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PENSION PREFUNDING, AGEING, AND DEMOGRAPHIC UNCERTAINTY

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ABSTRACT: Pension prefunding can be used to smoothe contribution rates in economies where ageing will increase pension expenditure. But how extensive should prefunding be, in a defined benefit pension system, when there is considerable uncertainty concerning future mortality, fertility, and migration? We study the prefunding rules in the Finnish earnings-related pension system with an OLG simulation model. Increasing the degree of prefunding could yield a more even intergenerational outcome and make future generations' position better, but it is quite possible to overshoot and harm current generations too much. Making the degree of prefunding fertility-dependent seems a useful alternative. With declining fertility, current large cohorts would pay modestly increased contributions. The accumulated funds, however, will be huge in relation to the wage bills of smaller future cohorts.

Key Words: Pensions, partial prefunding, ageing, demographic uncertainty

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TIIVISTELMÄ: Tavoitteena on tutkia, miten työeläkkeiden rahastoinnilla ja rahastojen käytöllä voidaan vaimentaa väestön ikääntymisen aiheuttamaa eläkemaksujen nousupainetta. Lähtökohtana on nykyinen Suomen yksityisen sektorin työeläkejärjestelmä. Rahastopolitiikan arviointikriteereinä käytetään vaikutuksia kansantaloudellisiin muuttujiin, työnantajan ja työntekijän eläkemaksuihin, eläkejärjestelmän oikeudenmukaisuuteen ja kotitalouksien hyvinvointiin. Tulosten mukaan rahastoinnin kasvattaminen nyt, kun työvoiman määrä on vielä suuri, olisi hyvä tapa tasata väestön ikääntymisen kustannuksia eri sukupolvien kesken. Erityisen suositeltavaa lisärahastointi on silloin, jos ikääntyminen on odotettua nopeampaa.

Väestöepävarmuudelta voidaan suojautua tehokkaasti ottamalla syntyvyys huomioon rahastointisäännössä. Tuloksia on laajemmin esitelty julkaisussa Eläkerahastot ja väestön ikääntyminen, Eläketurvakeskuksen tutkimuksia 1999:2 ja ETLA B 158.

Asiasanat: työeläkejärjestelmä, rahastointi, ikääntyminen, väestöepävarmuus

1. INTRODUCTION

The debate concerning pension funding has two main branches. One, perhaps somewhat passing, is that between PAYG and fully funded systems, which is also found under the heading of pension privatisation. The other, emerging branch concerns prefunding as a tool for preparing for the effects of population ageing on pension expenditures. The former branch relates funding more to defined-contribution systems, whereas the latter include issues related specifically to prefunding in defined-benefit pension systems. This paper belongs to the latter category.

Our paper makes the point that once the decision to prefund has been done, the rules for funding have to be decided, and these rules are crucial for the success of the prefunding policy. The rules define the amounts of new funding and withdrawals from funds. We concentrate on rules that relate prefunding to pension rights and demographic developments, and discuss only shortly other types of funding.

Our starting point is the current Finnish private-sector earnings-related pension system. It is based on a defined benefit principle, but is at the same time partially funded with forward-looking funding rules. We analyse the impacts of changing the prefunding rules, keeping the determination of the benefits intact and letting the contribution rate to adjust. The method we use is to simulate the policies with a numerical overlapping-generations model.

The paper also characterises the impacts of demographic uncertainty on the pension system and the aggregate economy. Analysis of the previous population forecast errors shows that the uncertainty is much larger than generally is recognised considering the time horizons used by pension systems. This uncertainty both increases the need for preparing for future and makes the creation of good funding rules a demanding task.

The paper is organised as follows. Section 2 surveys recent relevant literature and describes some existing prefunding practices, especially those in Finland. In Section 3 we describe both the stochastic population simulations and the overlapping-generations general equilibrium model that uses these simulations as inputs. Section 4 analyses the effects of increasing the degree of prefunding in the Finnish pension system, and Section 5 discusses the effects of complementing the current rules with a fertility-dependent component. Section 6 concludes.

2. PREFUNDING IN DEFINED BENEFIT SCHEMES

2.1.1 Background

Pension reform literature is passing the stage in which there was a vigorous fight in favour and against privatisation of the pension system. Privatisation, in its most simple version, means a shift from a public defined benefit pay-as-you-go system to a private fully funded defined contribution system. The consensus, if any, is based on the recognition of, on one hand, the efficiency, intergenerational fairness and transparency of the private system, and on the other, the low individual risks and administrative costs of the public system. The role of pre-funding policy is, according to this consensus, less important than the most enthusiastic supporters of privatisation claim, but is seen more as means of smoothing the intergenerational incidence of ageing costs (see e.g. Sinn 1998).

Sinn (2000) states that, in present value terms, there is nothing to be gained from a transition from PAYG to funded system, even though the latter would offer a permanently higher rate of return[1]. But he sees a partial transition to a funded system as a way to overcome current demographic crisis. Funds would replace missing human capital with real capital, and thus help smoothing tax and child rearing costs across the generations.

Changing circumstances may warrant a change in the degree of funding within the pension system. Orszag and Orszag (2000) note that committing to the up-front costs associated with moving from a PAYG system to a prefunded system – without any assurance that the costs could be recaptured if the reform turns out to be less beneficial than had been anticipated – may be unwise. Therefore funding rules should be flexible.

If the aim is to stabilize the contribution rate in a defined benefit system, many kinds of flexibility in prefunding might be warranted. Short term variations in the tax base due to business cycles can be addressed by buffer funds. Buffers are also used to alleviate the intergenerational burden due to retirement of baby boom generations. We consider the most important long term risk to be deviations in demographic variables, perhaps going beyond the known variation in the size of current age cohorts.

Fertility and pension system have been connected in many studies. Sinn (1998a) emphasises the role of a PAYG system as an insurance for individuals against not being able to have children, or having ungrateful children who are not willing to take care of their parents. He notes that the system unfortunately also facilitates free-riding – voluntarily not having children. The question whether pension benefit should be related to the number of children the retiree has had, has also been addressed, see e.g. Sinn (1998b) and the references therein. Many current public pension schemes have already features which promote fertility. The often used measure is to allow pension accrual to take place also during maternity leave.

Pension prefunding is a fundamental part of most voluntary pension schemes. Palacios and Pallares-Mirallès (2000) classify the mandatory schemes according to the financing principles and find that about half of mandatory schemes are purely pay-as-you-go financed. About a third have some reserves, even though they are based on a defined benefit (DB) principle. In most cases these funds are, however, transitory and dissipate after the schemes mature.

The reasons given for prefunding vary. In Sweden, the initial idea was to neutralize the negative effect of a PAYG scheme to private saving and to use the reserves as a buffer against cyclical variations (Sundén 2000). In Finland, the official explanation for partial funding was the need to smoothe the expenditure pressures due to population ageing, but also other interpretations have been given. The Employees' Pensions Act (TEL) was created in negotiations between trade unions and employers' organisations. Short-term bargaining considerations and the need for political support may well have been important factors (see Lassila and Valkonen 2000a).

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[1] The main point is that the determination of pension rights can be shifted in a DB scheme to be the same as in a DC scheme. Thereafter it is only question of the size and implications of the intergenerational income transfer due to the financing method of the pension system.

2.2 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 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[2]: 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 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 in the retirement age. Then we aggregate to 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, new pension right accrues for each worker, and a part of the present value of the right is prefunded. For someone already retired, a part of the money prefunded in her working years is used to pay a part of her pension. Equations (1) and (2) 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*.

(1) $$h_{t,i}^{IN} = a\sum_{j=65}^{M} kg_{t,i}S_{t,ij} / (1+r^{h})^{j-i} \qquad i = 23,\ldots,54 \quad \text{individual accumulation rule}$$

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

According to equation (1), a share *a* of the present value of the pension right accruing in period *t* to workers aged between 23 - 54 is put to funds. The present value includes all old-age pension years, from 65 to a maximum age denoted by *M*. The labour income *g*

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[2] 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 would have 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 (2000a), were calibrated so that the required funding would stay at the prevailing level, and 0.5 % is a result of that calibration.

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 %.

The discount factor includes both an interest rate and survival probabilities. The fund rate of interest, used in this calculation, is administratively set. We denote it by r^h. The term S in (1) describes the expected effects of mortality. Only a share S of those in age group i in period t is expected to be alive in age j.

Equation (2) 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 using another administratively set interest rate, the so-called *TEL-calculated interest rate* (assumed here constant for a simpler exposition).

Equations (1) and (2) are in practise 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 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 (1), by the number of workers n in the age group, and summing over all age groups. This is done in equation (3). The total amount withdrawn from funds is obtained analogously (equation 4). Three other aggregates are defined in equations (5) to (7): 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.

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

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

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

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

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

The dynamics of the total amount of funds, *H*, follow from equation (8) and the contribution rate is determined as a residual from equation (9).

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

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

Contributions must be sufficient to cover that part of pension expenditure which does not come from withdrawals from funds, plus new funding and transfers, minus the difference between real yield *r* on funds and the TEL-calculated interest rate[3].

To better see the role of demographics in the determination of contributions, we insert equations (3) - (7) into equation (9) and reorder.

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

The first term on the RHS is the ratio of pension expenditure to 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 wage bill, is demographicly 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 ages below 23 and above 54 are low. The fourth term includes all adults in the numerator and working-age people 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 to 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 the two rates equal.

If the goal is to smooth the time path of contributions, equation (10) shows then roughly the 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 in time. So the variability in the PAYG part is reduced by transforming a part of it to a constant.

The question we ask is: 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 perhaps should reflect also 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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[3] 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.

Besides funding, there are other ways a pension system can prepare for different elements of demographic uncertainty. Longevity could be dealt with by linking pension benefits to life expectancy. This has been done in Sweden (see Sherman, 1999). Net emigration can be a very difficult problem, because it may leave very little time to adjust. One possibility is indexing the benefits to the developments of the wage bill (see Disney, 1999). Partial rather than full indexing may be called for, as the latter may make the benefits very unpredictable, which should be avoided as retired persons have usually very limited possibilities to react to benefit cuts. Fertility changes, on the other hand, affect the pension system with a longish delay. Lassila and Valkonen (2000b) compares longevity-adjustment and indexation of the benefits to total wages to the fertility adjustment in prefunding as devices of intergenerational redistribution of demographic risks.

3. THE MODEL

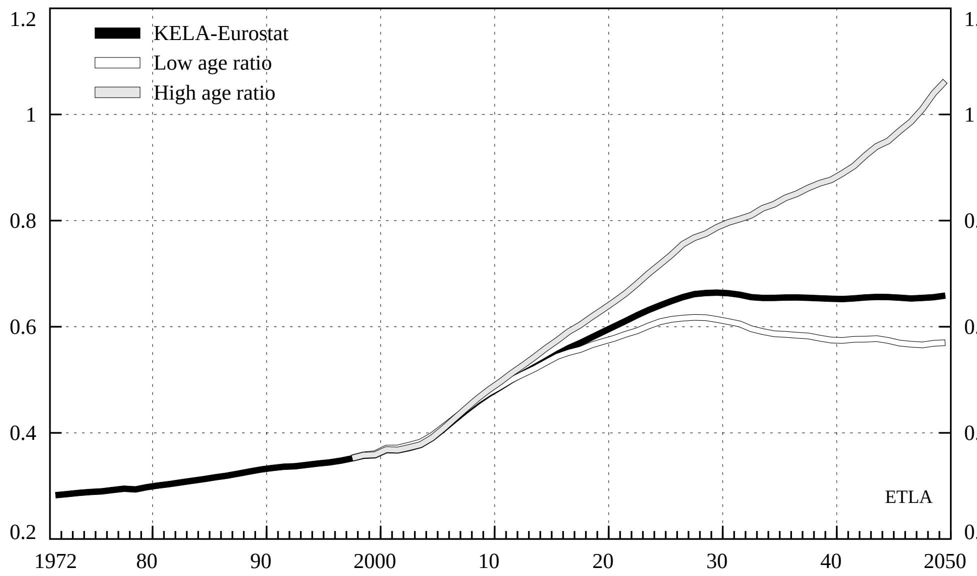
Our main tool is an overlapping-generations general equilibrium simulation model. It uses as inputs different demographic scenarios, produced by stochastic population simulations. Technically this is straightforward. Intellectually there is a gap: there is no uncertainty in OLG model. The households 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. Clearly it would be more satisfactory to have uncertainty included; we feel, however, that the results are interesting enough to fully justify our method, while waiting for more suitable models.

3.1 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. He provided two sample paths for this study. They are reported also in 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 divided by the number of people between ages 20 – 59. From this ordering, the two samples closest to the limits of 80 % confidence interval in 2030 were chosen.

Figure 1 shows these realisations, and the base scenario also. The 80 % confidence interval in the age ratio in 2030 is wide: the limits are 0.613 and 0.787. This can be roughly translated into pension language: with a 10 % probability Finland will have 8 pensioners or more for every 10 working-age persons, and with a 10 % probability there will be 6 pensioners or less for every 10 working-age persons in 2030, provided that the actual retirement age will not increase substantially. In any case, the increase will be large, as the current ratio is 3.5 pensioners for 10 working-age persons.

Figure 1. 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 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.

3.2 OLG 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 demand and supply period-by-period. There is no money or inflation in the model. Households and firms are the 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 (12), lifetime budget constraint (13) as well as determination of gross labour incomes (14), reference pension (15), old-age pensions (16) and the discount factor (17):

$$(11) \qquad Max_{c,l,B} \qquad \sum_{t=1}^{T} \frac{1}{1-\frac{1}{\gamma}} \frac{U_t^{1-\frac{1}{\gamma}}}{(1+\delta)^{t-1}} + \mu \frac{B_T^{1-\frac{1}{\gamma}}}{(1+\delta)^{T-1}} \quad ,$$

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

(13)

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

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

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

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

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

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 (13) 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.

The θ-parameters describe how the pension rights are related to career earnings. More weight is given to the last working years, because in practise 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 on 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: λ_1 is currently 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.

Decision problem of the firms

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 the 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 (19), the CES production function F_t (20), the accumulation condition of the capital stock K_t (21), the determination of the firm's debt B_t^F (22) and the investment adjustment cost function G_t (23).

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

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

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

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

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

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

The equations (18) and (19) 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 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 d 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 of 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. The domestic demand of 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. 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 e.g. the government with an intertemporal budget constraint, and trade and capital flows with the rest of the world[4]. The modelled pension system includes employee's contribution rate and prefunded disability and other early pensions, which are not important for our results. The model's unit period is five years, and the annual funding rules have been modified accordingly. The model is described in more detail in Valkonen (1999) and Lassila (2000).

Actuarity ratio

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.

$$\text{(24)} \quad A^R = \left(\sum_{t=1}^{T} s_t^Z R_t + \sum_{t=T_W+1}^{T} z_t R_t \right) \Big/ \left(\sum_{t=1}^{T_W} \tau_t^l g_t R_t \right)$$

If the actuarity ratio equals 1, the cohort gets the same rate of return on pension contributions than it would have got from financial markets. A ratio less than 1 describes a usual situation in PAYG pension schemes, after the initial generations who have got a ratio in exceed of unity. Actuarity ratio is closely related to the money's worth calculations familiar from the pension reform discussion in the United States.

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4 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 the ageing starts to have effect. The dual income tax system allows the capital incomes to be much less taxed. These features emphasize the benefits of labour income tax smoothing, which could be achieved via prefunding of pensions.

4. BASELINE SCENARIO

Our baseline simulation includes the interaction between population, the pension system and the rest of the economy. The ageing of the population is due to the continuous increase in life expectancy and the low birth rate. According of the official forecast, the Finnish population reaches the maximum in the beginning of the 2020'ies. The main point is, however, that the working age population starts to diminish already after a few years and the amount of pensioners increases strongly, since the baby-boom generations retire. The low retirement age and the maturing of the pension system magnify the economic burden.

The forward-looking firms react to the expected reduction in labour force by lowering the growth rate of investments and by developing labour-saving production methods. The excess demand of labour accelerates the growth of wages, even though also the employer's pension contribution rate rises. The wages are supported by the dampened growth of exports, which improves the terms of trade of the economy. From the point of view of the workers, the outcome is, however, negative, since the higher consumer prices and the higher employee's contribution rate lowers the growth rate of the purchasing power of wages.

In the capital markets, there is initially an excess supply of financial capital due to falling investment rate and the still high pension saving. The generated surplus is invested abroad. The pension saving diminishes, however, gradually and also the aggregate household saving reduces due to ageing. The insufficient saving finally turns the current account surplus to a permanent deficit. With lower marginal product of capital the market value of the firms drops from the initial growth path. In the case of open capital markets, this is compensated to the investors by higher dividends, which can be distributed due to reduced need for investment finance. An alternative view of the capital market development suggests that since the ageing is common to largest countries, the initial high saving rate lowers the interest rate. This falling trend turns after two decades and the interest rate climbs gradually after that, but does not return to the initial level before the end of this century.

According to the baseline scenario, the private sector pension expenditures rise about 20 percentage points and average pension contribution rate rises about 10 percentage points of the corresponding aggregate wages during the first half of the century. The gap is explained by the fact that the pension funding increases. The larger investment returns of the fund mitigates the needed long-term hike in the pension contribution rate. While the benefit determination rules remain intact, the higher contribution rate nevertheless weakens significantly the actuarial fairness of the pension system.

5. EFFECTS OF CHANGING THE PREFUNDING RULES

5.1 Increasing the degree of prefunding

We study the effects of raising the degree of prefunding (parameter *a* in equation 1) of the private sector old-age pensions from one third to two thirds (1 % p.a.) and to one (1.5 % p.a.) from 2005 onwards. Funding still takes place only between ages 23 – 55 and the disability pension funding remains unaffected.

The development of the total contribution rate depends on the demographic trends. In the base alternative (KELA-Eurostat), increasing funding to two thirds results in a roughly horisontal path for the contributions. A higher degree of funding would be over-reacting: contribution rate could be lowered after 2025. This overshooting would be even more pronounced in the low age ratio scenario. But in the low fertility (high age ratio) case a 2/3 degree of funding would not suffice to yield stable contribution rates, see Figure 2.

Similar developments can be seen in actuarity rates (Figure 3). Increasing the degree of prefunding could yield a more even outcome and make future generations' position better, but it is quite possible to overshoot and unintentionally harm current generations too much. The prefunding degree is not an easy policy instrument to use.

5.2 Adding fertility to the determinants of prefunding

Current prefunding rules provide some automatic smoothing of pension contribution rates in the case of changing demographics. As funding takes place for each worker, the more there are retired workers the more there are also funds. And these funds are used to pay a part of the pension benefits of these retired workers. Thus the contribution rates need not rise in full proportion to the number of retirees.

If we think of the ratio of pensioners to workers, current prefunding rules react to the numerator. To stabilize the contribution rate more, also the denominator should be taken into account. This is the subject of this section.

Table 1. Total contribution rate and assets of the pension funds in 2000-2070.

	Total contribution rate, %				Assets, per cent of total wages			
	Current rules	Pre-funding rate 2/3	Pre-funding rate 1	Fertility dep. pre-funding	Current rules	Pre-funding rate 2/3	Pre-funding rate 1	Fertility dep. Pre-funding
Kela-Eurostat								
2000	20.4	20.3	20.2	20.3	139.9	140.0	140.0	139.9
2010	23.9	28.3	32.7	24.8	181.3	228.2	274.8	191.9
2020	27.6	31.5	35.3	28.0	207.3	304.9	401.6	224.7
2030	30.1	31.7	33.3	30.0	219.2	360.3	497.7	240.4
2040	31.2	30.2	29.4	31.0	227.6	395.6	556.3	252.0
2050	32.7	29.8	27.4	32.1	231.9	412.2	583.4	257.2
2060	34.1	30.8	27.9	33.4	232.8	418.0	594.9	256.9
2070	34.6	31.6	29.0	34.2	232.9	420.5	602.1	256.3
Low age ratio								
2000	20.1	20.0	19.9	20.0	132.1	132.1	132.2	132.1
2010	23.6	27.5	31.4	24.6	167.9	209.7	251.1	178.2
2020	26.9	30.3	33.7	27.4	187.9	275.0	361.3	206.9
2030	28.6	29.8	31.1	28.0	196.1	321.5	443.7	217.0
2040	29.0	28.0	27.2	28.2	203.0	350.6	492.3	220.6
2050	30.4	28.0	25.9	29.4	206.5	363.6	513.7	218.2
2060	31.4	28.5	26.0	30.6	202.9	361.1	513.0	208.0
2070	30.6	28.3	26.2	30.7	199.3	356.5	509.6	202.7

High age ratio								
2000	20.3	20.2	20.2	20.3	137.7	137.8	137.9	137.8
2010	24.2	28.5	32.8	26.8	181.3	227.5	273.4	206.2
2020	29.1	32.9	36.7	31.6	213.0	312.3	410.6	271.6
2030	33.8	35.0	36.2	37.3	235.0	385.2	531.2	345.2
2040	38.1	35.8	34.0	37.6	258.3	447.8	627.7	410.6
2050	45.7	39.8	34.9	39.5	280.6	496.3	697.2	445.4
2060	50.8	43.3	37.0	40.2	280.7	503.5	711.1	413.3
2070	46.0	40.1	35.0	37.6	256.9	466.9	667.6	334.0

We amend current old-age pension funding rules so that, for each funding cohort (a cohort between ages 23 – 55), the amount funded depends also 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 will be retired. This fertility effect varies between cohorts, and for each cohort it varies in time.

The fertility correction changes equation (1) into (1'):

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

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 to the birth sizes of the younger cohorts. If the funding cohort is bigger than the younger cohorts, *b* exceeds unity and thus funding is increased. If fertility increases and younger cohorts are bigger, funding declines compared to 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 e.g. the age 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.

Table 2. Total contribution rate and assets of the pension funds in 2070, baseline and with higher interest rate

	Total contribution rate, %		Assets, per cent of total wages	
	Baseline scenario	Higher interest rate	Baseline scenario	Higher interest rate
Kela-Eurostat				
- current rules	34.6	30.8	232.9	272.2
- prefund. rate 2/3	31.6	25.3	420.5	493.9
- fertility depend.	34.2	30.0	256.3	299.4
Low age ratio				
- current rules	30.6	27.3	199.3	231.3
- prefund. rate 2/3	28.3	22.8	356.5	416.9
- fertility depend.	30.7	27.2	202.7	235.0
High age ratio				
- current rules	46.0	41.0	256.9	307.4
- prefund. rate 2/3	40.1	31.6	466.9	557.9
- fertility depend.	37.6	29.7	334.0	403.1

Figure 4 shows that fertility-dependent prefunding would not make much difference in the basic population scenario and in the low age ratio case. But it would make a huge difference if fertility would decline, as in the high age ratio case. The contribution rate would then be somewhat higher than with current rules for about 30 years, but after that the rate would stabilize below 40 per cent instead of rising to 50 per cent.

From figure 4 it seems that a rather modest increase in contribution rates, although for a longish period, facilitates a very sizeable decline later. This is precisely what happens. The simple explanation is that, with declining fertility, there are much more people paying the modestly increased contributions than there will be in the future paying as contributions the PAYG part of current large cohorts. With many payers the funds accumulate and will be huge in relation to the wage bills of smaller future cohorts

Fertility-dependent prefunding also makes actuarity rates more even, especially in the case of high age ratio, see Figure 5.

Macroeconomic and welfare effects

In all the policies described above the pre-funding rate is initially accelerated. Therefore the macroeconomic outcomes are similar and it is sufficient to describe the overall trends.

Shifting the timing and scale of pre-funding involves necessarily adjustments in the contribution rate. From the point of view of aggregate economy, it does not matter whether the employer's or employee's rate is shifted, the impact on net wages is identical. In a defined benefit system, a hike in the contribution rate due to increase in pre-funding represents a pure tax. Consequently, it lowers the incentives to supply of labour during the active funding phase. The overall efficiency outcome is, however, likely to be marginally positive, since the larger investment incomes cut the future top rate of contributions.

The initial reduction in the labour supply due to the jump in the contribution rate reduces marginal productivity of capital and spurs firms to lower somewhat the investment rate. Later this trend reverses. Household saving reacts in a similar way to the variation in the pension contribution rate. The increase in pension saving dominates in the capital markets cutting the current account deficit permanently.

The overall impacts are, as expected, in the case higher funding degree policies more prominent than in the case of birth rate adjustment policy, when the demographic trends follow the official forecasts. The beneficial macroeconomic outcomes of the latter policy are evident only in the high age ratio scenario. In this case the gains of active pre-funding really strike out both because of the strongly reduced distortions in labour supply and the markedly lower foreign net debt, which would otherwise burden heavily the small future household generations.

Any increase in pre-funding reduces the welfare of the current workers due to the lower net wage. Correspondingly, the future households gain. For the final evaluation, one should therefore to be able to add the gains and losses of various household generations. This procedure is, however, subject to many objections. The main features can anyhow be observed from the figures describing the relative compensated variations by generations (see Figure 6). They show that a gain from active pre-funding is possible also in the baseline case, but in the low fertility rate scenario the improvement in welfare is large. This applies especially to the policy of linking the funding rate to fertility.

6. CONCLUSIONS

We have considered the performance of pension prefunding rules in a defined-benefit system and in an environment where there is considerable uncertainty concerning future demographic developments. In the rules, new funding and withdrawals from existing funds are related to accrued individual pension rights, as is currently the situation in the Finnish pension system, and to fertility. Pension prefunding can smoothe contribution rates in economies where ageing will increase pension expenditure. But funds that are sufficient in one demographic outcome are too small in another and may be too high in a third one.

Increasing the degree of prefunding, in relation to accrued pension rights, in the Finnish earnings-related pension system could yield a more even intergenerational outcome and make future generations' position better. The likelihood of demographic scenarios in which this would happen is large with small increases in funding but gets smaller with larger increases funding. It is quite possible to overshoot and harm current generations too much. Thus, a fixed degree of prefunding is hardly the best choice.

Making the degree of prefunding fertility-dependent would not make much impact in the basic population scenario but if fertility would decline, a rather modest increase in contribution rates would facilitate a very sizeable decline later. With declining fertility, there are more people paying the modestly increased contributions than there will be people in the future paying as contributions the PAYG part of current large cohorts. With many payers the funds do accumulate and will be huge in relation to the wage bills of smaller future cohorts. Funding rules that combine accrued pension rights and fertility seem to be worthy of further investigations.

Designing prefunding rules that work well in uncertain demographic environment is not a trivial matter. That should not be used as an argument not to prepare for the future, but instead as a starting point to study alternatives and compare their performance by e.g. simulation studies. Although the tools for such studies are not ideal yet, they provide valuable insights into the properties of various prefunding rules under different demographic outcomes.

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Figure 2. Effects of increasing old-age pension prefunding on pension contributions and funds

Total contributions | **Funds, % of wages**

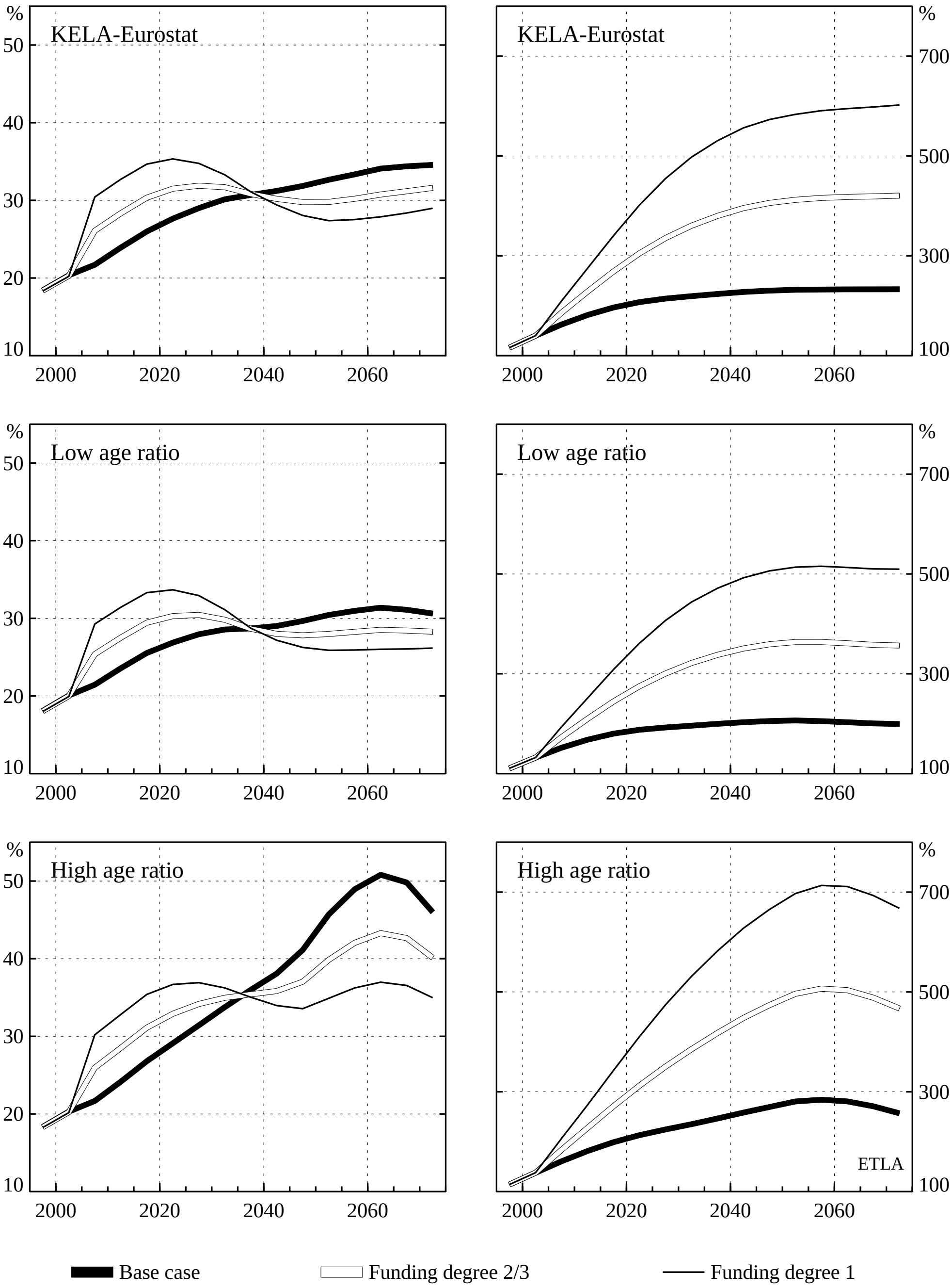
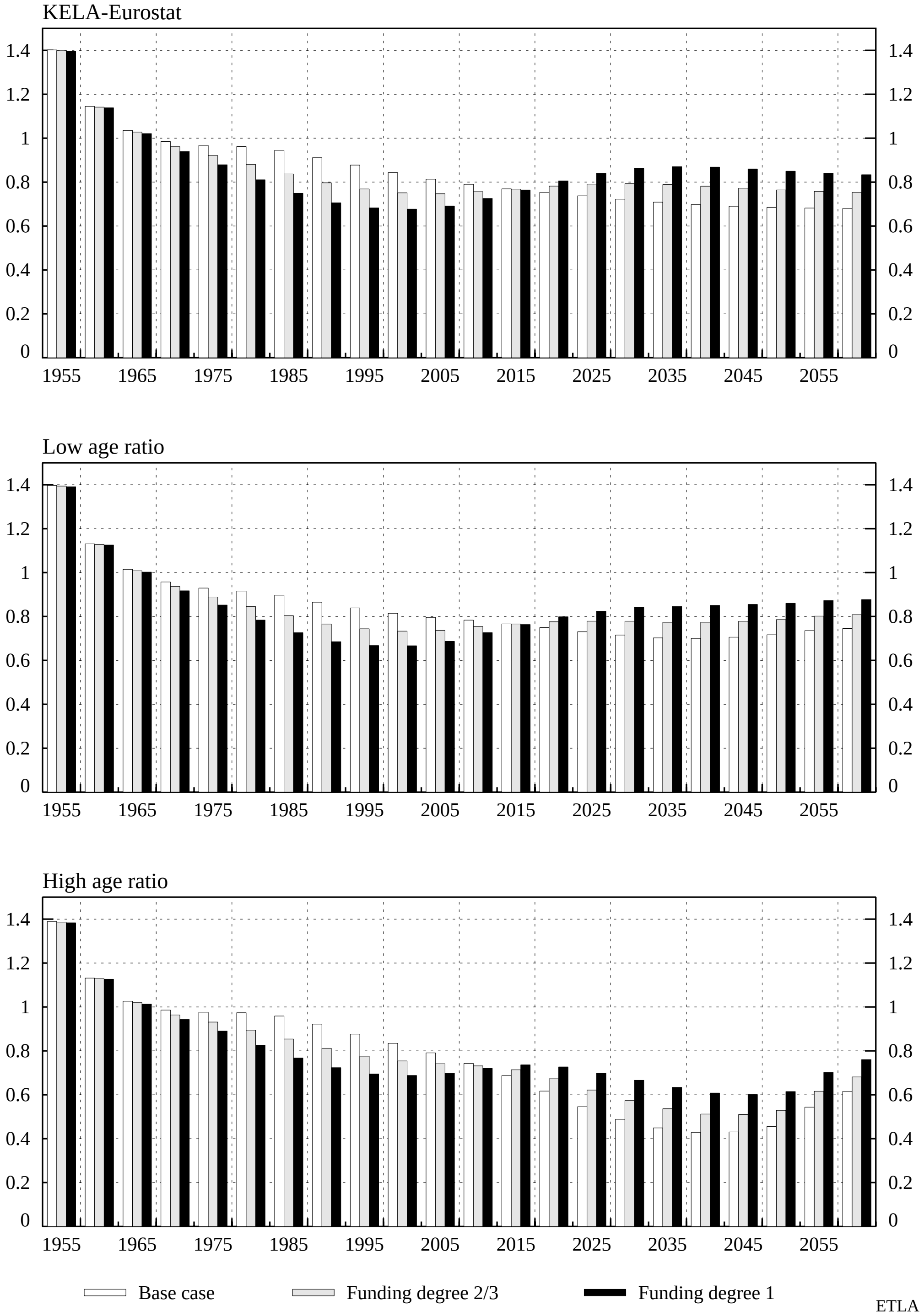


Figure 3. Effects of increasing old-age pension prefunding on actuarity rate



Cohorts denoted by the year of entering labour force.

Figure 4. Effects of fertility-dependent prefunding on pension contributions and funds

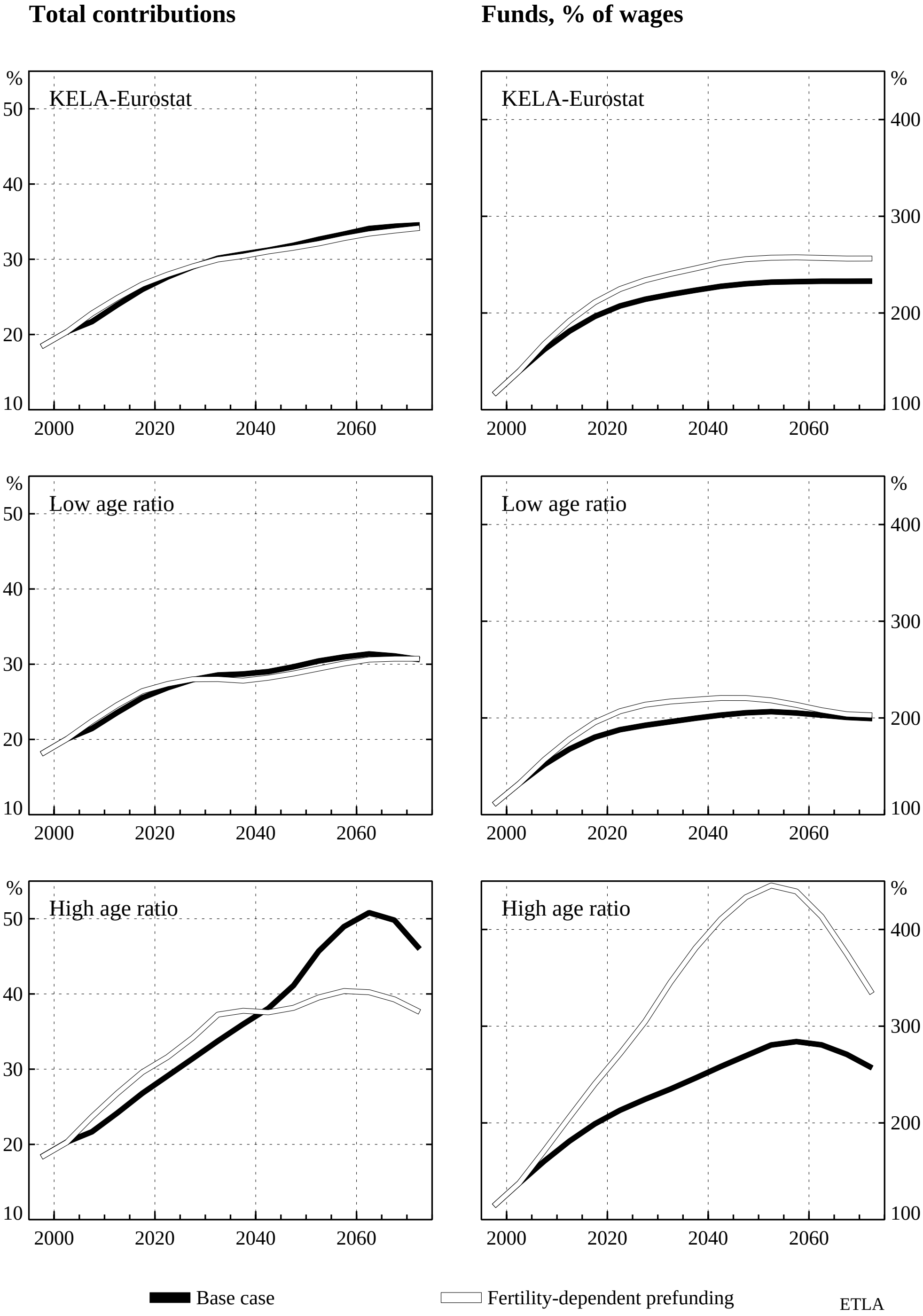
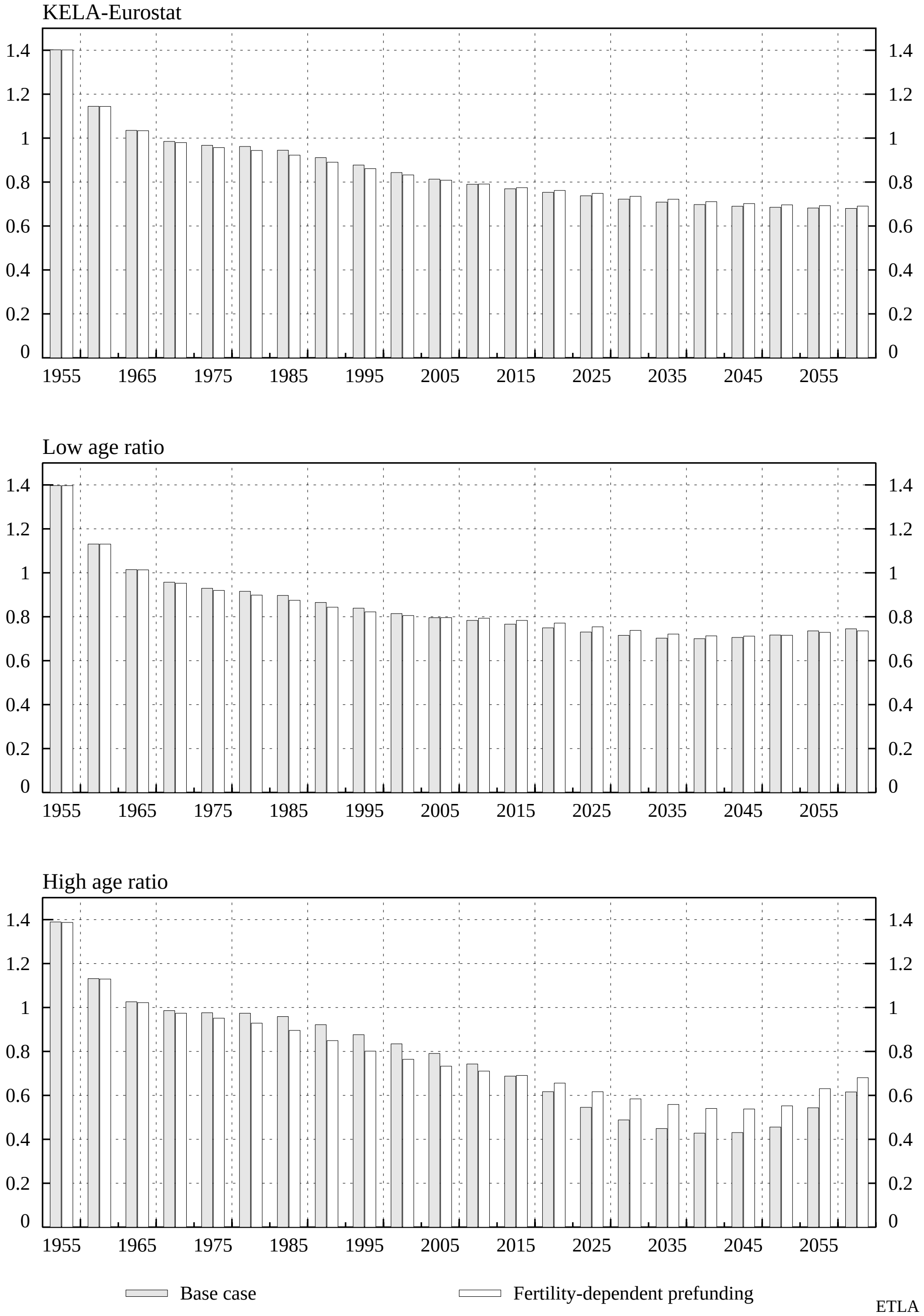
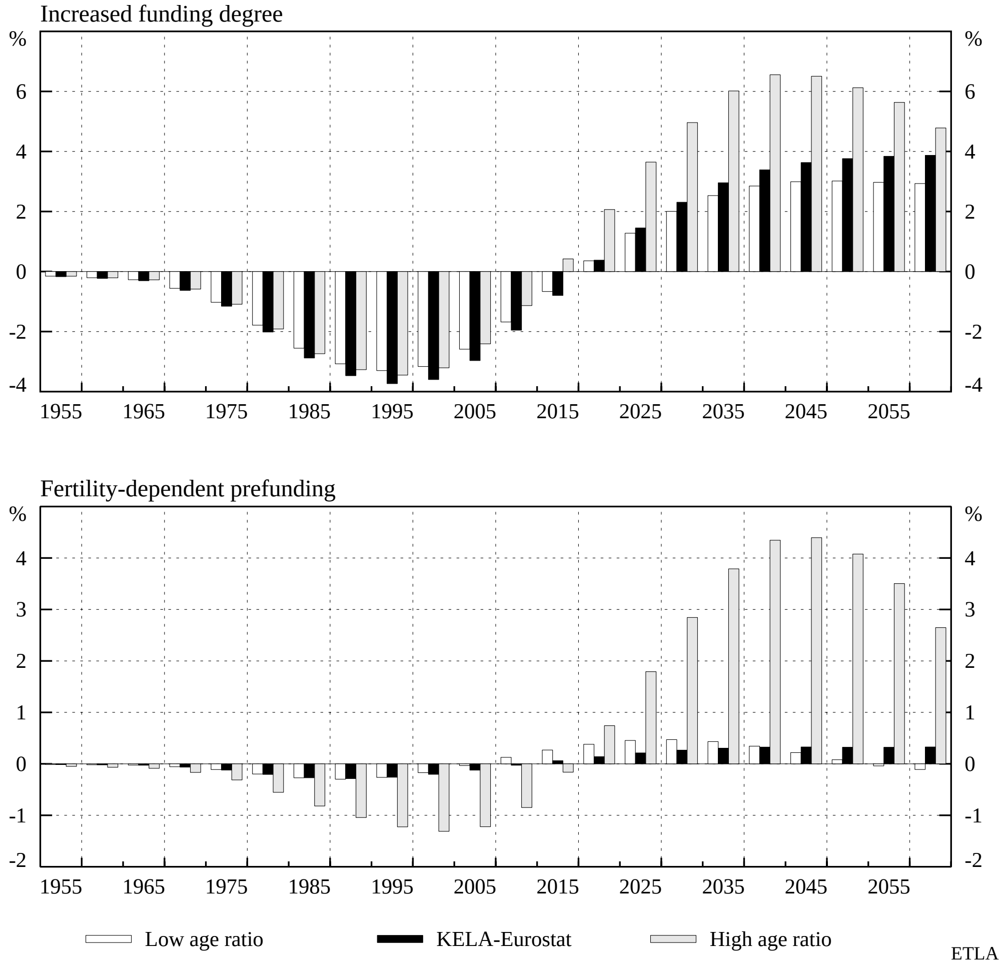


Figure 5. Effects of fertility-dependent prefunding on actuarity rates



Cohorts denoted by the year of entering labour force.

Figure 6. Welfare effects



Cohorts denoted by the year of entering labour force.

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