The Budgetary and Economic Consequences of Ageing in the Netherlands[1]

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Research Memorandum 9909

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[1] This paper is based on a report requested by the Ministry of Economic Affairs. The first author was affiliated with this Ministry at that time. We would like to thank Eric Bartelsman, Cees Kortleve and Cees Oudshoorn for many useful comments on an earlier version of this report.

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Abstract

The Netherlands will be confronted with an almost doubling of the old-age dependency ratio over the next forty years. The costs of the ageing population are primarily reflected in larger expenditures on pensions and health care. This paper explores the consequences of ageing in a baseline scenario simulated with a dynamic general equilibrium model. The sensitivity of the results are discussed under alternative scenarios for the interest rate and population projections. Finally, the effects of two types of reform measures in the pay-as-you-go social security system are explored.

1. Introduction

All OECD countries will be confronted with an ageing population. For some countries, the peak in the number of elderly people will occur earlier than for other countries and for some countries the share of the number of elderly in the total population will be higher at its peak than for other countries. Nevertheless, the demographic pattern will be broadly the same for all these countries.[2]

In this report we will focus on the consequences of population ageing for the Netherlands. Figure 1 exhibits, for three different scenarios, the projected dependency ratios of the number of people of 65 years and older, divided by the number of people in the age categories of 20-64 years.[3] Under the baseline scenario, this dependency ratio, which we denote by D65+ henceforth, rises rapidly from 22% in 1999 to a peak of approximately 43% in 2038. After the peak, the dependency ratio falls somewhat, but it remains structurally high at a level of around 40%. Roughly speaking, the projected pattern is the result of the baby-boom in the beginning of the fifties of this century, combined with a structural reduction in the projected fertility rate and a structural increase in (projected) life expectancy. The babyboom is responsible for the slight peak towards the end of the thirties of the next century, while a low fertility and a high life expectancy together cause the number of elderly to remain high. The "grey" scenario and the "green" scenario depict rather extreme (and unlikely) outcomes. Under the grey scenario, primarily driven by a projected further fall in fertility and a strong increase in life expectancy, D65+ rises steeply until it reaches a peak of 52% in 2040. After the peak, it falls marginally and then resumes its rise, to reach a level of 57.5% in 2100. Under the "green" scenario, which is based on exactly the opposite developments for fertility and life expectancy, D65+ attaines a maximum of 36% in 2037 and then falls back and stabilises at a level of around 27.5%, still 5.5% points above the current value for D65+.

The grey and the green scenarios are rather extreme cases. Therefore, it is very likely that actual population developments will remain between these two scenarios. The finding that population ageing is a structural, rather than a temporary problem, thus seems rather robust against the underlying assumptions about fertility and life expectancy (see also De Beer, 1999, and De Beer and Beetsma, 1999).[4]

Below we will investigate the costs and macroeconomic consequences associated with population ageing. We do this under the assumption that the current institutional

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[2] De Beer and de Jong (1998) provide demographic projections for the countries in the European Economic Area.

[3] As a way to illustrate the ageing pattern of the population, this measure is preferred instead of the number of 65 years and older as a share of the total population. The reason is that the group of 20-64 years old contains almost all of those who are in the labour force, which is the group that has to bear the (financial) burden associated with an ageing population.

[4] Immigration and emigration also play a role, albeit a less important one.

setting remains (largely) unchanged in the future. The costs of an ageing population are primarily reflected in the larger number of pensions that have to be paid out and the greater demand for health care. The results are based on simulations of the Broer (1999) model for the Dutch economy.

The remainder of this paper is structured as follows. Section 2 briefly explains the model on which the simulations are based. Section 3 discusses the budgetary and economic projections for the baseline scenario. Section 4 investigates the effects of alternative scenarios for exogenous variables, in particular the real interest rate and the population forecasts, while Section 5 explores the consequences of two alternative policy scenarios: public pension premium smoothing and a partial shift from public towards more private pension provision. Finally, Section 6 concludes the main body of this report. The Appendix contains a description of the model, details about the simulations and the values of the important parameters.

2. The model

The simulations are based on the model of Broer (1999), which in turn is an extension of the model developed by Broer and Westerhout (1997). The Broer (1999) model is a dynamic general equilibrium representation of a small open economy (the Netherlands), with an exogenously given real interest rate and exogenous labour-augmenting technological progress (2% a year). The capital and output markets are perfectly integrated into the world market. Labour, however, is perfectly mobile across sectors, but completely immobile across borders.

The population has an overlapping generations structure with individuals that have an age-specific probability to die. Individuals not only differ in terms of their expected age, they also differ in terms of their productivity and therefore their income. In other words, there is both inter- and intragenerational heterogeneity in the model.

The model tries to capture the most important institutional arrangements for the Netherlands. Details about the model and, in particular, the institutions can be found in the Appendix and in Table 1, which describes the various types of taxes/premia and their sources. However, for the remainder of this report it is useful to describe briefly the main features of the Dutch pension system and the Dutch health insurance system. The reason for this is that the costs associated with these institutions in particular are affected by population ageing.

The pension system

The pension sector is characterised by two (complementary) schemes. The first is a public pension scheme (AOW), which operates on a pay-as-you-go (PAYG) basis. It provides a flat, minimum benefit to any person of 65 years or older. The scheme is financed through levies on labour and capital income of those younger than 65 years. Those who are 65 years or older are exempt from AOW contributions.

The other scheme supplements the AOW for retirees who previously enjoyed wages above the social minimum. The scheme is funded and its benefits are based on

the final pay and the number of years a person has been employed. Contributions to this supplementary pension scheme are levied on labour income if it exceeds a certain threshold (the "franchise"). These contributions are deductible for income tax and AOW contributions. However, the benefits will be subject to income taxation.

The health insurance sector

As is the case for the pension sector, the health insurance sector is composed of a public and a private scheme. Low-income (i.e., low-productivity) households are publicly insured. They pay a premium which is proportional to their labour income, as well as a small, nominally fixed premium. The public health insurance system, which operates on a PAYG basis, reimburses nearly all health care expenditures. Higher-income households are privately insured. They pay a lump sum premium. The private health care system reimburses a fixed proportion of the health care expenditures of their clients.

Within the public health insurance sector there is also a second scheme (the AWBZ), to which both publicly and privately insured households contribute. The AWBZ provides coverage for special medical treatments.

General remarks about the simulations

The simulations are based on the national accounts (and other data) for 1997. The variants we discuss below all assume that the public debt/GDP ratio is kept constant at 68.5% (its value for 1997) and that the income tax rate acts as the closure variable for the intertemporal government budget constraint. In other words, the income tax rate is endogenous, while the other tax rates are exogenous. In addition, all the simulations (except for those based on the "grey" or "green" scenarios – see below) use the baseline population projection, as shown in Figure 1. Finally, all but one (see below) of the simulations assume that the (world) real interest rate remains constant at 5.5%.

Although the input data are based on 1997 figures, the income tax rate and the premium levels that are endogenous (AOW, public health care and AWBZ) will not exactly match their actual 1997 levels, because they follow from solving the model. Because the way institutions are embedded in the model is a simplification of reality, our figures for the consequences of population ageing need to be interpreted with care.

The simulations based on the alternative paths for the exogenous variables or the alternative policy scenarios – see Sections 4 and 5 below – are all implemented after a re-calibration of the model. Hence, under the alternative scenarios, the 1997 solutions of the endogenous variables will in general be different from those under the baseline scenario.

3. Simulation results: the baseline case

Population ageing has its counterpart in a fall in the size of the working-age population as a share of the total population. The labour supply as a share of the total population

(see Figure 2), which is primarily determined by the relative size and the labour force participation rate of the working-age population, falls more than 5 percentage points (from 35.7% in 1999 to a minimum of 30.5% in 2035).[5] When measured as a fraction of the number of 19-65 years old, the labour supply falls from 45.6% in 1998 to a minimum of 37.6% in 2035 (see Figure 3). The participation rate in the labour force is driven by two opposing forces. First, there is an intratemporal substitution effect from goods consumption to time-related consumption (health care and leisure), caused by the increase in the tax and premium wedge. Second, this larger wedge reduces net future income. This implies a fall in individual wealth, which stimulates labour supply.

The projections thus show that the costs of population ageing have to be borne by the falling share of the population that actually works. This is in particular the case for schemes that are financed on a pay-as-you-go basis. Such schemes are balanced on a year-by-year basis. Hence, any disbursements in a year have to be matched by equal revenues from premium income.

Indeed, as Figure 4 reveals, AOW (public pension) premium payments as a share of GDP rise from 6.2% in 1999 to a peak of 11.3% in 2037. After having reached their peak, they fall slightly and remain at a level of around 10.4%. The steep increase in the AOW-premium is the result of two factors. First, the number of public pensions to be paid out rises relative to the number of people in the labour force. This is a "numerator" effect. Second, there is a "denominator" effect, because the distortions that arise from the premium increases (not only AOW, also other premia) lead to reduced labour participation rates. In effect, the pattern of the AOW premium closely follows the projection of D65+.

Public health insurance premia (Figure 5) and AWBZ premia (Figure 6) as shares of GDP follow patterns that are very similar to those projected for AOW. The reason is that the elderly demand more health care than the average population member. The public health insurance premia rise from 2.2% in 1999 to a maximum of 3.5% in 2039, while AWBZ premia rise from 3.6% in 1999 to a maximum of 5.7% in 2039.

The projected contribution rate for supplementary pensions rises during the first two decades of the next century (see Figure 7). However, the increase is moderate: 1.2%-points between 1999 and 2019. The reason is that the pension funds already own a substantial amount of assets, because they are legally required to be able to cover the (discounted) accumulated pension rights of those already participating in the fund. Future entrants will start paying a premium that is sufficiently large to cover the additional obligations created by the entry. A mismatch between assets and obligations will arise if the interest rate changes or if the wage growth rate changes. A fall in the

[5] Labour supply as depicted in Figure 2 is measured in full-time equivalents divided by the population size. More precisely, it is computed as the aggregate amount of time spent on work in the economy divided by the total available amount of time (i.e., the number of individuals times the available amount of time per individual, which has been normalised to unity). Subsequent labour-supply figures have a similar interpretation.

interest rate (discussed below) raises the present value of the outstanding obligations and requires a rise in the premium. Because pension income is linked to the development of real wages, a rise in the wage rate similarly leads to a higher premium. In the event of a mismatch, the gap between pension assets and projected pension obligations will be closed at a rate of 10% a year.

Total taxes as a share of GDP (Figure 8) rise from 33.5% to a peak of 37.8% in 2035.[6] This change can largely be ascribed to higher consumption tax revenues. While income tax revenues fall during the next two decades (following the fall in the labour supply), consumption tax revenues rise sharply, because consumption as a share of GDP increases substantially. This increase is in line with the ageing pattern of the population: although pensioneers tend to set aside part of their pension, anything that is not set aside implies a decumulation of accumulated wealth and should be counted as an increase in consumption.[7] Figure 9 depicts the sum of all tax and premium payments (excluding supplementary pension premium payments) as a share of GDP. This is a measure of the relative size of the collective sector in the total economy. The relative size of the collective sector increases from 45.6% in 1999 to a peak of 58.2% in 2037, an increase of more than 12.5 percentage points.

Figure 10 shows national savings as a share of GDP. National savings is defined as the sum of private and public sector savings. Over the coming years the national savings rate will rise by approximately one percentage point to a maximum of 27.6% in 2007, after which it declines until it reaches a minimum of 16% in 2043. This pattern of savings is primarily explained by the increase in the number of old that draw from their private pensions. As explained above, the old decumulate their (pension) wealth, which implies a reduction in national savings.[8] The fall in national savings is largely accounted for by a rise in consumption as a share of GDP. Consumption rises from 40% of GDP in 1999 to a maximum of 50% in 2037. It then falls, after which it stabilises at around 45%.

Investment as a share of GDP (depicted in Figure 11) falls by approximately 2.5 percentage points between now and 2026, when this ratio reaches its lowest level. This fall is primarily the result of a shift of labour to sectors that use no capital (the health care and health insurance sectors). The fall in investment and the initial increase in the savings rate are reflected in an improvement in the current account, which rises from 9.5% in 1999 to 11% in 2007. After 2007, the current account starts falling until it attains a minimum of −0.5% in 2043. The first two decades of the fall are driven by the falling savings rate, which dominates the falling investment rate. After 2026, investment picks up again, which, together with a savings rate that is still falling, causes the current account to deteriorate further.

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[6] These figures thus *ex*clude AOW, AWBZ and public health insurance premia.

[7] On this point, see Miles (1999).

[8] The increase in the number of public pensions and the increase in the demands for health by the old does not have a direct affect on national savings, because these schemes are financed on a pay-as-you-go basis.

Even though the exogenous rate of labour-augmenting technical change has been set at 2%, the GDP growth rate fluctuates over time (see Figure 13). In particular, it falls over the next three decades, primarily because labour supply falls.

Figures 14 displays the relative compensating variations for an individual of the average productivity type. The relative compensating variation of a particular generation is defined as the share of its lifetime wealth (for generations that enter the labour market before 1997, the remaining lifetime wealth) that it would need to receive in addition to its actual lifetime wealth, so that its lifetime utility, corrected for technological progress, is equal that of the generation that enters (at age 18) the labour market in 1997. This correction needs to be made because on a steady-state growth path the utility of future generations will be higher as a result of technological progress.[9] The time-profile of the relative compensating variations is thus a way to illustrate the intergenerational distribution of the costs of population ageing. Indeed, along a steady state growth path (which requires a constant population composition by age (and skills)), the relative compensating variations will be equal to zero for all generations.

(Virtually) all generations older than the generation that enters the labour market in 1997 would have to make a positive transfer, because these generations need to contribute (or have contributed) less to the costs of population ageing, while all generations entering after 1997 contribute more and would need to receive a positive transfer. The relative compensating variations rise until around 2030 and then stay at approximately the same level, because the relative number of older people remains high.

4. Alternative scenarios for exogenous variables

This section describes the consequences of alternative developments for some of the exogenous variables. We alter the path of only one variable at a time.

4.1. A decline in the world interest rate

Figure 12 showed that, under the baseline scenario, in which the real interest rate is assumed to remain constant at the level of 5.5%, the current account will improve during the coming decade and then start to deteriorate. Nevertheless, the current account will remain at a substantial surplus at least during the coming three decennia. In effect, therefore, during this period the Netherlands will be accumulating net foreign assets, which will help to shoulder the costs of population ageing. Obviously, it will not be possible for all the countries that experience an ageing population, to run current account surpluses. The increase in the net supply of capital on the world market as a result of enhanced national savings will drive down the world real interest rate.

[9] The correction is obtained by premultiplying generation t's utility by a factor $(1+\alpha)^{(1997-t)/(1-1/\gamma)}$, where t is the year in which the generation enters the labour market, $\alpha = 0.02$ and $\gamma = 0.25$.

In this subsection we investigate the budgetary and economic consequences of such a fall in the real interest rate. Figure 15 exhibits this alternative scenario (based on Chaveau and Loufir, 1997), in which the real interest rate gradually falls from 5.5% in 1997 to a low of 3.8% in 2023 and then restores in order to stabilise at a level of 4.4%. In the model this time pattern for the real interest rate is implemented as an anticipated shock.

To illustrate the effects of the interest rate shock more clearly, we discuss these effects in terms of deviations of variables from their baseline path. While the public pension (AOW) system is hardly affected, the fall in the real interest rate has substantial effects on the contribution rate for supplementary pensions, which initially jumps upward by almost 8.5 percentage points (see Figure 16). The contribution rate has to be raised to match projected pension liabilities, which increase for two reasons. First, because of the fall in the interest rate, existing liabilities are discounted at a lower rate and, hence, their net present value is higher. Second, the gross wage rate, to which pension benefits are linked, rises (see below). This effect is particularly pronounced for a pension system based on final pay. The contribution rate is gradually being reduced, as the coverage gap is being closed.

The interest rate shock has substantial intergenerational redistribution effects. Those who are retired or close to retirement need to contribute at most marginally to the reduction in the coverage gap, while the younger generations or the generations that enter the labour market in the coming years have to make substantially larger contributions. In addition, the fall in the interest rate reduces non-human wealth, which in particular hits the older generations that are not too far from retirement and that have accumulated substantial equity holdings.

The decline in the real interest rate stimulates investment (see Figure 17). Wages rise and, hence, the labour supply (see Figure 18) gradually rises after an initial fall. The initial fall is caused by the reduced incentive of young households to save and, hence, to supply labour. This intertemporal substitution effect on leisure is reinforced by the expected future increase in the wage rate. The intertemporal substitution effect reverses in later years, when the labour supply rises as a result of lower wealth.

During the first decades of the next century the current account (Figure 19) shows a substantial fall, which, at its maximum, implies a current account that is more than 4.5 percentage points below its baseline outcome. This fall can be attributed to the fall in the factor income component of the current account and the diminished incentive to save. The increase in investment is thus primarily financed by foreigners.

4.2. The “grey” scenario

The model has been re-calibrated for two alternative population projections, the “grey” and the “green” scenarios (see Figure 1). As mentioned in the Introduction, the grey scenario is primarily driven by assumptions about a favourable development of life expectancy and a further reduction in fertility rates. The green scenario is based on exactly the opposite assumptions. Although none of these scenarios is particularly likely to materialise, it may nevertheless be useful to get an idea of the size of the

deviations from the baseline scenario implied by these alternative projections. In addition, when contemplating policy adjustments in response to population ageing, there could be a case for being on the "safe" side and making adjustments that are robust against the possibility that the ageing problem turns out to be worse than under the baseline projection.

The implications of the grey scenario are quite straightforward. Relative to the baseline AOW as a share of GDP rises over the entire horizon (Figure 20). By the end of the coming century it exceeds its baseline level by almost 3 percentage points. The supplementary (private) pension premium (Figure 21) initially goes up by 2.3%-points and then gradually declines and stabilises at a level that is approximately 0.6%-points above the baseline path. The initial increase in the supplementary pension premium results from a mismatch between pension assets and pension obligations. Next to the increase in life expectancy, the latter rise because the future fall in the labour supply increases the capital share in production and thus leads to a rise in wages. Because pensions are of a defined-benefit nature, pension obligations rise. The other major changes are a steady increase in the health care premium (Figure 22) and the AWBZ premium (Figure 23) over time. By the end of the coming century they exceed, as shares of GDP, their baseline projections by about 1.0%-points and 1.8%-points, respectively.

The reduced availability of labour leads to a steady fall in investment, until investment stabilises around 2050 at a level of 1.8%-points below the baseline. Relative to the baseline, national savings rise during the first three decennia and then fall again. The combination of a fall in investment and higher savings in the first half of the 21st century implies a strong improvement in the current account which deviates by a maximum of almost 3.9%-points from the baseline in 2031.

4.3. The "green" scenario

Under this scenario, the AOW as a share of GDP steadily falls over time relative to the baseline (see Figure 24), although it continues to rise in absolute terms. By the end of the coming century it is 2.7%-points below its baseline level. The (supplementary) pension premium drops by 2.4%-points initially, after which it starts rising. As is the case with AOW premia, relative to the baseline public health insurance (Figure 25) and AWBZ (Figure 26) premia as shares of GDP steadily fall over time.

Labour supply as a share of the total population jumps up initially, then falls and starts rising again around 2017 (see Figure 27). It stabilises towards the end of the coming century. Investment (Figure 28) shows a similar pattern, while national savings (Figure 29) deteriorate sharply to reach a minimum of 2%-point below their baseline level around 2030. Taking the effects on savings and investment together, it is clear that the current account (Figure 30) should deteriorate sharply. It reaches a minimum around 2030. Then the current account recovers, but it remains always at least 1.5%-point below its baseline level.

5. Alternative policy scenarios for social security

We have seen that along the baseline projection the premia for AOW, public health care insurance and AWBZ rise substantially in the coming decades. This increase in pressure from the public sector on the economy not only has important intergenerational redistributive effects (mainly from the young to the old), it also leads to efficiency losses.

In this section we therefore explore the effects of two alternative types of social security reform, both of which reduce the efficiency losses associated with the costs of population ageing. The first proposal for reform is AOW premium smoothing over time. Because the efficiency losses associated with a given premium are larger when premia are already high, premium smoothing reduces the discounted value of the efficiency losses. The second reform measure is a 10% cut in AOW benefits. The ensuing shift from public to private pension provision reduces the marginal wedge on labour income.

5.1. AOW premium smoothing

Relative to the baseline projection, AOW premium smoothing redistributes resources from current workers to future workers. Hence, the costs associated with population ageing will be more evenly spread out over the generations.
The AOW premium rate is held constant at a level of 12.6%. This is the constant rate that intertemporally balances the public pension system. It implies an initial increase of 3.4%-points relative to the baseline rate. Although the AOW premium rate is held constant through time, AOW as a share of GDP varies through time. Figure 31 depicts AOW as a share of GDP relative to the baseline. During the first two decades, AOW will remain above the baseline projection and the AOW buffer fund will be accumulating assets. After that AOW falls and stays below the baseline projection. The permanent reduction in AOW relative to the baseline is the result of two factors. First, the returns on the accumulated assets will be spread out over the entire horizon from then onwards. Second, the reduction in efficiency losses in the economy allows an additional reduction in the premium.

Premia other than AOW are hardly affected by the change in the social security system. Only the premium rate for supplementary pensions (Figure 32) initially rises by more than one percentage point. This is the result of the initial fall in the labour supply relative to the baseline (Figure 33). The fall in the labour supply narrows the base on which premia are levied. To cover their obligations, pension funds need to raise premia. The labour supply falls initially (relative to the baseline) because of the rise in the tax and premium wedge. The increase in this wedge falls over time, resulting in a recovering of the labour supply.

National savings (Figure 34) as a share of GDP are almost unaffected in the coming first decade. Although the AOW premium and the supplementary pension premium increase, which in itself boosts national savings, these effects on national savings are to a large extent offset by a fall in private savings. The fall in premia in the

future boosts the labour supply and, hence, saving. After 2007, national savings rise steadily relative to the baseline projection up to a maximum of almost 4.5%-points above the baseline. Similarly, the current account (Figure 35), which worsens initially relative to the baseline, improves until it reaches a maximum in 2037 of more than 5%-points above the baseline.

5.2. A reduction in AOW benefits

Under this scenario, we assume a 10% reduction in AOW benefits. Relative to the baseline, the fall in AOW as a share of GDP increases from 0.57 percentage point in 1999 to approximately 0.92 percentage point (see Figure 36). The reduction in the AOW premium is to some extent replaced by an increase in the premium for supplementary pensions (see Figure 37). However, the supplementary pension premium is less distortionary than the AOW premium, because, in contrast to AOW benefits, the size of the future pension benefits is directly related to the premium payments. The supplementary pension premium rises because households with productivity above the franchise level are compensated for the fall in AOW benefits by an increase in supplementary pension benefits. The resulting discrepancy between the pension fund's projected benefit obligations and its assets has to be closed by an increase in the supplementary pension premium. This premium increase diminishes over time, as the gap between obligations and assets is reduced.

The lower AOW premium reduces the marginal wedge for workers and thus stimulates the labour supply (Figure 38), although the effect is not large. The increase in the labour supply reduces wages and stimulates investment (which mitigates the fall in wages). The pension reform benefits the current and future young generations. These generations all profit from the reduced deadweight loss. However, the current old generations lose from the reform. As they are exempt from AOW premium payments, they do not benefit from the fall in the AOW premium. Yet, their pension income falls because it is tied to a wage rate which is below its baseline level. In addition, households that have productivity below the franchise level, receive lower AOW benefits. Figure 39 displays for several productivity types the percentage increase in the remaining lifetime wealth that is needed to bring a generation's utility back to its baseline level.

5.3. A reduction in AOW benefits combined with a fall in the real interest rate

Here we combine a 10% reduction in AOW benefits with the interest rate shock discussed in the previous section. Not surprisingly, the new paths for the budgetary and economic variables are in between the outcomes that are obtained when each deviation from the basic scenario is considered in isolation. Relative to the baseline, AOW as a share of GDP (Figure 40) falls during the first decades and then recovers partly. As far as the supplementary pension premium is concerned, the two variations on the baseline scenario strengthen each other. The supplementary pension premium (Figure 41)

exceeds its baseline level by 8.7 percentage points in 1999 and then gradually falls to its long-run level of approximately 2% points above its baseline value.

6. Conclusions and directions for further work

In this report, we have explored the budgetary and economic consequences for the Netherlands of the ageing population. The analysis has largely been conducted under the assumption that existing institutions and provisions remain unaltered. Projections of the CBS show that, along the baseline, the dependency ratio of the number of people of 65 and older and the number of 20 – 64 year old rises from 22% in 1999 to a peak of approximately 43% in 2038. This increase in the relative number of elderly has substantial consequences for the AOW, public health insurance and AWBZ, whose shares of GDP rise by 5.1, 1.3 and 2.1 percentage points, respectively, between now and their peaks in the next century (under the baseline scenario). Tables 2a – c summarise the numerical consequences of the population projections for the various premium rates. The changes in the premium rates translate directly into the marginal wedge. Hence, they give an indication of how the incentive to supply labour changes as a result of the costs associated with population ageing.

Not only have we analysed the consequences of population ageing under the baseline scenario, we have also explored a number of variants: a fall in the real interest rate, a grey population variant, a green population variant, AOW premium smoothing and a partial shift from public to private pensions. The analysis of AOW premium smoothing makes clear that, even though AOW premium smoothing may be efficiency improving, it may take a long time before the benefits from such a switch materialise. The reason is that initially the switch to a constant AOW premium slows down the economy, as the increase in the tax and premium wedge discourages labour supply. Because it takes so long before the benefits can be reaped, the implementation of such a type of reform should not be delayed for too long.

Although the model that underlies the simulations is rich in institutional detail and thoroughly microfounded, a number of elements whose relevance is directly related to the population ageing is missing. In particular, unemployment or non-participation in the labour market are the outcomes of carefully chosen time profiles for the preference parameters rather than the result of institutional features or frictions. The next step in this research project is therefore to extend the model in such a way that unemployment and labour market participation are directly related to these factors.

With this extension the model can be used to explore three possible avenues to deal with the costs of population ageing. The first is to investigate policy alternatives that stimulate labour market participation. A second avenue is to reconsider existing provision levels, for example a reduction in AOW benefits, a gradual increase in the pension age or a gradual shift from AOW to a more funded system. Finally, and in as far the other measures are not sufficient, there could be the possibility of additional saving (at the public level) to bear the costs of population ageing.

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Appendices

The model

This appendix briefly describes the model that has been calibrated to obtain the numerical results. The model is developed in Broer (1999). This Appendix draws rather heavily on the model description in his paper. For technical details we refer therefore to Appendix 1 in Broer (1999).

There are eight sectors and four markets in the model. The sectors are households, private enterprises that produce tradeables, private health insurance firms, a health care sector, public health insurance (basic health care and AWBZ), a pension sector (basic and supplementary pensions), a government sector and a foreign sector. The markets are the labour market, the tradeable goods market, the market for health care and the capital market. Wages and the price for health care are domestically determined, while the prices for tradables and capital are determined on world markets. Labour is perfectly mobile across sectors, but not across borders. Financial capital is perfectly mobile internationally. Furthermore, all assets (private and public bonds and equity) are perfect substitutes.

Other features of the model include, first, the presence of both inter- and intragenerational heterogeneity. More specifically, individuals differ in terms of age and productive skills. Second, productive skills are age-dependent, thus giving rise to a non-constant age-wage profile. Third, health care is age-dependent. Finally, the model is calibrated on a non-steady-state demographic projection of population growth.
Firms in the tradable goods sector maximise the discount sum of net (of taxes and premia) dividend income. Changes in the capital stock are subject to adjustment costs. Firms issue debt in fixed proportion to the value of their capital, so that the marginal source of finance is retained earnings. The production function is characterised by a two-layer (nested) constant-elasticity-of-substitution (CES) structure. The first layer is a CES function of raw materials and value added. The second layer is a CES function of capital and (effective) labour. Domestically- produced tradables are perfect substitutes of foreign goods. Although workers differ by age and skill type, all sources of labour input are perfectly substitutable. Finally, technological progress is purely labour augmenting.
The demography is characterised by an overlapping generations structure. Each household/individual has an age-dependent probability of dying in a given period. These probabilities are directly computed from the year-to-year transition matrices of the age-specific population shares in the total population projections. Households maximise their expected lifetime utility over the consumption of goods, health care and leisure, subject to their lifetime budget constraint and a constraint for the available amount of time in each period. The period utility index is characterised by a two-layer (nested) CES structure. The upper tier is a CES function of tradables consumption and consumption of a composite commodity, which is written as a CES function of leisure and health care (the lower tier). The utility parameters regulating the (intratemporal) trade-off among tradables, leisure and health care consumption depend on individuals'

age and on the state of the technology. The age-dependency of these parameters is needed to mimic the retirement decisions of the elderly and to allow the demand for health care to rise with age. The main characteristic of health care is that it is time consuming. Households insure themselves against their death risk, by leaving their remaining assets to an insurance company that pays them a return on their assets as long as they are alive. In terms of the taxes and premia they have to pay, we need to distinguish households along the following dimensions: young and old (i.e., they have pension income), whether they are covered by public or private health insurance (public insurance is mandatory below a certain income level) and whether they accumulate supplementary pensions (high income) or not (low income).

The health care sector produces both regular health care and AWBZ care. The sole input is labour of different skill types applied in fixed proportions. Due to perfect labour mobility, wages equal those in the tradables sector, for any specific productivity type.

The private health insurance sector produces services with labour as the sole input. Only households with a wage rate above a certain threshold level are privately insured. The private health insurance sector operates on a pay-as-you-go basis: in each period, aggregate premium revenues equal reimbursements for health care consumption and wage outlays for those employed in this sector. Budgetary equilibrium determines the fixed insurance premium for each household.

Public health insurance is compulsory for households with a wage below a certain threshold.[10] Like the private insurance sector, this sector operates on a pay-as-you-go basis. The sources of revenues are income-related premium payments, a fixed contribution for each insured household, a contribution from private health insurance firms (MOOZ) and a government subsidy. Outlays consists of reimbursements for costs of health care consumption and compensation for labour (the only input). Budgetary equilibrium determines the level of the income-related premium.

The AWBZ scheme provides coverage for special health care expenditures. Demand for these services is assumed to be proportional to the demand for other health care services. Operating costs consist of labour costs. The AWBZ premium is set so as to equalise premium revenues and the sum of reimbursements and operating costs.

The pension sector is structured as follows. First, there is a basic pay-as-you-go (PAYG) scheme that pays out a constant benefit to anyone who is 65 years or older. Revenues consist of premia levied on labour and capital income of young households. Benefits are determined by the requirement that the current net benefit be proportional to the current net (average) wage rate. The proportionality factor is the “social security replacement ratio”. Second, there is a supplementary pension scheme to which households only contribute if their income exceeds a certain franchise level.[11] Pension

[10] In contrast to reality, this threshold is based on the hourly wage rate (i.e., the skill level) of individuals. This avoids jumps in the individuals’ budget constraints and thus simplifies the optimisation of individual decisions.

[11] In contrast to reality, the franchise level is based on the hourly wage rate (i.e., the skill level) of individuals.

fund regulations require that projected benefit obligations (the discounted sum of all future pension benefits of all those that are eligible) be covered by the funds' assets. This determines the premium for supplementary pensions. Any discrepancy between projected pension benefits and accumulated assets has to be closed at certain speed through adjustment of the pension premium.

The productive activities of the government consist of education and general government. Both activities require only labour, in fixed proportions per skill type, as input. The amount of education to be provided for a given household is exogenous, but age dependent. Labour input required for general government is proportional to the population size. Other expenditure categories for the government are interest payments on public debt, disability insurance payments, transfers to households, transfers to foreigners and the public health insurance subsidy. Disability insurance payments depend on the (exogenous) age-disability profile. The public health insurance subsidy is proportional to reimbursements for health care by the public health insurance sector. Transfers to households are linked to population size and net wages, while transfers to foreigners are linked to population size and productivity growth. On the revenue side the government disposes of income taxes (labour income, interest income and dividend), indirect taxes and corporate taxes.

Finally, there is the foreign sector. Net foreign assets equal the present value sum of differences between net exports and net foreign transfers.

B. Calibration of the model

The model has been calibrated to the National Accounts of 1997. Except for population growth (and the real interest rate in two instances), the calibration uses a steady-state growth path for all exogenous variables for the period after 1997. Population growth is based on the demographic projections of Statistics Netherlands (CBS), which run until 2100. The simulations of the model are run until 2200 (in order to attain a steady state), under the assumption that the population composition remains constant as of 2101. In all the simulations, the income tax rate is used as the variable that closes the government budget. Mortality rates (used in the weighting of future expected utility flows) are derived from the CBS population projections.

The population projections are the result of five basic factors:[12] the current population composition, the (projected) fertility rate of women (i.e., the average number of children given birth to by a female), (projected) life expectancy and (projected) immigration and emigration flows. A higher fertility rate implies a younger, faster-growing population, while a longer life expectancy implies a population with relatively more elderly people. The effects of migration are more ambiguous, although the average immigrant is younger than the average person in the total population. Hence, more immigration dampens population ageing. More

[12] A more detailed description of the factors that drive the population forecasts can be found in De Beer, 1999, and Beetsma and De Beer, 1999.

emigration also reduces the seriousness of population ageing, because a lot of emigrants are elderly nonresidents who return to their home country.

The specific pattern of the projected dependency ratio in the base case scenario (Figure 1) is the result of the babyboom in the beginning of the 1950s of this century (which causes the peak towards the end of the third decade in the next century), a structurally high life expectancy and a structurally low fertility rate.

The baseline projection assumes an average of 1.7 children per woman in the next century. As a result of further improvement in working and living conditions and medical progress, life expectancy is assumed to increase further in the next century, although the speed at which it improves will diminish. Immigration will remain stable, assuming that enhanced migration pressure and more restrictive admission policies will approximately offset each other.

Not surprisingly, the baseline population projections are surrounded by a lot of uncertainty, especially those projections that are further ahead into the future. Therefore, we also explore the consequences of two alternative population projections. The “grey” variant assumes relatively low future fertility rates and a relatively favourable development of future life expectancies. By way of contrast, the “green” variant assumes relatively high fertility and relatively low life expectancy. These two scenarios are rather extreme and, hence, actual developments will most likely remain between these two alternatives.

Values of Important parameters

Preferences:

Rate of time preference	= 2% (a year)
Elasticity of substitution between tradables and leisure/health care index	= 0.66
Elasticity of substitution between leisure and health care	= 0.65
Intertemporal elasticity of substitution	= 0.25

Technology:

Labour saving technological progress	= 2% (a year)
Technical depreciation rate of capital	= 11.5%(a year)
Cost share of capital in tradables	= 36.3%
Cost share of labour in tradables	= 38.8%

Cost share of raw materials in tradables	= 24.9%
Elasticity of substitution between raw materials and value added in tradables	= 0.5
Elasticity of substitution between capital and labour in tradables	= 0.5

Institutions:

Fiscal depreciation rate of capital	= 5.5% (a year)
Fiscal lifespan of capital goods	= 13 years
Number of years between entering labour force and entitlement basic pension	= 47
AWBZ expenses as fraction of health consumption	= 0.77
Dividend tax rate	= Tax rate on labour income
Tax rate on capital gains	= 0%
Consumption tax rate	= 25%
Tax rate on interest income households	= 0.5 * Tax rate on labour income
Maximum total pension benefits	= 70% of final pay

Other:

Real interest rate (baseline)	= 5.5%
Debt/capital ratio (in tradable goods sector)	= 0.5
Maximum lifespan individual	= 100 years

Tables

Table 1: Bases on which taxes and premia are levied

Tax/premium rate:	Base:
Capital gains tax	Capital gains
Dividend tax	Dividends
Interest income tax	Interest income
AWBZ-premium	Dividend income, interest income, labour income, AOW, supplementary pension, age-dependent transfers
Labour income tax	Labour income, AOW, supplementary pension, age-dependent transfers
Public insurance premium	Labour income*, transfers*, AOW*, supplementary pension*
Public pension premium	Dividends, interest income**, labour income**
Supplementary pension premium	Labour income ***
Consumption tax	Tradable goods consumption

* = only for those with skill level below threshold ("Ziekenfondsgrens")
** = only for interest income of those under 65 years
*** = for all incomes above franchise level

Table 2a: AOW premium rate in various years and across various scenarios

Scenario:	1999	peak (year reached)	2100
Baseline	9.2%	16.5% (2035)	15.6%
Interest rate shock	10.1%	17.1% (2037)	16.1%
Grey	9.4%	20.1% (2100)	20.1%
Green	8.9%	14.4% (2036)	11.5%
AOW premium smoothing	12.6%	12.6% (all years)	12.6%
Reduction in AOW benefits	8.4%	15.1% (2037)	14.2%
Reduction in AOW benefits plus interest rate shock	9.2%	15.6% (2037)	14.7%

Table 2b: Public health care premium rate in various years and across various scenarios

Scenario:	1999	peak (year reached)	2100
Baseline	5.6%	8.0% (2041)	7.7%
Interest rate shock	5.9%	8.0% (2043)	7.7%
Grey	5.7%	9.9% (2086)	9.9%
Green	5.5%	7.0% (2036)	6.2%
AOW premium smoothing	5.8%	7.8% (2047)	7.6%
Reduction in AOW benefits	5.6%	8.0% (2043)	7.7%
Reduction in AOW benefits plus interest rate shock	5.9%	8.0% (2043)	7.7%

Table 2c: AWBZ premium rate in various years and across various scenarios

Scenario:	1999	peak (year reached)	2100
Baseline	4.3%	5.7% (2044)	5.6%
Interest rate shock	4.7%	6.0% (2043)	5.9%
Grey	4.4%	6.8% (2100)	6.8%
Green	4.2%	5.2% (2042)	4.8%
AOW premium smoothing	4.4%	5.6% (2048)	5.5%
Reduction in AOW benefits	4.3%	5.7% (2044)	5.5%
Reduction in AOW benefits plus interest rate shock	4.7%	6.0% (2044)	5.9%

Figures

Figure 1: Dependency ratio of number of 65 years and older divided by number of 20 - 64 years old.

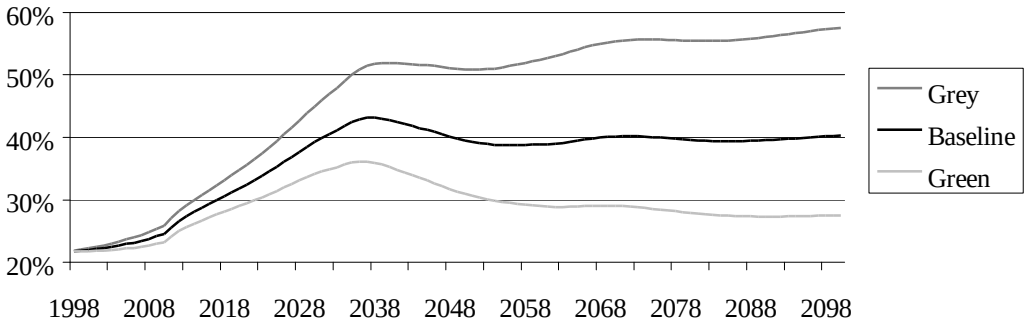

Figure 2: Labour supply as a share of the total population (baseline)

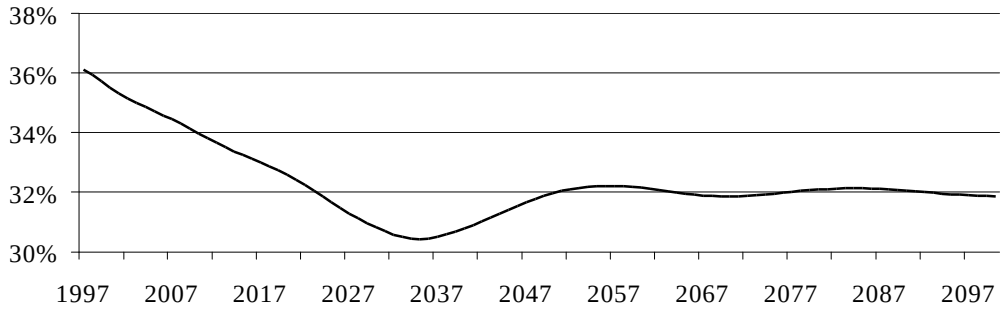

Figure 3: Labour supply (in full-time equivalents) as a share of 18-64 years old (baseline)

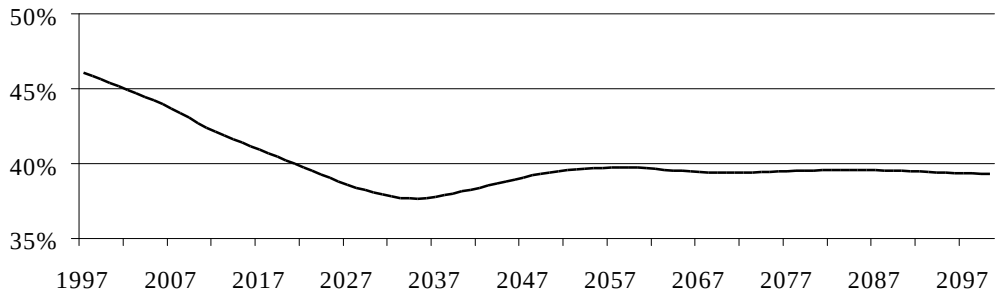

Figure 4: AOW as a share of GDP (baseline)

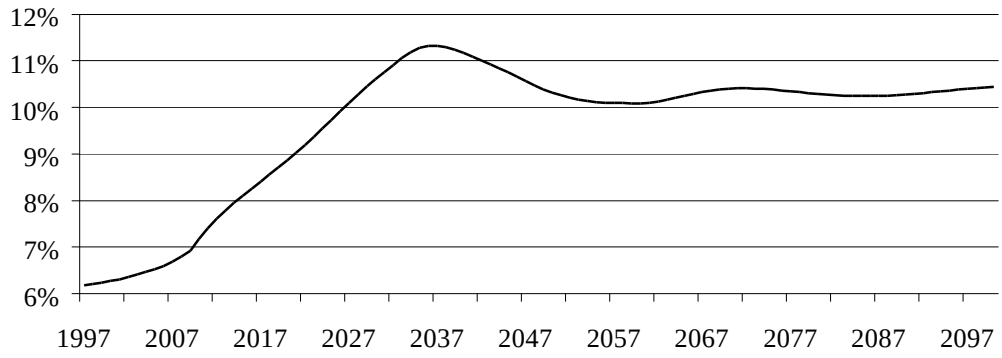

Figure 5: public health insurance as a share of GDP (baseline)

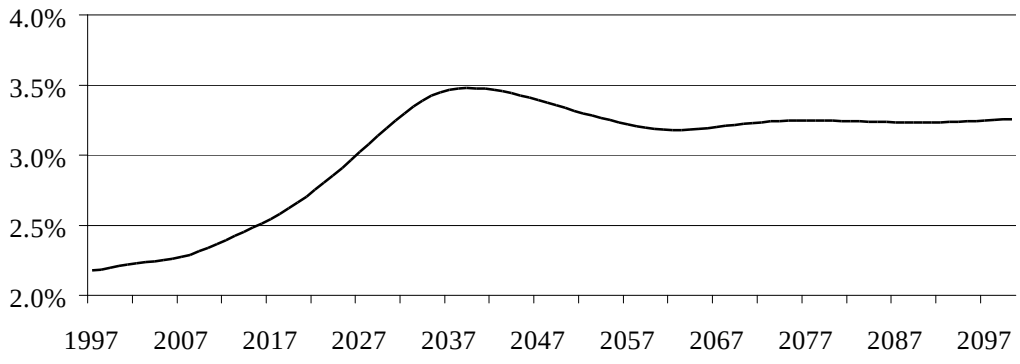

Figure 6: AWBZ as a share of GDP (baseline)

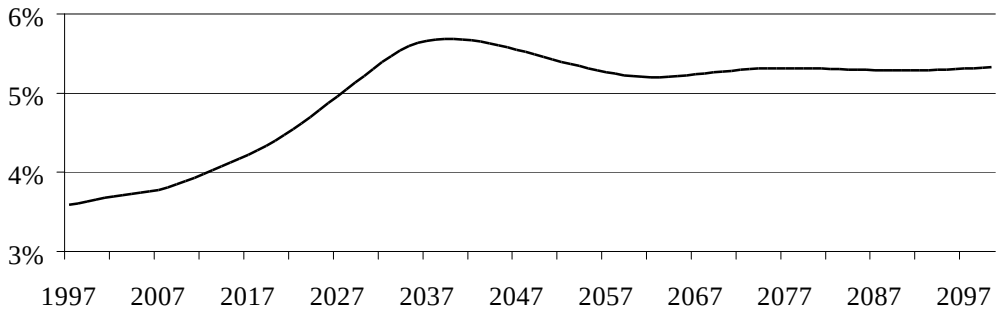

Figure 7: Supplementary pension premium (baseline)

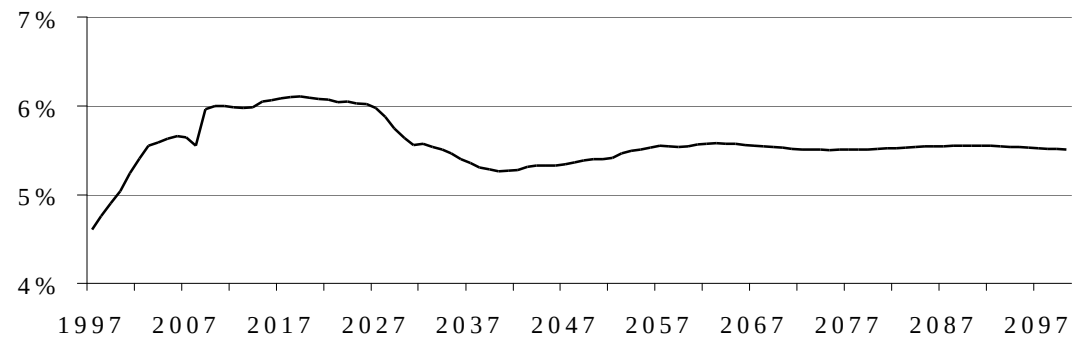

Figure 8: Total taxes as a share of GDP (baseline)

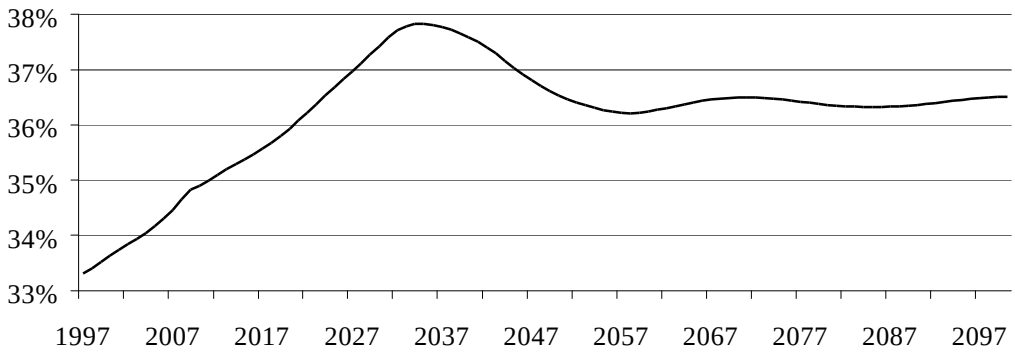

Figure 9: taxes plus premia as a share of GDP (baseline)

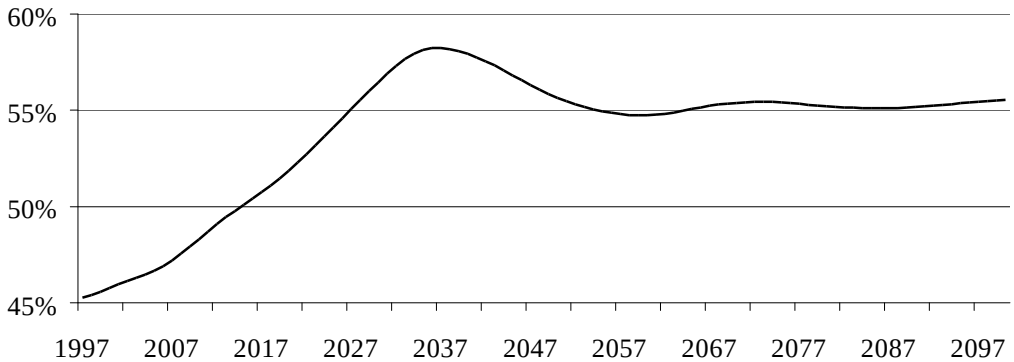

Figure 10: National savings as a share of GDP (baseline)

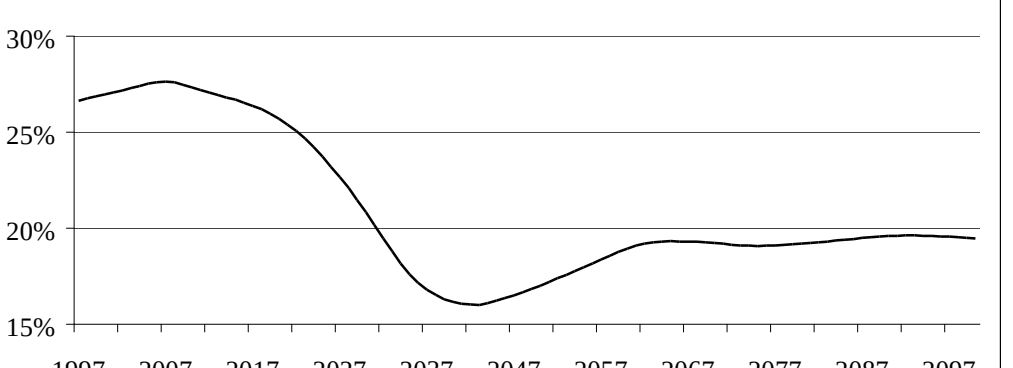

Figure 11: Investment as a share of GDP (baseline)

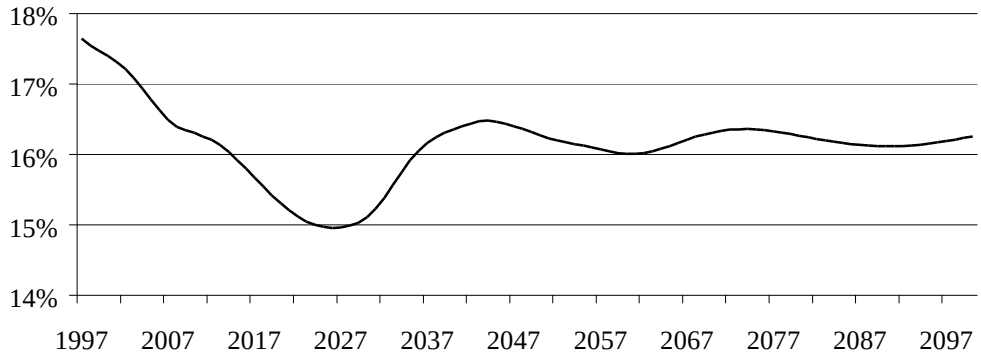

Figure 12: Current account as a share of GDP (baseline)

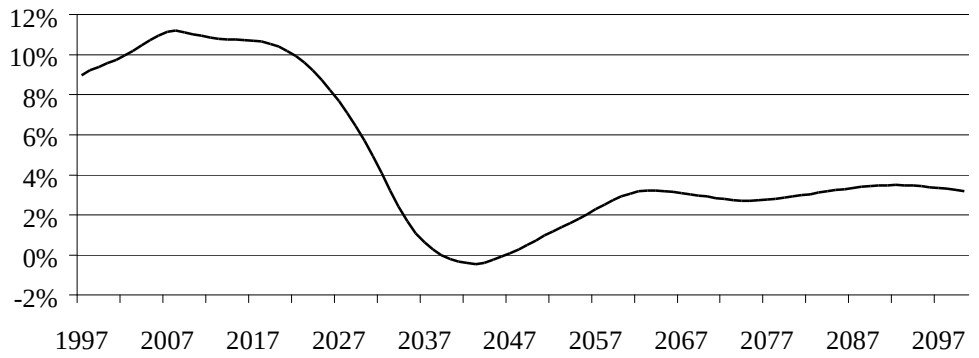

Figure 13: GDP growth rate (baseline)

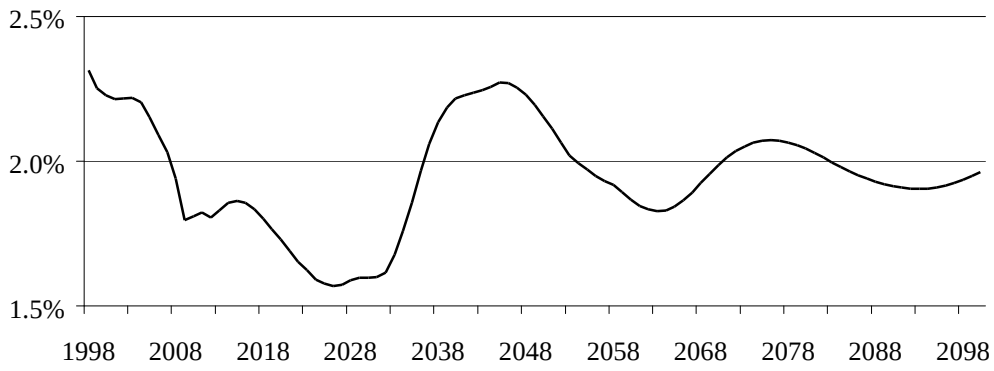

Figure 14: Relative compensating variations average productivity type (baseline)

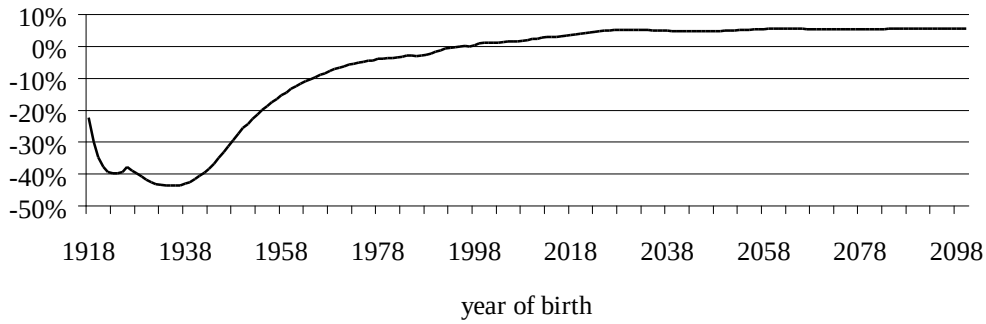

Figure 15: Real interest rate (alternative projection)

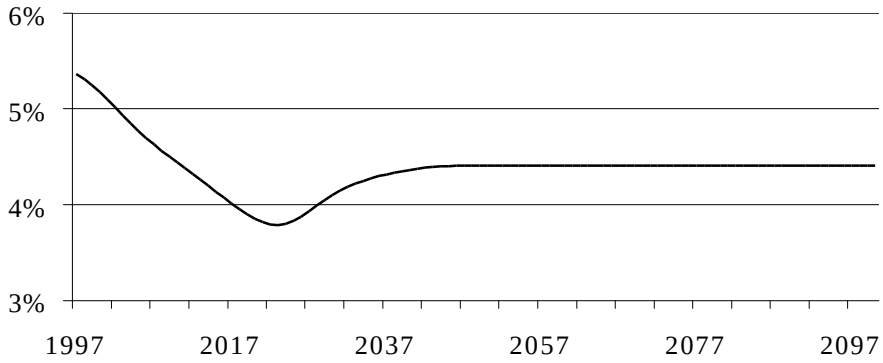

Figure 16: supplementary pension premium (fall in real interest rate)

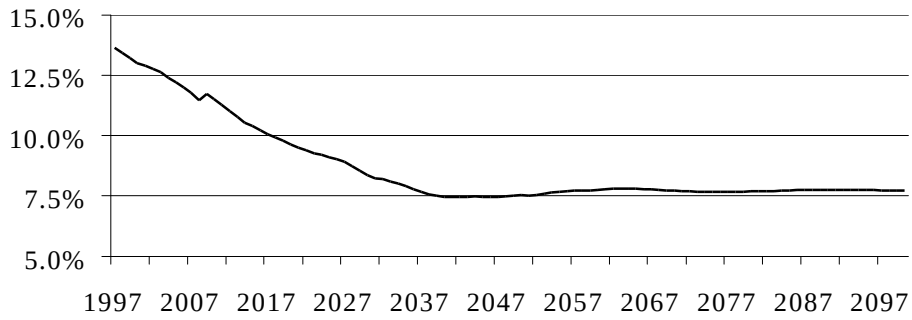

Figure 17: Investment as a share of GDP
(fall in real interest rate)

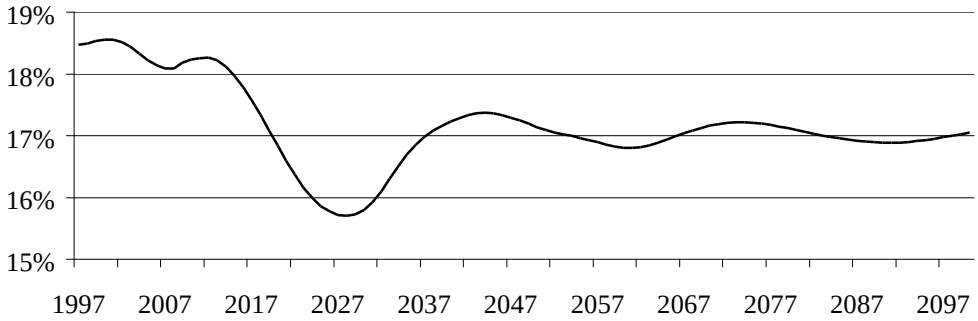

Figure 18: Labour supply as a share of 18-64 years old
(fall in real interest rate)

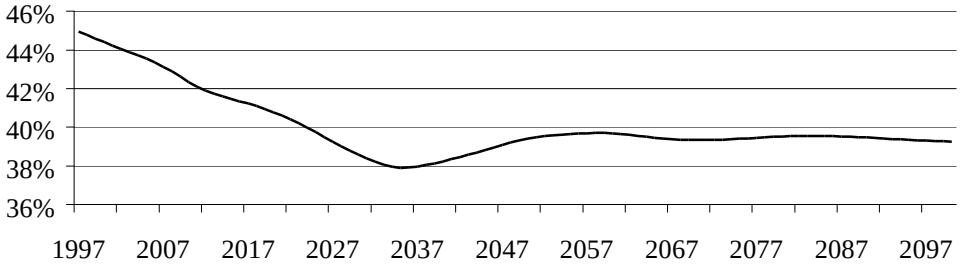

Figure 19: Current account as a share of GDP
(fall in real interest rate)

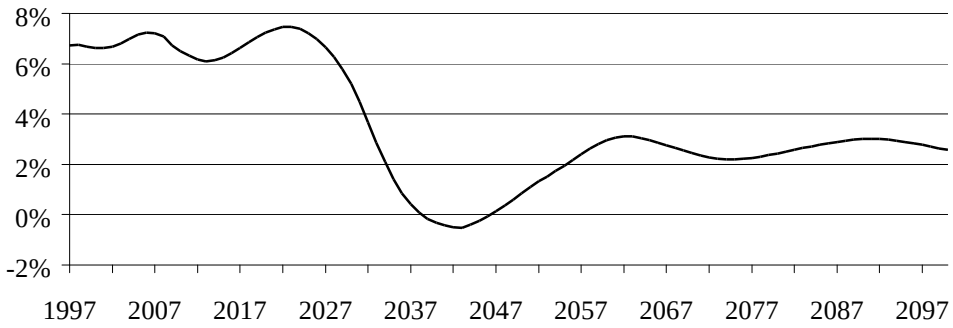

Figure 20: AOW as a share of GDP
(grey scenario; dev. from baseline)

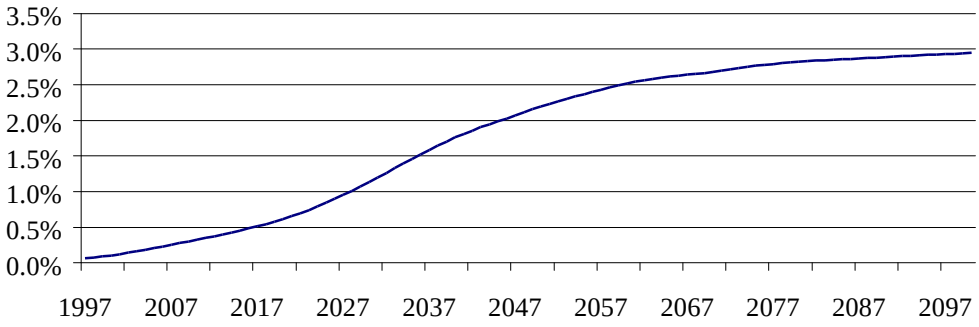

Figure 21: supplementary pension premium
(grey scenario; dev. from baseline)

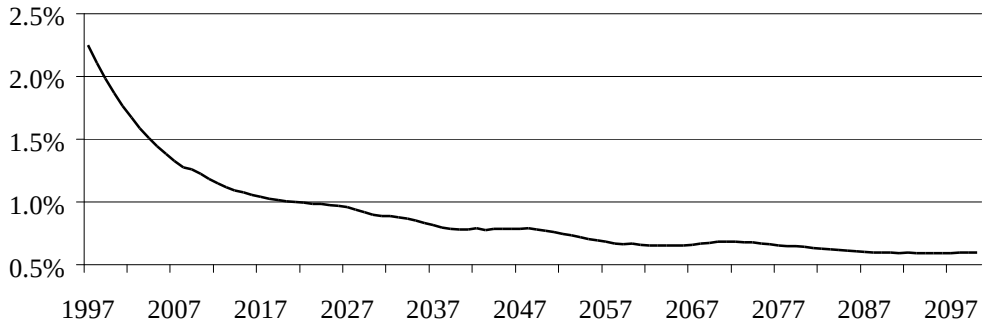

Figure 22: public health care premia as a share of GDP
(grey scenario; dev. from baseline)

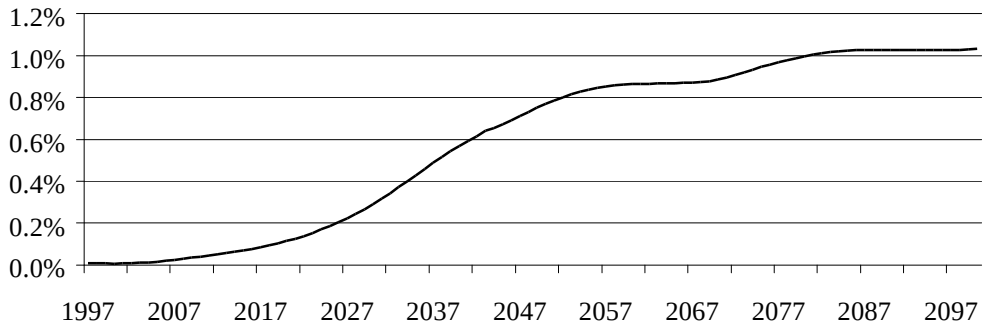

Figure 23: AWBZ as a share of GDP
(grey scenario; dev. from baseline)

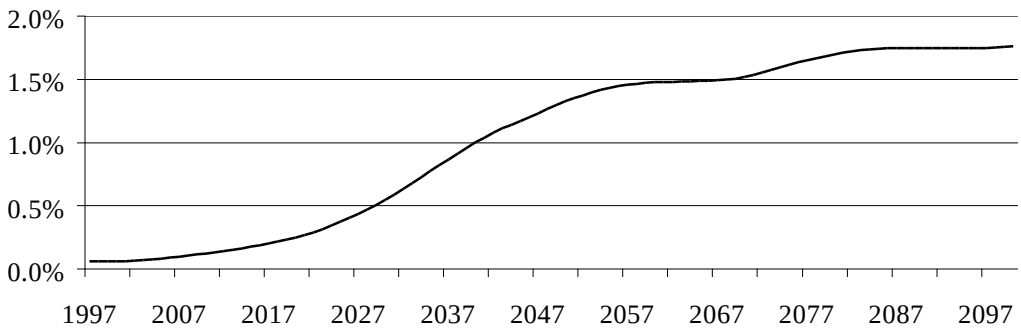

Figure 24: AOW as a share of GDP
(green scenario; deviation from baseline)

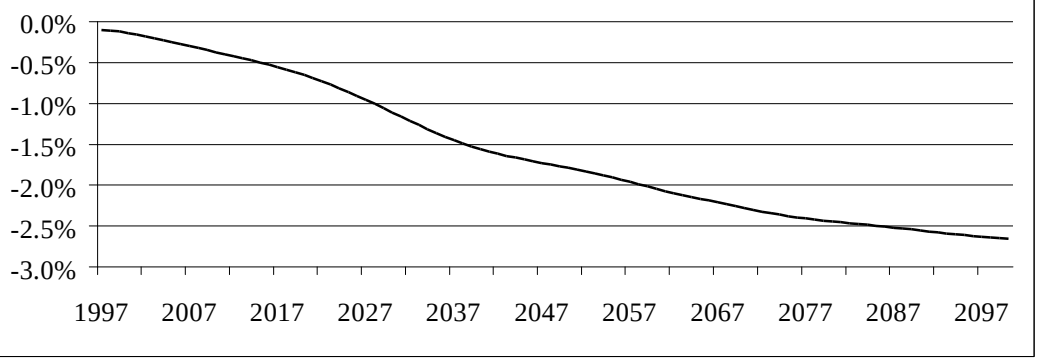

Figure 25: public health care premia as a share of GDP
(green scenario; deviation from baseline)

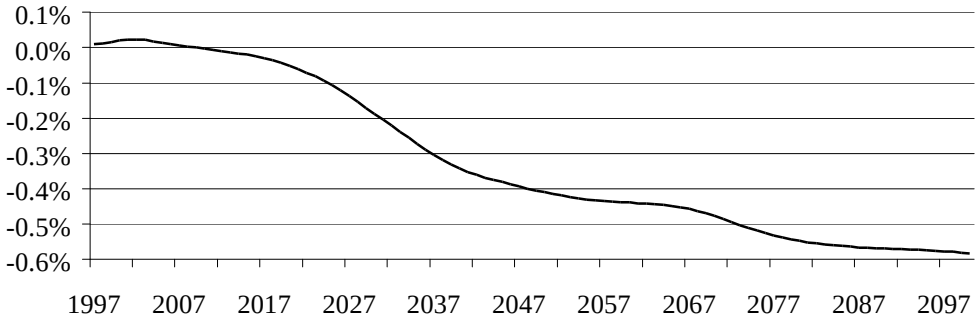

Figure 26: AWBZ as a share of GDP
(green scenario; deviation from baseline)

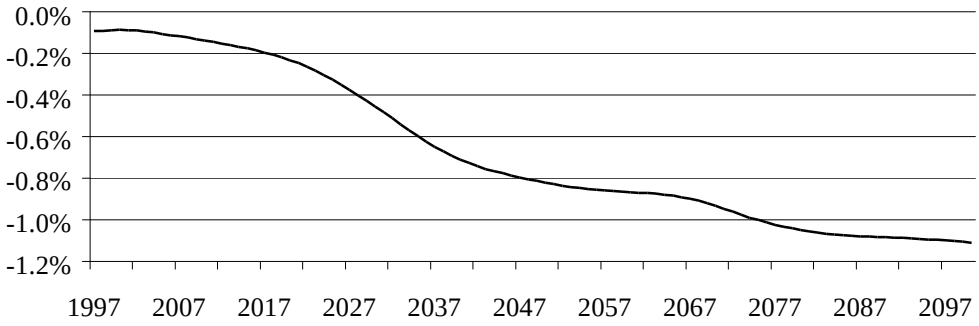

Figure 27: labour supply as a share of 18-64 years old (green scenario; dev. from baseline)

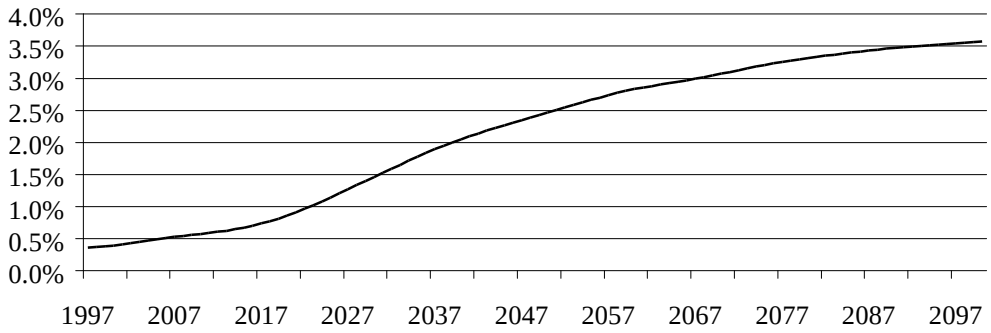

Figure 28: Investment as share of GDP (green scenario; deviation from baseline)

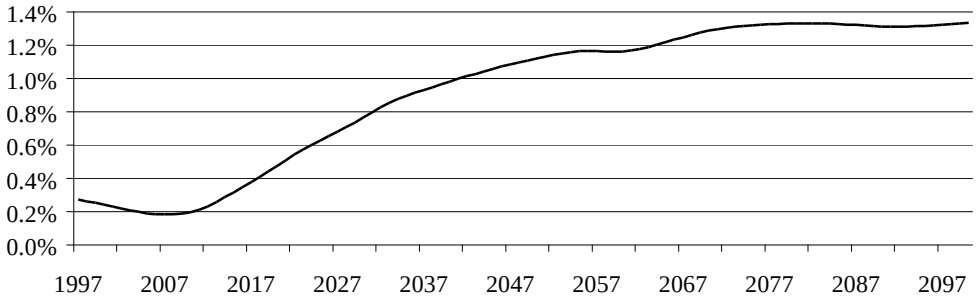

Figure 29: National savings as share of GDP
(green scenario; dev. from baseline)

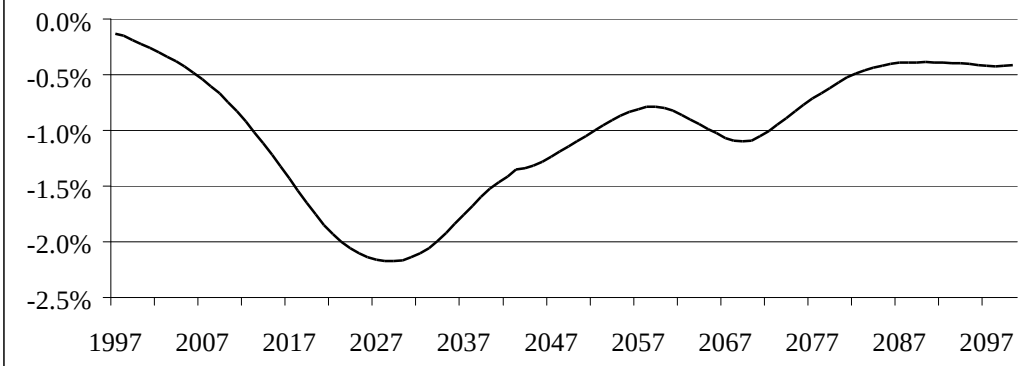

Figure 30: Current account as share of GDP
(green scenario; deviation from baseline)

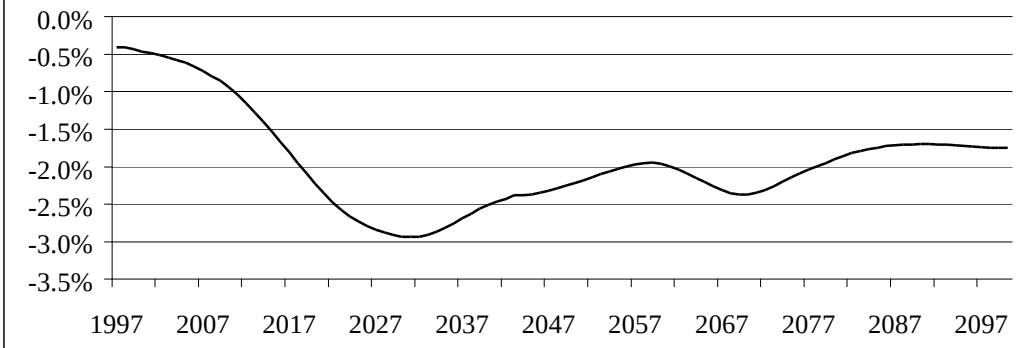

Figure 31: AOW as a share of GDP
(AOW premium smoothing; deviation from baseline)

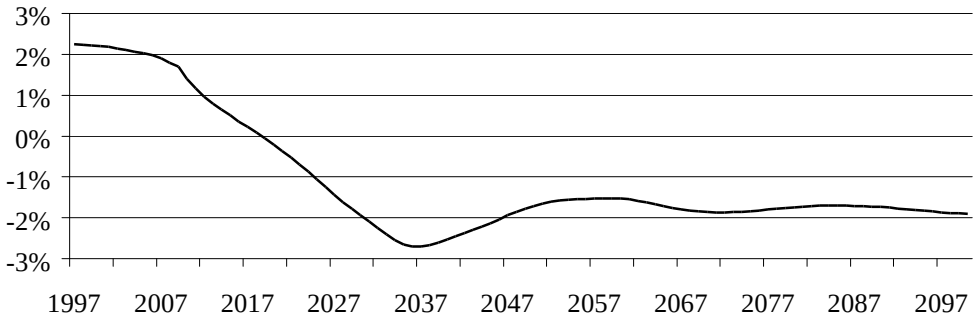

Figure 32: supplementary pension premium
(AOW premium smoothing; deviation from baseline)

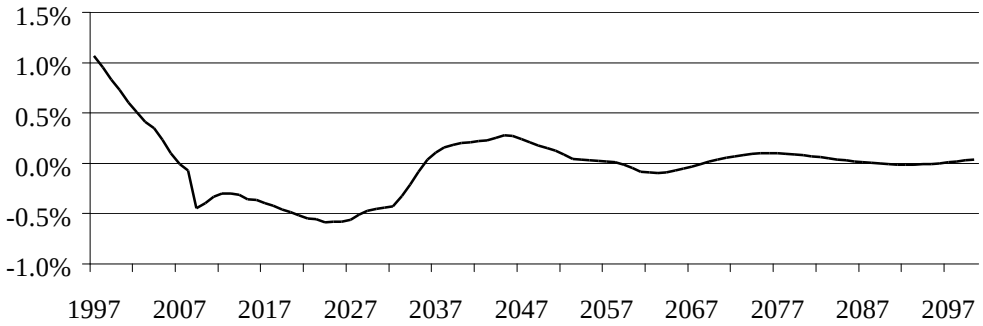

Figure 33: labour supply as share of 18-64 years old
(AOW premium smoothing; deviation from baseline)

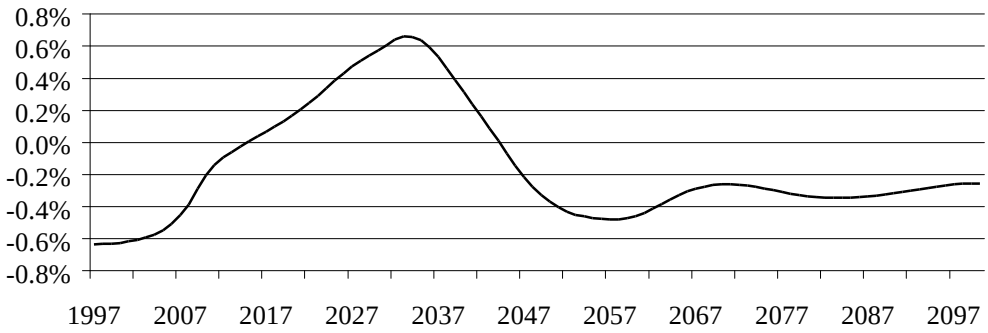

Figure 34: National savings as share of GDP
(AOW premium smoothing; deviation from baseline)

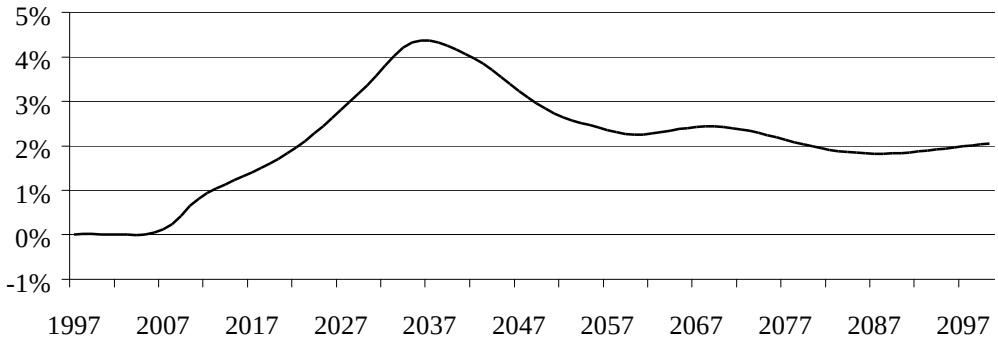

Figure 35: Current account as share of GDP
(AOW premium smoothing; deviation from baseline)

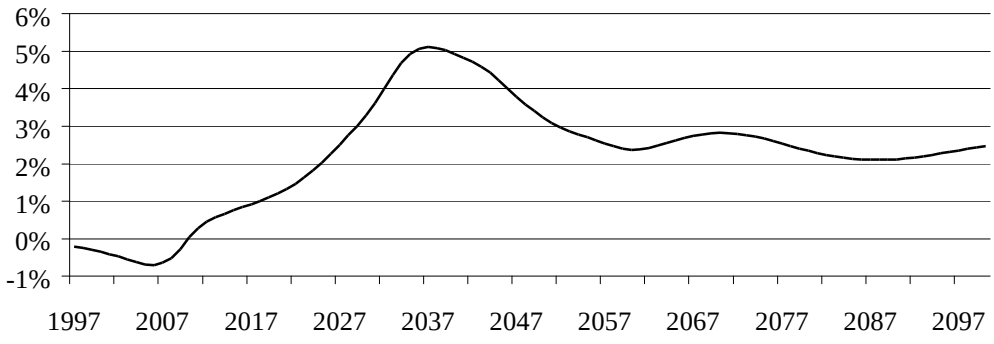

Figure 36: AOW as a share of GDP
(transition scenario; deviation from baseline)

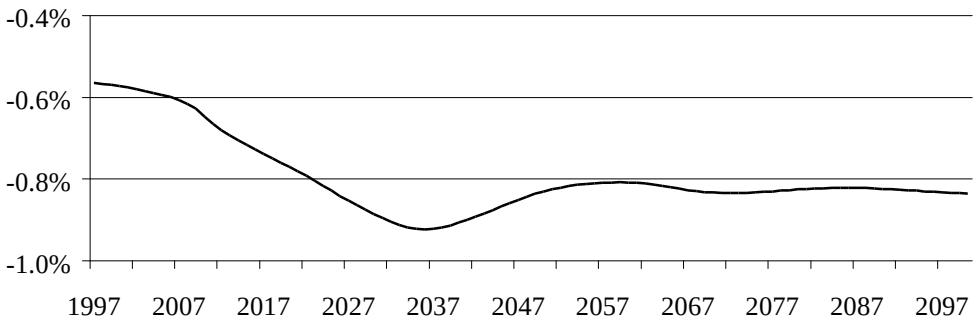

Figure 37: supplementary pension premium
(transition scenario; dev. from baseline)

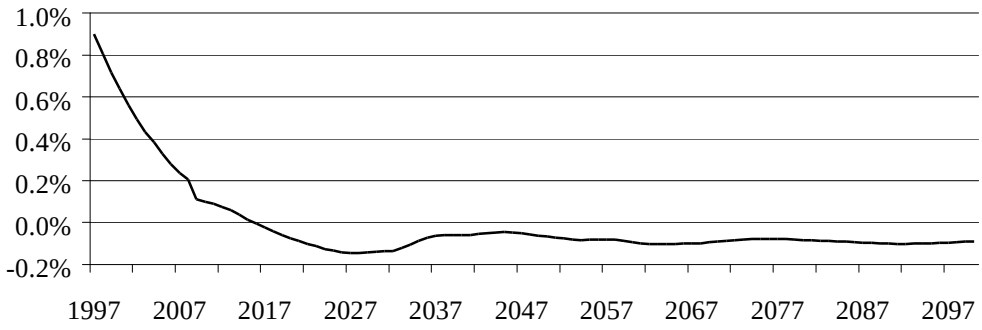

Figure 38: labour supply as a share of 18-64 years old
(transition scenario, dev. from baseline)

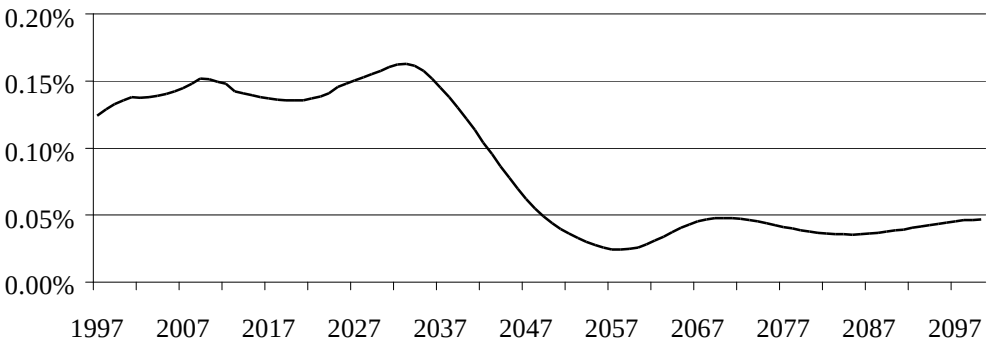

Figure 39: Relative compensating variations different productivity types (transition scenario)

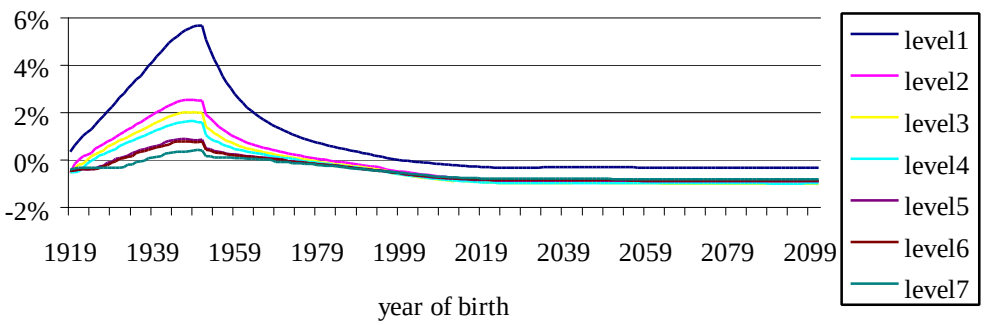

Figure 40: AOW as a share of GDP (transition scenario + int. rate shock; dev. from baseline)

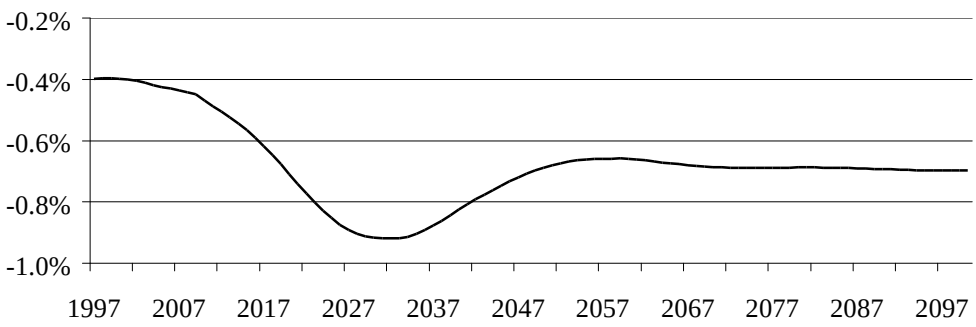

Figure 41: supplementary pension premium (transition scenario + interest rate shock; dev. from baseline)