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Pre-funding Expenditure on Health and Long-term Care under Demographic Uncertainty

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Public health and long-term care services are predominantly used by old people and financed by taxes paid by working-age people. Fluctuating sizes of generations create variations in tax rates, similar to what occurs in pension contribution rates. Pre-funding is a commonly suggested cure for this variation in pension systems: could and should expenditure on health and long-term care also be pre-funded, and if so to what degree? To address this question, we examine several pre-funding rules using Finland as an example. If the focus is on tax smoothing during the next few decades, an effective rule is a buffer fund whose construction is based on the current population forecast. But if we lengthen the time horizon, the benefits of using rules conditional on new demographic information become evident, even though they may result in higher tax-rate variation during the first few decades.

1. Introduction

Recent studies (EPC, 2001; OECD, 2001) show that expenditures on health and long-term care are expected to rise markedly due to population ageing in most industrialized countries. In Finland, expenditures will increase faster (3.9 per cent of GDP by the year 2050) than on average in the E.U. (2.7 per cent of GDP by the year 2050). Higher expenditures create problems that resemble closely those addressed by ongoing pension reforms. The main differences between financing the pension system and care expenditures are that the latter are affected more by factors other than the demographic transition and that the increased demand for care will draw workers from other sectors and thereby crowd out other production. The latter feature may have strong feedback effects via the labour market to unit costs of care, especially in cases of unfavourable demographic trends.

It is anticipated that the demographic transition will increase the number of pensioners and reduce the working-age population, which implies that current PAYG financing of pensions will lead to rising income transfers from young and future generations to the baby boomers. Sinn (2000) claims that, due to low fertility, the baby-boom generations have enjoyed lower costs of caring for and educating children. Therefore they should compensate for the missing human capital by saving and accumulating real capital. The same argument can be used to justify pre-funding of health and long-term care expenditures, since these costs are mainly financed by a PAYG principle with the working-age population paying the most.

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In addition to the intergenerational equity issue, variation in tax rates should be avoided for two other reasons. One is Barro's (1979) well-known argument about the progressively increasing distortions of taxation when tax rates rise. Another is that forward-looking risk averse individuals suffer welfare losses when future tax rates are subject to change. Thus welfare could be enhanced through pre-funding rules that reduce either the expected or unexpected variation in tax rate.

Although population ageing is a very likely and well anticipated trend in the developed countries, too little attention has been paid to the fact that the actual extent of future ageing is highly uncertain. This uncertainty must be taken into account when considering funding and tax smoothing. We have shown in another paper (Lassila and Valkonen, 2001) that making the degree of pre-funding fertility-dependent appears to be a useful alternative in pension systems where funding is collective and partial.

Pre-funding medical expenditures is not a new idea. The earlier literature is, however, based on different ideas and methods from this study: see, for example, the discussion on whether the Medicare programme in the U.S. should be financed by individual accounts (Feldstein, 1999; Seidman, 2000), or similar discussions in Germany (Grabka *et al.*, 2002) and Australia (Fitzgerald, 2001). Our aim is to show that carefully designed rules for collective pre-funding of the expected care costs smoothes future tax rates efficiently.

Here we use a four-part methodology. First, we quantify demographic uncertainty by using a large amount of randomly chosen population scenarios from a stochastic population forecast. Second, we generate a predictive distribution of the demanded amount of services by combining age-specific expenditures with population paths. The third step is to produce the initial expenditure paths associated with each of the population scenarios using a numerical overlapping generations model. Finally, we simulate the effects of various pre-funding rules on the level and timing of taxation. We look at both the median and the variation of the relevant tax rate as well as the probability of excess funding as criteria for assessing the value of pre-funding policies.

The paper is structured as follows. In section 2 we present our methodology in more detail. In section 3 we introduce the pre-funding rules and simulate their effects on the financing costs of health and long-term care in Finland. Section 4 concludes.

2. Methodology and model

2.1 Age-specific public care expenditure

We use as data the weights of current state subsidies to municipalities in Finland which in turn are based on age-specific expenditure calculations. The data show (see Figure 1) that the costs, especially those related to long-term care, increase considerably during old age.[1] Our data also include expenditures on day care, which allows the favourable effects of low fertility on total costs to be considered. Compared to the age-profile of pensions, this cost profile peaks at the very old ages. The implication from the point of view of funding the care costs of baby-boom generations is that there is more time to accumulate funds before the expenditures start to increase.

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[1] Much effort has been devoted to the question of whether age or proximity-to-death is a better indicator for health care costs (see e.g. Madsen *et al.,* 2002). Our sensitivity analysis shows that performing the pre-funding analysis with age-specific mortality rate weights does not change the results markedly. This is at least partly due to the importance of the size of the contemporaneous labour force on the tax rate.

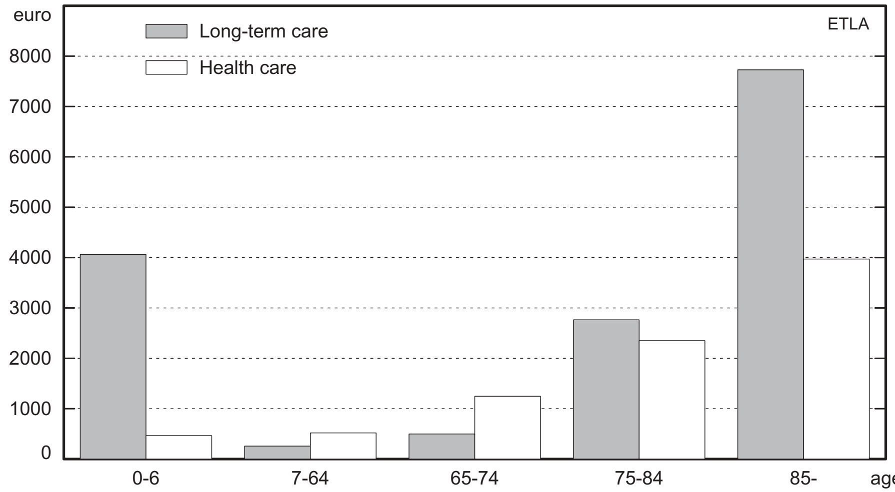

Figure 1: Age-dependent state subsidy to municipalities

2.2 *The fund*

Pre-funding in our analysis takes place in the form of a separate fund within the public sector. It has rules, usually based on observed or predicted demographic developments, that determine the inflows to and outflows from the fund. The assets in the fund yield interest at the same constant rate as all assets in the economy.

Let us denote the age structure of population in period t by the vector N_t. Its element $n_{i,t}$ is the number of people in age bracket i. We assume that actual population is known with a one-period lag. Let us denote the forecast for N_{t+j}, made in period t, by $N^F_{t,t+j}$. All such forecasts made in period t form the set F_t, with the forecast horizon denoted by S.

$$F_t = \left[N^F_{t,t},\ N^F_{t,t+1},\ \ldots,\ N^F_{t,t+S}\right] \tag{1}$$

Information about the population available at time t is denoted by Z_t. It consists of population data and forecasts from period t-T onwards. T is assumed to be large enough, say 100 years, to contain all relevant forecast information concerning the cohorts still existing in period t.

$$Z_t = [N_{t-T},\ N_{t-T+1},\ \ldots,\ N_{t-1},\ F_{t-T},\ F_{t-T+1},\ \ldots,\ F_t] \tag{2}$$

We assume that taxes τ are set each period to equal the sum of public expenditure G, part of which is dependent on population structure, the interest payment of the constant public debt B based on a constant interest rate r, and the increase in the care fund H minus its interest income.

$$\tau_t = G_t(N_t) + B_{t-1}r_t + H_t - H_{t-1} - H_{t-1}r_t \tag{3}$$

Changes in the care fund are determined by the inflow and outflow rules:

$$H_t = H^{IN}_t(Z_t) - H^{OUT}_t(Z_t) + H_{t-1}(1 + r_t) \tag{4}$$

We will experiment with different funding rules in section 3.

The care fund could of course be combined with the public debt in our analysis, without losing anything in generality. We prefer to have a separate fund simply to stress the fact that explicit demography-based debt policy rules do not exist in any country.

2.3 Quantifying demographic uncertainty

Statistical methods of expressing demographic uncertainty have been developed recently (e.g. Alho, 1990; Lee, 1999). These methods quantify uncertainty probabilistically, based on analyses of past demographic data and the judgment of experts. Fertility, mortality and migration are considered as stochastic processes. The parameters of these processes are fitted to match the errors of past forecasts. Thereafter, sample paths for future population age groups are simulated. We use in our analysis randomly chosen sample paths from the stochastic population forecast for Finland, reported more closely in Alho (2002).

A general finding in new demographic studies is that uncertainty is typically underestimated in official national demographic forecasts.[2] As a consequence, too narrow a range of policy alternatives is often entertained. Furthermore, Auerbach and Lee (2001, p. 3) state that: "There is a tendency in policy debates to view extreme uncertainty about the long run as a reason for inactivity, but . . . this intuition is generally wrong." The relevant response of risk averse agents is to prepare for the bad outcomes. One way of preparing is to look for pre-funding rules that limit the variation of future tax rates.

Greater focus on long-term issues has given more weight to the question of the reliability of population forecasts. But demographic uncertainty is still often considered by using *ad hoc* alternatives (such as "high" and "low" scenarios).[3]

Studies that do consider demographic uncertainty mainly use actuarial models to analyse the sustainability of pension systems (e.g. Burdick and Manchester, 2003; Holmer, 2003; Lee *et al.*, 2003; Congressial Budget Office, 2001). The exceptions in this line of research are Lee and Miller (2001), who study health care, and Alho and Salo (1998) and Creedy and Scopie (2002), who also forecast social expenditures with partial equilibrium actuarial models.[4] The effects of both economic and demographic uncertainty on public finances are studied in a similar framework by Lee and Tuljapurkar (1998). Alho and Vanne (2001) used generational accounting to perform a corresponding risk analysis. The method of stochastic forecasting has been applied also to the unit costs of health care: see Boards of Trustees (2003). The issue of intergenerational risk-sharing properties of various fiscal policy rules has been analysed earlier mostly using theoretical two-period models: see e.g. Bohn (2001, 2002, 2003).

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[2] See e.g. Anderson, Tuljapurkar and Li (2000).

[3] Lee and Edwards (2002, p. 11) mention four ways in which this scenario-based approach to assessing the uncertainty of forecasts is seriously flawed. The first concerns assumptions about cross-correlations between fertility and mortality, which by the nature of the method are usually either +1.0 or −1.0. The second is that fertility and/or mortality will always follow the highest plausible path or the lowest; long-run fluctuations like the baby boom are ruled out. Thirdly, the method provides inconsistent indications of uncertainty to differing outcome variables such as population size, life expectancy and old age dependency ratios. Fourthly, the method is intrinsically unable to assign probabilities to its high-low ranges.

[4] We use the term "actuarial model" to emphasize the interaction between demographic trends and the rules of the health care and social security system. Definite actuarial research on these issues takes the point of view of a private insurance company: see e.g. Olivieri and Pitacco (1999).

In our earlier work (Lassila and Valkonen, 2001, 2003) we combined a few well defined population sample paths from a stochastic population forecast with a numerical OLG model and studied pension policy options under demographic uncertainty in Finland. Alho *et al.* (2002) were the first to analyse ageing using a large set of OLG model simulations of the Lithuanian economy.

In this study we combine age-specific expenditure data with different population paths from the stochastic population forecast to produce a corresponding amount of paths for a care demand index. Transforming the demand index into public expenditure scenarios requires some strong assumptions and use of an economic model. We assume that the demand index describes the demand for labour employed in the production of care services. This implies that demand dictates supply and that there is no productivity growth in the production of those services (or if there is it is used to increase the quality of services). The share of publicly provided services is assumed to remain constant in the future. The price of the labour input consists of wages and employers' social security contributions. The other input in the production of services is the domestic good produced by the private sector, and its use is determined so as to keep its expenditure/GDP ratio fixed.

2.4 The economic model

The economic framework that we use is an open economy version of the well known Auerbach/Kotlikoff-type numerical overlapping generations simulation model (Auerbach and Kotlikoff, 1987). The model consists of lifetime utility maximizing perfect foresight household generations, firms, foreign agents, and several types of public sector institutions. It generates equilibrium price paths for labour, goods and capital markets and balances public sector expenditures and receipts. The unit period in the model is five years. The model has been described in Lassila and Valkonen (2001, 2003); a detailed description is available from the authors.

3. Simulations

3.1 The simulation set-up

We use 100 randomly chosen sample paths from the stochastic population forecast to determine the size and age structure of the household sector, as well as the value of the demand index of care services in each point of time in the future. These data sets are used as inputs in the OLG model. The corresponding 100 simulations give us the required predictive distribution of the tax rate.

We have implemented the pre-funding rules in the model as follows. Each of the pre-funding rules comes into effect from the beginning of the year 2005. This was announced in the year 2000. Pre-funding is financed by a lump-sum tax in order to avoid interpretative difficulties due to tax distortions. Actually, these costs are financed from several sources and by many taxes in Finland. The funds are collected by the central government. The investment policy is irrelevant in our model due to the no-arbitrage condition and lack of uncertainty in financial markets. Perfect foresight households are assumed to know which population path the economy follows and to perform their lifetime planning accordingly. The government only knows the behaviour of the economy (the economic model), the initial non-stochastic population forecast (the demographic model) and, with a one-period lag, the realized population size and structure. The tax rate reported describes the sum of the care expenditures and effects of pre-funding on the central government finances as a share of GDP.

We use several indicators to approximate the goodness of the tested pre-funding rules. The limits of the confidence intervals of the predictive distribution describe the probabilities of ending up with tax rates that deviate markedly from the expected path. They also give an idea of the trade-off between short-term and long-term variations in the tax rate. The number of cases in which there is a decrease in the tax rate is an indicator of excess funding. The shape and the location of the scatter plot of tax rates helps to visualize the effects of the various rules.

3.2 *The base-run distribution*

Figure 2 describes the predictive distribution of expenditures on health and long-term care/GDP. The median of expenditures/GDP increases almost by a half during the next 65 years from its current level of somewhat over 8 per cent. The lower limit of the 80 per cent confidence interval is 10 per cent at the end of the period and the upper limit is about 14.5 per cent. This is to say that the demographic transition raises the expenditures with a very high probability.

Furthermore, in the majority of the population sample paths, the demand for services increases until the baby-boom generation has deceased, but expenditures *per capita* continues to grow because the population of working age diminishes and life expectancy increases. This permanently upward sloping trend is very challenging from the point of view of tax smoothing.

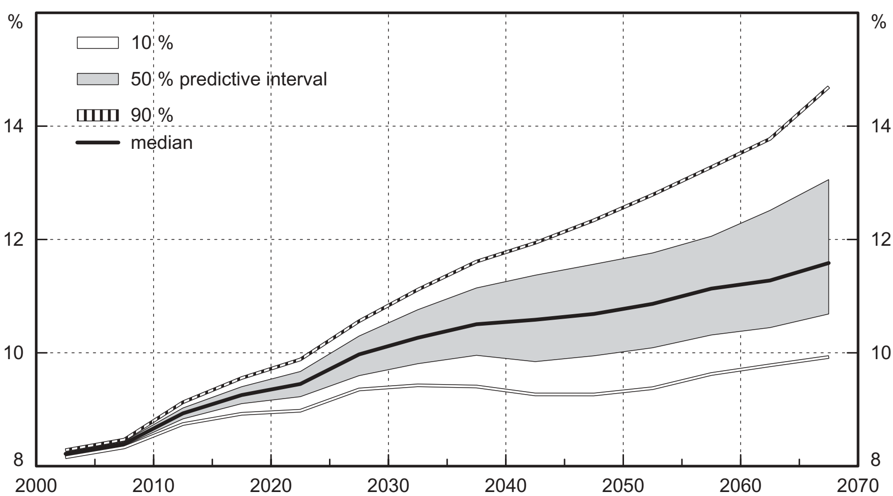

Figure 2: Expenditure on social welfare and health care/GDP

3.3 *The Buffer Fund*

The Buffer Fund rule is formulated to give a fixed sustainable tax rate for the next 90 years if the non-stochastic baseline population forecast comes true. The tax rate is calculated by dividing the discounted sum of forecast expenditures by a discounted sum of the projected tax base. This same fixed tax rate is applied to all model simulations independently of the realized population path. Since the equilibrium tax rate initially generates more money than that needed for the expenditures, it accumulates a fund.

Depending on the population scenario, the size and time of existence of the fund varies quite widely after a few decades. Since about a quarter of the population paths lead to an exploding fund, we set an additional rule that the maximum size of the fund is the value of GDP.

The results presented in Table 1 show that the median increase in the tax rate between 2005 and 2080 is less than half of 1 per cent with buffer funding, three percentage points less than without funding (there is an initial increase of about two percentage points in the tax with the buffer fund, not shown in the table). The distribution of tax changes is very narrow during the first 40 years. From 2040 onwards the tails of the distribution get wider, however, due to two opposite groups of cases: either the fund runs dry and the tax rate becomes the same as without funding, or the fund hits the maximum limit and the tax rate is reduced.

Figure 3 confirms the above findings. Each data point in the scatter diagrams corresponds to a tax rate in one of the population paths and in one period. The horizontal axis measures the tax rate in the baseline case and the vertical axis the tax rate in the case of pre-funding. The diagonal shows the cases in which the tax rate is the same with and without pre-funding.

As we can see from the uppermost parts of the figure, the tax rate in the pre-funding case is initially higher than the tax rate without pre-funding (data points are above the diagonal). The benefits of the buffer fund are most evident during the 2030s, when the tax rate is in all cases almost fixed. After that there are a growing number of population paths in which the fund has used all the money, and the tax rate has risen to the same level as in the baseline case. Among these cases are those where the health and long-term care expenditure in relation to GDP increases most. On the other hand, about one-fifth of the population paths lead to the maximum amount of the fund, and in these cases the tax rate will fall substantially below the initial level, due both to favourable demographics and the interest income from the fund.

The buffer fund rule stabilizes the tax rate well during the next three to four decades, even though the government is not allowed to react to the realized population statistics. After that it runs into problems. A more sophisticated rule, which, for example, updates the fixed tax rate after each ten-year period to be in line with the latest population forecasts, would limit the effects of demographic uncertainty somewhat better. The obvious danger in buffer funding is that if long-term expenditure calculations are not updated often enough, the fund can be used to postpone possible unpleasant decisions. This short-sightedness may necessitate abrupt measures after the fund is drained.

3.4 Generation-specific funds with a fixed contribution rate

The idea of a generation-specific fund is to collect yearly a fixed amount of money and allocate it to the generational accounts of current workers. The amount allocated to each generation depends on the share of this generation in the aggregate labour force. Contributions are raised during the working age years (20–64) and used for expenditures during the years 65–89. The generational fund is allocated to retirement years using a forecast for the future expenditures. The expenditure calculation uses assumptions about future productivity growth as an indicator of the increase in labour costs and the latest

Table 1:
Change in tax revenues/GDP that finance the care costs

	From 2005 to 2080			**From 2005 to 2040**			**From 2040 to 2080**		
	Median and average	**Upper and lower limit of 50 %**	**Upper and lower limit of 80 %**	**Median and average**	**Upper and lower limit of 50 %**	**Upper and lower limit of 80 %**	**Median and average**	**Upper and lower limit of 50 %**	**Upper and lower limit of 80 %**
Baseline (no pre-funding)	3.39	5.30	9.21	2.33	3.01	3.76	1.13	3.22	5.21
	4.27	2.17	1.16	2.34	1.61	0.84	1.94	0.09	−0.55
Buffer	0.35	3.03	7.47	0.21	0.26	0.33	0.05	2.77	6.96
	1.56	−0.10	−2.07	0.31	0.15	0.11	1.25	−0.22	−2.27
Care1	2.35	4.02	7.80	1.98	2.66	3.43	0.36	2.32	4.17
	3.12	1.14	0.36	1.99	1.28	0.46	1.13	−0.57	−1.10
Care65	1.21	2.70	5.24	1.41	2.14	2.95	0.24	0.97	2.08
	1.77	0.31	−0.31	1.45	0.54	−0.14	0.33	−0.78	−1.44
TemporaryA	2.08	3.92	7.82	0.67	1.39	2.20	1.44	3.47	5.43
	2.95	0.89	0.00	0.72	0.02	−0.89	2.23	0.41	−0.23
TemporaryB	2.25	4.13	8.02	0.84	1.54	2.34	1.46	3.52	5.51
	3.13	1.05	0.10	0.87	0.16	−0.72	2.26	0.42	−0.22
Expenditure75	0.98	2.42	5.07	0.70	1.54	2.42	0.65	1.84	3.40
	1.77	0.23	−0.30	0.74	−0.11	−0.94	1.03	−0.31	−1.03
Predetermined	0.95	2.66	6.31	0.72	1.48	2.14	0.15	2.11	4.15
	1.75	−0.28	−0.86	0.77	0.13	−0.82	0.97	−0.66	−1.27

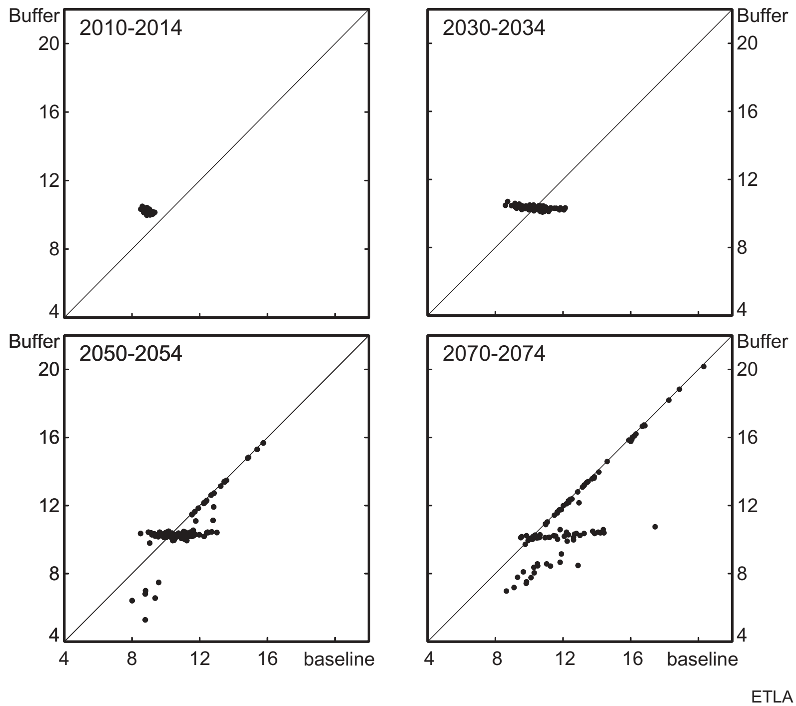

Figure 3: Care-financing tax revenues/GDP with and without the Buffer Fund

population statistics as an indicator of future mortality. The current interest rate is assumed to determine the future yield of the fund.

The pre-funding rules for a fund which starts from zero are as follows. Denote the sum of contributions raised in period t by H_t^{IN}. The money allocated from this sum to a cohort of age i, is $h_{i,t}^{IN}$. This is determined as a share of the cohort's working-age population, $n_{i,t}$, within the aggregate working-age population, see equation (5),

$$h_{i,t}^{IN} = H_t^{IN} n_{i,t} / \sum_{l=1}^{9} n_{l,t} \tag{5}$$

where $l = 1, \ldots, 9$ describes the five-year cohorts in ages 20–64 in period t.

The amount $h_{i,t}^{IN}$ allocated to the cohort in period t is planned to be used during the old-age years. The amount that will be withdrawn in period j is denoted by $h_{i,j,t}^{IN}$ and determined by multiplying the total pre-funded amount by period j's share of the expected total expenditures. The future expenditures are discounted with the expected interest rate r^h. In order to estimate the future expenditures, we need information about the age-specific care expenditures $x_{j,t}$ during the old-age years. We also need an estimate of future productivity growth, μ^{j-i} to be used as an approximation of the increase in future unit labour costs. The third element to be considered is life expectancy: S is the probability of surviving from period i to period j, and is calculated from the latest available (t-1) cross-section of population statistics.

$$h^{IN}_{i,j,t} = a_{i,t} x_{j,t} \mu^{j-i} (1 + r^h)^{i-j} S_{t-1,i,j} \quad \text{where} \tag{6}$$

$$a_{i,t} = h^{IN}_{i,t} \Big/ \left(\sum_{j=10}^{14} x_{j,t} \mu^{j-i} (1 + r^h)^{i-j} S_{t-1,i,j} \right) \tag{7}$$

and $j = 10, \ldots, 14$ describes the five-year cohorts in ages 65−89 in period t.

The aggregate amount of money actually withdrawn from the fund for the cohort of age i in period t is determined as the sum of the period-specific contributions and the accrued interest. The interest rate used is the realized yield r_t, which could deviate from the expected values but in these simulations coincides with them.

$$h^{OUT}_{i,t} = \sum_{s=1}^{9} h^{IN}_{s,i,t-i+s} \prod_{u=t-i+s}^{t-1} (1 + r_u), \; i = 10, \ldots, 14. \tag{8}$$

As a whole, in period t, the money withdrawn from the fund is the aggregate amount of all workers' contributions aimed for this period, H^{OUT}_t.

$$H^{OUT}_t = \sum_{i=10}^{14} h^{OUT}_{i,t} \tag{9}$$

The last equation of the pre-funding rule is equation (4) which describes the end-of-period pre-funded stock as a sum of the fund at the end of the previous period, the incoming contributions and the interest income, minus the withdrawn amount.

3.4.1 Permanent funds with a fixed contribution rate

The Care1 Fund. The first generation-specific pre-funding rule we test is called the Care1 Fund. According to this rule, the government starts to collect from 2005 onwards contributions corresponding to 1 per cent of the value of private consumption to the fund. As mentioned earlier, contributions of equal size are paid by all working-age individuals, i.e. it is a lump-sum tax.

Figure 4 describes the simulated tax/GDP ratios that are needed to finance the scheme without pre-funding and if the Care1 Fund rule is followed. Two results are immediately evident. The tax smoothing effect is, even though universal, quite limited, and the benefits are not seen before the latter part of the century. Table 1 shows that, compared to the baseline case, the limits of the confidence intervals are about equally wide during the first 40 years and marginally smaller after that, indicating that this rule does not help much to redistribute or limit the uncertainty in the tax rate caused by demographics. So, applying the pre-funding rule only to current working-age people yields positive results very late. Also the pre-funded amount was insufficient to smooth the tax rate efficiently. Correspondingly, the initial tax hike required for pre-funding is small (about 0.45 per cent of GDP).

The Care65 Fund. To tackle the problems of only small and late outflows from the fund we look at a pre-funding rule called the Care65 Fund. This rule is also implemented in 2005. The size of the funded amount is increased tenfold, i.e. the yearly contributions correspond to 10 per cent of the value of private consumption. The timing problem is dealt with by a

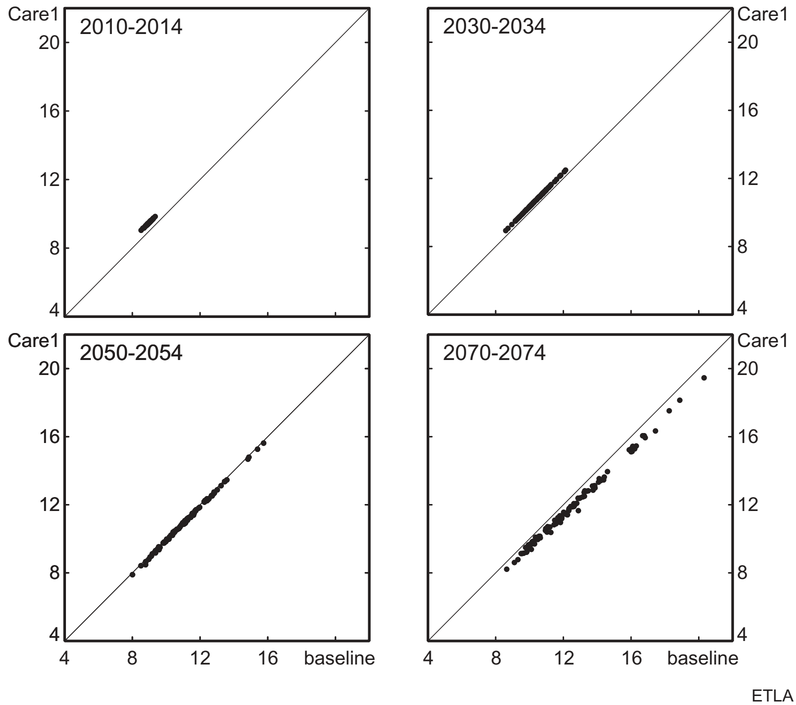

Figure 4: Care-financing tax revenues/GDP with and without the Care1 Fund

new large fund, which is run as if the pre-funding had been started from the beginning of the last century. The initial amount in the fund is financed by increasing government debt. The resulting interest expenses raise the tax rate used as the criterion of the goodness of the rule.

The predictive distribution of the resulting tax rates is presented in Table 1 and Figure 5. The scale of the tax smoothing effect is now larger than with the Care1 Fund. The median increase in the tax rate is smaller (after an initial increase of about 1.2 percentage points) during the next 40 and 80 years. The limits of the confidence intervals are slightly wider during the next four decades, but much narrower after that. The benefits of lower and less variable tax rates are again seen very late, actually only after the year 2070 (Figure 5). It seems, however, that the rule reduces the final variation in the predictive distribution of the tax rate more efficiently than it increases the variation in the early stages of pre-funding. Thus, a limited intergenerational redistribution of risks is achieved with a trade-off between the risks during the first and the second half of the century. Again, the time difference between costs and benefits suggests, however, that the Care65 Fund would not be politically popular.

3.4.2 Temporary funds with fixed contribution rates

With benefits of the permanent funds visible only much later, the question arises as to whether a temporary fund would yield a lower tax rate earlier. Temporary pre-funding also allows re-evaluation of the benefits of the policy, when more information about the size of the future expenses has been revealed.

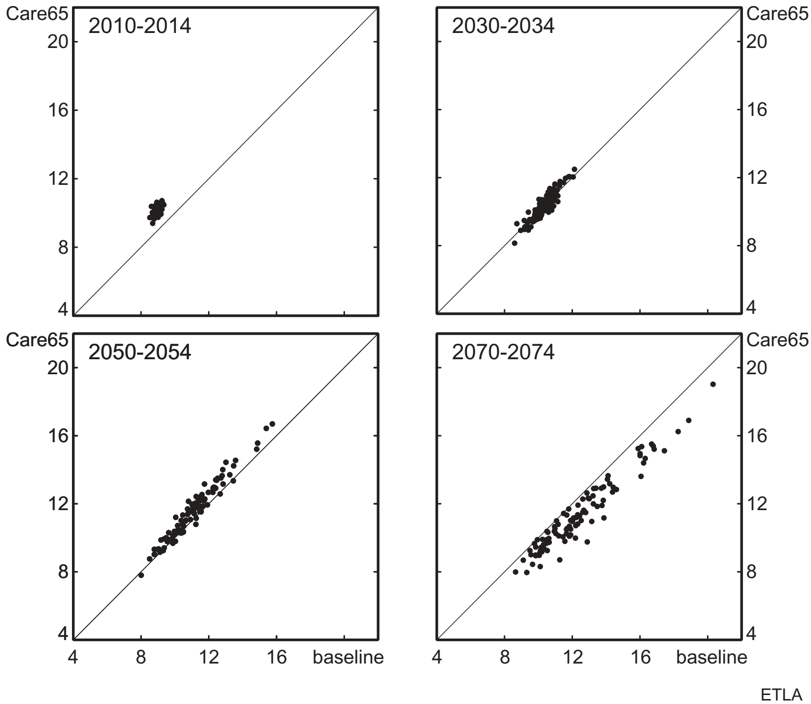

Figure 5: Care-financing tax revenues/GDP with and without the Care65 Fund

In the case of the temporary CareA Fund, lump sum contributions corresponding to 2 per cent of private consumption expenditures (0.9 per cent of GDP) are collected during the years 2005–2024. As it turned out that the probability of excess pre-funding is quite large, another rule, called CareB, was also tested. This rule determines the contribution to be 2 per cent in the years 2005–2014 and 1 per cent in the years 2015–2024. In both temporary funding schemes, the generation-specific allocation and withdrawal rules are similar to those of permanent pre-funding.

It turns out that these rules are quite effective in smoothing the expected increase in tax rates. The main benefits are seen from the 2050s to the 2070s, but it is likely that already during the 2030s the tax rate is lower (see Figure 6). The fund is likely to be drained during the 2070s, with the tax rate jumping to the same level as in the base case. These jumps in taxes, after all the money has been withdrawn from the fund, seem to be the main problem in temporary pre-funding. The rules used do not markedly affect the wideness of the confidence limits calculated from the predictive distribution of tax rate changes (see Table 1).

3.5 Pre-funding based on forecast expenditures

Instead of collecting a fixed amount of money yearly and allocating it to the generational accounts of current workers, we now turn to funding rules where both the total amount collected and the amount allocated to each generation depends on the projected

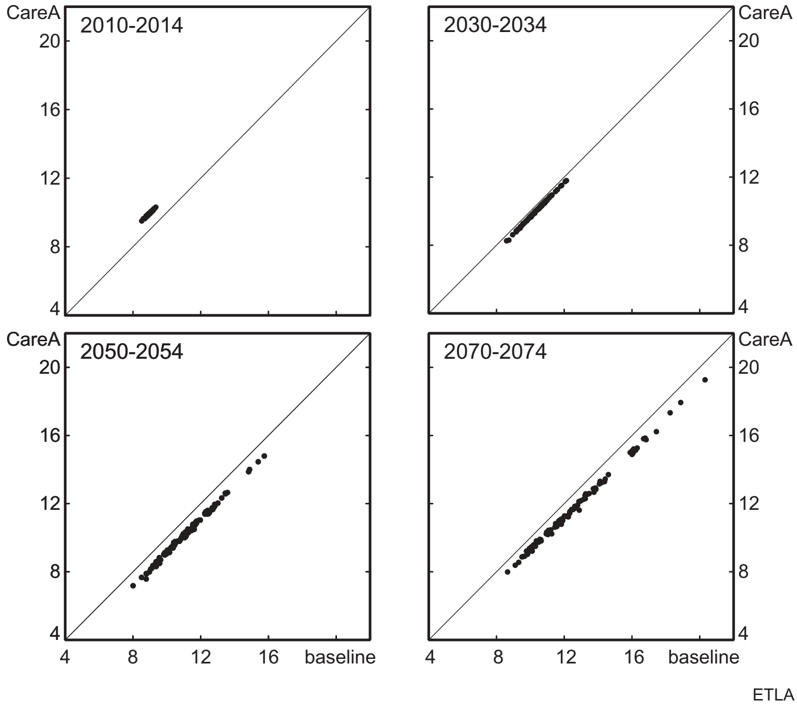

Figure 6: Care-financing tax revenues/GDP with and without the Temporary CareA Fund

future expenditures. We also concentrate on a narrower age group within the old-age population. Statistics show that the majority of the expenditures on health and long-term care are due to those who are older than 75 years. Furthermore, the number of those people in Finland is increasing rapidly, first because of the ageing of baby-boom generations and after that because of continuously increasing life expectancy.

With the Expenditure75 Fund we pre-fund the costs caused by each generation in ages 75–99. The pre-funding takes place when those generations are at ages 50–74. The funded amount is calculated as follows. First, the estimated future expenditures after age 75 are discounted to the current pre-funding year. These expenditures are forecast using the latest information on the population and assumptions about future productivity growth. The discount rate is the same as the expected yield of the funds. Then, an amount corresponding to 1/25 of the expenditures is put into the fund (in our model the calculation is actually performed on a five-year basis). This pre-funding is financed by lump sum taxes, i.e. all living adult cohorts participate in financing. When the cohort reaches the age of 75 and for all ages after that, the contributions collected for that age and the interest accrued are transferred from the fund to the central government in order to pay for the expenses.

For those cohorts which are younger than 55 years when the rule becomes effective, the pre-funding can be financed totally by the new contributions. We describe below the details of the rules for those generations. Details on estimating the expenditures of the existing older cohorts and the corresponding debt-financed fund are omitted here for purposes of brevity.

Assume that E_0^{CARE} is the initial aggregate amount (in the period 1995–1999) of expenditures on health and long-term care, and c_i the age-specific expenditure *per capita* in age group i. Then, the initial costs $x_{0,i}$ for a cohort of age i are as follows.

$$x_{0,i} = \left(c_i / \sum_{j=-3}^{16} c_j n_{0,j} \right) E_0^{CARE} \tag{10}$$

$n_{0,j}$ describes the number of persons in age group j. The index numbers $j = -3, \ldots, 0$ describe the cohorts of age 0–19, and $j = 1, \ldots, 16$ the cohorts of age 20–99.

The expected discounted value of the expenditures in period t for a cohort of age i is correspondingly:

$$\sum_{j=12}^{16} x_{0,j} \mu^{t+j-i} (1 + r^h)^{i-j} n_{i,t} S_{t-1,i,j} \tag{11}$$

where $j = 12, \ldots, 16$ are the five-year periods in which the money is withdrawn from the fund. The future expenditures are discounted with the expected interest rate r^h. Future productivity growth μ^{j-i} is again used as an approximation of the increase in future unit labour costs and S is the probability of surviving from age i to age j.

During period t, the aggregate amount of prefunding H_t^{IN}, consists of pre-funding for five-year cohorts as follows.

$$H_t^{IN} = \sum_{i=7}^{11} \left(0.2 \sum_{j=12}^{16} x_{0,j} \mu^{t+j-i} (1 + r^h)^{i-j} n_{i,t} S_{t-1,i,j} \right) \tag{12}$$

where $i = 7, \ldots, 11$ and $j = 12, \ldots, 16$. The multiplier 0.2 is due to the five-year unit period.

Equation (13) describes the aggregate amount of H_t^{OUT}, which will be withdrawn during period t. The amount is the sum of previously made period-specific contributions and the interest income accrued to them.

$$H_t^{OUT} = \sum_{j=12}^{16} \left(0.2 \sum_{i=7}^{11} x_{0,j} \mu^{t} (1 + r^h)^{i-j} n_{i,t-j+i} S_{t-j+i-1,i,j} \prod_{u=t-j+i}^{t-1} (1 + r_u) \right) \tag{13}$$

The interaction of stocks and flows is again depicted by equation (4).

Table 1 shows that the rule smoothes the tax rate better than the corresponding fixed contribution rate rule, the Care65 Fund. Only part of this is because the initial increase in the tax rate is slightly higher here. Furthermore, a comparison of the limits of the confidence intervals demonstrates that the variation in tax rates is somewhat larger in the 2040s, but smallest of all the rules examined for the whole period 2005–2080, implying that the rule limits the variation in the tax rate and shifts the risks earlier in time. Figure 7 reveals that the risk shifted is that connected with very unfortunate demographics. Another way to express this appealing feature is, should Finland be lucky in future demographics, in the sense that total age-dependent care demand does not increase much, then the Expenditure75 rule would not have much effect.

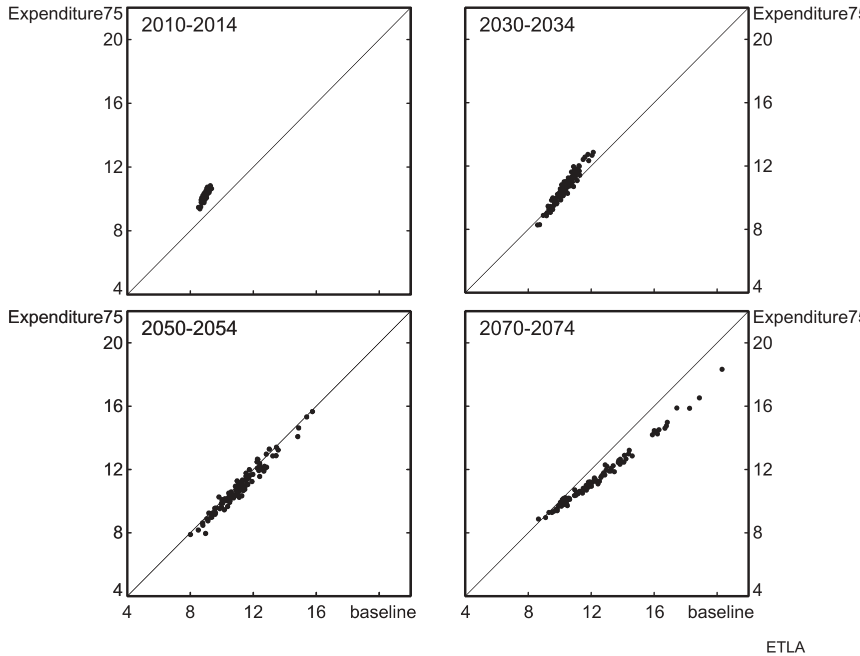

Figure 7: Care-financing tax revenues/GDP with and without the Expenditure75 Fund

3.6 Pre-funding based on a predetermined GDP share

In all the previous funding rules, the size of the fund varied endogenously. In the next experiment, the size of the fund is predetermined to be a given share of GDP, independently of the realized population scenario. The norm for the share is chosen to be the median of the predictive distribution of the fund paths when the Expenditure75 Fund rule is followed. Consequently, also the required initial tax rate increase, not seen in Table 1, is of equal size (1.2 per cent of GDP).

The idea of this funding rule corresponds closely to a predetermined path for the public debt. Following the rule means that the time path of the government's net wealth/GDP is fixed and tax rates and income transfers adjust to balance the budget, if more money to finance the public services is required.

The results resemble those resulting from the simulations with the Expenditure75 Fund rule (see Figure 8). However, in the case of the predetermined fund, the limits of the confidence intervals are somewhat narrower during the first half of this century and significantly wider thereafter. This unwanted feature emphasizes the benefits of using new information about population statistics efficiently. A forward-looking rule discovers and starts to react to the expensive population paths earlier.

3.7 Comparing the pre-funding rules

All the tested pre-funding rules smooth the tax rate needed to finance care costs. Table 1 gives a comparison of the results. We want to concentrate on the smoothness after funding

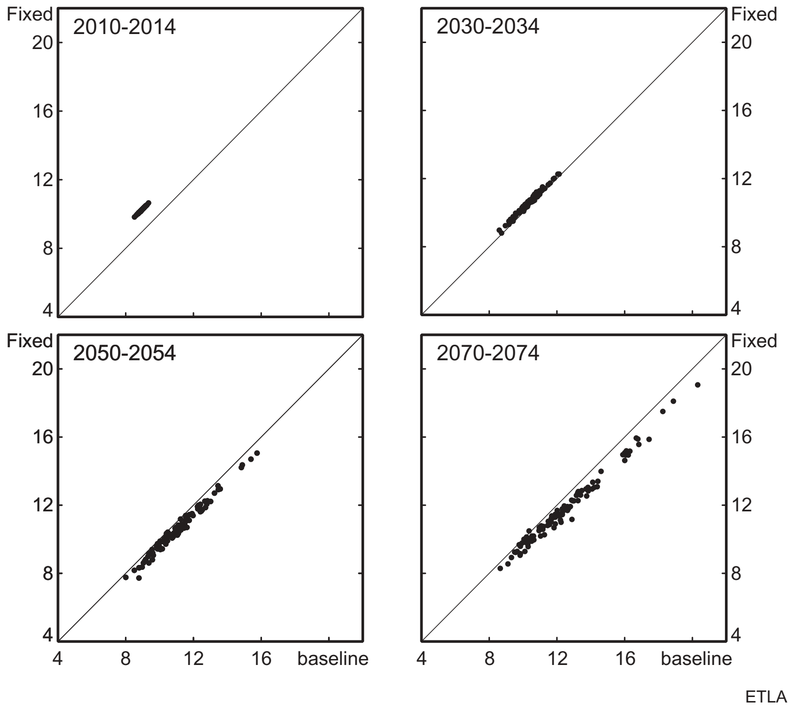

Figure 8: Care-financing tax revenues/GDP with and without the Predetermined Fund

has been implemented, and thus have left out the initial increase in taxes that the implementation caused. Table 1 includes both the medians and the averages of the predictive distributions. In all the cases the averages are larger than the medians. The averages can here be interpreted as expected values of the tax changes. The medians can be interpreted as estimates of the tax changes generated by various funding rules in the case of the baseline population forecast. The predictive distributions are not symmetric around the median. This means that evaluating the expected costs of ageing cannot be done using one population path only.

Classifying the results by two different time horizons clarifies the trade-off between short-term and long-term risks. If the focus is on tax smoothing over the next 40 years, the Buffer Fund rule is the most effective. But if we double the horizon to 80 years, this rule generates even larger variation in the tax rate than the current PAYG rule. The scatter diagram shows that the Buffer Fund would provide no help should any of the most expensive population paths come true. Correspondingly, if we use either the Care65 or the Expenditure75 rules, the initial variation is higher, but that during the second half of the 21st century is smaller. These funding rules would also curb the tax increases under the most expensive population paths.

Pre-funding can also be excessive. Funding too little and too much are not symmetric cases. Increasing funding requires the unpopular decision to raise taxes, and smaller increases are easier to accept. Thus, in the future, looking back to the present time, we would probably be happier with not pre-funding too much. This provides us with another tool for comparing different funding rules. Looking at the simulations, we can say that excess funding has taken place if somewhere in the future the tax rate declines significantly. Different threshold values for a "significant tax rate decline" can be used. Table 2 shows the share of cases in the 100 population paths where excess funding was observed, with three different threshold values. The unit period in the calculations is five years, so qualifying for "excess" requires that there is a pair of five-year periods, not necessarily successive but both within the total period of 2005–2084, where the tax rate in the earlier period exceeds that in the latter period by at least the threshold value.

Table 2:
Probability of excess funding under various pre-funding rules

	Threshold		
	0.5 per cent of GDP	**1.0 per cent of GDP**	**2.0 per cent of GDP**
Baseline	32	9	1
Buffer	37	27	20
Care1	47	26	3
Care65	75	51	17
TemporaryA	71	35	5
TemporaryB	41	20	2
Expenditure75	83	56	5
Predetermined	81	55	14

Note: The proportion of cases in which the tax revenues/GDP that finance the care costs fall more than the threshold value in some sub-period of 2005–2080.

Demographic uncertainty implies that it is hard to avoid excess saving with predetermined funding rules in all the possible population paths. Table 2 shows that a tax rate reduction on the scale of 0.5 to 1 per cent of GDP is quite likely in all the cases, but least probable when there is no pre-funding. The big funds, which are financed initially with debt (Care65 and Expenditure75) as well as the Predetermined Fund seem to be most prone to generate excess funding, which means overshooting in tax rates. The same applies, with somewhat lower probabilities, to a tax rate reduction of 1 to 2 per cent of GDP. When the large tax cuts of more than 2 per cent of GDP are compared, Expenditure75 improves its position markedly. The Buffer Fund rule, on the other hand, leads to excess funding quite often; these are cases where the fund grows to the maximum limit. The TemporaryB Fund seems to be the best of the funding rules, if all the tax reduction threshold values are considered together.

4. Conclusions

In the non-stochastic population path of the baseline scenario the demand for services increases until the baby-boom generation has deceased. However, expenditure *per capita* continues to increase also thereafter, since the population of working age diminishes.

Furthermore, the predictive distribution of expenditure shows that the probability of avoiding tax increases is very low. This is very challenging from the point of view of tax smoothing. Our analysis shows that the variation in the size of the working-age population is a crucial factor behind the outcomes, irrespective of the exact link between age and care expenditures.

All the pre-funding rules studied smooth the tax rate. The scale and timing of the effects, however, vary strongly depending on the chosen rule and the realized population scenario. The rules generate a large variation in the size and timing of the fund, and thereby in the net wealth of the government.

We use several indicators as criteria for goodness of the pre-funding rules tested. The limits of the confidence intervals of the predictive distribution describe the probabilities of ending up with tax rates that deviate appreciably from the expected path, and also give an idea of the trade-off between short-term and long-term variation in the tax rate. The number of cases in which there is a decrease in the tax rate is an indicator of excess funding. The shape of the scatter plot of tax rates helps to visualize the effects of the various rules. We do not try to combine these criteria under any social welfare function, since doing so would inevitably be *ad hoc*. Instead, we characterize the main results as follows.

If the focus is on tax smoothing during the next few decades, an effective rule is a buffer fund designed to stabilize the tax rate should the current population forecast come true. But if we lengthen the time horizon to the end of the century, the virtues of using continuously updated demographic information to evaluate future expenditures become evident. The Buffer Fund rule generates in this time scale even more variation than the current pay-as-you-go rule: it shifts the effects of demographic risks towards the future. In this respect it differs from all the other rules studied, which shift the risk effects from the distant future towards the present.

Temporary funding rules also give more weight to the near future. They have substantial tax smoothing effects which vanish in the long run, and have relatively low probabilities of excess funding. Permanent pre-funding rules which use population information perform better in smoothing taxation in the long run, since they increase funding earlier if necessary. With these rules the risks are shifted towards current generations: variation in financing costs increases marginally during the first few decades, but declines more after that.

The preference order between the funding rules depends on the time horizon of the decision-maker. The relatively short planning horizon of the buffer fund and the temporary pre-funding rules can be justified by noting that the determinants of the expenditures become more uncertain with longer horizons. It is also harder to get political support for reforms where the costs are immediate and the benefits come after decades. From a generational point of view, permanent demography-based pre-funding rules are preferable. Further research could concentrate on a combination of a buffer rule and some permanent demography-based pre-funding rule. Such a combination might bring forward the tax smoothing effects to the near future without shifting risks excessively into the distant future.

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