

PALMNET:
A Pension ASSET and Liability Model for the Netherlands *

Maarten van Rooij, Arjen Siegmann and Peter Vlaar**

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Abstract

This study presents a pension model geared to the typical pension contract in the Netherlands. It is based on a defined benefit/average earnings pension system. Nominal benefits are guaranteed and indexation is intended. The model provides a framework for analysing adjustments to such factors as the asset mix, retirement age, returns and the method of discounting, premium setting and indexation. The importance of uncertainty over interest rate movements and returns on shares is made explicit by means of stochastic and historical simulations. In this, PALMNET differs from existing, often deterministic pension models. The main findings are, first, a wage-indexed defined benefit pension is still affordable despite the current shortfall of wealth of pension funds. Second, fair value accounting considerably increases the volatility of pension premiums. Third, reducing risks by adjusting the asset mix towards more bonds is costly in terms of average premiums, but reduces the volatility. These conclusions are based on realistic to conservative assumptions regarding returns and risks.

Keywords: Actuarial pension model; Monte Carlo simulation; historical simulation

J.E.L. Code: C15, C59, G23, J18

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**Corresponding author: De Nederlandsche Bank, Research Department, P.O. Box 98, 1000 AB Amsterdam, The Netherlands, tel: +31 (0)20 524 3189, e-mail: p.j.g.vlaar@dnb.nl.

1 INTRODUCTION

The Dutch pension sector seems to be in deep crisis currently. Pension fund assets fall far short of target levels at which an indexed pension can be promised at all times with a high degree of certainty. In other words, the cover ratio, i.e. the ratio between the pension capital and the provision for pension liabilities, is far below the target ratio. There are several reasons for this situation. First, in the 1990s pension funds increasingly concentrated on equity investments. The escalating returns on shares during that period caused pension fund cover ratios to soar, so that pension premiums were cut to well below break-even level. The stock market crash at the turn of the century exposed the downside of equity investments, namely the higher risks. A second cause of the funding shortfall is the gradual decline in bond yields from the early 1990s onwards. Since the future pension liabilities had been discounted at a fixed actuarial interest rate of 4% from as long ago as October 1969, the high nominal interest rate of the early 1990s meant that pension funds had large hidden reserves. Those reserves were used partly to link nominal pension entitlements to wage inflation. Now that interest rates have dropped to around 4%, those hidden reserves have vanished, so that the implicit buffer for indexation has been wiped out. To some extent, this decline in the hidden reserves has been offset by lower wage inflation and hence a reduced need for indexation. However, the real interest rate has also fallen; so far this has not led to any adjustment in the discount rate for pension liabilities, but that is bound to happen. The fixed actuarial interest rate method is being replaced by a fair value accounting method in which pension liabilities are calculated on the basis of current bond yields. According to the Pensions Advisory Commission CPB/DNB/PVK (2003), at the end of 2002 the assets of the average pension funds still covered only 75% of the indexed pension liabilities on the basis of this method.

In a letter to the pension funds in September 2002 the PVK [Pensions and Insurance Supervisory Authority of the Netherlands] outlined a pension capital restoration scheme. Examples of possible measures which could aid the restoration are in increase in pension premiums, incomplete indexation of pensions or modifications to pension schemes (e.g. switching from a final salary to an average earnings system). The PVK's letter distinguishes between the situation of acute shortfall of cover (cover ratio below 105%) and cover which falls short of a particular target level, set partly according to the extent to which pension funds invest in equities. Instances of acute shortfall of cover are expected to be rectified within a year, while recovery plans spread over a number of years could be submitted for building up buffers tailored to particular situations.

In the run-up to a government decision on the regulation of financial supervision of pension funds in the Pensions Act [*Pensioenwet*], this triggered a public debate on the desirable level of the target cover ratio (depending on the degree of security that should be offered to pensioners) and the length of the recovery period. The government's decision, hereinafter "Outline Agreement" (Ministry of Social Affairs and Employment, 2004), gives a broad description of the arrangements for the financial

supervision of pensions funds, arrangements which are to form the basis of the new Pensions Act. The government stresses that pension fund members must be able to rely on a high level of security, and also focuses on the specific long-term orientation of pension funds and the negative prosperity effects of sharp fluctuations in pension premiums. This is reflected in the choice of a maximum recovery period of fifteen years and a security benchmark of 97.5%, i.e. in normal circumstances, the risk of a fund facing a shortfall of cover one year later must not exceed 2.5%. These calculations relate to guaranteed pension levels, generally expressed in nominal money terms. As soon as guarantees are given regarding pension indexation, additional provision must be made. This is not necessary if pension funds make it clear that any indexation is conditional. Regarding the method of discounting, the Outline Agreement starts from the fair value principle.

The aim of this study is to create an analysis framework within which the often implicit policy choices required in regard to the pensions issue are made explicit and their effects can be extrapolated. The starting point here is a pension fund that uses an average earnings system in which the nominal benefits are guaranteed, while the fund also aims to link the benefits to wage inflation. This aim of indexation is decisive for setting the fund premiums. Focusing attention on the index-linked pension, and not just the nominal pension as in the Outline Agreement, is crucial, particularly for an average earnings system, since a nominal average earnings pension is highly unattractive for young members. If insufficient capital is built up for indexation, the pension system may thus be endangered, cf. Van Ewijk and Van de Ven (2004). The provision necessary for the definite nominal commitment is calculated on the basis of the nominal bond yield, while both a fixed actuarial interest rate method and a fair value accounting technique can be applied to the indexation aim. Apart from the method of discounting, the model also provides some insight into the effects of changes to the asset mix, the raising of the retirement age, the cutting of pension entitlements, the calculation of premiums and an increase in the rate of participation in the labour market. The study only gives a partial view in the sense that macro-economic consequences of the policy choices are not modelled. Existing models for the pension sector are often deterministic, while the uncertain investment returns are crucial for the choices relating to the pensions issue. PALMNET differs from the existing models by its heavy emphasis on stochastics in investment returns, providing a sounder basis for weighing up risks and returns. The model was calibrated using aggregate data for the Dutch pension sector as a whole, but can also serve as a basis for a model for a specific fund.

The layout of the report is as follows. Section 2 describes the Dutch system of provision for old age in general, and the build-up via pension funds in particular, and outlines the importance of pension build-up in the context of an ageing population. Section 3 discusses the key elements of the model. This is not a model that has been developed to its limits, but a flexible 'workhorse' which can be used as the basis for computing many policy variants under varying assumptions. The section is concluded with a

discussion on the differences between the fair value accounting principle and discounting with a fixed actuarial interest rate. Section 4 presents a number of deterministic calculations to give an idea of the quantitative links between, for example, pension premiums and returns. Section 5 describes a number of stochastic situations, taking explicit account of the fact that bond yields and returns on equity investments are highly uncertain and may progress according to various scenarios. Section 6 sets out the results of historical simulations. This analysis better reflects the correlation of returns on shares over time. Section 7 offers a number of concluding remarks. Annexes 1 and 2 respectively discuss the calculation of the target cover ratio and the level of shortfall premiums required.

2 THE DUTCH PENSION SYSTEM

This section gives a general view of the background to the Dutch system of old age provision, the role of the pension funds in building up pension capital and the impact of ageing. It also considers the Dutch situation from an international perspective. Finally, it positions the model in relation to a number of existing models for ageing and pensions in the Netherlands.

2.1 Three pillars

The Dutch system of old age provision is based on three pillars. The first is the basic pension for everyone aged 65 and older, under the Old Age Pensions Act [*Algemene Ouderdomswet*] (AOW). This benefit is funded by the government via the pay-as-you-go method, i.e. the current AOW pensions are paid out of current premium income. The second pillar concerns employees' compulsory membership of their employer's group pension scheme, whereby employees save for a pension in addition to the AOW benefit according to a capital funding system. This means that the actual pension premiums are placed in a savings pot which is used to pay benefits from the retirement date. This money is managed by pension funds which collect the premiums and pay out the pensions, deal with the administration of pension rights and invest the resources, principally in equities, bonds and property. The third pillar of the old age provision comprises schemes which people arrange individually in addition to the first and second pillar schemes.

The Statistics Netherlands (CBS) National Accounts give an idea of the relative importance of the first and second pillars at macro level. The annual AOW contributions paid (as part of the first two payroll tax bands in box 1) and pension premiums paid (by employers and employees together) roughly balance one another. The same applies as regards AOW benefits and other pensions, although the total pensions paid out since 2000 exceed the total paid in under the AOW. A clear trend is apparent here, because in 1980 AOW expenditure at macro level was still more than double the other pension benefits. In comparison with the first two pillars, benefits paid under individual schemes via single premium and annuity policies are of minor importance. However, that importance is tending to grow. In a representative survey, persons under the age of 65 stated that they expected that, on average, 10% of their income after the age of 65 would come from benefits under annuity and single premium policies (Van den End e.a., 2002).

2.2 Pension capital in the Netherlands

The Netherlands has roughly 850 pension funds. They currently manage some 400 to 500 billion euro in pension capital for around 6 million active members, 2 million pensioners and 7 million non-actives

(persons who are no longer contributing premiums but have built up pension rights which they are not yet using). Pension funds discount the expected future pension liabilities (depending on rights built up and the life expectancy of members) on the basis of a fixed actuarial interest rate of 4%. The amount thus calculated, the provision for pension liabilities (*PPL*) comes to around €400 billion.

Taking the country as a whole, the resources corresponding to every euro of expected liabilities at the end of 2002 were estimated at 1.08 euro, in other words, the cover ratio at macro level was roughly 108%. That figure is low, given the importance of a high degree of security regarding pension benefits, the uncertainty over investment income, in particular, and the actuarial interest rate of 4% which is perhaps set too high. In fact, pension funds do not only aim to provide a guaranteed pension but also try to link benefits to the price index (inflation-proof pensions) or to wages (prosperity-linked pensions). However, according to the Outline Agreement the funds do not need to set any more money aside for this aim of indexation, provided the conditional nature of the indexation is made clear to members so that they cannot gain the false impression that they are entitled to it.

In the figures calculated above, the amount of pension liabilities is significantly higher and the corresponding cover ratio is substantially lower than the levels stated if the expected liabilities are discounted at the current real market interest rate, which is below the level of the fixed actuarial interest rate. We discuss this in detail in the model description and calculations in Sections 3, 4 and 5.

2.3 Dutch pension accrual in the international context

Under Dutch law, membership of the employer's group pension scheme is compulsory. Generally, both the employer and the employee pay pension contributions, the employer bearing the greater part of the cost. Pension premiums are charged on gross wages of employees after deduction of a specific amount, known as the statutory offset (*franchise*). That offset is generally linked to the level of the AOW benefit. The idea behind this is that people save for a pension above the first pillar of income. The amount on which pension contributions are paid is called pensionable salary or premium base.

Most pension schemes in the Netherlands are 'defined benefit' schemes, which means that a particular amount of pension is promised for the contribution paid. This contrasts with 'defined contribution' schemes in which only the financial contribution is fixed and the eventual benefit depends on the return on the funds invested. As regards the level of benefit promised, most pension contracts only guarantee a nominal pension. However, they also aim to link pensions to the wage or price index, though this indexation may be cut if the pension fund managers consider that desirable (in practice, if the pension capital is insufficient). The Dutch situation can therefore best be described as a *defined benefit nominal pension* combined with a *'target benefit'* index-linked pension.

Defined benefit schemes can be divided into final salary and average earnings schemes. In a final salary scheme, the pension benefit is linked to the latest salary earned. If employees make their way up the ladder in a company, the employer pays the additional pension costs, known as 'past service', to ensure that their pension rights grow as well. In the average earnings system, the pension benefit is linked to the average salary earned. That makes it easier to control the cost of pensions for the employer, and distribute the cost more fairly among the individual employees. Although the majority of pension schemes in the Netherlands are still of the final salary type, there is a clearly rising trend towards average earnings schemes. The proportion of final salary schemes dropped from 67% in 1998 to 54% in 2003. Also, various pension funds, including some with many members such as the ABP and the PGGM, have stated that they are switching to an average earnings system.

Internationally, the Dutch system of old age provision is in a unique position. Only few countries have saved for their pensions in a comparable manner via a capital funding system. Moreover, under the Dutch system, most pension schemes (97% in 2003) are defined benefit schemes. The United Kingdom and the United States, countries which have also built up substantial pension capital according to the capital funding system, have a greater number of defined contribution schemes, and the proportion is increasing. In the Netherlands, annuity and single premium policies, a significant element of third pillar provision, often fall into this category.

2.4 The impact of ageing

Demographic trends, such as the decline in the birth rate and longer life expectancy, are slowly but surely creating an ageing population. Owing to the decline in the birth rate after the post-war baby boom, which peaked in 1965, the percentage of people over the age of 65 in the Dutch population will increase sharply, especially between 2010 and 2030. For every Dutch person currently over the age of 65 there are five people in the 20-64 years age group; according to the latest Statistics Netherlands population forecasts, this ratio will double in thirty years to 2:5. In international terms, the decline in the birth rate in the Netherlands came late, so that the ageing of its population will peak at a relatively late stage. This gives the Netherlands plenty of time, compared to other countries, to anticipate these trends. The Netherlands is also in a better starting position to absorb the financial impact of ageing than many other countries, because a substantial part of the pension provision is arranged via the capital funding system. However, in the Netherlands, too, on the basis of the existing schemes, the AOW outgoings will rise steeply and there will be a large increase in long-term care costs. Also, the ageing of the population is likely to lead to a smaller labour supply and to a large volume of pension saving in the preliminary phase. At first, this will trigger higher wage increases (and hence higher indexation costs) and less scope for investment; this will most likely lead to a temporary decline in bond and equity yields (Knaap, e.a., 2003; Canton e.a., 2004). Furthermore, owing to the heavy

emphasis on capital funding, the Netherlands is particularly sensitive to inflation, because steep price rises can affect the pension capital which has been built up. The pension model is sufficiently flexible to present the range of variants for trends in wages and inflation and yield scenarios (see Sections 4 and 5).

2.5 Models for ageing and pensions

The above developments are no surprise. Demographic changes lend themselves particularly well to early warning. Various existing models have therefore been devised, each from its own perspective, for studying ageing, taking account of the Dutch pension system. One example is the analysis by Huijser and Van Loo (1986). In the mid 1980s they were already describing the effects of various scenarios for demography, inflation, productivity, yields and different policy options for funding old age provision. These were deterministic scenarios with no role for the pension fund cover ratio.

The Generational Accounting Models applied to the Dutch situation by Hebbink (1996, 1997) and Ter Rele (1997a, 1997b), for example, are related to this study. Those models compute the impact of the ageing population on the sustainability of public finances. The AOW pensions bill and long-term care costs are particularly important here. Second pillar pensions play at most a limited role, via the pension premiums which the government pays as an employer.

More recent are the GAMMA model produced by the CPB (Netherlands Bureau for Economic Policy Analysis) (Draper and Westerhout, 2002) and the IMAGE model produced by OCFEB (Knaap e.a., 2003). These general equilibrium models identify not only the public sector but also households, businesses and pension funds. The advantage of the models is that they have a sound theoretical basis and take account of interactions between the various sectors. The models are based on the assumption of 'perfect foresight': expectations coincide with reality so that uncertainty is disregarded. One effect of this is that no distinction can be made between equities and bonds. Since there is no uncertainty in respect of yields, there is no 'equity premium', the additional yield on equities in return for a higher risk. In this deterministic world, the cover ratio concept is also less relevant.

The model devised by Van Heerwaarden, Eikelboom and Den Heijer (1996) is specifically geared to pension funds. It is based on a detailed micro model for individual pension funds, distinguishing according to the members' age group, gender and status (active, retired, non-active). Results at macro level can be obtained by aggregating a number of 'archetypal' pension funds. The model is deterministic and geared closely to the modelling of pension fund liabilities. The PALMNET model, as explained in Section 3, concentrates more on the asset side of pension funds and the influence of stochastic investment returns on the ratio between capital, liabilities and desired premium levels. In that sense, there are greater similarities with the stochastic design of ALM studies conducted by

pension funds. Those studies are updated at very regular intervals and aim at the optimum composition of the asset mix, paying attention to various asset categories (equities, bonds, property, etc.), the geographical distribution of investments and the duration of the various investments, for example. The PALMNET model considers a significantly longer horizon and focuses more on questions concerning the design and sustainability of the pension system and the balance between premium levels, premium variability and pension security. The macro-economic consequences of premium setting or discounts on benefits or pension rights are for the time being not modelled.

3 PALMNET: A DESCRIPTION OF THE MODEL

This section describes all the elements relevant to the model: the data used, the assumptions applied and the evidence supporting the choices made. This description is essentially based on the standard version of the model. The standard choices are generally not limiting in the sense that the model is flexible enough to perform calculations for several variations on the standard version.

3.1 Pension scheme

The model describes pension schemes implemented by group pension funds in the Netherlands. Group company and industry-wide pension schemes insured at life insurers are not considered. The model is geared as closely as possible to the typical pension contract in the Netherlands. This means that we model an average earnings scheme, i.e. any past service is not included, as it normally is in a final salary scheme. It should be noted that many Dutch pensions are currently still based on final salary schemes. As stated in section 2.4, the trend towards more average earnings schemes, which began quite a while ago, appears to be increasing, as large pension funds such as the ABP and the PGM are switching from final salary to average earnings systems. As a result, for the period which we are considering (up to 100 years ahead), the average earnings system is more relevant than the final salary schemes. Furthermore, we opt for the accrual rate of 1.9% of pensionable salary, which is higher than the rate usually applied in final salary schemes (1.75% of pensionable salary), so that the benefit level is not necessarily any lower than in final salary schemes. As is usual, the pensionable salary figure is obtained by deducting a statutory offset from gross pay. That offset is based on the pension payable to a single person under the AOW. The pension model is based on an 'index-linked pension': the aim is to increase the accrued pension rights each year in line with the rise in collectively agreed wages. The retirement age is taken as 65 years. This is the state retirement age at which the AOW pension becomes payable. One of the variants in Section 4 studies the impact of raising the retirement age.

In the model, only the individual old age pension is calculated actuarially. This is to some extent restrictive as old age pensions account roughly for only about two third of total benefits of pension funds. Especially surviving relatives pension is also very important accounting for roughly 23% of total benefits. Besides these categories, substantial payments are made on account of pre-pension (5%) and disablement pension (5%). Developments in these categories are much more difficult to model individually however. Instead, we will assume that these categories will change proportionally to the developments in the individual old age pension. In other words, it is assumed that total pension rights and benefits will always be one and a half times as much as those for the old age pension alone.

3.2 Data

The model uses a number of data, namely the initial pension fund data (Source: PVK), demographic data and macro-economic data. In 2002 the benefits paid out and premiums collected by pension funds totalled €14.4 billion and €18.5 billion respectively. At the end of 2002, pension fund assets net of debt totalled €427 billion, bringing the nominal cover ratio to 108% (at an actuarial interest rate of 4%). At macro level, the average pension premium is 10.5% of the gross payroll. On that basis, we estimate the gross wage bill for members of pension schemes run by pension funds at €176 billion in 2002.

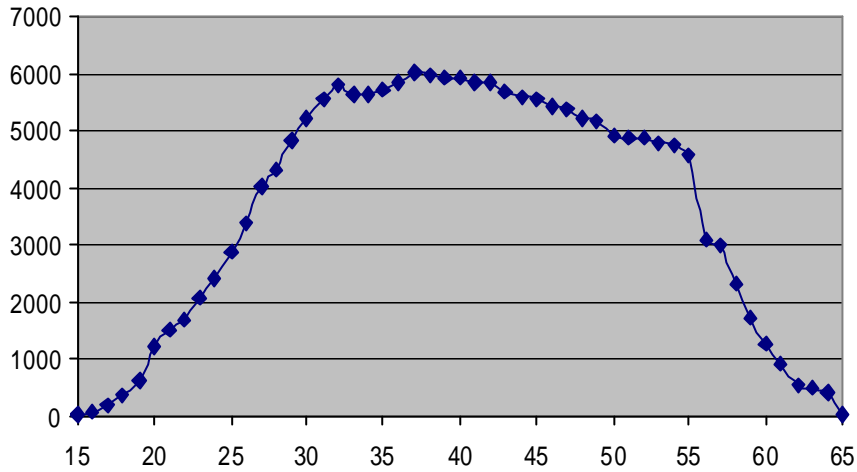
To model demographic trends, we use the mean variant of the latest Statistics Netherlands population forecasts for 2003 to 2050, with an extrapolation to 2100 on the basis of constant birth and mortality rates per age group. For each calendar year, these data divide the Dutch population into 100 age groups, starting with the 0-year age group and ending with the over 99 age group.

In the standard version of the model, we use a number of default values for the key macro-economic variables: inflation, wages, long-term interest rate and equity yields, based on historical values during low inflation. In the stochastic simulations, we furthermore introduce uncertainty with respect to interest rate changes and stock returns by means of extra random shocks. For inflation, we assume a rate of 1.75%. Although this is relatively low in historical terms, it is in line with the inflation target for the euro area, set at a maximum of 2%. The increase in collectively agreed wages is taken as 3% (1.25% above inflation). The average for the long-term interest rate or bond yield is taken as 4.75%, while the average equity yield, based on an equity premium of 3%, is taken as 7.75%. To ensure that the figures are up-to-date, we use the actual yields achieved in 2003 and the expected increase in wages up to 2005 (in line with the Autumn Agreement on the freezing of collectively agreed wage increases in 2004 and 2005). Consequently, for the years 2004 and 2005 the calculations are based on gross wage increases of 1.4% and 0.6% respectively.

The total gross pay per age group was determined on the basis of Statistics Netherlands data on the average gross earned income per age group in 2001, combined with the population structure and labour market participation rates for 2002. Figure 3.1 shows the resulting earned income by age of the Dutch population in 2002. Although the average wage bill for employed persons increases up to the 55-59 age group, the total wage bill is highest for the 37-year-olds in 2002. The reason for this is the gradual decline in participation in the labour market from age 28 onwards. The steep fall at age 56 is due mainly to the population structure, caused by the post-war baby boom. Given the current interest in the effects of ageing and the various measures to promote the participation of older workers in the labour market, such as the abolition of the voluntary early retirement ('*VUT*') scheme, likely changes

in the participation rate per age group can be incorporated, e.g. according to the CPB estimates (Van Ewijk e.a., 2000).

Figure 3.1 Total wage bill per age group (in millions of euro) in 2002.



3.3 Model equations

The model can be roughly divided into definition equations and behaviour equations. The definition equations indicate the trend in pension fund variables, given the movement in economic variables and the policy decisions taken. The behaviour equations model the policy decisions taken in the pension sector. Variables which influence the pension sector are total assets, provision for pension liabilities (*PPL*), premiums, accrual and benefits. Premiums and investment income on assets form the pension income; benefits are the largest expense item.

Portfolio investments

The asset mix which we consider comprises two categories of investments: equities and bonds ¹. As a general rule, we assume a fixed asset mix of 50% equities and 50% bonds, the asset mix of the average fund nowadays. In practice, the mix varies according to developments on the equity and bond markets, but we assume that the asset mix is rebalanced at the end of the year. The bond yield is driven by changes in interest rates. The expected equity yield is equal to the expected bond yield plus an equity premium. Where interest rate movements are concerned, we assume an error correction mechanism for adjustment in line with a long-term equilibrium level (in the standard version that equals 4.75%):

$$\log(\text{interest_rate}) = 0.25 \cdot \log(\text{equilibrium_rate}) + 0.75 \cdot \log(\text{interest_rate}(-1)) + \text{interest_rate_shock}$$

The interest rate shock reflects the uncertainty in interest rate changes. We choose for a logarithmic specification because interest rate volatility increases in the level of the interest rate. Moreover, this specification prevents interest rates from becoming negative. For the deterministic scenarios, the shock is put at zero, while in the stochastic scenarios random samples are taken from a normal distribution with a standard deviation of 15% (at an interest rate level of 4.75% this means an interest rate volatility of 0.71 percentage points). These parameter values are based on historical developments during low inflation.

With respect to the equity premium we do not assume any dependence over time since equilibrium mechanisms on the stock market cannot be demonstrated convincingly in empirical terms.

$$\text{Equity_yield} = \text{equilibrium_rate}^{0.25} \text{interest_rate}(-1)^{0.75} + \text{equity_premium} + (e^{\text{equity_shock}} - 1)$$

The equity shock (for logarithmic returns) is also assumed to be normally distributed with a standard deviation of 18% (in percentage terms this means 18.5%). From a historical point of view, 18% volatility is realistic provided currency risk is hedged. The normality assumption is adequate as the fat-tailedness of equity returns only applies to higher frequency data. The correlation between interest rate and equity shocks can be freely selected, but is set at zero since periods with positive and negative correlations both occur on a regular basis.

Benefits

By definition, pension benefits increase by the level of indexation (collectively agreed wage increase minus any cut in indexation) and with the number of pensioners. This specification disregards the fact that the next generation of pensioners has probably built up more pension than previous generations. With increased prosperity, the current level of income and hence the pension built up has also increased in relative terms. Moreover, the number of economic sectors where employees build up their pension rights via their employer has risen steadily over the years. This is taken into account in the model by means of an exogenous additional increase in the pension benefits in the initial years, so that the growth of benefits presents a realistic pattern. Apart from this exogenous increase, benefits in the model depend on adjustments to the retirement age and past cuts in indexation. In the long term, the level of benefits is modelled in such a way that, for a stationary fund, i.e. a fund in which the number of members joining and leaving is stable, both the liabilities and the benefits increase by the rate of indexation.

¹ The equities category also includes other high-risk investments, particularly property. The general term 'real assets' is actually more appropriate to this category.

Wages

The total gross wage bill in the model is determined by the number of employed persons per age group multiplied by the average earnings for the age group in question, the figures then being aggregated for all cohorts. Starting with the total gross wage bill per cohort in 2002, wages per age group y increase by the number of persons and the participation rate in the group aged y -years, and the collectively agreed wage increase. The equation below describes this relationship.

$$\text{Wage_growth}(y) = \text{population_growth}(y) + \text{participation_growth}(y) + \text{collective_wage_growth}$$

The starting point for the total wage bill in 2002 is hereby adjusted to take account of the fact that not every worker is building pension rights at a pension fund. The total wage bill for the 20- to 64-year old is scaled such that the average pension premium was exactly 10.5% in 2002. Based on this comparison, the average pension fund participation rate was 95.5% in 2002. Basing the growth of wages on population growth per age group automatically takes account of the structure effect on wage growth caused by the change in the age mix of the working population. We disregard other components of incidental wage increases, such as changes in the average standard of education of the working population, or wage drift caused by a shortage on the labour market. The sensitivity of these components is easy to examine by calculating a higher increase in collectively agreed wages.

Basis of premium calculation

The basis for calculating an employee's contribution is gross pay minus the statutory offset. This offset represents the pension payable under the AOW. There is no need to build up pension in respect of this income element (so no premium is charged). In practice, however, the exact level of the offset varies from one pension fund to another, e.g. in conjunction with the accrual rate and the type of scheme (final salary/average earnings). In this model, we calculate the statutory offset as $(10/8) \times$ AOW for a single person. This amount is marginally higher than the minimum wage and corresponds to the decision to base the model on an average pension fund as typical of all pension funds. The basis calculated in this way comes to roughly 56% of gross pay.

Since we are using the total wage bill per cohort, we have to approximate the total basis on which premiums are calculated per age group. Taking *offset_pp* as the offset per person, we can calculate the offset per age group as:

$$\text{offset}(y) = \text{population}(y) * \text{participation_rate}(y) * \text{offset_pp} * \text{part-time_factor} * \text{participation_factor}$$

The part-time factor allows for the fact that part-timers also build up pension, even though their income may not exceed the statutory offset. The participation factor corrects for the fact that not

everyone is building up pension rights at a pension fund. The basis of premium calculation per age group is now equal to the wage bill per cohort minus the offset per cohort. Naturally, the basis has a minimum level of 0.

Accrual of new pension rights

Given the basis of premium calculation, it is easy to determine the amount that a pension fund must set aside for the accrual of new pension rights. The accrual rate is taken as 1.9%, in line with the accrual rate of a typical pension fund with an average earnings scheme. This means that 1.9% of the premium base is guaranteed as pension (in nominal terms) from age 65 onwards until death. On the basis of age, mortality tables and the discount rate, it is possible to determine for each age group how this right is reflected in a provision for old age pension liabilities, in other words: the discounted value. Expressed as a formula:

$$\text{Accrual_old_age}(y) = 0.019 * \text{premium_base}(y) * \text{accrual_factor}(y, \text{discount_rate})$$

The accrual factor represents the single premium required to buy 1 euro of pension from retirement age until death. This factor is calculated in actuarial terms by using the 1995-2000 mortality table (average for men and women) and varies with age and discount rate (or actuarial interest rate). In order to compensate for an expected rise in life expectancy, the mortality table is set back by two years. That is to say, the calculation of, for instance, the single premium needed for a 30-year old who retires at 65 is based on the single premium of an 28-year old who retires at 63. Aggregation over all age groups then gives the total amount that has to be added to the *PPL* in the year in question on account of new pension rights built up. In order to calculate the accrual of all pension rights, the accrual for old age pension is multiplied by 1.5, thereby assuming a constant relationship between old age pensions and other categories such as surviving relatives pension and disablement pension.

Premium

The actuarial or break-even premium is the premium that just covers new pension rights and administration costs (these grow in the model with the collectively agreed wage increase). This premium is a useful benchmark as it gives a good indication of the intergenerational fairness of pension premiums. As the cost for an individual pension scheme will be approximately the same, even though for an individual scheme the result will be more dependent on the actual portfolio returns, a pension premium that is far above the break-even point undermines the intergenerational solidarity as the individual expected benefits no longer outweigh the individual costs.

Although the break-even premium is optimal from an intergenerational fairness point of view, in practice the premium will often deviate from this value. For instance, if the pension fund currently suffers from shortfalls, extra premiums need to be levied in order to finance the gap. A big surplus on the other hand facilitates lower premiums because the buffer yields a profit. In the model, the pension premium indeed depends on the cover ratio. With high cover ratios, premiums can be lower while an increase is needed if cover ratios are low. The speed of adjustment is fixed in the basic path, but can also be varied. Although prompt premium adjustment is desirable from the point of view of pension security, from a macro angle it is clear that keeping premiums as stable as possible minimises the disruption. The reason is that the premium can be seen as an implicit tax, e.g. because a shortfall premium does not bring higher pension rights but only serves to build up the pension fund capital buffer. To limit premium volatility, the maximum increase or reduction in pension premiums is 2.5 percentage points per annum. In the basic version of the model, premiums are set as follows:

Real cover ratio (in %)	Premium (as % of premium base)
Under 118	Annual increase of 2.5 percentage points to a maximum of 35%
118 – 125	Actuarial premium
125 – 140	Actuarial premium minus linear reduction
140 – 200	No premium
over 200	Negative premium

The target figure of 118% applies to discounting at a fixed actuarial interest rate and an asset mix comprising 50% equities. This figure is calibrated in such a way that the probability of a shortfall of cover in any one year is 2.5% (see Annex 1). Under fair value accounting, the target cover ratio needs to be significantly higher (129% for 50% equities) owing to the volatility of the liabilities. An alternative premium scheme which can be chosen for the model with a cover ratio below the target level is one with a 15-year recovery programme bringing the cover ratio to the target level (see Annex 2). In that case, there is no longer any maximum limit on the rate of premium (increases) since recovery over 15 years cannot otherwise be guaranteed. The 15-year recovery period is in line with the government's proposals in the Outline Agreement. The reduction in the actuarial premium is calculated by means of linear interpolation between the level of the cover ratio at which the reduction applies and the level of the cover ratio at which the premium is zero. Above a certain cover ratio, premium refunds are necessary since the investment profits on the buffer at a given moment exceed the provision necessary for new pension rights built up. Without a premium refund, the cover ratio would then continue to grow exponentially.

Indexation

Apart from the premium, indexation – or rather the cut in indexation – is determined on the basis of a graduated policy plan.

Real cover ratio (in %)	Indexation
under 85	No indexation
85 – 105	Cut declining on a linear basis
105 – 125	Full indexation, no making good of shortfall
over 125	Full indexation with cuts made good

Full indexation means that the pension liabilities are increased by the average rise in collectively agreed wages. A cut in indexation means that the pensions do not fully keep pace with wage increases. However, any cut applied is made good if the cover ratio level is adequate ². Making good means that the existing pension rights are increased by the percentage cut, but not that the actual cuts in respect of past benefits between the time of the cut and the making good is paid out retrospectively. The mechanism for making good is important, because without it the pension accrual for younger people is far less attractive.

Provision for Pension Liabilities (PPL)

Given the above definitions, the following equation can be presented to show the growth in provision for pension liabilities (*PPL*):

$$PPL = PPL(-1) * (1 + \text{discount_rate}/100 + \text{indexation}/100) * \text{correction_mortality} \\ + \text{accrual_new_rights} - \text{benefits}$$

Both discounting and indexation influence all liabilities to the same degree, on the basis of equal treatment of all actives and non-actives as regards indexation and any cuts. Besides, old liabilities have to be adjusted if new insights regarding mortality rates become available. The variable ‘accrual’ represents newly acquired pension rights and is thus additional to the *PPL*. Since the *PPL* is a provision for the payment of benefits, benefits are charged to the *PPL*. Since pension costs are incurred in the distant future, the variable *PPL* plays a crucial role. The *PPL* represents the discounted value of all deferred liabilities. The *PPL* increases with the level of future benefits, and (via the discount rate) as the average date for paying the benefits draws nearer. Both effects will become apparent in a sharp rise in the *PPL* in the basic path in the years ahead, because there is a large group

of people over age 50 sitting at the top of the salary scale and building up substantial pension rights and hence future benefits. At the same time, the date for paying benefits to this group is rapidly approaching.

Discount rate

The discount rate plays an important role in the pattern of the *PPL* described above. The traditional method of discounting uses a fixed actuarial interest rate, in which the maximum permitted rate is prescribed by the supervisory authority. This maximum permitted actuarial interest rate has remained constant at 4% for pension funds since October 1969. Although this actuarial interest rate was originally intended as a nominal discount rate for determining the capital needed just for the nominal guarantee, this rate gradually came to be seen as a real interest rate. That means that the pension provision on the basis of a 4% actuarial interest rate would be enough not just for the nominal benefits but also for indexation in line with wage inflation. In the 1980s and the first half of the 1990s this view was entirely realistic, since the actual bond yield deflated by wage inflation was around 5% or more. However, the gradual decline in bond yields caused the real interest rate to fall to 2 to 3%. Pension capital equal to 4% *PPL* thus no longer guarantees full capital funding. However, while bond yields were declining, pension funds were also increasingly investing in real assets on which a higher return could be expected. Consequently, the average real return on the investment portfolio could still be as high as 4%, but now this is only an expectation and there is no longer a reasonable degree of certainty.

An alternative method of arriving at a discount rate is based on “fair value” or “market value”, whereby the current market value of future pension rights is determined as far as possible. From 2005, this method will become the international accountancy standard and it is destined to play a prominent role in Dutch pension supervision, too. The method is based on the assumption that the commitments given must be capable of transfer to a third party at any time, if that should be desirable. The value of unconditional commitments corresponds to that of a government bond portfolio guaranteeing the same cash flow. For nominal commitments, this means discounting at the current yield on government bonds. For real commitments, there is no portfolio available which directly reflects market conditions, since there is no market in wage-indexed loans. To apply the concept of fair value here, it is therefore necessary to make an assumption regarding future wage trends. According to the fair value principle, conditional commitments would have to be valued on the basis of option calculations. The pension fund’s commitment to pay index-linked benefits in the future, subject to certain conditions, can be seen as a combination of call options written on the fund investment portfolio with the strike price set

² The cut is made good as soon as possible, provided the cover ratio is not thereby reduced below the 125% minimum.

as the cover ratio at which indexation begins, and call options purchased with the strike price as the cover ratio corresponding to the level where maximum indexation applies.

An important difference between the actuarial interest rate method and the fair value method is that the former departs from a continuity approach while the fair value method focuses on the risk of the sponsor's insolvency. In the case of continuity, the average expected long-term yield is in fact the most relevant, whereas in the case of the sponsor's insolvency, it is only the exact value of the commitments at that moment that counts. As regards unconditional (nominal) commitments (including indexation already granted), the discontinuity approach is appropriate, as these commitments have to be guaranteed, even if the sponsor goes down. The fair value principle agreed in the Outline Agreement is therefore correct here. In PALMNET, the nominal cover ratio is also determined on the basis of the nominal current bond yield.

In contrast, the fair value method which uses replicating bond portfolios is less suitable for assessing the indexation aims of a pension fund, as such a fund will have to invest at some risk (associated with a higher return in the longer term) in order to keep premiums at affordable levels. The replicating bond portfolio is therefore almost inevitably out of line with the actual investment portfolio of a fund which aims to provide indexation. Instead of assuming the return on an inappropriate *replicating* portfolio, we can therefore opt to discount the conditional commitments at the expected long-term real return (conservative estimate) on a portfolio which is *considered representative*. Given a projected real interest rate of 1.75%, an equity premium of 3% and a representative asset mix with 50% equities, this gives a fixed actuarial interest rate of 3.25%. The inclusion of the equity premium in the discount rate implies that full capital funding of pension rights is no longer guaranteed. This is justified by the fact that indexation is an *aim* but no *guarantee*. If returns are disappointing, the degree of indexation can be reduced. Moreover, shortfalls can be offset by charging shortfall premiums. However, it is important to stress that the above balancing in respect of the 50/50 mix should not be seen as a free choice, i.e. the mix is directly related to the risk which can be deemed acceptable for pension build-up.

In PALMNET, for determining the real cover ratio (the cover ratio including commitments concerning full wage indexation) it is possible to choose between a fixed actuarial interest rate method and a fair value method. In the latter case, the discount rate is equal to the current bond yield minus the assumed wage increase (which determines indexation), plus any risk premium³. The risk premium is justified in the case of fair value accounting by the fact that the level of indexation is uncertain, first because the

³ Since the interest rate varies, the recursive *PPL* rule is not directly applicable under fair value. Instead of the current interest rate, an 'equilibrium interest rate' is used to determine new build-up and an 'equilibrium' *PPL*. The actual *PPL* is then calculated from the equilibrium *PPL* on the assumption of a fixed 16-year duration for the commitments. The nominal cover ratio is also calculated on the basis of this principle.

future movement in wages is not known and second because indexation is conditional upon sufficient capital in the pension fund. Uncertain benefits are worth less than definite guarantees, and can therefore be discounted at a higher rate. However, this argument has the unwelcome logical consequence that a fund with a highly solvent, committed sponsor actually ought to apply a lower risk premium for the discount rate, since the probability of cuts is smaller for this fund. But that would give a solvent fund a higher value for the *PPL*, and – given a desired level for the cover ratio – it would need more capital than a comparable fund with a less solvent sponsor. From the point of view of pension security, that is the exact opposite of the target situation. In any case, it is impossible to determine with any certainty the ‘right’ value for the risk supplement, nor the future values for the bond yield, wage inflation or equity premium. In practice, as in the actuarial interest rate method, we assume a risk supplement of 1.5%. The difference between the actuarial interest rate method and the fair value method for indexed commitments is thus that the actuarial interest rate method assumes a fixed real rate of interest in the long term, while the fair value method assumes a constant rate of wage inflation.

The model thus generates both a figure for the necessary provision for nominal commitments and a figure for indexed commitments. However, these two variables are not directly comparable since they are calculated by different approaches. The nominal cover ratio is based on a discontinuity approach and controls the fair value guarantee for nominal benefits only. In contrast, the real cover ratio indicates whether the total capital is expected to be sufficient to meet all liabilities in the long term (including conditional indexation). Under normal circumstances, the real liability will be greater than the nominal liability. However, that need not be the case under the actuarial interest rate method, because once the nominal bond yield falls below the actuarial interest rate, the nominal liability is higher, though this does not have to affect the indexation policy. In the model, only the real cover ratio is used to determine the premium and indexation policy. The nominal cover ratio provides an additional check and corresponds to the cover requirement under the Outline Agreement, but does not normally play an active role.

In the case of the fair value approach using the option valuation method, additional provisions would be needed for indexation commitments, on top of the nominal provision. However, we did not consider this method since there are a number of serious objections to its practical application. First, the method provides the wrong incentives. A fund that has insufficient cash resources is ‘rewarded’ for a policy that minimises the chances of recovery, because in that case the option value is lowest, and so is the current shortfall. Second, the desired capital buffers needed for the nominal commitments and indexation are not independent. The nominal buffers are necessary in case of disappointing investment returns, whereas the indexation buffers actually provide ‘protection’ against good investment returns. These provisions therefore cannot just be added together. Third, the practical feasibility of these option

calculations is limited, as options have to be calculated with a term from one to sixty years; as well as that, they are all inter-dependent. Fourth, the method leads to unstable circular reasoning so long as the indexation is not (almost) fully guaranteed, because once a sponsor pays in additional capital in order to compensate for a shortfall of cover, the probability of future indexation increases. This also increases the indexation option value and hence the total pension commitment, which will in turn lead to a shortfall of cover. Finally, the assumed transparency of the method is also limited. Although the pension fund balance sheet shows the actual amount that indexation is worth, it is not easy to translate that into a likely indexation percentage, for example.

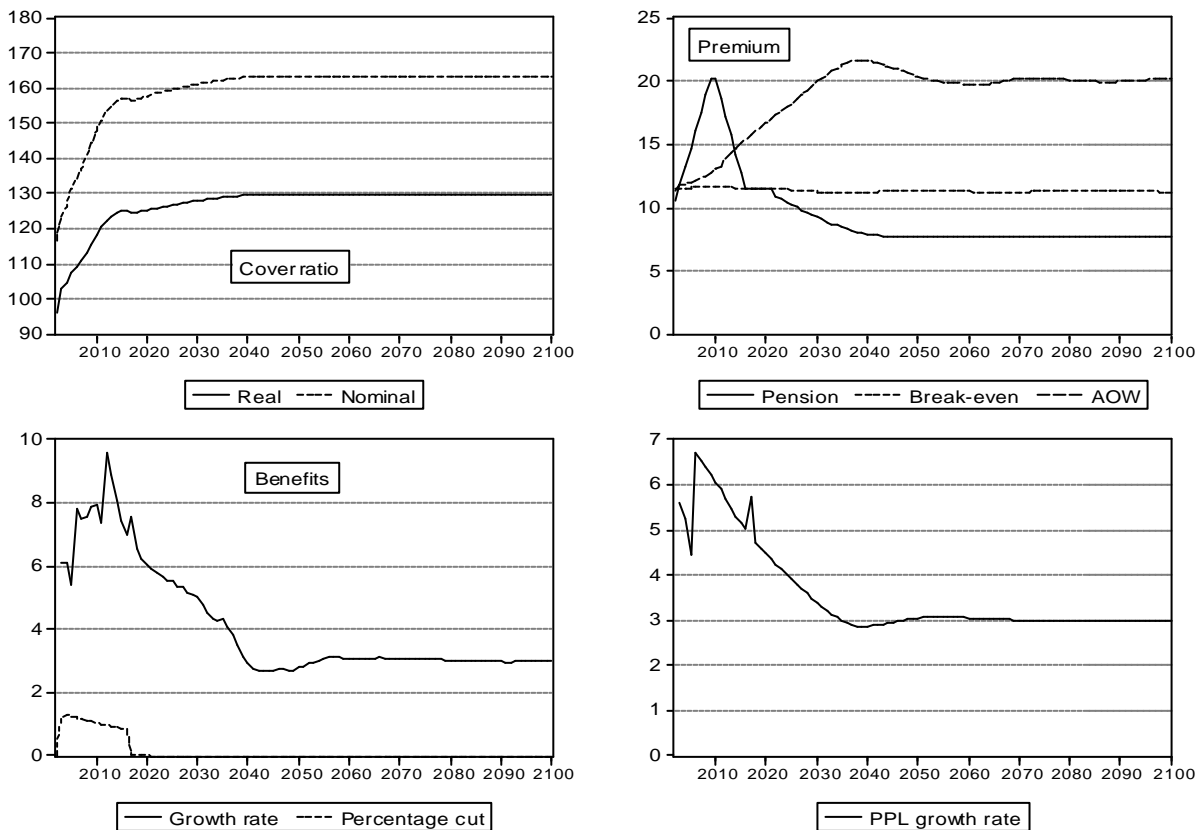
4 RESULTS FOR THE DETERMINISTIC MODEL

This section presents the model results for the 2003-2100 planning period. They are based on a deterministic analysis, i.e. we consider a situation with no uncertainty about actual future figures for financial/economic variables. The advantage of the deterministic approach is that the results are easy to understand since they portray the average scenario and, by varying the assumptions, provide an insight into the quantitative links between different variables. However, Sections 5 and 6 do take account of the uncertainty that plays a major role in real life. The following account begins with an analysis of the basic path with all the standard assumptions. That is followed by a sensitivity analysis revealing how the results change when parameters are adjusted.

4.1 Basic path

Under the basic assumptions, Figure 4.1 for the 2002-2100 period shows the trend in the cover ratio (in percentages), premium (in percentages of the gross wage bill) and the percentage increase in benefits and provision for pension liabilities.

Figure 4.1: Trend in the cover ratio, premium, benefits growth and *PPL* growth in the basic path.



The real cover ratio in Figure 1 follows an upward trend from its starting point of 96.2% in 2002 (at an actuarial interest rate of 3.25%) to an equilibrium level of around 130% achieved by about 2040. The

nominal cover ratio increases proportionately in this deterministic setting to an equilibrium level of 163.5%. The pension premium initially rises at a maximum rate from 10.5% of the gross wage bill in 2002 to 20.2% in 2009. In 2010, the target cover ratio of 118% is reached, after which the premium starts to fall at the maximum rate. From 2022, the premium falls below the break-even level since part of the new pension rights can be paid for out of the return on the capital buffer. Eventually, the premium stabilises at around 7.7% of the gross wage bill, which is some 3.6 percentage points below the break-even premium.

With the data on demographic trends and wages, we can also calculate the expected level of the AOW contribution (see Figure 4.1). As a result of the ageing population, the costs of the AOW will total around 20% of the gross wage bill from 2030 (roughly double the figure in the initial year). The low pension premium in the long term therefore offers partial compensation for the sharp rise in the AOW contribution.

The bottom two panels show that benefits and *PPL* grow rapidly in the initial years, as a result of the growing number of pensioners. Benefit expenditure growth peaks in 2012, after which it levels out to an equilibrium level of 3%. This is the growth figure that corresponds to a stationary fund, i.e. a pension fund in which the number of members joining and leaving is stable. The peak in *PPL* growth in 2017 results from making up for the cut in indexation applied in 2003 and 2004. In these years indexation was reduced due to insufficient cover ratios at the end of 2002 and 2003. No cuts are made in other years, partly because of the modest increase in wages in 2004 and 2005 under the Autumn Agreement.

4.2 Sensitivity analysis

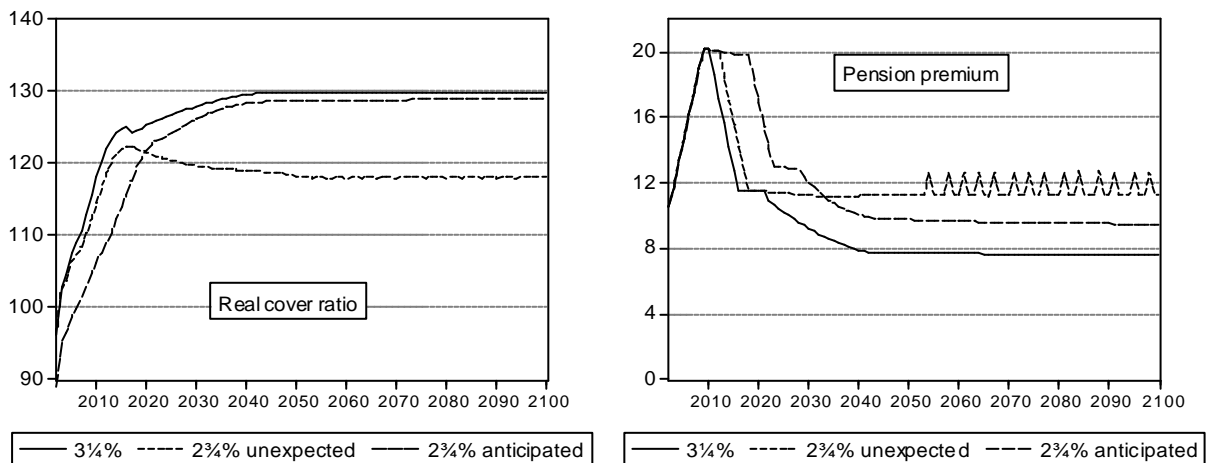
Although a genuine analysis of pension policy can only be conducted in a stochastic system (Section 5), the consequences of some changes to economic assumptions can also be demonstrated clearly in a deterministic setting. We present the influence on the premium path for four variants, namely a lower equity premium, an asset mix with fewer equities, a higher retirement age and a higher life expectancy. We disregard the effects on benefits and *PPL* because they hardly change or follow directly from the cover ratio.

Variant 4.1 a one percentage point cut in equity premium

The first variant considers an unexpected, one percentage point cut in the equity premium; instead of 3%, the equity premium is just 2%. As a result of lower equity yields, the pension premium has to be almost 4 percentage points higher (see Figure 4.2). The main factor behind this substantial effect is the ratio of about 4.5 between the *PPL* and the wage bill. At a cover ratio of 100%, a 0.5% fall in the

return on investments (assuming 50% equities) thus has to be offset by a 225 percentage point increase in the premium compared to the basic path. The interest-bearing buffer further augments this effect. If the lower real return is not noticed, and people continue to apply an actuarial interest rate of 3.25%, the average cover ratio will fall sharply, even below the target value. Also in the long term the premium remains high, with incidental peaks after the target cover ratio is not reached. On the other hand, if the actuarial interest rate is also cut by half a percentage point, this actually has a positive effect on the capital buffer in the long term. Although the cover ratio remains fractionally lower than in the case of the higher return, since in this case the liabilities (the denominator) are discounted at a lower actuarial interest rate, the total capital is still substantially greater in the long term. However, considerably higher premiums are needed to build up this larger capital sum in the initial stages. In the long run, the premium remains about 1.8 percentage points higher. Incidentally, the assumption of a 3% equity premium is already on the conservative side. During the 1960-2003 period, the average equity premium for a representative, internationally diversified portfolio for Dutch pension funds was 4.3%, for example. Dimson, Marsh and Staunton (2002) examine the equity premium for 16 industrialised countries over the 1900-2000 period and find average premiums ranging from 3.3% to 10.3%, despite the effects of two world wars and the 1930s crisis. The probability of a lower equity premium than the assumed 3% is small against this background. The effects of a wage increase which is half a percentage point higher on average, or a nominal interest rate which is half a percentage point lower, are exactly the same in this deterministic setting however.

Figure 4.2: Effects of a real investment return which is half a percentage point lower on average.



Variant 4.2 Adjustment of the asset mix

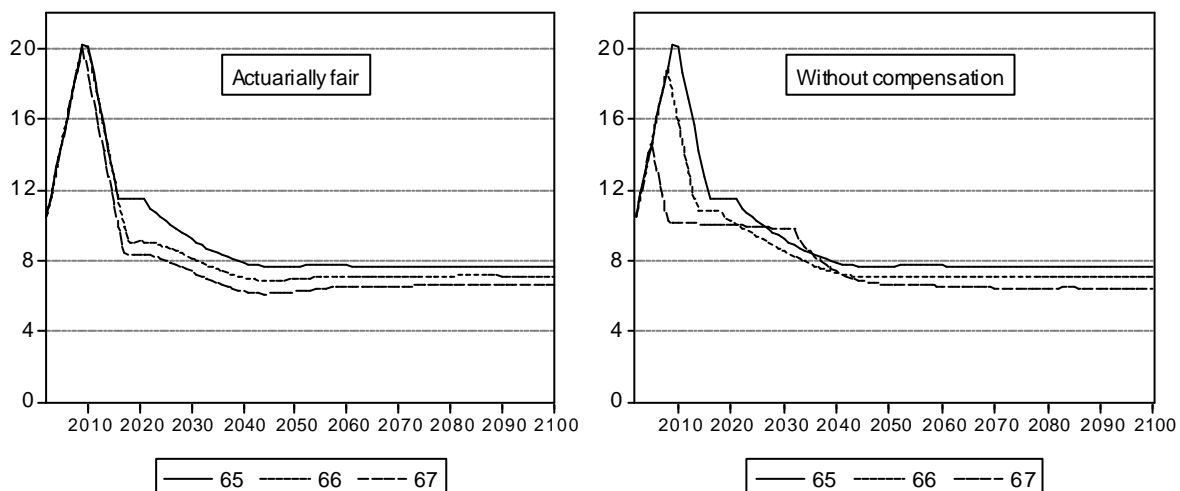
The volatility of the return on assets can be reduced by lowering the percentage of equities in the asset mix in favour of bonds. It is easy to see that, in a deterministic world, a 1 percentage point reduction in the equity premium is equivalent to reducing the proportion of equities in the investment portfolio

from 50% to 33%. Since the effects on the expected return are known in advance, the anticipated scenario given in Figure 4.2 applies here. Reducing the risks by holding fewer equities is an expensive proposition, on average, especially in the initial stages. The smaller percentage of equities does justify a somewhat lower target cover ratio, which mitigates the initial problems to some extent, but at the same time the steady state premium increases somewhat.

Variant 4.3 A higher retirement age

An alternative method of catering for the alleged pensions crisis is to increase the retirement age (Bovenberg, 2003). Calculations are performed for two variants, both assuming that the retirement age is increased immediately in 2004 (see Figure 4.3). In the first variant, actuarially 'fair' allowance is made for accrued rights in the form of higher benefits from the new retirement age. In contrast, in the second variant there is no allowance for the loss of one or two years of pension benefits. If accrued rights remain intact, raising the retirement age does hardly anything to ease the pensions problem. In the short term, reducing the retirement age only has a positive effect on the pension funds' funding shortfall if promised benefits lapse without full compensation. However, the break-even premium for new pension accrual is immediately lower in both variants, as a result of postponement and curtailment of the benefit period. In the somewhat longer term, the pension premium will therefore fall for both variants.

Figure 4.3: Effects on the pension premium of an adjustment to the retirement age.

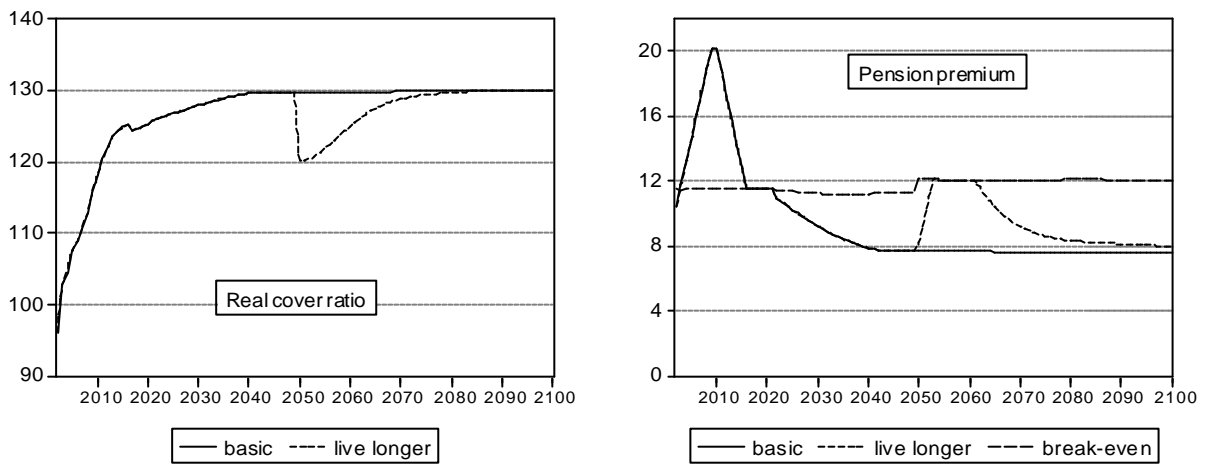


In addition, the total effect of these calculations is probably overstated as a change in the retirement age does affect the old age pension, but not the surviving relatives pension. Consequently, the fixed ratio between total pension and old age pension rights needs to be increased.

Variant 4.4 A higher life expectancy

One of the insurance risks of a pension fund concerns the uncertainty with respect to the life expectancy. A lower mortality rate means that pension benefits need to be paid longer which imposes an extra burden for the fund. In the standard model we already take a rising life expectancy into account by subtracting two years in the calculation of new pension rights. Effectively, this means we implicitly assume the average life expectancy to be two years more than those based on the 1995-2000 mortality tables. Figure 4.4 shows the consequences of an even bigger rise in life expectancy. Starting in 2050, the expected life span is further increased by two years. This results in an increase of the *PPL* with 7.7%. Also the break-even premium increases by 7.7% to about 12% of the gross wage.

Figure 4.4: Effects of a rise in the life expectancy



5 STOCHASTIC SCENARIOS

The calculations in the preceding section are based on a situation with no uncertainty about the future. However, uncertainty over investment income or future benefits is an essential feature of the pensions debate, because although a high-risk investment strategy may result in lower premiums on average, the downside is that an excessively poor performance can lead to unacceptably high shortfall premiums and/or cuts in benefits. The explicit modelling of uncertainty via scenario analysis reveals the implicit balancing of risk against return. This type of insight gives an extra dimension to policy decisions: it is not only a low premium/high cover ratio that is desirable, but perhaps even more so a pension system that can withstand shocks. The probability of a shortfall of cover is also a key factor in the Outline Agreement. This can only be properly analysed in a simulation context.

Pension funds are influenced by many risk factors. The main ones are probably uncertainty over equity yields, interest rate changes, the trend in wages and mortality tables. Volatility plays a particularly important role as regards equity yields and interest rate changes. In the pension model, this influence is represented by basing the results on Monte Carlo simulations. For each scenario, 1000 paths are generated for the cover ratio, premium decisions, etc. Each path is based on samples taken from the probability distribution of equity and bond yields for the years 2004-2100. The shocks affecting performance are taken from a normal probability distribution with an expectation and a variance based on historical values (except that the equity premium is set lower, at 3%). The standard correlation between shocks affecting interest rates and equities is set at zero since periods with positive and negative correlations both occur regularly. The scenario results are presented by considering the average of the 1000 paths for each year, as well as the 97.5%, 95%, 90%, 80% and 50% percentiles. In the case of the 97.5% percentile, in the year in question 2.5% of the paths lead to a less favourable outcome while 97.5% of the 1000 paths produce a more favourable picture. The 50% percentile is also referred to as the median.

For the moment, wage and price inflation in the model are deterministic, one reason being that, in order to calculate the liabilities, it is not only the current inflation rate that matters, but more particularly the expected inflation over the whole investment horizon. This expected inflation is difficult to measure (especially for wage inflation) and it seems unlikely to fluctuate sharply in the short term. In the long term we can assume that inflation changes will be associated with changes in nominal interest rates. In that sense, interest rate volatility can be taken as real interest rate volatility. Since both premium setting and the indexation scale in the model are based on the real cover ratio, this is not a major drawback. Only the patterns shown for the nominal cover ratios may give an over-positive picture.

We first present the results for the default values of the pension model. This basic scenario assumes that premiums are increased by the maximum stages if the cover ratio is inadequate. Scenario 2 and subsequent scenarios are based on making good the funding shortfalls using 15-year recovery plans. Scenario 3 considers the paths that follow on the assumption of fair-value accounting. Scenarios 4 and 5 respectively then take a lower actuarial interest rate and a lower percentage of equities in the asset mix. Scenario 6 looks at the effects of an investment strategy in which the percentage of equities depends on the level of the cover ratio. Finally, the last three scenarios depict the impact of higher and lower equity yields, whether or not anticipated.

5.1 Scenario 5.1: basic scenario with maximum premium increase if the buffer is inadequate

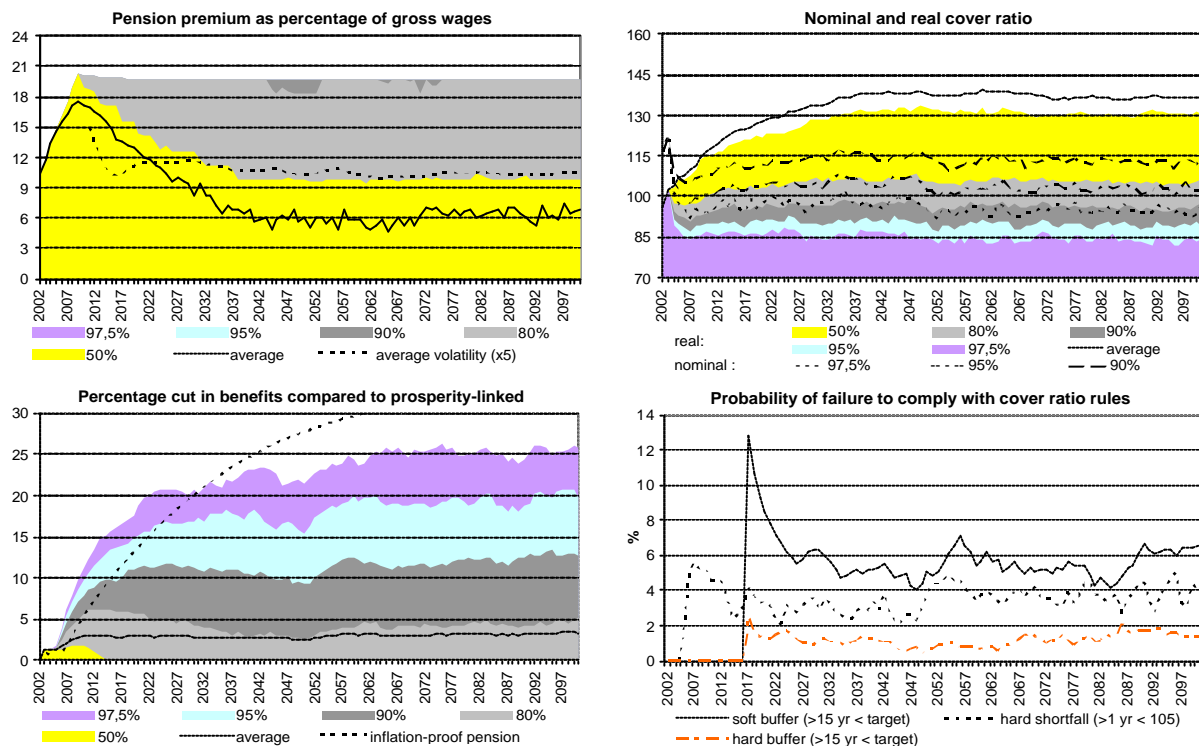
Figure 5.1 summarises the results of the standard scenario, which is based on the same assumptions as the deterministic scenario shown in Figure 4.1:

- Discounting of all liabilities (including the aim of indexation): fixed actuarial interest rate of 3.25%.
- Target cover ratio (real): 118%.
- Equity premium: 3%.
- Equilibrium interest rate: 4.75%.
- Volatility (standard deviation) percentage change interest rate: 15%.
- Volatility (standard deviation) equity yield: 18.5%.
- Correlation between interest rate changes and equity yield: 0.
- Percentage of equities in the asset mix: 50%.
- Wage inflation: 3%.
- Average duration of bonds in portfolio: 5 years
- Average duration of pension liabilities: 16 years.
- Retirement age: 65 years
- Indexation cut: maximum at a real cover ratio of 85%, nil from 105%, made good from 125%.
- Premium: 2.5 percentage point increase (to a maximum of 35% of basis for calculation) at a real cover ratio below 118% break-even to 125%, positive to 140%, refund from 200%.

For the purpose of premium setting, the cover ratio and the percentage cut in benefits, the figure shows both the average value over the 1000 paths (the expectation), and the 50%, 80%, 90%, 95% and 97.5% percentile. In addition, for the purpose of premium setting the average volatility is shown over the duration of the various scenarios. For each scenario, the standard deviation is calculated over a moving 10-year period, in which the negative premiums are set at zero. These values are then averaged over the 1000 scenarios. As regards the cover ratio, it shows both the real cover ratio (including the aim of indexation) and some percentiles of the nominal cover ratio. The latter is calculated on the basis of a

bond yield with no risk supplement. In addition, the figure shows the percentage of cases in which the real cover ratio remains below the target ratio of 118% for longer than 15 years (soft buffer) and the probability of a nominal shortfall of cover for more than one year in relation to the 105% threshold, and the probability of an inadequate nominal buffer (hard buffer) for more than 15 years (nominal cover ratio below 130%). The percentage cuts are also compared with the cut in an inflation-proof pension (indexation based on price inflation) compared to the prosperity-linked pension (indexation based on wage inflation).

Figure 5.1: Standard scenario with maximum premium increase if the buffer is inadequate



In comparison with the corresponding deterministic path (Figure 4.1) it is noticeable that the average premium setting in the equilibrium situation is lower in the stochastic scenario. This is due to the higher average cover ratio in the case of stochastic returns, because better than expected performance is not always fully offset by lower premiums, whereas an adverse performance does lead to a sharp increase in premiums. Against the lower average premiums, there is therefore an about 20% probability that the maximum premium will have to be paid. The average premium is lower than the median premium (the minimum premium payable in 50% of cases); this is because, when the cover ratio is very high, very substantial premium refunds are sometimes granted.

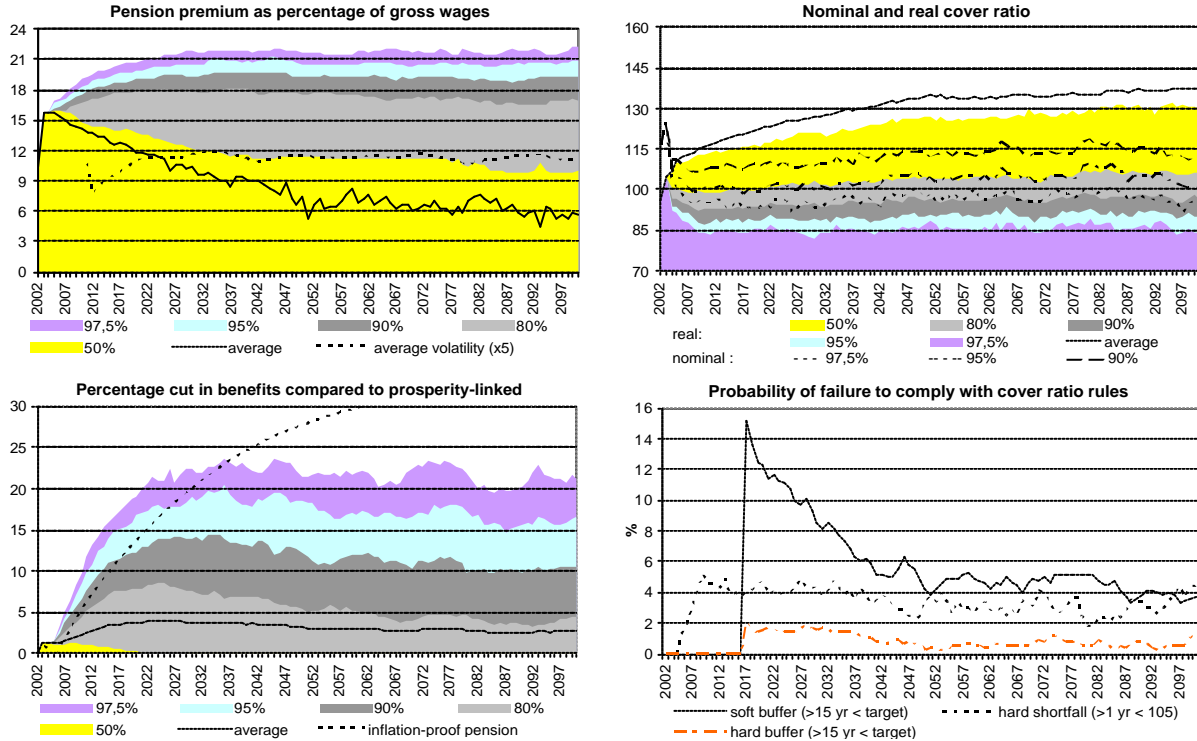
As regards indexation, the median cut is even less than the one in the deterministic scenario in that there is no cut in indexation in at least 50% of cases after 2015. In the 2.5% worst cases, on the other hand, the average benefit level is at least about 25% lower than it would have been without a cut in the

indexation. For the 5%, 10% and 20% worst scenarios, these percentage cuts are respectively around 20%, 12.5% and 5%. In comparison with an inflation-proof pension, benefits are initially lower owing to the low wage increases in 2004 and 2005, and because of cuts. However, from 2011 onwards, people with an inflation-proof pension are better off in just 20% of cases. From 2015, 2025 and 2031 onwards, the number of such cases is 10%, 5% and 2.5% respectively.

As regards the real cover ratio, we find that the probability of a shortfall of cover is still around 13%, even though the target ratio was chosen in order to keep that risk down to just 2.5%. That is because the actual cover ratio is lower than the target ratio in over 35% of all scenarios. If that is the case, although extra premium increases are applied, the probability of a shortfall of cover is still higher than 2.5% during the recovery period. We also find that the probability of a shortfall of cover is too high in the case of the nominal cover ratio. Even in the long term, there is still a 6% probability of it falling below 105%, whereas the target is 2.5%. However, the probability of inadequate cover and excessively low buffers in the long term is relatively small, in spite of the assumed independence of equity yields.

5.2 Scenario 5.2: 15-year recovery plan with inadequate buffer

Figure 5.2: Standard scenario for 15-year recovery plan with inadequate buffer



The second scenario that we consider here is more in line with the government’s Outline Agreement with employers and labour unions in the sense that, where buffers are inadequate, a shortfall premium is charged on top of the break-even premium to ensure that the fund is likely to meet the target cover

ratio again after 15 years (see Annex 2). Here it is assumed that the shortfall premium is not adjusted until the target cover ratio has been achieved and for as long as the actual cover ratio is at least equal to the anticipated cover ratio from the recovery plan. If new, adverse shocks scupper the original recovery plan, that plan is replaced by a new plan with a new 15-year horizon. However, the basic condition here is that the pension premium cannot be lowered before the target cover ratio has been achieved. Figure 5.2 shows the results.

In the first instance, premiums rise less steeply under this scenario. Although that is attractive in macro-economic terms, it means that the recovery takes longer. In first instance, the less aggressive premium adjustment increases the probability of buffers remaining inadequate for a long time. If portfolio returns remain low for a long time on the other hand, the maximum premium can increase above 20% of gross wages, whereas in the previous scenario they were limited. Consequently, the maximum cut in benefits is somewhat lower under this scenario. The probability of nominal and real shortfall of cover in this scenario is 5.2% and 13.5% respectively in the long term.

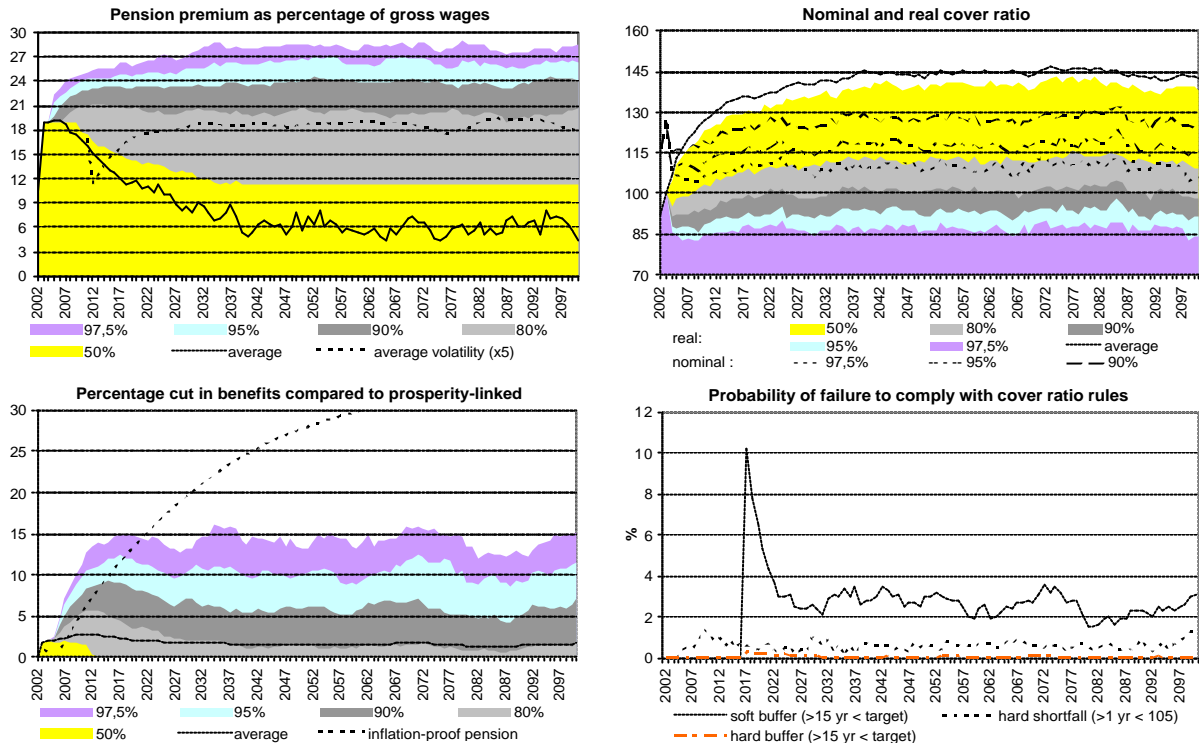
5.3 Scenario 5.3: 15-year recovery plan under fair-value accounting

The third scenario (Figure 5.3) applies fair-value accounting not only to the determination of the nominal cover ratio, but also to the total liability (nominal plus indexation aim). To determine the discount rate for the real cover ratio, we assume a risk supplement of 1.5% on top of the real interest rate. This discount rate is therefore equal to the current bond yield minus 1.5% (where 1.5% corresponds to indexation minus the risk supplement). Since in this case the liabilities change with the bond yield, the real cover ratio becomes more volatile. Consequently, the target cover ratio has to be 129% (instead of 118%), in order to keep the probability of a shortfall of cover one year later down to 2.5% (see Annex 1). The cover ratios up to which the break-even premium is charged and above which cuts are made good or premium holidays are granted are increased proportionately to 136.5% and 153% cover. In accordance with the above scenarios, premiums are still refunded from a cover ratio of 200% upwards.

The most striking difference between this scenario and variants with a fixed actuarial interest rate is that the pension premiums are very much higher at the extremes. This is because the pension liabilities rise very rapidly if the bond yield falls. For example, if the bond yield drops from 4.75% (the equilibrium value) to 3.32% (2 standard deviations lower) that causes a 25% increase in the *PPL*. The implicit assumption under fair value is that this low interest rate level will persist. The interest rate effect on the capital is much smaller, since only 50% is invested in fixed-interest securities; moreover, the average duration of the investments is just 5 years while for the liabilities it is 16 years. If this duration mismatch is eliminated, e.g. by means of compensatory contracts on the swap market, the

premium volatility is reduced but is still greater under fair value accounting than at a fixed actuarial interest rate.

Figure 5.3: Standard scenario with 15-year recovery plan under fair-value accounting



Since the bond yield actually tends towards an equilibrium level in a stable inflation environment, the actual recovery will proceed faster and, in comparison with the preceding scenario, a cut in indexation will be less likely. Moreover, the probability of a (long-term) shortfall of cover is slightly reduced. This scenario appears favourable, especially as regards the nominal cover ratio. That is a direct result of the fact that the discount rates for real and nominal liabilities are fully correlated, and premiums are set on the basis of real liabilities. However, the costs of this lower probability of a shortfall of cover are considerable in the form of far more volatile premium paths (the standard deviation is around 3.8 percentage points per annum, against 2.2 for the fixed actuarial interest rate), with very extreme peaks.

The premium volatility shown is in fact an underestimate, since no account is taken of the actual bond yield in calculating new pension accrual and shortfall premiums. If fair value accounting is applied totally consistently, the expected return has to be continually adjusted to the prevailing market interest rate. In the model, we refrain from doing this because it would greatly increase the calculations entailed. This implies that both the break-even premium and the shortfall premium will be even higher than the figures calculated here if the market interest rate is lower than the long-term equilibrium interest rate.

5.4 Scenario 5.4: 15-year recovery plan with a lower actuarial interest rate

An alternative method of reducing the probability of a shortfall of cover is to assume a lower actuarial interest rate. A lower actuarial interest rate offers protection against an over-optimistic assessment of the long-term equilibrium real interest rate or the equity premium. Compared to the fair-value method, this has the advantage that the liabilities are easier to predict and so the cover ratio is less volatile. In addition, a steep rise in the nominal interest rate will not immediately put pension funds under pressure to refund premiums.

Figure 5.4: Scenario for 15-year recovery plan with a fixed actuarial interest rate of 2.75%

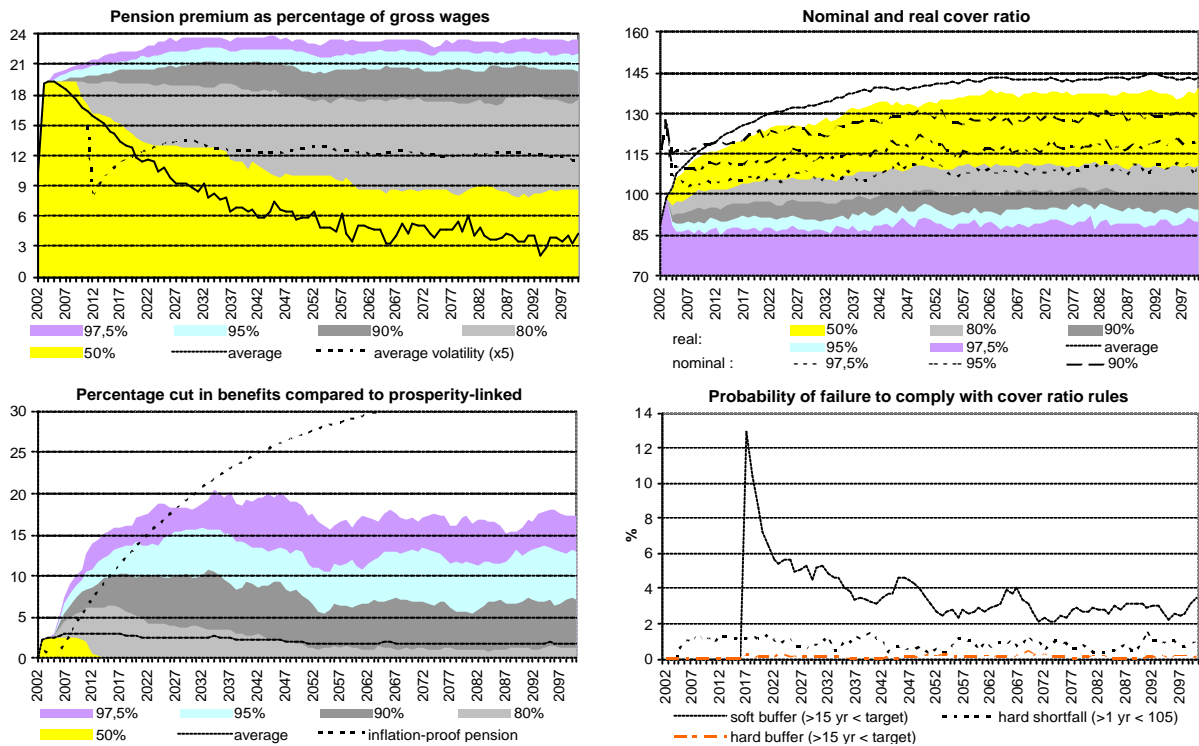


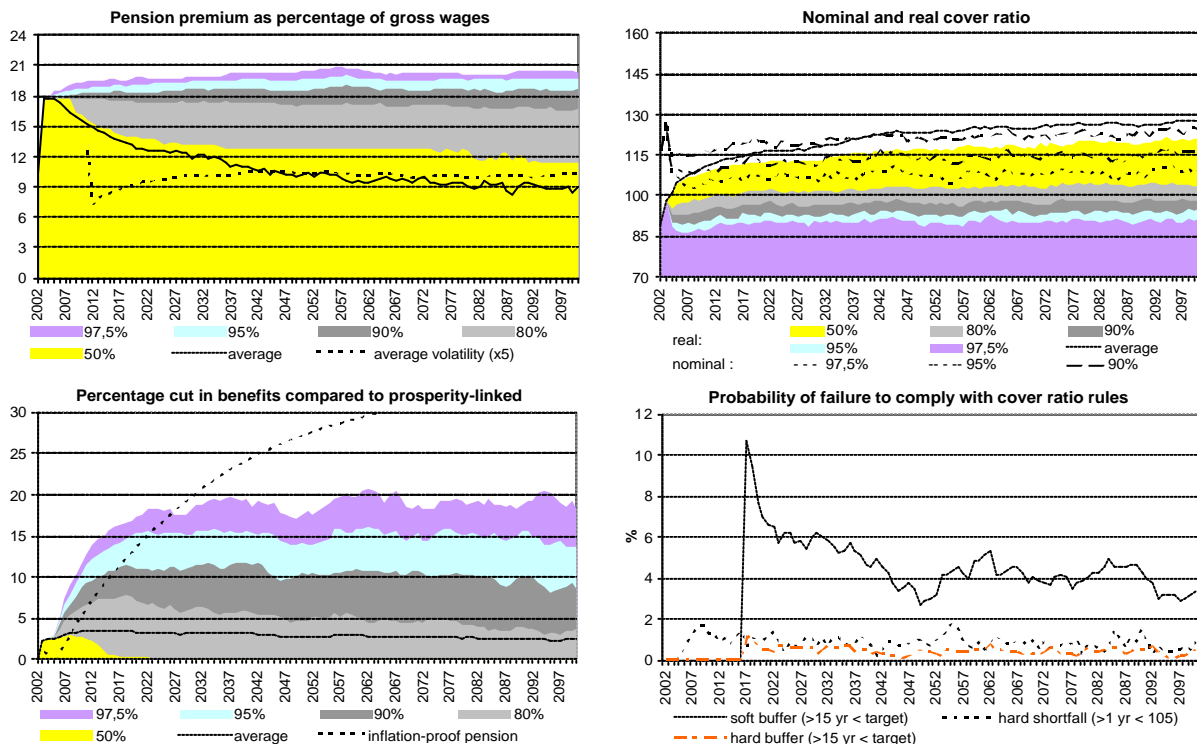
Figure 5.4 shows the results for a fixed actuarial interest rate of 2.75%. The lower actuarial interest rate has no influence on the target cover ratio (which is still 118%), since the uncertainty over the yields is unchanged. At the lower actuarial interest rate, pension premiums initially rise by more than in Scenario 5.2. The premium of about 19% in 2003 is comparable to the premium needed under fair value. The probability that premiums may continue to rise thereafter is much smaller for a fixed actuarial interest rate than under fair value however. Moreover, premium volatility is substantially lower, at around 2.5 percentage points, than under fair value. The difference between the actuarial interest rate and the fair value method as regards the percentage cut and the cover ratios is smaller for the lower actuarial interest rate. The probability of the real cover ratio remaining persistently too low is less if the actuarial interest rate is lower, because the lower discount rate implies higher capital at a given cover ratio, and that also means a higher expected investment income. In the long term, the average premium level is therefore lower than under a higher actuarial interest rate. Overall this

scenario looks attractive, although the necessary initial increase in premiums may look too expensive at present, in view of the macro-economic implications.

5.5 Scenario 5.5: 15-year recovery plan with a lower percentage of equities in the asset mix

The probability of a shortfall of cover and premium volatility can be further reduced by lowering the percentage of equities in the asset mix, and hence the investment risk. Figure 5.5 shows the results of cutting the percentage of equities from 50% to 33%. The lower percentage of equities affects the target cover ratio, which is 111.5% at a fixed actuarial interest rate (against 118% for 50% equities). The premiums holiday threshold and the cover ratio up to which the break-even premium is charged and above which cuts are made good are adjusted proportionately to 132.5% and 118% respectively. Premium refunds are still made from a cover ratio of 200% upwards. Once again, we assume a fixed actuarial interest rate of 2.75%, in accordance with the expected real investment return on 33% equities. This relationship between the actuarial interest rate and the expected return is not automatic. As a rule, the actuarial interest rate reflects the expected return on a representative portfolio. However, it is always permissible to apply a lower actuarial interest rate, and that is strongly to be recommended if the expected return on the actual portfolio is lower than that on the representative portfolio. Conversely, the actuarial interest rate cannot be increased in the case of a riskier portfolio.

Figure 5.5: Scenario for 15-year recovery plan with a lower percentage of equities in the asset mix



As a result of the lower percentage of equities, the volatility in the premium setting does indeed decline. Even for the worst yield paths, the premium setting is still acceptable. However, on the other hand the average premiums charged are around 3 percentage points higher than in the basic scenario with 50% equities and an actuarial interest rate of 3.25% (Figure 5.2), and as much as 5 percentage points higher than in the scenario with 50% equities and an actuarial interest rate of 2.75% (Figure 5.4). This also occurred in the deterministic scenarios (Figure 4.2). As regards the percentage cuts and the probability of a persistent shortfall of cover, the results are slightly less favourable than those of the previous scenario.

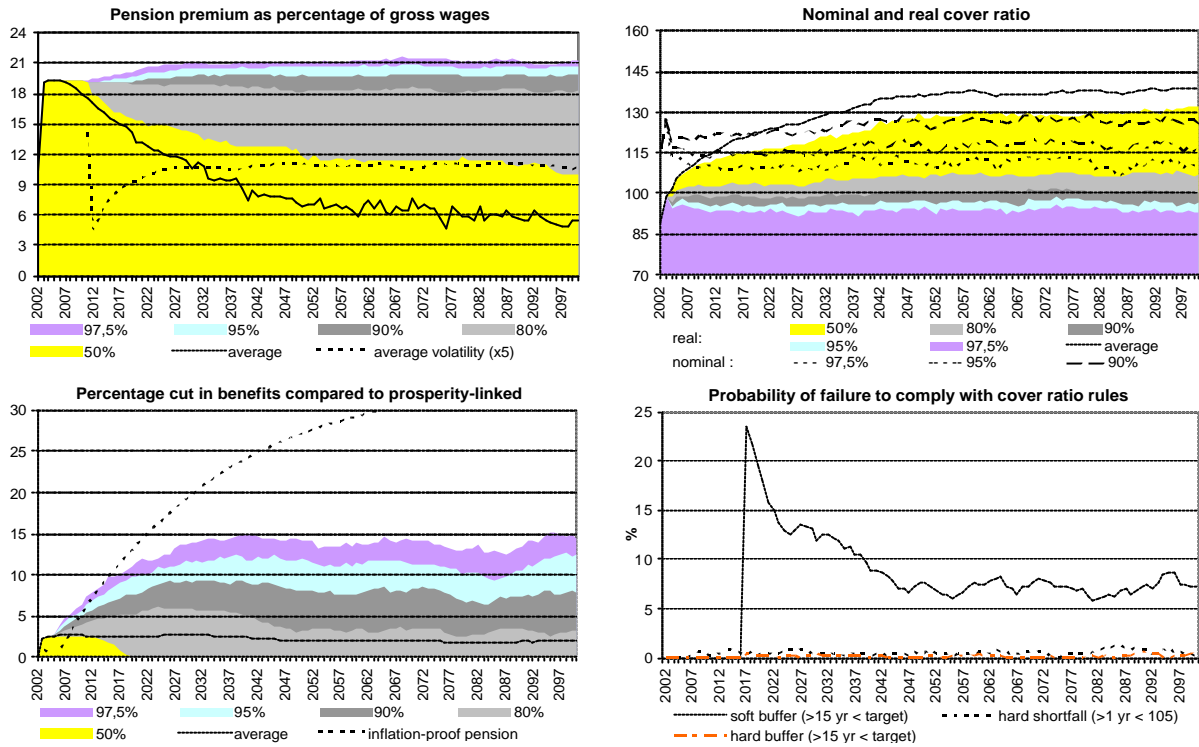
5.6 Scenario 5.6: 15-year recovery plan with a variable percentage of equities in the asset mix

The greatest drawback of fewer equities in the asset mix is therefore the higher average premiums. One possible compromise is to adjust the asset mix on the basis of the level of the cover ratio. If the cover ratio is high, it is possible to take more risks, so the percentage of equities in the asset mix can increase. Conversely, a fund which is short on cover owing to a stock market crash will have to adjust its asset mix and sell equities. This idea became particularly popular after the succession of three bad investment years from 2000-2002. On the one hand, a fund with a shortfall of cover can withstand fewer shocks, which is an argument for reducing the risk and hence cutting down on equities. On the other hand, the fact that a bond portfolio generates relatively low yields will limit the chances of a speedy recovery. In addition, this strategy means that equities have to be sold at precisely the moment when their price has fallen. However, in the current simulation setting, that is no disadvantage since equity yields are assumed to be totally independent over time (i.e. we assume that there is no mean reversion). If the strategy were adopted of insisting on selling after a crash, there would also be the risk that pension funds would reinforce the volatility of the stock markets and the correlation between equity yields and interest rate changes.

Figure 5.6 shows the effects of a variable asset mix. The assumed percentage of equities in this flexible variant is 20 up to a cover ratio of 100%, and then increases in a straight line to 50 at a cover ratio equal to the target. This target cover ratio is 118%, even if the percentage of equities is temporarily reduced, because the aim is to have 50% equities. An actuarial interest rate of 2.75% is applied in the simulation. The most striking result is that recovery is hampered in the case of a variable asset mix. The probability that the cover ratio will still fall short of the target in 2017 is as much as 23%. Even in the long term, the probability of inadequate buffers persisting for longer than 15 years is relatively high. The lower chance of recovery is also evident in the percentage cuts. There is a greater probability of a small cut, but on the other hand, in the worst scenarios the percentage cut is smaller than if the proportion of equities were fixed. As regards the premium setting, the scenario offers a favourable picture with a low level of premiums on average, low volatility and no extremes. However,

with this scenario in particular we might wonder whether the assumption of independent equity yields is actually all that realistic. We shall consider this further in Section 6.

Figure 5.6: Scenario for 15-year recovery plan with a variable percentage of equities



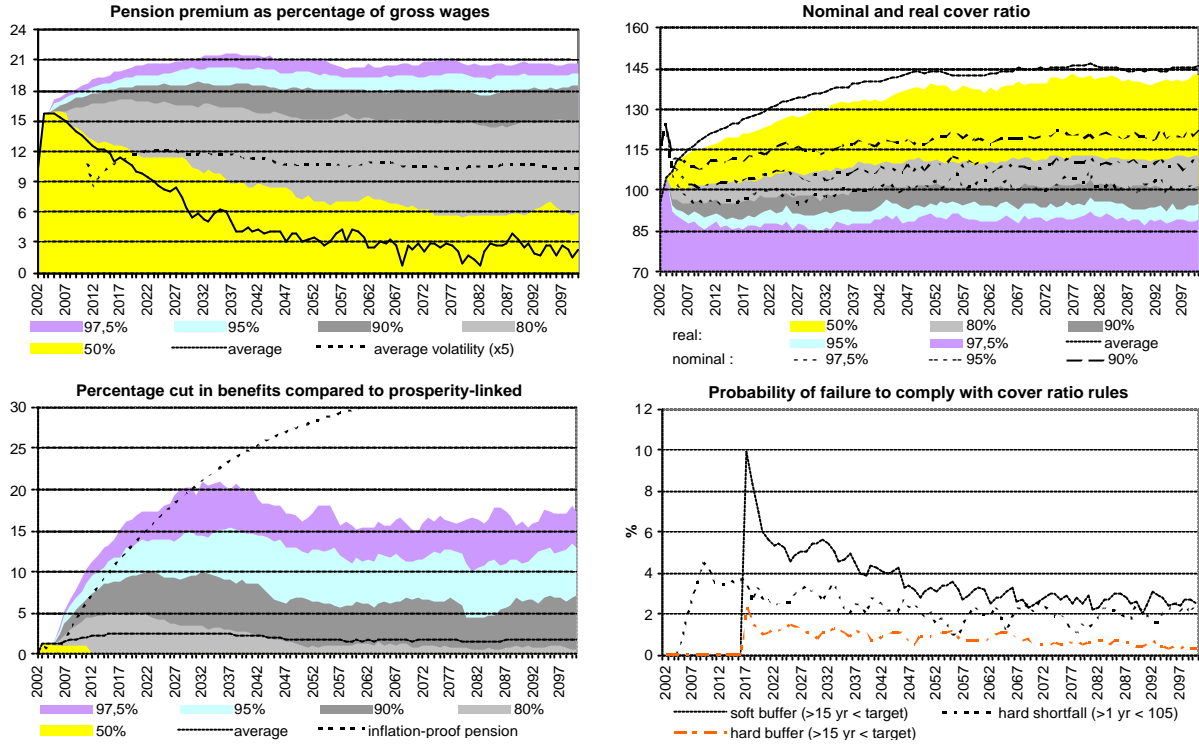
5.7 Scenario 5.7: 15-year recovery plan with a higher equity premium

On grounds of prudence, we apply a standard equity premium of 3% in this study. We deliberately chose this conservative figure, which is below the historical levels observed, to avoid any excess optimism. In this scenario we present the effects of this cautious assessment by taking the equity yields from a probability distribution in which the actual equity premium is 4%, which is closer to the historical values. We set the actuarial interest rate at 3.25% and leave the cover ratio at 118%. This means in fact that we still assume the lower equity premium for the purpose of calculating the cover ratio and pension premiums, and that the actual equity yields are highly likely to come up to expectations.

The higher average equity yields have a substantial positive effect (see Figure 5.7). The average pension premium comes down to below 3% in the long term, while the maximum premium and the volatility of premium payments are also lower than in the standard scenario (Figure 5.2). This is due partly to the higher cover ratios. In the long term, the probability of a nominal shortfall of cover is roughly 3.4%. The probability of a real shortfall of cover is still almost 9% in the long term, but there is little probability of persistently inadequate buffers. As regards the percentage cuts, the picture is

also favourable, comparable to the scenario with a 3% equity premium and an actuarial interest rate of 2.75% (Figure 5.4).

Figure 5.7: Scenario for 15-year recovery plan with a 4% equity premium



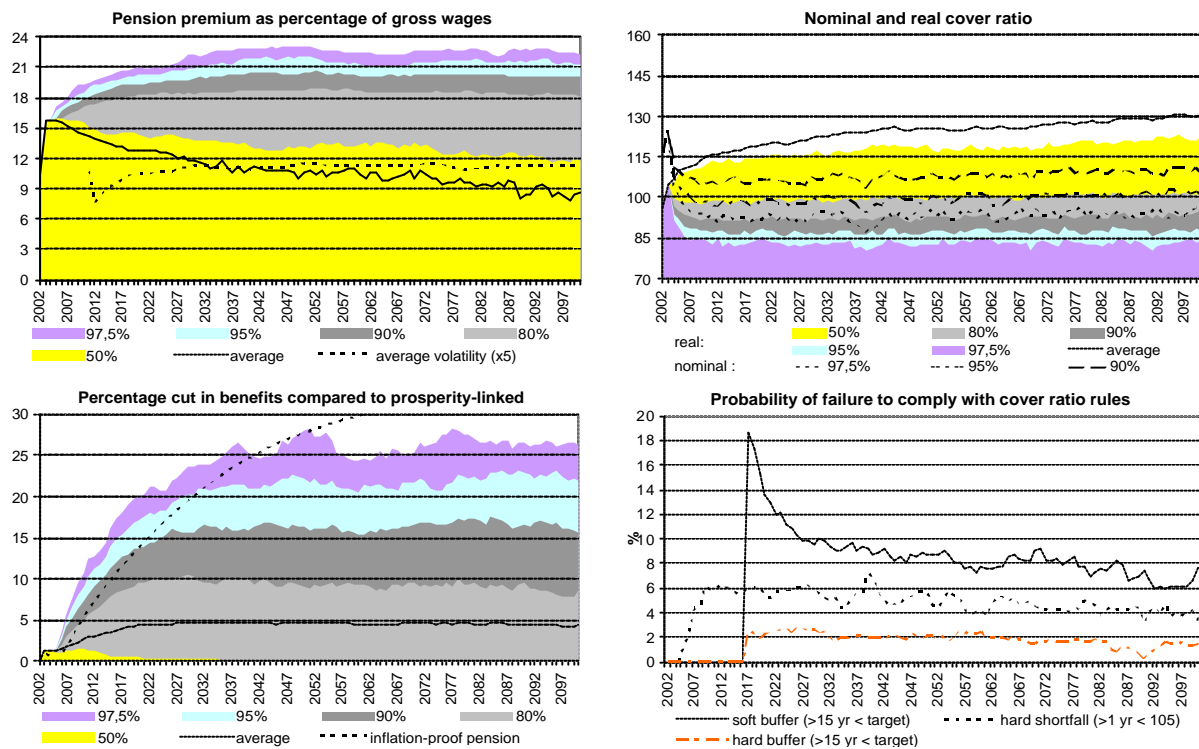
5.8 Scenario 5.8: 15-year recovery plan with ex-post lower real investment returns

Although the assumptions applied as regards bond and equity yields are realistic to conservative, the future remains uncertain, by definition. Scenario 5.8 shows the effects of a half a percentage point fall in real investment returns. These lower returns may be due to a further decline in the equity premium or a larger increase in gross wages (if the nominal interest rate falls, the results for the nominal cover ratio change). The reason for the disappointing real investment returns (higher wage increases or a lower equity premium) actually matters, because given a lower real interest rate on account of higher wage increases it is possible that bigger indexation cuts may nevertheless coincide with greater purchasing power for pensioners, namely if prices do not inflate as strongly as wages. We set the fixed discount rate at 3.25%, and the target cover ratio is still 118%.

The over-optimism concerning investment returns leads to a less favourable picture (Figure 5.8). The average pension premium is 3.5 percentage point higher than the one in the standard scenario with a 15-year recovery plan (Figure 5.2). This is due partly to the lower cover ratios, which increases the probability of their entering the danger zone. At the extremes, the pension premiums are hardly any higher. This is because we are using 15-year plans based on the more optimistic expectations

regarding yields. The fact that yields fall short of expectations increases the probability of non-compliance with cover ratio rules; the cover ratio is more frequently and more persistently below the target level. This also increases the probability of indexation cuts and the maximum level of cut. In fact, this variant is broadly the mirror image of the previous scenario in which investment returns came up to expectations based on a conservative estimate.

Figure 5.8 Scenario for 15-year recovery plan with ex-post lower real investment returns



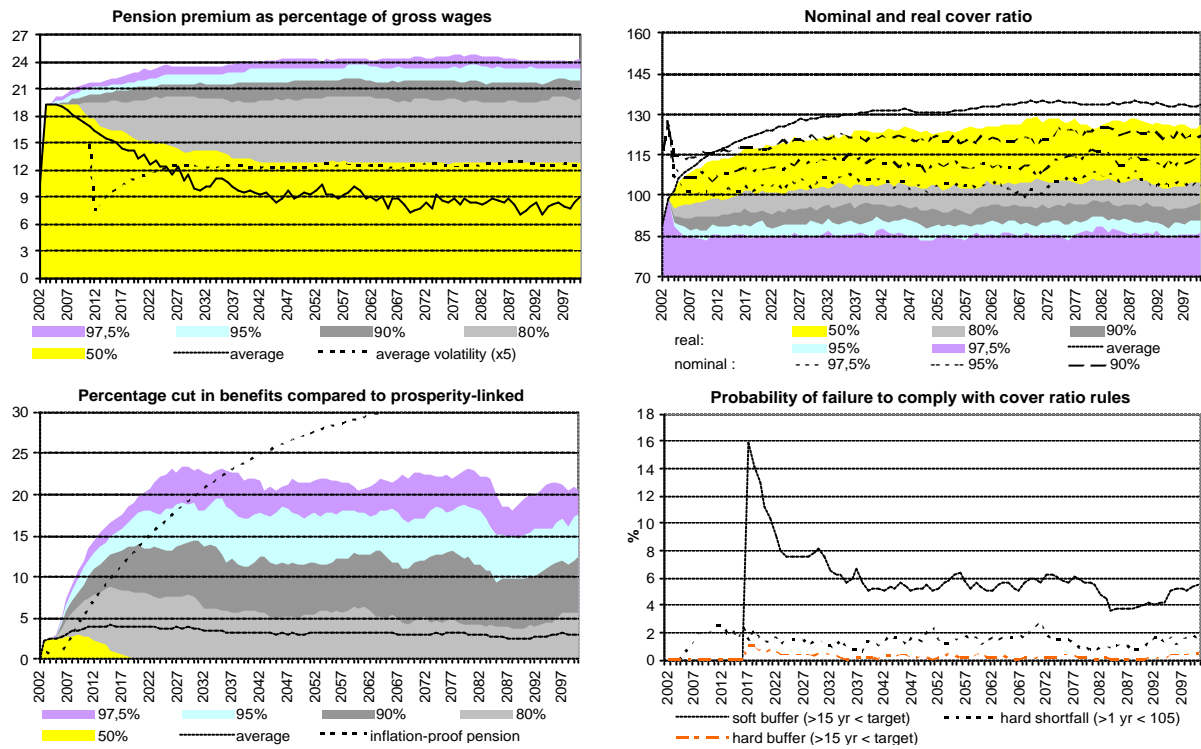
5.9 Scenario 5.9: 15-year recovery plan with anticipated lower real investment returns

The next logical question is how things look if we anticipate lower real investment returns by simultaneously reducing the fixed actuarial interest rate by half a percentage point to 2.75%. It is not in fact likely that people would remain too optimistic about the expected real returns for 100 years.

The effect is that, given a cover ratio below the target level, the premiums will be set more aggressively because lower returns are expected. This brings the average premium level down in the long term to around 8.5% of the gross wage bill. The reason is that with a lower actuarial interest rate a larger amount of capital is needed to meet the cover requirements. The return on the capital buffers can be used to reduce premiums. Also, the shortfall of cover is rectified more quickly, after which the interest-bearing buffers become a factor once again. This means that the average cover ratio is higher and there is less probability of an indexation cut, and the maximum cut is lower than when returns fall short of expectations as in Scenario 5.8. The main conclusion of the last three scenarios is therefore that a pension system in which the assessment of expected returns is conservative to realistic offers

favourable long-term prospects as regards the average premium levels and pension security (i.e. the probability of an indexation cut and the maximum level of the cut, and the probability of periods with a shortfall of cover). On the other hand, in cases where the cover ratio falls short of the target level, relatively strenuous measures are necessary. Viewed from the angle of macro-economic stability, the timing of such measures is often unfortunate.

Figure 5.9 Scenario for 15-year recovery plan with anticipated lower real investment returns



6 HISTORICAL SIMULATIONS

The stochastic scenarios in the previous section were presented in the form of Monte Carlo simulations, i.e. 1000 paths were simulated for the trend in investment returns to provide a clear picture of the uncertainty in that respect. In conceptual terms, this means that we in fact assume that the future will manifest itself as one of these 1000 paths. Another familiar simulation technique, as used in Value-at-Risk calculations by banks, is the historical simulation. This describes what would happen if an event or a series of events from the past were to recur. The advantage of this approach is that the results are not influenced by assumptions about distributions, for example.

In the stochastic simulations we assumed that equity yields are totally independent of past performance. This means that we take no account of the current level of the stock market. Although mean reversion on the stock market is difficult to demonstrate, we can nevertheless assume that the probability of a crash declines if there has recently been a slump in the market⁴. Since the analysis horizon stretches far into the future where pensions are concerned, it is worth investigating the importance of equilibrium recovery on the stock market in more detail.

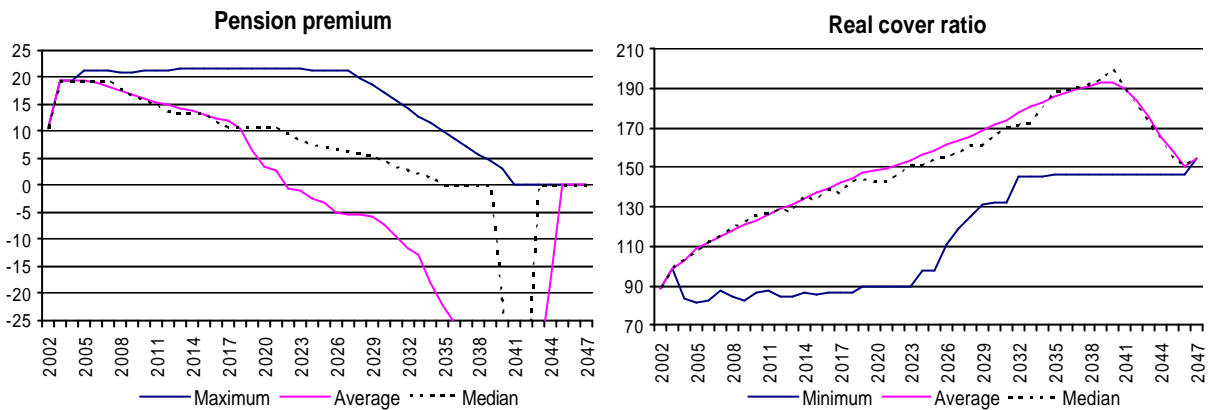
This is done on the basis of a historical simulation, for which we use real equity yields and real interest rates from 1960 to 2003. In the analysis we assume that yields from 2004 will follow the same path as historical yields. For yields from 1960 onwards, this therefore gives a prediction for the period 2004-2047. If we select a later starting point from the 1960-2003 period, the prediction horizon is correspondingly shorter; for example, using yields during the 2000-2003 period only offers a prediction up to 2007. Apart from the inclusion of equilibrium tendencies, the historical simulation has the additional advantage that time-varying correlations between interest rates and equity yields are implicitly taken into account.

As regards real interest rates, we use the yields on Dutch long-term government bonds and Dutch inflation. In contrast, the real equity yields are based on an international portfolio spread with the yield being assumed to equal a weighted average of the real equity yields in the various regions. The implicit underlying assumption is that the currency risk is fully hedged, and the costs of the hedge are equal to the inflation differential between the Netherlands and the region in question. As regards the spread, for the 1970 – 2003 period we take the MSCI total return indices for the Netherlands (15%), rest of Europe (35%), the US (40%) and Japan (10%), for the 1965 – 1969 period we take the total return indices for the Netherlands (20%), the UK (30%) and the US (50%), and for 1960 – 1964 we take just the indices for the Netherlands (50%) and the US (50%).

⁴ A regression of equity yields based on the one-period delayed ratio between the price index and nominal GDP suggests that 'overvaluation' on the stock market has an average half-life of 4 to 7 years.

Figure 6.1 gives the results for the pension premium and the cover ratio assuming an asset mix containing 50% equities and a fixed actuarial interest rate of 2.75%. These assumptions correspond to the stochastic scenario in Figure 5.4. The maximum pension premium over all 44 historical yield paths is 21.5% of the gross wage bill, somewhat less than the 95% -percentile in the stochastic scenario. For all scenarios with a starting year between 1960 and 1986, there are substantial premium refunds during the stock market boom corresponding to the late 1990s, up to cumulative 36% of gross wages, without this leading to premiums being charged after the stock market crash years, 2000-2002.

Figure 6.1 Historical simulation with 50% equities and an actuarial interest rate of 2.75%



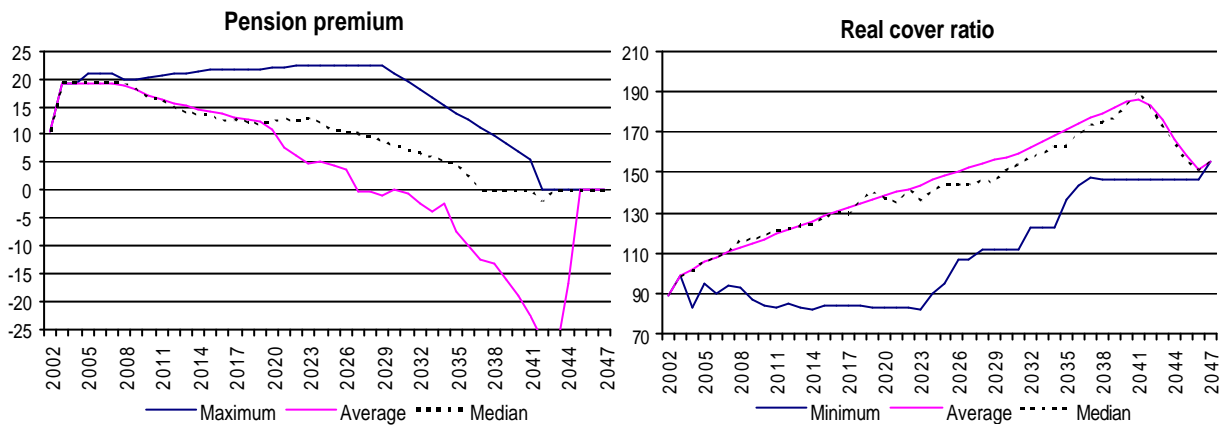
By 2008, the average cover ratio is already above the target of 118% and rises steadily thereafter to 190% in 2037. The very high real interest rate and equity yields of the 1980s and 1990s make the pension funds effortlessly rich. Even with the most negative yield paths, the real cover ratio remains just above 82%, comparable to the 97.5% percentile in the stochastic scenario. Almost every year, the minimum cover ratio relates to a different scenario. Only if future yields correspond to those for the 1969-2003 period will the cover ratio remain below the target level for longer than 15 years (namely 16 years). One of the reasons for this relatively favourable result is the inclusion of the predicted low wage increase in 2004 (1.4%) and 2005 (0.6%). Also, the positive performance by equities in 2003 (20%) secured a significant improvement in the starting position (cover ratio of 98.5% at the end of 2003 with an actuarial interest rate of 2.75%).

The importance of the mechanisms restoring equilibrium on the stock market is mainly of relevance for the assessment of a variable asset mix. Figure 6.2 shows the results of a historical simulation with a variable asset mix. As in the case of the stochastic simulation (Figure 5.6), the percentage of equities is assumed to be 20 until the cover ratio reaches 100%, rising to 50 when the cover ratio equals the target.

It is even more apparent than in the stochastic simulation that adjusting the asset mix in line with the financial position of the fund has hardly any positive impact on the recovery. In the series of poor

investment years, 1973-1974 and 2000-2002, it is true that a prompt reduction in the percentage of equities would have initially helped to keep the cover ratio from falling far below 100%, yet the subsequent recovery path is considerably more arduous. Since less advantage is taken of the stock market rally, the cover ratio remains low, making it harder to cope with further negative shocks. Moreover, the premium setting is significantly higher on average, without being offset by lower premiums at the extremes. A flight-to-quality when cover ratios are low is therefore not very attractive on the basis of either the stochastic simulation or the historical yield paths.

Figure 6.2 Historical simulation with 20 to 50% equities and an actuarial interest rate of 2.75%



7 CONCLUSIONS

This study presents an actuarial pension model (PALMNET) appropriate to the typical pension contract in the Netherlands. We assume a defined benefit pension system based on average earnings, in which the nominal commitments are guaranteed while the fund also aims to link the pension rights to wage inflation. However, this indexation is conditional on a management decision, which in practice means that indexation is applied if the pension assets permit. The model provides an analysis framework for investigating the possible consequences of adjustments to such factors as the asset mix, retirement age, life expectancy, method of discounting, equity premium and the method of setting premiums or indexation. The importance of uncertainty about interest rate movements and equity yields is demonstrated explicitly via stochastic and historical simulations. In this, PALMNET differs from existing, usually deterministic models. The simulations are based on realistic to conservative assumptions regarding yields and volatility, and plausible choices of strategy as regards indexation and premium setting. The pension model is sufficiently flexible so that, if necessary, many variations of these assumptions and choices can be analysed. The starting point for the model is that, in the case of yields falling short of expectations, leading to excessively low capital buffers, recovery mechanisms take effect via premium setting and cuts in indexation, if necessary on the basis of long-range plans. The study design is partial in the sense that it does not model the macro-economic implications of the choices made.

The main conclusions are:

- A wage-indexed pension is still affordable even in the present situation in which pension funds have a substantial funding shortfall. For average portfolio returns, the pension premium may gradually be reduced after an initial rise to about 16% of gross wages to about 14% in 2010, 12% in 2020, 10% in 2030, 9% in 2040 to an equilibrium level of about 6% in the second half of this century. If yields remain much lower than to be expected on the other hand, premiums may have to rise to above 20% however.
- Aiming at a cover ratio in which the probability of a shortfall of cover one year later is equal to 2.5%, in combination with the application of long recovery periods, implies a significantly higher real probability of a shortfall of cover. In the standard scenario of the pension model, in which the aim is to provide a wage-indexed pension, that probability is roughly 13.5%. However, if the aim is to provide a prosperity-linked pension, the probability of a shortfall of cover for the nominal guarantees is lower, but still higher than 5%.
- Making wage indexation conditional upon the existence of adequate capital buffers means that a fully prosperity-linked pension is not achieved in a small number of cases. Thus, the cumulative cut in indexation is at least 20% in the 2.5% worst cases. However, since wage inflation outstrips price

inflation, an inflation-proof pension is often achieved in these cases, though not always in the initial years.

- Longer recovery periods are associated with a greater probability of funding shortfalls and cuts in indexation. Furthermore, a lower average cover ratio leads to a higher average pension premium in the long run. On the other hand, in the most unfavourable cases the pension premium is actually not as high.

- The application of fair value accounting to the conditional commitments greatly increases the premium volatility, with sometimes great extremes in the case of low interest rates. The lower probability of a nominal shortfall of cover under fair value accounting can also be achieved at lower cost by applying a lower actuarial interest rate.

- Reducing the percentage of equities in the asset mix from 50% to 33% yields a 2 to 3 percentage point reduction in the premium required at the given actuarial interest rate if the investment performance falls far short of expectations. However, this is offset by the fact that the *average* annual premium is around 5 percentage points higher (as a percentage of the gross wage bill).

- Reducing the percentage of equities in the asset mix in response to a low cover ratio considerably hampers the recovery. While the probability of acute problems in the short term (1 to 5 years) is slightly smaller, there is a substantially greater probability of problems in the medium term (6 to 20 years).

- Raising the retirement age only improves the capital position of pension funds in the short term if accrued pension rights (the pension payable at age 65) are not or not fully offset by a higher pension in later years.

- Workers and pensioners gain pension security if the premiums are based on a conservative estimate of investment returns, resulting in a low actuarial interest rate. This reduces the probability of periods of funding shortfall and indexation cuts. It also brings higher average cover ratios, so that pension premiums are lower, on average, in the steady state. In view of the pension funds' existing shortfalls, however, such a strategy would cause very steep premium increases in the short term, which would have unwelcome macro-economic consequences in the current state of the economy.

ANNEX 1: CALCULATION OF THE BUFFERS REQUIRED

The volatility of the cover ratio can be calculated from the equity and interest rate volatility and the partial derivatives of the cover ratio according to equities and the interest rate:

$$\mathbf{s}_C^2 = \begin{bmatrix} \frac{\partial C}{\partial Y} \\ \frac{\partial C}{\partial R} \end{bmatrix} \begin{bmatrix} \mathbf{s}_Y^2 & \mathbf{r}\mathbf{s}_Y\mathbf{s}_R \\ \mathbf{r}\mathbf{s}_Y\mathbf{s}_R & \mathbf{s}_R^2 \end{bmatrix} \begin{bmatrix} \frac{\partial C}{\partial Y} \\ \frac{\partial C}{\partial R} \end{bmatrix}$$

where \mathbf{s}_C , \mathbf{s}_Y and \mathbf{s}_R are the volatilities of the cover ratio, equity yields and interest rate changes respectively, and \mathbf{r} the correlation between the latter two variables. The partial derivative of the cover ratio to equities is:

$$\frac{\partial C}{\partial Y} = \mathbf{a}C_0$$

where \mathbf{a} is the percentage of equities in the investment portfolio and C_0 is the original cover ratio. The derivative to the interest rate, for a fixed actuarial interest rate, is equal to:

$$\frac{\partial C}{\partial R} = \frac{-d_{ass}(1-\mathbf{a})C_0}{1+r}$$

where d_{ass} is the average duration of bonds in the investment portfolio and r is the interest rate. Under fair value, there is an additional term on account of the uncertain pension liabilities

$$\frac{\partial C^f}{\partial R} = C_0^f \left(\frac{d_{lia}}{1+r+\mathbf{d}-index} - \frac{d_{ass}(1-\mathbf{a})}{1+r} \right)$$

where d_{lia} is the average duration of the liabilities, d is the risk supplement in the discount rate under fair value and $index$ is the average expected indexation rate. On this basis it is possible to calculate how large the buffer needs to be if the probability of a shortfall of cover occurring within one year is to be only 2.5%:

$$C^{target} = C^{min} / (1 + \mathbf{m} - 1,96\mathbf{s}_C)$$

where C^{min} is the minimum cover ratio and μ the expected real return:

$$\mathbf{m} = r + \mathbf{a} * equity_premium - index$$

ANNEX 2: CALCULATION OF SHORTFALL PREMIUMS

To ascertain the premium required we assume a fixed shortfall premium over 15 years, on top of the break-even premium, to finance new accrual and administration expenses. This shortfall premium can be calculated as follows:

$$E_t(C_{t+1}) = \frac{E_t(W_{t+1})}{E_t(PPL_{t+1})} = \frac{W_t(1 + E_t r_{t+1}) + (p_{t+1}^{act} + p^{shortfall})base_{t+1} - benefits_{t+1} - costs_{t+1}}{PPL_t(1 + disc_{t+1} + index_{t+1})(1 - cut_{t+1}index_{t+1}) + accrual_{t+1} - benefits_{t+1}}$$

The expected cover ratio for the ensuing period $E_t(C_{t+1})$ depends on the change in the capital (W) and on the provision for pension liabilities (PPL). The capital increases by the investment income (the expected nominal return being $E_t r_{t+1}$) and the premium payments (p_{t+1}^{act} and $p^{shortfall}$ are the actuarial and shortfall premium percentages respectively and $base_{t+1}$ is the premium base) and reduces by the benefits paid out and the administration expenses. The PPL increases by the discount rate ($disc$), indexation ($index$), with the possibility of a cut in the indexation, and the new accrual of pension rights and reduces by the benefits paid out. The actuarial, or break-even, premium is equal to the accrual plus administration expenses. If the discount rate is equal to the (constant) expected real return⁵, we can also express the expected cover ratio as:

$$E_t(C_{t+1}) = 1 + \frac{(C_t - 1 + cut_{t+1}index_{t+1})PPL_t(1+r) + p^{shortfall}base_{t+1}}{PPL_t(1+r)(1 - cut_{t+1}index_{t+1}) + accrual_{t+1} - benefits_{t+1}}$$

If we then assume that, for the purpose of calculating the shortfall premium, we cannot take account of indexation cuts after period $t+1$, the shortfall premium can be calculated as:

$$p^{shortfall} = \frac{(C^{target} - 1 + cut_{t+1}index_{t+1})PPL_t(1+r)^{15} + (C^{target} - 1) \sum_{i=0}^{14} (1+r)^i (accrual_{t+15-i} - benefits_{t+15-i})}{\sum_{i=0}^{14} (1+r)^i base_{t+15-i}}$$

The first part of the numerator gives the value of the current shortfall in 15 years' time, taking account of a possible reduction in the PPL owing to a cut in the indexation in the initial period. The second

⁵ Using a fixed actuarial interest rate method, we set the expected return equal to the actuarial interest rate. The implicit assumption under fair value is that the future interest rate is equal to the current interest rate. However, in order to calculate the shortfall premium and the new pension accrual, we assume the long-term equilibrium interest rate (plus an equity premium), since continuous adjustment of the expected return in line with the current interest rate entails too many calculations owing to the age-dependent value of new pension accrual.

part reflects the fact that the break-even premium can be lower if the target cover ratio is higher than 100%, since these reserves also generate income. This effect also means that a smaller premium base causes a less than proportionate need for a higher shortfall premium. The denominator gives the future value of the premium base in the coming 15 years.

If the discount rate in the calculation of the *PPL* and the actuarial premium differs from the expected real rate of return, no simple formula can be determined. If the discount rate is lower than the expected rate of return, it is actually conceivable that the shortfall premium might be negative, since in that case the capital is likely to grow faster than the liabilities.

The expected path for the cover ratio then follows the recursive rule:

$$\hat{C}_t = \frac{\hat{C}_{t-1}PPL_{t-1}(1+r) + premium_t - benefits_t - costs_t}{PPL_t}$$

In a deterministic world, this shortfall-premium rule means that the cover ratio target is met exactly after 15 years. However, in practice the return will deviate from the expectations in almost every year. If the return exceeds expectations, we do not alter the shortfall-premium rule unless the target cover ratio has been achieved, in which case the shortfall premium can be dropped. If the return is too low so that the actual cover ratio falls below the specified path, there are basically two options. Either an additional shortfall premium is determined on the shortfall in relation to the specified cover ratio, or the old shortfall premium is replaced by a new one based on the current shortfall in relation to the target cover ratio. In the first case, 15 shortfall premiums could theoretically apply at the same time.

Figure A.1: Real cover ratio and pension premium in the event of multiple parallel shortfall premiums

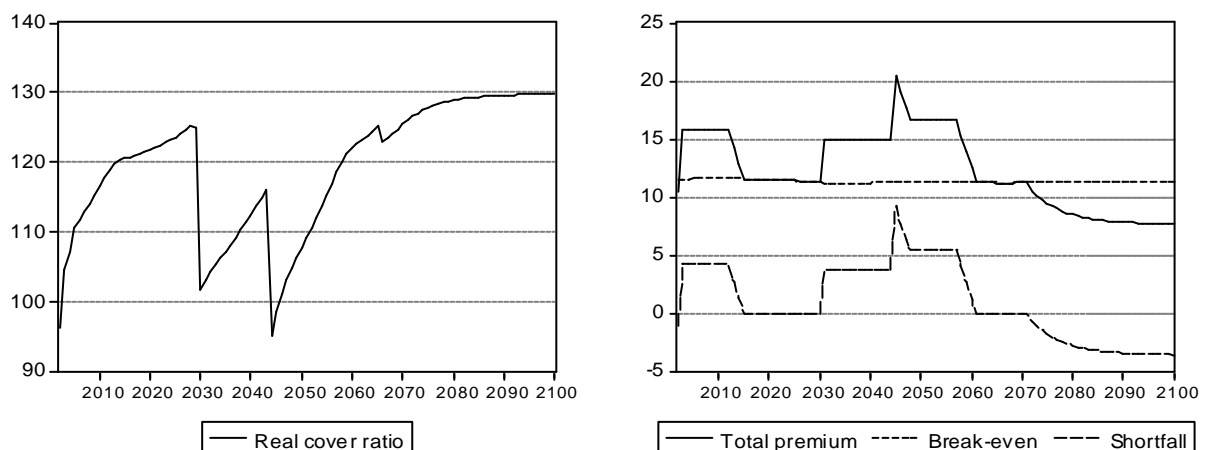
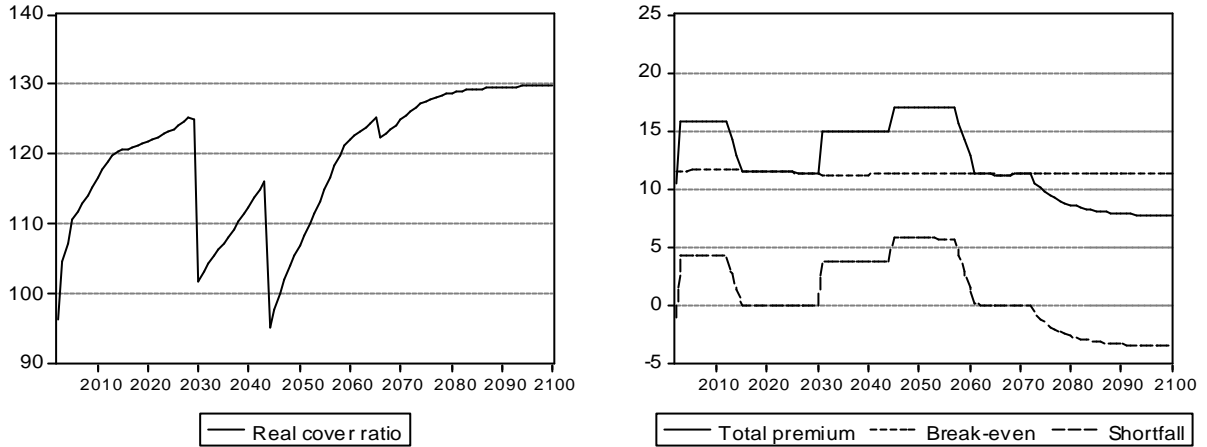


Figure A.1 shows how the cover ratio and premium percentages change in the case of multiple shortfall premiums if the return deviates from the expectation only in 2030 and 2044. A clear disadvantage of this method is that the premium setting may become highly volatile with possibly very

great extremes at the top end. If a new shortfall premium is set in the event of a new negative shock, the premium path becomes more attractive (Figure A.2).

Figure A.2: Real cover ratio and pension premium with revised shortfall premium



However, we impose the additional condition that a new recovery plan must never lead to a lower shortfall premium. If the shortfall premium according to a new 15-year recovery plan were to lead to a pension premium lower than that under the old plan, the old premium is maintained until the target cover ratio is achieved. That premium may therefore be charged for longer than 15 years.

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