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Population ageing and fiscal sustainability of Finland: a stochastic analysis

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Abstract

This study analyses the fiscal sustainability of the Finnish public sector using stochastic projections to describe uncertain future demographic trends and asset yields. While current tax rates are unlikely to yield sufficient tax revenue to finance public expenditure with an ageing population, if developments are as expected, the problem will not be very large. However, there is a small, but not negligible, probability that taxes will need to be raised dramatically, perhaps by over 5 percentage points. Such outcomes, if realised, could destabilise the entire welfare state. The study also analyses three policy options aimed at improving sustainability. Longevity adjustment of pension benefits and introduction of an NDC pension system would reduce the expected problem and narrow the sustainability gap distribution. Under the third option, pension funds would invest more in equities and expect to get higher returns. This policy also limits the sustainability problem, but only under precondition that policymakers in the future can live with substantially larger variation in the value of the funds without adjusting tax rules or benefits.

Väestön ikääntyminen ja julkisen talouden kestävyys: stokastinen analyysi

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Tiivistelmä

Tutkimuksessa analysoidaan Suomen julkisen talouden kestävyyttä käyttäen stokastisia arvioita kuvaamaan tulevaisuuden väestöriskejä sekä varallisuuteen ja velkoihin liittyviä tuottoriskejä. Väestön ikääntyessä eläkemenot ja julkiset terveys- ja hoivamenot kasvavat ja koulutusmenot pienenevät, jos menot henkeä kohti kehittyvät nykykäytännön mukaisesti. Jos väestö ikääntyy odotuksenmukaisesti ja tuottoihin ei liity pitkäaikaisia yllätyksiä, nykyinen verotaso ei riitä näiden menojen rahoittamiseen, joskaan korotustarve ei ole kovin suuri. Vaikka suuren korotustarpeen – bruttoveroasteella mitaten esimerkiksi yli 5 prosenttiyksikköä – todennäköisyys on suhteellisen pieni, sitä ei kuitenkaan voi jättää huomiotta. Tarpeen realisoituminen uhkaisi koko hyvinvointijärjestelmän tasapainoa. Tutkimuksessa tarkastellaan kolmea rahoituksellista kestävyyttä parantavaa toimenpidettä. Eläkkeiden elinaikakerroin, joka tulee lähivuosina voimaan, parantaa kestävyystilannetta ja vähentää siihen liittyvää epävarmuutta. Samoin tekisi siirtyminen ruotsalaistyyppiseen maksuperusteiseen mutta ei täysin rahastoituun eläkejärjestelmään (NDC). Politiikka, jossa eläkerahastot sijoittavat enemmän osakkeisiin, parantaa odotettua rahoitustilannetta, koska sijoitusten odotettu tuotto kasvaa. Tämä edellyttää, että rahastojen koon suurempi vaihtelu ei johda eläkesääntöjen muuttamiseen. Kestävyysarvioihin liittyvä epävarmuus kasvaa suuremman riskinoton myötä.

Avainsanat: julkinen talous, rahoituksellinen kestävyys, riskit, stokastiset simuloinnit

JEL-luokittelu: H30, H62, H63, J11

Contents

1   Introduction

Population ageing will in the coming decades result in age structures vastly different from anything previously experienced. It will put pressure on public finances, since the elderly, whose population shares are increasing, are net recipients of public outlays and those in working ages, a declining group at least relatively and in many countries absolutely, are the net payers.

Analysis of sustainability is thus needed to make a realistic foresight on whether the public sector can in the future finance the services and transfers it has explicitly or implicitly promised to citizens. This is especially important in Nordic countries where public transfers and services are extensive and people on the whole seem to count on them when pondering on how the old age will turn out economically.

This study concerns the sustainability of public finances in Finland. It considers the large public sector which consists of the state, the municipalities and the social security institutions including the statutory earnings-related pension system.

We wish to utilize the empirical research concerning the uncertainty in demographic projections. Studies show that official long-term demographic projections, both national and international, have in the past been highly uncertain and in some respects systematically biased. Although better use of statistical methods might reduce the biases, the uncertainty remains. Other studies have evaluated the effects of demographic uncertainties on the economic consequences of population ageing, and shown, not surprisingly, that economic estimates also become very uncertain. The results of this study support these findings.

We also wish to expand the sustainability analysis with considerations concerning increased risk-taking in public asset management. Public sector financial assets have grown rapidly and portfolios have been shifted towards more equity holdings. This is most clearly seen in pension funds of the statutory earnings-related pension system, where the explicit aim is to alleviate or prevent the projected increase in pension contributions by acquiring better asset yields. Similar developments, although not explicitly stated and much less discussed in public, can be observed in other parts of public sector. In these choices Finland is not alone, the tendencies are clear in many countries where the public sector holds significant amount of financial assets or the pension systems are partly or fully funded. Asset yields have on average been good in recent years, increasing the hopes in the minds of many that more risk-taking will be a crucial factor in solving the fiscal threats caused by ageing populations.

Demographic and asset yield uncertainties are included in our sustainability analysis by making stochastic simulations with a numerical economic model. The model in question is a general equilibrium model with an overlapping generations

structure. It produces a base stochastic projection for the Finnish economy for several decades ahead. This projection is then treated as data, and various sustainability measures and calculations are derived from it.

In Section 2 of this study, we discuss general issues of sustainability and the role of uncertainty in the analysis, based on previous research. We then present, in Section 3, the stochastic long-term projection for the Finnish public sector finances. The sources of uncertainty are future demographics and future asset yields. We also discuss several methodological issues and practical choices. Based on this stochastic projection, the sustainability of Finnish public finances is analyzed and discussed in Section 4. The discussion concerns both economic and methodological issues. Policy implications of stochastic sustainability analysis are discussed in Section 5. Section 6 concludes with the key findings of the study.

2 Measuring sustainability under uncertainty

Sustainability analysis has its origins in theoretical models of 1980s, which consider public debt dynamics. The simplest approach is based on an accounting identity, in which the change in debt/GDP is fully determined by the current primary surplus, previous amount of debt and the difference between real interest rate and the growth rate of the economy.

The empirical analysis developed later to two directions, described by Langenus (2006) as backward-looking and forward-looking approaches. The backward-looking approach aims to test econometrically from historical data either whether public debt and the primary balance are stationary or whether public expenditure and revenues are co-integrated (see eg Bohn, 2005, 2007). If not, fiscal policy is considered as unsustainable. The results describe how policy has previously managed to maintain sustainability. The limitations of this approach are obvious. It does not use any information concerning the future and also the role of the current policy stance is limited. Furthermore, it does not give any advice how policy should be changed. Therefore these exercises have not gained much attention in policy discussions.

The forward-looking approach projects future values for the determinants of the debt dynamics and develops measures that quantifies the needed adjustment if unsustainable dynamics is detected. The quality of data and the elaborateness and sophistication level of the used models have developed a lot in past few years, but there is still much room for improvement.[1]

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[1] 'The process of developing long-term budgets is in its infancy, and there is neither a single analytical approach nor a fiscal rule for sustainable development that has achieved agreement as best practice.' Ulla (2006).

Two observations have shaped the recent projections. The first is that population structure is changing due to the low fertility and increased longevity. The second is that most of the public expenditures related to individual citizen are generated either before or after working years whereas most of the tax revenues are generated during working years. Combining the information on the age-dependent public expenditures and revenues and the population projections allows evaluation of the effects of population ageing on public finances.

Synthetic indicators

Literature proposes several measures, called as synthetic indicators, which quantify the amount of fiscal adjustment needed to restore sustainability. Blanchard (1985) defines a 'tax gap' as an immediate adjustment in the total tax rate that allows the debt/GDP ratio to converge to the current level at a give terminal date. A corresponding flow indicator, developed by Buiter (1985) is a 'primary gap' defined as an immediate adjustment in the primary balance that would fulfill the same terminal debt condition.

It was later noted, however, that the required fiscal adjustment depends heavily on the chosen terminal date. Therefore, alternative specifications, which estimate these indicators assuming infinite horizon, have been developed. Another later refinement considers the amount of terminal debt. A more stringent condition assumes that the present value of all future surpluses and deficits equals current debt, implying that the debt will finally be fully repaid (Heller, 2003). This condition is known as the present value budget constraint.

In practice, also the choice of the initial values is important. Business cycles may cause temporary variation in tax receipts, expenditure, interest rates and in the value of the government's assets. The magnitude of the necessary discretionary measures depends, however, on the cyclically adjusted initial total tax rate or primary balance.

European Commission uses two sustainability measures that are directly elaborated from these indicators. The first one measures the difference between current total tax rate and a tax rate that is required to generate public debt/GDP ratio of 60 per cent in 2050. The second measures the tax gap, or the corresponding primary balance, that equalize the current public debt and the present value of all future surpluses and deficits (EPC, 2006).

It is worth noticing that international comparisons of sustainability gaps are not necessarily very informative. For example, a low-tax country with a large sustainability gap can restore sustainability with tax increases and still the total tax rate may remain lower than the one in another country with high initial tax rate and no sustainability gap.

Economic models

One element that influences the results is the economic model used in the sustainability analysis. Recent sustainability assessments have utilized three types of economic models. Majority of the calculations has been made with accounting models. A special example of these models is generational accounts. A less frequently used framework is macroeconometric models. Third choice is numerical dynamic general equilibrium models, often with overlapping generations household structure.

Generational accounts include detailed description of the current links between age structure of population and the public sector finances. The other data needed consists of a population projection and assumptions about future employment rates, productivity growth rate and interest rate (see eg Alho and Vanne, 2006). A similar simple macroeconomic setting is in use also in other accounting models (see eg Duyck et al, 2005). Accounting models thus often provide elaborated description of financial flows between individuals and public sector, but have minimum macroeconomic contents and no behavioral effects.

Sustainability analysis performed by the European Commission takes the results of the national pension projections as given, but projects the other age-dependent expenditures using similar methodology as in generational accounts. They consider also the influence of the size of the working-age population on the growth rate of the GDP. The lack of any behavioral reactions weakens the relevance of the performed sensitivity and policy analysis.

The most developed approach is the use of dynamic general equilibrium models, in which the household sector consists of overlapping generations. These models take into account the interaction between demographic structure and the factor markets of the economy, encompassing thereby implications of growth models. They can also produce the outcomes of actuarial pension models and generational accounts, since it is possible to model the pension system rules and detailed links between age of the household generations and public expenditures and revenues. They suit well to policy analysis, since households react to policy. For the same reason, they are able to track well the sensitivity of the public sector finances to variation in factors that are out of reach of domestic policy.

Risks and stochastic projections

The forward-looking approach is sensitive to the accuracy of the projections. Uncertainty in numerical analysis of public finances is typically assessed by generating a baseline scenario and some alternatives in order to reveal the sensitivity of the baseline to some salient variables. For example, European

Commission (EPC, 2006) uses a large amount of different scenarios for the most important variables to describe alternative futures.

It has long been known that this scenario approach suffers from many problems (see Törnqvist, 1949). A general finding in new demographic studies is that uncertainty is typically underestimated in official national demographic forecasts (Anderson et al, 2001) and thereby eg in pension expenditure projections (Lassila and Valkonen, 2008a). As a consequence, a too narrow range of policy alternatives is often entertained. A new way of dealing with the uncertainty is to use stochastic models.

Stochastic sustainability analysis can be described by four steps.[2] First, a large amount of sample paths of the key variables is produced using stochastic models. Second, future public expenditure and taxes associated with each of these paths are simulated using an economic model. Thirdly, the simulation results are transformed to sustainability gaps or primary gaps. Fourthly, the predictive distributions of the gaps are presented and the probabilities of unsustainable paths are evaluated.

Studies that utilize stochastic population projections mainly use accounting models to analyze the sustainability of pension systems (eg Burdick and Manchester, 2003; Holmer, 2003; Lee et al, 2003; Congressial Budget Office (CBO) 2001; Auerbach and Lee, 2006; Keilman, 2005). The exceptions in this line of research are Lee and Miller (2001) and Lassila and Valkonen (2004), who study health care, and Alho and Salo (1998) and Creedy and Scopie (2002), who forecast also social expenditures with an accounting model. The method of stochastic forecasting has been applied also to the unit costs of health care, see Boards of Trustees (2003). The effects of both economic and demographic uncertainty on aggregate public finances are studied in a similar accounting framework by Lee and Tuljapurkar (1998, 2001). Alho and Vanne (2006) and Sefton and Weale (2005) used generational accounting to perform a corresponding risk analysis.

In Lassila and Valkonen (2001 and 2003) we combined a few well-defined population sample paths from a stochastic population forecast with a detailed numerical OLG model and studied pension policy options under demographic uncertainty in Finland. Alho et al (2002) and Alho, Jensen, Lassila and Valkonen (2005) were the first to analyze ageing using a large set of OLG model simulations of the Lithuanian economy. Recently ageing expenditures have been analyzed in a similar fashion in Finland (Lassila and Valkonen, 2005 and Kilponen et al, 2006), Germany (Fehr and Habermann, 2004), the Netherlands (Draper et al, 2008) and Denmark (Jensen and Børlum, 2005).

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[2] There is also another branch of numerical stochastic sustainability analysis, performed mainly by IMF. It analyses the vulnerability of debt to adverse shocks. Sustainability simulations are performed typically for the short or medium term using highly aggregated econometric models (see eg Mendoza and Oviedo, 2004).

3 A stochastic long-term forecast for the Finnish economy

3.1 The FOG model

We simulate the sustainability of public finances using a perfect foresight numerical overlapping generations model of the type originated by Auerbach and Kotlikoff (1987). It is modified to describe a small open economy and calibrated to the Finnish economy. The FOG model consists of five sectors and three markets. The sectors are households, enterprises, a government, two pension funds and a foreign sector. The labor, goods and capital markets are competitive and prices balance supply and demand period-by-period. There is no money or inflation in the model. The unit period is five years, and the model has 16 adult generations living in each period. The model is described in more detail eg, in Lassila and Valkonen (2007b).

We assume that the pre-tax rate of return on saving and investments is determined in global capital markets. In trade of goods the country has, however, some monopoly power, which makes the terms of trade endogenous. Foreign economies are assumed to grow with the trend growth rate of the domestic labor productivity.

The driving forces of the model economy are the transitions in the demographic and educational structure of the population and the trend growth of labor productivity. Population is ageing due to longer lifetimes, low fertility rates and the transition of baby boomers from working age to retirement. We use the stochastic population projection produced by Professor Juha Alho in 2006.

Educational level improves in the future since the current middle-aged generations have on average much lower level education than the young ones. The improvement raises productivity of labor. Each household generation is divided to three educational groups with different lifetime productivity profile determined by empirical observations of recent wage profiles. The educational shares are supposed to develop in future in line with the official projections.[3]

Labor input is determined partly by exogenous assumptions and partly due to endogenous adjustments in the model. Exogenous factors are trend growth of labor productivity (1.75 % per annum in private goods production), demographic trends, educational gains and unemployment rate. The model is calibrated so that the trend labor productivity growth and the following higher wages do not affect the labor/leisure choice of the households, which otherwise is endogenous.

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[3] Ludwig et al (2007) provides an example of studies where population ageing influence educational decisions, since wages rise and rate of return on capital falls. The studied economy is closed and growth is endogenous. These features emphasize the initial effects of population ageing on factor prices and growth.

One interesting issue is how the future labor force is allocated between public and private sector. Our starting point is that the increased number of people in the old age and near death increases the demand for health and old age care. It is not obvious whether the increased demand will be satiated by public or private provision. We assume that these demography driven additional services are produced in private sector, but production costs are paid totally by the public sector. These services are produced using labor and intermediate goods as inputs. There is no productivity growth in the production. The shares of employees in private and public sector are kept constant.

Real wage adjusts to equalize the value of marginal product of labor and labor costs in the production of private goods and services. The rest of the workers, who provide tax-funded services produced in private and public sector, earn the same wage.

Public expenditures have strong connection to the age of individuals. Provision of public services is allocated mainly either to the early part of the life cycle (day care and education) or to the last ten years (health care and old age care). Similarly, income transfers are distributed mainly either to young families or to retired individuals. This is why the changes in the demographic structure are so important for the public expenditures. We assume that all income transfers (except the earning-related pensions) are fully indexed to wages because any other assumption would have dramatic consequences to income distribution in the very long term analysis. Other than age-related expenditure is assumed to grow at the same rate as the GDP.

Revenues of the public sector originate from two types of sources in the model. The majority of the receipts are accumulated by income taxes, consumption taxes and social security contributions. Another noteworthy revenue source is the yield of the public sector wealth. The yield of the wealth is important especially for the pension funds, but also the central government has substantial amount of financial assets.

We assume that the modeled main subsectors of the general government, such as the municipal sector, the public and the private sector pension fund and the national social security institute, have their own budgets, which are balanced either by social security contributions or earned income taxes. The only exception is the state budget, which is balanced using a lump sum transfer. Earned income tax brackets are adjusted with the growth of the economy. Households are modeled to react to the income and substitution effects of taxation and social security contributions, fully appreciating the pension rights earned when working.

In the baseline projection the assets and liabilities of local and central government grows at the same rate as the GDP, but the pension funds follow their current prefunding plans.

3.2 The non-stochastic projection

Model simulations show, that the interactions between changes in the demographic structure, private markets and fiscal sustainability are strong. Ageing generates market price reactions, which tend to mitigate the initial changes in supply and demand. For example, while working age population shrinks, wages will rise. This encourages labor supply. On the other hand, public sector activities magnify the demography-based need for market adjustments. Population ageing increases public expenditures and slows down the growth of the tax bases, which put a strain on labor income tax rates and thereby on labor supply. Furthermore, the increase in labor demand in publicly financed services intensifies the competition for the scarce labor.

Analysis of the separate elements of aggregate demand reveals that the shift towards older population structure increases the share of consumption at the expense of investments. The share of service production increases, because the increasing number of elderly needs health care and old age care. Net exports decreases and the growth rate of GDP slows down. Since the country has some monopoly power in world markets, the terms of foreign trade becomes somewhat more favorable due to the diminishing export supply.

Population ageing also affects the balance between national saving rate and investment rate. Both rates are expected to fall, when the baby boomers move over from labor force to retirement. The reaction of the investment rate is expected to be somewhat stronger. In a small open EMU country, like Finland, the following surplus in the current account leads to a capital outflow and accumulation of foreign assets, but not changes in the domestic interest rates.

The labor markets of the model adjust smoothly to the diminishing labor force. In the real world, keeping up the productivity growth rate with diminishing labor force requires frictionless reallocation of workers to the most productive firms and industries. The roles of well-designed institutions and education as a precondition of smooth adjustment are emphasized.

Labour input consists of two types of elements, the number of hours worked and the productivity of the workers. Demographic trends lower the number of working-aged population, but since real wages are likely to increase, there will be more hours worked during the lifetime of the individuals. Unemployment rate and early retirement are projected to decrease somewhat in Finland because of the new pension system rules and since the economic incentives to work are more lucrative in tight labor markets.

Ageing of the population reduces the labor input available for private good production, due both to lower number of working age population and to the higher demand of publicly financed services. The following higher labor costs cause some endogenous substitution of labor for capital. This improves labor

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productivity. In our non-stochastic projection this channel has some role only at the latter part of the century, since productivity increase due to the improved educational level keeps up the labor input measured with efficiency units until 2060's. Figure 3.1 describes the simulated labour supply, scaled so that period 2000–2004 is 1. The data encompasses the changes in demographic and educational structure and the endogenous labor supply decisions of the households, but not the trend growth of labor productivity.

Figure 3.1   **Labour supply**
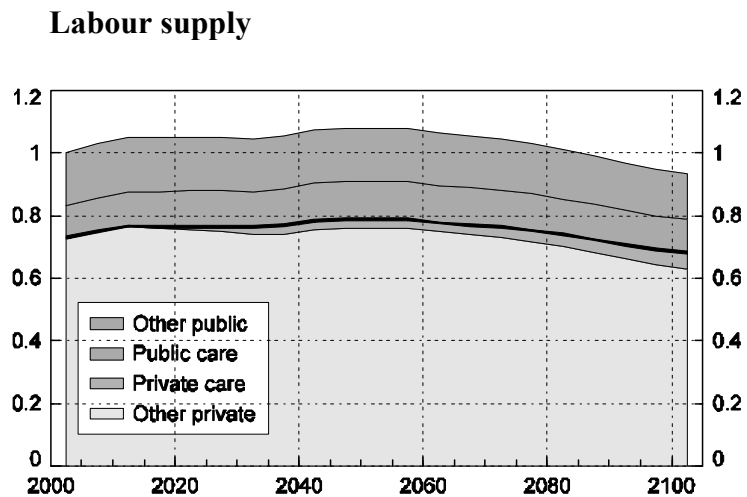
The following table gives an idea of the age-dependent expenditures/GDP in the non-stochastic population path. Due to the inevitable increase in uncertainties as the projection horizon increases, the numbers decades ahead have low forecasting accuracy. The main message is that the higher expenditures seem to be a permanent phenomenon.

Table 3.1   **Age-dependent public expenditures/GDP, %**

	2000–2004	2025–2029	2050–2054	2075–2059
Pensions	11.1	15.5	14.7	15.4
Other income transfers	6.1	5.4	5.3	5.2
Health and long-term care	8.4	9.5	9.9	10.4
Education	6.5	6.1	6.0	6.0
Total	32.1	36.5	35.8	37.0

Two basic factors define the development of future tax and social security contribution receipts. The first is the growth and structural change in the tax bases and the second is how tax rates are determined. Population ageing lowers the growth rate of the economy. It increases the share of consumption and reduces the share of earned incomes as tax bases. The share of capital income tax revenues

does not change much, because the only sector which changes its saving behavior a lot is the first pillar pension funds, and their capital income is not taxed.

The total tax rate increases from 44.8 per cent in 2000–2004 to 46 per cent in 2050–2054 and further to 48.7 per cent in 2100 in the non-stochastic projection.

3.3   The stochastic projection

Uncertainty over future demographic and economic trends affects profoundly the way how we analyze the sustainability of public finances and design policy to improve sustainability. Population ageing represents itself a realization of a demographic risk. If seen earlier, the policy would have undoubtedly been different. More importantly, we always face the same uncertainty, when we make predictions about sustainability of current fiscal rules or any alternative policies.

It is not obvious how we should analyze fiscal policy under uncertainty. The first problem is to define which, from the point of view of sustainability, the most important sources of uncertainty are.

One way of approaching this issue originates from generational accounts, which define in detail the connection between age and taxes and public expenditures. It shows clearly that majority of taxes are paid from labor incomes and majority of public expenditures are allocated either to childhood or to retirement. Therefore the obvious candidates for uncertainty factors are the numbers of employed and retired people and the growth rate of labor productivity, which determines the growth rate of wages. In the Finnish case the marked amount of financial assets and liabilities in the public sector makes also the yield variation in financial markets important.

Considering a small open industrialized economy, where the required rate of return on capital as well as the rate of technological change is determined largely from abroad, it is easy to see that these economic risks are not easily controlled by the government. The same conclusion applies also to demographic risks, since population policy is not seen as very efficient in the long term.[4]

After defining the relevant sources of risks, the second question is how to evaluate and measure the future uncertainty. Our approach is to estimate stochastic models using historical data and to simulate a large amount of future paths for the relevant variables.

The resulting output can be used to describe future probabilities, assuming that uncertainty is similar in future as it has been in the past. This approach has

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[4] Several papers of Bohn (2001 and 2003) analyze risk sharing properties of social security applying numerical OLG models with stochastic inputs. One argument in favor of PAYG systems is that factor prices react to realization of demographic risks limiting the required changes in the pension contribution rates. The outcome depends strongly on the assumed closed economy setting.

become common in descriptions of demographic uncertainty (see Alho and Spencer, 2005) and in evaluation of short-term financial market risks.

The nature on uncertainty influence policy implications. A low degree of persistence of the shocks allows intergenerational risk sharing, eg using financial market assets to smooth out the fluctuations. Therefore it is important to create a right conception of the relevant risks.

The third step in stochastic sustainability analysis is to simulate the economic model using the sample paths of the stochastic model as inputs. In early versions of the analysis these models were very simple, see eg Lee and Tuljapurkar (1998). The development of computational methods and computing capacity has improved dramatically the possibilities to model the demographic trends, economic behavior and the prevailing fiscal systems with a more policy relevant precision. We use our numerical overlapping generations model (FOG) in the stochastic simulations.

The households in the FOG model have perfect foresight, eg they know in each of the simulated cases which of the sample paths of the stochastic population forecast and the pension fund yield are the relevant ones. In an optimal simulation model, the household would be risk-averse and consider both the idiosyncratic and aggregate demographic, labor market and financial market uncertainty in their utility maximizing decisions. These types of models with detailed description of demographic structure and public sector do not, however, exist yet due to computational problems.

The final part converts the simulation results to probabilistic measures of fiscal sustainability, such as the predictive distribution of sustainability gap. The analysis can be supplemented with policy simulations. Comparison of the simulation results under current policy rules and new rules provides information about the expected effects of the policy measure as well as the effects on the probability of unsustainable paths.

Description of risks

In case of demographic uncertainty, we utilize the recent (2006) stochastic population forecast made for Finland by Professor Juha Alho. The forecast is produced by estimating stochastic models for fertility, mortality and migration, as explained in Alho, Cruijsen and Keilman (2008), simulating these models 3000 times and compiling the results with a cohort component method. The resulting populations vary around a non-stochastic population projection which has a total fertility rate of 1.8, annual net immigration of 6000–7000 for the first 50 years and zero after that, and increasing life expectancies for the next 100 years. Figure 1 presents the outcome as predictive distributions of number of people in the given age groups for the next 50 years.

The grey area depicts the 50 per cent confidence intervals for the number of people in the presented categories. For example, there is a 50 per cent probability that the number of prime age workers in Finland is between 2.4 million and nearly 2.8 million in year 2050. Even allowing demographic uncertainty of the given size, the main message of the simulations is that we will see a strong population ageing taking place during next decades. It is also very likely that the old age ratio will stay at high level very long time.

Since most of the public expenditures are aimed at old age and most of the taxes are paid during working years, a permanent shift in old age ratio means that the sustainability of public sector finances is under considerable strain in the expected population path, but also that sustainability is permanently vulnerable to further demographic shocks.

Figure 3.2 **Demographic uncertainty in Finland**
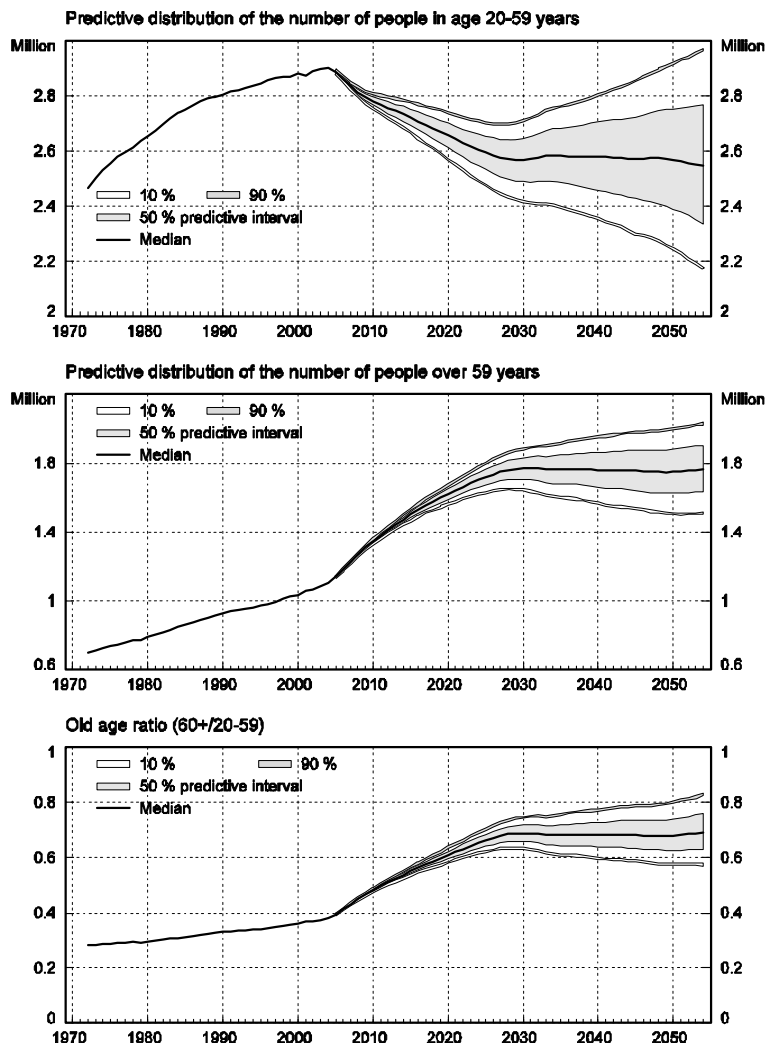
The other risk considered is the financial market yields. Data depicting various assets, geographical areas and time spans shows large differences for expected yield and the variation. Therefore we consider our results as indicative. The estimated stock and bond market yield distributions are modeled to determine the yield risk of pension funds and the asset/debt portfolio of the central government (but not to affect the saving and investment decisions of the private sector).

Figure 2 depicts the quantities of financial market risks that we use in this study. It shows the distribution of the real 5-year returns of bonds and equities, expressed as annual rates.[5] Equity returns are truncated in the figure; the cumulative density function shows that the yield is below -5% in over 10% of cases, and higher than 15% in over 15% of cases. In the portfolio of private sector pension funds 40 per cent is allocated in stocks and 60 per cent in bonds. There is about 50 per cent probability that the real rate of return is between 2–6 per cents in each 5-year period. The expected real annual yield is 3.9 per cent.

Figure 3.3 **Asset yield uncertainty**
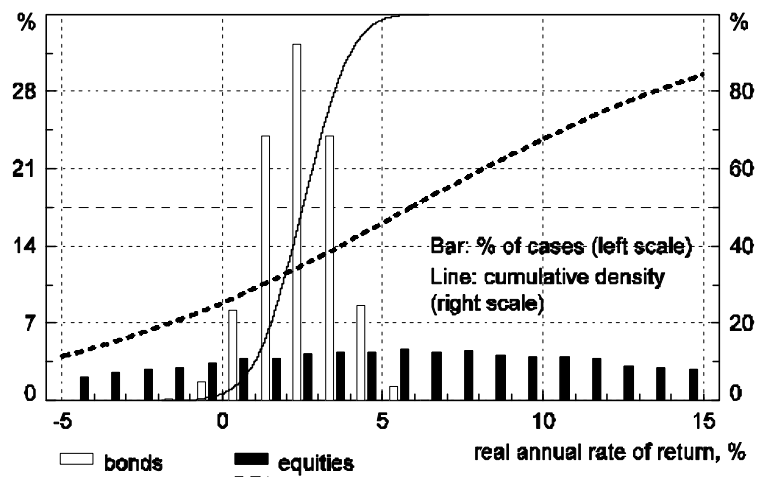
The investment risk is allocated to the pension contributions in the Finnish defined benefit pension system. A higher rate of return increases the proceeds that can be used to pay pensions, and lowers thereby future contribution rates. It affects the pensions only insomuch as the lower employers' pension contributions raise wages and thereby the indices that are used to upgrade pension accruals and

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[5] The estimated stock market yield is based on Finnish Stock Exchange data (OMXHCAP) from years 1927–1999. The average real rate of return on stocks is set to 6 per cent, with estimated variance of 10.97. The real interest rate data is from the IMF Financial Statistics. We use German bond data from years 1955–2005, because of the too short time series of usable Finnish data. The average value for the real interest rate is set to be 2.5 per cent, with estimated variance of 0.87. Since the unit period in the model is 5 years, we use 5 year averages of the yield variables. Bond and stock yields are assumed to be non-correlated.

paid pensions (the weights of wages and consumer prices are 0.8/0.2 during working years and 0.2/0.8 during retirement).

Baseline stochastic projection

The next step is to run the FOG model 500 times using the sample paths of the stochastic models as inputs. Demographic uncertainty affects strongly the labor market outcomes. The following figure shows the predictive distribution of aggregate labor supply (measured in efficiency units, excluding trend growth of labor productivity) in the economy.

Figure 3.4   **Predictive distribution of the aggregate labor input, ind. 2000–2004=1**
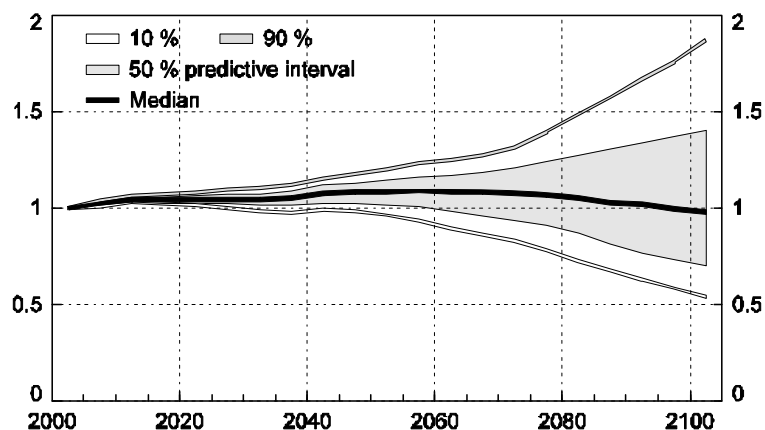
Realization of a fertility risk leads to a consequent change in the number of workers only just with a long lag. This keeps the labor supply uncertainty in check during the next 2–3 decades. In hundred years there is about a 10 per cent probability that the supply will be either twice as high as the current level or just half of it.

Due to the large variation in the amount of employed in production of goods the corresponding predictive distribution of wages is wide. The highest wages can be found with demographic structure in which the labor force is small, but there is a large population of elderly people who need care and cure.

Public expenditures

As mentioned earlier, public expenditures are sensitive to the demographic structure. The following table describes the simulated predictive distribution of

the main age-related expenditures. There is a 50 per cent probability that the expenditures are between 34.8 and 38.1 per cents of GDP in 2050. Other than age-related expenditures are assumed to grow at the same rate as GDP.

Table 3.2 **Predictive distribution of the age-related expenditures/GPD in 2050, %**

	2000–2004	2050–2054				
		d1	Q1	Md	Q3	d9
Pensions	11.1	13.5	13.9	14.6	15.4	16.1
Other income transfers	6.1	4.8	5.0	5.4	5.8	6.2
Health and long-term care	8.4	8.7	9.3	10.0	10.9	11.7
Education	6.5	5.4	5.7	6.1	6.6	7.1
Total	32.1	33.4	34.8	36.2	38.1	40.0

Total tax rate and assets of the public sector

Demographic uncertainty influences the tax and contribution revenues mainly because of the varying size of the working-age population. Therefore, the uncertainty in the size of the tax bases of the central and local government is not very large until the 2030's, when uncertainty in fertility starts to have its effect on the number of workers.

Since the public sector has a marked amount of assets, the role of financial market uncertainty is large in the revenue side. The main channel is the yield of the private sector pension funds. Any unexpected yield increases the share of prefunded part of pensions. When these funds are later run down to pay the pensions, the need for additional contribution finance is mitigated. Therefore, the pension contribution rate reacts with a lag to the variation of the yield of the pension funds. In case of the central government, the financial market risks influence both the yield of the assets and the interest expenses of the debt and thereby directly to the need for yearly tax revenues.

Figure 3.5 shows the simulated distribution of the total tax rate in Finland. Total tax rate consists of all taxes and social security contributions paid by the private sector, divided by the value of gross domestic product. The tax-to-GDP ratio increases in the long term with probability of about 75 per cent, which indicates that public finances are unsustainable. On the other hand, with the same probability, the tax rate remains below 50 per cents during next 70 years. So the gap is not likely to be so large that it would, eg markedly weaken the credit ratings of the government and cause thereby additional pressure to sustainability.

Figure 3.5   **Predictive distribution of the total tax rate**
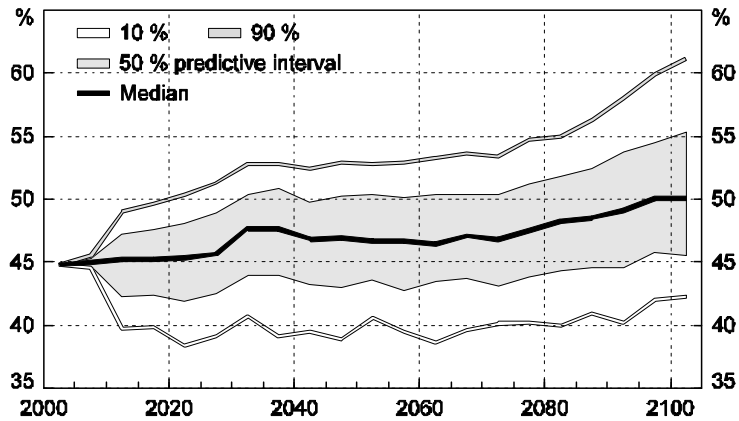
One should remember that this distribution is conditional on the assumptions of following the current prefunding rules of the pension system and fixing the assets and liabilities of the central government and municipalities in proportion to GDP to the current level. The next figure depicts the consequent predictive distribution of the net assets/GDP of the public sector. The variation is due to the effect of demographics and asset yields on the pension funds.

Figure 3.6   **Predictive distribution of the net financial assets/GDP of the public sector**
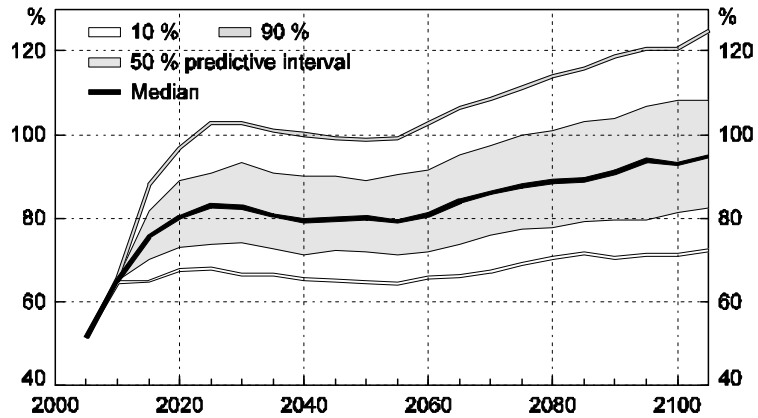
4 Sustainability in Finland: indicators and interpretations

4.1 Three indicators of sustainability

The stochastic projection described in the previous section contains all the numerical information on the sustainability of Finnish public finances. In this section we reduce it to three sustainability indicators and interpret the results.

The first indicator is based on the predictive distribution of the total tax rate, the sum of all taxes and private sector social security contributions expressed as a percentage of GDP. We choose some upper limits or critical values to this tax rate and calculate probabilities of exceeding the limits in the future. Although any such limit must be arbitrary, they help in discussing the possible size and timing of the sustainability problem.

The second indicator is the predictive distribution of the net public financial wealth, assuming that total tax rate is held at the initial level. Here we are interested in probabilities of high negative wealth.

The third indicator is the sustainability gap. It combines tax revenue and public expenditure projections and, as a present-value calculation, also takes the time dimension out of them.

All three indicators are commonly used in non-stochastic sustainability analyses. The stochastic environment brings in an additional dimension, which is straightforward to see and discuss in the first two cases but more complex in connection to the sustainability gap.

Total tax rate

All three indicators are presented in Figure 4.1. The upmost chart considers the total tax rate. The total tax rate in 1996–2000 was on average 46,5%. That is the highest 5-year total tax rate in the Finnish tax history. It has been lowered since, which we take as an indication that it was not viable. We calculate the probability of exceeding that limit in the future. The base period tax rate was about 2 percentage points below the peak. The upmost line in the following figure depicts the share of paths exceeding the previous peak. This is likely to happen in 2030s and again further in the future.

The figure also shows the probabilities of taxes exceeding two other limit values. Outcomes more than 5 percentage points higher than in the base period would mean that the tax rate is well over 50% of GDP. The probability for this is about 20% from 2030s to 2070s, when it rises close to 50%. The likelihood of

very high tax rates, at least 10 percentage points higher than in the base period, remains small until 2090s.

Figure 4.1   **Indicators of fiscal sustainability in Finland**
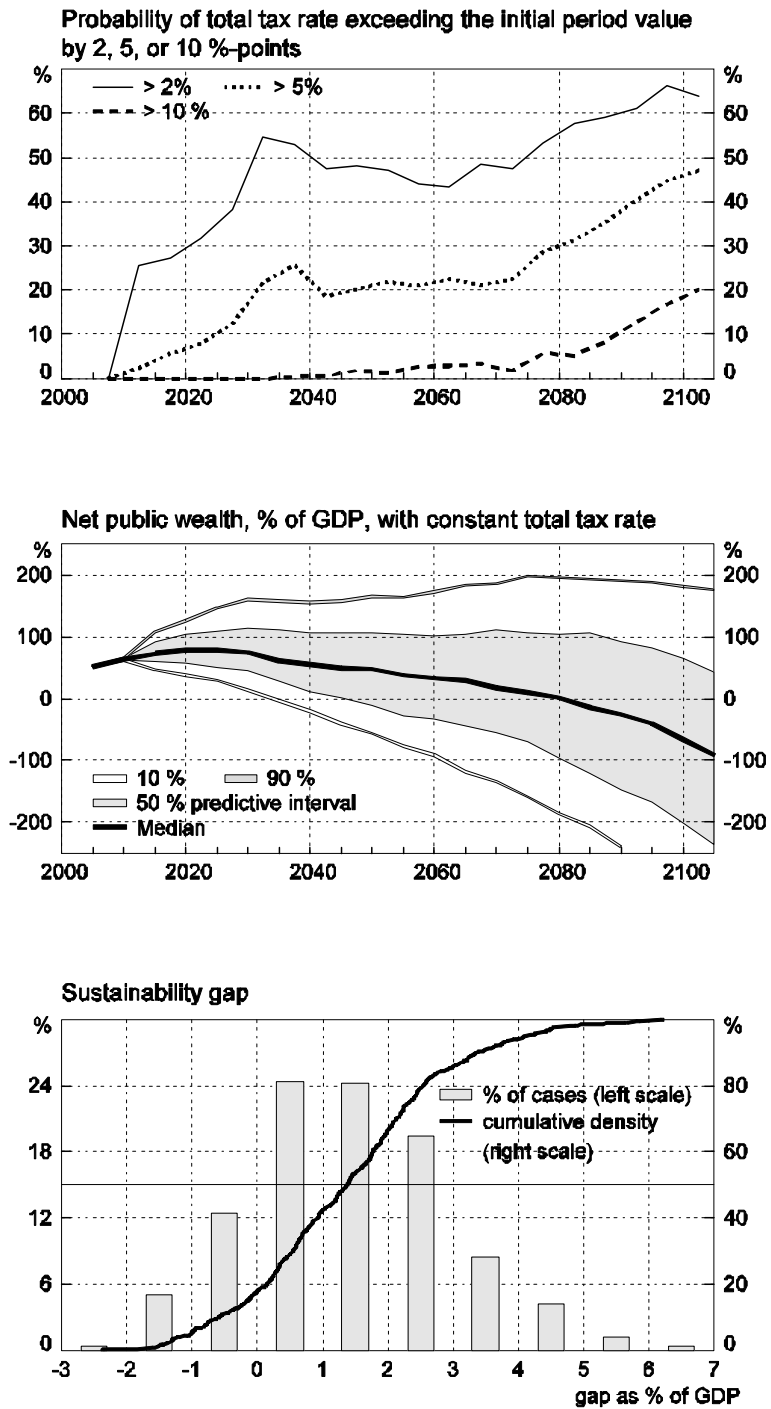
Net public financial wealth

Another way to look at the outcome is to calculate the total public net wealth assuming that the total tax rate is held at its initial level. All deviations of the tax income thus obtained from the tax income in the base projections are added to net public wealth and assumed to yield the stochastic bond yield. The result is a transformation of the base projection data. If taxes were actually held constant, there would be behavioural effects: households and firms would make different decisions than in the base projection. Such effects are not included in this calculation.

The middle part in Figure 4.1 displays the wealth outcome. The median of the net public wealth stays positive for eight decades, but then turns increasingly to the debt side. The whole distribution also bends downwards in time. The tails reflect the uncertainty that grows in time, but also the expected problem becomes larger.

The wealth outcome confirms the view that the expected problem is not very large, but it is a problem if something is not done. It also shows that the good initial net wealth position postpones the debt problem to become evident.

The figures above both show that the longer the view we take, the larger the sustainability problem is. The burden of ageing does not go away after 50 years or even 100 years.

Sustainability gap

The sustainability gap is the difference between a hypothetical constant tax rate and the initial tax rate. The constant tax rate should be such that, if implemented immediately, it would exactly suffice to pay the projected public expenditure and keep net public wealth on a desired level.

Within this general definition there are several options to be decided. Our sustainability gap choice aims to answer the following question. To what constant level should taxes be immediately set, so that if extra revenues were invested in bonds, the tax level is sustainable for at least 100 years? For the net public wealth we assume that the base projection rules and choices apply, so that pension funds evolve according to their current funding rules and other parts of the net public wealth are held in constant proportion to GDP. We also assume that the new incentive effects from the tax change are ignored and all households and firms behave as in the base projection.

Let $Y(i,t)$, $\tau(i,t)$ and $r(i,t)$ denote GDP, total taxes and bond yield in simulation i in period t, and $\tau(0)$ the initial tax level. The sustainability gap K in this simulation is then

$$K(i) = \frac{\sum_{t=1}^{T} [\tau(i,t) - \tau(0)] Y(i,t) D(i,t)^{-1}}{\sum_{t=1}^{T} Y(i,t) D(i,t)^{-1}} \qquad (4.1)$$

where D(i,t) is the discount factor

$$D(i,t) = \prod_{s=1}^{t} (1 + r(i,t)) \qquad (4.2)$$

With 500 simulations we get a distribution of the gap. The lowest part of figure 4.1 shows both the density function histogram and the cumulative density function of that distribution.

The median gap is 1,4 percentage points of GDP. The probability of a zero gap or a negative gap is almost 20%. The probability of a 2 percentage points or larger gap that would need a permanent raise over the previous highest total tax rate, is about one third. The probability of over 4 percentage points gap is about 5%. Thus, according to this estimate, Finland very likely has a sustainability problem. Curing it by immediate tax raises would lead to tax rates close to the previous maximum but more likely below it than over it, and very unlikely over 50% tax rate permanently.

4.2   Interpretation of fiscal sustainability in Finland

The three indicators show, first of all, that while the current tax rates are unlikely to yield sufficient tax income for financing public expenditure under an ageing population, in expected terms this problem is not very large. That is, the required tax increase is probably not very large and it is even possible that taxes can be lowered in the future.

However, they also show that there is a small, but not negligible, probability that taxes need to be raised dramatically, say, over 5 percentage points. Such outcomes, if they realise, risk at destabilizing the whole welfare state. We believe that in such situations future social services or social transfers, or both, will be scaled downwards from the levels that current rules would produce in the future. Like other Nordic countries, Finland has a large public sector, meaning that it has given a big promise to all citizens concerning their welfare. People have trusted the promise; private pension and health insurance is rather insignificant. Thus unexpected changes in public services and transfers could potentially be very harmful for many people. In our view, this is the real sustainability problem that Finland faces.

The most straightforward policy recommendation would be to immediately either increase taxes or cut public expenditures so as to reduce the expected sustainability gap. However, the problem with that policy is the risk of saving too much. In order to substantially reduce the probability of very bad outcomes (the right hand tail of the gap distribution), the public sector should be saving a lot more. That, however, makes it quite probable that in the future it turns out that we have saved too much. In addition, following such a policy would probably be politically very difficult.

Instead of reducing the expected (or median) sustainability gap by increased savings, we would advocate policies that directly tackle the problem associated with the right hand tail of the gap distribution. Generally speaking, this means designing rules that adjust public expenditures with the economic environment in as smooth and predictable way as possible. In section 5, two of the three policies that we consider aim to do that.

4.3   Discount rate and time horizon

Two important choices in the indicators concern the length of the horizon – how far into the future we aim to look – and the discount rate with which we bring the future to the present day. We'll start from the latter.

Discount rate

Evaluation of financial sustainability requires valuation of income and expenditure flows realizing at different points of time in future with different intrinsic uncertainty. Normally the valuation process includes simple discounting of all the flows with more or less arbitrarily chosen common discount factor. The choice of the factor is not however, an innocuous decision.

A higher discount rate reduces the importance of fiscal deficits taking place far into the future. So, the necessity of immediate action becomes less compelling. But if higher discount rate is due to higher expected rate of return on pension funds, early increase in contribution rate and/or cut in pensions are expected to be more effective to restore sustainability. On the other hand, if the higher discount rate used is due to riskier policy, it is not clear how much sustainability is actually improved.

The price of risk can easily be detected from market quotations of risky and riskless assets, if the financial flows are traded in public markets. In case of public sector budgets, there are few flows that are well priced. Most obvious are the

interest expenses and investment yields. Third budget item that has direct link to financial markets is receipts from capital income taxes.

If these financial flows were examined separately, a right discount factor would most likely be the market rate that properly considers the riskiness of that flow. So, eg if the government decides to borrow from the bond markets and invest the sum in stock markets, the flows should be discounted so that sustainability assessment of the public finances do not change, if the risk aversion of the government corresponds the one observed in the markets.

In case of the other than above mentioned budget items, the links to financial markets are less clear. The amount of tax revenues and social security contributions varies heavily with the growth rate of the economy and especially with the wage bill. Also a large majority of expenditures are linked with wages, eg public sector labor costs and wage indexed income transfers.

Consequently, it is more difficult to choose the discount factor for the total public finances. If the separate items of the budget are discounted with different factors, they cannot be aggregated as a one number describing the sustainability gap of the public sector. On the other hand, a higher risk should somehow be visible in the sustainability calculations. For example, it is not clear how we should consider the expected improvement of sustainability due to higher investment risk taken by a pension fund.

One further aspect is the interaction between market yields and long-term sustainability projections. Financially unsustainable public sector has to pay a higher risk premium and thereby a higher interest on its debt. On the other hand, population ageing is expected to lower the aggregate investment rate more than saving rate (see eg Krueger and Ludwig, 2007 and Saarenheimo, 2005), and the consequent current account surpluses tend to lower the riskless interest rate. Older population may also be more risk averse, implying that risk premium may increase. Should these factors be considered, when the time path of the discount factor is chosen for the sustainability calculations? Are there any other reasons to make year-by-year projections of the relevant discount rate?

In practice, either of the following two of choices is generally used. The first is to discount all the financial flows with a fixed riskless long-term interest rate, ie the expected interest rate of the public debt. This is a common practice in non-stochastic sustainability assessments. Another choice is to base the used discount rate on some indicator of risky market yields, eg on a weighted average of the observed yields on the net assets of the government. It recognizes both that governments are often at the same time debtors and creditors and that the actual financial flows often include risk premium.

The only way to escape the discount rate choice problem is not to discount at all. A sustainability analysis would then report a baseline total tax rate path that satisfies the given long term net wealth condition or a net wealth path of the government assuming that total tax rate is kept constant. Under uncertainty, the

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outcomes would be corresponding predictive distributions of future total tax rates or net wealth.

The nature of uncertainty also plays a definite role. If the uncertainty relates to short-term variation around a constant mean, it is more a question of public sector solvency than long term sustainability. But if the deviations from the mean are persistent or if also the value of the mean is uncertain, the role of relevant discount rate is more important.

Newell and Pizer (2003) claim that the discount factor should decline in time, if the future path of the discount rate is uncertain and persistent. It is a direct implication of the fact that the expected discounted value of a project is higher than the discounted value which is computed using an average rate, because discounted values are a convex function of the discount rate. See also Weitzman (2007).

In sustainability gap calculations, an immediate increase in the tax rate would generate a fund that creates capital incomes, and one has to make an assumption about the portfolio composition and the rate of return on this fund. Similarly, if the future expenditure path allows a permanent future reduction in the total tax rate, one should decide whether an immediate tax cut is allowed to increase the debt or reduce the assets of the general government. We have chosen to discount the future financial flows using the realised bond yields in each simulated path, as equation (4.1) shows. We could have chosen any combination of bonds and equities. In addition to the gap introduced previously, with bond yields as the discount factor, the gap in Figure 4.2 is calculated also with the equity yield as the discounter. The choice of the discount factor has an effect on the outcomes, as the figure reveals, but luckily it does not seem to be a crucial one.

Figure 4.2   **Gap distributions with two discount factors**
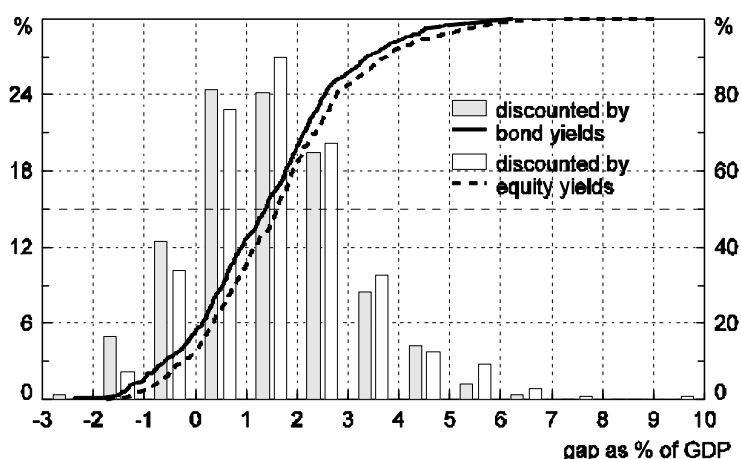
Still, the discount rate could well be very important for the numerical outcomes of the gap. Figure 4.3 shows that individual realizations of the gap vary considerably with the choice of the discount rate.

Figure 4.3 **Gap realizations with two discount factors**
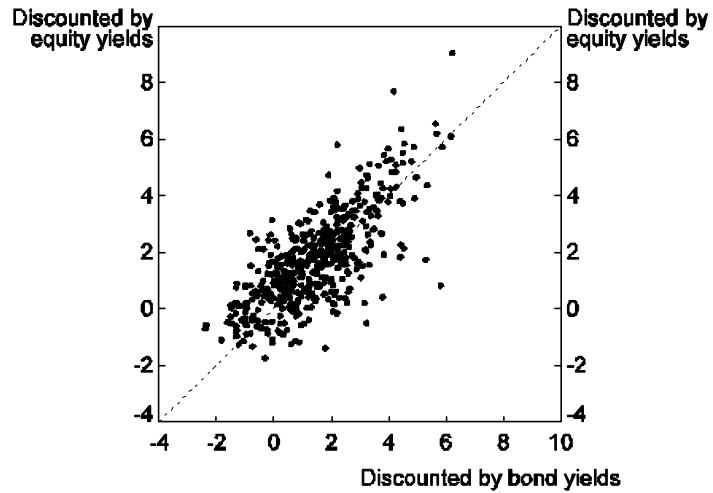
Choosing bond yields as a discount rate is certainly more conventional than choosing equity yields would be. Bond yields are usually chosen because they contain less risk than equities do, and in deterministic calculations the missing risk aspect is thus tried to be held as small as possible.

How far into the future do we need to look?

The top and middle parts of Figure 4.1. both show that the longer the view we take, the larger the sustainability problem is. The burden of ageing does not go away after 50 years or even 100 years. The values of the sustainability gap also depend on the length of the horizon. Figure 4.4 shows that the median gap would be half a percentage point smaller with a 50-year horizon than with a 100-year horizon. The differences sustain over the whole distributions.

Figure 4.4   **Gap distributions with different horizon lengths**
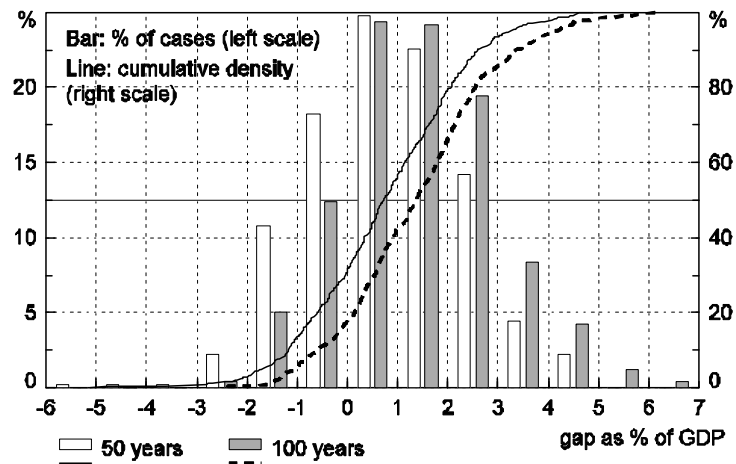
Blanchard et al (1990) defined three sustainability gap horizons. The first was one year, the second, 5 years, was for 'medium term' and the third, 40 years, was for 'long term' that should be used for population ageing issues. The general practice among EU countries for long-term is currently about 50 years. According to our results, this understates the permanent nature of the changes in population age structure.

We sympathize with researchers who say that sustainability analysis requires a very long horizon. Lee and Anderson (2005) note that 75 years is too short a period in analysing the sustainability of US social security, and suggest 500 years as a suitable representation of infinite horizon. They note that "The very phrase 'infinite horizon forecast' makes many people snicker, and indeed many serious demographers believe it is pointless and misleading to forecast population beyond 25 years or so" (p. 83). Long horizon is also required in policy issues related to sustainability. In analysing the Notional Defined Contribution concept in pension systems, Auerbach and Lee (2006) use 500 years in their 'stochastic laboratory' experiments. Their population age distribution is stochastically stable. This requires strong specific assumptions. Fertility, eg is modelled as a stationary stochastic process with a long-term mean 1.95 births per woman, and the implied decline in the total population is prevented by assuming a suitable amount of immigrants.

The main reason for not going beyond 100 years is that that would exceed the normal use of the model that produces the demographic inputs to FOG. Stochastic population simulations used in this study were produced by the Program on Error Propagation (PEP). The uncertainty of future fertility and mortality were empirically determined to represent the level of uncertainty observed in the past, and the error model for migration was based on a time series analysis, but was

judgmentally calibrated. Thus the uncertainty in simulated futures is based on careful empirical research. But there seems to be a limit, in the researchers' minds, on the length of the time horizon during which the past uncertainties provide a realistic base to assess future uncertainties. For long term forecasting PEP has the option of keeping error variances at a fixed level from some forecast year on. After that limit year the errors follow a matching AR(1) process. The limit year was 50 years in the future in Alho and Vanne (2006), and their total horizon was 100 years.

5 Economic policies and sustainability risks

5.1 Introduction

We consider three policy measures that are all motivated by sustainability problems. They all have strong implications on how demographic or economic risks are shared between different groups in the economy. Furthermore, they are relatively new policy measures, either recently applied in some countries or seriously discussed, and their risk implications have not been thoroughly studied.

The first policy, longevity adjustment of pension benefits, addresses one demographic risk, the future length of life. The adjustment reduces the effect of future changes in old-age mortality to pension expenditure. The second policy is switching from defined-benefit pension system to non-financial defined contribution (NDC) system. It addresses both demographic and economic risks.

Both these measures reduce sustainability risks. They either decrease or remove the expected problem and narrow the sustainability gap distribution. In both these policy options a precondition for smaller financial sustainability risk is that any political risks due to lower pensions is not realised.

In the third policy, pension funds invest a larger share in equities and expect to get higher returns. This policy addresses the expected sustainability problem. At the same time it gives less weight to financial risks than the current policy. Assuming that the increased risk itself does not cause problems, comparing the sustainability gap distributions reveals the long-run consequences of this policy. In our example, the whole distribution shifts to towards smaller gap values and the total sustainability risk is reduced, even though the distribution gets wider. But just assuming that the increased risk can be managed as well as the smaller risks in the base case is not sufficient. Increased variation in asset yields causes larger variation in net public wealth or other parts of the budget constraint. We illustrate the quantities of these changes and discuss possible ways they could have unexpected consequences to public expenditure.

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All three policies concern earnings-related pensions. The third policy could equally well be carried out in other public portfolios. One could find counterparts and analogies in central or local government activities for the first two policies also, but the pension system is ideal for our purposes, because it has so well defined rules. Although we present the results and the sustainability consequences for the large public sector, the policies are applied only to the Finnish statutory private sector earnings-related pension system (TyEL). The policy analysis is carried out by using the data provided by the base stochastic scenario, and thus does not include behavioural responses to the measures considered.

5.2 Longevity adjustment of pensions

In anticipation of future gains in life expectancy, several countries have passed laws that automatically adjust pensions, if life expectancy changes. The aim is to preserve the expected present value of future pensions. If benefits are received for more years, then pensions per year will be lower. The reform has been propagated as a way of improving sustainability of pension systems in a fair way.

The economic effects of longevity adjustment have been analyzed before with stochastic simulations by Alho et al (2005), Fehr and Habermann (2006) and Lassila and Valkonen (2007b, 2008b). Its effects have also been simulated as a part of a Swedish type Non-financial defined contribution (NDC) pension system, see Auerbach and Lee (2006), and Lassila and Valkonen (2007a). Longevity adjustment was also a part of a proposed comprehensive reform of the US social security system, see Diamond and Orszag (2003). The effects of this reform package was simulated by the Congressional Budget Office, see CBO (2004). This study extends the analysis to consider the implications of the reform for the aggregate public sector sustainability.

The policy option is to adjust pensions to the expected longevity of the cohort at the time of retirement. It allows reacting to surprises by adjusting the labour supply. This option is in use in Sweden and also in Finland where, from 2010 onwards, new old-age earnings-related pensions will be affected by the rule. Longevity estimates are based on observed ex-post cross-sectional survival data.

Longevity adjustment usually decreases the contribution rates, and the reduction is the bigger the higher the rate would have been without the reform. Thus longevity adjustment works very nicely as a cost saver. On the other hand, contribution rates are higher in demographic worlds where labour is scarce, wages higher and replacement rates lower. Thus longevity adjustment increases the uncertainty in replacement rates. It thereby significantly weakens the defined-benefit nature of the Finnish pension system and brings in a strong defined-contribution flavour. But it is important to note that demographic uncertainty itself

reduces the defined-benefit feature, so adopting longevity adjustment is a change in degree, not a change in kind.

Longevity adjustment of pension benefits is included in our base stochastic projection. Here we study how removing it would affect fiscal sustainability in the large public sector. Figure 5.1 shows the sustainability indicators in the base case and without longevity adjustment.

Removing longevity adjustment would lead to higher pensions than in the base case, and thus the total tax rate would be higher. Tax rate increase would realise gradually in time, as the top part of Figure 5.1 shows. If the total tax rate would be kept at the initial level, net public wealth would go down more rapidly than in the base case. There wouldn't, however, be any marked difference during the first 30 years, as the middle part of Figure 5.1 reveals. But summing up 100 years into the sustainability gap shows that longevity adjustment is very likely a strong policy measure. Without it the median gap would be almost one percentage point higher. Furthermore, the effect of adjustment is the larger the bigger the sustainability problem would be without it. Thus longevity adjustment gives substantial 'insurance' to public finances, by rearranging a large part of aggregate longevity risks to be dealt with completely outside the public sector.

Figure 5.1   **Sustainability effects of removing longevity
                    adjustment of pensions**

Probability of total tax rate exceeding the initial period value
by 2, 5, or 10 %-points

Net public wealth, % of GDP, with constant total tax rate

Sustainability gap
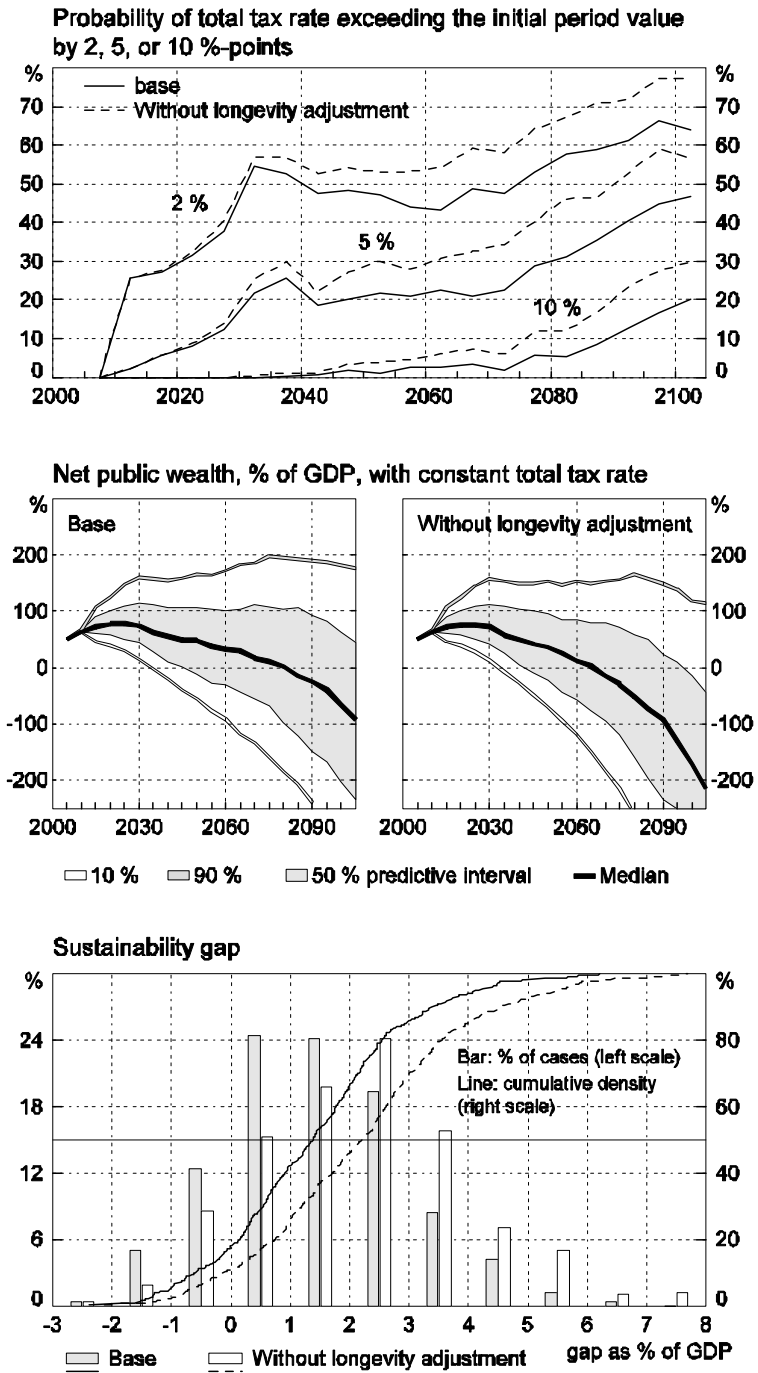
5.3   Introduction of a notional defined contribution (NDC) system

The notional (or 'non-financial', a term preferred by the World Bank) defined contribution (NDC) approach aims to keep pension contributions at a constant level and still to provide reasonable pensions. A pioneering application is the Swedish old-age pension system. A key element is the balance mechanism, to be automatically applied if the finances appear insufficient. The balance mechanism is based on the concept of 'balance ratio' – a ratio of assets to liabilities. When the ratio is below unity, it will act like a brake: it will slow down the indexation of notional pension accounts as well as of pension benefits.

If the contribution rate is constrained, the burden will fall on replacement rates. When and how the burden will fall, depends on how the world will turn out to be – especially, what will the demographic and economic future contain. In Lassila and Valkonen (2007a) we showed that a direct application of the brake to the Finnish pension system (TyEL) shifts risks into the future and to future generations. Depending on the chosen contribution rate level, the brake system could be interpreted to be a form of postponing new decisions for decades, or a slow way of running down the system, or a way to pile up huge reserves. In Lassila and Valkonen (2008c) we showed that fiscal sustainability in the TyEL system can be achieved by scaling the brake appropriately.

The balance ratio and the balance mechanism

Two elements are needed to construct the brake.[6] First, a summary measure of the financial situation of the pension system – the balance ratio. And second, we need to define how and when the measure affects pension benefits.

The value of contributions in a pay-as-you-go pension system depends on the degree to which the contributions can finance the pension liability. This means that the flow of contributions is compared to a stock of pension liabilities. The essential question is, how many years of contributions are related to the current stock of liabilities. The Swedish solution is the concept of expected turnover duration, which is the expected average time between when a contribution is made to the system and when the benefit based on that contribution is paid out.

Contributions multiplied by expected turnover duration indicate how large a pension liability can be financed by contributions given the income and mortality patterns prevailing in the period measured. The contribution asset CA is the product of the annual contributions C and the turnover duration T.

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[6] The brake, and the Swedish pension system, is described in eg Könberg et al (2005), Palmer (2002), Settergren (2001) and Settergren and Mikula (2005).

$$CA(t) = C(t)T(t) \tag{5.1}$$

The second asset of the system consists of possible pension funds. Sweden has buffer funds, and their value is added to the contribution asset, to get the total value of assets.

Pension liabilities are those pension rights that have been accrued up to the time of calculation. In a defined benefit system the evaluation of the rights involves several technical choices, but the heuristically the issue is clear.

Denoting the balance ratio by B, the pension liability by D and the pension funds by F, we can define the balance ratio the ratio of assets to liabilities, as follows.

$$B(t) = \frac{CA(t-1) + F(t-1)}{D(t-1)} \tag{5.2}$$

If the balance ratio is bigger than one, the total value of the contribution asset and the pension funds exceeds the liabilities, and the finances appear sound. If not, the balance mechanism is turned on.

An essential feature of the Swedish balance mechanism is that only observed values of the variables are used. This choice is dictated partly by the aim of avoiding possible manipulation of the terms in the balance ratio. Forecasts are easier to manipulate than observed data. The downside of this choice is that no future changes can be taken into account ex ante. Even though the ageing of the population is foreseen, it does not affect the brake until it happens. This may postpone the adjustment of the pension system (when compared to a corresponding forward-looking automatic rule).

We have applied equations (5.1) and (5.2) to the Finnish earnings-related system (TyEL). Since a direct application could lead to solvency problems (see Lassila and Valkonen 2008c), we scale the brake by dividing it by its period 2005–2009 value $\overline{B}$. We denote the scaled brake by B^*

$$B^*(t) = B(t)/\overline{B} \tag{5.3}$$

Both pension rights and benefits are index-linked, with 80–20 weights on wages and consumer prices, respectively, during working years and 20–80 weights after retirement, irrespective of retirement age. The index can be described by a function $I(t,\lambda)$ stating that the change in wages w from the base period 0 to period t is weighted by λ and the change in consumer prices p is weighted by $1-\lambda$. Employee's contribution e is deducted from wages in this calculation.

$$I(t,\lambda) = \left(\frac{w(t)(1-e(t))}{w(0)(1-e(0))}\right)^{\lambda}\left(\frac{p(t)}{p(0)}\right)^{1-\lambda} \hspace{3cm} (5.4)$$

The balance mechanism uses the numerical value of the scaled balance ratio to diminish the changes in pension benefits and pension rights that come from indexation. With low balance ratios, the changes may become negative. When the balance mechanism is triggered for the first time the function $J(t,\lambda)$ is applied

$$J(t,\lambda) = B^*(t)I(t,\lambda) \hspace{3cm} (5.5)$$

When the balance mechanism continues to be on, the previous index value J is multiplied by the new scaled balance ratio value and the change in the basic index I.

$$J(t,\lambda) = J(t-1,\lambda)B^*(t)I(t,\lambda)/I(t-1,\lambda) \hspace{3cm} (5.6)$$

If the scaled balance ratio again exceeds 1, equation (5.6) still continues to be applied as long as $J(t,\lambda) \leq I(t,\lambda)$. After that the index I will be applied. This means that if the balance ratio is high for a sufficiently long period, not only is balancing switched off but also the index effects that cumulated are eventually cancelled.

We study a version of NDC where the pension contribution rate is raised to a level which would balance the pension system in the expected case. We have analyzed this policy from the pension system's point of view in Korkman et al (2007) and in Lassila and Valkonen (2008c).

Pension contributions are immediately increased when the move to NDC system is implemented. This means an immediate increase in the total tax rate, which increases the probability of exceeding the 2% threshold value during period 2010–2025, as depicted in the top part of Figure 5.2. After that the probability is usually smaller than in the base case. The probabilities of exceeding the higher threshold values are always smaller with NDC than under the base case. This is not surprising; a small tax increase early on reduces the need for larger increases later.

The middle part of Figure 5.2 shows the effect on net public debt. Notice that the constant total tax rate in the NDC case is different from (higher than) the tax rate in the base case. This explains why net wealth is likely to accumulate in the NDC case, whereas it turns, with high probability, into an exploding net debt in the base case.

Figure 5.2   **Sustainability effects of moving to NDC pension system**

Probability of total tax rate exceeding the initial period value by 2, 5, or 10 %-points

Net public wealth, % of GDP, with constant total tax rate

Sustainability gap
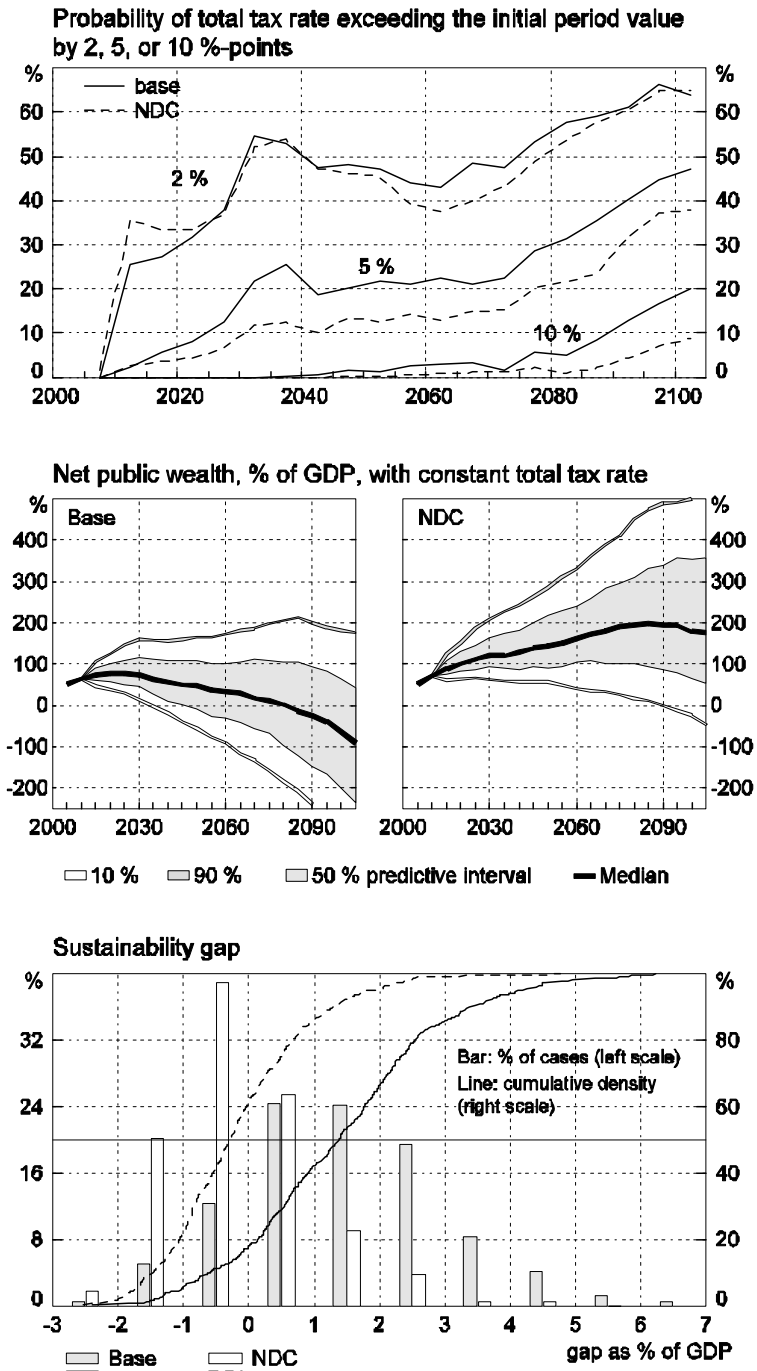
The immediate tax increase shifts the whole sustainability gap distribution to the left in the bottom part of Figure 5.2. The median gap becomes slightly negative, indicating that the total tax rate is probably set too high. But the gap distribution shows also that NDC includes a significant risk-sharing property. The likelihood of high sustainability gap values is dramatically reduced. Thus NDC,

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even more than longevity adjustment, gives substantial 'insurance' to public finances, by removing the public arrangement of sharing demographic and economic risks between generations and leaving these risks directly for individuals to face and, hopefully, to prepare for.

We do not mean to imply that this re-division of risks is a good thing, and that narrow gap distributions are something to strive for at any cost. Gap distributions tell nothing about the welfare consequences of these measures, which should be the crucial factors in actual policy decisions.

5.4   Increasing the share of equities in public sector portfolios

The financial liabilities of the Finnish central government consist of public debt and the financial assets consist of the partially state-owned companies and the loans to private sector. In addition, pension funds have well diversified portfolios which mainly include domestic and foreign bonds and equities.

Global economic growth and low-inflation policies have helped to earn unparalleled real rate of return on stock market investments during last 15 years. At the same time, the strengthened primary balance of the state and the rapid growth of the domestic economy have helped to lower the public debt/GDP ratio. Consequently, the Finnish public sector is now in a position where pension funds are large and growing and also the state has almost as much financial assets than debt.[7] Part of the outcome is due to the deliberate policy of preparing for population ageing expenditures by saving and the rest is due to successful investment policy and lucky timing.

The evident success story raises two types of questions. The first concerns the principles that should guide the future amount of saving. The second concerns the criteria that should be used for portfolio management. These issues are intertwined, since with successful investment policy the required amount of saving is smaller.

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[7] At the end of year 2006 the amount of liabilities was 43 per cent of GDP and financial assets 39 per cent of GDP. IMF includes in its debt sustainability assessments also contingent liabilities of the government. These realise mainly during major economic crises. Contingent liabilities can either be explicit, such as guarantees, or implicit, such as bailouts of banks.

Figure 5.3 **Sustainability effects of investing more in equities**

Probability of total tax rate exceeding the initial period value by 2, 5, or 10 %-points

Net public wealth, % of GDP, with constant total tax rate

Sustainability gap
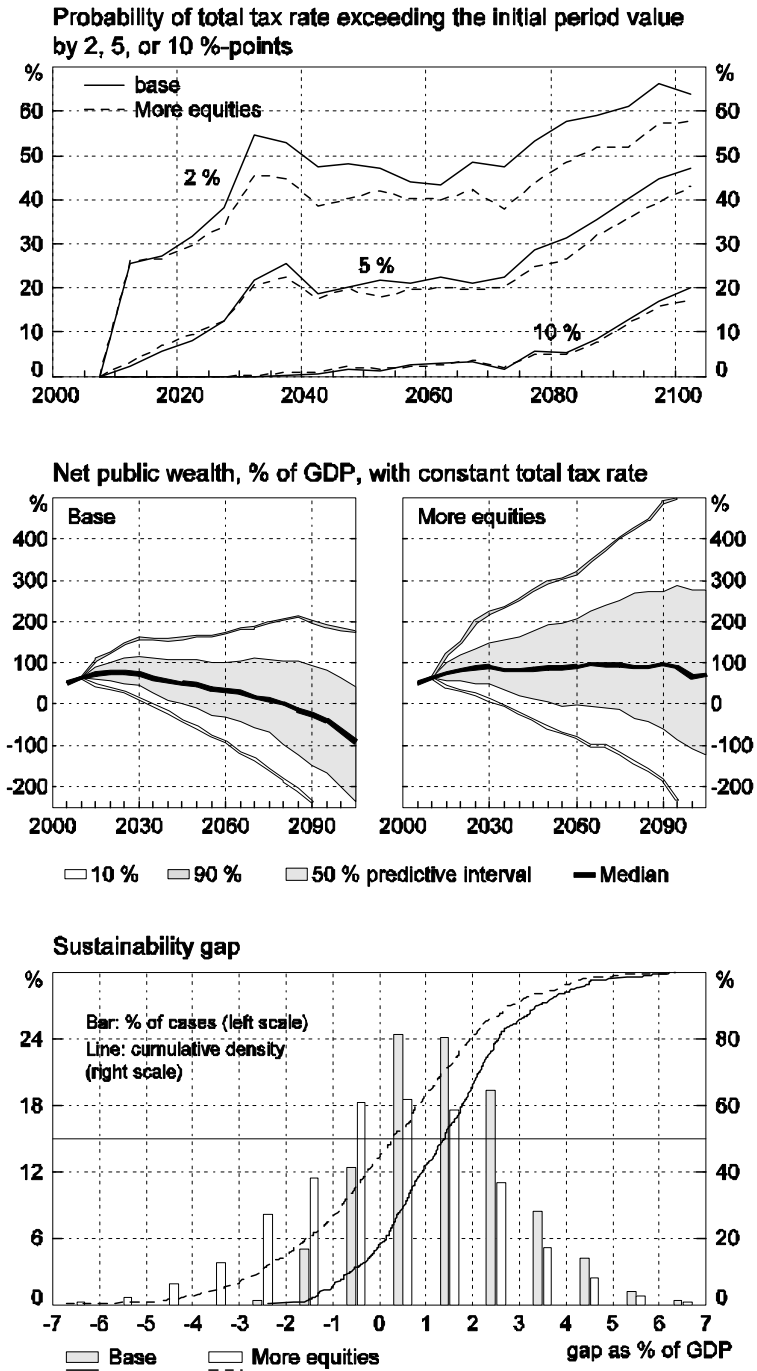
Investing more in equities

Increased risk-taking in pension funds was discussed in Finland in 2005–2006 by a group of financial expert, pension actuaries and administrators. The idea was to improve sustainability of the statutory private sector pension system (TyEL) by

allowing higher risky equity positions. An amendment in solvency rules of pension funds was suggested in a working group report. Simulations with the new rule (see Ranne, 2007) show, that it should enable the pension companies to increase the share of stock market investments approximately by 10 per cents. The reform was implemented in 2007. A stochastic analysis of the effects of this reform on the sustainability of the TyEL system has been reported in Lassila and Valkonen (2008c).

Here we go further and ask what the implications for the overall public sector sustainability are, if we raise the share of stocks in the pension fund portfolios from current 40 per cent to 67 per cent. This shift is assumed to be permanent. Two thirds is the share that the Canadian pension system (CPP) invested in equities in 2006.

Higher rate of return lowers with some lag the pension contribution rate. Since these contributions can be deducted in taxation from wage income with marginal tax rates, a lower contribution rate raises the tax revenues of the state and municipalities.[8] Therefore the influence of the investment yields on the aggregate public sector sustainability is larger than can be detected just looking at the financial flows of the pension system.

Investing more in equities improves fiscal sustainability, according to all three indicators in Figure 5.3. Probabilities of tax rates exceeding the 2% increase threshold are always smaller than in the base case. With the 5% threshold the probabilities are usually smaller, and with the 10% threshold the probabilities are practically the same in both cases. The net wealth distributions show similar development in the middle part of Figure 5.3. The ranges depicted move upward with better yields from riskier investment.

Sustainability gaps in the bottom part of Figure 5.3 also show an improvement. The median gap is reduced by 1.1 percentage points. With more risk, the whole gap distribution shifts to the left. Better expected yields seem to dominate the increased risk.

Looking at probabilities of tax increases over the 10% threshold, however, sometimes show a higher likelihood with the riskier portfolio than in the base case, although these probabilities are very small. Similarly, looking at lower limits of net public wealth distribution (Table A2.4 in Appendix 2), shows that with more risk the net wealth may go below that in the base case. Thus Value-at-Risk considerations with very low risk levels would not show improvements in sustainability. These risk levels would be higher if the relative risk of equities to bonds would be larger than assumed here. To see the importance of this, we made a sensitivity analysis with respect to the riskiness of equities (see Appendix 1).

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[8] Actually, both employers and employees pay pension contributions. Wages adjust, however, to changes in employers' contribution rate. Therefore it is possible to approximate the tax revenue implications by assuming that only the employees' contribution rate responds to the total amount needed.

The results appear to show that the behaviour of sustainability indicators is not sensitive to the assumptions on volatilities.

The risk aspect in the gap analysis is interesting when we compare the three policies. Investing more in equities differ from the two other policies in that with more risk-taking the gap distribution gets wider. Both longevity adjustment of pension benefits and moving to non-financial defined contribution pensions narrow the gap distribution. And, importantly, they reduce the likelihood of severe sustainability problems, whereas investing more in equities appear to be more effective in cases where the sustainability problem is small, and less effective when the problem is large. This is at least partly because the risk itself creates part of the problem: if asset yields go down in the base projection, pension system and thus the whole public sector are in financial difficulties. If the funds have taken higher risks, as they take in the alternative, they may be in even bigger difficulties than with low-risk portfolios.

Despite the modest reservations expressed above, the improvement in the sustainability indicators in Figure 5.3 is remarkable. We think that the improvement is genuine. It is not a result of some missing or faulty piece in calculating the indicators. Looking at these indicators only, the policy recommendation would be: Take more investment risk, it enhances fiscal sustainability.

We also think that looking only at these indicators would be grossly insufficient. The main thing they leave out is that taking more risk would make the public sector economic development more volatile. Below we discuss and try to illustrate this and bring out its potential consequences.

Investment risks and political risks

Increased risk becomes visible in increasing volatility of some part of the public sector's budget constraint. The budget constraint can be presented as follows.

Return on public wealth, including capital gains,
      = public expenditure
      − tax revenue
      + change in public wealth

Investing more in equities increases the variability on the left-hand side of the budget constraint. Variability must increase also on the right-hand side. The

volatility of one or more of three main categories, namely public expenditure, tax revenue and net public wealth, must increase.[9]

Table 5.1 displays the expected consequences and the implications for the variability of the three policies. Comparing the figures in the rightmost column shows that removing the longevity adjustment would increase variation in public expenditures. Consequently the variation in tax rates would also increase, as the tax rate standard deviations show. Changes in variation in net wealth changes and asset yields are practically nonexistent. Moving to NDC reduces variation in tax rates and in public expenditures. It hugely increases variation in net public wealth changes, because the funds now act as buffers. Larger variation in fund size causes larger variation in asset yields also. Increased risk-taking increases the variation in asset yields. That increases variation in net wealth changes and in tax rates (variations in wealth changes are transformed into variations in the amount of wealth in Table 5.2). Public expenditure remain practically unchanged, there are only slight changes in pensions through the effect that changing employee contribution rates have on pension indexes.

Both the base projection and the policy simulations described above assumed that municipalities and the state balances the budgets year-by-year by adjusting tax rates. Other choices are also possible. It may be that tax rate variation can be controlled, and more variation should be put to net public wealth. It may also be that public expenditure should take more variation, with the idea that expenditure reflects the financial position of the public sector.

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[9] We assume that there are no marked changes in correlations between variables. In our simulations, there aren't.

Table 5.1 **Predictive distributions of the public sector budget items 2010–2050, % of GDP**

	Asset yield		Tax revenues		Change in wealth		Public expenditure	
	E	σ	E	σ	E	σ	E	σ
Base								
d_1	1.37	3.66	43.42	2.54	1.29	1.47	46.66	1.21
Q_1	2.18	4.29	44.45	3.10	1.49	1.77	47.09	1.43
Md	3.74	5.14	45.70	3.68	1.73	2.14	47.72	1.79
Q_3	5.26	6.16	46.91	4.41	2.02	2.55	48.41	2.18
d_9	6.60	7.27	47.83	5.12	2.26	2.97	48.96	2.65
More equities								
d_1	1.41	4.93	40.96	2.82	1.31	2.42	46.59	1.20
Q_1	2.72	5.89	42.84	3.48	1.60	3.01	47.06	1.43
Md	4.72	7.26	44.81	4.30	1.99	3.77	47.67	1.79
Q_3	7.22	8.85	46.59	5.26	2.45	4.59	48.34	2.19
d_9	9.51	11.00	47.75	6.54	2.92	5.66	48.94	2.69
Without longevity adjustment								
d_1	1.37	3.66	43.71	2.61	1.29	1.48	46.83	1.29
Q_1	2.18	4.29	44.77	3.16	1.50	1.77	47.39	1.55
Md	3.74	5.14	46.05	3.77	1.74	2.14	48.08	1.95
Q_3	5.27	6.17	47.29	4.53	2.02	2.55	48.78	2.50
d_9	6.61	7.28	48.28	5.24	2.28	2.97	49.51	3.09
NDC								
d_1	1.49	4.09	44.74	2.13	1.50	2.21	46.04	1.05
Q_1	2.47	4.81	45.22	2.48	2.08	2.68	46.70	1.30
Md	4.41	5.86	45.86	2.91	2.86	3.39	47.48	1.66
Q_3	6.70	7.29	46.60	3.54	4.23	4.29	48.25	2.13
d_9	9.09	8.76	47.26	4.18	5.73	5.64	49.07	2.65

How to read Table 5.1: There are 500 simulated paths. Thus, for each budget item, there are 500 expected values (E) for the period 2010–2050. There are also 500 standard deviations (σ), each describing variation within one path during the period 2010–2050. The expected values are sorted into ascending order, and their distributions are described by deciles d_1 and d_9, quartiles Q_1 and Q_3 and the median Md. The standard deviations are sorted in a similar fashion. Sorting is carried out separately for each budget item, and expected values and standard deviations are sorted separately. Table 5.2 gives similar distributions for path-wise minimum and maximum values of net public wealth.

Table 5.2   **Net public wealth 2010–2050, % of GDP**

	Public wealth	
	min	**max**
Base		
d_1	58.27	83.66
Q_1	61.81	89.04
Md	66.75	95.65
Q_3	72.30	106.10
d_9	76.59	114.98
More equities		
d_1	52.20	94.24
Q_1	56.43	102.86
Md	63.13	115.95
Q_3	72.22	137.51
d_9	78.49	159.10

The increase in the variation of the net public wealth is large. Thus we must try to envision what that would mean for the year-to-year decision making concerning public policies. Political risks are important here.

It is quite possible that both good and bad equity yields may result in changes in expenditure rules. In a good situation it is difficult to resist different constituencies' demands, and in bad times expenditure cuts are politically possible. In the base scenario, there is no direct link between net asset yields and public expenditure. Indirect links exist. With increased risk, the issue is whether any direct link follows. Will there be a regime shift which makes the base scenario assumptions concerning expenditure rules void?

It is also quite possible that both good and bad equity yields may result in changes in tax rules. In a good situation it is difficult to resist different constituencies' tax reduction demands, and in bad times tax increases are politically possible. With more risk-taking, a regime shift which makes the base scenario assumptions concerning tax rules void may become more likely.

Yet another political economy issue is the potential power through equity holdings. If the public sector owns equities in domestic firms, pressures to carry out owner policies with other aims than pure maximization of wealth value may become high and lead to decisions preventing eg downsizing or plant closures. If equities concern companies that are not operating domestically, pressures may be small. But demands may arise to change the portfolio towards domestic ownership, and end up with owner-policy demands.

Thus the assumption that portfolios with different risk levels can be managed equally well in the public sector is by no means an innocuous one. On the other hand, it cannot be said that they cannot. We conclude that these issues need be considered and discussed when considering higher risk-taking. If both these

considerations and the gap distribution change seem good, then go on with more risk-taking, otherwise not.

BOX 1. Investment policy of the government

Recent discussion on prefunding of pensions in many countries promotes investment policy that takes larger risks in stock markets. One part of these discussions suggests a transition to individual accounts. The motivations given are the efficiency gains (better labour supply incentives) and the higher rate of return available in stock markets.

Another part of the discussion refers to the benefits of intergenerational risk sharing. The taxing power of the general government increases the capacity of risk taking, compared to the other market actors, since future generations could be included in risk sharing using the net wealth position of the government. A formal example can be presented in a two-generation world, where young generations are constrained in taking stock market risk. It is then optimal that social security system invests in the stock market.

Third ingredient comes from the sustainability problems due to population ageing. Governments have strengthened the net asset positions by lowering the amount of public debt and in some countries also by increasing assets of the pension funds.

Aims and constraints of investment policy

The portfolio management issue is complicated. Portfolio strategies must adapt to many kinds of objectives and constraints. The simplest rule of maximising the yield with accepted risk level is still a good starting point for the analysis. Other goals and constraints can be classified in many ways. Some of these can be derived from economic theory or from the existing legislation or other institutional rules. Some political justifications are presented as being premised on elements of economic theory, such as externalities and other market failures. Some other motivations of the promoted portfolio policies may be basically relevant, but the practical implementation is too extensive.

Large funds allure many kinds of interest groups which suggest worthwhile investments. One example of the problematic ownerships and unjustified risk positions is the large stocks of some listed companies that the Finnish government possesses. Maintenance and supply during crisis requires that some fundamental functions of the society must be under the control of the government. This does not, however, explain government-owned paper mills. There is a large literature suggesting that government ownership causes corporate governance problems since it may induce promotion of politically slanted goals in stead of maximization of the firms' value.[a]

Another quasi-economic reasoning refers to the use of the pension funds to compensate for capital market failures. The market problems are said to weaken economic growth and thereby indirectly endanger the sustainability of public finances. But economic theory says that the correction should be aimed at the initial market failure, not at the outcomes. Attempts to interfere in market prices by financial investments have little effect or just weaken the market signals.[b]

More interesting and difficult is the issue of risk management of the assets, when intergenerational risk sharing and tax smoothing are among the objectives. If benefit rules are fixed, it is likely that tax smoothing is beneficial for intergenerational fairness.

Tax smoothing and solvency

Barro (1979) claims that in a deterministic world with distortionary taxes, tax smoothing over time is optimal. In ageing societies there will be a need to raise permanently the tax rates after a decade or two. If the aim of policy is to smooth the expected future tax rates, immediate increase in taxes or a cut in expenditures is required.

Bohn (1990) generalizes the result saying that in an uncertain world, taxes should be smoothed also over states of nature. This refers directly to the uncertainty concerning future expenditures, tax receipts and the yield of the portfolio.

So, the actual question is how to smooth taxes with portfolio policy in a situation where the government should save more in the medium term, but there is large uncertainty concerning the future developments of the revenue and expenditure flows in the long term. This uncertainty affects both the amount that should be saved and the portfolio policy that should be followed.

Another issue that strongly influences the portfolio decisions is the solvency constraints of the general government. They can be implicit such as the rising interest rate of the government debt when indebtedness increases or explicit such as the year-to-year solvency requirement of the pension funds.

If the yield process is symmetric around a known expected value and there are no solvency constraints, the government can use net assets efficiently to smooth taxes. In this buffer fund strategy, the only guideline for investments is to maximize long-term yield of the portfolio.

Buffer fund strategy may turn out to be deficient, if asset prices have positive correlation with tax revenues and/or negative correlation with public expenditures and the size of the fund is adjusted to balance the budget. In good times interest rate is low and asset prices high. In bad times the buffer fund needs liquidity, but the asset prices are low and interest rates high.

With liquidity constraints, a hedging strategy may be optimal. In hedging strategy, the correlation between asset yields and primary balance affect the design of the portfolio. Obvious policy choices are either to lower the yield variation with less risky portfolio, or to aim at active hedging by choosing a portfolio, which correlates negatively with the primary balance.[c] Both choices are likely to restrict the obtainable yield.

The order of superiority of these policies is an empirical question. If tax revenues and public expenditures are strongly correlated, less hedging is needed to stabilize the tax rate. If liquidity constraint is important, more hedging is preferred.[d]

[a]Bohn (2002a) extends the discussion to include rent-seeking in all politically motivated investment decisions. The consequent suggestion is that government should avoid all assets with high idiosyncratic risks.

[b]Some papers analyze the influence of government portfolio policy on aggregate capital market prices and thereby the choices of households (Abel, 1999). These studies are not very relevant in case of small open economies, like Finland. Davis (2001) discusses reasons why government's portfolio composition may be important.

[c]Bohn (2002b) suggest that the government should issue wage-indexed and longevity indexed bonds. In addition to directly holding assets and liabilities the government may use capital income taxation to redistribute risks between generations (Smetters, 2006).

[d]Hilli (2007) includes several articles that analyse risk management in individual Finnish pension insurance companies. The questions assessed and the stochastic methods used have many points of contact with our analysis. See also Davis and Fabling (2002). Also Finnish actuaries have long history of developing and applying risk theory. One example is stochastic simulations of asset risks; see Pentikäinen et al, 2004.

END BOX 1

BOX 2: Risks and discounting in sustainability measures

The increased use of equities in retirement plans has raised the question on how one should analyse the sustainability consequences of taking more investment risk in the hope for better rates of return. Munnell and Sass (2006, p. 5) note that 'A central issue in the debate over the introduction of equities is the thorny question of how to treat the risk in such investments when evaluating the finances of retirement income systems.' They discuss the issue at length and conclude that, for policy purposes, one should compare streams of income with similar risk characteristics. We find this conclusion unsatisfactory – it reduces the dimension of the comparison in an issue where the dimension is crucial. One-dimensional sustainability analysis is improper here.

The whole risk issue is difficult with just one or a few deterministic projections for the future. There is disagreement on the proper discount rate under risk. In the US, the actuaries in the Social security use the expected rate of return in their sustainability analysis, but the Congressional Budget Office (CBO) use the long-term Treasury rate in their analysis of the Social Security. The CBO assumes that the increase in expected yield is exactly offset by the increased risk. This approach means that we know the consequences of increased risk-taking to long-run sustainability at the outset – it has no effects.

In 2001, the US Congress used the expected rate in analyzing the Railroad Retirement System proposal, but the Office of Management and Budget (OMB) used the Treasury rate in the same analysis. We quote the latter: 'Investments by National Railroad Retirement Investment Trust in private assets pose some challenges for budget projections. Equities and private bonds earn a higher return on average than the Treasury rate, but that return is subject to greater uncertainty. Sound budgeting principles require that estimates of future trust fund balances reflect both the average return and the cost of risk associated with the uncertainty of that return. (The latter is particularly true in cases where individual beneficiaries have not made a voluntary choice to assume additional risk.) Estimating both of these separately is quite difficult. While the additional returns that these assets have received in the past are known, it is quite possible that these premiums will differ in the future. Furthermore, there is no existing procedure for the budget to record separately the cost of risk from such an investment, even if it could be estimated accurately. Economic theory suggests, however, that the difference between the expected return of a risky liquid asset and the Treasury rate is equal to the cost of the asset's additional risk as priced by the market. Following through on this insight, the best way to project the rate of return on the Fund's balances is to use a Treasury rate. This will mean that assets with equal economic value as measured by market prices will be treated equivalently, avoiding the appearance that the budget could benefit if the Government bought private sector assets.' OMB (2003, p. 439–440).

Increased risk-taking in pension funds was discussed in Finland in 2005–2006 by a group of financial expert, pension actuaries and administrators. An amendment in solvency rules of pension funds was suggested in a working group report. The report presented contribution levels with different expected asset yields, but with no corresponding risk considerations. The report did, however, contain simulated fund size distributions under different portfolio choices. The reform was implemented in 2007.

The Finnish Centre for Pensions (FCP), an institution that is responsible for the official long-term outlooks of the statutory pension system, assumes in their latest review (Biström et al, 2008) a higher average real yield of 4% instead of the earlier assumption of 3,5%. The increase is linked both to the portfolio shift and to the history of rates of return between 1997 and 2006. Increased risk is not analysed in the review. This is analogous to the US Social Security actuaries' practice.

Much of the problems discussed above disappear when stochastic projections are used instead of deterministic. The asset yield risk can be dealt with coherently – it appears in the income stream realizations. Sometimes equity yields are good, sometimes bad, and on average they are better than bond yields which, on the other hand, vary less. These equity and bond yields are included in the base stochastic projection and, with different weights, in the riskier alternative projection. In calculating the sustainability gaps, we again use the stochastic bond rate as then discount factor. The resulting gap in each realization thus tells to what constant level the tax rate should be immediately raised, so that if extra revenues be invested in bonds, the tax level would be

sustainable. An obvious alternative discount rate would be a weighted rate of return, with bond and equity weights varying between the policies. Based on considerations in section 4.3, we don't think the results would be markedly different.

END BOX 2

6 Conclusions

Our view of the sustainability of Finnish public finances is that while the current tax rates are unlikely to yield sufficient tax revenue for financing public expenditure under an ageing population, in expected terms this problem is not very large. The required tax increase is probably not very large and it is even possible that taxes can be lowered in the future. However, there is a small, but not negligible, probability that taxes need to be raised dramatically, say, over 5 percentage points. Such outcomes, if they realise, risk at destabilizing the whole welfare state. We believe that in such situations future social services or social transfers, or both, will be scaled downwards from the levels that current rules would produce in the future.

Like other Nordic countries, Finland has a large public sector, meaning that it has given an extensive promise to all citizens concerning their welfare. People have trusted the promise; private pension and health insurance is rather insignificant. Thus unexpected changes in public services and transfers could potentially be very harmful for many people. In our view, this is the real sustainability problem that Finland faces.

In studying the sustainability of public finances in Finland, we have paid attention to the uncertainties both in demographic projections and in future asset yields. Indeed, the eye-catching feature of this report is the prevalence of quantified uncertainty graphs. The reason for making the uncertainties explicit is that this way neither the makers nor the users of the analysis can avoid considering them. Our premise is that without this explicit approach uncertainty would very likely be underestimated and in any case too little attention would be given to it.

Committing ourselves to look at the uncertainties in long-term projections has an important effect on the view we form concerning fiscal sustainability. Even if the expected outcome seems almost viable or non-problematic, the risks are also considered. It is virtually certain that all stochastic projections of this type will show that there is some probability that things go bad. The probability may be big or small, but it certainly is there. And this reflects reality – it certainly is possible that future can turn out unfavourable for fiscal sustainability because of unlucky

demographics alone. We all know this, but with different approaches such as deterministic projections we might neglect it. Here we recognize it, think about its relevance, and think what should and could be done about it.

A straightforward policy recommendation would be to immediately either increase taxes or cut public expenditures so as to reduce the expected sustainability gap. But to substantially reduce the probability of very bad outcomes, the public sector should be saving a lot more. That, however, makes it quite probable that in the future it turns out that we have saved too much. In addition, following such a policy would probably be politically difficult.

We concentrate on policies that tackle, besides the expected imbalance, also the problem associated with outcomes worse than expected. This means designing rules that adjust public expenditures with the economic environment smoothly and predictably. We also consider a policy of addressing the expected sustainability problem by taking more financial risks. All these policies have strong implications on how demographic or economic risks are shared between different groups in the economy.

The first policy, longevity adjustment of pension benefits, addresses risks related to future length of life. The adjustment, to be applied in Finland from 2010 onwards, reduces the effect of future changes in old-age mortality to pension expenditure. The second policy is switching from defined-benefit pension system to non-financial defined contribution (NDC) system. It addresses both demographic and economic risks. Both these measures reduce sustainability risks. They either decrease or remove the expected problem and narrow the sustainability gap distribution. In both these policy options a precondition for smaller financial sustainability risk is that any political risks due to lower pensions is not realised.

In the third policy, pension funds invest more in equities and expect to get higher returns. This policy addresses the expected sustainability problem at the expense of increasing financial risks. Assuming that the increased risk itself does not cause any problems, comparing the sustainability gap distributions reveals the long-run consequences of this policy. In our example, the whole distribution shifts to towards smaller gap values and the total sustainability risk is reduced, even though the distribution gets wider.

But just assuming that the increased risk can be managed as well as the smaller risks in the base case is not sufficient. Increased variation in asset yields causes larger variation in net public wealth or other parts of the budget constraint. We illustrate the quantities of these changes and discuss possible ways they could have unexpected consequences to public expenditure and taxation. The question is whether this increased variation leads to situations where the rules and assumptions behind the projections are no longer valid. The problems can be due to legislative or market-driven reasons, such as solvency rules of the pension funds, or due to political reasons, such as the pressure to increase expenditures

because of temporarily high yields. Improvement in sustainability by risk-taking is possible, but necessitates a comprehensive evaluation of the current risk position and future risks and an agreement of the rules that are followed when the baseline projection is not realised.[10]

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[10] This research report was written before the autumn 2008 crisis in financial markets. The Ministry of Social Affairs and Health reacted to the crisis by preparing a temporary draft bill that would amend the solvency rules and strengthen the solvency capital of the pension funds. The aim is to avoid forced sale of stocks. In practise this means that the value of the pension funds is allowed to react fully to the falling stock prices. The values of the funds are still above the solvency limits, and there are no signs yet (13.10.2008) that the low stock prices would translate into realization of political risks in the form of lower pension benefits in future.

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Appendix 1

Sensitivity analysis of relative asset risks

In section 5.4, when analysing the sustainability consequences of taking more investment risk by pension funds, we noted that the results may depend on the relative risk of equities to bonds. To see whether this is important, we repeat the policy analysis with alternative equity yield realizations where the riskiness is increased.

Alternative equity realizations y, expressed as annual real percentage rates of return, are obtained from the original realizations x by transforming them according to equation (A1.1). The new series has the same expected value but its standard deviation is 1,1 times the original standard deviation.

$$y(i,t) = 1,1(x(i,t) - 6) + 6 \tag{A1.1}$$

Figure A1.1   **Pension funds' yield with two portfolios and two risk assumptions**
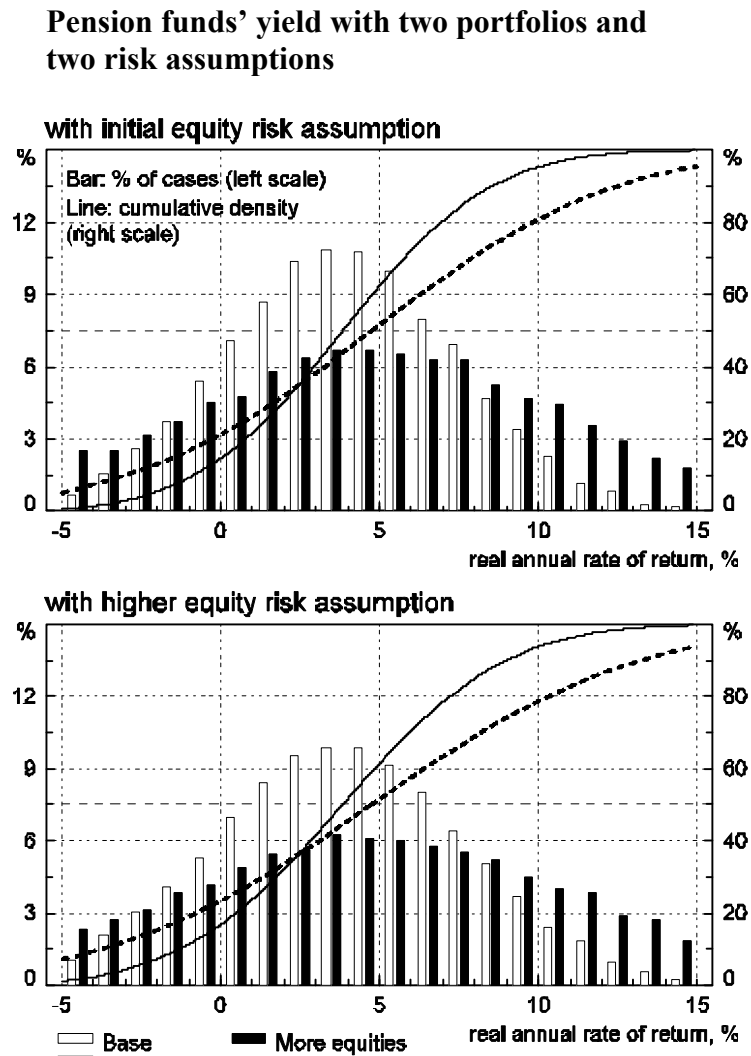
Figure A1.1 shows the yield distributions of pension funds' portfolios in four cases. The upper part of the figure shows the yields of two different portfolios with the original risk realizations. The base portfolio and the more risky portfolio both were used in the policy analysis in section 5.4. The lower part shows the yields with the alternative risk realizations. We have new distributions for both the base case and the more risky portfolio. The yield frequencies are flatter in the latter case. The cumulative densities do not visually differ very much, although there is more mass in the tails (cut out from the picture) in the latter case.

Figure A1.2 shows the three sustainability indicators, calculated with alternative equity yield realizations, in the base case and with portfolios investing more in equities. They give a similar impression of the consequences of taking more investment risk to that presented in section 5.4. With more risk, the probabilities of given tax increases become smaller or remain the same, the predicted net wealth distribution shifts upward, and the sustainability gap moves toward smaller gap values. Thus the results do not seem very sensitive to the assumptions on the relative risks of equities and bonds.

Perhaps the sensitivity analysis should be done with a bigger risk increase. But the factor 1.1 used above is not insignificant, either, as it means that the variance grows by 21%.

Increased equity risks increase variation in the budget items, as can be seen by comparing Tables A1.1 and A1.2 below to Tables 5.1 and 5.2 in section 5.4. Thus it may be that the variation aspect – how to live with higher risks – is more sensitive to the volatility specification than the long-run sustainability measures.

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Figure A1.2   **Sustainability effects of investing more in equities, when equity risk is higher**

Probability of total tax rate exceeding the initial period value by 2, 5, or 10 %-points

— base
--- More equities (higher risk)

2 %
5 %
10 %

Net public wealth, % of GDP, with constant total tax rate

Base

More equities (higher risk)

□ 10 %   □ 90 %   □ 50 % predictive interval   ▬ Median

Sustainability gap

Bar: % of cases (left scale)
Line: cumulative density (right scale)

□ Base   □ More equities (higher risk)   gap as % of GDP
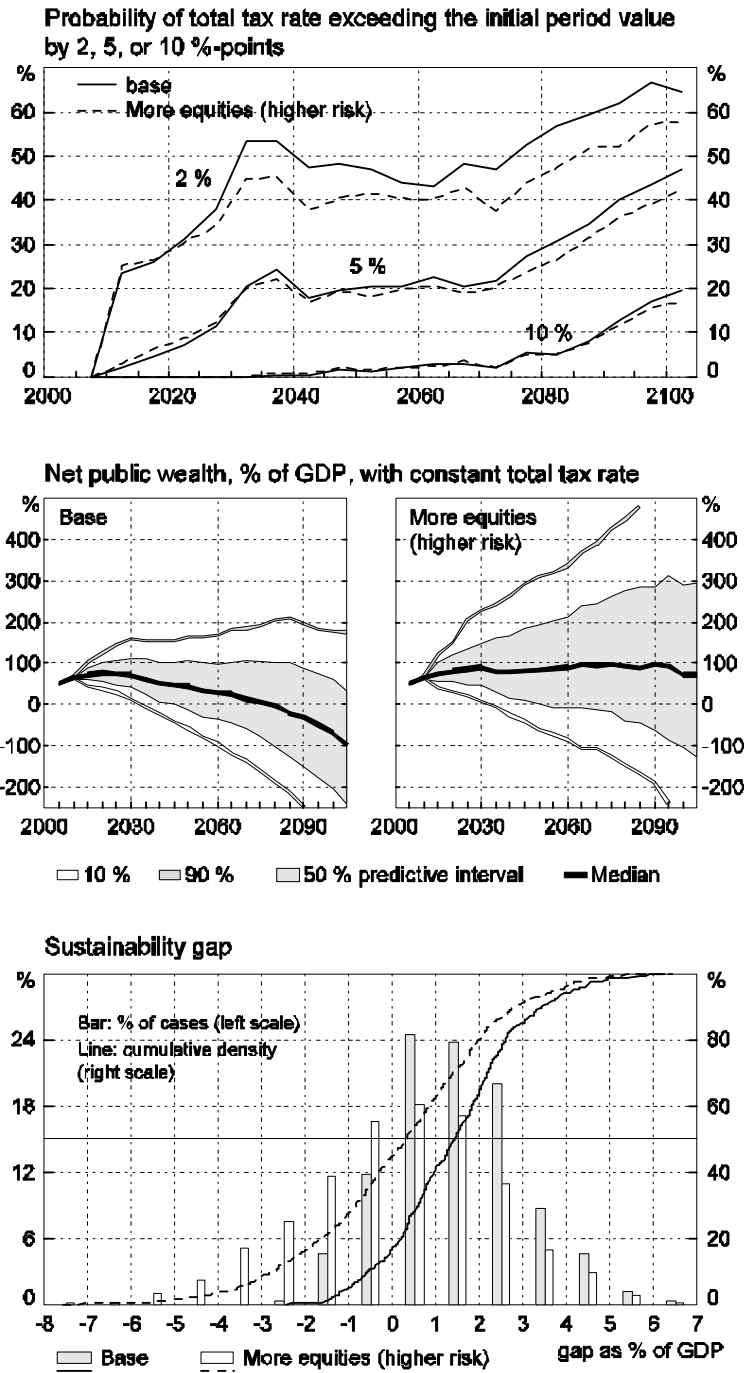
Table A1.1   **Predictive distributions of the public sector budget items 2010–2050, when equity risk is higher**

	Asset yield		Tax revenues		Change in wealth		Public expenditure	
	E	**σ**	**E**	**σ**	**E**	**σ**	**E**	**σ**
Base								
d_1	1.19	4.01	43.45	2.40	1.26	1.57	46.72	1.24
Q_1	2.14	4.71	44.49	2.92	1.47	1.92	47.20	1.46
Md	3.79	5.68	45.74	3.46	1.73	2.32	47.90	1.79
Q_3	5.50	6.80	46.94	4.16	2.04	2.78	48.61	2.24
d_9	7.03	8.06	47.86	4.86	2.30	3.31	49.28	2.70
More equities (higher risk)								
d_1	1.39	5.12	40.70	2.71	1.26	2.60	46.56	1.25
Q_1	2.75	6.11	42.76	3.35	1.56	3.29	47.05	1.45
Md	4.78	7.54	44.81	4.14	2.00	4.16	47.70	1.80
Q_3	7.38	9.16	46.67	5.18	2.51	5.12	48.27	2.18
d_9	9.74	11.47	47.78	6.57	3.05	6.36	48.92	2.69

Table A1.2   **Net public wealth 2010–2050, when equity risk is higher**

	Public wealth	
	min	**max**
Base		
d_1	56.89	84.17
Q_1	60.42	89.78
Md	65.75	97.21
Q_3	71.64	108.96
d_9	76.20	118.48
More equities (higher risk)		
d_1	50.13	95.43
Q_1	54.70	104.93
Md	61.51	120.24
Q_3	71.10	144.47
d_9	77.93	169.12

Appendix 2

Tables

Net public asset figures are those at the beginning of the year. For the other variables, the year denotes the first year of the five-year period. In predictive distributions, p05 and p95 denotes percentiles for 5% and 95%, d_1 and d_9 are the first and ninth deciles, Q_1 and Q_3 are the first and third quartiles, and Md is the median.

Table A2.1   **Total tax rate % of GDP in the base projection**

	p05	d_1	Q_1	Md	Q_3	d_9	p95
2010	39.3	40.6	42.7	45.1	46.8	48.3	49.2
2020	37.4	39.5	42.4	45.3	47.5	49.4	50.3
2030	39.7	41.3	44.1	47.2	49.5	51.5	52.1
2040	38.6	40.4	43.5	46.5	48.9	51.1	52.2
2050	39.2	41.3	43.8	46.4	49.5	51.4	52.7
2060	37.3	39.6	43.6	46.2	49.4	51.9	53.0
2070	39.2	40.9	43.4	46.5	49.4	52.0	53.4
2080	38.2	40.7	44.4	47.7	50.7	53.3	54.8
2090	39.0	41.0	44.6	48.4	52.3	55.8	58.1
2100	39.0	42.6	45.4	49.2	53.6	58.4	60.9

Table A2.2   **Net public assets % of GDP in the base projection**

	p05	d_1	Q_1	Md	Q_3	d_9	p95
2010	64.6	64.7	64.9	65.1	65.3	65.5	65.5
2020	63.3	67.6	73.0	80.3	89.1	96.7	102.7
2030	64.2	66.5	74.2	82.6	93.1	102.8	107.5
2040	62.3	65.4	71.4	79.4	90.0	100.0	106.6
2050	61.6	64.6	72.0	80.1	89.0	98.8	106.9
2060	62.2	65.7	72.1	80.9	91.3	102.8	110.9
2070	63.1	67.2	76.0	86.1	97.2	108.4	116.4
2080	65.7	70.5	77.7	88.7	100.9	113.8	122.1
2090	66.6	70.5	79.3	90.8	103.8	118.7	129.8
2100	66.6	71.2	81.4	92.9	108.0	120.3	131.0

Table A2.3   **Probability of total tax rate exceeding the initial period value by 2, 5, or 10%-points**

	Base			Without longevity adj.		
	2	**5**	**10**	**2**	**5**	**10**
2010	25.6	2.4	0.0	25.6	2.4	0
2020	31.6	8.0	0.0	32.2	8.8	0
2030	54.6	21.8	0.0	57.0	25.4	0.4
2040	47.4	18.6	0.6	52.8	22.2	1.2
2050	47.2	21.8	1.2	53.0	30.0	3.8
2060	43.2	22.4	2.8	54.4	30.6	6
2070	47.6	22.4	1.8	58.2	34.4	6
2080	57.6	31.2	5.2	67.0	46.2	12.2
2090	61.2	40.4	12.8	71.6	52.8	23.4
2100	64.0	47.0	20.2	77.0	56.6	29.8
	NDC			More equities		
	2	**5**	**10**	**2**	**5**	**10**
2010	35.8	2.6	0.0	26.2	3.2	0.0
2020	33.6	4.4	0.0	30.0	9.4	0.0
2030	52.2	11.8	0.0	45.6	20.8	0.2
2040	47.2	10.0	0.0	38.6	17.6	1.0
2050	45.4	12.6	0.2	42.0	17.8	1.8
2060	37.6	13.0	0.8	40.0	20.2	2.6
2070	43.2	15.2	1.2	37.8	20.2	2.0
2080	53.6	21.6	1.0	48.4	26.4	5.0
2090	60.6	31.8	4.4	51.8	35.8	12.0
2100	64.8	37.8	9.0	57.6	43.0	17.4

Table A2.4   **Net public assets % of GDP with constant tax rate**

a) base

	p05	d₁	Q₁	Md	Q₃	d₉	p95
2010	61.6	62.1	63.2	64.3	65.5	66.4	67.0
2020	25.3	38.9	57.7	77.3	102.7	125.5	144.1
2030	1.2	13.4	44.9	74.5	115.2	160.1	190.2
2040	-36.3	-20.3	10.4	55.6	106.9	155.7	186.1
2050	-83.1	-55.9	-10.7	47.9	106.9	165.1	193.1
2060	-124.1	-91.9	-31.6	32.9	102.4	173.0	198.5
2070	-177.8	-134.0	-55.5	16.7	110.6	186.4	253.1
2080	-239.3	-184.9	-97.0	2.3	103.3	204.8	276.3
2090	-342.0	-240.1	-148.2	-24.9	93.0	200.3	294.6
2100	-449.5	-353.8	-201.8	-65.1	64.4	181.9	289.9

b) without longevity adjustment

	p05	d₁	Q₁	Md	Q₃	d₉	p95
2010	61.6	62.1	63.2	64.3	65.5	66.4	67.0
2020	25.0	38.7	57.6	77.0	102.5	125.3	144.0
2030	-0.7	12.1	43.5	72.8	113.2	157.9	187.8
2040	-42.5	-26.5	4.1	50.5	103.1	149.8	182.3
2050	-98.9	-68.8	-23.3	37.3	95.0	153.1	182.5
2060	-153.6	-118.2	-57.0	12.9	86.0	153.3	174.6
2070	-228.5	-181.3	-93.9	-14.7	79.6	153.7	234.4
2080	-309.6	-258.4	-158.5	-50.5	58.1	165.9	237.7
2090	-457.1	-349.6	-234.2	-93.1	23.3	150.2	234.8
2100	-639.6	-491.6	-311.9	-170.2	-14.0	118.4	202.7

c) NDC (with a higher constant tax rate due to raised pension contributions)

	p05	d₁	Q₁	Md	Q₃	d₉	p95
2010	69.0	69.5	70.6	71.6	72.8	73.7	74.3
2020	48.8	63.6	81.3	101.6	128.6	152.3	172.0
2030	50.6	62.6	91.8	122.3	163.7	209.8	246.5
2040	41.6	58.0	87.6	129.9	180.5	241.5	276.8
2050	34.9	58.5	90.0	144.1	217.9	284.3	331.0
2060	17.1	39.7	103.3	163.0	240.7	328.7	366.4
2070	-9.2	33.0	102.7	180.1	283.2	389.3	461.0
2080	-30.7	16.1	98.9	194.1	310.6	449.9	540.6
2090	-56.5	-0.2	88.3	194.6	339.8	490.4	594.6
2100	-86.3	-24.0	65.4	178.5	355.3	499.6	630.1

d) more equities

	p05	d_1	Q_1	Md	Q_3	d_9	p95
2010	61.6	62.1	63.2	64.3	65.5	66.4	67.0
2020	15.9	32.1	55.3	82.5	120.0	149.7	179.5
2030	-7.2	8.8	47.5	91.2	148.3	223.0	271.1
2040	-44.3	-22.6	19.7	82.5	165.0	252.3	314.2
2050	-88.6	-56.9	4.3	87.7	192.7	295.4	356.6
2060	-118.2	-81.0	-1.9	91.2	207.6	317.1	376.5
2070	-165.8	-101.1	-9.4	94.7	238.6	373.0	475.0
2080	-209.2	-140.9	-35.6	89.8	269.1	424.0	565.5
2090	-285.2	-183.9	-60.2	96.9	274.5	488.0	643.0
2100	-358.7	-270.5	-106.2	65.1	275.7	503.7	692.5

Table A2.5 **Sustainability gaps, % of GDP**

	p05	d_1	Q_1	Md	Q_3	d_9	p95
Base	-1.0	-0.6	0.3	1.4	2.3	3.4	4.1
Without longevity adj.	-0.6	-0.1	1.0	2.2	3.3	4.5	5.5
NDC	-1.7	-1.4	-0.9	-0.3	0.5	1.3	1.8
More equities	-3.3	-2.5	-1.1	0.3	1.7	2.7	3.8

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