Sustainability by increasing financial market risk-taking? A stochastic analysis of the Finnish pension system

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Abstract

The financial portfolios of the pension funds in Finland have been shifted towards more equity holdings. The explicit aim is to alleviate or prevent the projected increase in pension contributions by acquiring better asset yields. We analyze the sustainability consequences of this increased risk-taking. Using stochastic projections we compare distributions of sustainability gaps related to different risk characteristics. We show that increased financial market risk-taking is very likely to reduce the sustainability gap. But this is not sufficient analysis, as it includes an assumption that living is equally easy with different risk levels. Whether this is so or not should be carefully considered. Investing more in equities increases the variability of the asset yields. Variability cannot, however, increase in just one item of the budget constraint. The volatility of one or more of the other main categories, namely pension expenditure, contribution revenue and the size of the pension funds, must also increase. More volatile asset yields increase the probability of changes in benefit rules. Increased variation in contribution rates has negative incentive effects. Increased variation in fund sizes may incur political consequences for the ownership policies of funds or changes in pension benefit rules. Thus the increased risk may cause unforeseen changes to the pension system, with sustainability implications that may outweigh the expected gains from better asset yields.

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.

This study considers whether the sustainability of the private-sector earnings-related pension system in Finland is enhanced by increased risk-taking in pension funds. The explicit aim of investing more in equities is to alleviate or prevent the projected increase in pension contributions by acquiring better asset yields. In these aims 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.

We wish to analyze increased financial market risk-taking in a realistic risk environment. For this we 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 also support these findings.

Demographic and asset yield uncertainties are included in the 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 stochastic projections for the Finnish pension system for several decades ahead. These projections are then treated as data, and sustainability measures are derived from it.

In Section of this study 2 we discuss general issues of sustainability and the role of uncertainty in the analysis, based on previous research. We then present, in Section 3, stochastic long-term projections for the Finnish private-sector earnings-related pension system, with two different investment strategies. Based on these stochastic projections, the sustainability consequences of taking more investment risk is analyzed and discussed in Section 4. Section 5 concludes.

2. Measuring sustainability under uncertainty

The forward-looking approach of measuring sustainability is sensitive to the accuracy of demographic and economic 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 (EC, 2006) uses a large amount of different scenarios to describe alternative futures.

This scenario approach suffers from many problems (see, Alho, et al., 2005). A general finding in new demographic studies is that uncertainty is typically underestimated in official
demographic forecasts (Anderson et al. 2000) and thereby e.g. in pension expenditure projections of the European Commission (Lassila and Valkonen, 2008). 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[1]. 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 (e.g., Burdick and Manchester 2003, Holmer 2003, Lee et al. 2003, Congressial Budget Office 2001, Auerbach and Lee, 2006, Keilman, 2005). 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 our earlier work (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 pension policy has been analyzed in a similar fashion in Finland (Lassila and Valkonen, 2007) and Germany (Fehr and Habermann, 2006).

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[1] There is also another branch of numerical stochastic sustainability analysis, performed mainly by IMF. It analyses the vulnerability of public debt to adverse shocks. Sustainability simulations are performed typically using highly aggregated econometric models (see e.g. Mendoza and Oviedo, 2004).

Risks and discounting

There is disagreement on the proper discount rate under risk. In the U.S., the actuaries in the Social Security used the expected rate of return in their sustainability analysis, but the Congressional Budget Office used the Treasury rate in their analysis of the Social Security. In 2001, the Congress used the expected rate in analyzing the Railroad Retirement System proposal, but the Office of Management and Budget used the Treasury rate in the same analysis.

"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) is an institution that is responsible for the official long-term outlooks of the mandatory private sector pension system. In the 2007 review FCP assumes a higher average real yield of 4 % instead of the earlier assumption of 3,5 %. The increase is not linked entirely to the portfolio shift, it is based also on the history of rates of return, 5.8 % on average between 1997 and 2006. Increased risk is not analysed. This is clearly analogous to the U.S. Social Security actuaries' practice.

3. Stochastic long-term projections of the Finnish pension system

3.1 The economic model

We simulate the sustainability of the pension system 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 e.g., 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 Juha Alho in 2006.

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.

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. This assumption ensures that the shares of employees in private and public sector remain constant.

Real wage adjusts to equalize the value of marginal product of labor and labor costs in the production of private goods. The rest of the workers, who provide health and old age care services in private and public sector, earn the same wage. There is no productivity growth in the production of these services.

The households in the model have perfect foresight, e.g., 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 one. 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 earnings-related pension system is described in the Appendix.

3.2 Uncertainty in projections

Uncertainty over future demographic and economic trends affects profoundly the way how we analyze the sustainability of the pension system. 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 pension 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 new-born, 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 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.

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 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, e.g. 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 e.g., 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.

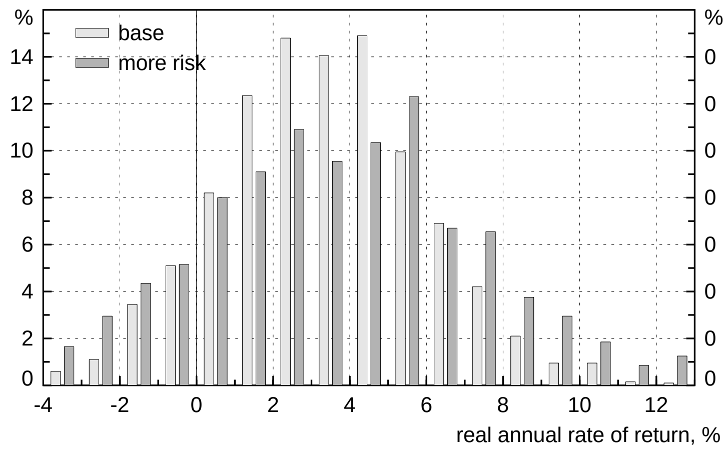
The final part converts the simulation results to probabilistic measures of fiscal sustainability, such as the predictive distribution of sustainability gap. The analysis can be supplemented with policy simulations. Comparison of the simulation results under current policy rules and new rules provides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

The first 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 of pension funds.

Figure 1 depicts an example of the financial market risks. It shows the histogram of annual real returns of private sector pension funds. In the base portfolio 28,6 percent is allocated in stocks and 71,4 percent in bonds. The expected average yield is 3,5 %. Since 2007 a new legislation allows pension funds to invest more in equities. In the more risky portfolio 40 percent is allocated in stocks and 60 percent in bonds[2], with an expected real rate of return of 3,9 %.

[2] 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 percent, with 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 percent, with variance of 0.87. Since the unit period in the model is 5 years, we use 5 year averages of the yield variables.

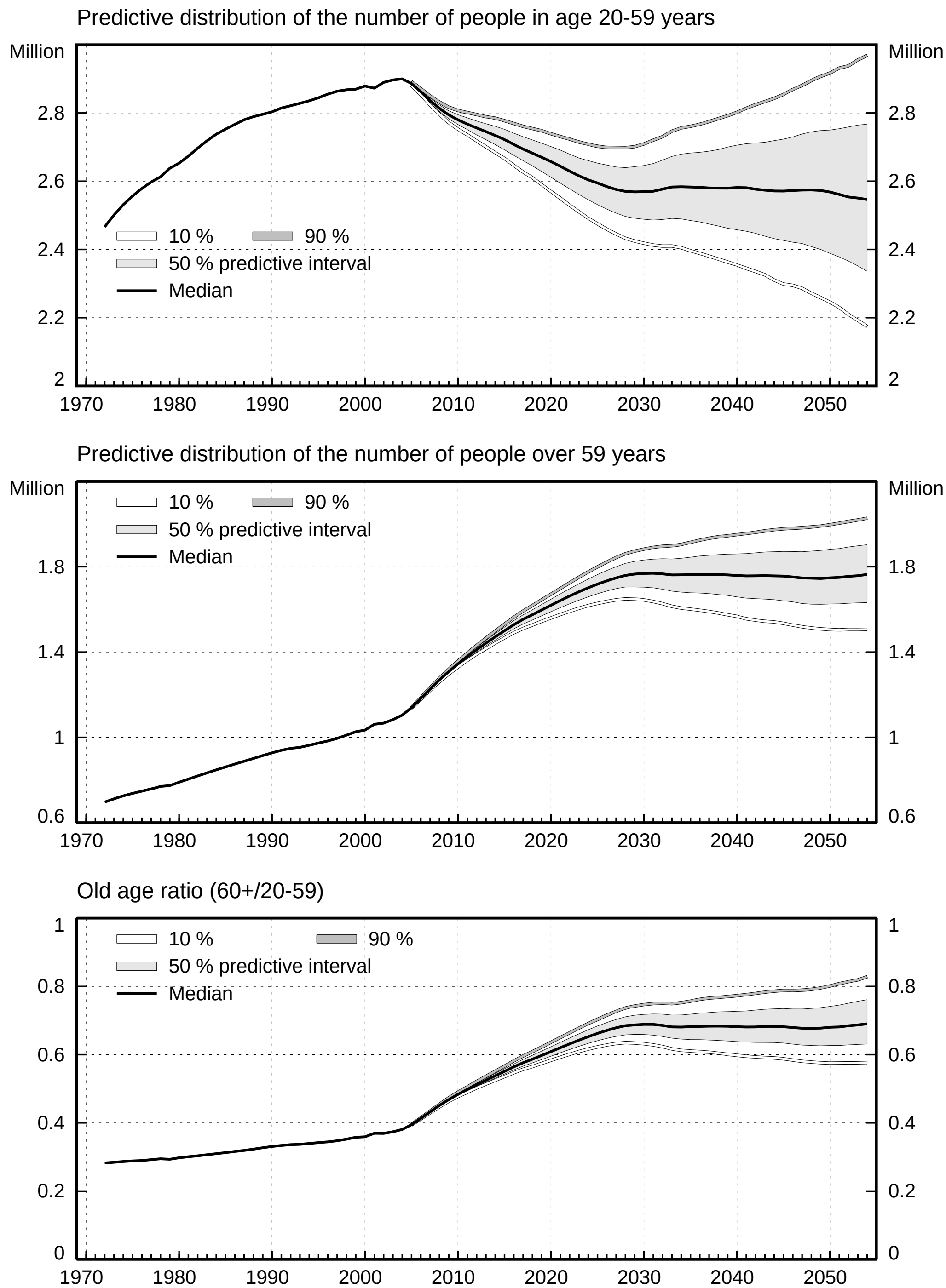
Figure 1. Asset yield uncertainty



In case of demographic uncertainty, we utilize a recent stochastic population forecast made for Finland by Professor Juha Alho. The kick-off population is that of the end of year 2004. The forecast is produced by estimating stochastic models for fertility, mortality and migration, simulating these models hundreds of times and compiling the results with a cohort component method. Figure 2 presents the outcome as predictive distributions of number of people in the given age groups.

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 percent 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.

Figure 2. **Demographic uncertainty in Finland**



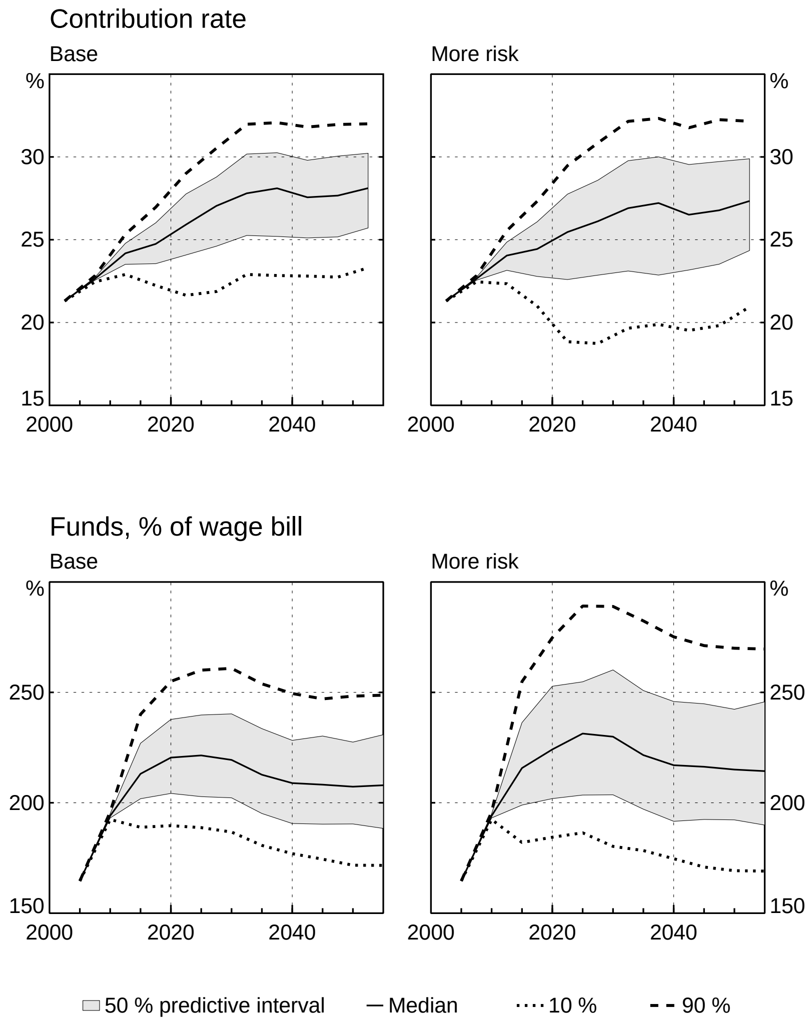
3.3 Stochastic pension projections

To obtain pension projections, we run the FOG model five hundred times using the sample paths of the stochastic models as inputs. We then replace the base yield realizations with the “more risk” realizations, and calculate the pension outcomes with only the pension system rules. We thus assume that the new incentive effects from the contribution change are ignored and all households and firms behave as in the base projection.

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. There is a marked lag until its effects are fully realized, since the yield is allocated to the individual accounts of the insured persons. The prefunding rules are described in detail in Appendix. The yield of the funds 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 paid pensions.

With two different sets of asset yield realizations we have the following two predictive distributions for the pension contribution rates and the pension fund sizes.

Figure 3. Predictive distributions of contribution rates and pension funds



4. Risk-taking and sustainability

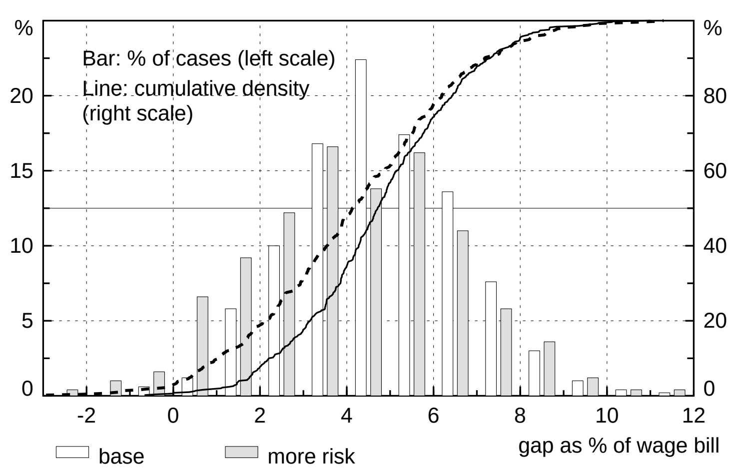
Risk-taking and sustainability gaps

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 the contribution rate be immediately set, so that if extra revenues be invested in a similar portfolio to what we are examining, the new contribution rate is sustainable for at least 100 years? Thus we use different stochastic discount rates, to compare different portfolios.

In a stochastic setting the answer is the gap distribution. The following figures show both the density function histogram and the cumulative density function of that distribution in the baseline case and the more risky case. Sustainability gap is presented using both the conventional 50 year horizon and 100 year horizon. The outcomes correspond to the implemented Finnish reform.

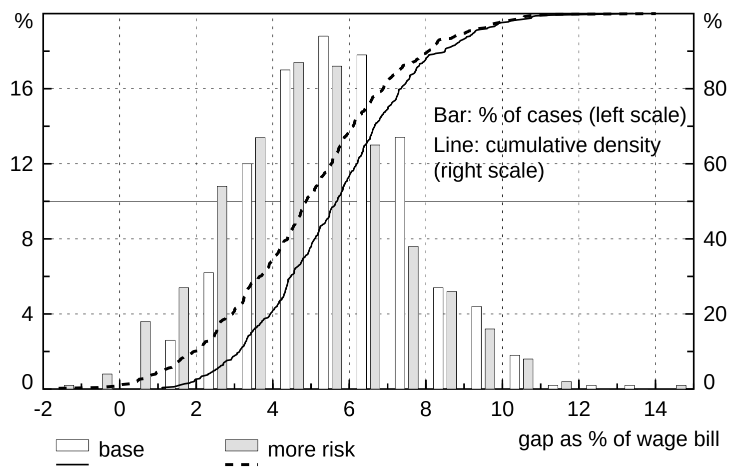
Figure 4. Sustainability gap (50 year horizon)



The baseline median gap is 4,8 percentage points. The probability of a zero gap or a negative gap is very small. The probability of a sizable gap, over 5 percentage points, is about 25 %. Thus, according to these estimates, the Finnish private sector pension system very likely has a sustainability problem.

Figure 5 shows the gap distribution with a longer time horizon. Ageing means a permanent change, and the gaps are larger if we account for a longer period into the future. Also the variation in the gap distribution is, as expected, larger.

Figure 5. Sustainability gap (100 year horizon)



Both Figure 4 and Figure 5 give a similar view on the effects of taking more risk: the gaps become smaller, sustainability is enhanced. In both cases the expected reduction in the gap is somewhat less than one percentage point.

There are some reservations that should be kept in mind. The yields may depend on the size of the gap and on the size of the initial tax rate. The larger the gap, the higher probably are the interest rates required for extra debt, so reducing the debt gives good yields, compared to investing in stocks. On the other hand, if the fund is large compared to the size of the markets, its investment policy may influence the market prices.

Sustainability gaps are typically presented without discussion how to close the gap, not to mention that general equilibrium analysis of the incentive effects is needed to dimension the actual measures implemented. A high initial tax rate strengthens the negative incentive effects of closing the gap with higher taxes. But also reforms that permanently lower replacement rates may markedly weaken labor supply incentives.

Risk-taking and variability in pension variables

Sustainability gaps take the time dimension out of sight. That may be innocuous if the issues considered have no major effects on how the rules and practices of the pension system evolve in time. Increasing asset yield risks, however, may have substantial effects on rules and practices.

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

Yield on pension funds, including capital gains
= pension expenditure
- contribution revenue
+ change in pension funds

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 pension expenditure, contribution revenue and the size of the pension funds, must increase. Which of these items react and by how much, depend on the pension system rules. In a DC system, the contribution rate is fixed. In prefunded DB systems, solvency rules may require immediate adjustment of contributions, if the value of the assets falls short of the value of liabilities.

Table 1 describes the expected consequences and the implications for the variability of increased risk-taking in the studied Finnish case. There is some indeterminacy about how the uncertainties should be allocated in projections of this type. In the projections mainly the contribution rates and the size of funds vary because of asset yields and other stochastic developments. Pension expenditures also vary quite a lot in relation to the wage bill; in our simulations this variation is mostly due to varying demographics.

How to read Table 1: There are 500 simulated paths. Thus, for each variable, there are 500 expected values for the period 2010 – 2050. There are also 500 standard deviations, each describing variation within one path during the period 2010 – 2050. The expected values are sorted into ascending order, and their distribution is described by deciles d1 and d9, quartiles Q1 and Q3 and the median Md. Standard deviations are sorted in a similar fashion. Sorting is carried out separately for each variable, and expected values and the standard deviations are sorted separately.

Increased risk-taking increases the variation in asset yields. Following the base projection practice, this would increase variation in changes in funds, and thus fund sizes, and it would increase variation in contribution rates. Pension expenditure would remain practically unchanged, there would only slight changes in pensions through the effect that changing employee contribution rates have on pension indexes.

It is not unreasonable to assume that variation in pension contributions due to asset yields would be subject to some efforts of control. That is why we have calculated the statistics for a policy where the contribution rate is held between 20 and 25 percent, and another alternative where the contribution rate is held constant.[3]

[3] Restrictions concern the sum of employer contributions and young employee's contributions. Since 2005, employees aged 53 and over pay contributions that are about 1.27 times that of younger employees, reflecting their higher accrual. In Table 1 the contribution rate is the sum of employer and employee contribution rates, where the latter is weighted from the age-dependent rates with corresponding revenue shares

Table 1. Pension system's budget items in 2010 – 2050, % of the wage bill.
Predictive distributions of expected values *E* and standard deviations σ .

	Asset yield		Contribution revenue		Change in funds		Pension expenditure	
	E	σ	E	σ	E	σ	E	σ
	Base (expected real rate of return: 3,5%)							
d_1	4.14	3.85	23.64	1.52	3.02	3.34	28.42	2.50
Q_1	5.33	4.49	25.20	1.95	3.63	3.92	28.98	2.79
Md	7.04	5.33	26.61	2.50	4.24	4.66	29.55	3.10
Q_3	9.00	6.30	28.06	3.25	4.90	5.49	30.22	3.50
d_9	10.93	7.31	29.25	3.94	5.51	6.43	30.90	3.90
	More risk (expected real rate of return: 3,9%)							
d_1	4.48	5.46	21.70	1.87	3.08	4.58	28.51	2.51
Q_1	5.84	6.34	23.79	2.33	3.76	5.47	29.06	2.83
Md	8.21	7.69	25.74	3.07	4.49	6.52	29.64	3.16
Q_3	11.09	9.12	27.60	4.06	5.34	7.83	30.34	3.56
d_9	13.38	10.81	29.01	5.08	6.08	9.12	30.99	3.97
	Base, with limited variation in contributions							
d_1	2.52	3.02	23.41	0.18	-2.43	3.65	28.55	2.55
Q_1	3.97	3.69	24.28	0.42	-0.62	4.61	29.08	2.85
Md	6.00	4.58	24.98	0.81	1.28	5.50	29.74	3.22
Q_3	8.33	5.62	25.28	1.42	3.09	6.55	30.42	3.62
d_9	10.59	6.58	25.41	1.97	4.43	7.70	31.19	4.09
	More risk, with limited variation in contributions							
d_1	2.57	4.14	22.40	0.27	-2.41	4.61	28.57	2.57
Q_1	4.28	5.16	23.40	0.70	-0.47	5.68	29.14	2.90
Md	6.99	6.60	24.44	1.32	1.86	7.10	29.79	3.24
Q_3	10.58	8.28	25.12	1.95	4.26	8.58	30.47	3.64
d_9	13.78	10.16	25.38	2.27	6.40	10.27	31.23	4.11
	Base, with fixed contributions							
d_1	3.67	3.94	26.60	0.02	0.28	4.66	28.30	2.49
Q_1	5.63	4.95	26.61	0.02	2.56	5.58	28.81	2.81
Md	8.23	6.11	26.61	0.02	5.56	7.06	29.48	3.16
Q_3	11.86	7.77	26.62	0.03	8.79	8.77	30.19	3.56
d_9	15.85	10.08	26.63	0.03	13.17	10.55	30.95	4.02
	More risk, with fixed contributions							
d_1	3.19	4.89	25.73	0.01	-1.06	5.58	28.39	2.52
Q_1	5.35	6.30	25.73	0.02	1.36	6.97	28.90	2.83
Md	9.10	8.43	25.74	0.02	5.13	9.23	29.57	3.19
Q_3	14.41	11.33	25.74	0.03	10.34	11.87	30.29	3.59
d_9	19.73	15.73	25.75	0.03	16.03	16.06	31.05	4.06

In both these cases the asset yield risks and other risks fall mostly on the fund sizes. This happens both in the base case and in the increased risk case. In the fixed contribution rate case the pension fund operates fully as a buffer fund. The fixed contribution rate is set to be at the level which is expected to be sustainable, i.e. it is higher than the median rate of the other cases.

Table 2 illustrates the variation is pension funds. We have also included the 5 % and 95 % points of the distributions.

Table 2. Pension funds in 2010 – 2050, % of the wage bill.
Predictive distributions of minimum and maximum values.

	Base		More risk	
	min	max	min	max
	Current funding rules			
$p_{.05}$	155.04	213.07	147.33	223.07
d_1	159.36	220.03	152.53	232.49
Q_1	171.68	231.15	163.92	248.27
Md	183.99	245.72	180.38	267.11
Q_3	197.27	262.68	195.80	293.77
d_9	208.49	280.55	212.28	321.04
$p_{.95}$	215.86	292.56	220.59	337.55
	Limited variation in contributions			
$p_{.05}$	-52.22	189.39	-59.78	185.45
d_1	-21.53	199.64	-19.85	201.84
Q_1	35.56	215.48	41.23	222.84
Md	100.78	234.57	113.86	253.65
Q_3	157.09	255.10	181.17	292.69
d_9	194.20	279.86	212.77	349.37
$p_{.95}$	207.28	294.12	227.57	401.57
	Fixed contribution rates			
$p_{.05}$	48.09	226.56	-12.15	206.89
d_1	78.72	240.85	33.15	227.61
Q_1	144.96	270.94	102.53	261.18
Md	211.53	314.62	186.78	325.25
Q_3	246.93	407.75	240.38	463.38
d_9	271.86	534.70	277.35	673.75
$p_{.95}$	285.66	627.71	295.30	765.60

The increase in variation of the size of pension funds can be very large. Thus we must try to envision what that would mean for the day-to-day or perhaps year-to-year decision making concerning public policies.

Increased variation in changes in funds, and thus in fund sizes, may have effects on how the system develops in time. Benefit rules are likely to be changed both if funds grow very large and if they become small. In a good situation it is difficult to resist different constituencies' demands, and in bad times expenditure cuts are politically possible.

Large funds may also increase pressures to use the funds to other good purposes instead of pensions, such as to back up domestic firms that are in difficulties. This could mean that bad firms would be subsidized. Eventually the asset yields would then fall. If equities concern companies that are not operating domestically, such 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 pension sector is by no means an innocuous one. On the other hand, it cannot be said that they cannot. Thus we conclude that these issues should be considered and discussed when considering higher risk-taking. Positive decision requires that the outcomes are well understood and there is an agreement what will be done, when the expected future is not realized.

5. Conclusions

We have analyzed the sustainability consequences of the increased risk-taking in the Finnish earnings-related pension system. Using stochastic projections we compare distributions of sustainability gaps related to different risk characteristics. This is a coherent way to include both the expected higher yield and the increased risk in the analysis. We show that, in the Finnish case, increased risk-taking is very likely to reduce the sustainability gap.

But we claim that this is not sufficient analysis. Comparing sustainability gaps includes a hidden assumption that living is equally easy with different risk levels. Whether this is so or not should be carefully considered. In case of pension systems, the problem is emphasized by the fact that the time horizon of the liabilities is very long. Previous experiences also show that the assets yields may be several decades high or low compared to the long-term averages.

Investing more in equities increases the variability of the asset yields. But variability cannot increase in just one item of the budget constraint. The volatility of one or more of the other main categories, namely pension expenditure, contribution revenue and the size of the pension funds, must also increase. The outcomes depend on the pension system details and should be extensively simulated.

The increased risk in itself may also cause unforeseen changes to the pension system, with sustainability implications that may outweigh the expected gains from better asset yields. Increased variation in contribution rates, which in a partially-funded defined-benefit system are partly labor taxes, has negative incentive effects. Increased variation in fund sizes may incur political consequences for the ownership policies of the pension institutions or changes in pension benefit rules. Increased variation in pension expenditure may reflect changes in benefit rules that are caused by the increased asset risks.

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Appendix: ***The Finnish earnings-related pension system***

The earnings-related pension system aims to provide sufficient retirement income to cover consumption comparable to levels enjoyed during working years and to current workers' consumption. It covers risks related to old age, disability and death of family earners. In cases where the earnings-related pension is absent or insufficient, the national pension guarantees a minimum income. Both of these first-pillar systems are mandatory. Below we describe the private sector earnings-related system.

Benefits

The pensions can be thought of as consisting of both disability pensions and old-age pensions. Every year's earnings and accrual rates directly affect the future pension. The accrual rate is 1.5 % per year between the ages of 18 and 53 and 1.9 % between the ages 53 and 62. Between the ages 63 and 68 the accrual is 4.5 % per year, aiming to reward later retirement in a cost-neutral way.

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. In the model, function $I(t,u,\lambda)$ states that the change in wages *w* from period *t* to period *u* is weighted by λ and the change in consumer prices *p* is weighted by 1-λ. Employee's contributions *e* are deducted from wages in this calculation.

$$(1) \qquad I(t,u,\lambda) = \left(\frac{w(u)\left(1-e(u)\right)}{w(t)\left(1-e(t)\right)}\right)^{\lambda}\left(\frac{p(u)}{p(t)}\right)^{1-\lambda}$$

We denote the accruals with *k(x)* where *x* refers to age. If retirement occurs due to disability, the pensioner is compensated for lost future accruals. The compensation depends on the age at the time of the disability event; we denote it by *f(z)* where *z* refers to the age during the last working period. After receiving the disability pension for five years there is a one-time level increase in the pension. This increase is 21 % for a person aged 26 or less, and smaller for older persons, so that those aged 56 or more get no increase. This feature is denoted by *a(x,z)*. Thus the pension benefit *b*, without longevity adjustment, for an individual *i* in age group x who retired at age *z* + 1 and had earned wage incomes denoted by *y* is as follows.

$$(2) \qquad \begin{aligned} b_i(t,x,z) &= a(x,z)\sum_{s=1}^{z} k(s)y_i(t-s)\left(1-e(t-s)\right)I(t-s,t-x+z,0.8)I(t-x+z,t,0.2) \\ &+a(x,z)f(z)y_i(t-x+z)\left(1-e(t-x+z)\right)I(t-x+z,t,0.2) \end{aligned}$$

where $x > z$.

Longevity adjustment

The pensions are adjusted for increasing life expectancy simply by taking the increasing longevity into account in the value of the annuity. The adjustment coefficient is a ratio of two present values of a unit pension, calculated at two different periods. The present value of a unit pension, which begins in period *t* and is calculated forward from age 62, is as follows.

$$(3) \qquad A(t,62) = \sum_{s=63}^{100} S(t-1,62,s)/(1.02)^{s-62}$$

The present value of a unit pension is a discounted sum of terms generated during various retirement years. The terms have two parts. The first term, *S,* expresses the survival probability from age 62 to age *s*, and the first subscript of the term demonstrates that the probability is evaluated using information available in period *t*, when the latest the observed mortalities are from period *t-1*. The survival probabilities are actually five-year moving averages. The second term is the discount factor where the discount rate is 2 % per year. In the model individuals die at the age of 100 at the latest.

The pension of a person born in period $t - 62$ is multiplied by the longevity adjustment coefficient *E(t,*62*)* after age 62. The coefficient is a ratio of two *A*-terms as follows.

$$(4) \qquad E(t,62) = A(2009,62)/A(t,62)$$

Prefunding on the individual level

The Finnish earnings-related system has collected substantial funds to smoothen the contribution increases due to population ageing in the future. Funding is collective but based on individual pension rights. Individual pension benefits do not depend on the existence or yield of funds. Funds only affect contributions. When a person receives a pension after the age of 65, his/her funds are used to pay that part of the pension benefit that was prefunded. The rest comes from the PAYG part, the so-called pooled component in the contribution rate.

Equation (11) describes new funding for an individual *i*. A share *g* of the present value of the pension right accruing in period *t* to workers in the age range 18 - 54 is put in the funds. The present value includes all old-age pension years, from 65 to a maximum age assumed to be 100. The labour income *y* creates a pension right for each year in old age. Discounting includes both the so-called fund rate of interest *q,* which is administratively set, and survival probabilities *S*. For prefunding purposes, the magnitude of the pension right is evaluated ignoring all future changes due to wage or price developments. Thus the value of the right is simply *k* times the labour income, without the employee contribution part, for each retirement year.

(5) $$h_i(t,x) = g\sum_{s=65}^{100} k(x)y_i(t)(1-e(t))S(t-1,x,s)/(1+q)^{s-x}$$

where x = 18,…, 54.

Equation (12) states that for a retired person the amounts prefunded earlier (when the current pensioner was between the ages of 18 and 54) for period *t*'s pension, with the interest accrued to them with rate *r* and leading to a total amount *v*, is used to pay a part of the person's pension. The interest accrued is assumed here to be constant for a simpler exposition. In practice it follows approximately the average market yield plus a margin, and must not be lower than the fund rate in equation (5).

(6) $$v_i(t,x) = \sum_{s=18}^{54} gk(s)y_i(t-x+s)(1-e(t-x+s))S(t-x+s-1,x-s,x)(1+q)^{s-x}(1+r)^{x-s}$$

where x = 65,…, 100.

Contribution rates

The equations (5) and (6) are important for the aggregate dynamics of the pension system, especially for the level and time path of the contribution rates.

Let *n(t,x)* be the number of workers and $\overline{h}(t,x)$ the average amount of new funding per worker in age *x* in period *t*. The total amount of new funding in period *t* is obtained by multiplying the average individual funding in age group *x* by the number of workers in the age group, and summing over all age groups where funding takes place. Analogously, *m(t,x)* is the number of retired persons and $\overline{v}(t,x)$ is the average amount withdrawn from the funds per retiree in each age group, and the total amount withdrawn from the funds is obtained by multiplying the average withdrawals by the number of retirees and summing over relevant age groups. Three other aggregates are defined in a similar fashion: the total wage bill from which the pension contributions are collected, denoting the average wage income at age *x* by $\overline{y}(t,x)$, the total amount of earnings-related pension expenditure, denoting the average pension of retired persons by $\overline{b}(t,x)$ and the total amount of other transfers from the pension sector, denoting the average transfer per person by $\overline{s}(t,x)$.

The time path of the contribution rate is given by equation (13). Besides employees, employers must also pay contributions, which we denote by *c(t)*, based on the wage bill. The left-hand side of the equation is the total amount of contributions. That must be sufficient to cover that part of the pension expenditure (first term on the right-hand side) that does not come from withdrawals from the funds (second term), plus new funding (third term), plus transfers (the final term).

(7)
$$\begin{aligned}\left[c(t)+e(t)\right]\sum_{x=18}^{64} n(t,x)\overline{y}(t,x) &= \sum_{x=18}^{100} m(t,x)\overline{b}(t,x) - \sum_{x=65}^{100} m(t,x)\overline{v}(t,x) \\ &+ \sum_{x=18}^{54} n(t,x)\overline{h}(t,x) + \sum_{x=18}^{100}\left[n(t,x)+m(t,x)\right]\overline{s}(t,x)\end{aligned}$$

Employer contributions were on average 16.8 % and employee contributions 4.6 % of wages in 2004. Future changes have been agreed to be shared 50-50 between employers and employees. Since 2005, employees aged 53 and over pay contributions that are about 1.27 times that of younger employees, reflecting their higher accrual.