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## DEMOGRAPHIC UNCERTAINTY AND TAXES

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**TIIVISTELMÄ:** Väestön ikääntyminen vaikuttaa talouteen paitsi suoraan markkinareaktioiden, kuten korkeampien palkkojen kautta, mutta myös epäsuorasti julkisen talouden kautta. Jälkimmäisiä vaikutuskanavia edustavat nousevien veroasteiden tuottamat käyttäytymismuutokset ja julkisen sektorin työvoiman kasvun aiheuttama syrjäytysvaikutus työmarkkinoilla. Tässä tutkimuksessa kuvataan ikääntymisen, veropohjien ja veroasteiden vuorovaikutusta simuloimalla Suomen talouden käyttäytymistä numeerisen limittäisten sukupolvien mallin avulla. Väestöennusteisiin liittyvä epävarmuus ja julkisen talouden menojen ja tulojen herkkyys väestökehitykselle aiheuttavat sen että kestämättömän korkeiden veroasteiden todennäköisyys on huomattavan suuri pitkällä aikavälillä. Tutkimuksessa etsitään parempia vaihtoehtoja verorakenteelle rahoittamalla eläkemaksujen nousu könttäsummaverolla tai arvonlisäverolla. Molemmissa tapauksissa talouden tehokkuus paranee ja kokonaishyvinvointi lisääntyy, mutta kokonaisveroaste nousee. Nämä piirteet korostuvat sellaisessa vaihtoehdossa, joissa ikääntyminen on odotettua voimakkaampaa.

**AVAINSANAT:** väestön ikääntyminen, väestöepävarmuus, verotus, numeerinen sukupolvimalli

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**ABSTRACT:** Population ageing generates direct market reactions, such as higher wages, but also indirect economic outcomes via the public sector. These are, e.g., labour market distortions due to higher taxes and crowding out of private production due to increased demand for public sector workers. We describe the interaction of ageing, tax bases and tax rates by simulating a numerical OLG model calibrated to the Finnish economy. Many of the sample paths of a stochastic population forecast lead to unsustainable tax rates. Financing the increase in pension costs by either a lump sum tax or by a consumption tax improve efficiency and increase welfare, but also raise the gross tax rate of the economy. In case of a markedly higher age ratio, these features of the tax reforms are emphasised.

**KEY WORDS:** population ageing, demographic uncertainty, taxes, computable OLG model

CONTENTS

# 1 Introduction and summary

The population of OECD countries is ageing. This phenomenon increases public expenditures and dampens the growth of aggregate tax bases. Since the financing of ageing costs burdens mostly the labour incomes, it threatens to generate a vicious circle of lower employment and higher labour income tax rates with larger dead weight losses and unjustified intergenerational income transfers.

This study analyses the interaction between demographic trends, public sector finances and the rest of the economy. We combine stochastic population forecasts to a numerical overlapping generations model[1] to describe these interactions. In addition, we simulate some policy options to reduce the negative incentive effects of higher taxes and to improve the intergenerational allocation of resources.

The FOG model employed here has been calibrated to the Finnish economy, which is characterised by high initial public expenditures and tax rates. On top of that, compared to the other EU countries, the Finnish population will age most rapidly during the next 30 years. An additional driving force in the model is the vigorous improvement in the average educational level, which promotes productivity growth.

The implications of ageing for public finances are many-sided. The major expenditure items such as social security, health and education are strongly age dependent. Even though there also are several other elements that have determined the trends of these costs in the past, the most evident future scenario is an increase in aggregate expenditures due to the change in the age structure of the population.

The main income transfer during old age is the earnings-related pension. Therefore, the details of the pension system strongly affect to the tax burden due to ageing. From a tax point of view, the most efficient way of organising pensions and their financing is a fully funded defined contribution system[2]. Prefunded pension schemes often generate significant intergenerational transfers of tax revenues, since the contributions are tax deductible and the benefits are taxable (EET-taxation). This transfer is more significant the more intensive is ageing.

In a pay-as-you-go financed pension scheme, the amount of labour supply distortions depends on the link between contributions and benefits. The tighter the link is, the less contributions reduce labour supply. Nevertheless, a hike in contribution rates due to population ageing represent a pure tax, since benefits are unaffected. An increase in taxation also follows from a transition to a partially funded system, since it requires financing of the already accrued pension rights with additional contributions.

Ageing also changes the sizes of tax bases. The simulations show, that wage rate rises due to reduced supply of labour, even though the employers' contribution rate also rises. Another factor supporting the growth of total wages is improved education. Therefore, the

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[1] The numerical OLG model is the dominating tool in macroeconomic analyses of pension reforms and other corresponding ageing studies, since the simulation results concern both efficiency and intergenerational income distribution, see e.g. Kotlikoff et al. (1998) and Fehr (2000). The idea of using sample paths from stochastic population forecasts to describe demographic uncertainty in an OLG model is presented in Lassila and Valkonen (2001).

[2] Its benefits are, nevertheless, not immune to the price effects of ageing. Furthermore, some studies argue that, considering the price risks and other economic uncertainty, the optimal intergenerational risk sharing necessitates a combination of a funded and a pay-as-you-go system.

aggregate growth rate of total wages first speeds up somewhat, but falls below the trend growth rate of productivity, when the reduction in labour force starts to dominate.

In the Finnish earnings-related pension system, the replacement rate is independent of incomes (no pension ceiling). Redistribution is carried out using a highly progressive income tax schedule. During the next two decades, the maturing of the pension system will raise the average replacement rate at the same time as the baby boomers retire. On impact, pension expenditures will increase rapidly. Consequently, tax receipts from pensions also expand strongly. The tax base will be permanently higher due to the continuously longer expected lifetime.

If households follow the predictions of life cycle theory, growth in the number of dissaving retired households will increase the receipts from consumption taxation, but decrease receipts from capital income taxation[3]. This takes place also in our simulations.

Some countries, like Finland, have prepared for the retirement of baby boomers by prefunding pensions and running down public debt. The current population forecasts show, however, that the burden of ageing is not markedly relieved even after the large generations have passed away. Furthermore, the main message from stochastic population forecasts is that demographic uncertainty is far larger than normally considered in political discussions and in policy rules. Hence, the optimal amount and the timing of changes in public sector net wealth are hard to define. Other possible political reactions to the looming expenditure increases are scaling down of the benefits and increasing the taxation of old-age incomes.

We study macroeconomic and welfare effects of two shifts in tax structure. Both aim to reduce the tax distortions and mitigate the intergenerational income transfers due to ageing. The policy options are to finance the increase in private sector pension expenditures either by using a lump sum tax or using a consumption tax (VAT). The results illuminate the importance of modelling the details of the prevailing expenditure and tax rules.

A shift to lump sum taxation promotes efficiency in labour markets and leads to a supply driven growth expansion. It also spreads the tax burden of financing the ageing costs towards the baby boom generations. Since these generations are far larger than the later ones who finance the expenditures under the current rules, the increase in the lump sum taxes do not need to be too large.

The more surprising result is the increase in the gross tax rate. Stabilisation of the employers' contribution rate in the private sector raises wages also in the public sector. Moreover, the stabilisation of the employees' contribution rate promotes growth of pensions, since these contributions are deducted from earned incomes when the pensionable wage is determined.

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[3] In fact, the life cycle theory typically holds in Europe only when accrued pension rights are considered as wealth. What we observe is that other parts of wealth are run down very slowly during old age, and inheritances increase. This means that the aggregate savings rate and the share of capital income tax receipts might even increase, when the baby boomers retire. Beyond that, the higher life expectancy and the willingness to convert the productivity gains partially to leisure (being manifested as early retirement) imply that more of the resources created during working age will be saved in the future and used during old age.

As the lump sum taxes are not too popular[4] and may cause new compliance costs, the next simulation considers financing the increase in pension expenditures by using a consumption tax. What we found out was that the macroeconomic effects as well the effects on public sector finances and on welfare are quite similar. So we can improve welfare by using more efficient tax structure, even though also the gross tax rate of the economy rises. The result is possible even without relying heavily on taxation of existing wealth[5].

The next question was how these tax reforms perform, if the demographic trends turn out to be more precarious. In the high age ratio scenario, the welfare gains are even larger, but distributed very unevenly between generations. Also the gross tax rate rises substantially, especially if the pension expenditures are financed with consumption tax. Therefore we cannot recommend the tax reforms if the aim is to create a tax system which redistributes fairly the outcomes of demographic shocks between generations. A better solution might be to combine the tax reform with rules which smooth the tax rates by using the demographic data efficiently. Example of these rules is a link between the public debt or prefunding policy and the number of new-borns (see Lassila and Valkonen 2001).

Section 2 presents the main elements of the FOG model and how taxes and public expenditures are modelled. Section 3 describes the simulation results and implications of ageing in the baseline case. The next section introduces the stochastic population forecast and those sample paths used to describe the demographic uncertainty. It also depicts and discusses the simulation results. Section 5 analyses the policy alternatives.

# 2 The FOG model

## 2.1 General information

We simulate the effects of the pre-specified demographic scenarios using a numerical overlapping generations model. This model (FOG) belongs to the A-K model tradition (see Auerbach and Kotlikoff 1987). It includes five sectors: households, enterprises, a public sector (including a central government, municipalities, a social security institution and two pension funds) and foreign agents.

The three types of households differ due to their varying educational level. The educational level, together with age, determines the working efficiency of each household class. These classes are further divided into lifetime optimisers and into myopic households. The lifetime optimisers follow the rule of maximising intertemporal utility, which is derived from consumption of goods and leisure and from joy-of giving bequests. The maximisation problem is subject to a budget constraint, which sets discounted wage income, pensions, other income transfers and inheritances equal to discounted consumption expenditure and bequests. Myopic households consume immediately their disposable incomes. All the incomes (except some income transfers) as well as consumption are taxed.

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[4] The approval ratings of Margaret Thatcher collapsed due to the “poll tax” implemented in Great Britain.

[5] In the well-known simulation by Auerbach and Kotlikoff (1987) a similar early announced tax shift reduces marginally efficiency (with stable population), but a surprising tax shift increases efficiency since it taxes existing wealth by lowering its purchasing power. This type of indirect wealth taxation is, however, subject to the time consistency problem.

The enterprise sector is described by a representative firm, which is small, listed and aims to maximise the market value of the firm. Taxation of corporate and capital incomes affects the required rate of return on investments.

The central government raises income and consumption taxes and spends the receipts by supporting municipalities, which produce public services, and by supporting the social security institution to finance the basic income transfers. The demand for public services as well as the amount of basic income transfers is based on age specific data and on the demographic structure. The expenditures and tax receipts are balanced using a lump sum tax or income transfer. Municipalities finance the production of services with state subsidies and with a proportional earned income tax, which balances the budget.

The mandatory earnings-related pension system is partially prefunded. It collects contributions, invests part of them and finances current pensions with the rest of the contribution receipts and with withdrawals from the prefunded amount. Employers and employees can deduct the contributions from their taxable incomes. About 90 per cent of the social cash benefits are subject to tax. The most important tax-free benefits are family allowances and social assistance.

The labour, goods and capital markets are competitive and prices balance supply and demand period by period. There is no money or inflation in the model. More details of the model and its calibration to the Finnish data are presented in the Appendix and in Valkonen (1999, 2002) and Lassila and Valkonen (2002b).

## 2.2 Assumptions about the growth factors and public sector variables

The driving forces in the simulations described below are population trends, higher education and the trend growth of labour productivity. We assume that ageing abroad does not affect the Finnish economy.

**Table 2.1 Demographic and economic assumptions**

| | |
|---|---|
| Demographic scenarios | - Baseline case: Kela-Eurostat (1998)<br>- Alternative scenarios: Alho (1998) |
| Growth of labour productivity | 1.75 per cent per annum both in Finland and abroad |
| Real interest rate | 3.5 per cent per annum both in Finland and abroad |
| Preference for leisure | Increases at the same rate as labour productivity |
| Terms of trade | Endogenous |
| Unemployment rate | Exogenous, falls from current 9 per cent to 6.9 per cent from 2004 and to 6.5 per cent from year 2009 |

The model considers almost all cash benefits as universal, but age dependent. Means testing is applied only to the basic pensions. Therefore we cannot study the aggregate incentive effects of taxes and income transfers.

**Table 2.2 Assumptions regarding public sector expenditures**

| | |
|---|---|
| Income transfers | Earnings-related pensions:<br>- determination: defined benefit system, no pension ceiling<br>- indexation: weights of CPI and wages are 0.5/0.5 during working years and 0.8/0.2 during old age<br><br>Other earnings-related transfers:<br>- determination: fixed share of age and education specific wages<br>- indexation: wages<br><br>Other income transfers:<br>- determination: aggregate distributed to households using current age specific data<br>- indexation: weights of CPI and wages are 0.5/0.5 |
| Social services | Demand index: based on current age-specific use and demographic scenario<br><br>Price: labour costs<br><br>Production: entirely in public sector, no productivity growth |

The model imitates the current rules of the earnings-related pension system[6].

The tax system of the central government is based on the DIT (dual income taxation) principle, which allows the separation of the progressive earned income taxation with high marginal tax rates from the flat, low capital income tax rates. The number of relevant household types is too small to allow a comprehensive description of the progressive tax schedule. Pensions are taxed with identical tax rates as wage incomes.

**Table 2.3 Assumptions regarding to the tax system**

| | |
|---|---|
| Taxation of earnings | Central government:<br>- the earned income tax is progressive<br>- a lump sum tax balances<br>Municipalities:<br>- the proportional earned income tax balances |
| Taxation of capital incomes | - low, equal and proportional tax rates<br>- *avoir fiscal* abolishes double taxation of dividends<br>- capital gains are taxed on accrual<br>- source principle applied to interest incomes |
| Taxation of consumption | - consumption tax of the central government covers both VAT and excise taxes |
| Social security contributions | - increase in pension contributions is divided fifty-fifty between employers and employees |

[6] Labour market parties have, however, agreed about a quite profound pension reform. This reform would introduce a flexible retirement age (from 63 to 67 years) and reduce markedly the possibilities to retire before the age 63. The main aim of the reform is to postpone retirement by 2-3 years, which is hard to achieve. The estimated outcome of the final negotiations and the corresponding decline in the private sector pension contribution rate varies largely, from 1.5 to 6 percentage points. On the other hand, the reform increases the costs of unemployment benefits.

# 3 The baseline scenario

*Macroeconomic outcomes of ageing*

The population of a given country may age for several reasons. In Finland, as in most western countries, the reasons are low fertility rate, increasing life expectancy and the ageing of the large baby boom generations. The baseline simulation show that low fertility rate and retirement of the baby boom generations reduce labour supply and generate an adjustment process in production and in labour markets. Capital is substituted for labour, but the growth rate of capital stock slows down. Wage rate rises, yet total wages may fall. The net effect on disposable incomes of households is negative due to higher pension contribution rates and taxes.

The demographic structure also affects aggregate saving. The higher the ratio of pensioners to middle-aged people, the lower is the savings ratio. On the other hand, the needed investments are much smaller in a shrinking economy. Therefore, we cannot a priori say what happens to the current account balance. Most simulations with an endogenous interest rate (assuming a closed economy or a large enough open economy) show that, initially, there is an excess supply of financial capital in world markets and the interest rate falls. This trend may, however, reverse when the investment rate has adjusted and the baby boom generations have passed away, at least if the retirement age is not raised. The longer retired people live, the more compelling is the need to save for old age. We used a fixed interest rate version of the model in simulations, which shows that the current account in Finland follows the trends described above.

*Public expenditures and tax bases*

The ageing of the population and the strong age dependency of most cash benefits increase income transfers. Furthermore, there is a double-cost effect in the production of public services. The demand for services increases and so do production costs, since unit labour costs rise. The expansion of the public sector labour force also crowds out private production and thereby the future tax base of the private sector pension scheme. The only expenditures that might fall are those cash benefits, which are not formally indexed to earnings.

The trends in overall public expenditures are presented in the following table. The numbers describe the 5-year averages of the model (e.g., 2000 means the average during the years 2000-2004).

**Table 3.1 Public expenditures/GDP in baseline scenario, per cent**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Earnings-related pensions | 9.4 | 12.4 | 15.1 | 16.3 | 15.8 | 16.2 |
| Other cash benefits | 6.6 | 5.3 | 4.8 | 4.3 | 3.8 | 3.4 |
| Services | 14.8 | 15.9 | 16.1 | 16.4 | 16.0 | 16.1 |
| Other expenditures | 10.5 | 10.5 | 10.6 | 10.6 | 10.6 | 10.6 |
| Total | 41.4 | 44.1 | 46.6 | 47.6 | 46.1 | 46.3 |

The higher pension costs and costs of public service production dominate the outcome, and the total expenditures grow by 5 percentage points during the next 20 years. Since the majority of the cash benefits are pay-as-you-go financed, this trend generates both increasing tax distortions in labour markets and an intergenerational shift of resources from young and future generations to current middle-aged generations.

The next table depicts the development of tax bases. The figures are adjusted for the trend growth of productivity. Net wages are total wages minus the tax deductible employers' social security contributions. Total wages keep pace well with productivity growth, even though the number of workers falls by a fifth. This reflects both higher wages owing to the scarcity of labour and the strongly improving educational level. Net pensions are total pensions minus pensioners' social security contributions. Aggregate pensions increase due to the larger number of pensioners, higher wages and the maturing of the pension system, which raises the replacement rate.

**Table 3.2 Tax bases in the baseline scenario** (index 2000=100, adjusted for trend growth)

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Total wages, net | 100.0 | 103.2 | 102.6 | 101.4 | 101.0 | 99.2 |
| Total pensions, net | 100.0 | 126.4 | 149.6 | 157.3 | 148.2 | 148.3 |
| Private consumption | 100.0 | 104.2 | 107.1 | 106.8 | 105.1 | 103.3 |
| Capital incomes | 100.0 | 99.0 | 98.3 | 97.4 | 95.8 | 94.5 |

As expected, in an ageing economy the tax base for consumption taxes broadens more rapidly than the tax base for wages. The other side of the coin is that capital incomes increase more slowly due to the lower average savings rate.

The tax and contribution rates show some diverging trends. The central government benefits from the austere taxation of pensions, the larger tax base of consumption taxation and from the reduction of the costs of other than earnings related cash benefits. Consequently, the earned income tax rate falls (actually, the lump sum tax is reduced, but in Table 3.3. these taxes are combined). The municipal tax rate rises somewhat due to the higher costs of public services.

**Table 3.3 Tax rates in the baseline scenario**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| *Personal taxation* | | | | | | |
| Income tax rate of central government | 10.9 | 10.3 | 8.8 | 8.2 | 7.4 | 7.2 |
| Income tax rate of local government | 15.7 | 16.8 | 16.5 | 16.8 | 16.2 | 16.3 |
| Employees' pension contribution rate | 4.4 | 5.8 | 8.1 | 9.5 | 9.3 | 9.6 |
| Employees' other social security contributions | 3.0 | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 |
| Pensioners' social security contribution | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| *Taxation of consumption* | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 |
| *Employers' social security contributions* | | | | | | |
| Pension contribution rate in private sector | 16.5 | 17.9 | 20.2 | 21.6 | 21.4 | 21.7 |
| Other social security contributions | 2.5 | 1.9 | 1.6 | 0.9 | 0.8 | 0.5 |
| Pension contribution rate in public sector | 18.5 | 26.7 | 20.2 | 17.1 | 14.2 | 15.9 |
| *Aggregates* | | | | | | |
| Tax receipts/GDP | 30.7 | 31.1 | 31.1 | 31.3 | 30.4 | 30.4 |
| Contribution receipts/GDP | 11.8 | 13.0 | 14.0 | 14.5 | 13.8 | 14.1 |
| Gross tax level | 42.5 | 44.1 | 45.1 | 45.8 | 44.2 | 44.5 |

The aggregate pension contribution rate rises by 10 percentage points in the private sector over the next 30 years, even though part of the pensions are financed using the yields of the pension fund assets. In the public sector, the pension contribution rate first rises but falls later due to the planned variation in the prefunding rate and due to the increase in the number of employees. The other social security contributions paid by employees and employers are expected to fall somewhat.

The gross tax rate rises by more than 3 percentage points during the next four decades, but falls slightly thereafter due to the decease of the baby boom generations and the improved educational level. Considering the recent history, this tax hike is not by itself devastating. One has to remember, however, that the starting point is the high initial tax burden of a Nordic welfare state. In addition, the incidence of additional taxation is largely on labour markets. Nor does the scenario consider presumable political risks of even higher expenditures, e.g., due to the pressures to raise the norms of social assistance or to expand the commitments of public sector health care and old age care.

Besides the political risks, there are always the risks of more negative economic and demographic trends. In the Finnish social security system most cash benefits and their financing are linked to earnings. Therefore, variations in wage level are normally not a problem for the sustainability of the system. Unemployment is, however, problematic, because it increases the number of person being supported, but diminishes the tax base. The same kind of problems may emerge from unexpected demographic scenarios, which we study in the next section.

# 4 Demographic uncertainty[7]

## 4.1 Stochastic population forecasts

Alho (1998) has made stochastic population forecasts for Finland. Based on previous forecast errors in fertility, longevity, and migration, he has modelled the uncertainty in demographics, and has made 1500 simulations with the model. Each simulation produces annual population data for the coming five decades. The following figures present some distributional statistics describing the data mass. Figure 4.1 presents the median of the size of the Finnish population, along with the first and ninth decile and the first and third quartile. The width of the intervals spreads rapidly in time. In 2030, in 80% of the simulations the population will be between 4.7 million and 6 million people, and the corresponding figures for 2050 are 3.8 million and 6.7 million.

In principle, all the 1500 alternative population paths could be used as inputs in a numerical OLG model, such as the FOG model used in this study. Evaluating different pension policy measures with the model would then provide a distribution of the effects, reflecting the demographic uncertainty in the background. A short cut was chosen instead. Alho provided two sample paths for the study by Lassila and Valkonen (1999). The 1500 simulations were ordered with respect to their age ratio statistic in 2030. The age ratio is the number of people over 60 years[8] divided by the number of people between ages 20 – 59. From this ordering, the two samples closest to the limits of the 80% confidence interval in 2030 were chosen[9].

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7 This section relies heavily on Lassila and Valkonen (2001b).

8 The average retirement age in Finland is 59 years.

9 The chosen age ratio fits well with the aim of illustrating the implications of ageing to the pension system, since it imitates the ratio of passive to active population. The overall public expenditures due to ageing depend, however, also on other factors, such as health and other care costs of the elderly, which increase heavily with age and are highest during last years of life.

**Figure 4.1. Finnish population**

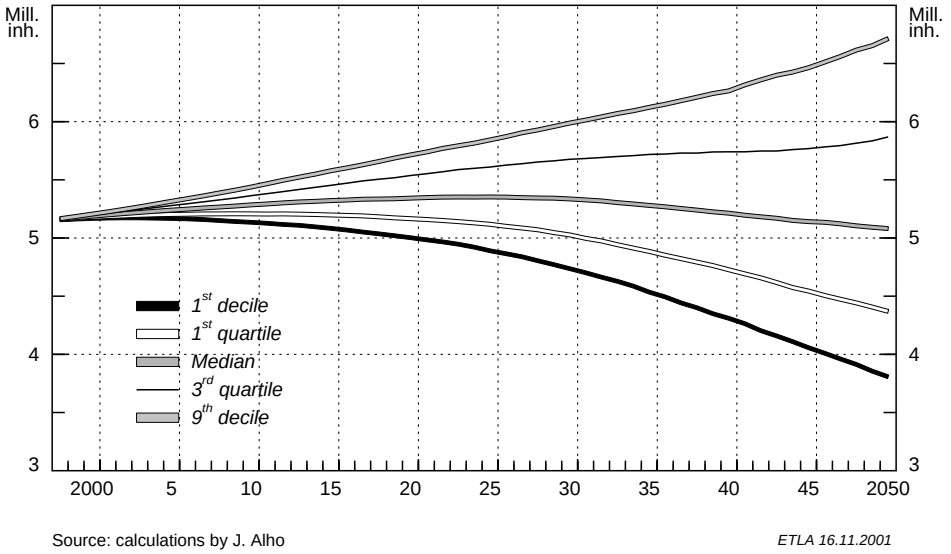
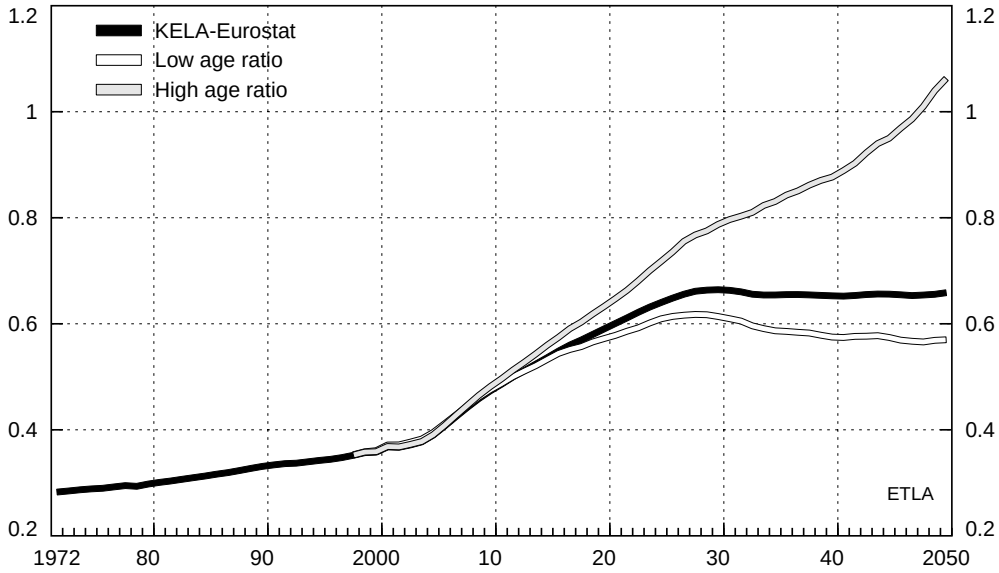



Figure 4.2 shows these realisations as well as the baseline (Kela-Eurostat) scenario. The 80% confidence interval in the age ratio in 2030 is wide: the limits are 0.613 and 0.787. This can be roughly translated into pension language: with a 10% probability Finland will have 8 pensioners or more for every 10 working-age persons, and with a 10% probability there will be 6 pensioners or less for every 10 working-age persons in 2030, provided that the actual retirement age does not increase substantially. The high age ratio is a result of declining fertility and net emigration[10], and the low age ratio is mainly the result of declining life expectancy.

**Figure 4.2. Ratio of population of ages over 60 to the population of ages 20-59**




Age ratio: ratio of population in ages over 60 to those between 20-59.
High (low) age ratio: nearest realisation to the upper (lower) limit of the 80 % confidence interval of the age ratio in 2030.
Source: calculations by J. Alho

[10] The current version of the model does not properly take into account the effects of emigration on the household wealth and on the pension system.

## 4.2 Public sector finances in the case of a high age ratio

The demographic trends behind the high age ratio scenario change the economy profoundly. The labour force diminishes nearly 50 per cent by the middle of the century. The substitution of capital for labour is much stronger than in the baseline case, which means that wages rise substantially. Therefore the costs of index-linked social security benefits, as well as the labour costs of producing public services, are much higher. It is important to notice that index adjustments are based on the wage rate, not on total wages, which now falls significantly.

**Table 4.2.1 Public expenditures/GDP in the case of a high age ratio**, per cent

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Earnings-related pensions | 9.5 | 12.5 | 15.8 | 18.2 | 19.2 | 22.3 |
| Other cash benefits | 6.6 | 5.3 | 4.9 | 4.4 | 3.8 | 3.5 |
| Services | 14.7 | 15.7 | 15.9 | 17.2 | 17.7 | 19.8 |
| Other expenditures | 10.5 | 10.5 | 10.6 | 10.6 | 10.6 | 10.6 |
| Total | 41.2 | 44.0 | 47.2 | 50.4 | 51.4 | 56.2 |

The tax bases reflect the diverging trends in incomes.

**Table 4.2.2 Tax bases in the case of a high age ratio**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Total wages, net | 100.0 | 100.9 | 95.9 | 88.9 | 81.3 | 71.3 |
| Total pensions, net | 100.0 | 124.4 | 147.5 | 155.8 | 147.6 | 150.7 |
| Private consumption | 100.0 | 101.3 | 100.6 | 93.5 | 84.6 | 74.0 |
| Capital incomes | 100.0 | 96.1 | 90.9 | 84.3 | 76.2 | 68.9 |

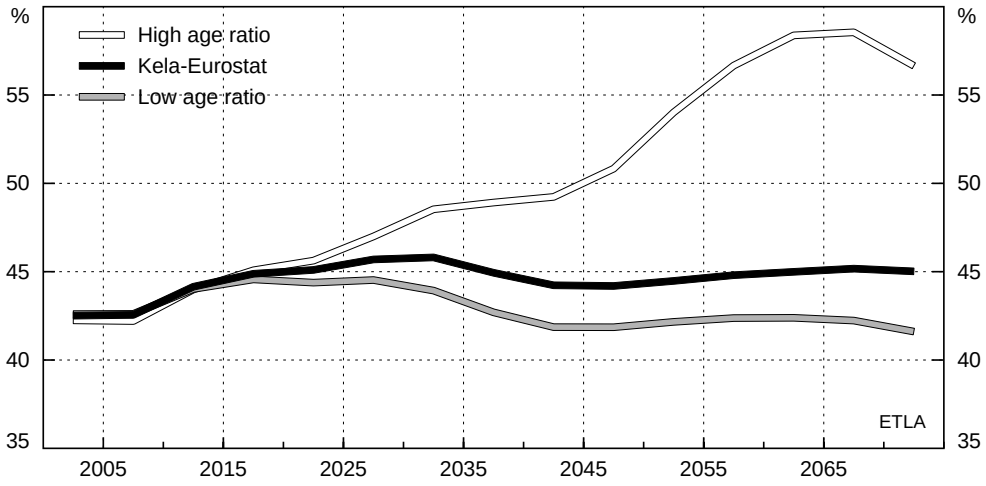
**Table 4.2.3 Tax rates in the case of a high age ratio**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| *Personal taxation* | | | | | | |
| Income tax rate of central government | 10.8 | 10.3 | 9.0 | 9.1 | 8.7 | 9.4 |
| Income tax rate of local government | 15.4 | 16.4 | 16.1 | 17.5 | 17.9 | 20.0 |
| Employees' pension contribution rate | 4.3 | 5.8 | 8.6 | 11.2 | 12.5 | 15.4 |
| Employees' other social security contributions | 3.0 | 2.0 | 1.5 | 1.5 | 1.0 | 1.0 |
| Pensioners' social security contribution | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| *Taxation of consumption* | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 |
| *Employers' social security contributions* | | | | | | |
| Pension contribution rate in private sector | 16.4 | 17.9 | 20.7 | 23.3 | 24.6 | 27.5 |
| Other social security contributions | 2.5 | 1.8 | 1.6 | 0.9 | 0.8 | 0.3 |
| Pension contribution rate in public sector | 18.8 | 27.3 | 20.9 | 18.2 | 13.7 | 15.9 |
| *Aggregates* | | | | | | |
| Tax receipts/GDP | 30.6 | 31.0 | 31.2 | 32.5 | 32.8 | 35.0 |
| Contribution receipts/GDP | 11.7 | 13.0 | 14.4 | 16.1 | 16.4 | 19.0 |
| Gross tax level | 42.2 | 44.0 | 45.6 | 48.5 | 49.2 | 54.0 |

The corresponding tax rates are presented in the Table 4.2.3. The larger expenditures and smaller tax bases imply politically unrealistic trends in tax rates. The taxes paid by households would cut half off the wage incomes. The gross tax rate is almost 10 percentage points higher in the year 2050 than in the baseline scenario. The high age ratio scenario, which is unlikely, but worthy of consideration, shows the vulnerability of the finances of the welfare state to demographic shocks.

We also simulated the effects of the low age ratio, but do not present the details of the outcomes here (they are described in Valkonen 2002). As noted above, this scenario is mainly a result of a shorter expected lifetime. As the survival rates fall most during old age, this scenario produces lower ageing costs. The gross tax rate does rise also in this case somewhat, but slides back near its initial level in the long term. From the point of view of individuals, this is not a tempting alternative due to earlier death. Figure 4.3 presents the time paths of gross tax rates in various age scenarios.

**Figure 4.3. Gross tax rates, current tax system**




## 5 How about a new tax structure?

The outcomes of population ageing described in the previous section are challenging from the point of view of public sector finances. The tax rates on labour incomes as well as the intergenerational income transfers increase markedly even in the baseline population scenario. Furthermore, the probability of a significantly gloomier demographic trend is high.

In defined benefit pension systems, the usual reactions to this type of development have, until recently, been to raise contribution rates. The recent pension reforms have also cut benefits, e.g., by reducing the weight of wages and increasing the weight of consumer prices in index adjustments. Some reforms (e.g., in Sweden) have aimed to redistribute the demographic risks. The methods used to do so are the introduction of individual pension accounts, fertility adjustment in defined benefit pensions and indexation of the pensions to an index that takes into account the number of wage-earners (see Lassila and Valkonen 2002a). The incentive problems have been reduced by creating tighter links between the

amount of pensions and paid contributions at the individual level (e.g., by moving towards a defined contribution system).

In health and old-age care services the decisions of public sector involvement have been more decentralised and uncoordinated. The amount of service production doubled in Finland during the past three decades, but only one third of the increase can be explained by changes in age structure. The risk of an uncontrolled increase in these expenditures because of population ageing is large.

## 5.1 Financing the increase in pension costs by a lump sum tax

We take here a somewhat more traditional step towards a more efficient tax structure. The aim is to reduce the tax burden of wage incomes and to improve the intergenerational allocation of resources. The actual measure is to introduce a lump sum tax, which finances the increase in pension expenditures in the private sector pension system. This policy measure is announced in advance and it is permanent.

Since the reform removes the increase in the labour market incentive problems, it generates a supply driven growth expansion. From the point of view of firms unit labour costs fall, which gives room for higher wages and employment. Total wages increase strongly compared to the baseline scenario.

**Table 5.1.1 Public expenditures/GDP, lump sum taxation**, per cent

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Earnings-related pensions | 9.5 | 12.5 | 15.5 | 17.0 | 16.6 | 17.3 |
| Other cash benefits | 6.6 | 5.3 | 4.8 | 4.3 | 3.7 | 3.4 |
| Services | 14.8 | 16.2 | 16.7 | 17.4 | 17.0 | 17.1 |
| Other expenditures | 10.5 | 10.5 | 10.6 | 10.6 | 10.6 | 10.6 |
| Total | 41.4 | 44.5 | 47.6 | 49.2 | 47.9 | 48.5 |

The higher wages and the freezing of the employees' pension contribution rate (the contribution is deducted from the pensionable wage when pensions are calculated) promote growth of pensions. Public sector workers also adopt the higher wage level. Therefore both the cash transfers and the public sector labour costs rise faster than the value of GDP. Aggregate expenditures therefore rise to a level, which is two percentage points higher than in the baseline case in the long term.

The corresponding figures for the tax bases are presented in the Table 5.1.2. All the incomes and the value of consumption increase due to the reform. The induced growth of consumption is, however, markedly smaller than the increase in wages and pensions. The difference describes the role of the new lump sum taxes paid by the households.

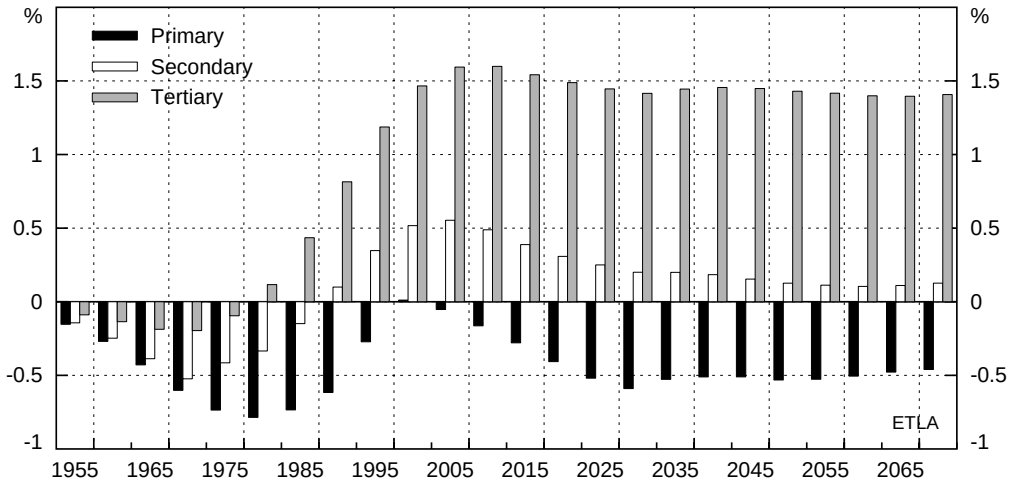
**Table 5.1.2 Tax bases in the case of lump sum taxation**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Total wages, net | 100.0 | 106.2 | 110.5 | 112.6 | 112.2 | 110.8 |
| Total pensions, net | 100.0 | 127.9 | 154.7 | 166.5 | 159.6 | 162.5 |
| Private consumption | 100.0 | 104.5 | 107.7 | 107.8 | 106.5 | 104.9 |
| Capital incomes | 100.0 | 99.5 | 99.4 | 99.2 | 97.9 | 96.7 |

These larger tax bases mitigate somewhat the effect of higher expenditures on the tax rates. The gross tax rate increases by the same magnitude as aggregate public expenditures.

We also calculated changes in household welfare due to the reform. The utility measure shows relative compensated variations by generations. They are measured as logarithmic differences between the new discounted rest-of-the-lifetime consumption expenditures and the consumption necessary to achieve the baseline utility at the new prices. Therefore, positive numbers express a welfare gain.

**Figure 5.1.1. Cohort-specific change in utility by educational level, lump sum tax reform**

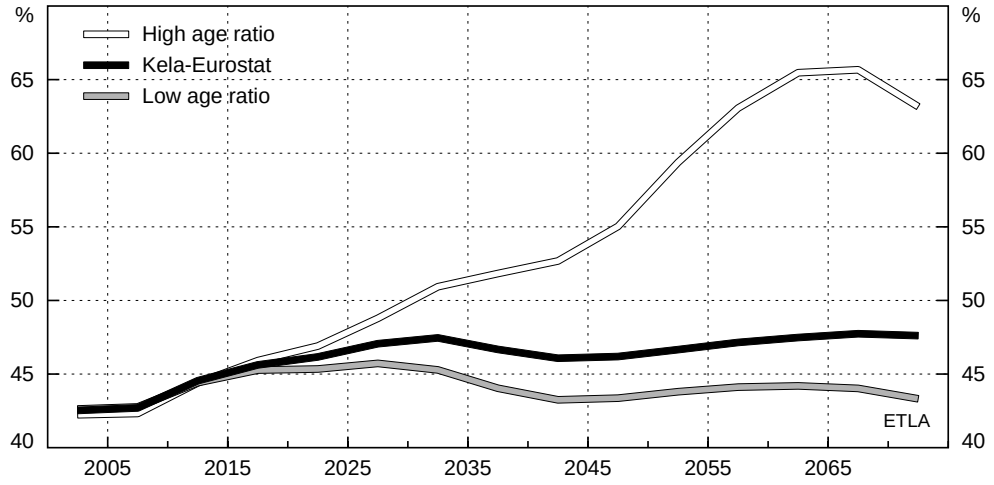



Cohorts denoted by the year of entering the labour force.

As expected, current pensioners and the baby boom generations suffer somewhat from the reform, since they are taxed more. The loss is higher, the lower is their educational level. This is because the tax reform compels the households to increase labour supply in order to finance their old age consumption. Poorly educated people must give up more leisure than the others. The well-educated households also increase labour supply, but the higher wage more than compensates the welfare loss due to diminished leisure hours. It is easy to imagine that the poor could be compensated for the minor utility losses and thus everyone could gain from the reform (the share of households with primary education is only about 5 per cent in the middle of the century). The overall result is that the new tax structure generates a higher gross tax rate, but is more efficient and therefore improves welfare.

We analysed also the sensitivity of the results to the demographic trends. In the case of a high age ratio, the welfare gains are even larger, but distributed very unevenly between generations. Since the gross tax rate also rises more in this case, it seems that both the benefits and disadvantages of the reform are emphasised, if population ageing turns out to be faster than expected.

**Figure 5.1.2. Gross tax rates, lump sum tax reform**




## 5.2 Financing the increase in pension costs by a consumption tax

Another studied tax reform substitutes the consumption tax for the payroll tax in financing the increasing pension costs. This reform is also announced beforehand and is permanent. After the measure, the consumption tax rate balances the expenditures and tax receipts of the central government. This means also that the general equilibrium repercussions of the reform are reflected in this tax rate.

The reduction of the tax wedge between the labour costs of the employer and the purchasing power of wages is not as big as in the case of a lump sum tax reform, but still outstanding. The higher labour supply increases capital stock, production and incomes. Wages also rise in this scenario.

As the increase in pension expenditures is most rapid during the years 2005-2030, the financing of the costs with consumption taxes accelerates the rate of increase of consumer prices during that period. It takes place at the same time as the improvement in the terms of trade (reduced supply of export goods increases the price). Therefore the real interest rate for the consumer is low during these decades.

The higher consumer prices initiate also an unwanted circle of index adjustments in income transfers, higher demand for public funds and a higher consumption tax rate. Therefore pension expenditures grow somewhat faster than in the case of lump sum taxation during the first couple of decades.

**Table 5.2.1 Public expenditures/GDP, consumption taxation**, per cent

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Earnings-related pensions | 9.5 | 12.6 | 15.7 | 17.3 | 16.6 | 17.3 |
| Other cash benefits | 6.6 | 5.4 | 4.9 | 4.4 | 3.8 | 3.5 |
| Services | 14.8 | 16.2 | 16.8 | 17.5 | 17.0 | 17.2 |
| Other expenditures | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 |
| Total | 41.5 | 44.7 | 48.0 | 49.7 | 48.0 | 48.6 |

The expansion of the tax bases is almost identical compared to the previous simulation.

**Table 5.2.2 Tax bases in the case of consumption taxation**

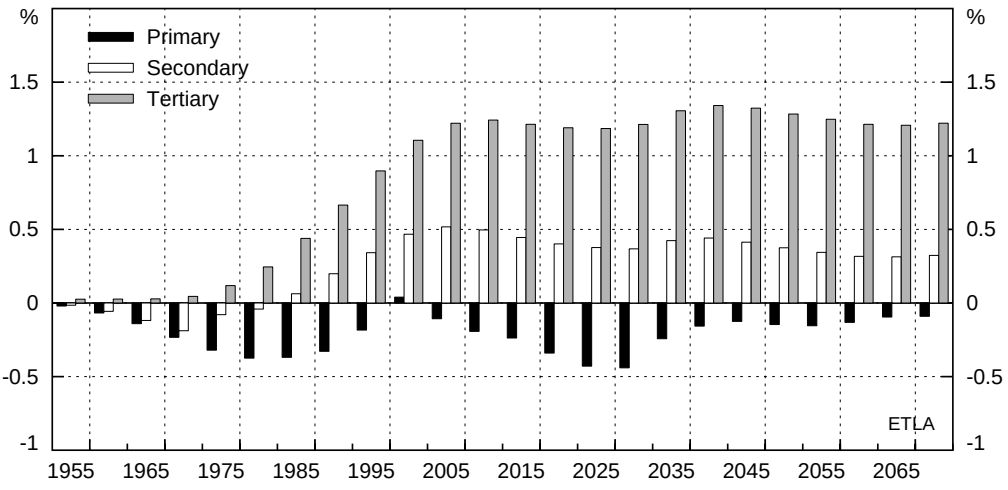
| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Total wages, net | 100.0 | 105.8 | 109.8 | 111.7 | 111.6 | 110.3 |
| Total pensions, net | 100.0 | 128.6 | 156.1 | 167.9 | 158.6 | 161.2 |
| Private consumption | 100.0 | 103.9 | 106.3 | 106.0 | 105.7 | 104.1 |
| Capital incomes | 100.0 | 98.5 | 98.0 | 98.4 | 97.7 | 96.4 |

The consumption tax rate is affected by several diverging factors. As noted above, the tax reform itself increases the need for tax receipts. On the other hand, the larger tax base and the lower cash benefits (other than pensions) reduce the required hike in the tax rate. In aggregate, the rate rises from its current 26 per cent to 31.5 per cent in 2040 but falls thereafter to 29 per cent.

Changes in household utility follow the lines of the previous reform. The less educated households suffer, but slightly less, because the indexed income transfers have a higher share in their incomes. The gains of the more educated are less pronounced and so is also the overall improvement in efficiency and welfare. Otherwise, both the macroeconomic and the utility outcomes are almost identical compared to the lump sum tax reform.

The result of improving efficiency in this type of tax reform is not new, see Auerbach and Kotlikoff (1987). In their simulations the gains were, however, sensitive to the early announcement of the reform. This is because the incidence of a surprise hike in consumption taxation is partly on existing wealth, and therefore the part which increases the tax wedge in labour markets does not need to be so high. We get significant gains from the reform even when the measure is announced beforehand. These extra gains are, at least partly, due to the falling size of the consecutive household generations. Also the taxation of previously accrued pension rights increases efficiency.

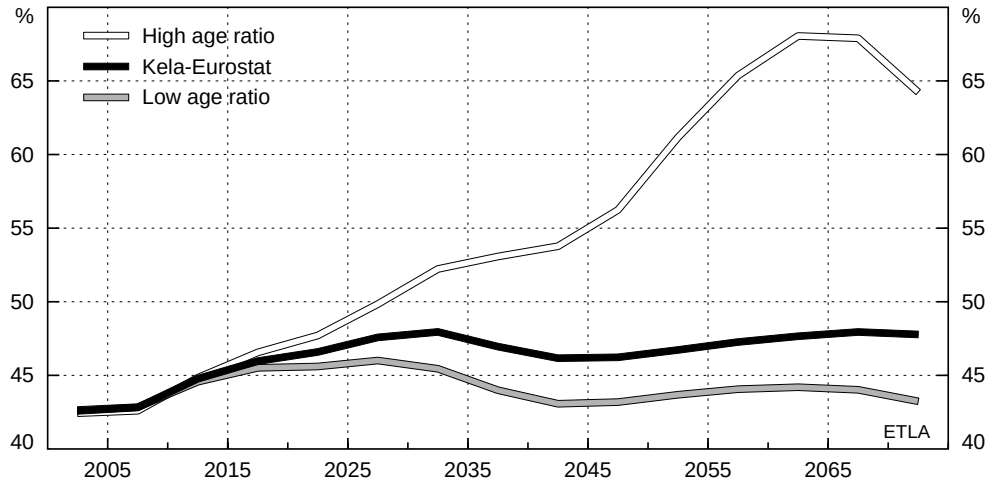
**Figure 5.2.1. Cohort-specific change in utility by educational level, consumption tax reform**




Cohorts denoted by the year of entering the labour force.

The sensitivity of the results to demographic trends was analysed by simulating the effects of the reform also in the case of a high age ratio. It again turns out that the welfare gain is much larger, but unevenly distributed. The timing of the gains is now different, since the biggest winners are those generations who gain most due to the large index adjustments of pensions during years 2050-2060. The tax reform also produces a much higher gross tax rate. Hence, both the benefits and weaknesses of the reform are larger. We suggest therefore that the tax reform should be combined with new rules which smooth the tax rates by using the demographic data more efficiently (see Lassila and Valkonen 2002a).

**Figure 5.2.2. Gross tax rates, consumption tax reform**



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# Appendix: Details of the FOG model

FOG is an Auerbach-Kotlikoff-type, perfect foresight numerical overlapping generations model. There are five sectors: households, enterprises, a public sector and a foreign sector. The labour, goods and capital markets are competitive and prices balance supply and demand period by period. There is no money or inflation in the model. Households and firms are forward-looking perfect foresight decision-makers.

*Household behaviour*

Households maximise the utility from consumption and leisure in different periods and the bequest that they give. The life-cycle plan for the household starting its work life at time $t = 1$ is the solution to the following maximisation problem subject to the periodic utility function (2), lifetime budget constraint (3) as well as the determination of gross labour incomes (4), the reference pension (5), old-age pensions (6) and the discount factor (7):

(1) $$Max_{c,l,B} \quad \sum_{t=1}^{T} \frac{1}{1-\frac{1}{\gamma}} \frac{U_t^{1-\frac{1}{\gamma}}}{(1+\delta)^{t-1}} + \mu \frac{B_T^{1-\frac{1}{\gamma}}}{(1+\delta)^{T-1}} \quad ,$$

(2) $$U_t = \left( c_t^{1-\frac{1}{\rho}} + \alpha l_t^{1-\frac{1}{\rho}} \right)^{(1-\frac{1}{\rho})-1}$$

(3)
$$\sum_{t=1}^{T_W} g_t \left(1 - \tau_t^e - \tau_t^w\right) R_t + \sum_{t=T_W+1}^{T} z_t (1 - \tau_t^w) R_t + R_i B_i + \sum_{t=1}^{T} s_t + \sum_{t=1}^{T} s_t^Z = \sum_{t=1}^{T} c_t p_t^C \left(1 + \tau_t^C\right) R_t - R_T B_T$$

(4) $$g_t = (1 - l_t) e_t w_t$$

(5) $$z^{ref} = \sum_{t=1}^{T_W} \theta_t b_t (1 - \tau_t^e) g_t \left( \frac{(1 - \tau_{T_W}^e) w_{T_W}}{(1 - \tau_t^e) w_t} \right)^{\lambda_1} \left( \frac{p_{T_W}^C}{p_t^C} \right)^{1-\lambda_1}$$

(6) $$z_t = z^{ref} \left( \frac{(1 - \tau_t^e) w_t}{(1 - \tau_{T_W}^e) w_{T_W}} \right)^{\lambda_2} \left( \frac{p_t^C}{p_{T_W}^C} \right)^{1-\lambda_2} .$$

(7) $$R_t = S_{1,1,t} (1 + r)^{1-t}$$

Households consider the possibility of early death by discounting future consumption and incomes by a factor which includes both the interest rate and the age-specific survival probability. The variable $c_t$ describes consumption, $p_t^C$ its price, $l_t$ is leisure, and of the constant parameters $\gamma$ is the elasticity of intertemporal substitution, $\delta$ is the rate of time preference and $\rho$ is the elasticity of substitution between consumption and leisure. Households receive a bequest $B_i$ at the age of $i$ and give a bequest $B_T$ before dying. The

parameter $\mu$ determines the strength of the joy-of-giving bequest motive. The aggregate amount of the generation specific transfers $S_t$ is determined to balance the revenues and expenditures of the central government. A life-cycle plan is made at the age of 20, and people plan to retire at the age of $T_W + 1$. The budget constraint (3) says that discounted lifetime wage and pension income equals discounted consumption expenditure. The terms $\tau^w$ and $\tau^C$ are income tax and value added tax parameters. We have excluded the capital income taxes from this presentation to simplify the expressions.

The $\theta_t$ parameters depict the replacement rates of the pension system. The $b_t$ parameters describe how the pension rights are related to career earnings. More weight is given to the last working years, because in practice the pensionable wage is aggregated over the last 10 years of each employment contract. As benefits depend on and contributions are paid from wages, there is an indirect connection between contributions and benefits at the individual level. This connection is not one-to-one, however, as all career earnings are not weighed equally. The indexing of accrued pension rights is different in working years and in retirement: in the current TEL index $\lambda_1$ is 0.5 and $\lambda_2$ is 0.2. The actual equations of the simulation model are the first-order conditions derived from the optimisation problem.

The model also includes myopic households, which consume each period the net incomes they receive. The model user can define the shares of the life cycle optimisers and the myopic ones. Another modification to the standard life time model is the savings fund, which describes a stock of wealth not included in the household planning. This fund consumes the after-tax interest incomes, which it receives from investments. The size of the stock is linked to the amount of aggregate wealth of the households. It might be interpreted as an instrument used to imitate precautionary saving in a world without uncertainty.

*The firms' decision problem*

Firms choose the optimal amount of investment and use of labour to maximise the price of their shares. The market value of the firm is determined as a discounted sum of future dividends. The problem can be presented as maximising in the beginning of period $t$ the dividends $D_t$ distributed during the period plus the value of the firm $V_t$ at the end of the period, subject to the amount of initial capital stock, the cash-flow equation of the firm (9), the CES production function $F_t$ (10), the accumulation condition of the capital stock $K_t$ (11), the determination of the firm's debt $B_t^F$ (12) and the investment adjustment cost function $G_t$ (13).

(8) $Max_{L,I,K} \quad D_t + V_t$. subject to:

(9) $$D_t = \left[p_t^F \left(F_t - G_t\right) - (1 + \tau_t^l) w_t L_t^F - r_{t-1}^d B_{t-1}^F\right] + B_t^F - B_{t-1}^F - p_t^K I_t$$

(10) $$F_t = A^F \left[\varepsilon K_{t-1}^{(1-1/\beta)} + (1-\varepsilon)\left(v^t L_t^F\right)^{(1-1/\beta)}\right]^{\frac{\beta}{\beta-1}},$$

(11) $K_t = (1-d)K_{t-1} + I_t$ ,

(12) $B_t^F = bp_{t-1}^K K_{t-1}$ and

(13) $G_t = \xi \frac{I_t^2}{K_{t-1}}$ .

Equations (8) and (9) have been simplified by leaving out the capital income tax terms. The price variables $p_t^F$, $p_t^K$ describe the prices of value added and the capital unit. $r_{t-1}^d$ is the domestic interest rate, which generates interest flows to be distributed during period t. The typical CES production function parameters are as follows: $A^F$ is the scale parameter, $\varepsilon$ is the share parameter and $\beta$ is the substitution parameter. $\nu$ describes the rate of productivity growth of labour. The accumulation of capital $K_t$ is explained by using the depreciation rate $\lambda$ and the amount of new investments $I_t$. The parameter $b$ describes the collateral value of the capital stock. In the last equation, the parameter $\xi$ determines the scaling of the investment adjustment costs.

Three of the four first-order conditions of the constrained optimisation are used as model equations, the fourth being the transversality condition.

*Markets*

The model includes four markets, which clear every period. In the labour market, firms demand labour according to the marginal productivity of labour rule. The labour input available to the firms depends on the households' aggregate labour supply and on the labour demand of public sector. The wage rate is determined by equating supply and demand.

Firms are sole suppliers in the market for the domestic good. The product is used by other firms as part of the composite intermediate and investment goods, by households as part of the composite consumption good and by foreign agents. The demand of domestic agents and the prices of the composite goods are determined by a cost minimising procedure. Domestic demand for the fixed-price imported good is also determined by minimising the costs of the composite goods. The perfectly elastic supply adjusts to demand in this market.

The fourth market is the capital market, in which saving and investments are balanced by the domestic interest rate. In the simulations we use a model version in which the interest rate is fixed to be the same as the rate in international capital markets. In this case total saving is the sum of domestic saving and foreign portfolio investments.

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