tax revenue in proportion to the intial benefit of each pensioner. In comparison, the G of Norwegian household incomes increased by 27.5 percent from 1986 to 2003 (Statistics Norway, 2007). The main reason for the increased inequality is the closer link between earnings and pensions in the new system. Labour incomes are more unevenly distributed than pension benefits, due to components such as the income guarantee and the annual income ceiling on

accumulating pension entitlements. An alignment with labour income therefore makes the pension system less redistributive. Strengthening labour supply incentives in a situation with high marginal income taxes will typically improve social efficiency allocation of resources. Thus, policymakers also face the classical trade-off between equality and efficiency when designing the accrual scheme in pension systems.

Figure 4 breaks annual pension benefits in 2050 down by pension income percentile. For the bottom four deciles, the reform leaves benefits largely unchanged because two major effects neutralize each other. On the one hand, pensions will be somewhat reduced because the minimum pension is completely given as an income guarantee, without the universal pension element in the present system. This implies that the reformed system requires more entitlements to bring an individual above the benefit of the income guarantee. On the other hand, the reform offers a high accrual coefficient combined with a more generous rule for tapering the minimum, guaranteed pension against earned income pension. Compared with a 100 per cent reduction in the present system, the reform reduces the tapering rate to 80 per cent. This will boost benefits for individuals who have low, but non-negligible entitlements for income pensions.

The top six pension income deciles will experience progressively higher benefits, reflecting both the increased accrual coefficient for pension entitlement and the sharpened actuarial properties of the system in general. Apparently, Figure 4 leaves the impression that the reform will make all beneficiaries better off, in spite of the reduction in aggregate public old age expenditures. Recall, however, that corrections for life expectancy and indexation are excluded from the distributional effects for the reasons give above. These are the major cost saving reform elements, whereas the system for accumulation of entitlements partially increases expenditures. On the other hand, the reported distributional effects also ignore income effects of possible tax cuts. Figure 4 is therefore a good indication of relative distributional consequences, but misleading seen in a fiscal perspective.

Figure 4. Pension benefits in 2050 by percentile. Benefits are shows for a constant level of the BPU, which is given a nominal anchor equal to its 2006 mean value (NOK 62 161)



7. Conclusions

Estimates of pension reform effects typically belong to one of three strands of literature: (1) Highly detailed dynamic micro simulation of purely mechanical effects on individual benefits and government pension expenditures; (2) Econometric studies of behavioural effects of particular elements of pension system, especially labour supply; (3) CGE estimates of the long run effects of rather stylized reforms on employment, fiscal sustainability and the inter-generational welfare distribution. This paper has integrated these approaches by combining a detailed dynamic microsimulation model and a large scale dynamic CGE model to assess how the 2006 Norwegian pension reform can be expected to perform when evaluated against three goals: (1) Improving fiscal sustainability, (2) stimulating employment, and (3) maintaining a relatively compressed distribution of old age benefits.

The fiscal motivation of a cost saving pension reform is less evident in Norway than in other countries. Indeed, our simulations clarify that the financial position of the Norwegian government will remain solid throughout the next 4-5 decades in the sense that the present pension system and other welfare schemes, as well as substantial government savings can be financed at tax rates lower than the present ones until 2050. However, Norway faces a fundamental fiscal sustainability problem in the long run since government expenditures will grow significantly faster than the tax base after 2020. Aging is the

main driver of this development, and the growth in public old-age pension expenditures is a key contributor. Here lies the fiscal motivation for a cost saving pension reform. The Norwegian reform is tailored to attack this long run fiscal sustainability problem; it is designed explicitly to reduce the long run growth in the pension expenditures and to stimulate employment, rather than to be immediately cost saving. A more actuarial adjustment of the annual old age benefit to changes in life expectancy and early retirement is the key reform element in this respect.

To what extent will the reform improve fiscal sustainability? Our findings justify an ambiguous conclusion. On the one hand, the pension reform is likely to significantly improve the financial viability of the Norwegian welfare state, as far as the evaluation is confined to the change in the necessary tax rate *levels*. Compared to the no-reform scenario, the scope for reducing such a broad based tax as the payroll tax rate passes as much as 9.5 percentage points in 2050. Most of the fiscal improvement is achieved by an expansion of the tax bases due to increased labour supply, rather than cuts in individual benefits. In 2050, employment exceeds the corresponding no-reform level by 11 percent, reflecting labour supply responses to the increased individual cost of early retirement, stronger dependency between earnings and entitlements, and induced growth in the after-tax consumer real wage rate. Delayed retirement is the main reason why public old age pension expenditures would be 12 percent lower than in the no-reform scenario in 2050.

On the other hand, the reform makes a surprisingly small contribution to resolve the long run fiscal sustainability problem characterised by a post-2020 gap between the *growth rates* of government expenditures and the tax base. The reform shrinks this gap from 0.99 to 0.92 percentage points, and the annual increase in the payroll tax after 2020 drops from 0.42 to 0.29 points. This kind of dynamic fiscal improvement can be completely attributed to accelerated growth in the tax base, whereas the reform has practically no effect on the annual growth rate of total expenditures after 2020. Interestingly, and contrary to the explicit goal of the reform, this conclusion also applies to the growth rate of public old age pension expenditures. Accordingly, the reform can indeed be expected to have strong cost saving effect on future public pension expenditures, but this effect reflects a shift in the expenditure *level* – not a lower long run *growth rate*. The small reform effects on the growth rates of the tax base and the government expenditure components, including the old age pensions, are quite robust to alternative exogenous assumptions on demography and labour supply responses.

The stronger labour supply incentives both at the intensive and extensive margins will improve the social efficiency of the human capital allocation, especially in the Norwegian economy with its high

marginal tax rates on labour income. However, this efficiency gain entails a quite large equity loss: The reform raises the Gini coefficient of old age benefits by 30 percent, reflecting the progressively higher benefits of the top six pension income deciles. Furthermore, the gap between average benefits of men and women is magnified.

Our results demonstrate that one would seriously underestimate the fiscal effects of the pension reform if behavioural effects and equilibrium repercussions were ignored. At the same time, a few non-controversial general equilibrium effects render the reform impotent in achieving the main goal of dampening the growth in pension expenditures: In a small open economy there will be a positive incidence effect on wage growth from the slower growth in the payroll tax rate. This causes accelerated growth in entitlements, directly through wage indexation of entitlements, and indirectly through labour supply. The resulting stronger growth in benefits turns out to neutralize the expenditure effect of slower growth in the number of old age pensioners. A related conclusion is that a future evaluation of the cost saving effect of reform should consider more budget components than the old age pension expenditures. Especially, the main effects may show up in larger tax bases. However, when econometricians study their time series in e.g. 2050, they face some hard identification problems; the pension reform will not be the only source to changes in tax bases after 2010.

Although the use of large empirical models in this paper has given priority to realism and gone a long way in a rather non-fashionable direction to account for all available information relevant for the policy evaluation, there is obvious scope for improvements. Specifically, consistency can be improved by merging the most important aspects of individual life courses and the general equilibrium mechanisms into an OLG-model with income heterogeneity within each cohort. Moreover, the importance of the labour supply responses at both the intensive and the extensive margins suggests that future modelling work should probably give priority to capturing the heterogeneity of labour supply behaviour found in micro econometric studies. A particularly interesting topic is whether female labour supply behaviour will further converge to that of men when ageing imposes a strong growth trend in the demand for old age care. The effect on female labour supply behaviour is likely to have large consequences on both tax bases and pension entitlements.

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Appendix 1

Sensitivity analysis

This appendix discusses two questions: First, how robust are the effects of pension reform with respect to assumptions about(a) longevity, (b) net immigration, (c) retirement response to increased life expectancy, and (d) labour supply response to a more actuarial pension scheme? Second, how do these reform effects compare with effects in the main alternative? Consistent with the analysis in the paper, we analyse long run effects on both the levels and the growth rates of the key variables.

Level effects

Longevity

The reform intends to neutralize the effects on public old-age pension expenditures of changes in longevity. We analyse how well the reform lives up to this intention by re-simulating both the baseline and reform scenarios under the assumption that average longevity increases by 0.19 years per annum, rather than 0.14 as in our main alternative. In 2050, the difference has accumulated to 2.2 years. The simulations demonstrate that the reform indeed works as intended, see Table A1. In 2050 the increase in longevity would magnify the reduction in public old-age pension expenditures from 12.2 to 17.1 percent. This reflects that prolongation of the existing non-actuarial system is more costly the longer people live as pensioners. The corresponding feasible cut in the payroll tax rate increases from 9.5 to 13.6 percentage points. Stronger labour supply incentives at both the extensive and intensive margin contribute to the magnified scope for tax cuts.

Immigration

The substantial increase in immigration to Norway over the last years has demonstrated that this variable is notoriously hard to predict. Our sensitivity analysis incorporates an increase in net immigration of 8 000 persons per year in both the no-reform and the reform scenarios, which is 50 per cent above the net immigration in the main demographic alternative. Since we assume that immigrants behave as Norwegians with the lowest education in all scenarios, it reduces *cet. par* the average labour market participation rate, earnings and pension entitlements. This explains why higher immigration magnifies the reduction in old-age public pension expenditures by 2.6 percentage points in 2050. However, the positive reform effect on the total tax base is weakened and the increase in the pre-tax wage rate is stronger when the population share of immigrants is higher. On balance, more immigrants will slightly reduce the cut in the payroll tax rate that can be financed by the reform.

Retirement behaviour

If the reform does not affect retirement of the non-disabled individuals, the reform effect on employment is reduced by 2 percentage points. The scope for cutting the payroll tax rate is reduced from 9.5 to 8.3 percentage points in 2050. The modifications are reversed if retirement is delayed by 1.9 years more than in the main alternative. Interestingly, the actuarial properties of the new system make the reform effect on old-age public pension expenditures nearly invariant to retirement behaviour, because adjustments of the annual benefit neutralise the expenditure effect of changes in retirement. However, a stronger retirement response magnifies the positive budget effect of the reform through the effect on the total tax base.

Table A1. Pension reform effects under alternative assumptions on demographics and labour supply. Deviations from respective reference scenarios in 2050. Percent unless otherwise indicated

	Main alternative	Demographics		Labour supply			
		Longevity	Immigration	Retirement		Intensive margin incentive	
Changes from main alternative		2.2 extra years	Additional 0.36 million individuals	Delayed by 0.9 extra years	Advanced by 1,7 years	Up 1 %p	Down 1%p
Payroll tax rate, percentage points	-9.5	-13.6	-9.2	-9.8	-8.3	-10.0	-9.2
Employment	11.0	13.4	10.7	11.6	9.0	11.7	10.2
Pre-tax wage rate	2.0	4.1	2.3	2.0	1.8	1.9	2.2
Consumer real wage rate. incl. stronger income dependency	9.4	11.5	9.7	9.4	8.9	10.4	8.3
Total tax base	6.4	8.8	6.0	6.8	5.0	6.7	6.1
Total government expenditures. of which	-5.9	-8.1	-6.6	-5.9	-5.5	-6.2	-5.7
Transfers to households	-3.6	-5.9	-5.1	-3.3	-3.8	-3.7	-3.6
Old-age pension expenditures	-12.2	-17.1	-14,8	-12.1	-12.1	-12.3	-12.1
Consumption, current prices	-8.7	-10.5	-8.5	-9.1	-7.5	-9.4	-8.1

Labour supply at the intensive margin

Varying the labour supply incentive effect of the reform at the intensive margin indicates that employment increases by about 0.7 percent when the perceived marginal wage effect of the reform increases with 1 percent. The corresponding effect on the payroll tax rate reduction is 0.5 percentage points. The reform effect on old-age public pension expenditures is negatively correlated with the strength of the labour supply effect, since entitlements increase with higher labour supply. The reason is that higher employment commands a negative modification of the wage rate effect. The reform

effect on the payroll tax rate is somewhat weaker if the change in the labour supply incentive is perceived as weaker.

Effects on growth rates

Table A2 shows the sensitivity of the reform effect on the average annual growth rates of key variables computed over the period 2020-2050. For comparison, recall from Section 4 that maintaining the present pension system implies that the growth in the main government expenditure components exceeds the growth in the tax base by 0.97 percentage points per year, and that the necessary annual increase in the payroll tax rate equals 0.42 percentage points after 2020. Recall also from Section 5 that the pension reform reduces the growth rate gap between total government expenditures and the tax base by only 0.07 percentage points. The corresponding growth rate gap between public old-age expenditures and the tax base shrinks by only 0.09 points. The annual increase in the payroll tax rate can be reduced by 0.13 percentage points compared to the no-reform scenario.

An important insight from our sensitivity analysis is that the reform effects on the growth rate of key variables after 2020 are quite robust. For employment, it ranges from 0.08 to 0.11 percentage points. The annual rise in the payroll tax rate can be reduced by 0.09– 0.13 percentage points, except for in the scenario with the highest longevity, in which the reduction of the tax rate growth is twice as strong, 0.21 points.

The robustness of the reform effect on the growth of the payroll tax rate mirrors the robustness of the relatively small effects on growth in both total government expenditures and the total tax base. We find the strongest reform effect on the total tax base growth rate in the scenario with relatively highest longevity, but the difference from the main reform alternative is only 0.02 percentage points. The growth in total government expenditure is hardly affected by the reform, irrespective of the variation in exogenous assumptions on demography and labour supply incentives. The negative reform effect on the growth rate gap between expenditures and the tax base varies between 0.04 (higher immigration) and 0.1 (increased longevity) percentage points. Moreover, the maximum deviation between the pre- and post-reform growth rates of old-age pension expenditures is as small as 0.03 percentage points.

The robustness of the reform effects on growth rates is a result of several counteracting effects. Compare, for example, the reform effects on the growth in old-age pension expenditures in the two polar retirement behaviour alternatives. Switching from no delay to the relatively strongest delay contributes to a perhaps counter-intuitive *increase* in the reform effect on the growth rates of old-age

pension expenditures (by a marginal 0.04 percentage points). However, the negative reform effect on the growth rates of the number of old-age pensioners is 0.12 points stronger in the case of the relatively strongest delay of retirement. This difference is almost neutralized by the reform effects on the growth in annual benefits: The gradual increase in the length of working careers entails growth in annual benefit in the new and more actuarial system.

A major intention of the pension reform is that a more actuarial system should strengthen public finances through slower growth in public old-age pension expenditures. We find that these effects are likely to be negligible. This finding is both surprising and robust, and it should be of obvious interest to policy makers.

Table A2. Pension reform effects on average growth rates 2020-2050 under alternative assumptions. Deviation from growth rate in corresponding no-reform scenario. Percentage points unless otherwise indicated

	Main no-reform alternative	Main reform alternative	Demographics		Labour supply			
			Longe-vity	Immigration	Retirement		Intensive margin incentive	
Changes from main alternative			2.2 extra years in 2050	Additional 0.36 million individuals in 2050	Delayed by 0.9 extra years in 2050	Advanced by 1.7 years in 2050	Up 1 %p	Down 1%p
Employment	0.19	0.09	0.11	0.08	0.09	0.05	0.08	0.09
Payroll tax rate, percentage points	0.42	-0.13	-0.21	-0.12	-0.13	-0.11	-0.13	-0.12
Total government expenditures	4.43	0.01	0.00	0.01	0.02	0.00	0.01	0.02
Government consumption	4.44	-0.05	-0.06	-0.05	-0.05	-0.04	-0.05	-0.05
Transfers to households	4.77	0.07	0.06	0.05	0.09	0.04	0.08	0.08
Public old-age pensions	5.57	-0.01	0.03	0.03	0.01	-0.03	-0.01	-0.01
Number of old-age pensioners	1.47	-0.23	– 0.22	-0.20	-0.26	-0.14	-0.23	-0.22
Average annual benefit, ex ante indexation	0.12	0.08	0.01	0.05	0.12	-0.02	0.07	0.07
Indexation based on wage growth	3.90	0.13	0.18	0.11	0.12	0.10	0.12	0.11
Total tax base, no-reform tax rates	3.46	0.16	0.12	-0.07	0.17	0.12	0.17	0.16
Total tax base, tax rates after reform	3.46	0.08	0.10	0.04	0.09	0.05	0.08	0.07
Gap between growth in expenditures and tax base	0.97	-0.07	-0.10	-0.04	-0.07	-0.05	-0.07	-0.05
Gap between growth in public old-age pension expenditures and tax base	2.11	-0.09	-0.07	-0.01	-0.08	-0.08	-0.08	-0.08