

RETIREMENT AGE POLICIES AND DEMOGRAPHIC UNCERTAINTY IN LITHUANIA: A DYNAMIC CGE ANALYSIS

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Preliminary

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Abstract:

According to stochastic population simulations by Alho (2001), population ageing in Lithuania is likely to have notable effects on labour markets in 2020's and onwards. This is somewhat later than in OECD countries, but the decline is more pronounced. The median of working-age population falls from 2.1 million in 2015 to less than 1.5 million in 35 years. Furthermore, there is about 10 percent probability that the number falls below 1 million.

A sizeable decrease in labour force puts enormous fiscal pressures on any PAYG pension system. We analyse how increasing the retirement age could help alleviate these problems, using one hundred realisations from Alho's population simulations as inputs in an overlapping-generations dynamic general equilibrium model of the Lithuanian economy. We consider two variations. Firstly, we increase the retirement age gradually to 65 years, so that the cohort born in 1960 is the first cohort with 65 as the official age for old-age pensions. In the second alternative we tie the timing and magnitude of retirement age increase to future demographic development in Lithuania. We study the effects of these two policies on the distributions of pension contribution rates, aggregate economic variables, and intergenerational welfare measures. We demonstrate that conditional retirement age policies must be designed carefully and studied extensively in order to have desired effects on both the expected outcomes and the uncertainty surrounding them.

Key words: Ageing, demographic uncertainty, retirement age, dependency ratio

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1. Introduction

Population ageing in Lithuania takes place later than in many other countries. The pressure on pension costs is postponed also for other reasons, such as the rather widespread contribution evasion which is reflected also in the paid benefits. Pension contribution rate may actually decline in the near future, and climb back to current levels and over in 15 – 30 years. This gives time to consider conditional retirement age policies, which usually is not the case because increasing the retirement age affects the pension system noticeably only after some delay.

Conditioning retirement age to demographics is one instrument in a group of pension policies that aims at reducing contribution variance. Other instruments are indexation of benefits to total wage bill, including fertility in the determinants of partial prefunding, and adjusting benefits for longevity. Conditional retirement age differs from the other instruments in that it uses, besides demographics, also demographic uncertainty calculations. All these measures also limit the expected long-term increase in the contribution rates due to ageing of population.

Section 2 of this study provides a new forecast for the Lithuanian population, and characterises the uncertainty of this forecast. In section 3 the pension system and its challenges are depicted. This section includes also a no-policy case outlook for the pension system and macroeconomic variables under demographic uncertainty. Section 4 analyses the interaction of a “traditional” exogenous increase in the statutory retirement age and demographic uncertainty. The next section studies a new kind of a policy experiment, which aims to reduce the variance of the pension contribution by using endogenously determined retirement age. The sixth section concludes.

2 Lithuanian demographics look dark

Population ageing in Lithuania is a demographic development expected to happen in the future. The expectation, like similar expectations in all European countries, is based on demographic forecasts. Economic assessments of ageing costs commonly rely on one basic demographic projection, supplemented by “high” and “low” demographic variants for sensitivity analysis. Lee and Edwards (2002, p. 11) offer four ways in which this scenario-based approach to assessing the uncertainty of forecasts of total population is seriously flawed. The first concerns assumptions about cross correlations between fertility and mortality, which by the nature of the method are usually either +1.0 or –1.0. The second is that fertility and/or mortality will always follow the highest plausible path or the lowest; long-run fluctuations like the baby boom are ruled out. Thirdly, the method provides inconsistent indications of uncertainty to differing outcome variables such as population size, life expectancy and old age dependency ratios. Fourthly, the method is intrinsically unable to assign probabilities to its high-low ranges.

One of the starting points of this study is that quantitatively the ageing phenomenon is very uncertain when we look beyond the next couple of decades. The work summarised here is based on Alho (2001).

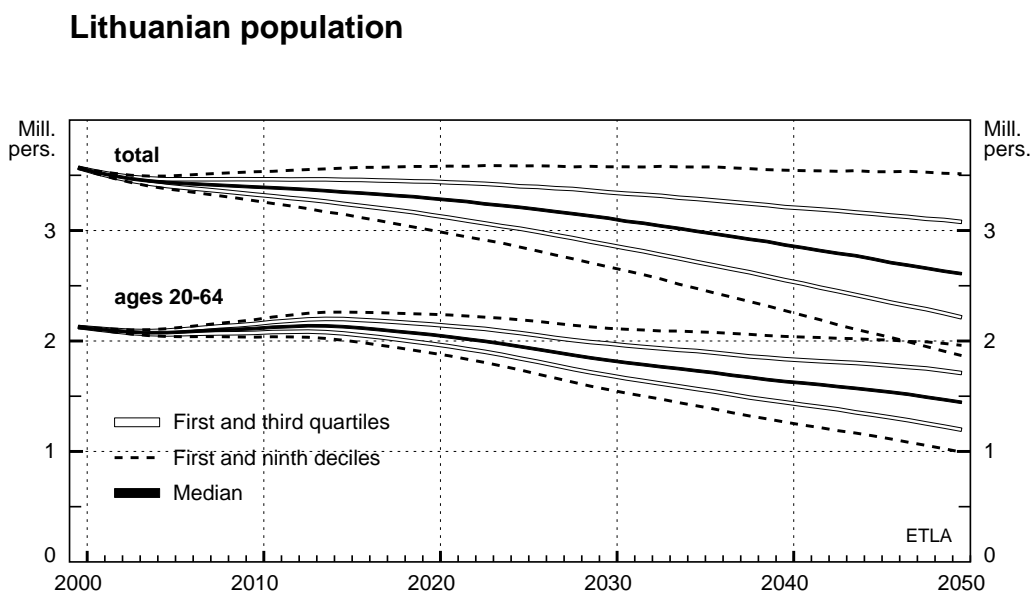
The basic assumptions behind the most likely scenario are as follows.

- fertility is assumed to stay at the prevailing level for the whole forecasting period. Total fertility rate is 1.35. This is in stark contrast to United Nations' and World Bank's fertility assumptions; both expect fertility rates to start increasing after 10 to 20 years and be close to 2 in 2050. Alho argues that evidence supporting their assumptions is weak, at best.
- mortality rates are based on observed decline between 1989 and 1999. The rates are smoothed to averages of the age-specific rates of change. The mortality rates for the oldest old are deemed unreliable, and instead the average of age-specific mortality rates in the four Nordic countries for females over age 90 and males over age 85 are used.
- migration is assumed to start from 17 000 net emigration per year and to decline gradually to zero by the year 2006. Alho presents arguments for both higher and lower choices.

The uncertainty around the most likely point estimates of fertility is based on Finnish time series from 1776 - 1996. Uncertainty in mortality is quantified from empirical estimates from Finland, which may be too low for Lithuania. Uncertainty in migration is based on judgment. Nothing specifically Lithuanian is included in these uncertainty considerations, because the information does not exist or is deemed unreliable.

The point forecast and the uncertainty are put into a model, which randomly produces 1500 different population paths for Lithuania. Their distribution shows which type of outcomes are more likely and which less. Figures 1 and 2 summarise the outcome.

Figure 1.



It is very likely that there will be fewer Lithuanians in the future than there are now. There is less than 10 % probability that the population in 2050 will be larger than in 2000. In the median outcome the population decreases by 0.5 million. And the

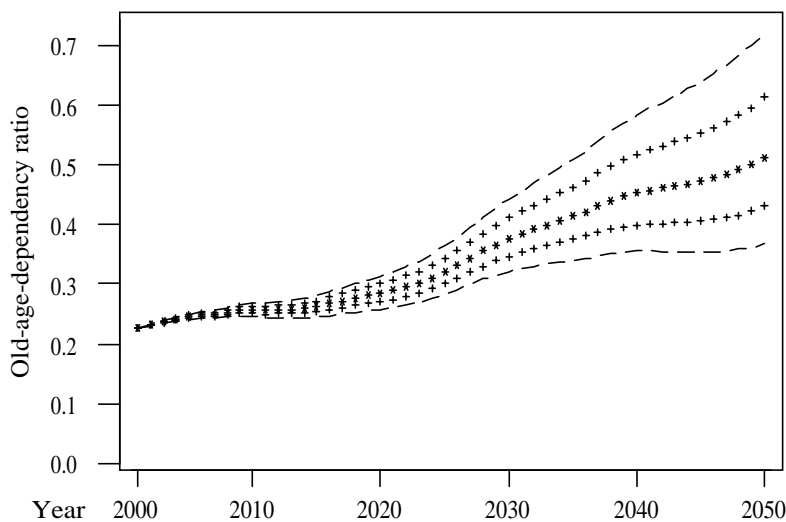
probability that there are less than 2 million Lithuanians in 2050 is well over 10 %. One may well say that Lithuania has a population problem, without going deeper into the ageing issue.

Uncertainty with respect to the size of population is also large. It is as likely that the population in 2050 is between 2.2 and 3.1 million as that it is either smaller than 2.2 or larger than 3.1 million. If one wants an interval that has 80 % probability to include the actual outcome, the limits are 1.8 million and 3.5 million. Uncertainty is sizeable already in 2020: the width of the 80 % confidence interval – the difference between first and ninth deciles – is over half a million people.

Figure 1 also links demographic uncertainty to the size of the future working-aged population. The median declines almost by a third in 50 years. The difference of the limits of the 80 percent confidence interval is about 1 million workers in 2050, i.e. the upper limit is twice as high as the lower limit.

Figure 2 describes the distribution of old-age dependency ratio (the ratio of population in ages 65+ over the population in ages 19-64) in 2000 – 2050. It is also calculated from 1500 simulations. The ratio more than doubles in the median outcome, and there is well over 10 % probability that it becomes three times as high as now by 2050.

Figure 2: Predictive distribution of the Lithuanian old-age-dependency ratio: median (*), first and third quartiles (+), and first and ninth deciles (-).



3. Lithuanian pension system and its challenges

3.1 The pension system and main problems

In principle, Lithuania has a pension system that appears both transparent and well-thought of. In practice there are severe problems related to contribution evasion and deficient coverage, old-age poverty, weak incentives, and fiscal sustainability.

There are two types of pensions in Lithuania: social insurance pensions based on contributions and financed from the separate social insurance fund and state pensions payable from the state budget. Both operate on a pay-as-you-go basis.

Social insurance pensions are paid from the separate state social insurance fund and are based on the amount of contributions paid and the length of the coverage. They constitute more than 90 % of Lithuanian pensions. The fund is financed by a 31% employer contribution on the wage bill plus a 3% employee contribution on their individual wages. Social security contributions are used to finance pensions (old-age, disability and survivorship), short-term benefits (sickness and maternity), as well as unemployment and health insurance partially. The pension system is described in more detail in Morkuniene (2002).

A previous study (Lassila et al., 2001) identified three groups of problems in the Lithuanian pension environment. The first consists of fiscal problems of the current pension system. These are partly connected with the tumultuous transition process, but will prevail due to the ageing of the population. The second problem group is the poverty of retired people. This results both from the low level of pensions and, to an increasing degree, declining coverage of the current system. The third group of problems is related to incentive issues, concerning working and saving incentives and also participation to the pension system. As a PAYG system with unfavourable future demographics, the rate of return from current contributions can be expected to be low. High redistribution within the system weakens further the work incentives of middle- and high-income earners. The fiscal difficulties due to unfavourable demographics point towards future political risks and make the credibility of the system suspect. These problems still persist. Although the fiscal imbalances are not likely to appear in the very near future, the coverage problem has if anything become slightly worse.

A group of researches has suggested a profound pension reform, which would include increases in the basic pension for a couple of decades, switching towards more VAT financing, and replacing the earnings-related part of the pension with a private mandatory fully funded scheme (see Lassila et al, 2001, and Jensen and Lassila 2002). The key feature behind the recommendation was the coverage problem. If one believes the current system is unsustainable, because increasing contributions are likely to make the contribution evasion more common, then the recommendation is indeed worth repeating here. If, however, one thinks that the current system can be sustained, and the coverage increased so that all Lithuanians are adequately insured for old age, then one must search for policies that help the sustainability and efficiency of the system.

In this study, Lithuania is a test ground for introducing demographic uncertainty into ageing analysis. We have shown that uncertainty is large. Thus the asymmetry mentioned by Auerbach and Hassett (2001) must be taken into account: with risk

aversion, outcomes that are worse than expected should weigh more than outcomes better than expected. Policies should be precautionary. We must ask how unfavourable demographics could hit Lithuania. What are the really bad cases Lithuania should be prepared for? One is straightforward to identify: declining labour force, due to low fertility and/or high emigration. It would result in very bad age ratios, which, with PAYG pensions, would cause high contribution rates and also create pressures for tax increases to finance age-related public services and transfers. Another financial problem may come from unexpected decreases in mortality of the retired.

3.2 Analysing the effects of demographic uncertainty

The use of different demographic scenarios, produced by stochastic population simulations, as inputs in an overlapping-generations general equilibrium simulation model is technically straightforward. Intellectually, there is a gap: there is no uncertainty in our OLG model. The households and firms in the model do not take into account demographic uncertainty in their decisions. They have perfect foresight of the future population development in each alternative. Although it would be more satisfactory to have uncertainty included, we feel, however, that the results are worth presenting as they are now.

Including uncertainty properly in our model would be difficult. Computational models of social security have developed very rapidly during the last few years, see, for example, Imrohorogly et al. (1999) and Rust (2000). Still, as far as we know, even the most sophisticated current numerical OLG models (see e.g. De Nardi et al. (1999)) can handle only idiosyncratic income and longevity uncertainty. Demographic uncertainty will cause uncertainty in macroeconomic variables.

Our simulations show that variation in macroeconomic outcomes due to demographic uncertainty is large. In Appendix 3 a 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 introduced in section 2.

Figure 3.1

Social security contribution rate in Lithuania, 2000-2050

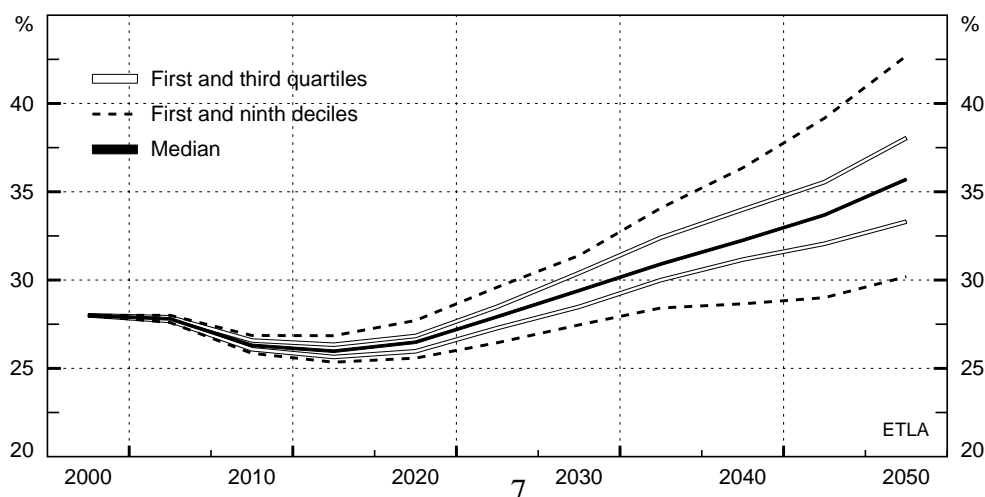


Figure 3.1 shows the distribution of social security contributions. The starting value of the contributions is set to 28, which includes both pension contributions and health contribution parts. Coverage is assumed to remain at the current low level.

After the initial decline, the current contribution level is again reached in 20 – 30 years. In 2050 the rate is almost certainly above the starting level of 28 %. The median estimate is 36 %, and there is 10 % probability that the level exceeds 43 %.

4. Increasing the retirement age to 65 years

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.

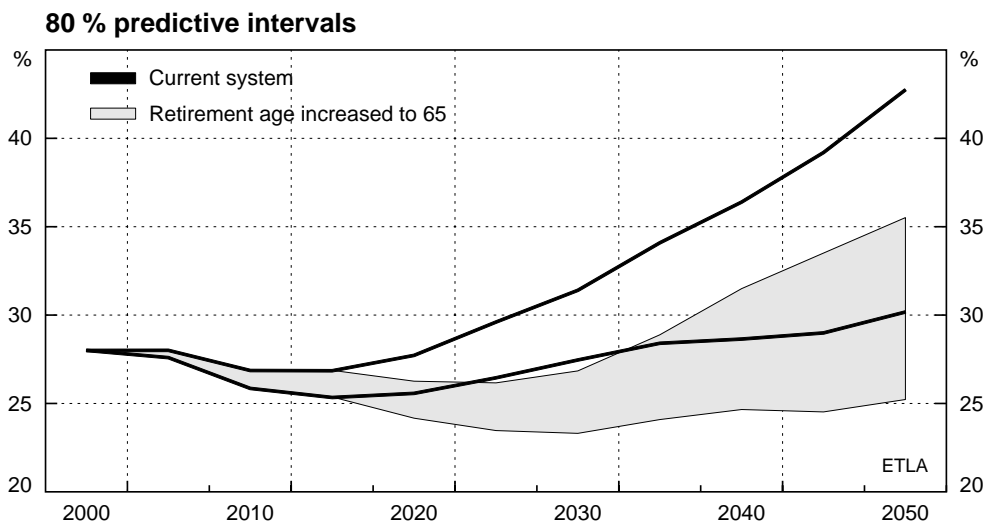
The effects of retirement age rules on labour supply depend on the possibility of continuing working and earning wages while receiving pensions. Lithuanian social insurance pension scheme allows one to receive wages and pension at the same time. But restrictions are applied to those who are under 65 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.

Increasing the retirement age cuts off pension payments to those age groups that are younger than the new retirement age but older than the previous age. It also increases earnings-related pensions as more work years add to the replacement rate. 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. 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 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 can be reduced correspondingly. 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.

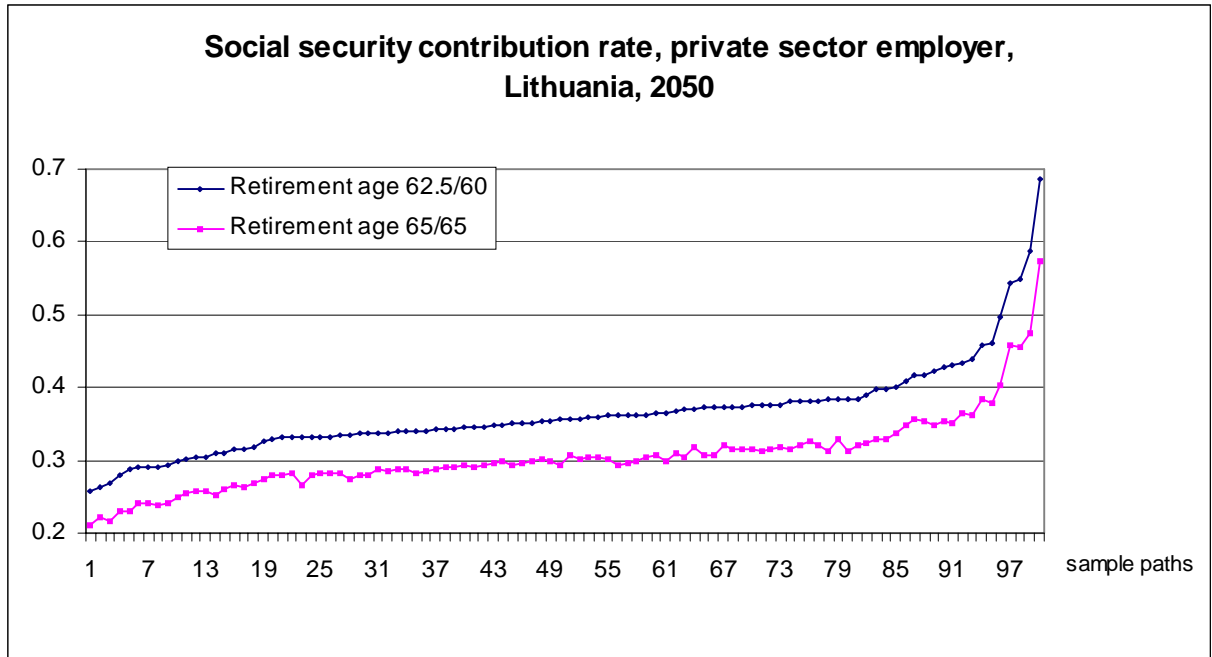
Social security contribution rate in Lithuania, 2000-2050



The lower employers' contribution rate allows higher wages. On impact, the labour supply increases more than just due to the higher retirement age. The higher income motivates people both to consume and to save more for old age. Part of the savings goes to the domestic capital stock, part goes abroad and net foreign debt declines. Firms react to the higher labour supply by investing and producing more. As the domestic demand increases less than production, exports grow and the term of trade deteriorate slightly.

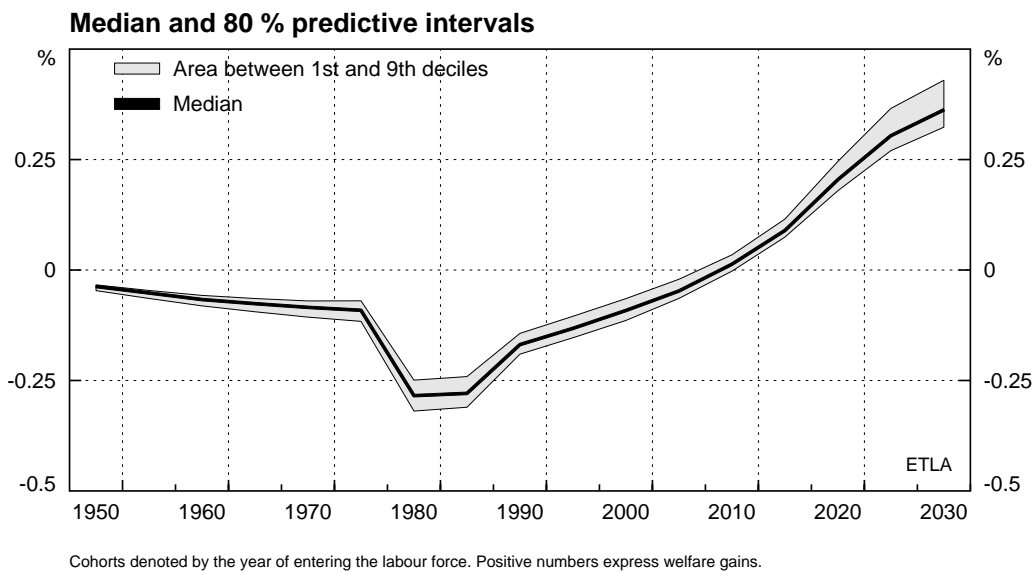
How does uncertainty change or what does it add to the description above? Very little, one is inclined to say. The median is a good descriptor of the likely effects, the 80 % confidence interval gets wider in time but remains narrow (see figure 2 in Appendix 3).

In the following, 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 input is. That depends on the effectiveness of those between 61.25 and 62.5 years of age. If their work efficiency is low - as in our simulations - the labour input will not increase substantially. They get some wage income for the work they do, but it does not compensate the loss of pensions and leisure during the period until they reach the new retirement age. Their lifetime utility decreases. Note that older generations also suffer a very small loss here. This is because (for computational reasons) the measure was assumed announced already in 1990, and workers reduced their labour supply during the 90s, in anticipation of having to work to older age.

Welfare effects from increasing the retirement age to 65

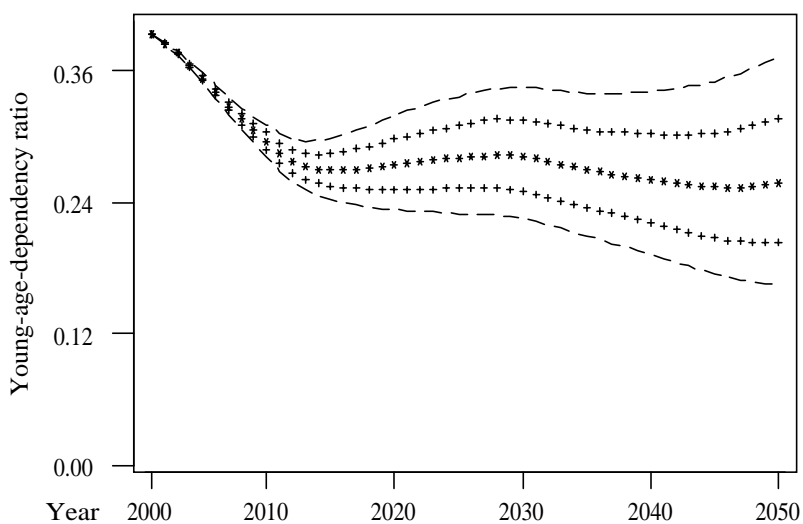


5. Conditional increase in the retirement age

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 to be increased.

The Lithuanian policy-makers could use the information in Alho (2001), specifically the young-age dependency ratio (see figure below). 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. 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

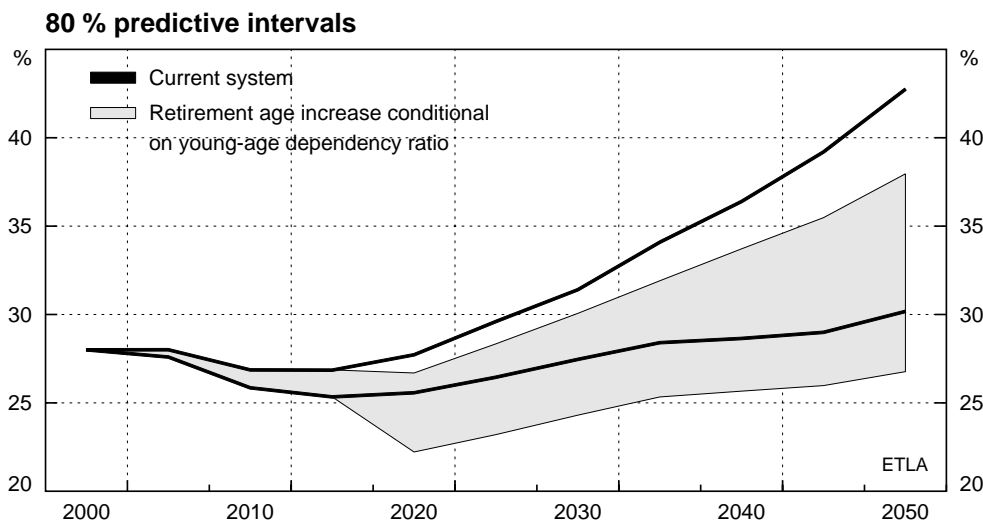
62.5 years. In 27 cases the retirement age was not initially increased. In 2050 the retirement age was 65 years in 52 cases, 63.75 in 13 cases, 62.5 in 15 cases and still 61.25 in 20 cases.

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

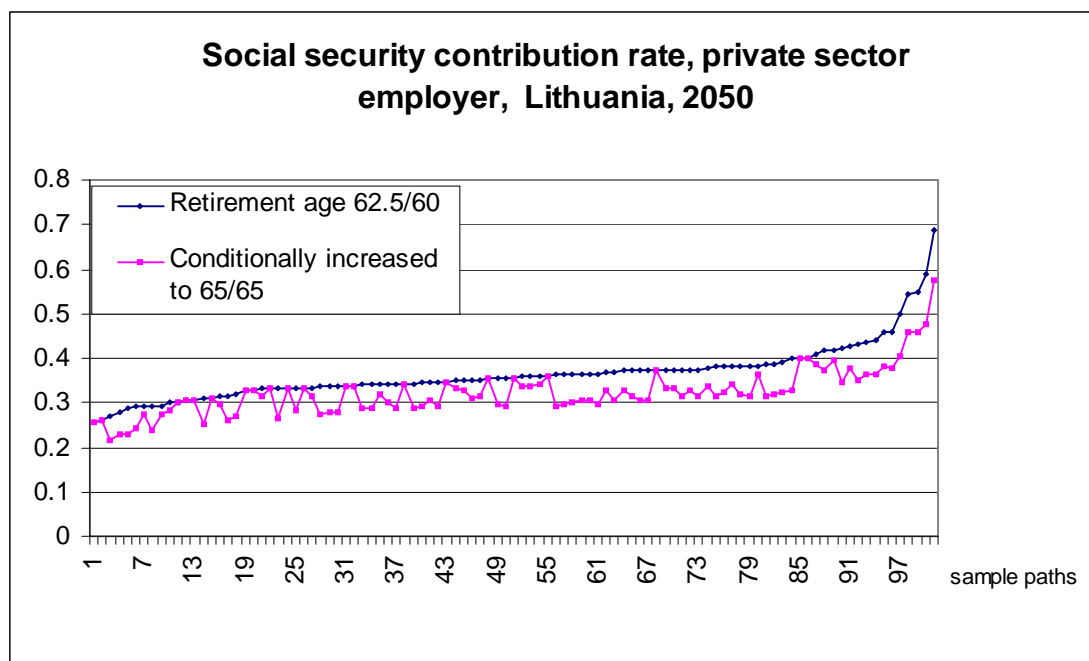
Retirement age increase lowers pension expenditure and contribution rates. The median cut in pension expenditure is 15 % in 2050, and the contribution rate is 5 %-points lower than without the increase. The uncertainty concerning the size of the effects is larger than it was with the fixed-schedule increase analysed in section 4. 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.

Social security contribution rate in Lithuania, 2000-2050



The conditioning doesn't quite hit the target, if we look at the situation in 2050. In most population paths where the contribution rate in the base case is above the median, the retirement age has been increased. But not in all cases. And in many of the good cases, where the contribution rate would not rise much or at all, the retirement age has also been increased.

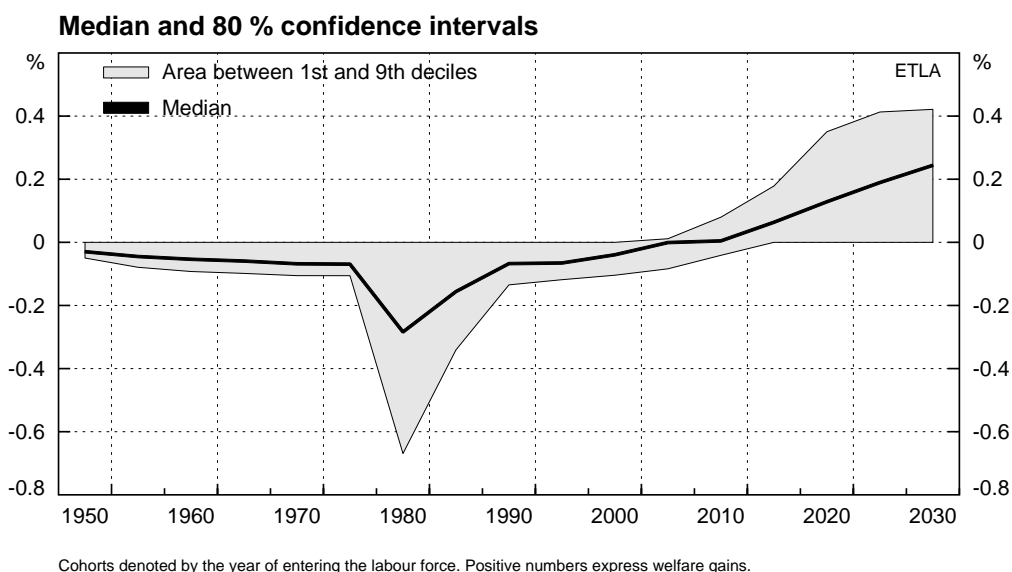


Looking closer at those population paths where the retirement age should have been increased but was not, one type was where both the numerator and the denominator of the young-age dependency ratio declined rapidly but the ratio stayed above the criteria. This happened when both the number of births declined and the number of working-age emigrants increased. The young-age dependency ratio was not a good predictor of the old-age dependency ratio. Migration was also the reason why some good cases led to retirement age increase: rapid immigration of working-age people declined the young-age dependency ratio but also prevented the old-age dependency ratio from increasing very much.

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 (see Appendix 3).

The distribution of welfare consequences of the conditional increase in retirement age is in the figure below. Some losses are larger than with the unconditional policy, because here the retirement age was in some cases risen directly to 65 years.

Welfare effects from conditional increase in retirement age



Summarising pension policies:

The following two tables summarise the effects of pension policies to contribution rates. It is important to notice that including uncertainty into analysis leads to new conceptual issues, in addition to multiplication of numerical results. The tables highlight this. The first table presents the distribution of outcomes, and the second table the distribution of policy effects. The figures in the tables answer two different questions; it holds both that the median of contribution rates in 2030 declines by 2.19 percentage points with the conditional increase in retirement age, and that at the same time the median effect of this measure is a decline of 1.77 percentage points.

Table 1 Distribution of social security contributions
Median rate and 50 % and 80 % confidence limits, %

Policy measure	2000	2030			2050		
		Median	50 %	80 %	Median	50 %	80 %
Current system	28	29.41	28.49	27.46	35.70	33.31	30.19
			30.40	31.39		38.05	42.69
Retirement age increase	28	25.05	24.20	23.31	29.83	28.06	25.24
			25.78	26.84		31.77	35.51
Conditional increase in retirement age	28	27.22	25.71	24.30	31.57	29.40	26.77
			29.09	30.06		34.05	37.96

Table 2 Distribution of policy effects on social security contributions
 Median effect and 50 % and 80 % confidence limits, %-points

Policy measure	2030			2050		
	Median	50 %	80 %	Median	50 %	80 %
Retirement age increase	-4.38	-4.18 -4.64	-4.07 -4.98	-5.64	-5.22 -6.48	-4.96 -7.23
Conditional increase in retirement age	-1.77	0.0 -3.95	0.0 -4.77	-5.12	-1.88 -6.36	0.0 -7.14

6. Conclusions

Conditioning retirement to demographics is one potential measure in a group of pension policy instrument that aims at reducing contribution variance. Other instruments are indexation of benefits to total wage bill, including fertility in the determinants of partial prefunding, and adjusting benefits for longevity. Conditional retirement age differs from the other instruments in that it uses, besides demographics, also demographic uncertainty calculations. All these measures also reduce the long-term increase in the contribution rates due to ageing of population.

We have shown that the size of future increase in pension contribution rates is very uncertain, because of the uncertainty inherent in demographic projections. Increasing the retirement age reduces the increase in contributions but does not much affect the uncertainty. But making the retirement increase conditional on demographics will affect also the uncertainty.

Obviously, designing conditional schemes for the retirement age requires some experimenting. The young-age dependency ratio does not alone contain sufficient information for conditioning. This kind of policies should be designed carefully and studied more extensively than has been possible in this project. The tools we have used, stochastic population simulations and a numerical OLG model, facilitate this type of analysis but also require further development (see Appendix 2).

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Appendix 1: The Lithuanian OLG model

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.

Some features, especially the pension system, are particularly Lithuanian in this model. Taxation, both from households' and firms' point of views, and from the tax revenue angle, resembles the Lithuanian situation in 2000. Mortality rates and fertility, and thus the population age structure and size, are derived from population simulations for Lithuania. The model has been calibrated so that public debt, net foreign debt, labour supply profiles by cohorts, pension - wage relations, and export share of output are close to those observed in Lithuania in 2000. The parameter values were taken from studies concerning other countries, as no studies concerning crucial parameter estimates have been carried out in Lithuania.

In the following we describe the behaviour of households and firms in more detail. Lassila (1999a) provides a fuller description of the model¹.

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).

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

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

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

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

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

$$(6) \quad Z_t = (1-g_t) B_t + (1-g_t) \Phi s k D_t [1-v_t(1-l_t)]$$

¹ Related pension policy studies are presented in the case of Finnish economy in Lassila and Valkonen (2001).

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 ν , 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.

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 (8), the CES production function F_t (9), the accumulation condition of the capital stock K_t (10), the determination of the firm's debt B_t^F (11) and the investment adjustment cost function G_t (12).

$$(7) \quad \text{Max}_{L_t, I_t, K_t} \quad \frac{1}{1 - \tau^g} D_t + V_t . \text{ subject to:}$$

$$(8) \quad D_t = (1 - \tau_t^F) \left[p_t^F (F_t - G_t) - (1 + s_s^f \tau_t^z) w_t L_t - r_{t-1}^d B_{t-1}^f - P_t^K I_t \right] + B_t^f - B_{t-1}^f$$

$$(9) \quad F_t = A^F \left[\varepsilon K_{t-1}^{(1-1/\beta)} + (1 - \varepsilon) (v^t L_t^F)^{(1-1/\beta)} \right]^{\beta-1}$$

$$(10) \quad K_t = (1 - d) K_{t-1} + I_t$$

$$(11) \quad B_t^f = b p_t^K K_t$$

$$(12) \quad G_t = \xi \frac{I_t^2}{K_{t-1}} .$$

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.

Appendix 2: Stochastic population simulations in an OLG model: some technical details and conclusions

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. Efficient data-handling procedures and algorithms are essential for this type of analysis.

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.

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.

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.

Appendix 3: Macroeconomic effects of population ageing and increases in the retirement age in Lithuania

We have chosen to 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.

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.

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.

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.

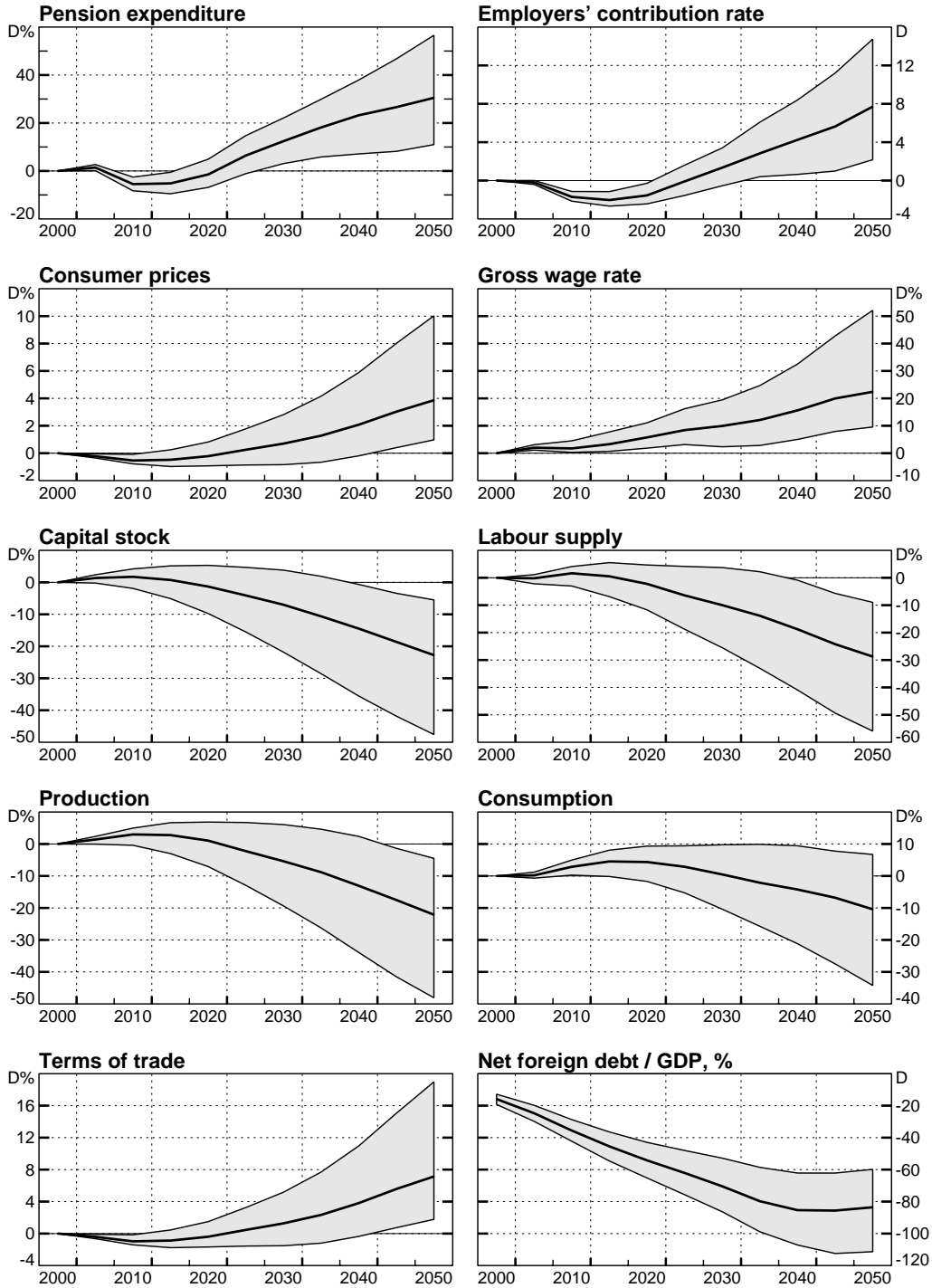
One of the baseline assumptions is that Lithuania, being a country in the middle of transition, has large potential for a catch-up of economic growth. As the assumed average yearly productivity growth of 3 percent is materialised, private production will be threefold in 50 years, even though the labour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

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.

It is likely 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 contribution rate is assumed to be changed to balance the pension expenditure and contribution revenue. No changes in the “coverage” issue are assumed. Here we take a technical viewpoint, and assume that the system is upheld and pensions paid even if it means contribution rates of 70 %. The median of the pension expenditures increases by third in the long term. Since the tax base declines, the median of the employers’ contribution rate increases by 8 per cent. One factor that limits the corresponding increase in the gross tax rate to few percentage points is the low participation ratio in the earnings-related pension system.

Effects of population ageing on pension system and macroeconomic variables

Median and 80 % confidence intervals

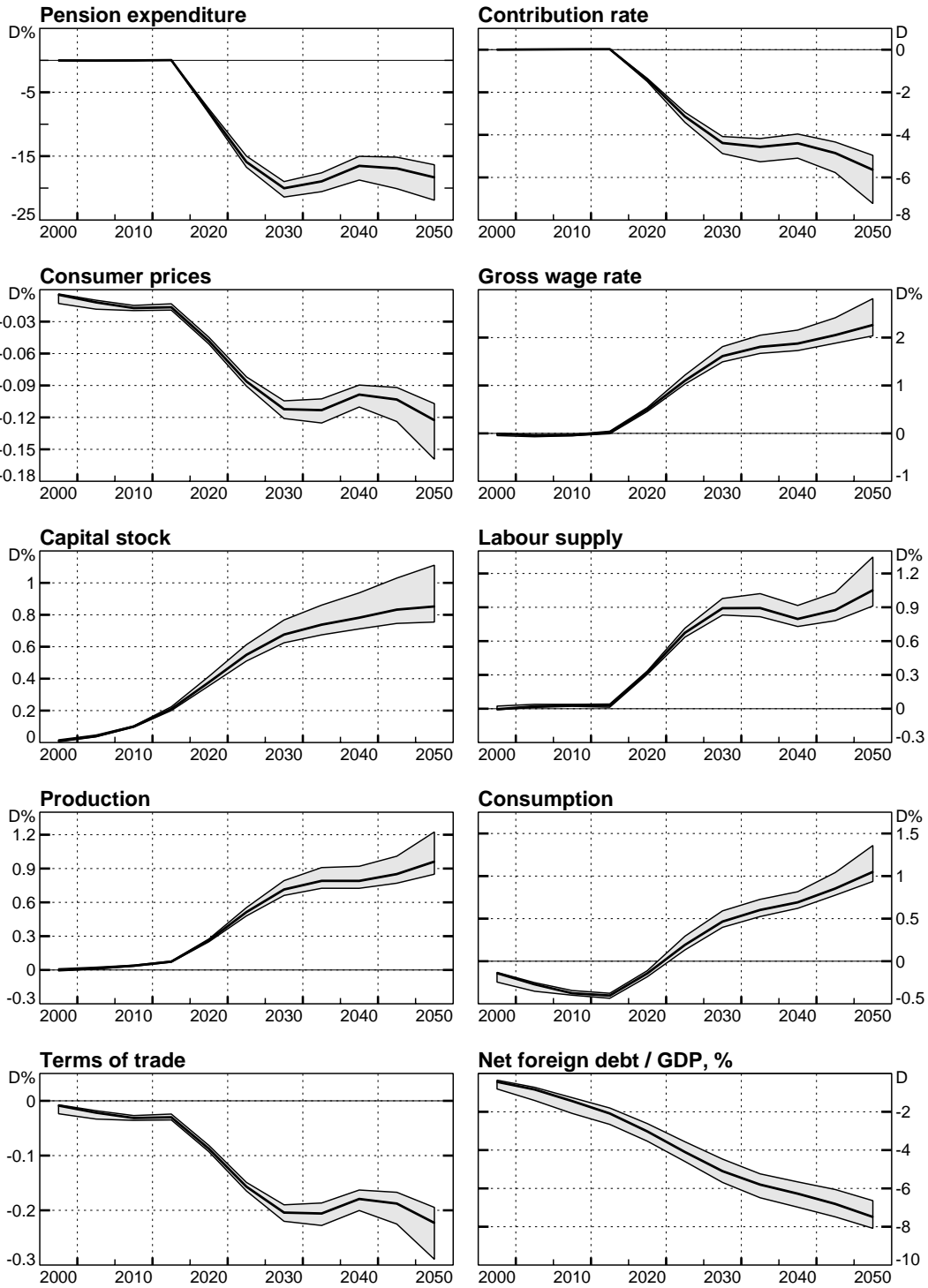


Deviations from a constant growth path
D = absolute deviations
D% = per cent deviations

ETLA

Effects of increasing the retirement age to 65

Median and 80 % confidence intervals



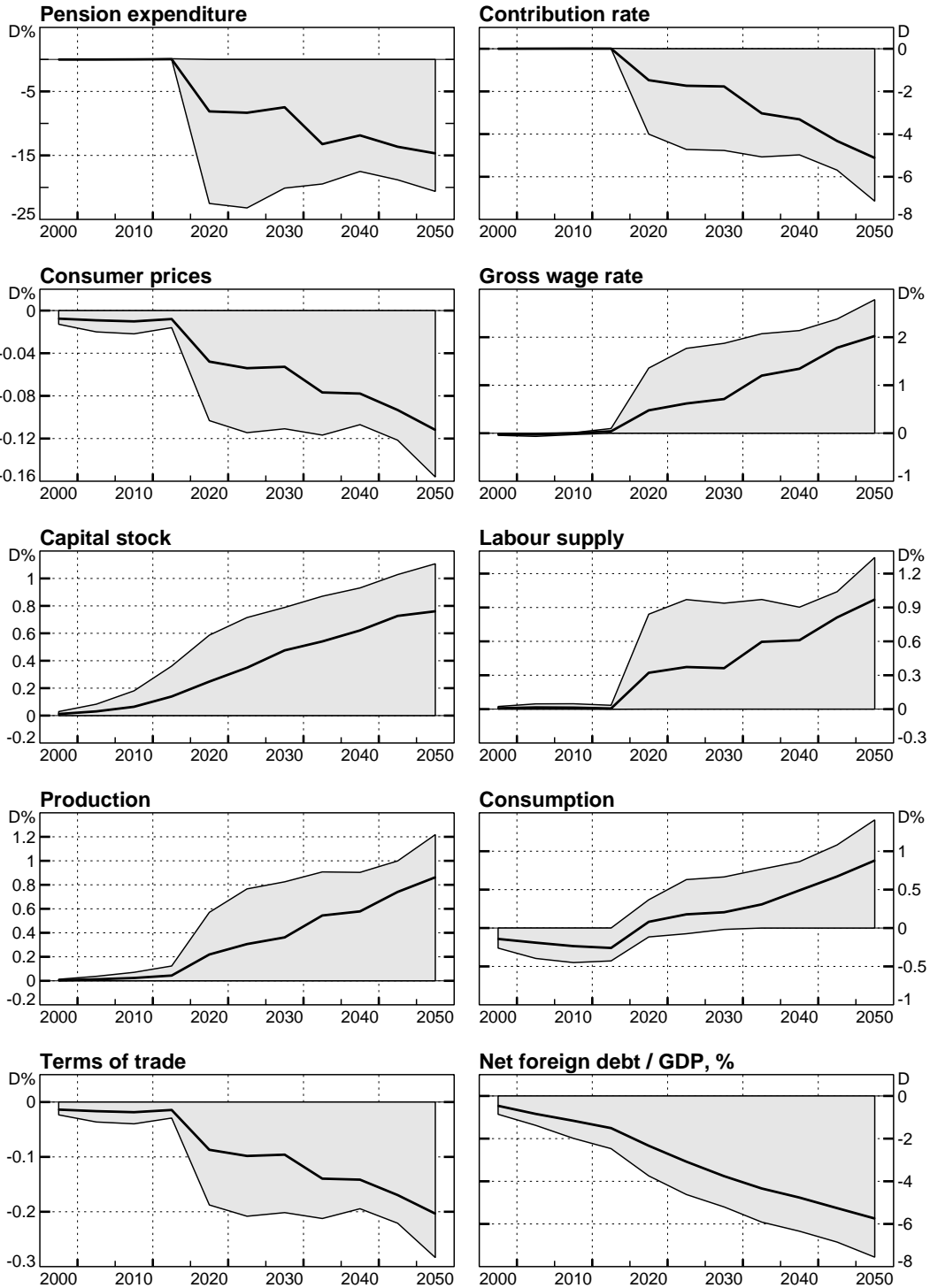
Deviation of simulation run from base run
 D = absolute deviation
 D% = per cent deviation

Area between 1st and 9th deciles
 Median

ETLA

Effects of conditional increase in retirement age

Median and 80 % confidence intervals



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

Area between 1st and 9th deciles
 Median

ETLA