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AGEING, DEMOGRAPHIC RISKS,

AND PENSION REFORM

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ABSTRACT: Ageing will increase pension expenditure and contribution rates. There is also increasing awareness that the risks connected to mortality, fertility, and migration are considerable. In pension reforms one must decide how these risks are to be shared between workers and pensioners, and also take into account that in the transition phases different cohorts may gain or lose. We discuss the risk-sharing and intergenerational distribution aspects of three pension policy measures that either have already been adopted or are being proposed in Sweden and Finland. Each of these methods, linking benefits to life expectancy, indexing benefits to the total wage bill, and using fertility-dependent prefunding, has its own advantages and weaknesses. Using a numerical OLG model, and realisations from stochastic population simulations, we demonstrate that these methods greatly enhance the sustainability of a pension system in unfavourable demographic outcomes but have practically no effects if the demographics remain stable. Thus the allocation of risks can be improved without fundamentally changing the systems.

KEY WORDS: Demographic uncertainty, pension benefits, longevity adjustment, indexing, partial prefunding, voting

JEL Classification: H 55, J11

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TIIVISTELMÄ: Tavoitteena on tutkia, miten eläkepoliittisilla toimilla voidaan tasata väestön ikääntymisen aiheuttamaa eläkemaksujen nousupainetta. Lähtökohtana on, että väestön ikääntymisen määrää ei etukäteen tiedetä: syntyvyyteen, kuolevuuteen ja siirtolaisuuteen liittyy kaikkiin merkittävää epävarmuutta. Tarkasteltavia toimenpiteitä ovat työeläkkeiden indeksointi, elinajanodotteen nousun huomioiminen eläkkeissä, ja rahastoinnin sitominen syntyvyyteen. Arviointikriteereinä käytetään vaikutuksia kansantaloudellisiin muuttujiin, työnantajan ja työntekijän eläkemaksuihin, eläkejärjestelmän oikeudenmukaisuuteen ja kotitalouksien hyvinvointiin. Jos väestökehitys on vakaata, ei toimenpiteillä ole juurikaan vaikutuksia. Jos taas väestökehitys osoittautuu epäsuotuisaksi, nämä toimenpiteet tasaavat väestön ikääntymisen kustannuksia tehokkaasti eri sukupolvien kesken. Täten ne parantavat väestöriskien kohdentumista eri sukupolville. Tuloksia on laajemmin esitelty julkaisussa Työeläkkeiden indeksointi, elinaikakorjaus ja väestön ikääntyminen, Eläketurvakeskuksen tutkimuksia 2000:2 ja ETLA B 172.

ASIASANAT: työeläkkeet, väestöepävarmuus, elinajanodote, indeksointi, rahastointi

Contents

I INTRODUCTION

Most current public pension systems are defined benefit PAYG systems. Following the defined benefit principle in the determination of pensions means that the contribution rate mainly absorbs the shocks generated by unexpected economic or demographic trends. Hence, it is mostly the current young and future working-age population that is affected by these shocks. It is very unlikely that, as defined, the intergenerational redistribution rule is optimal.[1]

Financing pensions with the pay-as-you-go principle implies that previous generations have already created an implicit pension debt, which must be financed by future workers. In some cases, the financing of the pensions is supported by partial prefunding. In Finland it is implemented so that the success of the investment policy only affects future contributions, not benefits. Hence, the arsenal of policy measures for improved intergenerational redistribution also includes prefunding rules, in addition to the determination of benefits.

Observing the existence of large baby-boom generations retiring soon, the low fertility rate and increasing longevity, one finds it easy to forecast that the population will age markedly during the next three decades. It is far less noticed that there is large uncertainty inherent in the population forecasts, taking into account that the relevant horizon for intergenerational risk smoothing by pension policy is very long. The uncertainty is revealed, for instance, by the studies of Alho (1998) and Lee (2000), which show that stochastic population forecasts give large confidence intervals to fertility, mortality and migration.

We study three methods of redistributing the economic impacts of population risks intergenerationally. The first method is to link the prefunding rules to fertility, implying that new funding reacts to the number of future workers. The other two methods, familiar from the Notional Defined Contribution (NDC) pension systems, are to link pensions to longevity and to changes in total wages. These approaches can be applied in current pension systems, without fundamentally changing the rules. In the comparison of these methods we use four criteria. These are the costs and actuarial fairness of the pension system, the aggregate economic implications and household welfare. We also perform a preliminary analysis of the political economy aspects of implementing these measures. The main question is whether there exists at any point of time a majority of voters who are in favour of one of the reforms.

The impacts of the redistribution methods are evaluated using a numerical general equilibrium model. The overlapping generations model (FOG) simulates the interaction of population trends, pension system rules and the rest of the economy during the next 100 years. The model also gives a number of winners and losers of any policy measure.

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[1] One of the justifications for a PAYG-financed defined benefit pension system is that it redistributes these risks between generations. In this discussion it is compared to a fully funded defined contribution pension system. One of the outcomes of the discussion is that a partially funded system is likely to be best (see e.g. Dutta et al. 1999). Our approach is tied to time and place: we simulate the dynamic effects of changing some rules in the current Finnish private-sector pension under chosen demographic paths. We look at future pension benefits and contributions and also the welfare of household generations. The latter requires that the general equilibrium repercussions are also taken into account.

We quantify in the next section the magnitude of demographic uncertainty and explain how it is applied in the FOG model. Section 3 describes the new policy measures and the justifications given for them. The fourth section presents the model used and the simulation results. Section 5 includes the voting analysis. Conclusions and policy recommendations are outlined in the sixth section.

II QUANTIFYING DEMOGRAPHIC UNCERTAINTY

Alho (1998) has made stochastic population forecasts for Finland. Based on previous forecast errors in fertility, longevity, and migration, he has modelled the uncertainty in demographics, and made 1500 simulations with the model. Each simulation produces annual population data for the coming five decades. The following figures present some distributional statistics describing the data mass.

Figure 1 presents the median of the size of the Finnish population, and the first and ninth decile and the first and third quartile. The width of intervals spreads rapidly in time. In 2030, in 80% of simulations the population will be between 4.7 million and 6 million people, and the corresponding figures for 2050 are 3.8 million and 6.7 million. Figure 2 shows the uncertainty in the number of births, and Figure 4 shows that longevity increases for both males and females, and that women will probably continue to live longer than men but it is not totally improbable that men will catch up.

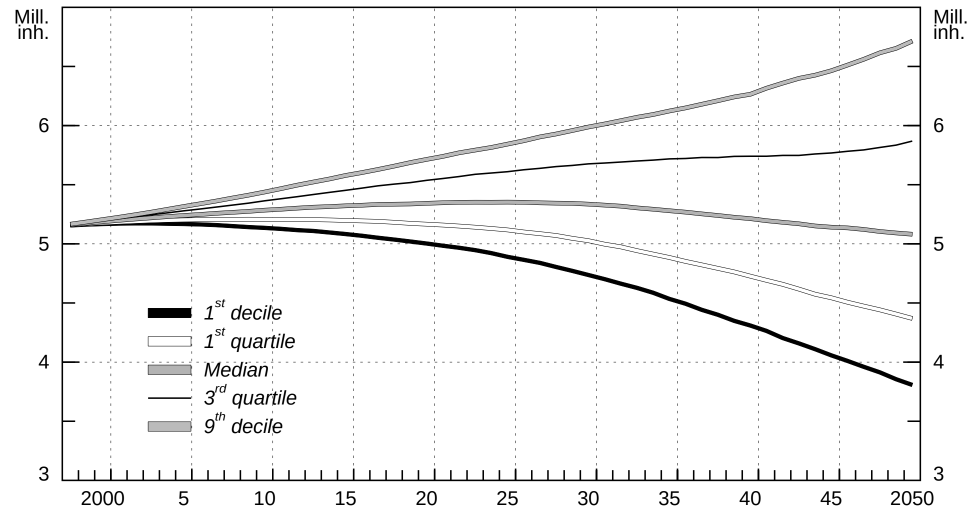
In principle, all the 1500 alternative population paths could be used as inputs in a numerical OLG model, such as the FOG model used in this study. Evaluating different pension policy measures with the model would then provide a distribution of the effects, reflecting the demographic uncertainty in the background. In practice, however, that has been well beyond our time resources, and a short cut was chosen instead. Alho provided two sample paths for the study by Lassila and Valkonen (1999). The 1500 simulations were ordered with respect to their age ratio statistic in 2030. The age ratio is the number of people over 60 years[2] divided by the number of people between ages 20 – 59. From this ordering, the two samples closest to the limits of the 80% confidence interval in 2030 were chosen.

Figure 4 shows these realisations as well as the baseline (Kela-Eurostat) scenario. The 80% confidence interval in the age ratio in 2030 is wide: the limits are 0.613 and 0.787 (Figure 1). This can be roughly translated into pension language: with a 10% probability Finland will have 8 pensioners or more for every 10 working-age persons, and with a 10% probability there will be 6 pensioners or less for every 10 working-age persons in 2030, provided that the actual retirement age does not increase substantially.

The high age ratio is a result of declining fertility and net emigration, and the low age ratio is mainly the result of declining life expectancy.

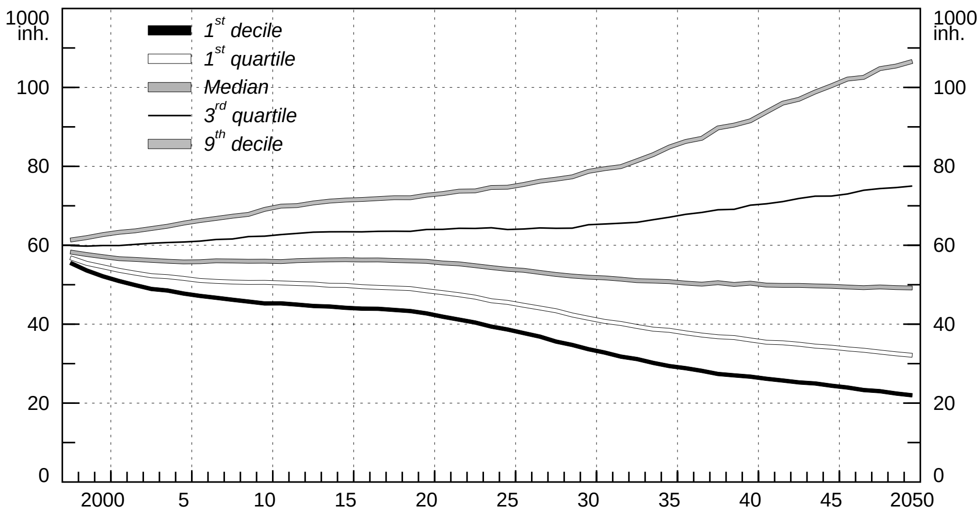
[2] The average retirement age in Finland is 59 years.

Figure 1. Finnish population



Source: calculations by J. Alho *ETLA 22.2.2001*

Figure 2. Number of children under 1 year of age by year-end



Source: calculations by J. Alho *ETLA 22.2.2001*

Figure 3. Newborn's life expectancy in Finland, 50 % confidence intervals

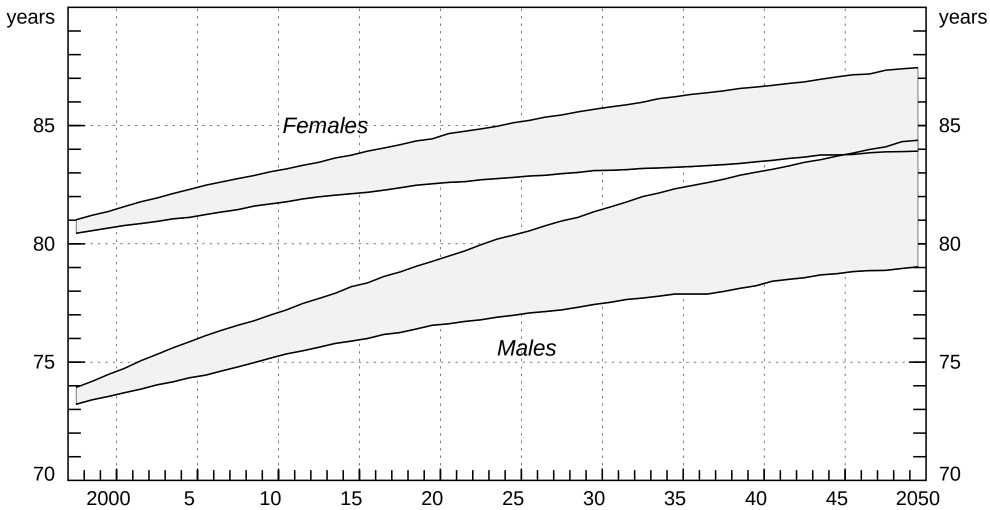
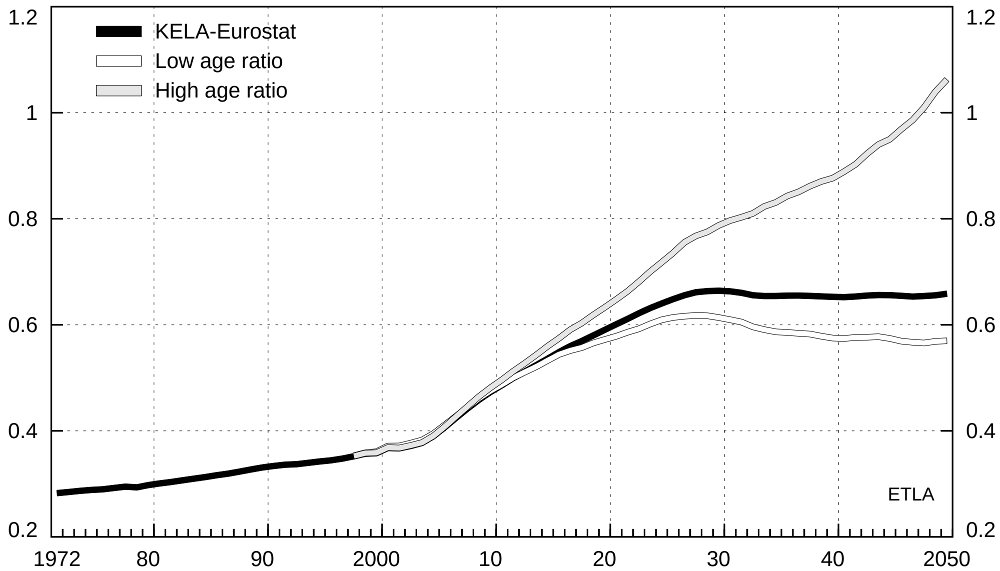


Figure 4. Ratio of population in ages over 60 to the population in ages 20-59



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

The four figures clearly demonstrate that there is huge uncertainty in demographic projections. Thus it is proper to consider the consequences of this uncertainty for pension politics and other ageing policies. Not all ageing research recognises this. Bovenberg and van den Linden (1997), for example, downplay demographic risks among the relevant risks:

"Demographic trends can be foreseen with some degree of accuracy, even over the long term. But there is considerable uncertainty about non-demographic trends (such as employment, wage growth, the return on capital, family formation and dissolution) that will affect systems of old-age insurance."

III THREE METHODS OF REDISTRIBUTING DEMOGRAPHIC RISKS

The well-known problems caused by population ageing to the current pay-as-you-go systems have generated a lively discussion about possible reforms. The Anglo-American discussion is concentrated mainly on the issue of privatisation, i.e. the pros and cons of shifting to a fully funded defined contribution system. The aims of reforms in Europe are more modest, but include many similar elements. The NDC scheme, which has recently been adopted in Sweden, Italy, Poland and Latvia, seems to offer an alternative, which provides efficiency-improving elements without large transition costs. The contribution rate promises to be stable and there are no investment risks. How is this scheme supposed to keep the promises? The solution is two-dimensional. Firstly, the benefits are linked more closely to contributions. Secondly, there are rules, which generate an endogenous adjustment of benefits to demographic or economic shocks.

The new way of dealing with increased life expectancy is to link pension benefits to average longevity. The higher the expected number of pension years, the smaller is the pension. Since life expectancy is likely to increase quite slowly and steadily in industrial countries, individuals already know early during their working age the probable amount of the reduction in pensions. Therefore they can adjust in advance by shifting labour supply and private saving correspondingly. Sweden has also adopted a flexible retirement age, which makes the adjustment even easier. The final outcome is that pensions are gradually cut, but in a way which is well justified.

The new Swedish pay-as-you-go earnings-related pension system also allocates the productivity growth risks increasingly towards the pension age. Pension rights generated during working age are indexed to per capita growth of incomes. After retirement the indexation is based on the long-term average growth assumption. Therefore, if the growth is higher, the pensions are raised, but the contribution base is also larger. If growth is slower than assumed, the real value of pensions diminishes and so the solvency of the system is supposed to be guaranteed.

Several observers (e.g. Valdes-Prieto 1999 and Scherman 1999) have noted that the adopted growth adjustment does not solve the problems caused by ageing. It does not take into account the effect of a diminishing labour force, since it is based on per capita incomes. The planners of the system were aware of this deficiency and have suggested the use of a "brake" in indexation if the solvency of the system is endangered. In practice, this brake would behave as if the pensions were indexed to the growth of total wages.

We simulated the effects of ageing using the Swedish type of growth adjustment. It turned out that without the brake the indexation rule markedly weakens the solvency of the pension system compared to, for example, indexation to price inflation, see Lassila and Valkonen (2000). This is because the shrinking labour force implies higher per capita wages (due to a higher capita/labour ratio) and so indexation raises pensions more, the faster the labour force falls. The result holds even in a case in which the employers' contribution rate is allowed to adjust to higher expenditures, thereby creating pressure on wages to fall.

The other indexation rule also considered in Sweden, but then rejected, is to link the pensions directly to total wages. Indexation to total wages well imitates the changes in the contribution base, thereby providing good means of adjustment both to long-term trends in productivity growth and population and to short-term variation in the participation rate and unemployment. A shift to a full indexation of pensions to total wages has, however, two apparent weaknesses. The first is that the method shifts almost all earnings risks to retirement age, and these risks might be large owing to, for example, exceptionally strong business cycles. Another problem is that the new pension level and contributions would be much higher after the shift. We show that both the problems can be mitigated with an adjusted total wage index (PasTEL), which still maintains the desired property of following the trends in the contribution base.

The third method, presented initially in Lassila and Valkonen (1999), is to link the pension prefunding rule to fertility.[3] The starting point is the current Finnish earnings-related old age pension system, which is partially funded. Current prefunding rules provide some automatic smoothing of pension contribution rates due to shifts in demographic trends. As funding takes place for each worker, the more retired workers there are, the more funds there are. These funds are used to pay a part of the pension benefits after the worker retires. Thus, the contribution rates need not rise in full proportion to the number of retirees. The remaining problem is that a major share of the pension costs is still financed by the PAYG principle, which means that the contribution rate is sensitive to the size of the working-age population.

Our aim was to modify the prefunding rule so that it would take into account the number of future workers. Fortunately, the number of new entrants in the labour force can be accurately forecast 20 years earlier, when information about births is available. We amend current old-age pension funding rules so that, for each funding cohort, the amount funded also depends on the size of the funding cohort relative to the size of recently born cohorts. It is important to note that the fertility-linked prefunding rule can also be applied in cases in which there are not yet existing pension funds. The benefits in these cases are, however, less impressive.

IV SIMULATION RESULTS

4.1 The simulation model

FOG is an Auerbach-Kotlikoff type, perfect foresight numerical overlapping generations model. It describes Finland as an open economy. There are five sectors: households, enterprises, a government, a pension fund and a foreign sector. The labour, goods and capital markets are competitive and prices balance demand and supply period-by-period. There is no money or inflation in the model. Households plan their whole future when they are young. They choose the allocation of time between labour and leisure in each period, the

3 See also Orszag and Orszag (2000). Sinn (2000) notes that generations with low fertility invest less in human capital. Therefore it is fair that they are forced to save and invest more and thereby finance the missing part.

timing of consumption between periods, and the amount of bequests given. The pension system affects these decisions by changing the resources available during various periods and the relative prices. Any policy measure generates a need to revise the life span plan. The model is described in more detail in Appendix 2.

We use, as the baseline, a recent population forecast made by the Social Insurance Institute, Finland. The alternative paths were chosen so that they corresponded to the lower and upper points of the 80% prediction interval of the age-dependency ratio in 2030.

The use of different demographic scenarios, produced by stochastic population simulations, as inputs in an overlapping-generations general equilibrium simulation model is technically straightforward. Intellectually, there is a gap: there is no uncertainty in our OLG model. The households and firms in the model do not take into account demographic uncertainty in their decisions. They have perfect foresight of the future population development in each alternative. Although it would be more satisfactory to have uncertainty included, we feel, however, that no essential changes in results could be expected. Prefunding changes the timing of contributions, not the risks related to benefits nor those related to disability or outliving one's savings. It is, however, possible that changing the prefunding rule would also reduce precautionary saving, if credibility of the pension system increased. Longevity adjustment and PasTEL indexing also affect the size of the PAYG system by affecting the benefit levels, and even if people wish to compensate for this by saving they cannot buy assets with exactly the same properties. Still, the intergenerational distribution effects dominate, and it is hard to see why the results would change if uncertainty were explicitly included.

Including uncertainty properly in our model would also be difficult. Computational models of social security have developed very rapidly during the last few years, see, for example, Imrohorogly et al. (1999) and Rust (1999). Still, as far as we know, even the most sophisticated current numerical OLG models (see e.g. De Nardi et al. (1999)) can handle only idiosyncratic income and longevity uncertainty.

4.2 Adjusting pensions to life expectancy

When the pension system was created in the beginning of the 1960s, the average life expectancy of a 65-year-old Finn was 13 years. According to current forecasts, the corresponding figure for 2050 is 20-21 years (Lindell 1999). This means that the time spent as a retired person is increased by a half. If we add to that the effects of generous early retirement systems, the trend in the support ratio is even more outstanding. When PAYG financing is used, future workers pay the burden, which means that the system creates a large intergenerational transfer of resources from the future. If this is considered unfair, there is a need to neutralise it, which can be done by adjusting pensions. Since in each point of time there is significant uncertainty about the future longevity (see Figure 3), a policy rule must be created which determines the size of the adjustment needed.

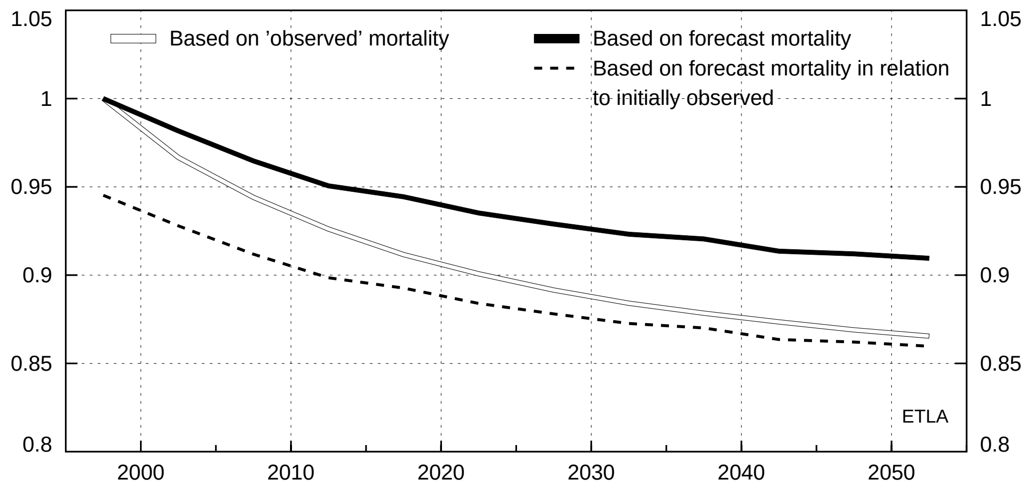
Observed v. forecast mortality in longevity adjustment

The Swedish application of longevity adjustment to pension benefits is based on observed mortality. Each year, the latest available statistics on age-specific mortality is used to calculate the expected remaining lifetime of those reaching the age of 65. An alternative would be to use forecast mortality specific to the cohort reaching 65. With increasing life expectancy, the forecast-based estimate of the length of the remaining lifetime exceeds that based on the latest observed mortality. One might then think that a longevity adjustment based on forecasts would yield bigger cuts in monthly pensions than an adjustment based on observed mortality. This is not likely to be true, however.

The adjacent graph (5) shows three longevity adjustment coefficients for Finland from 2000 onwards. All are based on the KELA-Eurostat demographic scenario. A coefficient based on "observed" mortality is used in this study. "Observed" means here that as the scenario actualises period by period, the coefficient is calculated from the previous period's age-specific mortalities. The forecast-based coefficient is calculated from the cohorts' forecast longevities, which require, in each period, the use of future periods' forecast mortality rates.

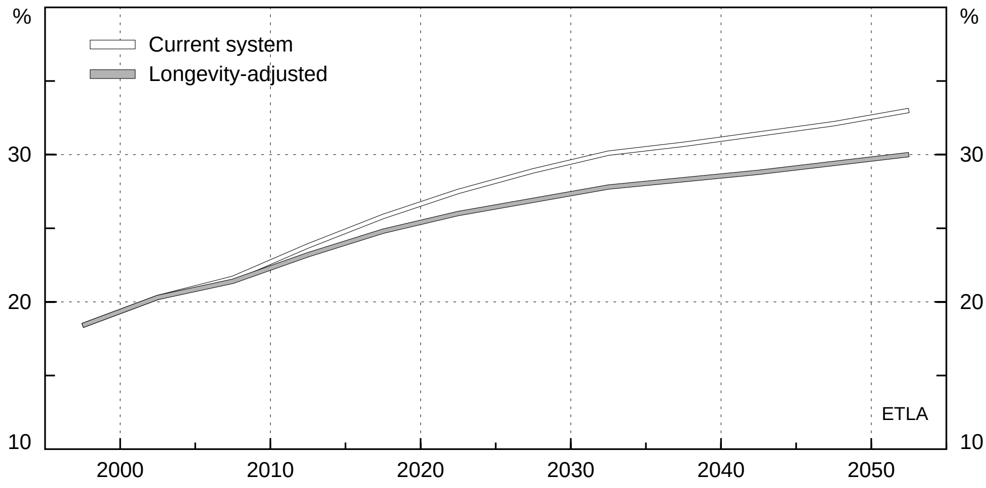
Each period's longevity is compared to the base period's longevity; the coefficient is the inverse of this comparison. Longevity adjustment to each cohort's pensions is done only once, when the cohort starts to receive old-age pensions (see p. 39). The coefficient based on "observations" goes below that based on forecasts, and thus results in greater reductions in monthly pension benefits. The reason is that the increase in longevity has already taken place in the base period's forecasts, but not in the observations. The cohort reaching 65 in the base period is already expected to live quite long, but the observed age-specific mortality rates in the period preceding the base period show a much shorter life expectancy.

Figure 5. Longevity adjustment coefficients



Only if the forecast-based longevities are compared to the observation-based longevity in the base period will the coefficient based on forecasts result in larger savings in pension expenditure. The third line in the graph illustrates this. The problem is that it produces a downward jump in the base period, creating a bigger difference between two adjacent cohorts than either of the other two coefficients.

Figure 6. Pension contribution rates and longevity adjustment



When the observed numbers are used in the longevity adjustment, the FOG model gives the following simulation results. The reduction is about 10 per cent in the real value of the individual pensions during the next 25 years. After that the adjustment increases slowly and reaches 13-14 per cent in 50 years (see Figure 5). When considering the scale of the cuts, it is useful to remember that even a modest yearly growth of 1.5 per cent would more than double pensions in 50 years. The longevity adjustment reduces aggregate pensions related to total wages, as well as the contribution rate, about 3 per cent in the long term (see Figure 6). A measure that describes the fairness of the pension system, *the actuarity rate*, shows that it is the current workers whose return from the new system is lower (see Figure 14 in Appendix 1), whereas the future workers consider the system fairer. If the population scenario with a high age-ratio is used, the decline in expenditures is twice as large.

The policy measure generates reactions in the labour and capital markets. The reduction in pension contribution rates leaves room for higher wages, thereby creating positive incentive effects and labour supply increases. On the other hand, the cut in future pensions promotes additional private saving for old age. The final criterion for the goodness of the policy is the welfare of households. As Figure 15 in Appendix 1 shows, the current working-age generations lose, but future ones gain. The implication is that for future households, the positive net wage effect dominates the reduction in pensions. If we calculate a discounted sum of lump-sum income transfers/taxes necessary to compensate for all the impacts of the measure, it shows that there is a slight improvement in overall welfare.

4.3 Indexation of pensions to total wages

The recent reforms in pension indexation have had two conflicting aims. The first is to cut the pension expenditures. It is achieved by decreasing the weight of wages and increasing the weight of some cost-of-living measure in the pension index. The second aim is to stabilise the pension contribution rate. That requires that the index reacts to changes in the contribution base, i.e. in the total wages. The conflict follows from the expectation that ageing will raise wages more than prices.

As noted in the previous section, indexation of pensions directly to total wages is expected to protect the contribution rate efficiently against variation in the contribution base. But if the starting point is the current pension systems, in which almost always there is less than complete indexation in wages, the shift to the new indexation increases pension expenditures and raises contributions. Since the measure affects the stock of pensions gradually, the transition period is long. Expanding the PAYG system this way creates negative incentive effects and transfers resources from future generations by raising the contribution rate.

Currently, the Finnish public pension system applies a combination of the wage-level index and the cost of living index in the indexation of pensions. During working-age the weights of wages and consumer prices are both 0.5 in this TEL-index. After retirement the weight of consumer prices rises to 0.2 and the weight of wages falls to 0.8. We modify TEL-index by substituting the total wages for the wage-level index. The use of this new index (PasTEL) eliminates the initial jump in the pensions and contributions, independently of the future trends in demographics. It also shelters the elderly from large variations in total wages. For technical details, see p. 40.

Interesting results emerge if the population follows the high age ratio path. In this case, the strong reduction in the labour force produces a higher wage rate, but smaller total wages. Therefore indexation to the wage rate reacts, from the point of view of the solvency of the pension system, in the wrong direction. Even in the Finnish case, in which the above described adjustment dampens the effect, the trend in the TEL-indices is evident (see Figure 7). Alternatively, if the PasTEL-index is used, the long-term contribution rate can be nearly 10 per cent lower (see Figure 8). Correspondingly, the actuarity rate is smoother (Figure 16 in Appendix 1) and the welfare of future households larger (Figure 17).

Figure 7. Changes in total wages and in current pension indices, high age ratio

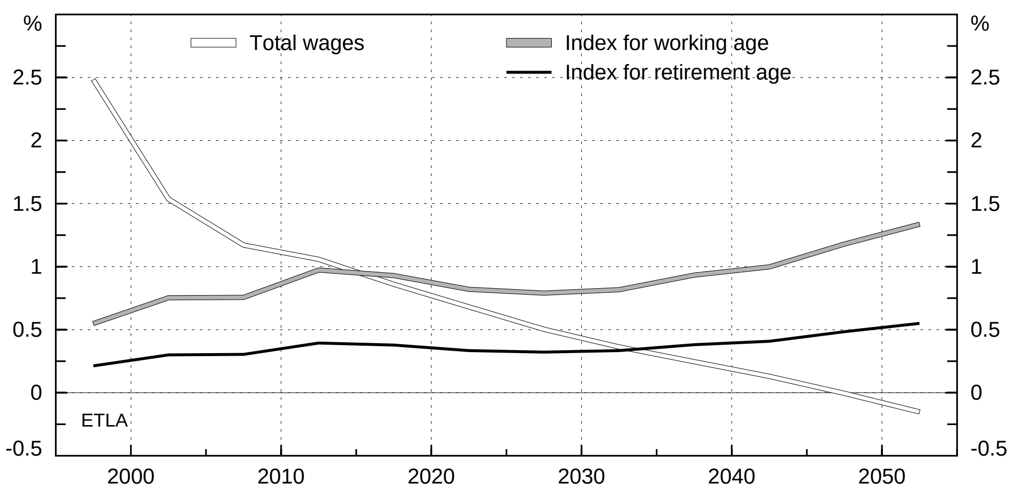
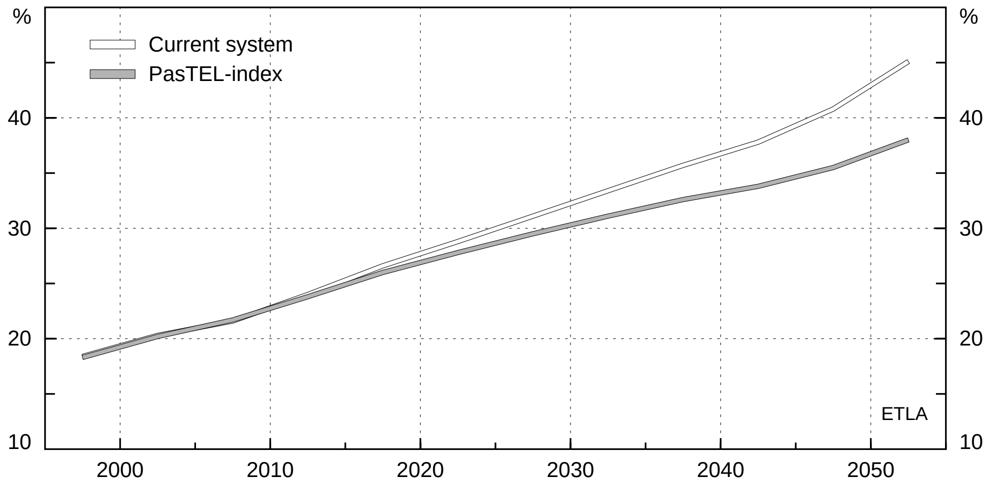


Figure 8. Pension contribution rates and PasTEL-index, high age ratio



4.4 Linking prefunding to the fertility rate

The stochastic population forecasts by Alho (1998) and Lee and Tuljapurkar (1998) imply that, compared with mortality and with immigration, changes in fertility have been more difficult to foresee. Therefore, it is this risk which endangers the solvency of the PAYG pension systems most.[4] On the other hand, the outcome of this risk is revealed earlier than in the other cases. Hence, if the fertility information is utilised fully, it allows more time for intergenerational redistribution of the financial burden. Fertility-linked prefunding even takes place much earlier than prefunding in a fully funded scheme, which is particularly important when the current demographic outlook is considered.

The main private-sector earnings-related pension system in Finland, the so-called TEL scheme, is partially funded. Funding does not affect pension benefits. It only affects the level and time path of contributions. A part of the old-age pension benefits, payable after age 65, is funded for each employee. Funding takes place between ages 23 – 54, so only benefits accrued during those years are (partially) funded. Of the 1.5% (of wage income) pension right accruing every year, 0.5% is funded. The present value of accrued rights is calculated using a 3% discount rate and a mortality table. No funding is done for benefit increases due to indexation (see Appendix 2, pp.39-40, and Lassila and Valkonen 2001a).

In the upper part of Figure 9 the prefunding period refers to a cohort, in the FOG model, born in 1975 – 79 and entering the labour force in 1995. When that cohort receives old-age pensions, in 2040 - 2065, the money prefunded in their working years will be withdrawn, with the interest accrued to those funds, and used to pay a part of their pensions (the rest comes from the PAYG part).

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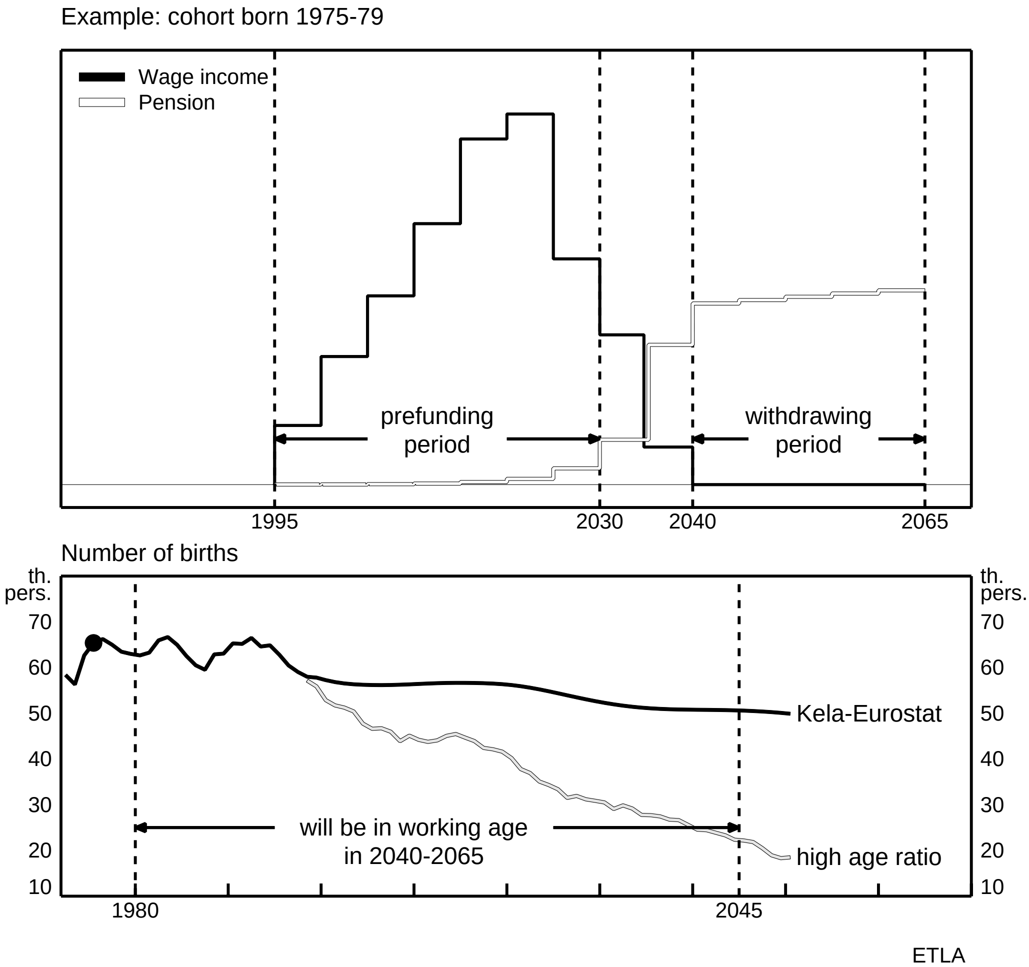
4 If pensions are initially fully prefunded, the problem is, of course, avoided. But when the starting point is an existing PAYG pension scheme, not even a transition to a fully funded system solves the problem of financing the already accrued pension rights, and the demographic risks involved.

We amend the current old-age pension funding rules so that, for each funding cohort (a cohort between ages 20 – 54 in our model), the amount funded also depends on the size of the funding cohort relative to the size of recently born cohorts. The idea is that we can estimate from the size of recently born cohorts the size of the work force in those future periods when the funding cohort is retired. This fertility effect varies between cohorts, and for each cohort it varies over time.

If the funding cohort is bigger than the younger cohorts, funding is increased. If fertility increases and younger cohorts were bigger, funding would decline compared with current rules, but neither of the scenarios in the lower part of Figure 9 has that feature.

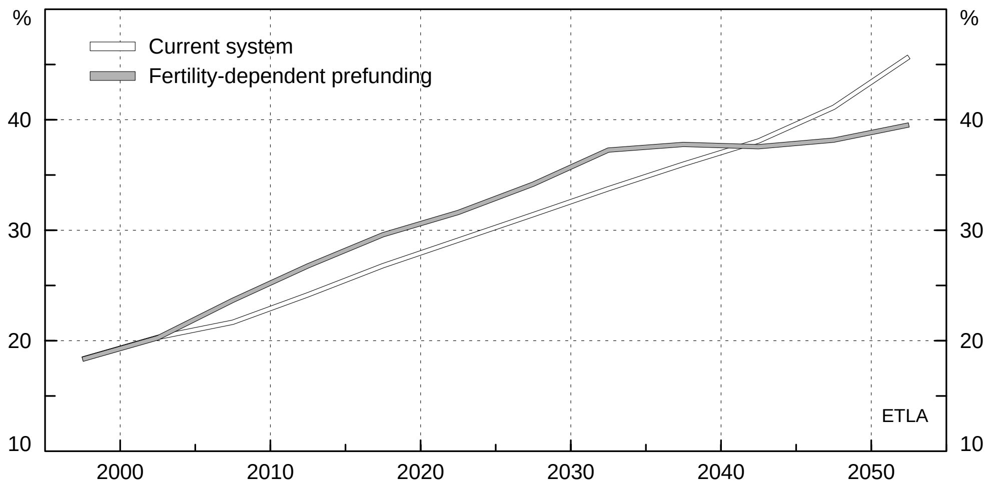
Figure 9. Prefunding of old-age pensions



In model simulations the new rule was calibrated so that it does not change markedly the amount of prefunding in the case of the baseline population forecast. But when the high age ratio with low fertility occurs, prefunding increases, requiring a somewhat higher contribution rate during the next 30 years (see Figure 9). After that the contribution rate stabilises to a level that is nearly 10 percentage points lower than in the case of the current pension system. The outcome is based on two factors. The first is the increased investment incomes from the markedly higher pension fund. The other is that the generations which benefit from prefunding are much smaller than the paying ones. Both the justifications imply that it is important to start to apply the new rule as soon as possible.

The actuarity rates described in Figure 18 illustrate that the fairness of the pension system decreases less when the new rule is followed. A rough simplification says that in terms of the fairness of the pension system, all unborn generations will benefit from the measure, and the current workers will lose. The welfare implications are similar (see Figure 19).

Figure 10. Pension contribution rates and fertility-dependent prefunding, high age ratio



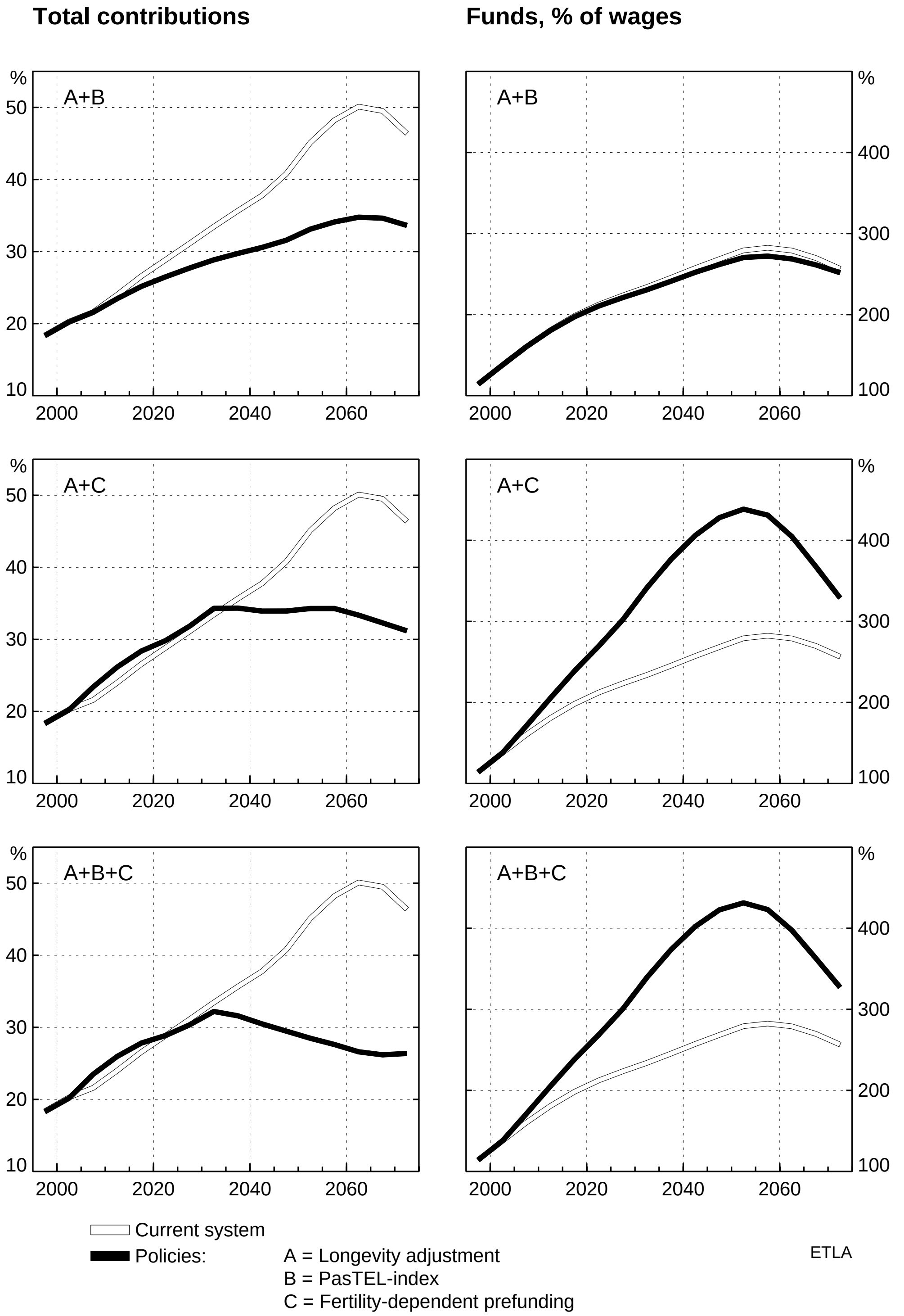
4.5 The aggregate effects of the measures

Unexpected changes in fertility, life expectancy and migration are very different kinds of risks from the point of view of pension systems. Table 1 lists the policy measures aimed at redistributing these risks between generations.

Table 1. Demographic risks and associated pension policy measures

Risk type / Measure	Fertility	Longevity	Migration
Link between life-expectancy and benefits	-	effective	-
Wage bill indexation	effective	-	effective
Fertility-adjusted prefunding	effective	-	-

Figure 11. Pension policy effects on contribution rates and funds, high age ratio



As we have learned from the previous sections, there are many choices to be made when implementing these rules. For example, adjustment for changes in life expectancy can be defined using either observed or forecasted numbers. Also, some adjustment should be used in the indexation of pensions to total wages, at least if consumer prices have heavy weight in the initial index. Furthermore, the optimal weights of the fertility of various cohorts in the prefunding rule are not well defined. Our simulation experiments with alternative specifications of the rules (not reported here) show, however, that the insurance role of these rules is not very sensitive to the details.

Figure 11 below shows the aggregate effects of the three measures on pension contributions and funds. Combining longevity adjustment and PasTEL-indexation does not markedly change the ratio of pension funds to total wages, but markedly lowers contributions by adjusting pensions and expanding the wage bill. The second presented alternative is the introduction of the PasTEL index together with a link between fertility and prefunding. The time path of contributions now climbs more rapidly until the year 2030 and falls thereafter. This is due to the accumulation and depletion of the pension fund and the larger investment incomes. The third case studied is a combination of all the three measures. As expected, it lowers the contribution rate most. Moreover, the kink in the contribution rate is more eye-catching. If the objective is to smooth the path of the contribution rate, the chosen combination of rules is not optimal in this demographic scenario. This observation is verified by noting that the actuarity rate of future generations is markedly higher than the rate of those cohorts which will start their working life during the next decade.

The final evaluation of the measures is that the combination of the measures efficiently redistributes the negative consequences of the high age ratio shock. The details and the optimal scale of the measures used remain to be solved in future studies.

V VOTING FOR A PENSION REFORM

5.1 Lessons from previous voting literature

Different factors in introducing, maintaining and structuring pension systems have been analysed in the public choice literature. Verbon (1993) finds four factors that explain the existence of public pension schemes. The first is that the young generations perceive a positive relationship between their contributions to the system and the benefits they expect to get themselves when they are old. This relationship can be modelled in various ways. In Browning (1975) and Boadway and Wildasin (1989a,b) voters believe that the pension system decision will remain unchanged indefinitely. The assumption is explained by infrequent voting or noting that the analyses apply only to steady states. Another possibility is to assume a social contract that ties the hands of the next voting majority. Kotlikoff, Persson and Svensson (1988) studied how a social contract, which benefits both young and old, can be formulated. Verbon (1987) and van Dalen and van Praag (1993) relate the future levels of social security positively to the current level with declining weights. In Hu's (1982) analysis the link between the current and future levels of social security is uncertain, but positive.

The second factor explaining public pensions is intergenerational altruism. Cuckierman and Meltzer (1989) show how the extent of intergenerational distribution in a political equilibrium depends on the strength of the voter's bequest motive and on the general equilibrium effects of the policy. If a voter is obliged to leave negative private bequests, he is in favour of public transfers from young to old.

The majority of pension systems generate intragenerational redistribution. In Tabellini's (1990) model, poor altruistic young people, as well as the elderly, also support the public pension system because it helps them to support their parents[5]. Conesa and Crueger (1998) note that the support for PAYG social security depends largely on the idiosyncratic income risks that the heterogeneous individuals face.

Verbon's fourth factor explaining pension systems is that the elderly force the young to maintain the system by political power. One can then ask where the limits of such behaviour are if there is no altruism. In simple two-period models, where there are no price effects, a majority voting rule leads to corner solutions of having no pension system or to a system where the retired use all the national wealth, depending on which generation is larger. One solution is to assume a representative democracy, in which government weights a different generation's utilities differently in decision-making. The use of an ad hoc weight function is not, however, a preferable solution.

Bütler (2000) analyses the majority voting aspect of several pension policy options using a computable OLG model, which describes a small open economy. The studied (permanent) reforms are cuts in benefits and increases in payroll taxes, in the earmarked consumption tax rate and in the retirement age. The simulations show that a higher retirement age dominates the other options. The closing rule of the rest of the public sector is shown to be important, since the amount of tax distortions generated by the pension system depends on this rule. The pension contributions paid by individuals do not affect their benefits in the model. This assumption is, consequently, also important for the results.

One feature of the economy, which might set limits to the intergenerational redistribution, and is absent from Bütler’s study, is the general equilibrium price effects. Lassila and Valkonen (1995) show that if a small economy joins a currency union, the voted replacement rate would be higher, since the interest rate reaction generated by the expansion of the PAYG system is missing.

These studies reveal that simulation models have many advantages over the theoretical two-period OLG approach. Computable models can incorporate a much more detailed description of, for example, the household lifecycle decisions, of social security rules and of the macroeconomic features of the economy.

5.2 Indicators of political support

A numerical OLG model allows one to calculate the utility consequences of policy changes for all cohorts, current and future. These utility gains and losses can be used in forming indicators of political support for various possible policies. We call these voting indicators.

Technically, we compare the baseline development with an alternative pension policy choice to see which is preferred by current households. ´Preferred´ refers to lifetime utility calculations between the two alternatives, where in both cases the future path of policy variables is believed with certainty. Next we ask whether the baseline path will be preferred in the next period, against the alternative of choosing the other policy option and staying on that path thereafter. Then we move on to the following period, and repeat the exercise. By calculating the share of winners we get a series of numbers, one for each pe-

[5] See, however, Mulligan and Sala-I-Martin (1999) for a critical assessment of the Tabellini’s approach.

riod. This is one ***voting indicator***. It is only defined against an alternative, which consists of a set of future paths each starting from the baseline path but at different points in time.

It is not clear whether we should consider the votes of the total adult population or just the working-age population. If pension policy decisions are actually made in labour market institutions, it may well be that the opinions of the working-age people count much more than those of pensioners. This may well be the case in Finland, where the statutory earnings-related pension system was created in co-operation with labour market organisations, and they are represented in the administrative bodies. They also negotiate together with the representatives of the central government about the future development of the pension scheme (see Lassila and Valkonen 2001b). We calculate the voting indicators also for those in working age.

The policy measures in the voting analysis have been implemented unexpectedly; the voters' had not anticipated them. The size of welfare changes is measured by compensated variations. In the FOG model, relative compensated variations by generations are measured by $100(\ln E_s - \ln E_c)$, where E denotes discounted lifetime consumption expenditure, s refers to the simulation run and c is consumption necessary to achieve the baseline utility at simulation prices.

Summary of results

Longevity adjustment:

In the Kela-Eurostat population scenario life expectancy increases. Thus it is not surprising that most people alive at present lose due to the longevity adjustment. Older workers realise they will get lower pensions than they have previously thought. They have only a few more years to work, and the contribution rate will not decline notably during that time. Middle-aged workers face bigger cuts in pensions, but also slightly lower contribution rates in the future. Young workers will face the biggest cuts of those working during the change, but they will also have time to see large reductions in contributions. Thus, it is a question of balancing the losses from benefit cuts and the gains from lower contributions. For voters at the time of the change, the balance is negative. All future generations will gain.

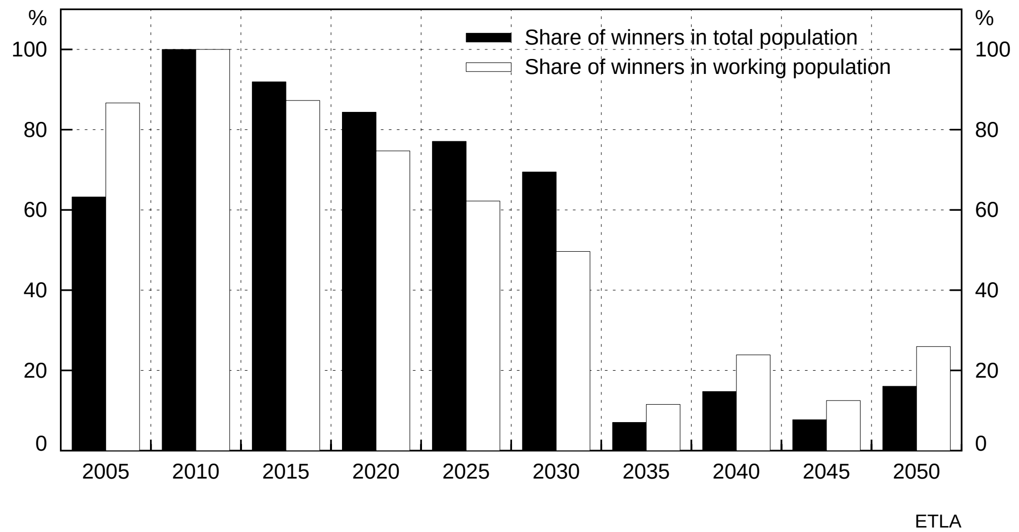
The case is the opposite to that of creating a PAYG pension system, where initial generations gain and future generations pay that initial gain. Here a (mostly) PAYG system is slightly reduced, current generations pay that bill, and future generations jointly enjoy the result.

Life expectancy is also increasing in Sweden. Thus it is likely that the above analysis, if applied to Swedish voters, would yield similar results. How could the Swedes decide to implement the longevity adjustment? Where does the support come from? Or, is there something wrong with the analysis?

One possibility is that the utility function in the model is badly flawed. Intergenerational altruism may be more common than in the chosen specification. Another possibility is that the decision-makers have ignored the utility analysis. The emphasis may be solely on public finances. Thirdly, the reference scenario may be wrong. Doing nothing may not be a relevant option; the expected increase in contribution rates must be dealt with somehow. We should compare alternative measures of preventing the rise in contributions. Fourthly, the result may be right. Making pension reforms may be too difficult in many countries, or at least reforms are postponed as far as possible.

In our low age ratio scenario life expectancy, in fact, decreases. Voters expect that to happen, and there is support for the policy which would increase the benefits (Figure 12).

Figure 12. Support for implementing longevity adjustment, low age ratio



Fertility-dependent prefunding:

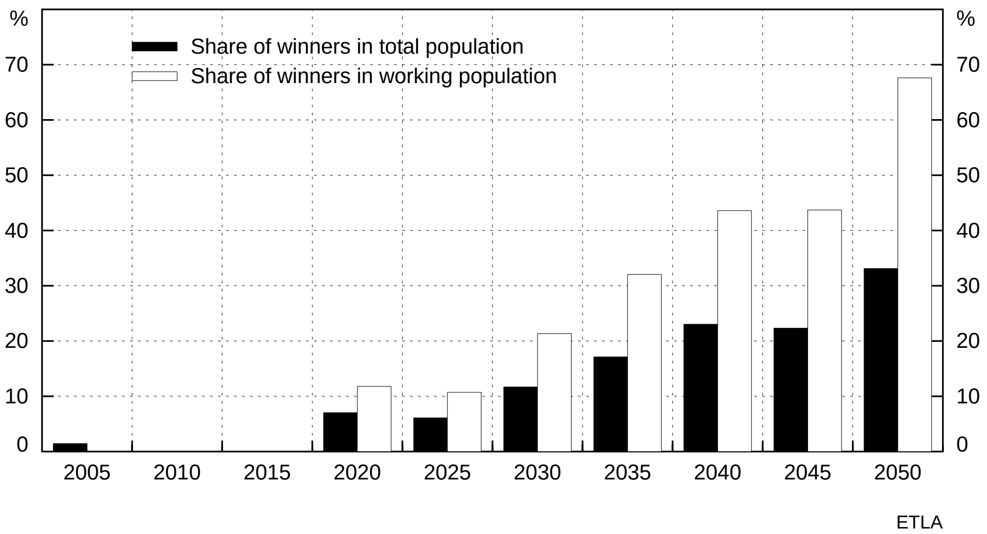
All voters lose both in the base scenario and in the high age ratio alternative. The losses are 4 – 5 times larger in the latter. In both scenarios fertility is declining, which requires more funding and higher contributions. This policy is very unpopular.

PasTEL-indexing:

Almost all voters lose in the base scenario; only old pensioners may gain a little. Again, the losses are much larger in the high-age ratio where the wage bill grows much more slowly than in the base scenario. But after 2020 some support also turns up, starting from young workers. In 2050 a majority of workers would support the change (Figure 13). The fastest decline in the working-age population is passing, and workers start to gain more from the reduced contributions. Moreover, the total wage index gives larger pensions than the current index after the year 2075.

One general feature emerges. The opposition to measures is the stronger the more effects the measures will have. Fertility-dependent funding would be very unpopular if fertility were expected to decline rapidly. The longevity adjustment would be easier to agree upon, if longevity were not expected to rise. Although this is unsurprising, it carries a lesson: the

Figure 13. Support for changing to the PasTEL index, high age ratio



policy rules should be implemented well in advance of the actualisation, or the general expectation of future actualisation, of the problems.

VI CONCLUSIONS

Our two starting points were that the demographic risks are larger than generally realised and that the current PAYG pension systems redistribute the risks mainly to the future working-age citizens. After that we presented three methods for improved intergenerational redistribution and simulated their effects.

A link between longevity and pension benefits impresses us as being well-justified and easy to implement. If information about the likely reduction in pensions is given early enough, individuals can already adjust during working age. The same applies to fertility-adjusted prefunding, since the financial burden is distributed to the whole working life. The wage bill indexation has two faces. The long-run trends in demographics and productivity are easier to foresee and adjust, but the short-term variations are not, which might be a problem in some cases (if the business cycles are strong, the pensioner is credit-constrained and the minimum income transfers are low). Another problem is the markedly higher benefits and costs generated by a shift to a pure total wage index. We solve both the problems by using the PasTEL-index, which combines the total wage index with a cost-of-living index.

Pension policies in Finland aim, quite correctly, at postponing the actual retirement age and increasing the rates of return on funds. One cannot, however, count on the success of these policies. And even if they succeed, unfavourable demographic outcomes may result in very high contribution rates. The mechanisms and rules studied here would react automatically to demographic developments. If no demographic surprise took place, the measures would have no effects, except the longevity adjustment, which would react to the increase in life expectancy. If demographics turned out to be very unfavourable, the measures would effectively alleviate the consequences to the pension system.

The overall outcome of this study is that if current pension systems use all the information included in the population forecasts more efficiently, the allocation of risks can be improved without fundamentally changing the systems. As many of the benefits require that the measures are carried out early enough and planned using a very long horizon, it is better that the reactions are based on rules rather than on discretion. The voting analysis also supports the idea of early implementation. Furthermore, as each of the above mentioned measures has its own advantages and weaknesses, some combination might be optimal.

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Appendix 1. Actuarity and welfare effects of the policy measures

Some additional effects of the above-suggested policy measures are presented in the following pages with figures. The criteria used for various policies require more explanation. Figures 13, 15 and 17 give information about the generation-specific actuarity ratios. Figures 14, 16 and 18 describe the changes in welfare.

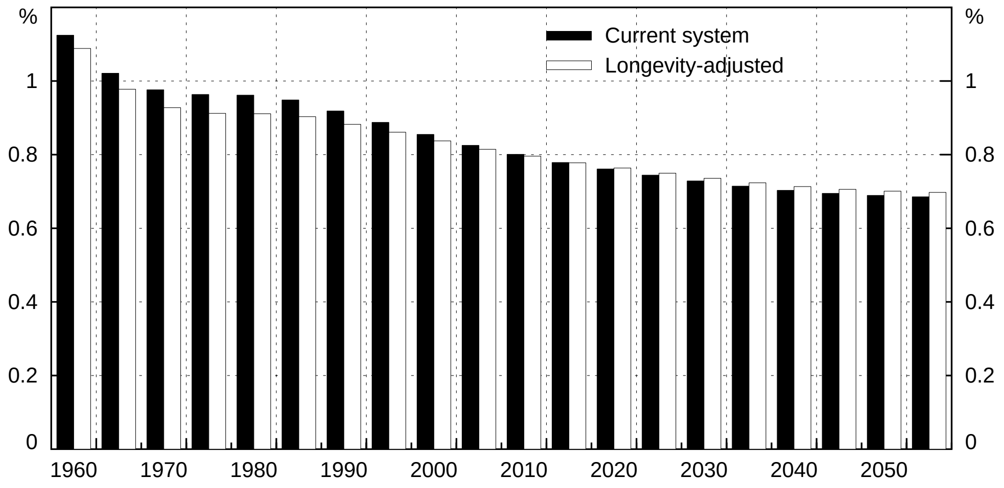
As an intergenerational measure of the connection between benefits and contributions we define the following. *The actuarity ratio is the ratio of a cohort's discounted benefits from the pension system to its discounted sum of payments to the pension system.* The benefits include old-age pensions, denoted by z, and, combined into s^Z, disability and unemployment pensions and all other pensions from the earnings-related pension system.

$$\mathrm{A}^R = \left(\sum_{t=1}^{T} s_t^Z R_t + \sum_{t=T_W+1}^{T} z_t R_t \right) / \left(\sum_{t=1}^{T_W} \tau_t^l g_t R_t \right)$$

The measure is closely related to the money's worth calculations familiar from the pension reform discussion in United States.

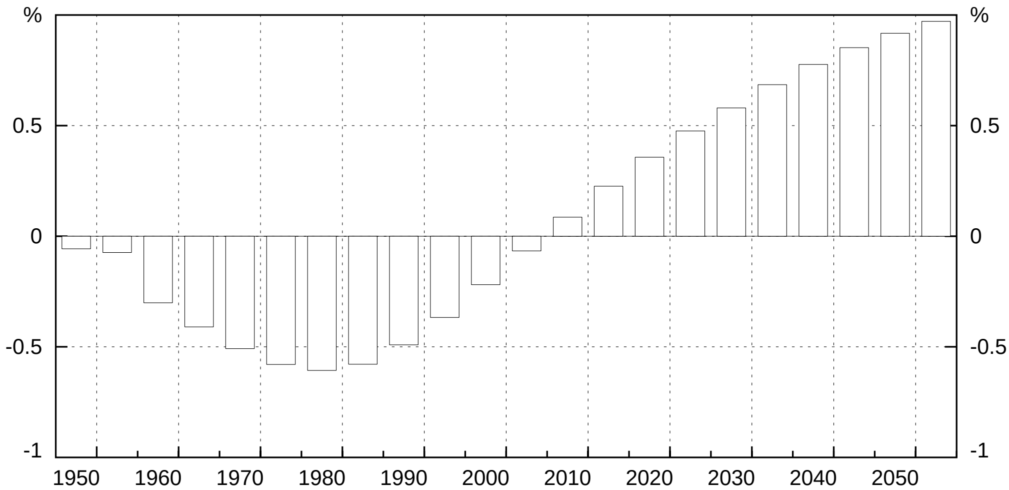
The utility measure shows relative compensated variations by generations. They are measured as logarithmic differences between the new discounted lifetime consumption expenditures and the consumption necessary to achieve the baseline utility at the new prices. Therefore, positive numbers express a welfare gain.

Figure 14. Actuarity rate



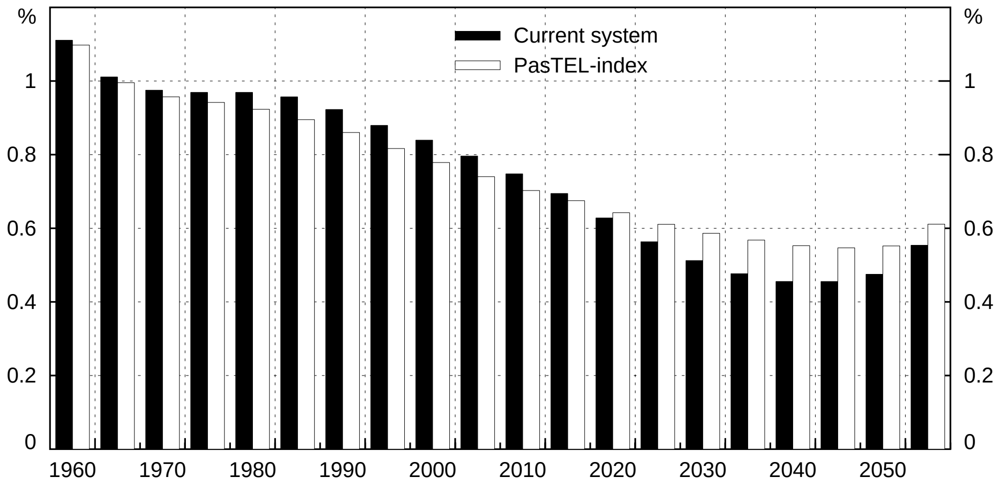
Cohorts denoted by the year of entering the labour force. ETLA

Figure 15. Welfare effects of longevity adjustment



Cohorts denoted by the year of entering the labour force. ETLA

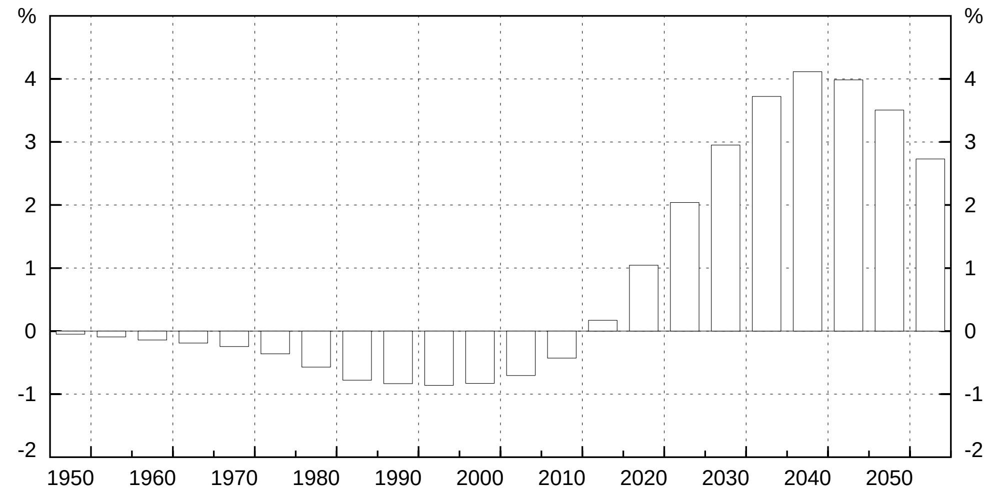
Figure 16. Actuarity rate, high age ratio



Cohorts denoted by the year of entering the labour force.

ETLA

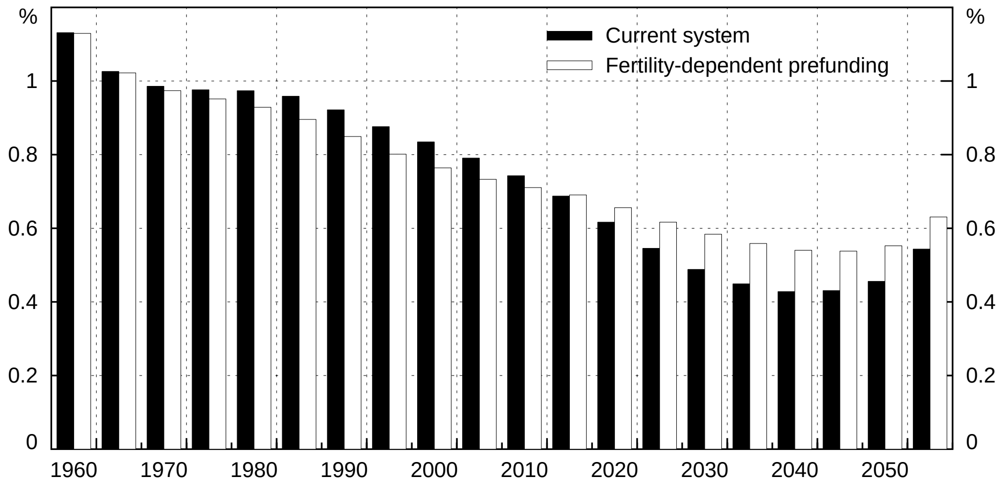
Figure 17. Welfare effects of PasTEL indexation, high age ratio



Cohorts denoted by the year of entering the labour force.

ETLA

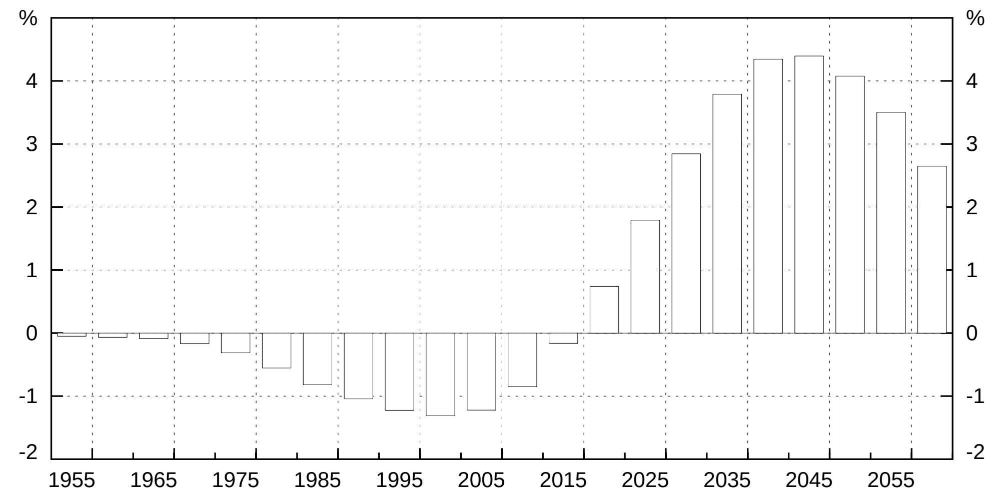
Figure 18. Actuarity rates, high age ratio



Cohorts denoted by the year of entering the labour force.

ETLA

Figure 19. Welfare effects of fertility-dependent prefunding, high age ratio



Cohorts denoted by the year of entering the labour force.

ETLA

Appendix 2. FOG Model

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

Household behaviour

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

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

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

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

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

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

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

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

Households consider the possibility of early death by discounting future consumption and incomes by a factor which includes both the interest rate and the age-specific survival probability. The variable c_t describes consumption, p_t^C its price, l_t is leisure, and of the constant parameters γ is the elasticity of intertemporal substitution, δ is the rate of time preference and ρ is the elasticity of substitution between consumption and leisure.

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

The θ_t parameters depict the replacement rates of the pension system. The b_t parameters describe how the pension rights are related to career earnings. More weight is given to the last working years, because in practice the pensionable wage is aggregated over the last 10 years of each employment contract. As benefits depend on and contributions are paid from wages, there is an indirect connection between contributions and benefits at the individual level. This connection is not one-to-one, however, as all career earnings are not weighed equally. The indexing of accrued pension rights is different in working years and in retirement: in the current TEL index λ_1 is 0.5 and λ_2 is 0.2. The actual equations of the simulation model are the first-order conditions derived from the optimisation problem.

The firms' decision problem

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

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

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

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

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

(12) $$B_t^F = b p_{t-1}^K K_{t-1} \quad \text{and}$$

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

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

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

Markets

The model includes four markets, which clear every period. In the labour market, firms demand labour according to the marginal productivity of labour rule. Households' aggregate labour supply is divided between public and private employment. The wage rate is determined by equating supply and demand in the labour market.

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

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

The presentation above describes only the relevant parts of the model. The actual model includes, for example, government with an intertemporal budget constraint[6], and trade and capital flows with the rest of the world. The modelled pension system also includes prefunded disability and other early pensions, which are not important for our results. Some other details of the pension system are described below.

Current pension prefunding in Finland: old-age pensions in the private sector

The main private-sector earnings-related pension system in Finland, the so-called TEL scheme, is partially funded, but funding does not affect pension benefits. It only affects the

[6] The amount of labour market efficiency losses due to the higher pension contributions depends on both the details of the pension system and on the tax structure of the economy. In the Finnish case, the overall taxation of earned incomes is high even before ageing starts to have an effect. The dual income tax system allows capital incomes to be taxed by much less. These features emphasise the benefits of labour income tax smoothing, which could be achieved via intergenerational redistribution of demographic risks.

level and time path of contributions. Funding is collective but based on individual pension rights. Currently the main prefunding rules are as follows.

A part of old-age pension benefits, payable after age 65, is funded for each employee. Funding takes place between ages 23 – 54, so only benefits accrued during those years are (partially) funded. The degree of initial funding is below one-third.[7] of the 1.5% (of wage income) pension right accruing every year, 0.5% is funded. The present value of accrued rights is calculated using a 3% discount rate and a mortality table. No funding is done for benefit increases due to indexation.

Funding of disability and unemployment pension takes place when the case occurs. The initial funded share is 80% and, again, no funding is done for benefit increases due to indexation. The pensions are paid, and funded, only until age 65. After that the pensioner receives the old-age pension.

In the following we concentrate on old-age pensions. We first describe the prefunding of the average employee's future benefits, and how the fund is run down during the retirement years. Then we aggregate to the total population level, to be able to present the dynamics of total funds, the mechanism of contribution determination, and the use of the yield of funds.

Prefunding on the individual level

Every year, a new pension right accrues for each worker, and a part of the present value of the right is prefunded. For someone already retired, the money prefunded in his or her working years is used to pay a part of his or her pension. Equations (14) and (15) below describe these funding rules for the average worker and pensioner in each age group i in period t. The gross labour income of the average worker in age group i is denoted by g.

(14) $$h_{t,i}^{IN} = a\sum_{j=65}^{M} kg_{t,i}S_{t,ij} /(1+r^{h})^{j-i} \quad i = 23\ldots54$$ individual accumulation rule

(15) $$h_{t,i}^{OUT} = -\sum_{j=23}^{54} h_{t-i+j,j}^{IN}(1+r^{TEL})^{i-j} \quad i = 65\ldots M$$ individual decumulation rule

According to equation (14), a share a of the present value of the pension right accruing in period t to workers aged between 23 - 54 is put in the funds. The present value includes all old-age pension years, from 65 to a maximum age denoted by M. The labour income g creates a pension right for each year from age 65 onwards. For prefunding purposes, the magnitude of this right is evaluated ignoring all future changes due to wage or price developments. Thus the value of the right is simply kg for each retirement year. Currently, k is 1.5%.

[7] There is no specified target for the share that is funded. Before 1997 funding between ages 23 – 54 was "full", in the sense that if there had been no wage inflation, the 5% nominal yield requirement of the funds would have resulted in funds sufficient to pay out, without any PAYG financing, exactly the benefits whose rights had accrued between ages 23 – 54. Needless to say, there was inflation both in prices and in wages, and funding was far from full. The changes made in 1997, described in Lassila and Valkonen (2001b), were calibrated so that the required funding would stay at the prevailing level, and 0.5% is a result of that calibration.

The discount factor includes both an interest rate and survival probabilities. The *ex ante* calculatory fund rate of interest, used in the prefunding rule (14), is administratively set to be very low, so that the pension institute could yield it in most circumstances. We denote it by r^h. The term S in (14) describes the expected effects of mortality. Only a share S of those in age group i in period t is expected to be alive at age j.

Equation (15) states that, for a retired person, the amount prefunded earlier (when the current pensioner was between ages 23 - 54) for period t's pension, and the interest accrued to those funds, is used to pay a part of the person's pension (the rest comes from the PAYG part). The interest accrued is calculated *ex post* using another administratively set interest rate, the so-called *TEL-calculated interest rate* (which follows approximately the average market yield plus a margin, but is assumed here to be constant for a simpler exposition).

Equations (14) and (15) are in practice interesting only to pension companies, as they are used in calculating their pension liabilities. Each company is responsible for the prefunded parts of the pensions of those insured in the company. The companies are jointly responsible for the rest of the pensions. But the equations are important, of course, for the aggregate dynamics of the pension system, especially for the level and time path of the contribution rate.

Aggregate pension funds and the contribution rate

The total amount of new funding in period t is obtained by multiplying the average individual funding in age group i, described in equation (14), by the number of workers n in the age group, and summing over all age groups. This is done in equation (16). The total amount withdrawn from the funds is obtained analogously (equation 17). Three other aggregates are defined in equations (18) to (20): the total wage bill, from which the pension contributions are collected, the total amount of old-age earnings-related pension expenditure, where the average individual pensions are denoted by z, and the total amount of other transfers from the pension sector.

(16) $$A_t = \sum_{i=23}^{54} n_{t,i} h_{t,i}^{IN}$$ new funding, total

(17) $$W_t = \sum_{i=65}^{M} n_{t,i} h_{t,i}^{OUT}$$ withdrawals from the funds, total

(18) $$G_t = \sum_{i=18}^{64} n_{t,i} g_{t,i}$$ total contribution base (wage bill)

(19) $$Z_t = \sum_{i=65}^{M} n_{t,i} z_{t,i}$$ total old-age pension expenditure

(20) $$S_t^Z = \sum_{i=18}^{M} n_{t,i} s_{t,i}^Z$$ other pensions from the TEL system

The dynamics of the total amount of funds, *H*, follow from equation (21) and the contribution rate is determined as a residual from equation (9).

$$(21)\qquad H_t = H_{t-1}(1+r^{TEL}) + A_t - W_t$$

$$(22)\qquad \tau_t^I G_t = Z_t + S_t^Z + A_t - W_t - H_{t-1}(r - r^{TEL})$$

Contributions must be sufficient to cover that part of pension expenditure which does not come from withdrawals from the funds, plus new funding and transfers, minus the difference between the real yield *r* on the funds and the TEL-calculated interest rate.[8]

To see the role of demographics in the determination of contributions better, we insert equations (16) - (20) into equation (22) and reorder.

$$(23)\qquad \tau_t^I = \frac{\sum_{i=65}^{M} n_{t,i} z_{t,i}}{\sum_{i=18}^{64} n_{t,i} g_{t,i}} - \frac{\sum_{i=65}^{M} n_{t,i} h_{t,i}^{OUT}}{\sum_{i=18}^{64} n_{t,i} g_{t,i}} + \frac{\sum_{i=23}^{54} n_{t,i} h_{t,i}^{IN}}{\sum_{i=18}^{64} n_{t,i} g_{t,i}} + \frac{\sum_{i=18}^{M} n_{t,i} s_{t,i}^{Z}}{\sum_{i=18}^{64} n_{t,i} g_{t,i}} - \frac{H_{t-1}(r - r^{TEL})}{\sum_{i=18}^{64} n_{t,i} g_{t,i}}$$

The first term on the RHS is the ratio of pension expenditure to the wage bill. The main demographic variable is the number of pensioners relative to wage earners. The second term is like the first one: the number of pensioners relative to wage earners is the crucial demographic factor. The third term, new funding relative to the wage bill, is demographically rather invariant: the numerator depends on the number of people between ages 23 and 54, and the denominator on those between ages 18 and 65. The overlap is 32 years, and in addition the labour force participation rates for persons below the age of 23 and above the age of 54 are low. The fourth term includes the total adult population in the numerator and the working-age population in the denominator. It varies with demography, but it should be kept in mind that other transfers from the pension system are rather small compared with old-age pensions. The fifth term, the interest accrual over the TEL rate, shows that the amount of funds relative to the wage bill is important for the contribution rate if the actual yield exceeds the administratively set rate. In the following we assume that the two rates are equal.

If the goal is to smooth the time path of contributions, equation (10) then shows the approximate effect of Finnish-type prefunding. The first part is the normal pure PAYG effect, which is reduced by the second term, in a way similar to reducing the pension benefit level. The cost of this reduction is the third term, which is roughly constant over time. So the variability in the PAYG part is reduced by transforming a part of it to a constant.

The question we ask is this: should we increase the role of this smoothening? The reasoning is simple: currently the amount withdrawn from the funds reflects only the number of current pensioners. It should perhaps also reflect the number of current workers. The third term will then also reflect the ratio of current workers to future workers. It becomes more responsive to demographic variations.

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[8] The yield differential varies between pension companies, and is the main factor in their competition for customers, which are employers providing pension insurance for their workers.

Fertility-dependent prefunding

We amend current old-age pension funding rules so that, for each funding cohort (a cohort between ages 23 – 55), the amount funded also depends on the size of the funding cohort relative to the size of recently born cohorts. The idea is that we can estimate from the size of recently born cohorts the size of the work force in those future periods when the funding cohort is retired. This fertility effect varies between cohorts, and for each cohort it varies over time.

The fertility correction changes equation (14) into (14'):

$$(14') \qquad h_{t,i}^{IN} = ab_{t,i} \sum_{j=65}^{M} kg_{t,i} S_{t,ij} / (1 + r^h)^{j-i}$$

where $b_{t,i} = n_{t-i,0} / f^i(n_{t-1,0},..., n_{t-i+1,0})$

The share of the present value of benefits that is prefunded is no longer *a*, but instead *a* multiplied by the term *b*, which depends on the size of the funding cohort (at its birth year), compared with the birth sizes of the younger cohorts. If the funding cohort is bigger than the younger cohorts are, *b* exceeds unity and thus funding is increased. If fertility increases and younger cohorts are bigger, funding declines compared with current rules. If the funding cohort and younger cohorts are equal in size, *b* equals 1.

The functions f^i are formulated so that, in effect, the future generations are represented with weights corresponding to their presence in the labour force during the years when the now funding cohort is retired. All those future generations cannot be included in the fertility correction: funding ends at age 54, and the youngest cohort included is thus 53 years younger than the funding cohort. But when the cohort reaches, for example, the age of 90, there are persons 72 years younger paying pension contributions. Still, the fertility correction captures a sizeable fraction of the future labour force. Details of the f^i functions are presented in Lassila and Valkonen, 1999.

PasTEL index

PasTEL index is otherwise identical to the current TEL index used in the calculation of pension benefits, except that the earnings-related part is not linked to the wage level, but total wages. Equations (5) and (6) are adjusted correspondingly as follows:

$$(5') \qquad z^{ref} = \sum_{t=1}^{T_W} \theta_t b_t (1 - \tau_t^e) g_t \left(\frac{(1 - \tau_{T_W}^e) L_{T_W} w_{T_W}}{(1 - \tau_t^e) L_t w_t} \right)^{\lambda_1} \left(\frac{p_{T_W}^C}{p_t^C} \right)^{1-\lambda_1}$$

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

Longevity adjustment

The pensions are adjusted to the increasing life expectancy simply by taking into account the increasing longevity in the value of 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 v and is calculated forward from age 65 (period 10), is as follows.

(25) $$a_{65}^{v} = \sum_{i=10}^{14} (1+r^{a})^{i-10} S_{v-1,10,i} (1-0.5(S_{v-1,10,i} - S_{v-1,10,i+1})) \left(\frac{w_{v+i-10}}{w_{v}} \right)^{\lambda^{a}}$$

The present value of a unit pension is a discounted sum of terms generated during various retirement years. The terms have three parts. The first is the discounting factor in which the discount rate is r^{a}. The second describes longevity. The first subscript of the S-terms, *v-1*, demonstrates that life expectancy is evaluated using information available at the first period *v*, i.e., the observations from period *v-1*. Since these probabilities change only at 5-year intervals, the calculation has been made by considering the average longevity during the period on condition that the person is alive at age 65. The third term describes indexation of the unit pension to wages. The parameter value λ^{a}, used in simulations, is 0.

The longevity adjustment coefficient E_{v0}^{v} is a ratio of two *a*-numbers as follows.

(26) $$E_{v0}^{v} = a_{65}^{v0} / a_{65}^{v}$$

Correspondingly, the pension of a person becoming 65 years old during period *v* is:

(6’) $$z_{t} = E_{v0}^{v} z^{ref} \left(\frac{(1-\tau_{t}^{e}) w_{t}}{(1-\tau_{T_W}^{e}) w_{T_W}} \right)^{\lambda_2} \left(\frac{p_{t}^{C}}{p_{T_W}^{C}} \right)^{1-\lambda_2}$$

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