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AGEING POLICIES AND DEMOGRAPHIC UNCERTAINTY IN LITHUANIA: A DYNAMIC CGE ANALYSIS

Research Report
P98-1023-R

This research was undertaken with support from the European Union's Phare ACE Programme 1998. The content of the publication is the sole responsibility of the authors and it in no way represents the views of the Commission or its services.

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1 AGEING POLICIES AND DEMOGRAPHIC UNCERTAINTY IN LITHUANIA: A DYNAMIC CGE ANALYSIS

1.1 The effects of uncertain population ageing on the Lithuanian economy and on the pension system

Ageing of Lithuanian population affects the aggregate economy directly by reducing the labour force and household saving, but also by increasing the public sector income transfers and raising tax rates. As emphasised in the earlier parts of the report, the uncertainty concerning the size and age-structure of population is high, which consequently implies large variation in macroeconomic and public finance outcomes.

The baseline demographic scenario

The baseline demographic scenario assumes that fertility rate stays at the prevailing low level for the whole forecasting period, life-expectancy increases and net migration gradually declines to zero. We also assume that the only change in the participation and employment rates is due to the higher statutory retirement age. These assumptions imply that labour supply (aggregate working hours) fall by more than third in 50 years. For the private sector employees the outcome is marginally weaker, since demand for public health care services reduces less than the working-aged population.

The continuous excess demand for labour generates an adjustment process in production and in labour markets. Firms substitute capital for labour, but the growth rate of the domestic capital stock and production slows down. The lack of labour compels firms to expand abroad. In domestic labour markets wage rate rises due to capital deepening and due to the higher price of the output (i.e. because of the improved terms of trade). The net effect on aggregate disposable incomes and consumption of households is, however, negative since pension contribution rates and taxes are higher.

Table 4.1 Macroeconomic variables* in the baseline demographic scenario

*Adjusted for productivity growth, index 2000-2004=100

	2000	2010	2020	2030	2040	2050
Labour input, total	100	101	96	87	76	65
Labour input, private sector	100	101	95	86	75	63
Labour input, public sector	100	101	96	87	76	65
Labour input, health care	100	100	101	100	97	90
Capital stock	100	101	97	90	81	72
Private production	100	102	99	92	82	72
Capital/labour	100	100	102	104	108	114
Production/labour input	100	102	104	107	110	114
Private consumption	100	102	103	98	92	85
Private investment	100	99	94	86	76	68
Exports	100	103	100	93	82	69
Wage rate	100	102	107	111	118	127
Terms of trade	100	99	100	102	105	110
Current account surplus/GDP	2.0	3.0	3.1	3.3	3.1	1.4

The demographic trend also affects aggregate saving. The higher the ratio of pensioners to young people, the lower is the savings ratio of the economy. On the other hand, the needed investments are much smaller in a shrinking economy. The balance in the capital market may be reached either by international capital flows or by shifts in the domestic interest rate or both. In our simulations interest rate is fixed and current account balance reacts. The induced surplus in the current account improves the foreign net debt position of the country and increases capital incomes.

Another relevant question is whether ageing also affects the export demand and terms of trade. Since export demand is assumed to be price-elastic and independent of the population ageing in export markets, the reduced supply of export goods raises their price and improves the terms of trade in the long term.

One of the baseline assumptions is that Lithuania, being a country in the middle of transition, has large potential for a catch-up of economic growth. The Table 2 below shows that if the assumed average yearly productivity growth of 3 percent is materialised, private production will be threefold in 50 years, even though the labour force shrinks.

Table 2. Macroeconomic variables in the baseline demographic scenario, no productivity growth adjustment

Index 2000-2004=100

	2000	2010	2020	2030	2040	2050
Labour productivity	100	134	181	243	326	438
Capital stock	100	136	175	218	264	316
Private production	100	137	179	224	269	315
Private consumption	100	138	186	239	301	372
Private investment	100	133	169	208	248	297
Exports	100	139	181	225	267	305
Wage rate	100	138	193	270	386	559

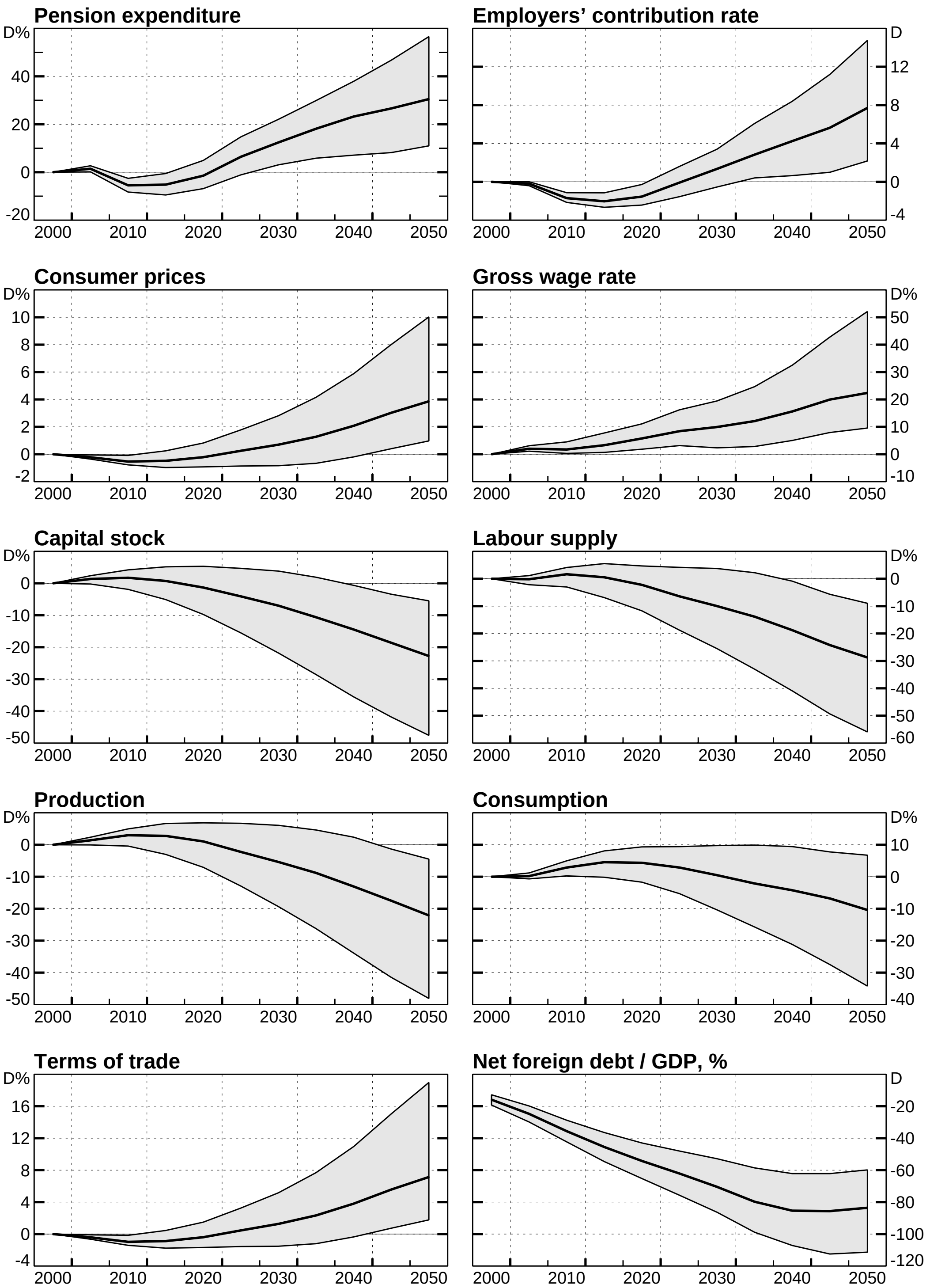
The ageing of the population and the strong age dependency of most cash benefits increase income transfers. Since the majority of the cash benefits are pay-as-you-go financed, the higher expenditure generates both increasing tax distortions in labour markets and an intergenerational shift of resources from young and future generations to current middle-aged generations. Furthermore, there is a double-cost effect in the production of public services. The demand for services increases and so do production costs, since unit labour costs rise. The expansion of the public sector labour force also crowds out private production.

The baseline population scenario shows that the economy has some time to adjust to the coming expenditure pressures. People have not had time to collect pension rights in the new pension system. The needed pension contribution rate is about 8 percentage points higher in the middle of the century. A factor, which limits the corresponding increase in the gross tax rate to few percentage points is the low participation ratio in the earnings-related pension system.

Demographic uncertainty

The next group of figures describes the future paths of macroeconomic and pension variables taking into account the demographic uncertainty. The values for each variable have been generated by simulating the numerical OLG model of the Lithuanian economy using 100 different population scenarios. These scenarios are drawn randomly from the 1500 sample paths of the stochastic population forecast introduced in the section 2 of this report.

Effects of population ageing on pension system and macroeconomic variables



Deviation from a constant growth path
D = absolute deviation
D% = per cent deviation

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There is one important note that should be considered when interpreting the figures. The time horizon of the genuine population scenarios is 50 years, i.e. shorter than the horizon of the model. The simulation results outside of the time horizon of the figures shows that if the change in the population structure stops, the economy and the public sector variables are likely to rebound somewhat from the values reached in the middle of the century. This is to say that, e.g. the employer's pension contribution rate may even fall later. The impression of the exploding median path is therefore likely to be misleading. Due to the largeness of demographic uncertainty in the long term, we cannot, however, formulate current policies relying on the later fall in the contribution rate. What we suggest is that we should concentrate on the information provided for the next 50 years and not to jump to any conclusions about the future further off.

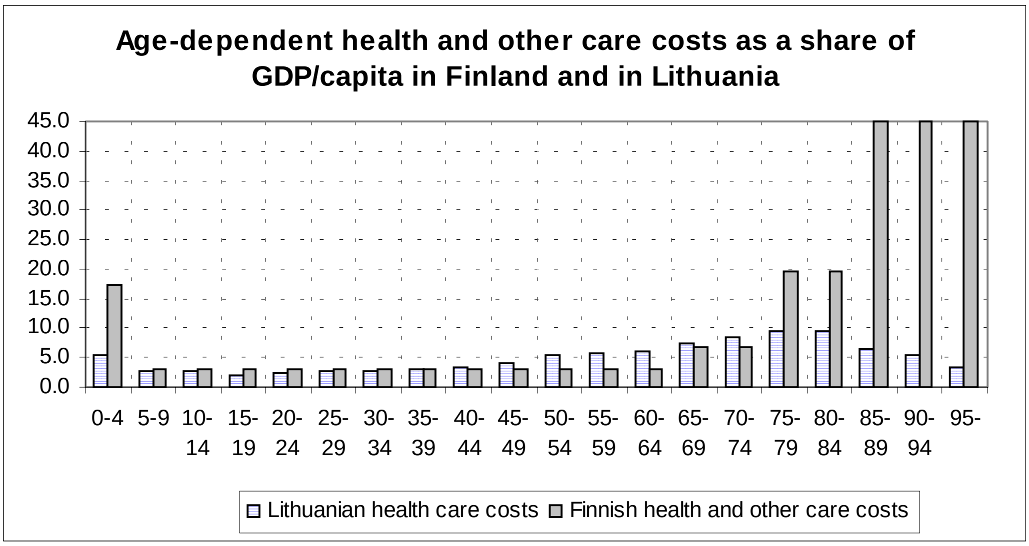
There are several possibilities to describe the amount of uncertainty in the output variables of the OLG model. We have chosen to typically show in the figures the median and the 80 per cent confidence intervals of the 100 simulations. Our simplified interpretation is that the shadowed area includes quite likely the actual path of the variable, assuming that population is the only exogenous driving force that varies.

The overall impression of the effects of demographic uncertainty on the macroeconomic variables is that they are not large during next 20 years. One obvious reason for this is the fact that it takes on average at least 20 years for a new-born to enter labour force.

On the other hand, in 50 years the information provided by single a population path is not very useful, since we cannot say much more than the sign of the change with high probability.

1.2 Health expenditures and demographic uncertainty

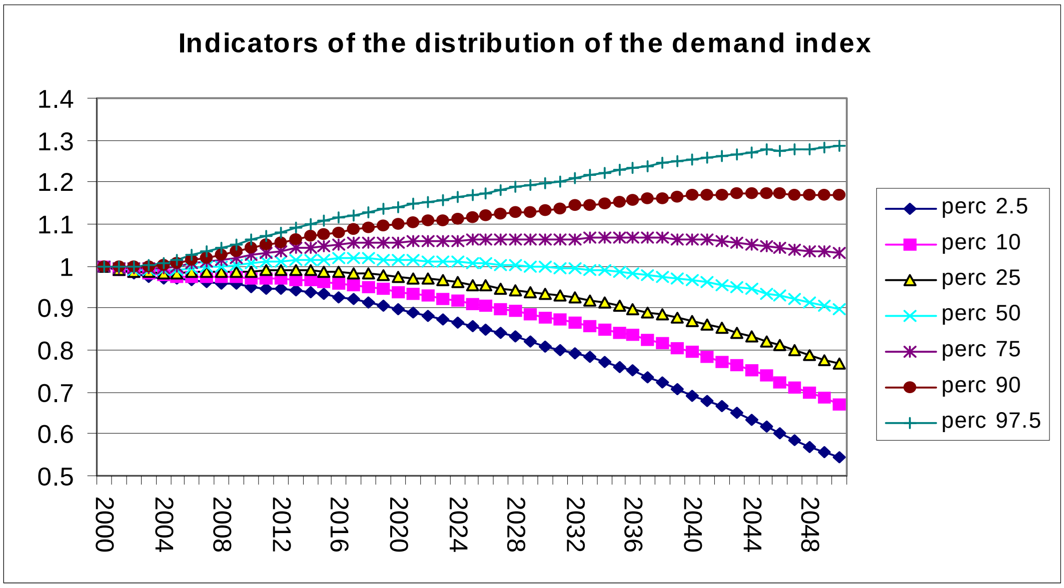
Health expenditures in one of the largest public expenditure items, which are strongly dependent on the age structure of the economy. The age-specific health cost data gathered by Morkūnienė and Murauskiene for the first time (see Section 5 in this report) allows us analyse the effects of demographic uncertainty on the amount of the expenditures.



The figure above compares the Lithuanian and Finnish expenditure data (the latter is based on the norms used for the state support to municipalities). Dividing the data by GDP/capita allows us to put the costs in the same figure. It seems that the ratio of age-specific costs to GDP is markedly lower in Lithuania in the very old ages. This reflects mainly the underdeveloped public provision of old age care.

We evaluated the future demand of health care services by combining a population forecast and the age-cost profile. The outcome is an index, which shows the amount of needed care. There are many strong assumptions behind this interpretation. It assumes firstly, that the age-cost profile is correctly measured and does not change in the future. The latter view is doubtful especially considering the oldest old, not least because we have so far few observations from these ages. Second strong assumption is that any possible quality improvements are exactly compensated by higher productivity[3].

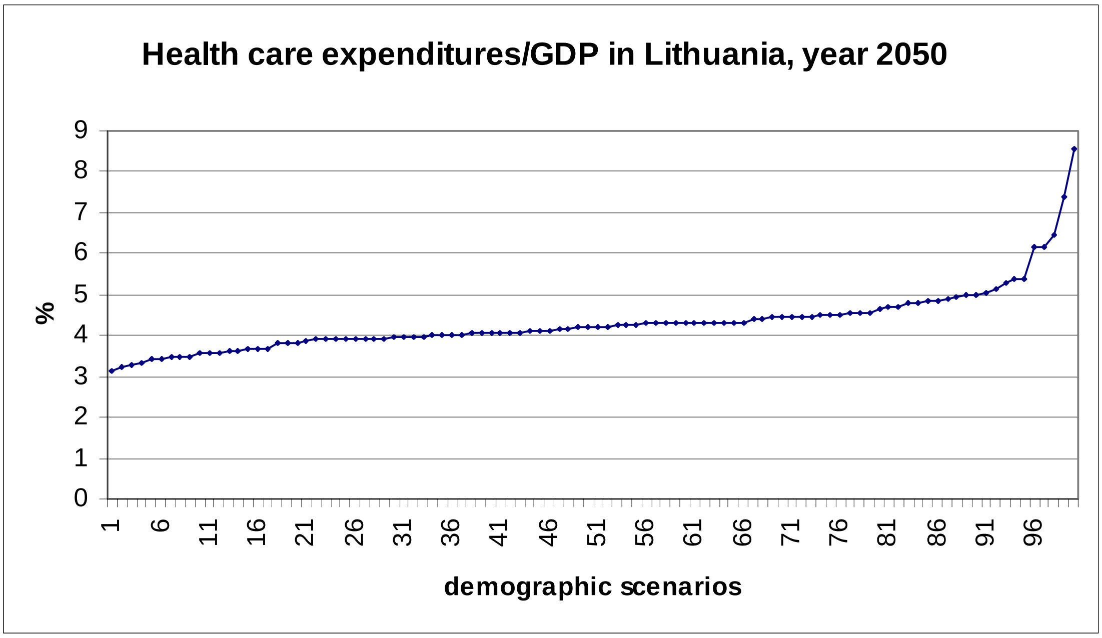
We describe in the following figure how the health care demand index varies due to different demographic scenarios. The data set is calculated using the 1500 sample paths of the stochastic forecast of Lithuania population. The median of the corresponding distribution rises slightly during first 20 years, but falls thereafter and ends to 10 percent lower level in 2050. It seems that the drop in the age-cost-profile in the very old age groups limits the impacts of the increasing number of those citizens. In the long term, the dominating effect is the reduction in the amount of elderly, which lowers the demand.



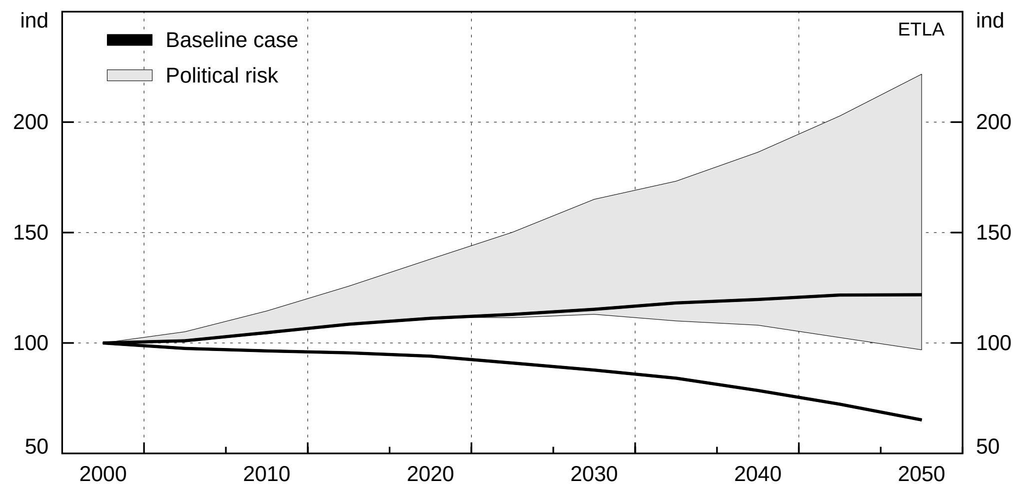
The index data was used as input in the OLG model to describe the demand for labour in the health care sector. The model generates the future time paths of unit labour costs, i.e. wages and social security contributions for each population scenario and thereby the distribution of aggregate labour costs.

3 OECD (2000) lists uncertainties concerning e.g., formal labour force participation of women, changes in coverage, effects of higher incomes on the demand, improved technology, medical price inflation, intensity of care and shifts in public/private provision of the services. In the case of Lithuania, an additional problem is lack of age-specific data on long-term care. But since the current demand and public sector costs are small, partly due to the undeveloped supply and low ability to pay, the future increase may well be large. In the developed countries, average costs of long-term care peak at much higher levels than the health costs.

The following figure tells us that the probability of having unsustainable expenditure paths is small, but cannot be ignored. It describes the ratio of expenditures to GDP in 100 simulations of the OLG model. The year chosen is 2050. More detailed analysis of the underlying factors reveals that the extreme cases are mostly due to the sensitivity of GDP to the demographic variations. This suggests that Lithuania should be prepared to problems in the financing and not so much to the uncertainty of the demand of labour. The result is, however, challenged next.



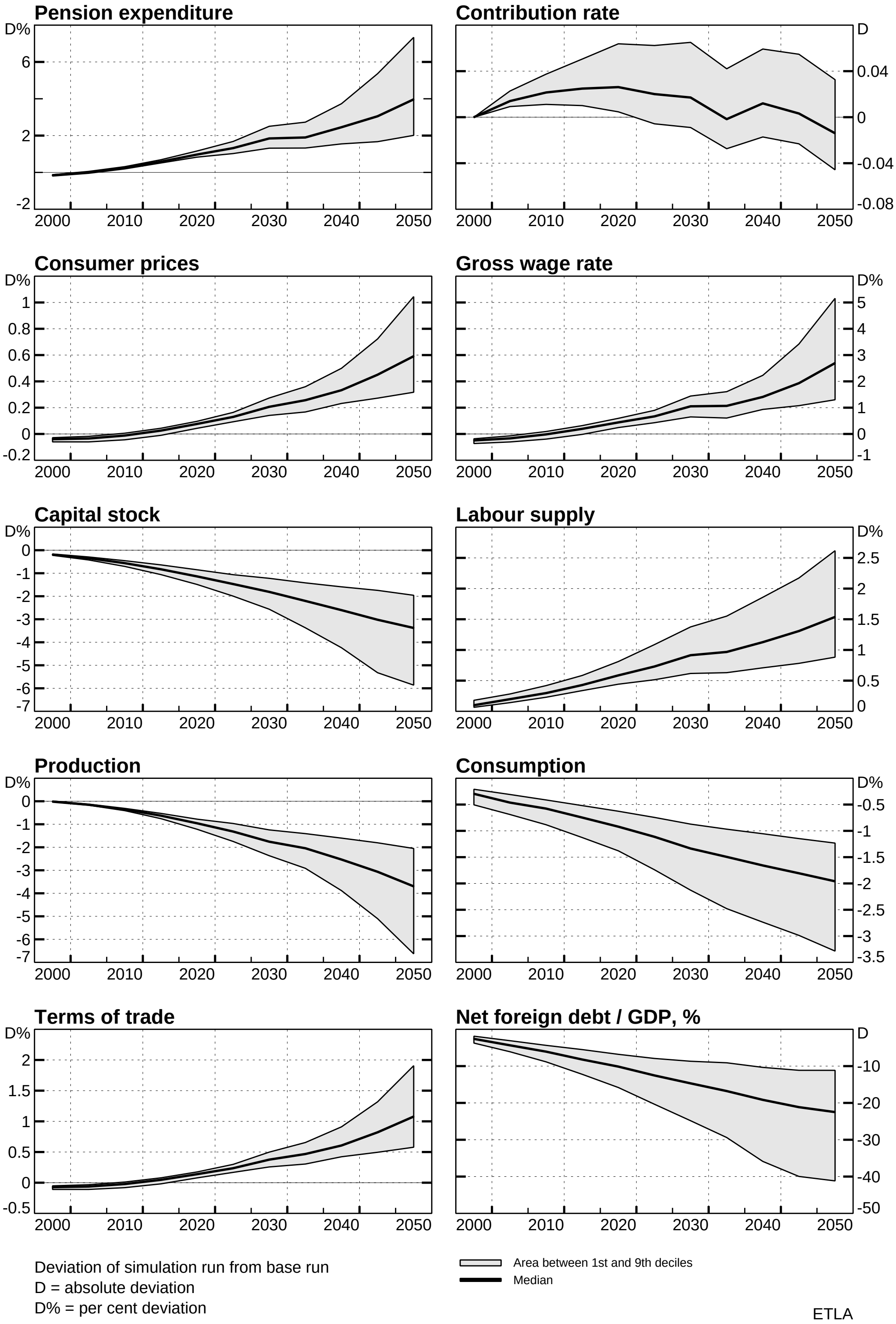
80 % confidence intervals of the demand index



We produced an example of the effects of political uncertainty. The sample paths from the Lithuanian stochastic population forecast were used to generate the distribution of the demand index also in a case, which might be called as "realisation of political risks". The

Effects of realisation of political risk

Median and 80 % confidence intervals



latter assumes that the age-dependent health care provision divided by GDP/capita is increased in a political process to a level, which corresponds current norm in Finland. The increase takes place smoothly in 30 years. The figure below compares the outcomes of this assumption to the variation of the demand index in the baseline case.

The results show that the political risk –scenario produces both markedly higher median and much broader limits for the 80 percent confidence level. The combination of higher age-specific demand and demographic uncertainty gives thereby much gloomier picture of the future expenditure risks.

The corresponding macroeconomic and pension system variables are described below. We assumed in the simulations that health care sector hires all the required additional workers independently of the labour costs generated. The increased demand for labour leads to a higher wage rate, which promotes somewhat aggregate working hours supplied. From the point of view of firms, the available labour input falls, which induce a lower capital stock and private production. Also consumption seems to decline, but one should note that the depicted change in the figure applies only to private consumption and does thereby not include the increased use of public services. The improvement in the terms of trade implies that the higher expenditure is partly financed by foreign consumers. Anyhow, the gross tax rate increases gradually to a permanently higher level, which means that young and future cohorts have to bear a larger lifetime tax burden for the services provided by the public sector. In other words, since the age ratio is permanently higher, the younger generation pays always more than a fair share. The efficiency losses due to higher tax burden depend on the tax used.

1.3 Demographic uncertainty and pension policy

We analyse four pension policy measures, using again the 100 population paths selected at random from the 1500 simulations. The policies are wage-bill indexation of pension benefits, instead of the current indexation to average wages, longevity adjustment of pension benefits, and two variants of retirement age increase. The fifth policy measure analysed is a tax reform in which the future increase in pension costs is financed by raising the value added tax rate.

1.3.1 Wage-bill indexation of pension benefits

An indexation rule considered, but rejected, recently in Sweden is to link the pensions directly to total wages. Indexation to total wages well imitates the changes in the contribution base, thereby providing good means of adjustment both to long-term trends in productivity growth and population and to short-term variation in the participation rate and unemployment. A shift to a full indexation of pensions to total wages has, however, one apparent weakness. The method shifts almost all earnings risks to retirement age, and these risks might be large owing to, for example, exceptionally strong business cycles.

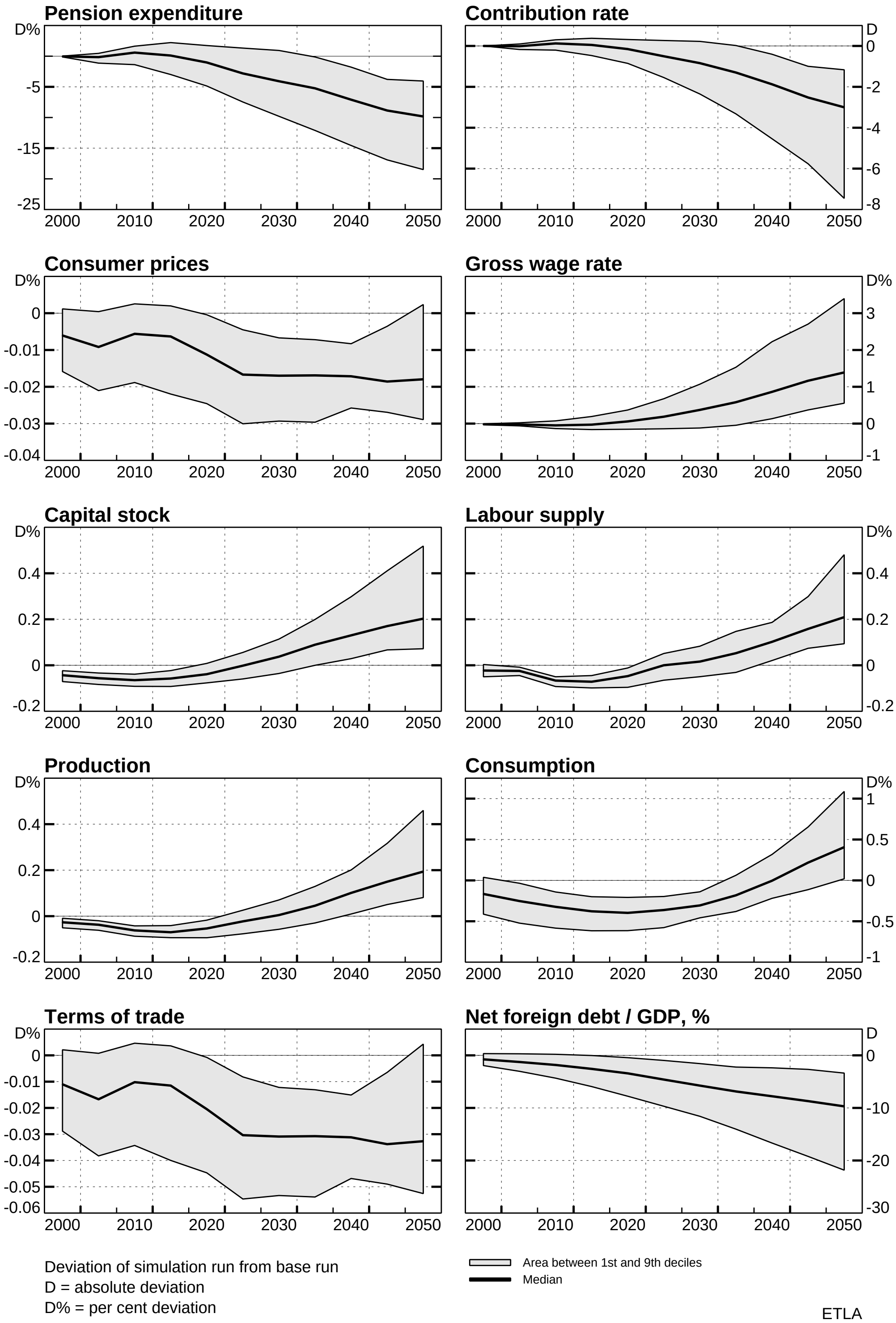
The incentive effects of full indexation are complicated. The weaker the link between the earned wage and pension benefit, the more the paid contribution represents a pure tax. If the tax features dominate, the efficiency of the economy can be improved by lowering the replacement rate. Actually, in an ageing economy, the wage bill indexation provides a lower replacement rate.

The details of the indexation are described in model appendix at the end of this section.

The measure was implemented in year 2005, and announced long before implementation. This gives marginal reactions also in period 2000-2004. The measure raises the pension expenditures and the contribution rate marginally during the first two decades. Wage rate does not, however, fall, since labour supply declines. The wage bill declines in the long term, which initiates a reduction in the contribution rate, higher wages and more labour supply.

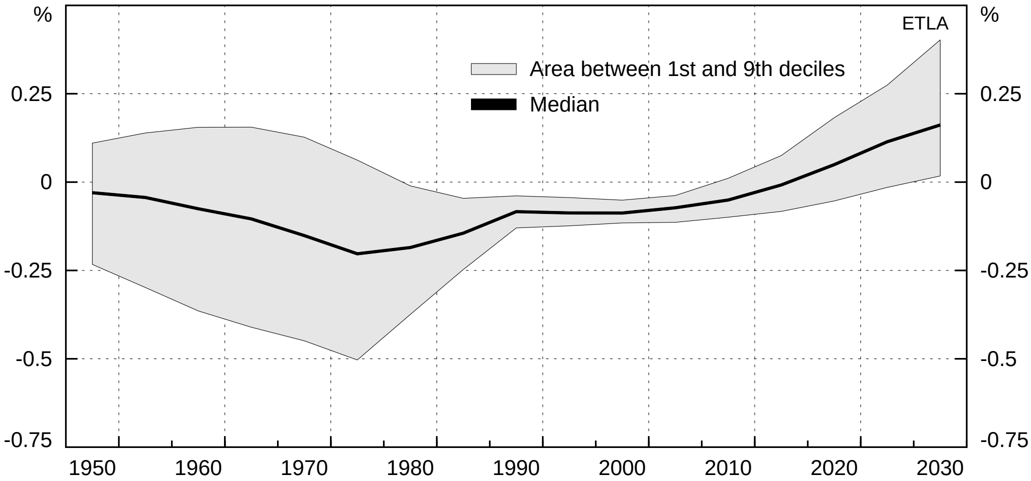
Effects of wage-bill indexation of pensions

Median and 80 % confidence intervals



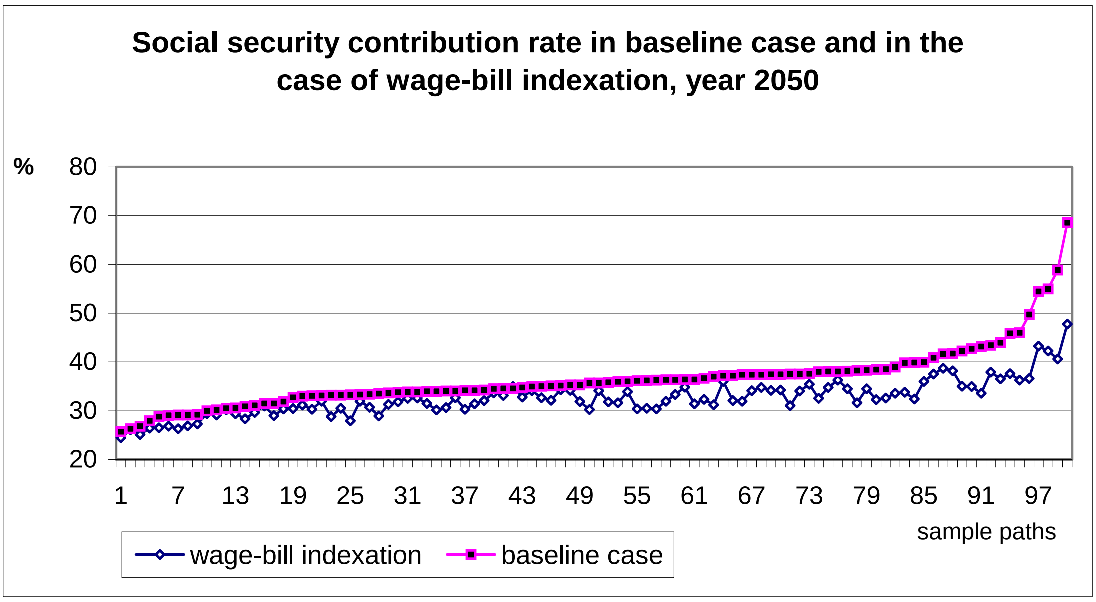
Welfare effects from wage-bill indexation

Median and 80 % confidence intervals



Cohorts denoted by the year of entering the labour force. Positive numbers express welfare gains.

From the above charts one could think that wage-bill indexing reduces contributions smoothly. This is not the case. In the chart below, the 100 simulations are ordered according to the contribution rate in 2050 in the baseline case, from low values to high. The new contribution values, with full wage-bill indexation, are also plotted. They do not form a smooth line, but a rather jagged one. This ”roughness” is in itself interesting and we must look for an explanation.



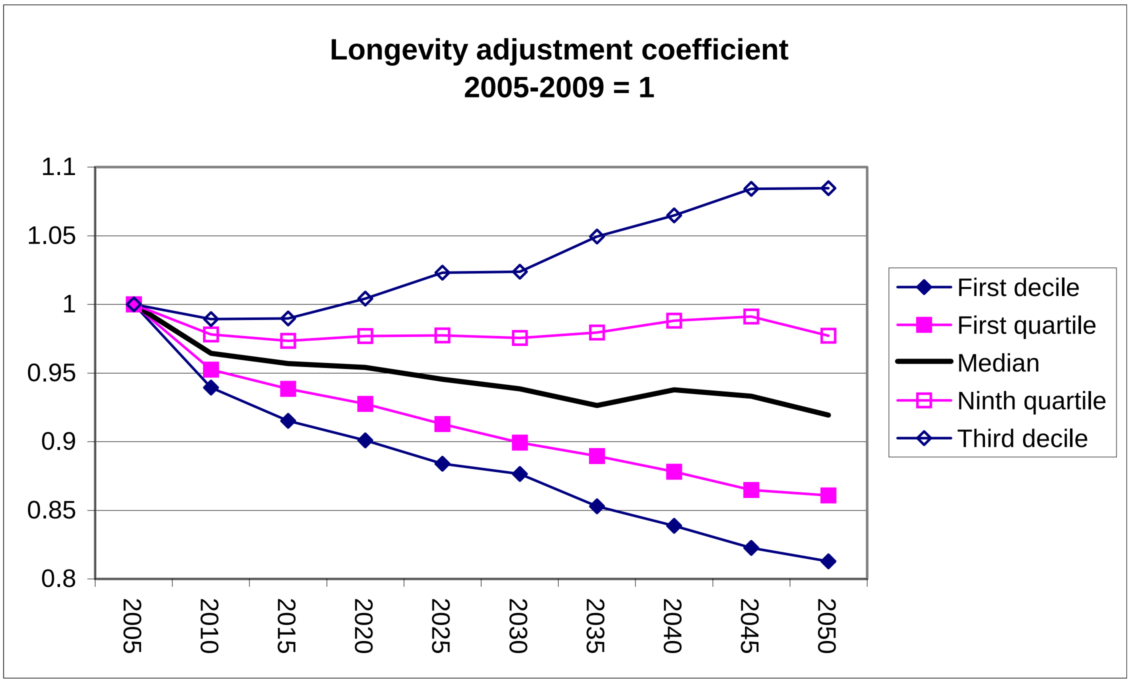
Still, one notices that, on average, the contribution rate declines more the higher it originally was. The measure is the more effective the more need for effectiveness there is. But there is some uncertainty on its effects.

1.3.2 Longevity adjustment of pension benefits

A new way of dealing with increased life expectancy is to link pension benefits to average longevity. The higher the expected number of pension years, the smaller is the pension. Since life expectancy is likely to increase quite slowly and steadily in industrial countries, individuals already know early during their working age the probable amount of the reduction in pensions. Therefore they can adjust in advance by shifting labour supply and private saving correspondingly.

The Swedish application of longevity adjustment to pension benefits is based on observed mortality[4]. Each year, the latest available statistics on age-specific mortality is used to calculate the expected remaining lifetime of those reaching the official retirement age. Each period's longevity is compared to the base period's longevity; the coefficient is the inverse of this comparison. Longevity adjustment to each cohort's pensions is done only once, when the cohort starts to receive old-age pensions.

The details of the longevity adjustment are described in model appendix at the end of this section.

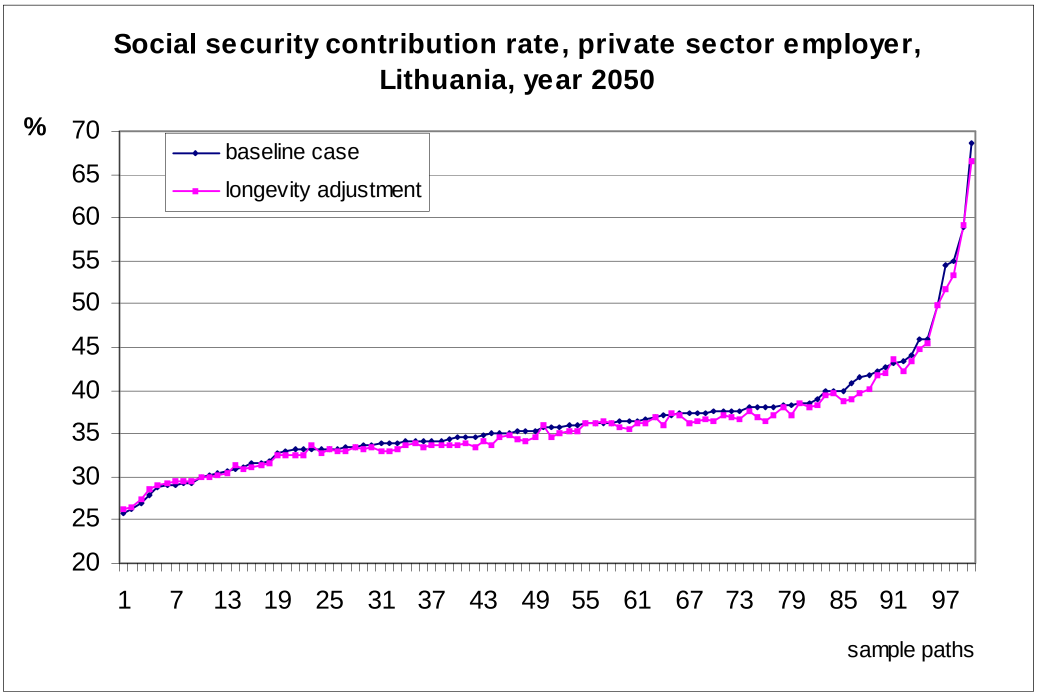


When the observed[5] numbers are used in the longevity adjustment, the LOG model gives the following simulation results for contributions (see graph below). The overall effects are small. One reason for this is that the adjustment concerns only the earnings-related part of the pension, not the basic part. Another is that the measure affects one new retiring cohort per period, so it comes into force very gradually

4 An alternative would be to use forecast mortality specific to the cohort reaching 65. With increasing life expectancy, the forecast-based estimate of the length of the remaining lifetime exceeds that based on the latest observed mortality. One might then think that a longevity adjustment based on forecasts would yield bigger cuts in monthly pensions than an adjustment based on observed mortality. Lassila and Valkonen (2002) claim that this is not likely. The reason is that in many countries the increase in longevity has already taken place in the base period's forecasts, but not in the observations.

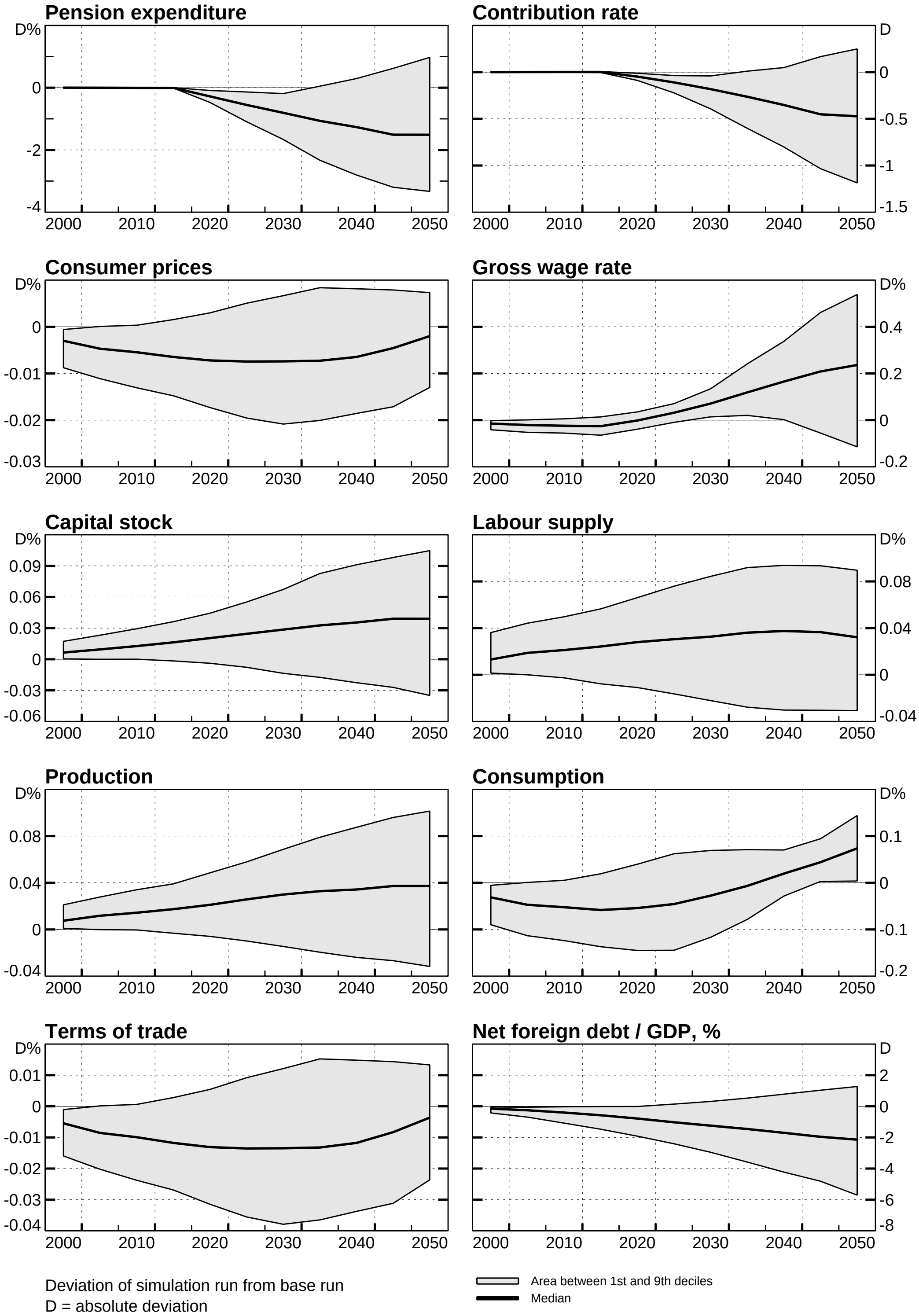
5 "Observed" means here that as the scenario actualises period by period, the coefficient is calculated from the previous period's age-specific mortalities.

This analysis has been somewhat crude, since we do not deem the current mortality information very reliable. That is why the period 2005 – 2009 was used as the base period, and first changes in pensions took place for those retiring in 2010 – 2014. Another weakness is that some migration is also counted as changes in mortality, as explained in section 4.4, but this effect is probably rather small. Despite these reservations the results seem to show that from a fiscal point of view longevity adjustment is not as important as wage-bill indexation. Still it might be a good measure and should be taken under serious consideration in the future when the mortality statistics have become more reliable.



Effects of longevity adjustment of pensions

Median and 80 % confidence intervals



Deviation of simulation run from base run
D = absolute deviation
D% = per cent deviation

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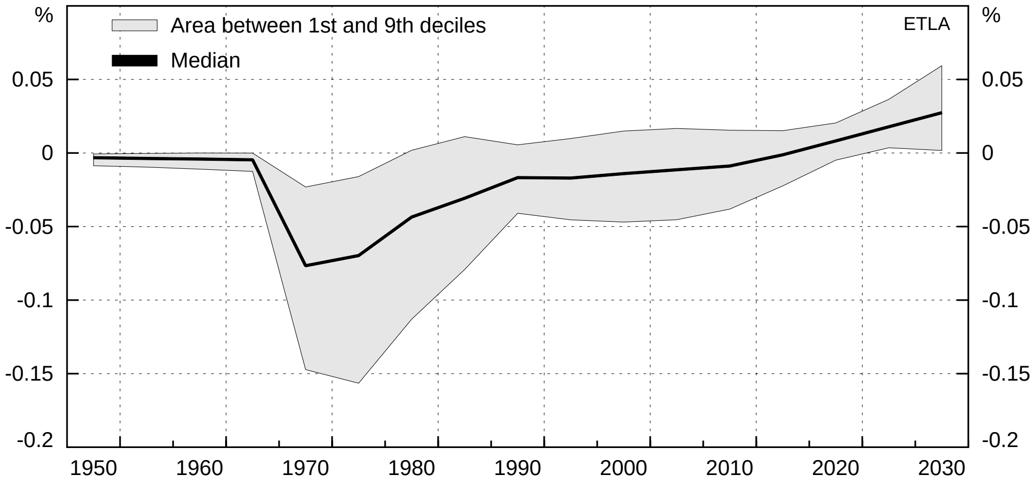
Welfare effects are shown in the following graph. It points out that the loss of welfare is largest to those generations, which are near to the retirement age. They have shortest time to adjust to lower pensions and enjoy the benefits of the lower pension contributions. However, all the changes in lifetime welfare are small.

Welfare effects from longevity adjustment

Median and 80 % confidence intervals



Cohorts denoted by the year of entering the labour force. Positive numbers express welfare gains.

1.3.3 Increasing the retirement age

The retirement age, after which a person can receive old-age pension benefits, was 55 years for women and 60 years for men in Lithuania in 1994. Since 1995 it has been increased by four months every year for women and by two months for men. The speed was later increased. In 2003 women's retirement age will be 60 years and men's 62 years 6 months. There is also a plan to continue the increase until both women's and men's retirement age will be 65 years. In the following simulations this is achieved in 2020.

The effects of retirement age rules on labour supply depend on the possibility of continuing working and earning wages while receiving pensions. Lithuanian social insurance pension scheme allows one to receive wages and pension at the same time. But restrictions are applied to those who are under 65 and receive more than 1.5 times the minimum wage. They lose the earnings-related part of the pension but can still get the basic pension.

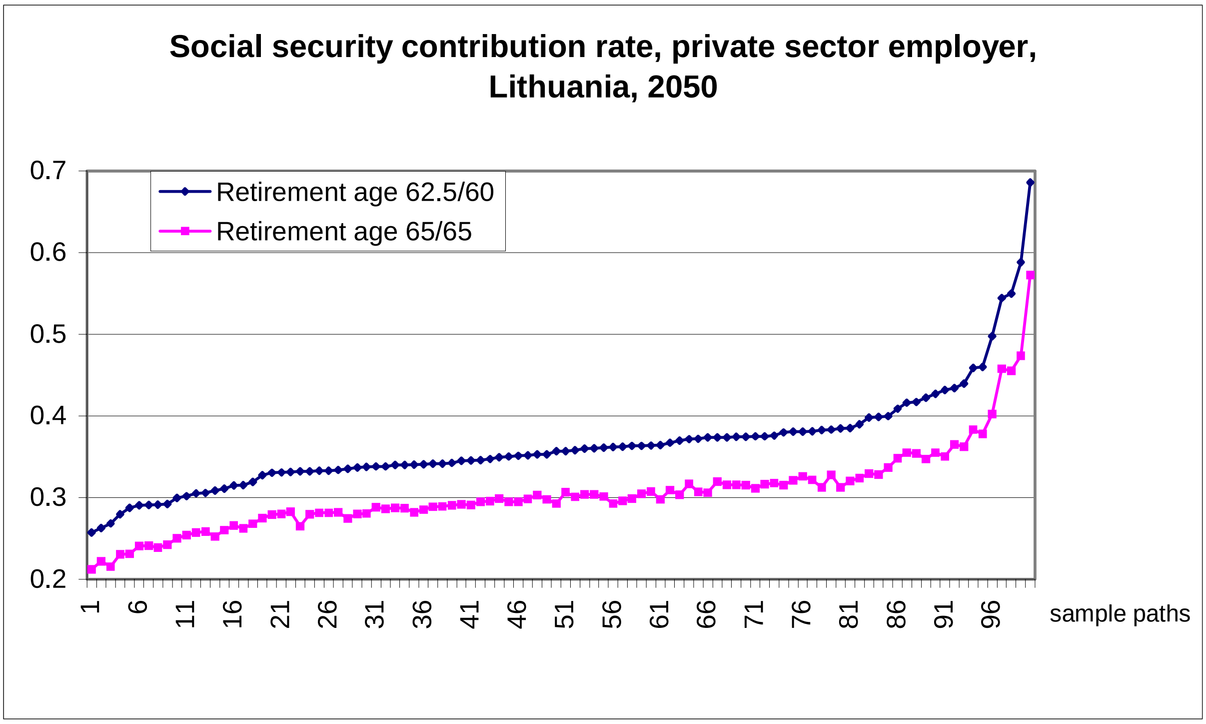
What does "increasing the retirement age" then mean? One, it cuts off pension payments to those age groups that are younger than the new retirement age but older than the previous age. Two, it increases earnings-related pensions as more years add the 0.5 per cent in the formula. Both of these increase the supply of labour. The third effect is that the period when working diminishes pensions gets shorter, so not only do new pension rights accrue but also old negative effects vanish. This holds on aggregate, not necessarily on the individual level. The fourth effect, which comes into force in time, is that when those generations that have earned pension rights according to the new age go past the retirement age, working then reduces these higher pensions, and this makes working less rewarding and thus reduces labour supply in these age groups. Thus the increase in the retirement age affects more incentives than restrictions on decision-making. The incentive effects encourage almost everybody to work more. There is also a pure income effect, as the basic part of the pension is paid during a shorter period.

Increasing retirement age, without demographic uncertainty, was analysed by Lassila (1999b), using the same OLG model. His results are very similar to the median results presented here.

The simulations show rather small effects on labour supply.

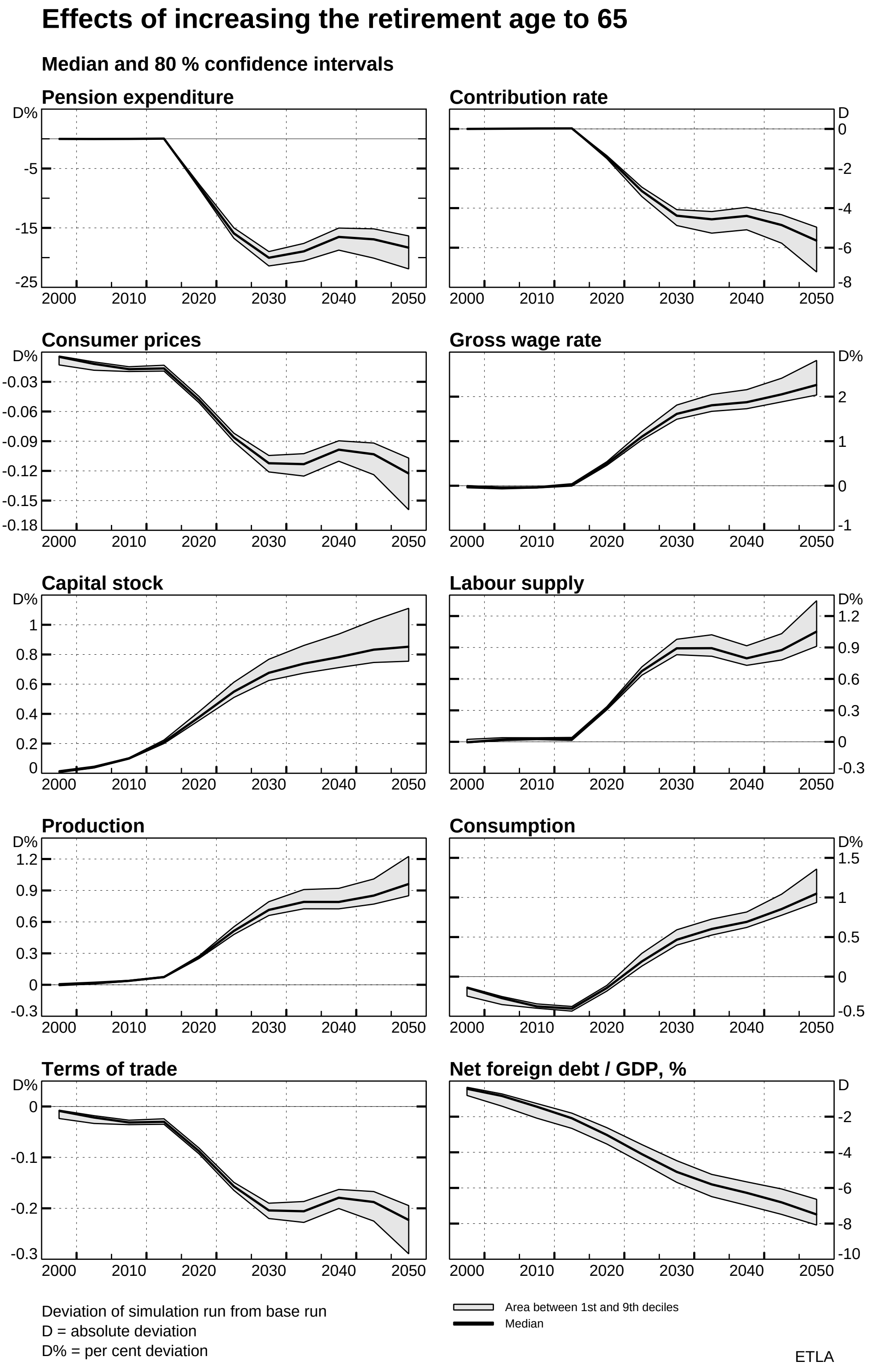
The increase in retirement age improves the fiscal situation of the social insurance fund. This is mostly due to the cut in the basic pension payment period, as the retirement age is raised. The contribution rate may be reduced. The size of the possible reduction is mainly determined by the relative amount of the population that belongs to the relevant age groups. The fall is also affected by the work efficiency in those groups. The size of pension benefits, the number of people covered by the system, the share of employers paying the contributions and the share of employees paying their contributions also affect the outcome.

When the official retirement age does not restrict the possibilities to work, which seems to be the case in Lithuania, the increase in retirement age shortens the period when pensions are paid, and is thus a way to cut benefits. People respond to this by saving and by working more. Part of the savings goes to the domestic capital stock, part goes abroad and net foreign debt declines or net foreign assets accumulate.



After the increases in labour supply the capital-labour ratio is no longer optimal, and investments increase accordingly. Increased consumption and investment leads to a current account deficit and an increase in net foreign debt. The terms of trade deteriorate slightly.

How does uncertainty change or what does it add to the description above? Very little, one is inclined to say. The median is a good descriptor of the likely effects, the 80 % confidence interval gets wider in time but remains narrow. This is in contrast to wage-bill indexation and to longevity adjustment.

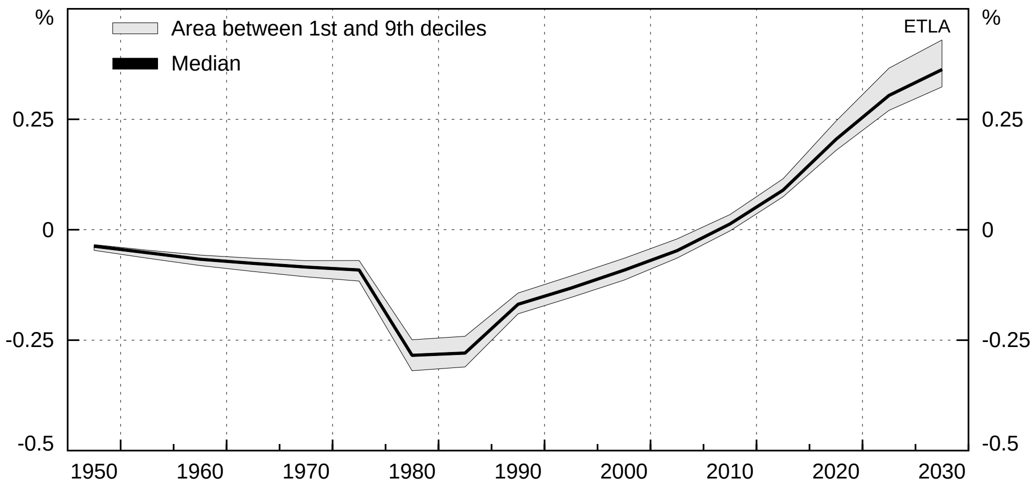


Next, the contribution rates are ordered with respect to current system rates in 2050. Increasing the retirement age lowers contributions rather smoothly, so the effect is not very sensitive to demographic uncertainty. One notices that the declines are larger on the higher end of the distribution. Increasing retirement age reduces the variance of the effects, but relative to the contribution rate without the measure the effects are roughly constant.

From the welfare point of view, the crucial thing is how great the increase in labour supply is. That depends on the effectiveness of those between 61.25 and 62.5 years of age. If they were as effective as younger generations the labour input would increase substantially. In this case everybody would gain, even those who suddenly have to work for more years than they earlier thought. They get a good wage income for the work they do, and it more than compensates the loss of pensions during the period until they reach the new retirement age. They suffer from reduced leisure for a while, but gain from the fall in the price of consumer goods in all remaining periods. But if their work efficiency is low - as in our simulations - their wage income is small, and their lifetime utility decreases. The gains of all other generations are also smaller in this case.

Welfare effects from increasing the retirement age to 65

Median and 80 % confidence intervals



Cohorts denoted by the year of entering the labour force. Positive numbers express welfare gains.

1.3.4 Conditional increase in the retirement age

The baseline distribution of the social security contributions show decreasing contributions for about 15 years, and then from 5 to 15 more years before the current contribution level is again reached. This gives time enough to tie retirement age increase to fertility in a manner that could encourage child-bearing. The higher fertility is the less retirement age needs be increased.

The Lithuanian policy-makers could use the information in this report, specifically the young-age dependency ratio (Alho, this report, Appendix IV). The young-age dependency ratio is the ratio of population in ages 0 – 18 to those in ages 19 – 64. Looking ahead to year 2020, this ratio is uncertain: although the working-age population in 2020 can be predicted with some confidence, the young have not yet been born.

A rule is announced: the retirement age depends on the young-age dependency ratio in 2020 and onwards. Specifically, if the ratio in 2020 is below the first quartile value in Alho's predictive distribution, the retirement age is increased to 65 years. If the ratio is lower than the median of the predictive distribution but higher than the first quartile, the retirement age is increased 63.75 years. If the value is above the median but below the third quartile, the retirement age is increased to 62.5 years. Finally, if the ratio is above the third quartile value of the predictive distribution, the retirement age remains at 61.25 years.

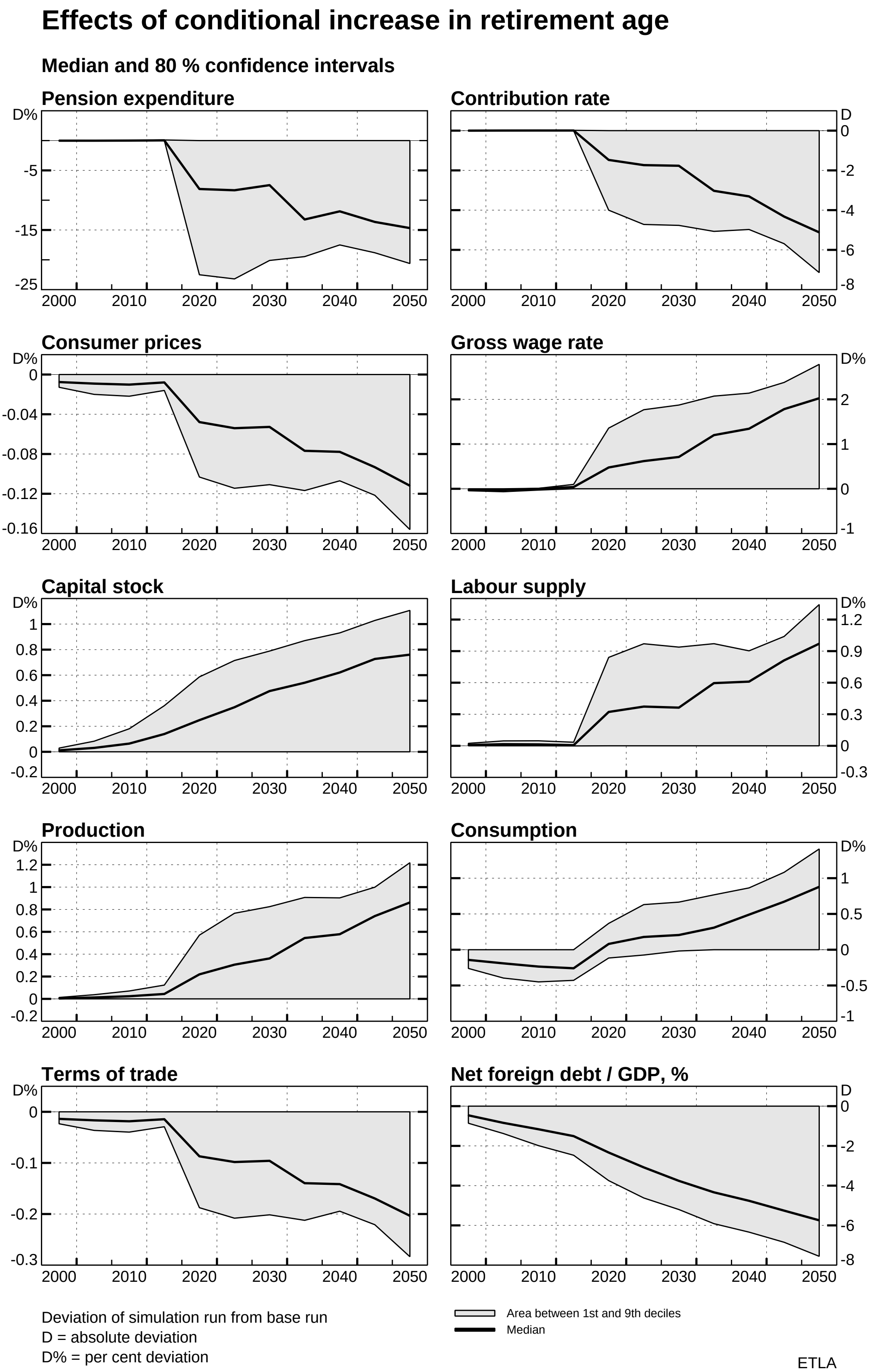
The increases in retirement age are irreversible. So, if further in the future the young-age dependency ratio increases, the retirement age does not decline. But if the dependency ratio decreases further the retirement age increases if the limit values described above are exceeded.

In 20 cases of our 100 population paths the retirement age was increased directly to 65 years starting from 2020. In 25 cases it was increased 63.75 years and in 28 cases to 62.5 years. In 27 cases the retirement age was not initially increased. In 2050 the retirement age was 65 years in 52 cases, 63.75 in 13 cases, 62.5 in 15 cases and still 61.25 in 20 cases.

The following model calculations illustrate the probable consequences of this policy rule, under the assumption that the policy has <u>no effects on future fertility and other demographic developments</u>. The first increases in retirement age take place in 2025, based on the young-age dependency ratio in 2020.

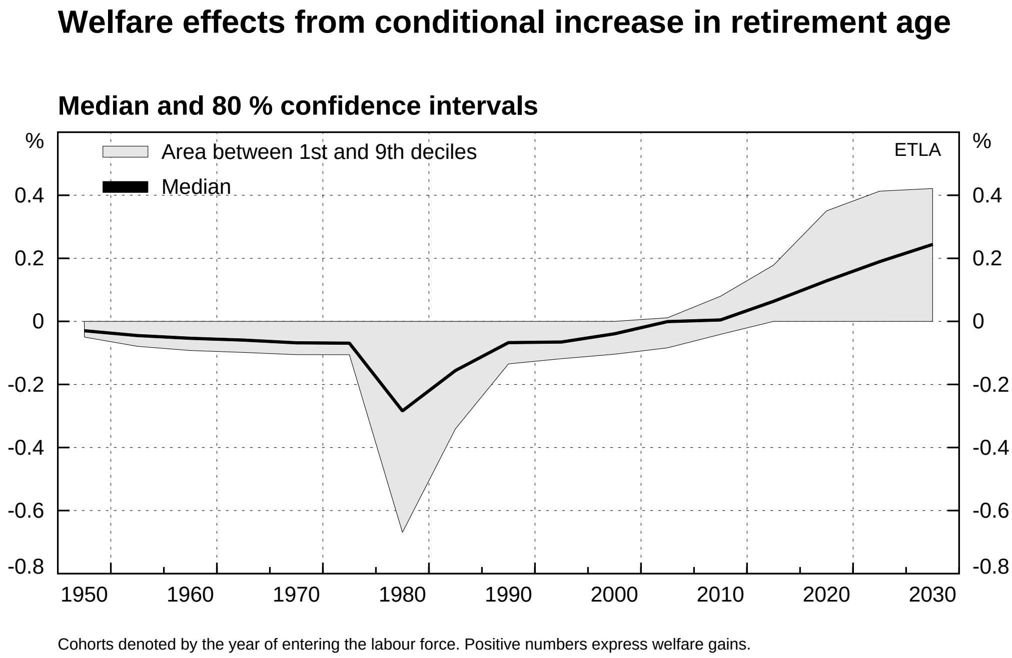
Retirement age increase lowers pension expenditure and contribution rates. The median effect on pension expenditure is 15 % in 2050, and the contribution rate is 5 %-points lower than without the increase. The uncertainty concerning the size of the effects is larger than it was with the fixed-schedule increase analysed in section 4.x. The 80 % confidence interval includes zero effects and on the larger side about 20 % reductions in pension expenditure and over 6 %-point decline in contributions.

Variation in contributions is larger with the dependency-based increase in retirement age policy; this example turned out to be slightly variance-increasing, not decreasing as we expected it to be. Obviously, designing conditional schemes for the retirement age requires some experimenting. This kind of policies should be designed carefully and studied much more extensively than has been possible in this project.



Qualitatively the macroeconomic effects are similar to those of the unconditional retirement age increase, but magnitudes differ. The effects are smaller, because the increases in retirement age take place later, if at all.

The distribution of welfare consequences of the conditional increase in retirement age is in figure below.



1.3.5 Funding the increase in the pension costs by a higher VAT rate

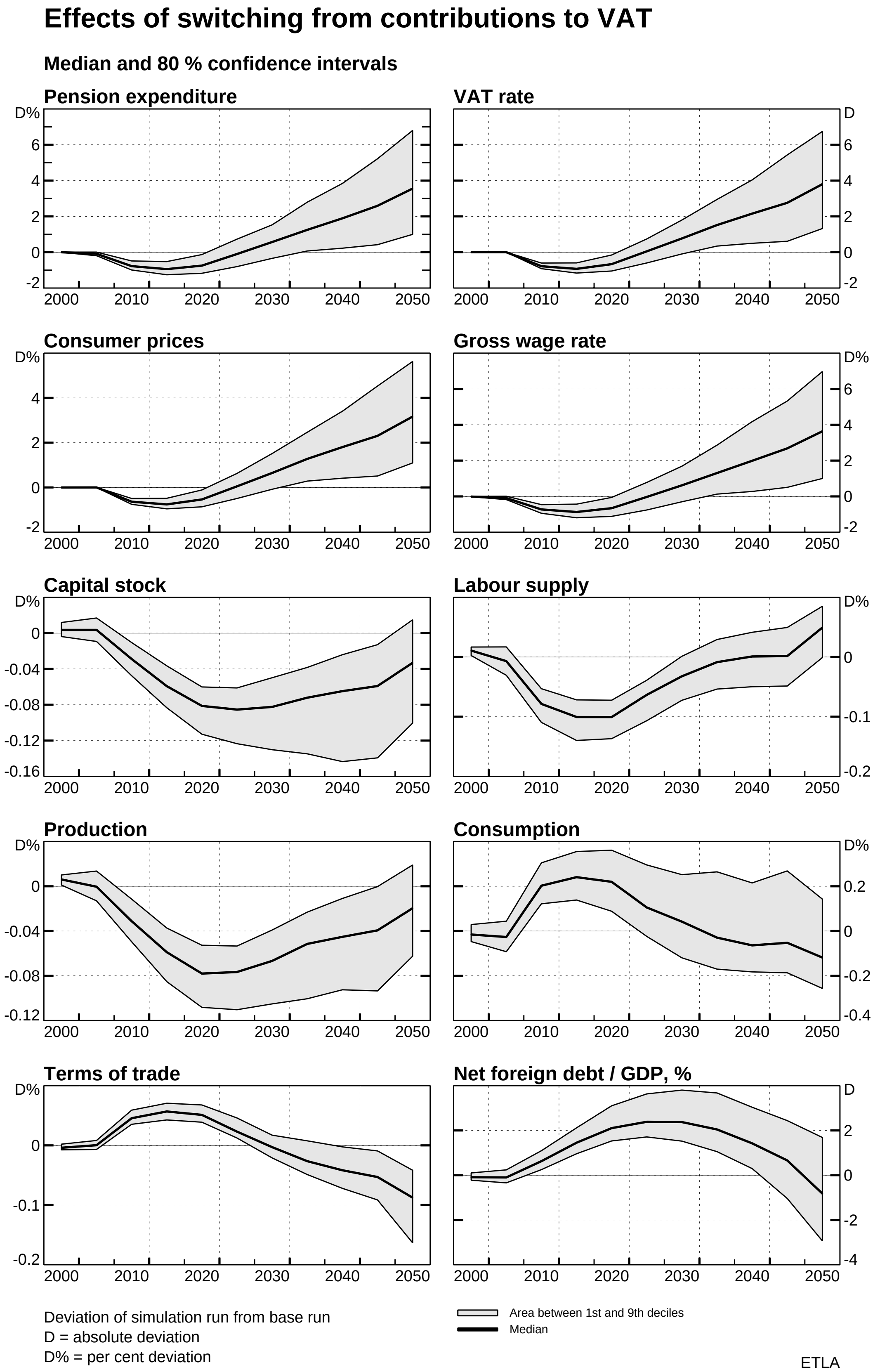
Motivations

The higher pension contribution rates of the future wage earners are mostly due to ageing of population. Since there are no corresponding improvements in the replacement ratio, this increase is almost a pure tax (the only actuarial justification is the longer lifetime). The looming negative labour market incentive effects have generated a discussion whether it would be wise to finance at least part of the costs by taxing consumption. Even though VAT is also a part of a tax wedge between labour costs of a employer and net wages, the tax base is larger (current financial wealth and income transfers are also included) and the distortion thereby is smaller. Hence, the measure would support growth and enhance welfare. Another often used justification for the measure, linked to the ageing problem, is that PAYG system is not fair for smaller younger generations. VAT is paid also by retired larger generations.

A special motivation for transition countries to use VAT finance is the low participation rate even in the mandatory pension schemes. A shift to VAT funding could help, not only because of easier control, but also due to the participation incentive created. Those who avoid contributions would still participate financing of the pension system, but without accrual of pension rights.

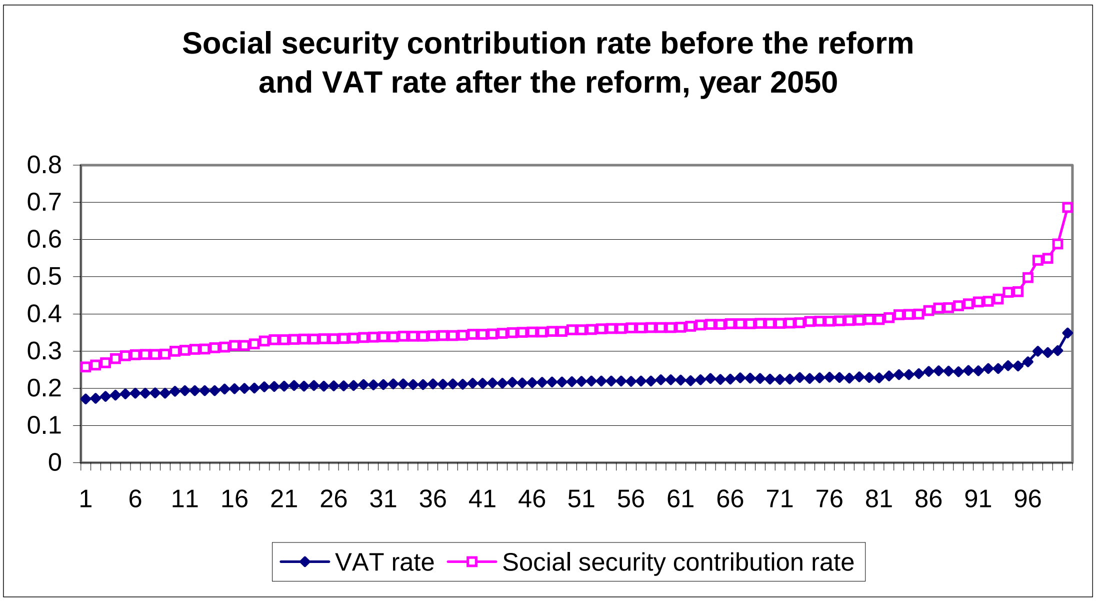
Macroeconomic effects

We fixed the employers' pension contribution rate to the current level and financed the needed amount by raising the VAT rate, and transferring the corresponding amount of tax revenues to the pension fund. This measure was implemented in 2010 and announced earlier.



Compared to the baseline simulation, the lower pension contribution rate raises wages and promotes labour supply in the long term. Initially, the wage rate and labour supply nevertheless decline, because the contribution rate does not fall as in the baseline case.

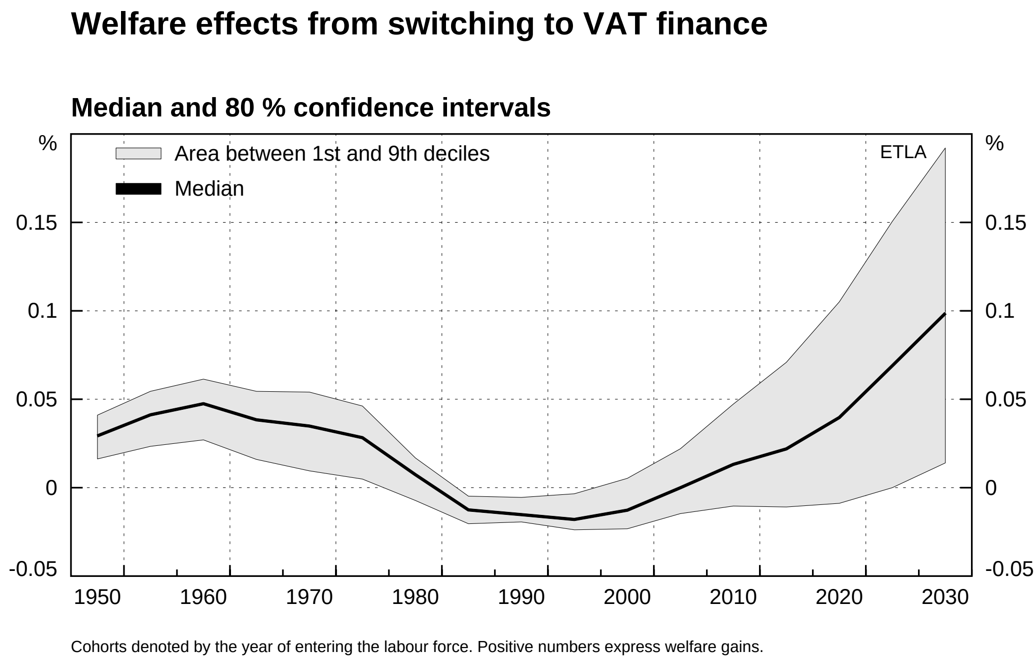
The reaction in labour supply is small in all periods. This is partly due to the limited participation to the pension system. Also the credit constraint may have some effect. In the beginning of working career it might be optimal to work less due to low productivity and wages, and lend to consume more. If this is not allowed, the labour supply may be too high. Hence, relaxation of the credit constraint by a higher net wage (lower contribution rate) may even reduce the labour supply, i.e. income effect is larger than the substitution effect. There is also a marginal intertemporal shift in consumption from future high VAT rate periods to the near by periods with lower tax rate.



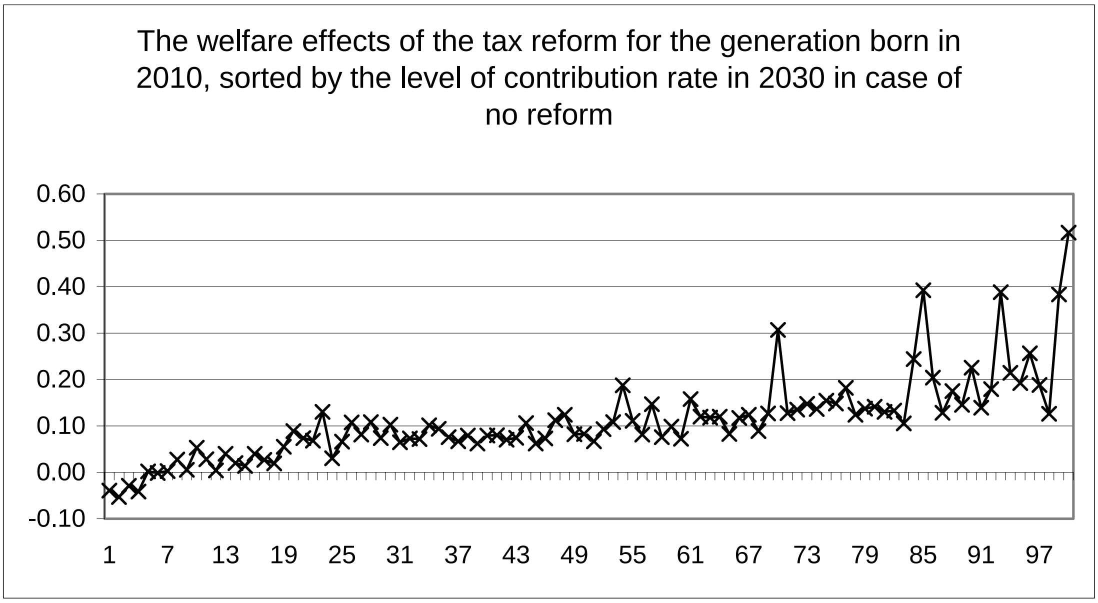
The figure above shows that the distribution of the balancing variables in 2050. In simulation before reform the VAT rate is fixed to 18 percent. Correspondingly, after the reform the social security contribution rate is fixed to 28 percent. The larger tax base does indeed limit both the increase and the variation in the balancing variable. The employers contribution rate (does not here include the constant contribution to health care fund) varies in the baseline simulation from 26 to 69 per cent, while in the tax reform case the corresponding population scenarios produce variation from 17 to 35 percentage points in the VAT rate.

Intergenerational equity

Standard method of evaluating the generation specific welfare effects is to calculate compensated variations. The figure below shows that the lifetime welfare change from the tax reform is small, but positive to most generations. The ones who are likely to lose little are the generations born between years 1960 and 1990. In the figure these generations are denoted by year labels between 1980-2010, since they start their working life as 20 years old in the model.



Demographic uncertainty does not play a major role in the welfare results of the already born generations. The gains are bigger in the cases of future high age ratios, which can be detected from the figure below. It shows that benefits of the tax reform increase in line with the future contribution rate.



1.4 Stochastic population simulations in an OLG model: some conclusions

Behind the analyses presented above is a lot of model work and model runs. Numerical OLG models produce a vast array of output with every single run. Here one analysis comprises of 100 base runs, 100 simulation runs, and calculation of differences between the two sets. It has taken time. The number of analyses done has not been limited by lack of ideas or alternatives, but simply by lack of time. The conclusion from this is that efficient data-handling procedures and algorithms are essential for this type of analysis.

Demographic assumptions after 2050

Stochastic population simulations were made for the years 2000 – 2050. This has been a conventional horizon, or one of the conventional horizons, used in these type of simulations. Overlapping-generations simulation models, on the other hand, require much longer horizons, typically over 200 years, to ensure a convergence to a new steady state or steady growth path.

In this study we have used the following assumptions after 2050. For each population path we have assumed that the size of new cohorts entering the labour force stays at the level it is in 2050 in the path. For mortality we calculate the rates from two population cross-sections in 2045 and 2050 and assume they stay constant thereafter. These rates thus include migration effects also. These assumptions are unsatisfactory if one looks at them as demographic forecasts, but to our mind satisfy the need of providing stable population structures and ensure the convergence of the OLG model calculations towards steady states or growth paths. This method does not make the population paths similar after 2050, but it freezes the differences.

These assumptions on demographics after 2050 do not seem crucial for the expected or median outcomes, or the expected or median policy effects, or the uncertainty characteristics of outcomes and policy effects before 2050. But they may matter very much for the intergenerational welfare measures. Not probably for the median outcomes but certainly for the distributional characteristics for those generations whose lifespans go beyond 2050, even partly. For those generations the uncertainty characteristics of welfare effects may be misleading, in the sense that they are not based solely on the well-founded assumptions behind the stochastic population simulations.

We do not think, however, that this feature can explain e.g. the narrowing of the welfare effect distribution of wage-bill indexation for the cohort entering labour force in 1990, compared to a cohort ten years older. The younger cohort lives only 10 years after 2050, those years are heavily discounted in the welfare calculation because mortality is included in the discount factor, and even in those years the population paths are not similar as noted above, the differences between paths just stay the same. So the narrowing of the distribution reflects something inherent in the developments before 2050, and is thus an interesting issue to pursue in further research.

But the different horizons of the two jointly used models create a potential source of unwanted effects and erroneous interpretations. One solution is to make the forecast horizon of stochastic population simulations longer. This is probably possible for a few decades. It is doubtful, however, whether the horizon could sensibly be expanded over 100 years. The distributions might explode in practice. Notice that this problem does not arise when working with single population paths, without considerations of demographic uncertainty.

Migration cannot be separated in the model runs

The OLG model used here includes the assumption that the wealth of those dying before age 90 is divided to the survivors of the same cohort. Mortality rates are included in households' discount rates. It is simply easier to model the use of wealth this way if the analysis includes mortality in all age groups. The idea goes back to Yaari (1965), and is widely used in OLG models, see e.g. Broer and Westerhout (1997). A problem is that in our demographic data mortality and migration cannot presently be separated. Emigration and immigration appear as changes in mortality in different age groups. We do not think this is essential for our analysis, because migration in old ages is not common, and wealth on the other hand is concentrated to the old. But certainly here is something to be developed in the future.

1.5 Conclusions

Our analysis has shown that, in the world of uncertain future demographics, it is useful to classify ageing policies into two different groups, based on how the policies are related to demographics. In the first group we put policy measures that do not directly depend on demographics, like increasing the retirement age. Neither the timing nor the magnitude of the measure depends on the population path in our analysis. In the second group are those policies whose magnitude or timing does depend directly on demographics, such as wage-bill indexation, longevity adjustment, and making the increase in retirement age conditional on young-age dependency ratio. Another way to describe group 2 policies is to say that they directly affect risk-sharing in the society. Risk-sharing between different individuals and generations is affected, and also the risk that the public pension system becomes unsustainable is diminished.

Why is this classification useful? Firstly, there are differences in the distribution of outcomes. Policies in the first group shift the distribution of outcomes, policies in the second group shift and reshape the distribution. This is not an exact difference but a descriptive one. Secondly, the effects of policies in the second group are much more dependent on future demographics than are the effects of policies in the first group. Thirdly, this division may be useful in designing new policies, or combining old policy measures in new ways. Specifically, by combining policies from both groups facilitates addressing both the expected problems and the more uncertain but also potentially more threatening possibilities at the same time. Some policies in group two, e.g. wage-bill indexation, address both these problems alone, but more efficient policies can probably be found from a larger base of measures.

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Appendix: THE LOG MODEL

The intuitive ideas

Both working-years and years after retirement must be kept in mind when one thinks about how a pension system affects man's life. Pension contributions are paid during the working period, and these contributions are used to finance the benefits of the payer or other people. The benefits are received after retirement. When studying who gains and who loses when a particular change in the pension system is made, the effects during these both phases must be taken into account for a person who is a worker when the change is made. Those already retired feel the consequences only as pensioners, but the effects vary also among them due to e.g. differences in expected remaining lifetimes or wealth. The effects vary among the workers because the rules of the pension system may depend on age and working history, wealth and indebtedness vary, work efficiency and wages are not the same for all, etc.

We model man as a rational agent. Whatever happens, people try to behave sensibly from their own point of view. Sense here refers to the aim towards as high welfare as possible. Welfare is defined to depend on two factors, consumption and leisure. Working is assumed to be no of joy as such; it is done only for the remuneration which is used to buy consumption goods. Whenever something unexpected happens in the economy, a pension policy measure is taken for instance, people will reconsider how much to work and consume. In this rethinking process views and expectations concerning the future have a large role.

Firms exist to facilitate the exchange of work efforts for consumption goods as effectively as possible. Besides work input, productive capital in the form of machines and equipment is also needed. They are financed by savings or borrowing. The ownership of firms is in the hands of households. The distribution of ownership is outside the scope of this study, as is also income distribution. The firms also aim at rational, forward-looking behaviour. Their target is to maximise the value of their shares, which is thought to be in the best interests of their owners.

Technically the model is an Auerbach-Kotlikoff-type, perfect foresight numerical overlapping generations model. The sectors are households, enterprises, a government, a social insurance fund, a foreign sector and in some simulations a private pension fund. The labour, goods and capital markets are competitive and prices balance supply and demand period-by-period. There is no money or inflation in the model. In the following we describe the behaviour of households and firms in more detail. Lassila (1999a) provides a fuller description of the model.

Household behaviour

Households maximise the utility from consumption and leisure in different periods. The life-cycle plan for the household starting its work life at time $t = 1$ is the solution to the following maximisation problem (1) subject to the periodic utility function (2), lifetime budget constraint (3) as well as the discount factor (4), and the pension equations (5) and (6).

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

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

(3) $$\sum_{t=1}^{T_w} \left[(1-l_t)e_t w_t (1-\tau_t^w - s^h \tau_t^e) + \tau_t^w D_t^0\right] R_t + \sum_{t=T_R}^{T} s^h Z_t R_t + \sum_{t=1}^{T} H_t R_t = \sum_{t=1}^{T} c_t p_t^C (1+\tau_t^C) R_t$$

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

(5) $$D_t = \frac{1}{\sum_i N_i} \sum_{i=1}^{T_w-3} N_i (1-l_t^i) e_t^i w_t$$

(6) $$Z_t = (1-g_t)B_t + (1-g_t)\Phi skD_t\left[1-v_t(1-l_t)\right]$$

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. The aggregate amount of the generation specific transfers H_t is determined to balance the revenues and expenditures of the central government. A life-cycle plan is made at the age of 20, and people plan to retire at the age of $T_W + 1$. The budget constraint (3) says that discounted lifetime wage, transfer and pension income equals discounted consumption expenditure. Households consider the possibility of early death by discounting future consumption and incomes by a factor which includes both the interest rate *r* and the age-specific survival probability *S*. The terms τ^w and τ^C are income tax and value added tax parameters, and D^0 is the lower limit of taxable income. The share of people contributing to the pension system (with a rate τ^e) is s^h.

For the calculation of the pensions, we define the average insured income from working, *D*, in (5) where *i* refers to age groups and *N* to the number of workers in the group. In the pension formula (6) *B* stands for the basic pension, *s* stands for the length of the person's social insurance record of working under labour contract, and *k* is the ratio of the person's income over the country's average income. There is a maximum of 5 for *k* in practise, but it is not relevant for the average household described by the model. The parameter is 0.005, implying that 0.5 per cent of the wage of the employee is added annually to the supplementary component of the future pension. The accrued pension rights are indexed to wages and employment through *D*. Also *B* is assumed to be proportional to *D* in time. Working after the retirement age reduces the earnings-related part of the pension through parameter *v*, which is zero before the retirement age.

The retirement age can be within a five-year unit period. In that period the person has work income as usual, pensions for the part he or she is retired, and working after retirement reduces the earnings-related part of the pension. We denote the share of working in that period by g, which is between zero and one. Increases in the retirement age are modelled through g. Initially $g = 0.5$ in the age group 55 - 59, and it gradually moves to the age group 65 - 69 and gets a value 0.

The actual equations of the simulation model are the first-order conditions derived from the optimisation problem.

Longevity adjustment

The pensions are adjusted to the increasing life expectancy simply by taking into account the increasing longevity in the value of annuity. The adjustment coefficient is a ratio of two present values of a unit pension, calculated at two different periods. The present value of a unit pension, which begins in period v and is calculated forward from age 60 (period 9), is as follows.

$$(7) \qquad a_{60}^{v} = \sum_{i=9}^{14} (1+r^{a})^{i-9} S_{v-1,9,i} (1-0.5(S_{v-1,9,i} - S_{v-1,9,i+1})) \left(\frac{w_{v+i-9}}{w_v} \right)^{\lambda^a}$$

The present value of a unit pension is a discounted sum of terms generated during various retirement years. The terms have three parts. The first is the discounting factor in which the discount rate is r^{a}. The second describes longevity. The first subscript of the S-terms, $v-1$, demonstrates that life expectancy is evaluated using information available at the first period v, i.e., the observations from period $v-1$. Since these probabilities change only at 5-year intervals, the calculation has been made by considering the average longevity during the period on condition that the person is alive at age 60. The third term describes indexation of the unit pension to wages. The parameter value λ^{a}, used in simulations, is 0.

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

$$(8) \qquad E_{v0}^{v} = a_{60}^{v0} / a_{60}^{v}$$

Correspondingly, the pension of a person becoming 60 years old during period v is:

$$(6') \qquad Z_t = (1 - g_t)B_t + E_{v0}^{v}(1 - g_t)\Phi skD_t \left[1 - v_t(1 - l_t)\right]$$

Indexation to total wage bill

Define the wage bill A^{w} at period t as

$$(9) \qquad A_t^{w} = \sum_{i=1}^{T_w-3} N_i(1 - l_t^{i})e_t^{i} w_t$$

With partial wage-bill indexation the pension becomes

$$(6'') \qquad Z_t = (1 - g_t)B_t + (1 - g_t)\Phi skD_9 \left(\frac{D_t}{D_9} \right)^{(1-\alpha^{w})} \left(\frac{A_t^{w}}{A_9^{w}} \right)^{\alpha^{w}} \left[1 - v_t(1 - l_t)\right]$$

where α^{w} is the indexation parameter. With full wage-bill indexation the parameter equals one.

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 period t the dividends D_t distributed during the period plus the value of the firm V_t at the end of the period, subject to the amount of initial capital stock, the cash-flow equation of the firm (9), the CES production function F_t (10), the accumulation condition of the capital stock K_t (11), the determination of the firm's debt B_t^F (12) and the investment adjustment cost function G_t (13).

(10) $$Max_{L,I,K} \quad \frac{1}{1-\tau^{g}} D_t + V_t \text{. subject to:}$$

(11) $$D_t = (1-\tau_t^F)\left[p_t^F (F_t - G_t) - (1+s_s^f \tau_t^z) w_t L_t - r_{t-1} B_{t-1}^f - P_t^K I_t \right] + B_t^f - B_{t-1}^f$$

(12) $$F_t = A^F \left[\varepsilon K_{t-1}^{(1-1/\beta)} + (1-\varepsilon)\left(v^t L_t^F\right)^{(1-1/\beta)} \right]^{\frac{\beta}{\beta-1}} \quad (13)$$

$$K_t = (1-d)K_{t-1} + I_t$$

(14) $$B_t^f = b p_{t-1}^K K_{t-1}$$

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

Tax parameters τ^{g} and τ^{F} refer to capital gain and corporate income tax rates, respectively. The price variables p_t^F, p_t^K describe the prices of value added and the capital unit. r_{t-1}^d is the domestic interest rate, which generates interest flows to be distributed during period t. The typical CES production function parameters are as follows: A^F is the scale parameter, ε is the share parameter and β is the substitution parameter. v 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.