Pensions and external effects of ageing; effects on distribution

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Pensions and external effects of ageing; effects on distribution

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Abstract

Ageing gives rise to concern about the sustainability of pay-as-you-go pension systems. One reform option suggested is to make the system actuarial by a tight connection between contributions and benefits. The incentives for the individual will then coincide with the interest of the pension collective. However, the individual actions – fertility decisions, working hours, timing of retirement – also contain a collective part not taken into consideration in the individual's utility maximisation, a 1/N problem. As pay-as you-go systems are indexed by growth, the index (rate of return) is influenced by these actions even if the system is 'actuarially fair'. We trace the effects of changes in fertility and early exit/changes in working hours on different generations in an overlapping generation model. The economic model (a stylised model of the economy in aggregate and the pension system) is fitted into a simulation model. We show that the collective effect /external effects are far from negligible. Different measures to cope with these effects are discussed.

Introduction

Ageing gives rise to concern about the sustainability of payg pension systems. There are a number of reform options in order to avoid ageing problems and the 'unfair' distribution between generations that follows from ageing. Ageing with respect to pension systems is not only caused by demographic changes like decreases in fertility and increases in life expectancy, but also by changing life courses in the form of delayed entrance into the labour market and early retirement. The proposed measures to amend sustainability range accordingly from tightening the link between contributions and benefits, stimulating fertility, encouraging delayed retirement age, letting increased longevity influence the benefit, to index in accordance with economic performance (see for example Fehr et al. (2003), Fenge & Meier (2003), Lassila & Valkonen (2002), Oksanen (2002), Sinn (1999)).

One reform option is a notional defined contribution system (a NDC), i.e. a growth-indexed, unfunded (pay-as-you-go) system with a tight connection between contributions and benefits. In such a system – an actuarial one – some actions have direct effects on the individual's pension benefits, reducing the excess burden inherent in non-actuarial systems. This goes for changes in the individual's labour supply (hours and effort). Yet, such a change will also have an effect on the economy's growth rate, equivalent to the rate of return in the pension system, as well as an effect on the outcome for all co-living generations, including those who did not change their behaviour.

The same is true when it comes to fertility. When individuals maximise their utility by deciding, among other things, on the number of children they are going to raise, they also affect the future rate of return in the pension system by affecting the future tax base.

Thus, the individual's actions have a collective effect as well as an individual one, i.e. cause external effects. The purpose of this paper is to estimate these external effects and to investigate the effect on distribution caused by demographic changes in defined contribution, payg pension systems indexed by growth. Our purpose is also to trace the effects on different generations of changes in fertility and labour supply/working hours. To do this we use an overlapping generation model. We use a simulation model of a stylised economy and a pension model of NDC-type (depicting the main features of the Swedish NDC pension system).[1] We will estimate the magnitude of the external effect and discuss remedies. In the next section we briefly discuss fertility and labour supply in payg systems. Then the model is described and fitted into the simulation model then presented, followed by results and a concluding discussion.

Fertility, early retirement and payg systems

In recent decades there has been a reduction in fertility from a reproduction rate of around 2 down to 1.7 as a European average. Decreases in fertility might in the short run increase the growth rate as time not used in reproductive work may be used for work in the labour market. Later on, decreased fertility will decrease the labour supply, and thereby the growth rate and thus the rate of return in the pension system, cet. par.. Besides, during the last few decades there has been a trend towards a decreasing retirement age. In combination with increased life expectancy the number of years as a pensioner has increased substantially. Decreased fertility and longer periods as pensioners are two important components in explaining increases in the dependency ratio.

A payg system is dependent on the willingness of people to raise children – reduced fertility is said to be one of the reasons behind the threatened sustainability. Child rearing is costly.[2] It costs time that otherwise could have been used for paid work and/or leisure and it costs money/consumption possibilities. In a pension system with a tight connection between contributions and benefits, time spent on child rearing lowers the contributions paid and thus the pension benefit for the parent. Thus, such a pension system gives rise to an incentive to reduce fertility compared to a system with no or only a loose connection between contributions and benefits. In maximising utility with respect to the number of children the individual is equating private marginal utility with private marginal cost. The effect of the fertility decision on future growth (and the rate of return) will not be included in the individual's opportunity costs, since this effect is negligible from an individual point of view; the 1/N-problem.

[1] The old Swedish system was a price-indexed, defined benefit payg system with a loose connection between contributions and benefits. A new system was launched in 1999. In the new system the major part is a payg, defined contribution system with a tight connection between contributions and benefits, a so-called Notional Defined Contribution system (NDC). It is growth indexed making co-living generations share the risks of bad years and the proceeds of good years. The index is based on average wage growth instead of the sum of wages (=the contribution base) introducing a possible destabilising factor. An automatic balance mechanism takes care of this problem. A smaller part is funded; individuals can choose from a large number of funds. For fuller descriptions, see Palmer (2000), RFV (2000).

There are studies showing that a pension system may in itself induce a decrease in the number of children people choose to raise (Cigno (1993), Cigno et al. (2000)). Also, in payg systems families with many children subsidise families with few or no children (Breyer & van der Schulenburg (1987). Thus, a subsidy to child rearing may be a Pareto improvement under certain conditions (Fenge & Meier (2003), van Groetzen et al. (2003)). Sinn (1999) draws the conclusion that reduced fertility may be a reason for switching from a payg system to a (partly) funded one. As those reducing their fertility do not have to support (many) children, there should be room for building a fund, i.e. engage in investments in physical capital instead of human capital. To conclude, there seems to be a case for subsidising child rearing or penalising those not raising children if the pension system is a payg one.

In many systems, mainly defined benefit ones, there are incentives for early retirement. There is massive empirical evidence that these incentives do give effects. (Gruber & Wise, 1999, and, for the Swedish case, Palme & Svensson, 1999). In Fehr et al. (2003) reform options considering early retirement are discussed. One option is to have a close connection between contributions and benefits – as is done in the Swedish system with the explicit purpose of delaying retirement. The utility maximising individual will take the effects on pension benefits into account in deciding on labour supply, but will not take his action's effects on the rate of return into consideration as his individual influence is insignificant; again the 1/N-problem.

The model

The model consists of two parts; the economy in aggregate and the pension system. The first part, the economy in aggregate, is condensed into the pension system from a macro point of view. The second part contains the pension system from an individual's perspective. The model provides the framework for the simulation model, which is a multi-period overlapping generation model. We have deliberately chosen a simplified model in order to clarify the effects of demographic changes, not letting them be obscured by specific pension rules, tax systems, and so on.

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[2] In most countries child rearing is heavily subsidised, through tax exemption and family based social insurance or through direct transfers and in-kind benefits.

The economy in aggregate

The economy is summarised in the budget restriction of the pension system:

$$q \sum_{i=e}^{x} w_i LS_i (1+g) = \sum_{i=x+1}^{D} b R_i \qquad \text{for all } t \qquad (1)$$

where q is contribution rate, w average wage, LS labour supply, g the growth rate, b pension benefit and R number of pensioners; e is the cohort entering the labour market, x the exit from the labour market and D death; i is co-living generations in the period.

The pension system is a defined contribution system; thus q is fixed. We do not specify the production technology behind w(i, t): each person supplying 1 unit of labour produces 1 unit of goods (no productivity growth is assumed).

LS is labour supply, determined by L, the number of people of working age, and by the individuals' supply to the labour market determined by the scenario chosen. R, the number of pensioners, consists of those working in previous periods.

The rate of return, (1+g), is derived within the model and follows from the chosen scenario.

The pension system[3]

In the NDC system pension rights accrue in an individual (notional) account. Each year's contributions (q * y) are added to the account and indexed by the indexation number. If the working period is from year e to year x, the k:th individual's accrued pension rights are

$$NW_k = q \sum_{j=e}^{x} y_{k,j} \prod_{j=t+1}^{x+1} (1 + \lambda_j)(1+z_j) \qquad (2)$$

[3] The model is an extension/reformulation of the one presented in Kruse (2002). It depicts the main features of the Swedish system although not in detail.

where NW is notional pension wealth and $y_{k,j}$ is the individual's wage income the j:th year, determined by working hours as well as hourly wage (= $h_{k,j}$ $w_{k,j}$). The indexation is by $(1 + \lambda_j)(1+z_j) = (1+g_j)$, which is the interest on the account, where λ_j is population/labour supply change and z_j the productivity change (z assumed to be zero in the basic simulations).

The yearly pension benefit is determined at the date of retirement as

$$b_{k,\, x+1} = NW_k / \eta_K \qquad (3)$$

and the benefit during the following years as

$$b_{k,\, x+i} = b_{k,\, x+i-1}\ (1+\lambda_{x+i-1})(1+z_{x+i-1}) \qquad i = 2 \ldots D \qquad (4)$$

where η_K is life expectancy estimated for k's cohort K at the date of retirement.[4] D is the year of death, and b is thus an actuarially calculated annuity (possibly apart from the risk difference between sexes and socio-economic groups), which in the NDC system will be indexed by the same factor as the accrued contributions. The options open to an individual to affect his or her pension benefit are through e, y (=hw), and x, while λ and z obviously are exogenously determined.[5] With an ageing population, $\lambda < 1$, the rate of return – and with it b – is reduced compared to a situation with a stable population.

The individual's labour supply

$$h_{k,j} = 1 - l_{k,j} - rp_{k,j} \qquad (5)$$

where h, l, and rp are the time used in market work, leisure and reproductive work respectively; in each period there is a time restriction as in eq. 5. Child rearing is time consuming. The fraction of time spent in child rearing, $rp_{k,j}$, cannot be used for market work. The opportunity cost of raising children is the income foregone in period 1: $w_{k,j}\,(1 - rp_{k,j})$ + its effects on $b_{k,j}$ a number of periods later.

Equations 1 – 5 constitute the basic model used in our simulations.

4 In an obligatory system η can be pooled between men and women and between socio-economic groups, thus giving rise to redistribution between these risk groups.

The simulation model

The basic model, equations 1-5, is used in an overlapping generation model with 9 co-living generations; each generation/ cohort lives in 9 periods.[6] The first period is spent in childhood, 6 periods as a worker and 2 as a pensioner. This depicts fairly well an adulthood of 45 years of working age (from 20 to 64) and 15 years as a pensioner (from 65 to 80) with a period length of 7.5 years.[7] In the first period no income is earned. In period 2 – and only in period 2 – the individual gives birth to children. As child rearing is time consuming, labour supply is reduced by 25 per cent for each child during that period, i.e. the cost of giving birth to a child is one quarter of labour supply per child.[8] In periods 3-7 the individuals supply 1 unit of labour and earn an income of 1 unit. The contribution to the pension system is 20 per cent of earnings in each period. The rate of return on the contributions is calculated using sum index. In the simulation model the only effect on indexation, or rate of return, is through changes in demographics and labour supply. The results are derived within a static setting; possible adaptations are discussed in the concluding section. We assume a small open economy; both the wage rate and the rate of interest are exogenously given.

The population consists of children, workers and pensioners. In each period a new cohort is born, children of the previous period enter the labour market, the oldest cohort of workers leaves the labour market and enters into retirement and the oldest pensioner cohort dies. At the outset we have a stable population with cohorts of equal size. We use the following connotations: K^t are those born in period t and children during that period. Those in the cohort K^{t-1} are born in period t-1, and so forth. In period 1 the children belong to the cohort K^1, their parents being K^0. Working cohorts in period 1 are K^0 to K^{-5} and the cohorts of pensioners are K^{-6} and K^{-7}. In period 2 the cohorts 1 to -4 are workers, -5 and -6 pensioners.

The model is then used to show how a change works its way through the generations, from one steady state to a new one.

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[5] Note specifically that λ will be influenced by the individual's behaviour; however, the individual will not take this into account in her/his decision as the effect is negligible.

[6] In order to test the sensitivity of the results to our particular model specification we also tested a model with an extended number of periods. Here both the working periods and the number of periods as a pensioner doubled. In addition, we tested a model with an increased number of individuals; the results were very robust.

[7] An objection may be raised that the childhood period is short. To our underständing this does not affect the results in a significant way. In future work, however, we will extend the model in this respect.

[8] It turns out that the results are not sensitive to the chosen reduction in work / the cost of raising children.

Results

In this section the effects of a number of scenarios are shown. In order to isolate the influence of the demographic change the simulations are performed ceteris paribus; no adaptations are allowed. Possible adaptations are discussed in the concluding section.

The measures we use are

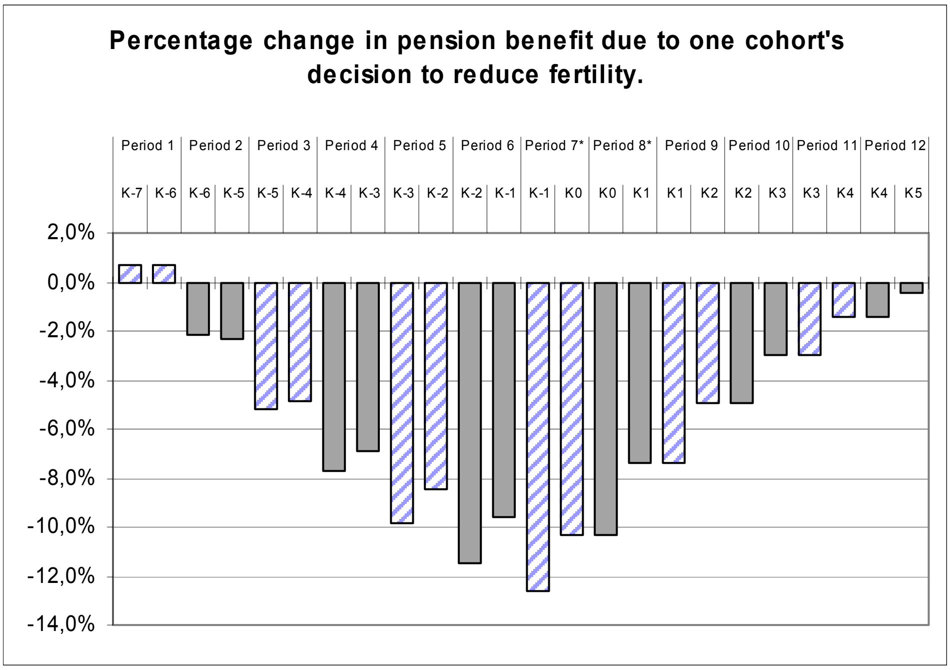
- pension benefit in absolute numbers
- percentage change in benefits compared to steady-state
- replacement rate
- benefit/contribution-ratio, i.e. the sum of benefits in relation to the sum of contributions

Changes in fertility

1 A temporary drop in fertility

In period 1 there is a drop in fertility, from a TFR of 2.0 to 1.67. In period 2 fertility is back at 2.0 again. In figure 1 the percentage change of the pension that would have been paid without a reduction in fertility is shown. The only cohort that will gain from the drop in fertility is the "old" pensioner in period 1 i.e. cohort K^{-7}. Their increase will be nearly 1 per cent. This is due to the increased labour supply in period 1 as K^{0} (the generation lowering the fertility) spend less time in reproductive work, which increases the sum of wages and the index. In period 2 and onwards labour supply is reduced as smaller cohorts are entering the labour market, which reduces the index. This will cause a gradual worsening of pensions for every cohort up until the cohort born (K^{-1}) just before the one that decides to reduce fertility.

Figure 1



* In the figure K^0 is represented by the individuals that do not reduce their fertility. The people who reduce their fertility in that cohort will not lose as much (about 7 per cent) since they have higher incomes and therefore also higher pensions.

The pension for cohort K^{-1} will be about 10 per cent lower in their first period as pensioners compared to what they would have had if the fertility had remained constant.[9] In the second period as pensioners the corresponding figure is 12 per cent. The succeeding cohorts will also experience a decrease in pensions but less pronounced than cohort K^{-1}. In total 13 cohorts in our model will be affected by the decision of one cohort to reduce fertility.

It is interesting to note that the individuals in cohort K^0 who decide to lower the number of offspring will also get a lower pension benefit (about 7 per cent) compared to what they would have received if they had kept it at the same level as the rest of the population. The total reduction of the pension benefit in absolute value will be 0.08 units for those in the cohort reducing their fertility. This should be compared to the increase in their net wage income, which is 0.20 units. Hence, the total gain for an individual who decides not to raise children is 0.12 units. To put these numbers in some perspective, they can be compared with the fall in aggregate pension benefit for all cohorts, which is 4.41 units.

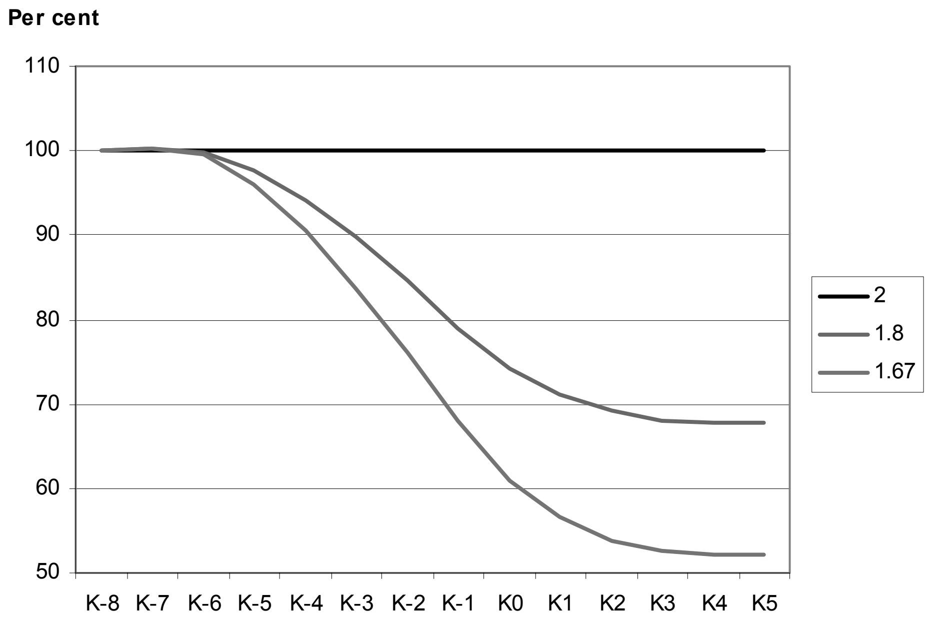
[9] In considering the numbers, do note that they are calculated from a sharp drop in fertility during a short period and that we only use a small number of cohorts compared to reality. In real life the drop in fertility would affect more generations and the process would stretch over a longer time. Still, the calculated numbers will give a good indication of the magnitude of the effect.

One way of calculating the external effect of reduced fertility is to compare the aggregate pension benefit for those who are affected by the change with the aggregate pension benefit without any change in fertility. In the model this can be done by sorting out the effect of the change in indexation. It turns out that the aggregate pension benefit without the change is 80.5 units and with the change the aggregate pension benefit is 76.1, which gives an external effect equal to 5.5 per cent [(76.1-80.5)/80.5].

2 A permanent drop in fertility

In order to study a permanent drop in fertility we use an extended model. The only change compared to the basic model is that every cohort has 60 individuals. In steady-state the fertility is 2.0. In this section we calculate two different scenarios. In one scenario the fertility drops to 1.8 in the first period and then stays on that level. In the other scenario the fertility drops to 1.67. Since, in both scenarios, every cohort will be smaller than the preceding one, the index will always be under 1, i.e. there will be a negative rate of return in the system. The first cohort that reduces fertility is cohort K^0. The lower fertility arises from a number of individuals not giving birth to children in the cohorts from cohort K^0 and onwards. The individuals not giving birth to children spend more time on the labour market. This means that the pension will also differ within a cohort. Figure 2 shows the benefit/contribution ratio for different cohorts when there is a permanent drop in fertility.

Figure 2. Benefit/contribution ratio. Different fertility rates.



The only cohort that gains from the drop in fertility is the old pensioners (K^{-7}). During their last period as pensioners the total contributions increase due to more time on the labour market for the individuals that do not raise children in cohort K^0. The index will be over 1 for that period. The pension will then be gradually lower for every cohort, which also means that the benefit/contribution ratio falls.

The first cohort (K^0) that reduces their fertility will only receive a pension that is equal to 75 per cent of paid contribution in the 1.8 case (60 per cent in the 1.67 scenario). It is also worth noting that all older cohorts, except cohort K^{-7}, will get lower benefits than their accumulated contributions, despite the fact that they have not changed their fertility. From cohort K^3 the fall in benefit/contribution ratio stops. Every cohort born after K^3 will get a pension that is about 68 (52) per cent of paid contributions in the 1.8 (1.67) scenario. The reason that the fall in benefit/contribution ratio ends is that the index will be the same in all periods thereafter. However, the index will be lower than 1. In the permanent drop in fertility scenarios there is a problem in calculating an external effect because a new steady state with a stable population will never be reached. Instead we have calculated the total loss in pension benefits compared to contributions for those cohorts that have kept the fertility at 2.0, i.e. cohort up to K^{-1}. It turns out that the total loss is 7.9 per cent of total contributions in the 1.8 scenario and 12.3 per cent in the 1.67 scenario.

Table 1 shows the pensions in absolute value for different cohorts when there is a permanent drop in fertility. The pension will be different between the first and second period as a pensioner, which also can be seen in the table.

Table 1 Pensions in absolute value. Permanent drop in fertility

Fertility rate	***1.8***		***1.67***	
Kohort	Period 1	Period 2	Period 1	Period 2
K-7	0.575	0.578	0.575	0.579
K-6	0.578	0.57	0.579	0.566
K-5	0.569	0.553	0.565	0.538
K-4	0.554	0.529	0.54	0.5
K-3	0.533	0.499	0.506	0.456
K-2	0.507	0.465	0.468	0.407
K-1	0.478	0.43	0.426	0.355
K0	0.449	0.405	0.382	0.319
K1	0.431	0.388	0.355	0.295
K2	0.419	0.376	0.333	0.282
K3	0.411	0.371	0.33	0.276
K4	0.409	0.37	0.327	0.273
K5	0.41	0.369	0.326	0.273

The values in the table can also be seen as replacement rates, since everybody has an income equal to 1 unit in their last working period. The replacement rate drops from almost 58 per cent to 37 per cent when the fertility drops to 1.8. In the 1.67 scenario the corresponding drop is from 58 per cent to 27 per cent. In most countries that have a paygo-system, it is complemented with a basic pension or a guarantee pension. The basic pensions generally gives higher replacement rates than the outcome of our calculations from permanent drop in fertility. If the basic pension is paid, the system has lost its actuarial feature.

3 Varying fertility, giving successive boom and bust generations

Varying fertility where large and small cohorts follow each other is a common demographic feature. In our next example we show what happens to pensions in absolute values and the benefit/contribution ratio when the fertility varies between high and low. In this scenario two cohorts with low fertility (1.8) are followed by two cohorts with high fertility (2.22). At the end of a cycle the population is back to 60 individuals. In a cycle there are four different types of cohorts; small cohorts with high fertility, large cohorts with low fertility and medium sized cohorts with low and high fertility. Since the fertility varies, the effects will also be different within a cohort. In the steady-state scenario everyone in the model gives birth to one child. In cohorts with low fertility a few individuals will not give birth to any children and will therefore spend more time on the labour market and pay more contributions. In the high fertility case some individuals within the cohort raise more than one child. This will lower their contributions since they spend less time on the labour market.

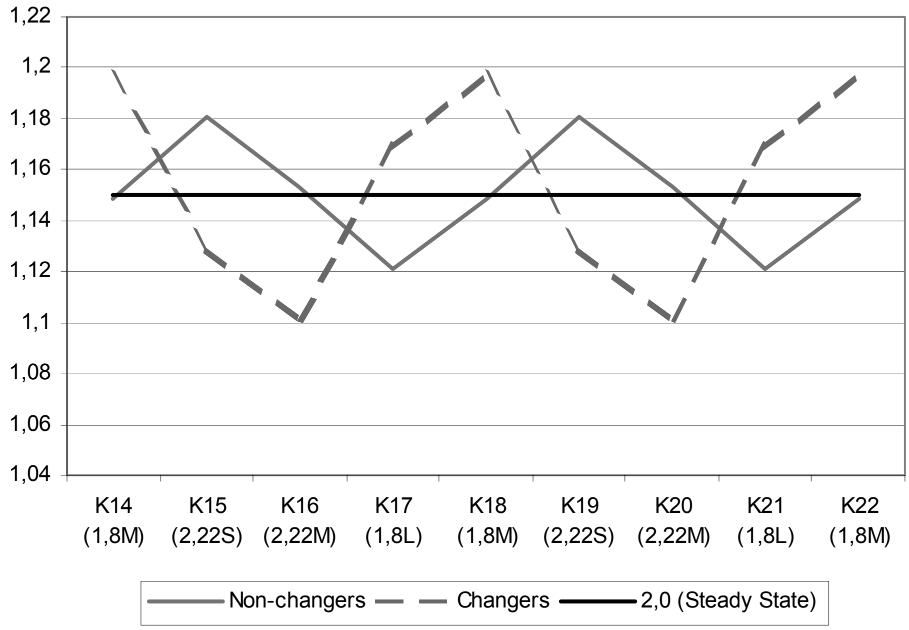
Table 2. Total pension and benefit/contribution-ratio in the bust-boom-scenario.

Cohort size	Fertility	Result for non-changers		Result for changers	
		Pension	b/c	Pension	b/c
Large	1.8	1.1207	0.975	1.1689	0.974
Medium	1.8	1.1481	0.998	1.1969	0.997
Medium	2.22	1.1528	1.002	1.1015	1.001
Small	2.22	1.1805	1.027	1.1286	1.026

In table 2 the results are presented for the people in the cohorts that do not change their fertility compared to steady-state (non-changers) and for the individuals that change their fertility (changers). The absolute value of pensions for the non-changers can be compared to the steady-state pension of 1.15. Any difference from that value is a pure index effect of the varying fertility. The large cohort is worst off since they only get 1.12 units of pension, which is less than the 1.15. The “winners” are the people born in a small cohort who get 1.18 units. The results for the medium sized cohorts do not differ much from the steady-state scenario. When comparing the result for the non-changers with the one for the changers, it can easily be seen that individuals in low fertility cohorts get a larger pension than the rest of the same cohort and vice versa for the high fertility cohorts. The simple reason behind this is that the individuals in a low (high) fertility cohort have paid more (less) contributions than the others within the cohort. The benefit/contribution ratio also shows that the index affects a whole cohort in a similar manner. The benefit/contribution ratio for the individuals that change their fertility is much the same as for the rest of the people born in the same cohort.

The external effect, calculated over a demographic cycle, is 0. Positive external effects are counterbalanced by negative ones, thus giving this result. Note, however, that it is not the same individuals that are exposed to positive and negative external effects. The cohorts with low fertility will be exposed to the negative external effect and vice versa.

Figure 3. Pensions in absolute value. Varying fertility.



Changes in labour supply

1. Early retirement by all cohorts from period 1 and onwards

We start with the same behaviour as in the basic scenario, i.e. everyone supplies 0.75 units of labour in the first working period, due to reproduction work, and 1 unit per period during the remaining periods. However, in period 1 those in the oldest working cohort (K^{-5}) start withdrawing from the labour market before the end of the period. We assume that they only work for 75 per cent of the period, withdrawing 25 per cent earlier than the cohorts "in front" of them. This earlier retirement corresponds to approximately 2 years. From period 1 and onwards every cohort behaves in this way.

As the system is actuarially constructed, the pension benefit for those taking early retirement is reduced from two sides: the notional wealth is smaller as less is paid into the account, and the division number is higher as the pension period is increased by a quarter of a period. This is the individual cost of early retirement. There will also be a collective cost due to a fall in the index. The reduction in pension benefit is greatest for the generation reducing their labour supply. However, the individual part must be assumed to be compensated for by the utility of leisure. Thus, the change can be said to hit hardest at the generations surrounding K^{-5}, i.e. K^{-6} and K^{-4}, as they have the greatest NW to be indexed. The younger the generation, when the change occurs, the smaller the accrued NW, and the smaller the effect on benefits. The replacement rate will decrease from 0.575 to somewhere between 0.47 and 0.49.

Table 3. Benefit/contribution-ratio and pension benefit during the transition period after advanced withdrawal.

Cohort	Benefit/contribution-ratio	Pension benefit per period in retirement
K^{-7} (pensioner)	0.978	0.575; 0.55
K^{-6} (pensioner)	0.957	0.55
K^{-5} (the cohort starting withdrawal early)	0.963	0.47
K^{-4}	0.97	0.47
K^{-3}	0.978	0.48
K^{-2}	0.986	0.48
K^{-1}	0.994	0.49
K^{0} (entering the labour market this period)	1	0.49

Due to early retirement in the cohort of the oldest workers there will be a reduction in the labour force and an increase in the number of pensioners. This change in the dependency ratio will, however, be an isolated phenomenon even if each and every succeeding cohort repeats this pattern. Thus, the effects will die away faster than in the case with reduced fertility. The external effect is also much smaller in this case, -2.5, compared to the temporary drop in fertility.

2. *Early retirement by one cohort*

In this scenario we assume that one cohort decides to retire early, while successive cohorts return to the old behaviour. Those who are already pensioners when this occurs will lose.

Table 4. Benefit/contribution-ratio and pension benefit when 1 cohorts withdraws early.

Cohort	Benefit/contribution ratio	Pension benefit per period in retirement
K^{-7}	0.978	0.575; 0.55
K^{-6}	0.978	0.55; 0.575
K^{-5} (withdraws early)	1	0.55
K^{-4}	1.01	0.58
K^{-3}	1.01	0.58
K^{-2}	1.01	0.58
K^{-1}	1.01	0.58
K^{0}	1.01	0.579

Older cohorts have a large NW that will decrease as the index becomes negative in response to K^{-5} 's early retirement. On the other hand they will also have a large NW in the next period when the index goes up again. As there is a symmetry here all successive cohorts after the one retiring early get the same outcome and a slight increase in pension benefit.

3 A general reduction in working hours

In Sweden some political parties propose a general reduction of working hours from 40 hours/week to 30 hours/week. In this section we examine what would happen to pensions if there were a general reduction of working hours of that magnitude. The general reduction of working hours starts in period 1 in the model, which means that cohorts K^{-7} and K^{-6} are already pensioners and cohort K^{-5} is working its last period and so on.

Figure 4. Difference between contributions and benefits, per cent. General reduction in working hours.

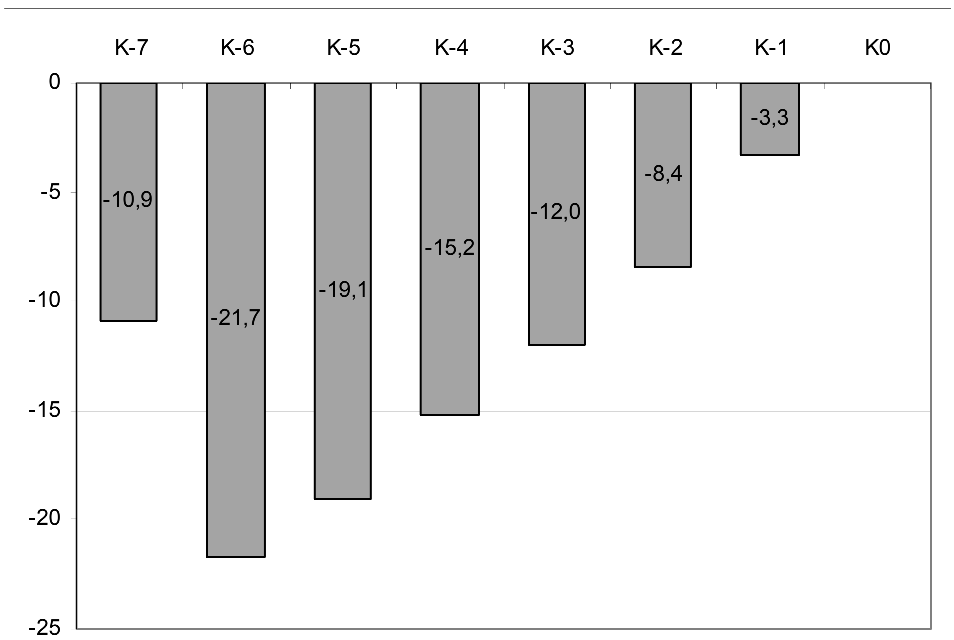


Figure 4 shows the results for different cohorts as the difference in per cent between contribution and benefits. The worst outcome is for the young pensioners (K^{-6}) when the reduction starts. Their pension will be almost 22 per cent lower than the contribution that they have paid. The effect then gradually fades away up until cohort K^{0} where the pension is equal to the contributions, a new steady-state. It is still worth noting that the pensions for cohort K^0 will be 22 per cent lower than they would have been if everybody had continued to work 40 hours/week. The external effect calculated as the difference in per cent between benefits and contributions for all cohorts that are affected by this change, i.e. cohorts K^{-7} to K^{-1}, is -14,5 per cent.

4 Deferred retirement in response to increased longevity

Life expectancy has on average increased by approximately one year for every decade. In a defined-contribution, actuarial system this is entirely borne by the pensioner in the form of a reduced benefit. As each period in our simulation model corresponds to approximately 7.5 years, the following example gives a fairly good hint of the effects of increased life expectancy. Approximating the historic development with an increase of half a year per period, the effect on pension benefits is as shown in table 5.

Table 5. Division number and pension benefit in the increased longevity scenario.

Cohort	Division number	Pension benefit
K-7	2	1.15/2 = 0.575
K-6	2.07	0.556
K-5	2.13	0.54
K-4	2.2	0.523
And so on		

Increases in longevity are known rather well in advance. Thus there is time for the individual to adjust in accordance with the anticipated change. The reduction in pension benefits may induce people to work longer hours and / or retire later in order to maintain their living standards in old age. People in the cohort K^{-6} can achieve the same pension benefit as those in K^{-7}, for example by working 5 per cent more during the working periods 2 to 6 (increasing working hours from 40 to 42 hours a week) or by delaying retirement by one and a half year. By doing so they will also affect the index and thus all co-living generations. The increase in labour supply generates a positive external effect, meaning that the increase in working hours in order to accommodate the increased longevity can be smaller than without the index effect.

Discussion, conclusions

Changes in fertility have a massive impact on pension benefits for all those surrounding the generation which changes its fertility rate. A temporary drop in fertility by one generation affects the pension benefits for a long period of time. Those belonging to the oldest pensioner group when the drop occurs, gain, while all other cohorts lose. A permanent drop reduces pension benefits continuously. The benefit/contribution ratio will persistently be below 1 and the pension benefits will be substantially lower than at the outset.

Most changes in labour supply/working hours do not have quite so severe effects as changes in fertility. A permanent change in retirement age results in a benefit/contribution ratio below 1 during the whole transition period. Those who are pensioners when the change occurs are affected the most. A temporary change in retirement age has hardly any effects, except for those who are pensioners when the change occurs. An over-all reduction in working hours has very severe effects, both on the benefit/contribution ratio during the transition period and on pension benefits ever after. These will be substantially lower than at the outset.

There is an obvious risk of conflict between generations. Those being pensioners, who did not lower their fertility and / or did not reduce their working hours will be hurt by such changes by the contemporary working generation. Furthermore, being old usually means less possibilities of mitigating the adverse effects by own activities.

In the introduction we called an NDC system an actuarial one. In this paper we have shown that the collective effect / the external effects are far from negligible, which means that the actuarial feature of a NDC system may be questioned.

The results are derived within a simplified model. All our scenarios are static. The advantage is that the effects of fertility and labour supply changes are isolated and will not be obscured by the specific features in a certain system. In reality, a number of adaptations may be thought of and, in future work, productivity changes, changing capital/labour ratio as labour supply changes, etc. should be included in the analysis. Here, we confine ourselves to a tentative discussion.

Fertility is not endogenous in our model, as we do not model / include any reaction functions.

In an implicit way, fertility might however be thought of as endogenous in the sense that the individual's cost of raising children is explicit. In our example the net gain of not raising a child is 0.12 units, i.e. 2 per cent of a life income.

A number of adaptations to decreased fertility may be thought of. One is increased investment in human capital: quality instead of quantity. If so, the decrease in income due to decreased labour supply will not be as pronounced as in our example. Another is that with decreased fertility each person in the labour force will have a greater capital stock to work with, K/L increases, again giving rise to productivity growth.

In order to avoid the costs of the external effect, one option might be to subsidise child rearing within the pension system. As the individual net cost of having a child is 0.12 units there is room for Pareto sanctioned subsidy, while the external effect is estimated to be 4.41 units.

An alternative way of reaching the same result would be to penalize those reducing their fertility. Sinn (1999) argues in favour of such a measure. The idea is that not raising a child gives room for extra contributions (savings) that might be funded. There is no explicit suggestion for how these extra means may be used. However, making the generation (or those within the generation) that reduced their fertility pay an extra contribution means that there will be a possibility of using these extra payments for increases in benefits for those who otherwise would lose. Also, funding the extra contributions is a way of substituting human capital with physical capital, keeping the growth rate constant or even positive in the face of decreasing fertility.

Pre-funding in response to changes in fertility is also discussed in Orszag & Orszag (2000). The focus is especially on the possibility of flexibility in funding as there is a large uncertainty in the forecasts of fertility. In the Orszag & Orszag setting the gain from pre-funding stems from a resulting increase in the capital stock that is assumed to increase GDP and thus the tax base, which in turn will mean that the dead-weight loss from taxes will decrease.[10] Bohn (2001) reaches a different conclusion. He focuses on changes in relative prices – wages and interest – and finds that although small cohorts have to pay increased

[10] Contrary to our specification of the pension system with a DC system they assume that all contributions (pay roll taxes) are taxes, giving rise to distortions and dead-weight losses.

contributions to sustain the benefits promised to a preceding large cohort,[11] their relative wages will be so much higher that they will be compensated.

Lassila & Valkonen (2002) suggest that the contribution rate may depend on the cohort's fertility rate. The pre-funding, i.e. a cohort's contribution rate, will depend on the relation between the number of newborn and the size of the cohort. A ratio below 1 triggers the pre-funding.[12]

It should be noted that some people within a cohort do fulfil the 'reproduction quota' while others do not. Raising the contribution rate for the whole cohort seems like a collective punishment. Another way of launching a fertility-based contribution rate with funding would be to have one contribution rate for people with no children and, another (lower) for people with 1, 2, … children. The level and time path of contributions would thus differ over most individuals' life span. As these prefunding parts of the contributions are levied in order to eliminate (or at least mitigate) the external effects of reduced fertility, these extra payments must be used either for increased capital stock that in turn will increase productivity and/or for payments to those whose pension benefits are reduced. Thus, this way of mitigating the risk of fertility changes will cause a deviation from the NDC principle where all contributions are accrued in an individual account. The pre-funding part will be a pure tax, causing the well-known dead-weight losses in the labour market. Child credits within the pension system to subsidise child rearing do not have the same distorting effects in the labour market and might therefore be a preferred alternative. However, child credits have to be financed by a tax, which in turn may cause distortions.

In defined benefit systems, shorter working hours is often subsidised. Thus, one reform option, in order to meet the demographic challenges payg systems are exposed to, is to tighten the link between contributions and benefits (see for example Fehr et al. (2003), Lassila & Valkonen (2002)). In this paper we show that not even an NDC system with its tight connection between contributions and benefits – a system supposed to be actuarial – is

[11] Again, a defined-benefit system is asumed.

[12] For the sake of illustration we have calculated such a ratio from Swedish population figures.
It turns out that the ratio of children to adults in reproductive ages was above 1 in 1970 (1.10), dropped to 0.94 in 1975, was below 0.8 in the 1980s, was 0.95 in the 1990s and dropped down to 0.75 in the 2000s. In order to compensate for the low fertility, all cohorts in the most reproductive ages would have had to pay an extra contribution for pre-funding since the middle of the 1970s.

perfectly actuarial as it does not take the external effect into consideration. There is a discrepancy between individual and social cost and the actuarial reduction in benefits in response to early retirement covers only the individual part. In order to correct for these external effects, they have to be internalised.

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