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Oil and Intergenerational Redistribution – the Case of Norway

Friedrich Fichtner
Christian Hagist

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Oil and Intergenerational Redistribution – the Case of Norway*

Friedrich Fichtner
Freiburg University (Germany)

and

Christian Hagist
Research Center for Generational Contracts, Freiburg University (Germany)

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Abstract

The Norwegian population will pass through an ageing process during the next decades which causes that the old-age-dependency ratio rises from currently 22 per cent up to 38 per cent in 2050 and 47 per cent in 2100. This ageing population induces increasing expenditures on old-age and disability pensions together with health and long-term care benefits while the public revenues from wage taxes and social contributions will decrease. At the same time, the revenues from petroleum activities decline. Therefore, it is unclear if the Norwegian fiscal policy is really sustainable or not even despite the formidable current conditions with a budget surplus of nearly 14 per cent of GDP and a net wealth of 26 per cent of GDP. Is Norway over-consuming its petroleum wealth?

Generational Accounting, Norway, Fiscal Policy, Intergenerational redistribution
JEL Classification: H50, J10

* Corresponding author: Christian Hagist, Forschungszentrum Generationenverträge (Research Center for Generational Contracts), Albert-Ludwigs-Universität Freiburg (Freiburg University), D-79085 Freiburg, Germany (Fax +49-761-203-2290, christian.hagist@generationenvertraege.de). We would like to thank Yngvar Dyvi, Erling Holmøy, Pål Knudsen, Stefan Moog, Vibeke Nielsen, Bjørn Sandvik, Johannes Vatter and participants of the Statistics Norway Research Seminar for valuable comments. All errors remain our own. Furthermore, financial support of the E.ON-Ruhrgas AG is gratefully acknowledged.

1. Introduction

In a paper in 1993 Auerbach et al. (1993) asked the question: "Norway: Is the nation over-consuming its petroleum wealth?". They analyzed this question with the method of generational accounting and back then their answer was: yes, Norway does over-consume. And this could still hold today as Norway still has one of the most generous public pension systems and life expectancy at births rose from 1992 (their base year) to today significantly from 77.3 to 80.5 and is expected to increase even further. At the same time the fertility rate, although close to the natural reproduction rate, stagnates at 1.9 children per fertile woman. However, things also have changed in the other direction: Firstly, net migration hit a record high in 2007 with 40,000 people, most of them relatively young and well educated. Secondly, the Government Pension Fund (GPF) became over the last decade the very role model how unfunded pay-as-you-go-systems could become partially funded. And thirdly, and possibly most important of all, oil prices went through the roof and will probably continue rise even further. In 1992, the base year of the Auerbach et al. (1993) paper, direct and indirect taxes related to petroleum activities were around 3.84 per cent of GDP. In 2007 this number was 13.3 per cent (including dividends). While according to Statistics Norway (2008) Norway had in 1992 a deficit of 14.8 billion Kroner (NOK), it saw a surplus of 396.6 billion NOK in 2007.

Generational Accounts for Norway were not only calculated by Auerbach et al (1993) but also by Steigum (1996), Steigum and Gjersem (1999). Steigum (2002) and Gjersem (2002) while certain aspects of generational accounting were also included in some National Budget reports. However, our goal is not only to update these studies with the newest developments (see above) but also to put a focus on the intergenerational dimension of the oil wealth and the related pension fund.

The paper is structured as follows: Section 2 describes briefly the method of Generational Accounting and the calculation of the sustainability indicators used. The method of Generational Accounting was introduced during the early nineties to estimate both explicit and implicit debt of public coffers in the long run. The sources of data used for these calculations are reported in section 3. Generational Accounting needs three kinds of data, a population projection, age- and sex-specific profiles and a general government budget of a certain base-year. Furthermore, we discuss in section 3 our choice for global parameters (growth and discount rates) and the influence of the public oil-revenues on the general budget. In section 4 we provide the results of the Generational Accounting analyses using different kinds of sustainability indicators. Furthermore we illustrate the findings of the sensitivity analyses, wherein we analyze the effects of different population scenarios and the choice of several parameters. Section 5 summarizes and concludes the paper.

2. The Methodology of Generational Accounting

To measure the sustainability of a country's public sector we use the method of *Generational Accounting* developed by Auerbach, Gokhale and Kotlikoff (1991, 1992 and 1994). In contrast to traditional budget indicators which are based on annual cash flow budgets, *Generational Accounting* is founded on the intertemporal budget constraint and therefore the long-term implications of a current policy can be computed.[1] The intertemporal budget constraint of the public sector, expressed in present value terms of a base-year b is:

$$B_b = \sum_{k=b}^{b-D} N_{b,k} + \sum_{k=b+1}^{\infty} N_{b,k} \,. \tag{1}$$

Let D denote agents' maximum age and $N_{b,k}$ the present value of year *b*'s net tax payments, i.e., taxes paid net of transfers received, made by all members of a generation born in year k over the remaining lifecycle. Then, the first right-hand term of equation (1) represents the aggregate net taxes of all generations alive in the base-year b. The second term aggregates the net tax payments made by future generations born in year $b+1$ or later. Together this is equal to the left-hand side of equation (1), B_b, which stands for the net debt in year b. That means if the sum of all living generations' net taxes, $\sum_{k=b}^{b-D} N_{b,k}$, is negative (i.e. if they receive a net transfer) and the net debt, B_b, positive, the sum of future generations' net taxes has to be positive to balance the government's intertemporal budget i.e. in a long-term perspective net transfers received by living generations plus the net debt of the base-year have to be financed by net taxes paid by future generations.

To calculate generations' aggregated lifecycle net tax payments, the net payment terms in equation (1) are decomposed into:

$$N_{b,k} = \sum_{s=\max\{b,k\}}^{k+D} T_{s,k} \; P_{s,k} \; (1+r)^{b-s} \,. \tag{2}$$

In equation (2), $T_{s,k}$ denotes the average net tax paid in year s by a representative member of the generation born in year k, whereas $P_{s,k}$ stands for the number of members of a generation

[1] The further description of the methodology of *Generational Accounting* is mainly based on Raffelhüschen (1999) and Bonin (2001). For an analytical derivation of the intertemporal budget constraint see Benz and Fetzer (2006) or Fetzer (2006). Hagist (2008) gives an overview about the empirical studies with generational accounting along with a discussion concerning critical points in theoretical as well as empirical terms.

born in year k who survives until year s. To compute the remaining lifetime net payments of living generations, the future demographic structure is specified conducting long-term population forecasts.

Typically, *Generational Accountants* disaggregate equation (2) even further. To incorporate gender-specific differences in average tax payments and transfer receipts by age, separate aggregation of the average net taxes paid by male and female cohort members is required. The products aggregated in equation (2) represent the net taxes paid by all members of generation k in year s. For generations born prior to the base-year the summation starts from year *b*, while for future born cohorts, the summation starts in year $k > b$. Irrespective of the year of birth, all payments are discounted back to the base-year b by application of a real interest rate r.

The age-specific net tax payment in year s of agents born in year k can be decomposed as

(3) $$T_{s,k} = \sum_i h_{s,k,i} \quad .$$

$h_{s,k,i}$ stands for the average tax or transfer of type i paid or received in year s by agents born in year k, thus of age $s-k$.[2] In equation (3), $h > 0$ indicates a tax payment, whereas $h < 0$ defines a transfer.

Applying the method of *Generational Accounting* it is conventionally assumed that initial fiscal policy and economic behavior are constant over time. Under this condition it is possible to project future average tax payments and transfer receipts per capita from the base-year age profile of payments according to

(4) $$h_{s,k,i} = h_{b,b-(s-k),i} \left(1+g\right)^{s-b}.$$

where *g* represents the annual rate of productivity growth. Equation (4) assigns to each agent of age *s-k* in year *s* the tax and transfer payment observed for agents of the same age in base-year *b*, uprated for gains in productivity. The base-year cross section of age-specific tax and transfer payments per capita is generally determined in two steps. First, the relative position of age cohorts between themselves in the tax and transfer system is estimated from micro-data profiles. In a second step the relative age profiles are re-evaluated proportionally to fit the expenditure and tax revenues of the base-year.

[2] In case of an isolated analysis of public subsystems like health care or public pension as conducted in the following chapters, *i* is just chosen so that all relevant payment streams are included in the analysis.

For living and future generations, division of the aggregate remaining lifetime net tax payments by the number of cohort members alive in year *s* defines the cohort's *Generational Account* in year *s*:

$$GA_{s,k} = \frac{N_{s,k}}{P_{s,k}} \quad . \tag{5}$$

Generational Accounts are constructed in a purely forward-looking manner, only the taxes paid and the transfers received in or after the base-year are considered. As a consequence, *Generational Accounts* cannot be compared across living generations because they incorporate effects of differential lifetime. One may compare, however, the *Generational Accounts* of base-year and future born agents, who are observed over their entire lifecycle.

To illustrate the fiscal burden of current fiscal policy we use seven sustainability indicators:[3] The starting point for the first indicators are the *intertemporal public liabilities* which can be computed by the assumption that the intertemporal budget constraint of the public sector (1) is violated:

$$IPL_b = B_b - \sum_{k=b-D}^{\infty} N_{b,k} \, . \tag{6}$$

The amount of *intertemporal public liabilities* measures aggregate unfunded claims on future budgets, assuming that the present policy will hold for the future. The first sustainability indicator, the *fiscal gap* (FG_b), can be derived if the *intertemporal public liabilities* are set in relation to base-year's GDP (GDP_b). This indicator is akin to the debt quota well known since the Maastricht treaty but it addresses the debt which will occur in the future and in the past:

$$FG_b = \frac{IPL_b}{GDP_b} . \tag{7}$$

How the policy adjustment required to redeem *intertemporal public liabilities* will affect generations' fiscal burdens is uncertain. For illustrative purposes, *Generational Accounting* typically assigns the entire adjustment to future generations which is equivalent to $k > b$. All tax payments made by members of future born cohorts are adjusted proportionally with the help of a uniform scaling factor θ. The factor θ is set to ensure balance of the intertemporal public budget defined in equation (1):

[3] For a discussion of measuring fiscal sustainability and the development of sustainability indicators, see Raffelhüschen (1999) and Benz and Fetzer (2006).

(8) $$h_{s,k,i} = \theta \times h_{b,b-(s-k),i} \left(1+g\right)^{s-b}$$

for and instead of equation (4). Computing the average age-specific net taxes paid by representative future born agents, the burden for future generations can be illustrated as an absolute difference between the *Generational Account* of the base-year agent and the *Generational Account* of the one year after base-year born agent. This is our second sustainability indicator, the *future generations' burden*.

(9) $$FGB = GA_{b,b} - GA^{\theta}_{b,b+1}$$

The third indicator that illustrates the burden of current fiscal policy is the *revenue gap*. In this case the scaling factor $\theta = \theta_{rev}$ reflects the enhancement of age-specific revenues in per cent for all generations which is necessary to close the intertemporal public budget constraint. It can also be interpreted as the ratio of the *intertemporal public liabilities* to the present value of all age-specific revenues of the fiscal system :

(10) $$\theta_{rev} = \frac{IPL_b}{\sum_{s=b}^{\infty} \mathrm{Re}v_s \cdot \frac{1}{(1+r)^{(s-b)}}}$$

with $\mathrm{Re}v_s$ referring to the sum of revenues in year s by all living generations in year s. Analogous to the *revenue gap*, we compute also the so-called *transfer gap.* In this case the scaling factor $\theta = \theta_{trf}$ reflects the necessary decrement of age-specific public transfers (*Trf*) like health benefits in per cent for all generations that is necessary to close the intertemporal public budget constraint. Constructing the *revenue* and *transfer gap*, we implicitly assume that the government is able to enforce an immediate adjustment of all taxes and contributions or transfers respectively.

As Benz and Fetzer (2006) have shown all the used indicators are computed with an infinite time horizon. In the practical calculation all relevant variables like population or cohorts' tax payments are projected for 300 years from the base-year on. Afterwards a geometrical serial is used to determine the remaining net tax payments. The choice of 300 periods is nearly completely arbitrary and just reflects a good approximation point for our analysis.

3. Data and Assumptions

To compute Generational Accounts and to calculate the described indicators, a population projection is needed. Furthermore the calculations require the expenditures and revenues of the

Norwegian public sector in 2007, age-sex-profiles for the different expenditure and revenue types and a growth rate of the productivity as well as a discount rate. The population projection in the following is calculated with a demographic program developed by Bonin (2001).

3.1 Population Projection

Generational Accounting requires detailed population projections, which distinguish between three possible scenarios titled *medium variant*, *high variant* and *low variant*. Based on different assumptions about the three parameters life expectancy, fertility and migration it is possible to derive a population projection for each of the demographic scenarios. Own calculations are necessary for the reason of *Generational Accounting's* assumed infinite time horizon: The official projections end in 2060 while we need a 300 years projection period. In these calculations we use for the parameters of the year 2007 the given data of Statistics Norway. The projected parameters until year 2060 in the different scenarios originate from the assumptions made by Statistics Norway (2008a). Table 1 shows those central assumptions of the three scenarios.

Table 1: Central Assumptions of Norwegian Population Projections

Parameter	Year	Scenario		
		Medium Variant	High Variant	Low Variant
Total Fertility Rate	2007	1.90	1.90	1.90
	2060	1.85	2.05	1.50
Life Expectancy at birth for females/males in years	2007	82.7/78.2	82.7/78.2	82.7/78.2
	2060	90.2/86.3	92.7/87.9	82.7/78.2
Net migration	2007	39,500	39,500	39,500
	2060	20,000	32,300	10,000

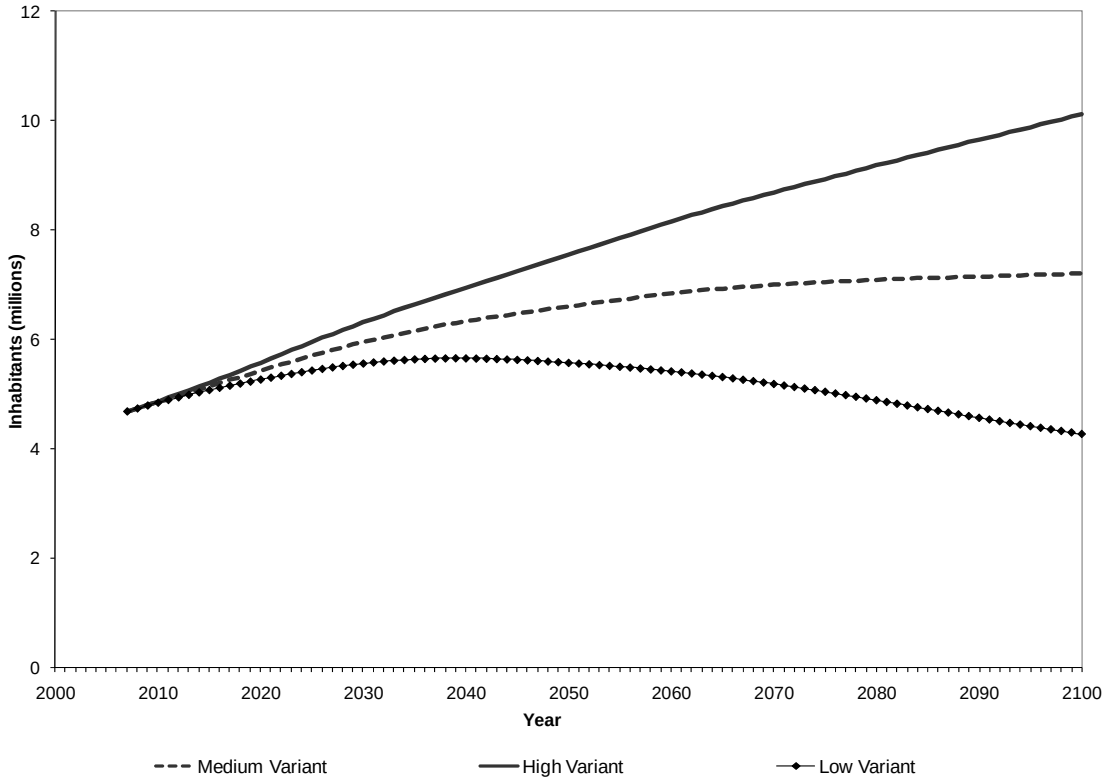
Source: Statistics Norway (2008a)

In the following the future size and structure of the Norwegian population can be anticipated for all three different demographic scenarios. The outcomes of these projections are shown in figure 1. Compared to the official calculations of Statistics Norway (2008a), we exactly hit the Norwegian population in 2050 within our medium projection.

In the *medium variant* of the Norwegian population projection which is shown in Figure 1 the population grows over the projection horizon. After this scenario the population increases from 4.7 million in 2007 to 6.3 million in 2100. The *high variant* causes a constant increase in terms of population. The population rises to 6.7 million until 2050 and 9.5 million until 2100. Only the *low variant* contains a decrease of the population. Until it reaches the year 2036, the population grows also in this scenario due to the increasing life expectancy of both men and women, afterwards a shrinkage process begins which causes a population of 5 million in 2050 and 3.9 million in 2100. For the following analysis we take the *medium variant* as our standard scenario if

not stated differently. Outcomes for the two other scenarios can be found in sector 5.2 of this paper.

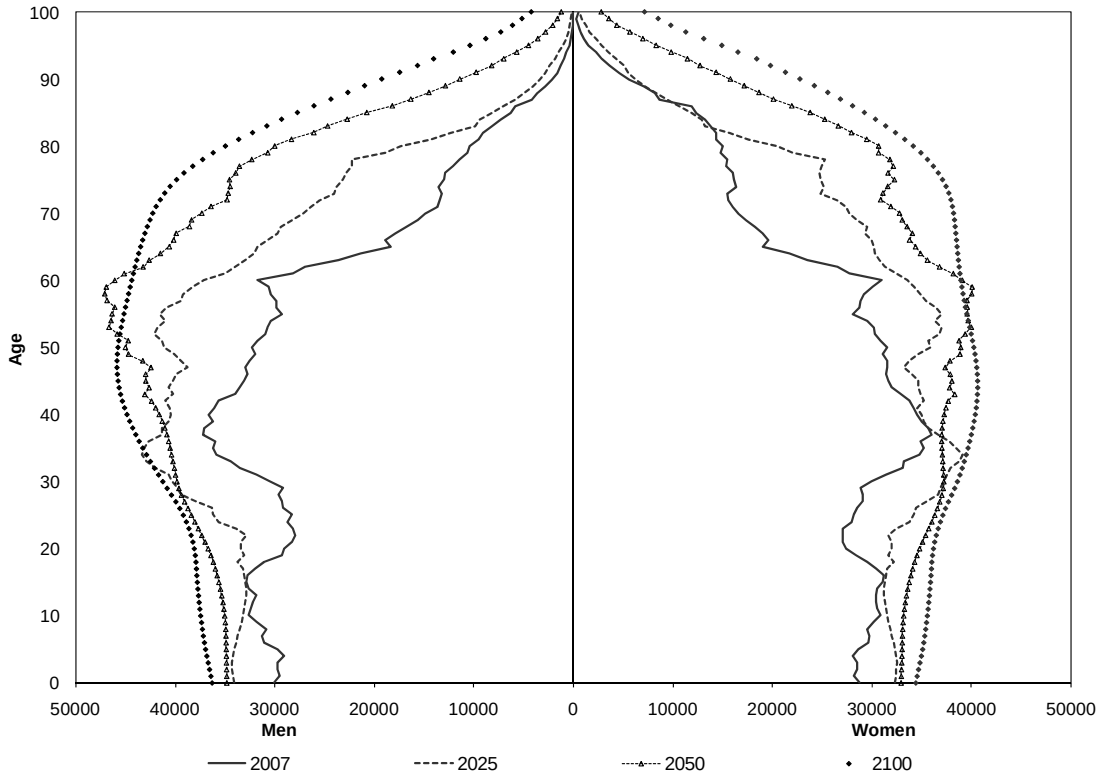
Figure 1: Different developments of the Norwegian population until 2100



Source: Own calculations

Figure 2 presents exemplarily the population projection based on the *medium variant* in the years 2007, 2025, 2050 and 2100 divided by age and sex. In the base-year the Norwegian population shows a few remarkable patterns. The first anomaly in the development of the Norwegian population occurred for the cohorts of the 86-year-olds until the 72-year-olds in 2007. This is caused by the Second World War. However, the effects of this war for the population structure in Norway are much less than in most other middle-European nations. In the following it came to the so-called “baby-boom” which was characterized by birth-rates of almost three children per woman. At the end of the 1960s the so-called “pill kink” finished this boom and caused a massive decrease of the population. Due to increasing fertility rates after 1985 the size of the population rises for the cohorts of the 22-year-olds and younger. The reasons for this increase are difficult to define, because it did not happen in most other middle-European countries. It can be assumed that it is mainly caused by a higher generosity in the Norwegian family transfer system.

Figure 2: Norwegian population in 2007, 2025, 2050 and 2100

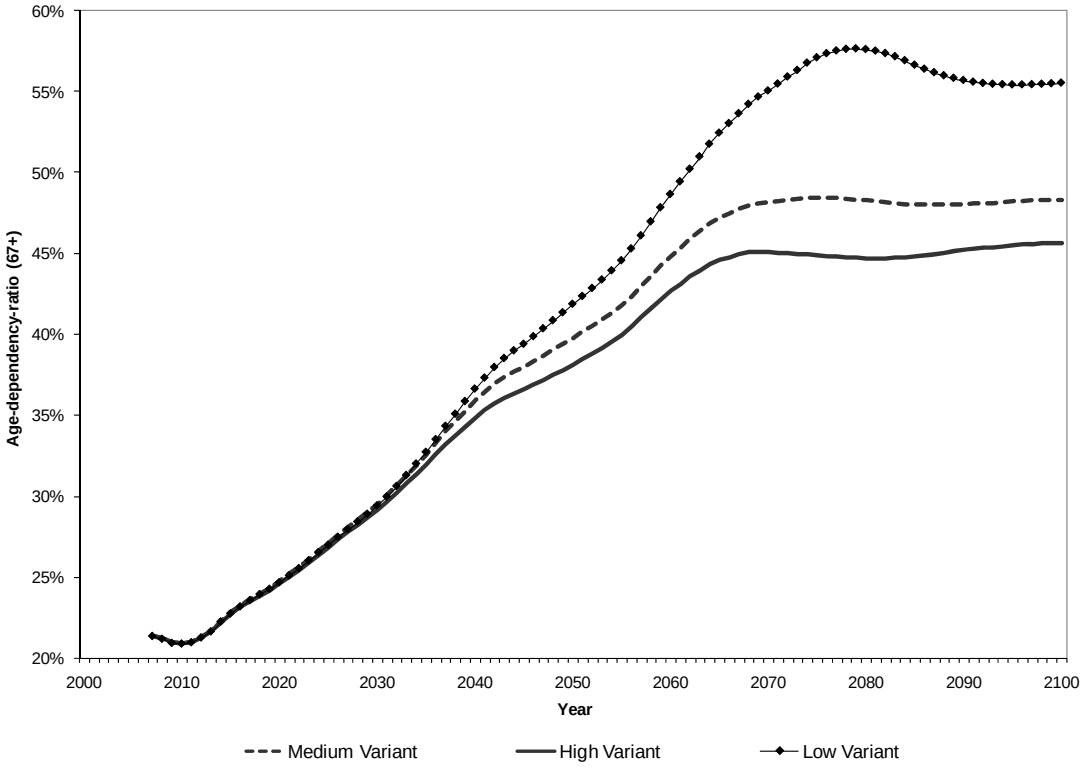


Source: Own calculations

One can see on the basis of figure 2 that the absolute size of the Norwegian population will increase in the future. Especially the number of members of cohorts above the age of 60 years will constantly grow, while the size of the younger cohorts will be almost stable. This is mainly caused by the augmentation of the life expectancy in Norway combined with more or less sufficient fertility rates. How and to what extent this future changes in the population structure include a change of the average age and especially of the ratios between the cohorts can be demonstrated by the old-age-dependency-ratio. This is defined by the ratio between members of cohorts older than 66 years to the sum of all generations between 20 and 66years.[4] This ratio shows more or less the proportion between the old part of the society and the younger working part. Therefore the future development of the old-age-dependency-ratio gives a first hint of how social security systems organized in a pay as you go-pattern will be imbalanced in the future.

[4] In the literature one find various different definitions with different age groups or restricted groups like working people under a certain age. However, in the case of Norway, the official retirement age is 67 years even when the actual retirement age is more likely around 63 years.

Figure 3: Development of the age-dependency-ratio until 2100 in Norway



Source: Own calculations

3.2 Public Sector Finances and Petroleum Revenues

The budget of the Norwegian general government which is shown in table 2 is characterized by a few remarkable patterns. The aggregates for revenues and expenditures which are discussed in the following are taken from Statistics Norway (2008b). Revenues include taxes on labor and capital incomes, value added tax, property tax and social insurance contributions. Moreover the largest part on the revenue-side of the Norwegian budget is given by the earnings out of the oil resources of the country. The public expenditures contain expenses for general public services, defense, public order and safety, economic affairs, and environmental protection, housing and cultural activities which are aggregated in the budget item “Governmental Consumption”. The aggregate *health expenditures* on the one hand is divided into four different subcategories according to Statistics Norway (2008c). The entry *disability and sickness* (in the original budget of Statistics Norway (2008b)) on the other hand is divided into again four subcategories after Ministry of Finance (2008) such as disability pensions, sickness benefits, vocational training and the early retirement scheme AFP.

Table 2: Public expenditures and revenues of the Norwegian General Government in 2007

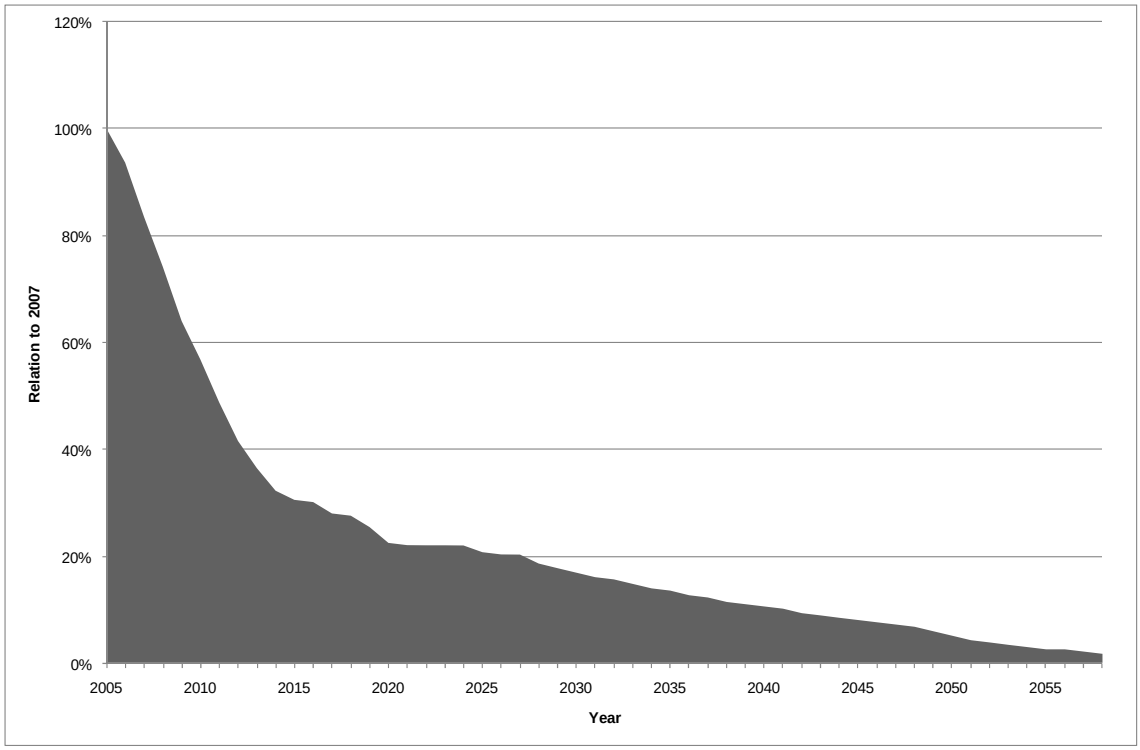
Public Expenditure (Billion NOK)		Public Revenues (Billion NOK)	
Government Consumption	201.66	Non-Oil Property Income	85.83
Oil related expenditures	21.10	Dividend GPF	78.40
Interest Payments	29.02	Property Income from Oil	108.82
Outpatient Medical Care	99.01	VAT	188.70
Inpatient Medical Care	34.15	Customs duties	2.02
Pharmaceuticals	13.02	Indirect Taxes on Oil	4.64
Long-Term-Care	46.96	Alcohol Tax	10.34
Health Administration	6.38	Tobacco Tax	6.82
Primary Education	51.58	Gas and Pollution Tax	39.20
Secondary Education	25.59	Real estate tax	5.54
Tertiary Education	28.95	Other indirect taxes	31.53
General Education Expenditures	14.05	Social Security Contributions	206.03
Old Age Pension	97.31	Income Tax without petrol	293.08
Survivor Benefits	5.74	Income Tax on petrol activities	190.30
Early Retirement Scheme (AFP)	3.96	Motorvehicle Tax	6.70
Disability Benefits	52.18	Other income	13.25
Sickness Benefits	27.97		
Vocational Training	28.50		
Family Benefits	66.93		
Unemployment Benefits	5.79		
Housing	2.34		
Social Welfare	12.39		
Total Expenditures	874.56		
Surplus	*396.62*		
SUM	1271.19	SUM	1271.19

Source: Own calculations based on Statistics Norway (2008b,c)

Public coffers in Norway are remarkable compared to other OECD countries. In 2007 Norway was blessed with a primary surplus of 425.64 billion NOK, nearly half the amount which the public sector spends. Four budget items should be highlighted concerning this number. Norway pays 29.02 billion NOK on interest for its public debt of 52 per cent of GDP in 2007 while receiving 78.40 billion NOK in interest and dividends from the Government Pension Fund (GPF). Alone from these figures, one can state that Norway has at least a booking net wealth. Furthermore, oil revenues either from taxes or dividends hit a record high in 2007 with a total of 303.76 billion NOK or 13.3 per cent of GDP. However, petroleum revenues will not be sustainable in the future. According to official prognoses of the OECD (2007) this ratio will shrink onto 0.4 per cent until 2060 taking into account price as well as output effects. Figure 4 show the assumed

development of oil revenues in relation to GDP which will be used in the forthcoming calculations.

Figure 4: Development of Norway's petroleum revenues



Source: Own calculations based on OECD (2007)

3.3 Micro profiles

Beyond the population projection and the base-year budget of the public sector are age-and sex-specific micro-profiles necessary to define the intertemporal budget constraint of the public sector. These profiles are needed to distribute the different aggregates of public revenues and expenditures on the cohorts which live in the base-year and hence to determine the future public revenues and expenditures in dependence on the demographic progression. Entries like government consumption which are not paid or consumed in an age-specific way are distributed with a flat per capita profile. The used age-and sex-specific profiles stem primarily from Statistics Norway and were made available upon request. Health expenditures profiles for in-and outpatient treatments, pharmaceuticals and long-term care are taken from Fetzer et al. (2005). All profiles together with an overview about how the different budget items are distributed are presented in the appendix.

3.4 Interest and Growth Assumptions

Because of the infinite time-horizon it is quite difficult to define the constant interest and growth rate, which are needed to predict the future revenues and expenditures of the public sector and

to analyze the sustainability of this system. Norway's government assumes for its calculation of the present value of the GPF a standardized growth rate (*g*) of 2.0 per cent and a discount rate (*r*) of 4.0 per cent with which we follow in our standard scenario except for two exceptions. To distribute the wealth of the GPF and the public debt over generations, it is necessary to consider the dividends of the GPF and the interest paid for the public debt as flows rather than just take the stocks into account (which would be sufficient to calculate the fiscal gap). However, with a discount rate we would greatly overestimate the public debt and underestimate the wealth of the GPF. That is why we calculate internal discount rates for these two budget items. Taking the formula for an eternal rent, the internal discount rate of the GPF is 4.4 per cent and for the public debt 2.45 per cent respectively. In addition these two budget items along with the oil revenues (see section 4.2) will not grow according to the technical progress and the demographic development but only to the discount rate so their present value is equal in every scenario (however, not their outcome per head logically). Additionally it is necessary to undertake appropriate sensitivity analysis to minimize possible empirical uncertainties which are caused by the unsuitable choice of the parameters.

4. The sustainability of Norway's fiscal system

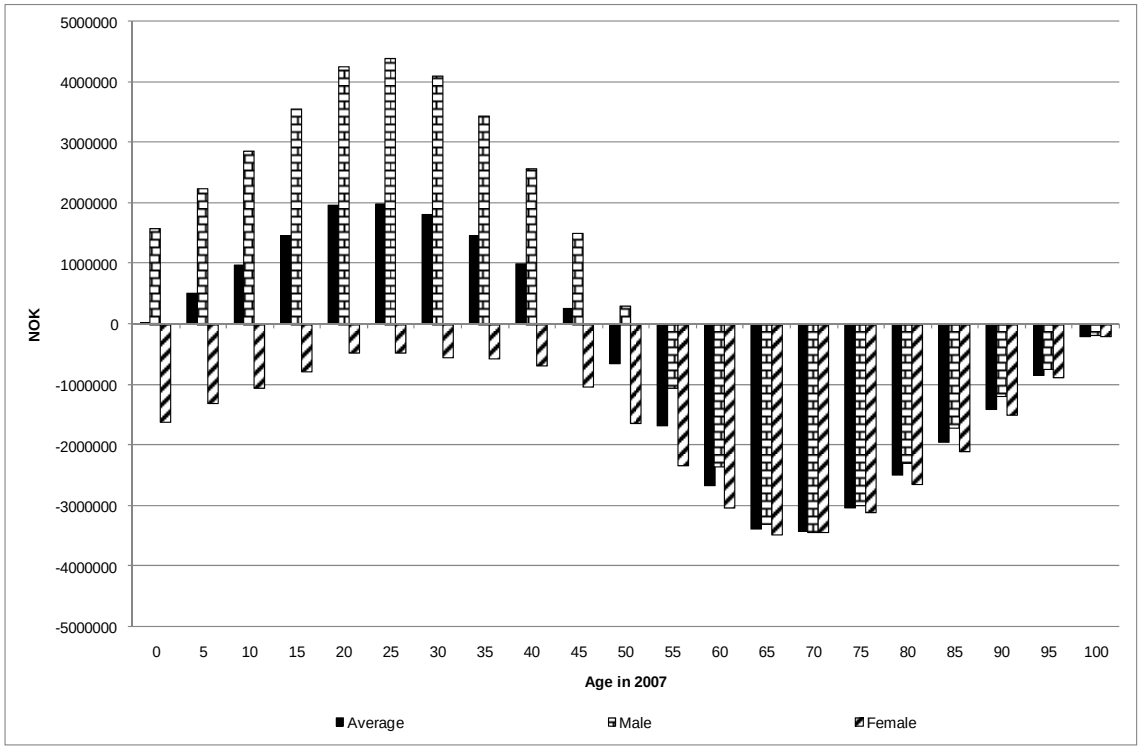
As described above, the Norwegian state is in the comfortable situation to have an explicit budget surplus at present. But this is mainly caused by the high oil revenues of the public sector and therefore it is unrealistic to assume that this will be constant in the future. Furthermore, the Norwegian population will getting older. Because of the comparatively high fertility rates in Norway, this ageing-process will be quite modest. However, it exists and causes an expanding number of retirees, which are amongst others entitled to receive benefits out of the public pension system and which are responsible for a major part of the public health care costs. The financial consequences of the described revenue-effect and the ageing-effect can be calculated by the method of Generational Accounting. The results of these calculations are shown in the following.

4.1 Generational Accounts

Figure 5 presents the first outcome of our analysis, namely the Generational Accounts of Norwegians distinguished by gender in our baseyear, 2007, according to our standard scenario (*medium variant, g=2%, r=4%*). At a first glance, one can recognize the classical result of a sinus-shaped pattern which is very common in OECD countries with strong pay-as-you-go systems. The young between 0 and 45 years finance the elderly generations from 50 years and older. Generational Accounts in average begin with 19,121 NOK for the present newborn and are at a maximum of 1,971,900 NOK paid by the representative 25 years old. This means that a 25 years

old Norwegian (nearly half male/female) pays 1,971,900 more in taxes and contributions over his/her remaining life-cycle than he/she will receive in transfers and subsidies from the Norwegian general government. This includes assigned oil revenues which are distributed evenly by (living) capita each year. The generation of 47 years olds is the first one which receives more than he/she pays in taxes over his/her remaining life-cycle. However, one should keep in mind that Generational Accounting is strict forward looking so living generations' accounts are not comparable. The major receiver is the generation of 65 years olds because after 65 years discounting lowers the Generational Accounts significantly. This pattern can generally be observed in many developed countries. However, two things are quite remarkable and perhaps special in the Norwegian case. Firstly, even for such an egalitarian country in respect to gender emancipation as Norway, the Generational Accounts between men and women differ quite substantially in quantitative as well as qualitative terms until the age of 50 years. One can clearly state that young Norwegian men carry at least fiscally the burden of Norway's welfare state. Surely, this outcome depends on the one hand highly on our chosen micro-profiles but also on the other hand to the indisputable higher life expectancy of women and their lower income on average.[5] Sadly, a sensitivity analysis concerning our incidence assumptions (via the micro-profiles) is yet not possible as better data at least to our knowledge is not available.

Figure 5: Generational Accounts of Norway



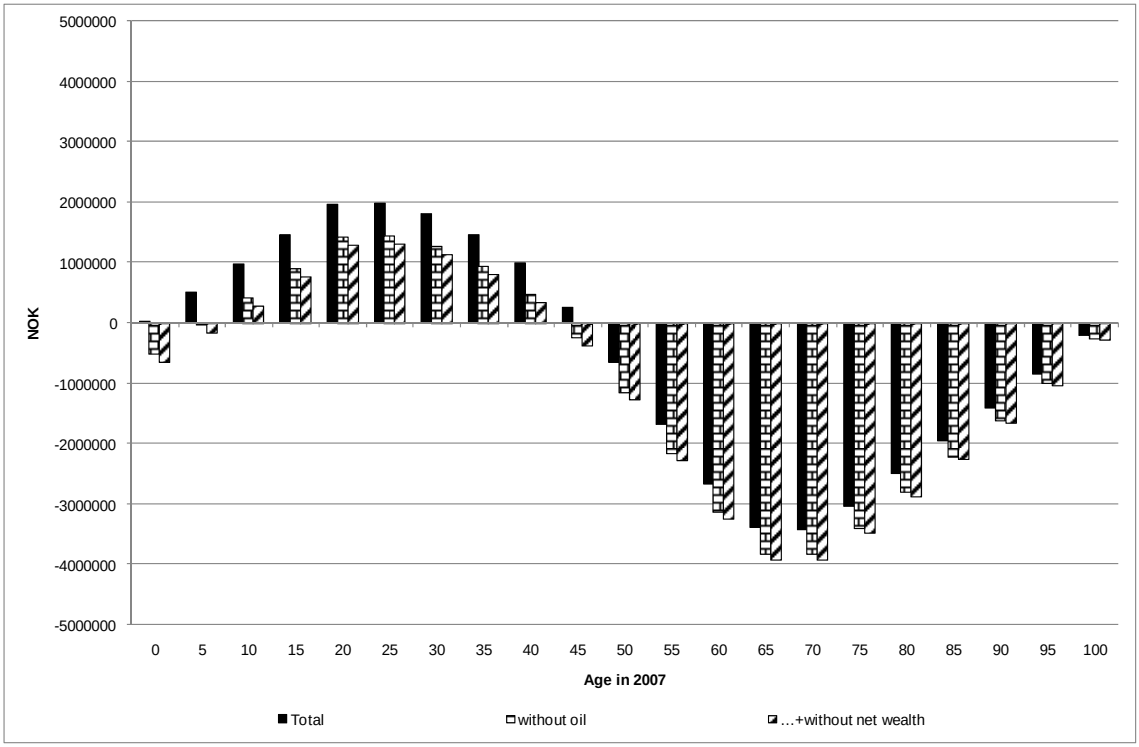
Source: Own calculations

[5] For example women receive the major share of family benefits while one could also assume that the incidence is really based on the child or the family (husband, wife, children) as a whole.

The even more remarkable result, however, is the account of the present average newborn. Even little, it has a positive sign (19,121 NOK). Comparing this to the generational accounts of Austria, France, Germany, Spain, Switzerland, the UK and the U.S. presented in Hagist et al. (2008), it is a unique pattern. However, this only holds if one accounts for the petroleum revenues and the dividends of the net wealth (GPF minus public debt) and only until for newborns in 2007 as newborns in 2008 are already starting their life with a net transfer of 34,252 NOK in the standard scenario.

As one can see in figure 6, Generational Accounts of every generation are significant lower without these two sources of funding. Looking only at the core public finances without oil and the generation fund the pattern we see in other countries holds also for Norway.

Figure 6: Generational Accounts of Norway: The importance of petroleum

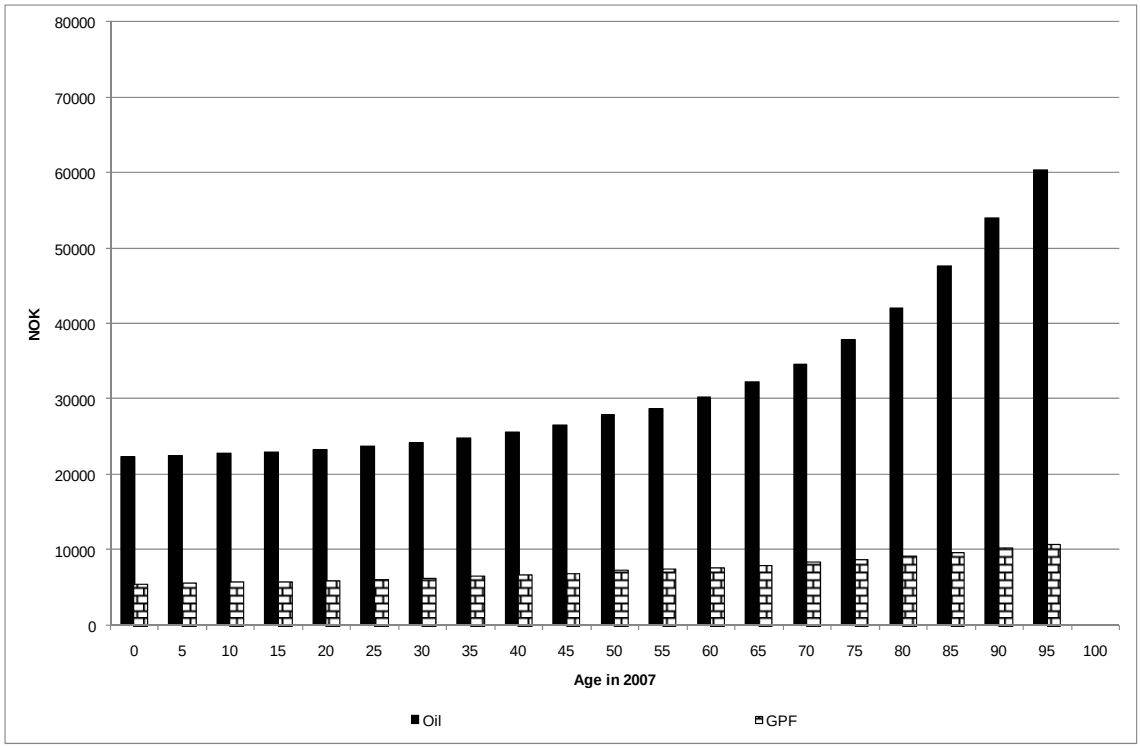


Source: Own calculations

As one cannot compare Generational Accounts between living generations, it is not clear from figure 6 which generations are benefiting the most from Norway's petroleum wealth. Therefore we compute annuities of the difference between two scenarios (e.g. the account of the 50 years old in the "Total" scenario minus the account of the 50 years old in the "…+without net wealth" scenario) weighted with the age-specific life expectancy. The results of this analysis can be seen in figure 7. While the GPF (minus the public debt) really distributes the dividends evenly across generations, oil revenues if they would be part of the general budget, would majorly benefit the living older generations. However, this is a flaw in our analysis as we take the petroleum revenues as "normal" tax revenues. However, current Norwegian policy attributes these

revenues directly to the GPF, so if this policy is handled properly it could really benefit all generations equally.

Figure 7: Generational distribution of the petroleum and GPF wealth



Source: Own calculations

4.2 The Fiscal Gap and other sustainability indicators

Our first sustainability indicator can be derived if the *intertemporal public liabilities*, i.e. the sum of the Generational Accounts for living and future generations weighted with their (expected) cohort size, are set in relation to base-year's GDP. The value of this so called fiscal gap for the whole Norwegian public sector in our standard scenario (*medium variant, g=2%, r=4%)* is 19.8 per cent.[6] This means that the Norwegian state is not sustainable but very close. However, as always one has to have a closer look to understand what is really going on. Public debt, the so called explicit public debt, was 52.0 per cent of GDP in 2007. The GPF hold assets in 2007 worth 78.3 per cent of GDP. The present value of petroleum related revenues amount to 124.8 per cent. Consequently the implicit debt of Norwegian fiscal policy (taxes not related to oil, social security contributions, expenditures for health and public pension, etc.) is 170.9 per cent of GDP. So it can be stated that while the Norwegian public sector as a whole is in a relatively comfortable position, the core fiscal policy itself is clearly not sustainable. A detailed description of the Norwegian sustainability gap and the multiple components is shown in table 3.

[6] In the literature, the fiscal gap is normally positive if a government is in debt i.e. if the demographic development puts a burden on public coffers. Hence, a negative algebraic sign imputes a net wealth over the long-term of the country's fiscal policy. Accordingly, in our other reported indicators we hold this terminology equivalent.

Table 3: Overview of components of the fiscal gap and other sustainability indicators (Population Scenario Medium Variant, g=2.0%, r=4.0%)

	Sustainability Indicators	Public Sector
in % of GDP of 2007	Implicit Debt	170.9
	Explicit Debt in 2007	52.0
	Petroleum Wealth	-124.8
	Fund Assets in 2007	-78.3
	Fiscal Gap	19.8
in %	Future Generations' Burden (in NOK)	67,900
	Revenue Gap	0.7
	Transfer Gap	0.7

Source: Own calculations

Our second indicator is the *future generation's burden*. To calculate this indicator, the *intertemporal public liabilities* and the number of people in future generations are set in proportion to each other (equation 9). This indicator implies that the entire adjustment assigns to future generations. The burden for future generations can be illustrated as an absolute difference between the generational account of the base-year and the generational account of the one year after base-year born agent (both not including petroleum revenues, fund assets or public debt). The future born generation in Norway receive 46,600 NOK per person more in transfers over their entire life-cycle than they will pay in taxes. On the other hand, the base-year born agent gets a net-transfer over his/hers remaining life cycle of about 114,500 NOK. Therefore, the future born agent has to carry a small burden compared to the corresponding living generation. This is also reflected in our last two sustainability indicators, the *revenue* and *transfer gap*. Norway's government would have to raise all taxes (except those on petroleum activities) by 0.7 per cent or could decrease all transfers by 0.7 per cent.

4.3 Sensitivity Analysis

To analyze the sensitivity of our results relating to our exogenous parameters interest and growth rate, r and g, and to our different population projections we calculate 15 different cases. Except our standard scenario, we test four more different settings around this combination: g = 1.5 vs. r =4.0 per cent, g = 2.5 vs. r = 4 per cent, g = 2.0 vs. r = 3.5 per cent and g = 2.0 vs. r = 4.5 per cent. Furthermore, we distinguish, how discussed above, between three possible population scenarios *medium, high* and *low variant*. Table 5 shows the *sustainability gap* for all possible population scenarios combined with the described growth and interest rate settings.

Table 4: Sensitivity Analysis of the Fiscal Gap
(in % of GDP of 2007)

	Medium Variant	High Variant	Low Variant
g=1.5% r=4.0%	-49.0	-5.4	-96.9
g=2.5% r=4.0%	154.8	329.5	11.2
g=2.0% r=4.0%	19.8	101.5	-57.9
g=2.0% r=3.5%	152.0	324.6	9.8
g=2.0% r=4.5%	-47.8	-3.6	-96.1

Source: Own calculations

How can be easily seen, the extent of the *fiscal gap* and in the case of Norway also its quality (debt or wealth) depends on the difference between the growth and interest rate. As the spread widens the *fiscal gap* decrease, i.e. is better, in all of the three scenarios. Regarding our three population scenarios it can be stated that the *low variant* is the most sustainable one when the growth-interest-spread is low. The most intergenerationally unbalanced situation using the indicator *fiscal gap* is therefore achieved by the *high variant* combined with the smallest difference between growth and discount rate (g = 2.5 vs. r = 4 per cent). However, this changes given larger growth-interest-spreads. The intuition behind this is probably the effects of migration. As seen above this differ quite between the scenarios. When the growth-interest-spread is low, the relative weight of petroleum revenues increases. As supply of petroleum is fixed, less people mean more revenues per head. The reverse is true for larger growth-interest-spreads. Concluding, in five combinations Norway is on an unsustainable path while in the other situations its public finances are clearly sound. However, this sensitivity analysis suggests that Norway's politician should not sit back and wait as even small variations of the exogenous parameters or different outcomes regarding the demographic development could harm the currently favorable position.

Even other indicators are not as sensitive relating to the different population scenarios like the *fiscal gap,* the quality if this argument remains.[7] The Norwegian *future generation's burden* has its minimum value in the *low variant* population scenario as well. But, in other cases the reaction of the *future generation's burden* is different, because the denominator of this indicator relates to the future size of the population.[8] It follows, the more people live in the future generation the more people can help to finance the given debt of the present generation. The Norwegian situation is different. The huge petroleum-wealth of the country causes that the smaller the future population is the higher is the petroleum-wealth per person and therefore the lower is the future burden per person.

[7] For details see table A1 in the appendix. Our ranking from above is also confirmed given both the revenue and transfer gap.
[8] For a description of other western Generational Accounts, see Hagist (2008).

4.4 Comparison to official fiscal sustainability analysis

As Norway is the only country to our knowledge that reports some measurement of fiscal sustainability over the long-run in the official budget, it is clearly of interest if our numbers are comparable to the ones that are announced in the budget of 2007.[9]

Mainly there are two major differences between our model and the one used by the Ministry of Finance of Norway. Firstly, while we take the base year's budget as given, the government of Norway corrects for the business cycle. As 2007 was quite a good year in terms of economic growth, these correction lowered the budget surplus from 396.62 to 341.77 billion NOK. For the corrections the Ministry of Finance uses a Hodrick-Prescott-approach to smooth direct and indirect taxes as well as unemployment benefits over the business cycle.[10] Secondly, the estimation of the present value of the petroleum wealth is for 2007 3,350 billion NOK which corresponds to 147.1 per cent of GDP, 22.3 percentage points higher than our estimation via the OECD data.[11] So in sum these two effects should cancel themselves out at least to some degree. Rather minor effects should have the probably slightly different demographic projections and micro-profiles as at least for the demographics the key parameters (expected fertility, expected life expectancy and expected net migration) are the same.

As the Ministry of Finance (2006) does not report fiscal gaps in our definition from equation (7), we have to transform our fiscal gap to an annuity. Given our model and assumptions about growth and discount rates, the Norwegian government would have to save 17.3 billion NOK every year. If we assume a (nominal) growth rate of 3.5 percent and a (nominal) discount rate of 6 percent (the assumptions of the Ministry of Finance (2006)) as well as the petroleum wealth with 147.1 percent of GDP and correct as the Ministry of Finance (2006) for the business cycle by about 54.854 billion NOK, this number augments to 78.3 billion NOK every year. The Ministry of Finance (2007) reports a band between 55.7 and 98.6 billion NOK.[12] So one could state that the official model is fairly comparable to ours. However, the Ministry of Finance (2006) only provides one sustainability indicator and says nothing specific about the intergenerational redistribution effects of Norway's fiscal policy, the Government Pension Fund or the Petroleum Wealth. Given that the Norwegian government has just recently decided on a major pension reform which will be law in 2011, the ability to show which generations are affected in which way is not only of academic but also of political interest. This will be the purpose of future research.

[9] The budget is reported by the Ministry of Finance (2006) and can be obtained under http://www.regjeringen.no /nb/dep/fin/dok/regpubl/stmeld/20062007/Stmeld-nr-1-2006-2007-.html?id=136600&epslanguage=NO.
[10] Benz and Hagist (2008) show that for Germany corrections for the business cycle do not have great impacts on the analysis with generational accounting. This seems to be different for Norway which should be the focus of more research.
[11] See section 2.4 of Ministry of Finance (2006) for the present value of the petroleum wealth.
[12] See section 3.3.2 of Ministry of Finance (2006) for the sustainability analysis and results.

5. Summary and Conclusion

The Norwegian population will pass through an ageing process during the next decades which causes that the old-age-dependency ratio rises from currently 22 per cent up to 38 per cent in 2050 and 47 per cent in 2100. This ageing population induces increasing expenditures on old-age and disability pensions together with health and long-term care benefits while the public revenues from wage taxes and social contributions will decrease. At the same time, the revenues from petroleum activities decline. Therefore, it is unclear if the Norwegian fiscal policy is really sustainable or not even despite the formidable current conditions with a budget surplus of nearly 14 per cent of GDP and a net wealth of 26 per cent of GDP. Is Norway over-consuming its petroleum wealth?

The answer to this question is an economist's favorite: It depends. As it turns out Norway comes as close to sound public coffers as a nation with such a welfare state gets. Given that our scenario concerning the petroleum wealth is probably rather conservative given current developments of the oil price, Norway should have even a little scope to maneuver with only smaller cuts of social programs compared to other countries as Germany or the U.S. However, given that parameters are uncertain and also the demographic development remains only theoretical given, Norway should be cautious. Of our calculated 15 cases of different demographic developments and different growth and discount assumptions, Norway ends up in eight of them in an unsustainable situation. As historical evidence and international comparison shows, reforms are much easier to implement while losers of reforms can at least to a certain amount be compensated.

To be fair, Norway seems already on this track. The existence of the Government Pension Fund alone seems not only to restrict government spending but also spreading the petroleum wealth equally over Norway's living as well as future generations. If the petroleum wealth would be consumed as it comes, elderly generations would benefit three times more than younger generations comparing annuities. Furthermore, women are encouraged to work more which would clearly benefit the public finances in the long-term as by now only young men carry the burden of the social welfare state. Last but not least, Norway's parliament passed a public pension reform in 2007 starting 2010 which is aimed to give incentives for Norwegians to work longer and which will take the rising life expectancy into account when calculating pension benefits. How this will affect our generational accounting analysis will be a topic for future research.

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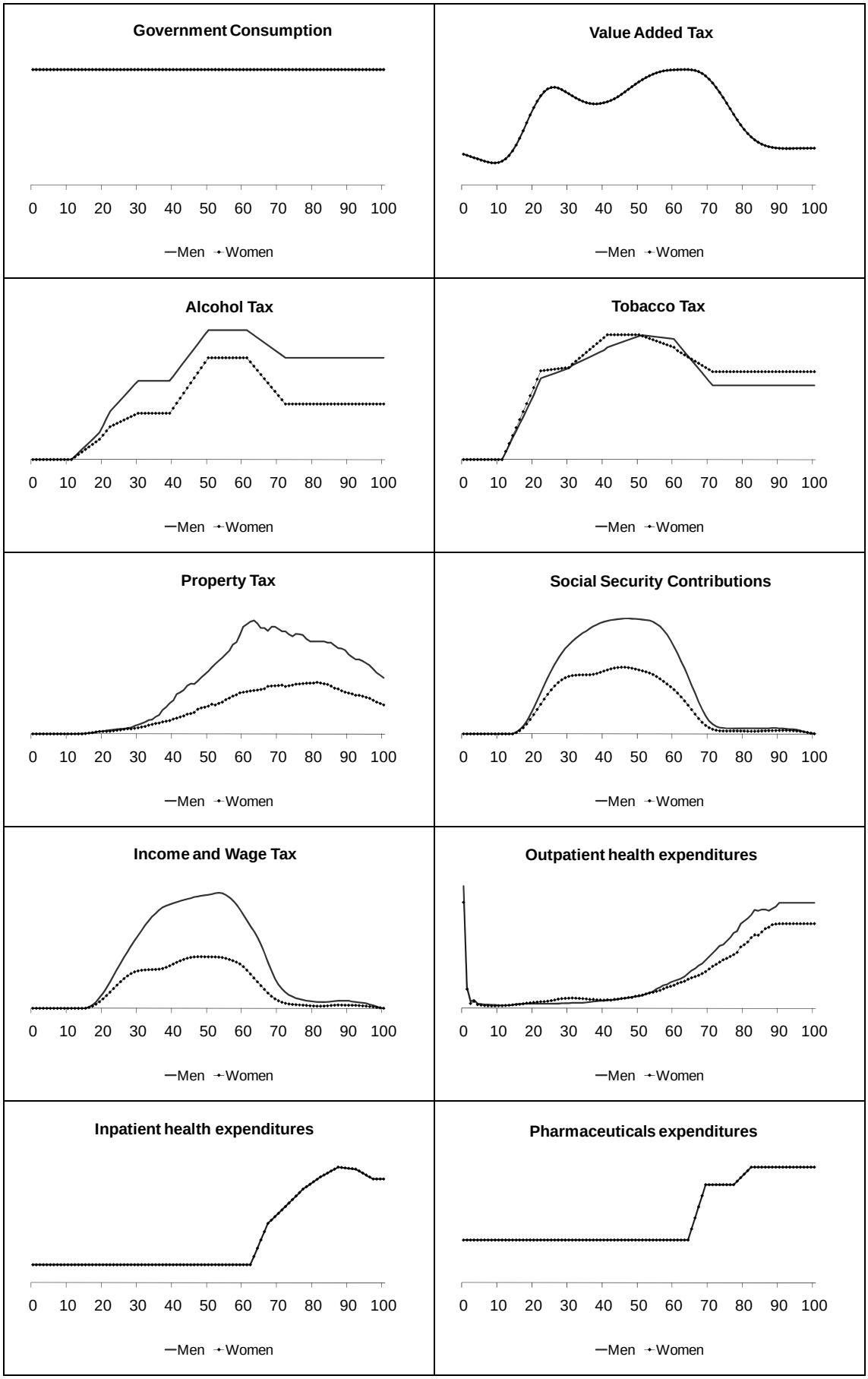
Appendix

Table A1: Sensitivity Analysis of the Sustainability Indicators

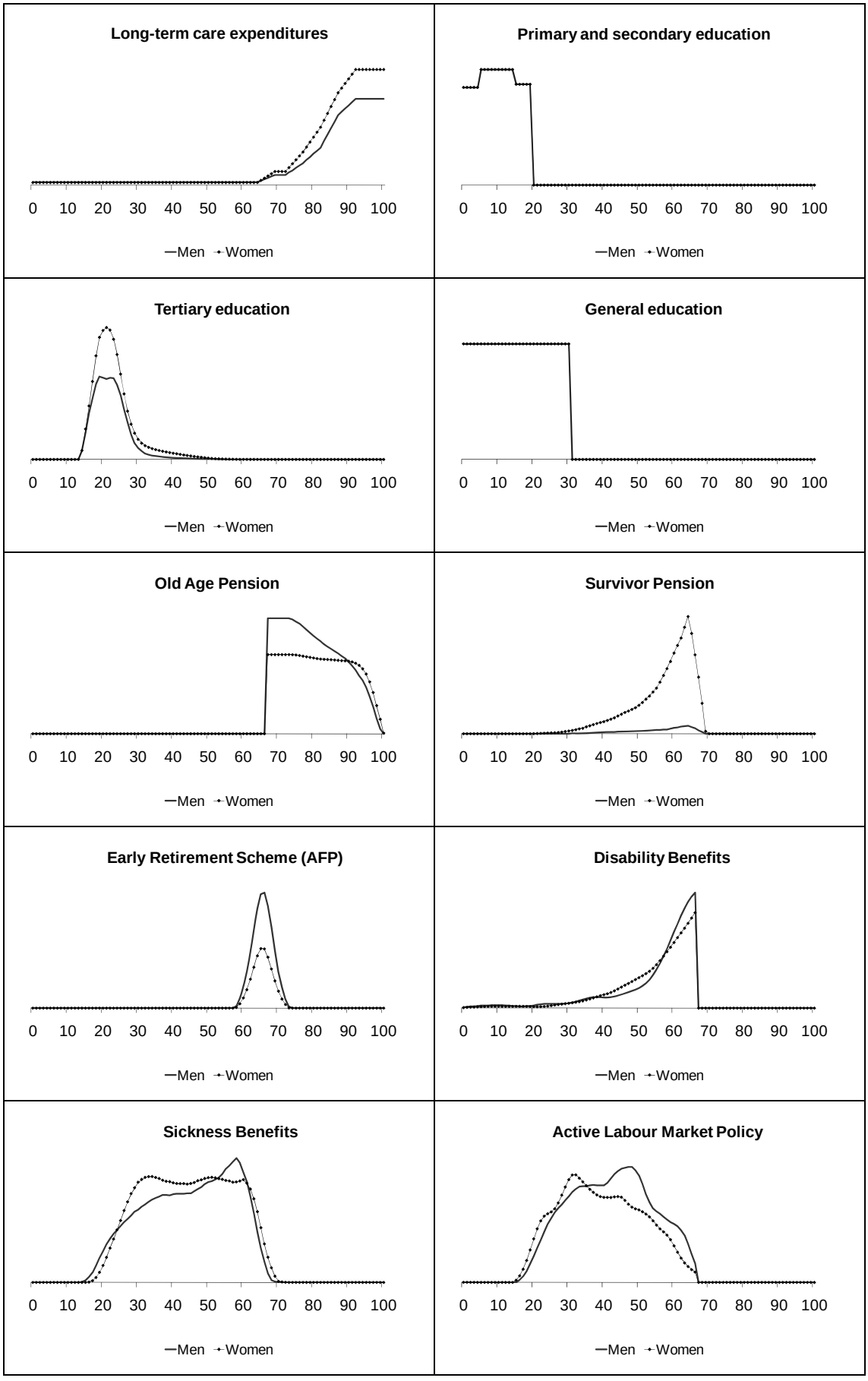
Spread	Indicators	Population Projection		
		Medium	High	Low
g=1.5% r=4.0%	*Fiscal gap (in % of GDP 2007)*	-49.0	-5.4	-96.9
	Petroleum Revenues (in % of GDP 2007)	-117.4	-117.4	-117.4
	Future Generations' Burden (in Thousand NOK)	-407.8	-75.2	-1121.3
	Revenue Gap (in %)	-2.2	-0.2	-5.1
	Transfer Gap (in %)	-2.2	-0.2	-5.3
g=2.5% r=4.0%	*Fiscal gap (in % of GDP 2007)*	154.8	329.5	11.2
	Petroleum Revenues (in % of GDP 2007)	-134.1	-134.1	-134.1
	Future Generations' Burden (in Thousand NOK)	602.4	890.9	33.5
	Revenue Gap (in %)	4.1	6.8	0.4
	Transfer Gap (in %)	3.9	6.3	0.4
g=2.0% r=4.0%	*Fiscal gap (in % of GDP 2007)*	19.8	101.5	-57.9
	Petroleum Revenues (in % of GDP 2007)	-124.8	-124.8	-124.8
	Future Generations' Burden (in Thousand NOK)	67.8	372.3	-575.3
	Revenue Gap (in %)	0.7	3.0	-2.5
	Transfer Gap (in %)	0.7	2.9	-2.6
g=2.0% r=3.5%	*Fiscal gap (in % of GDP 2007)*	152.0	324.6	9.8
	Petroleum Revenues (in % of GDP 2007)	-133.9	-133.9	-133.9
	Future Generations' Burden (in Thousand NOK)	594.2	882.7	24.2
	Revenue Gap (in %)	4.0	6.7	0.3
	Transfer Gap (in %)	3.8	6.2	0.3
g=2.0% r=4.5%	*Fiscal gap (in % of GDP 2007)*	-47.8	-3.6	-96.1
	Petroleum Revenues (in % of GDP 2007)	-117.5	-117.5	-117.5
	Future Generations' Burden (in Thousand NOK)	-397.0	-65.1	-1108.9
	Revenue Gap (in %)	-2.1	-0.1	-5.0
	Transfer Gap (in %)	-2.2	-0.1	-5.2

Source: Own calculations

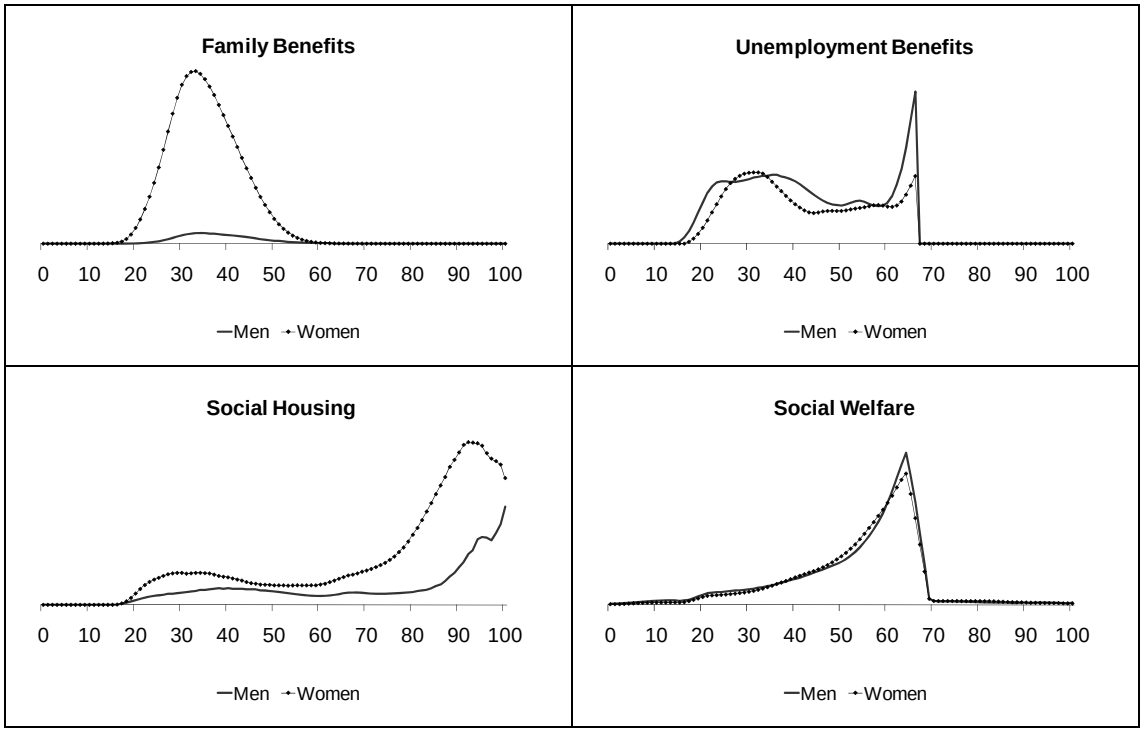
Table A2: Age- and Sex-Specific Profiles



Continuation Table A2



Continuation Table A2



Source: See section 3

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Forschungszentrum Generationenverträge
Albert-Ludwigs-Universität Freiburg
Bertoldstraße 17
79098 Freiburg
Fon 0761 . 203 23 54
Fax 0761 . 203 22 90
www.generationenvertraege.de
info@generationenvertraege.de

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