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Maarten van Rooij

Arjen Siegmann

Peter Vlaar

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Maarten van Rooij (DNB and Netspar)
Arjen Siegmann (Free University of Amsterdam)
Peter Vlaar (DNB and Netspar)*

Abstract

Market valuation is becoming more and more popular, both in accounting and regulation, as well as in academic circles. For pension funds and their participants, the knowledge that market-valued pension liabilities can indeed be transferred to a third party, if necessary, is a great virtue. Using a simulation model, this paper demonstrates the implicit costs and benefits of using market valuation for a typical Dutch pension fund, which offers a guaranteed average pay nominal pension with conditional indexation. The impact turns out to be fairly small, if fixed discount rates are still used for conditional rights. However, if market valuation is used for both unconditional and conditional rights, contribution volatility increases significantly. A remedy is to increase the duration of assets considerably. It is not clear, though, whether this option is available for large pension funds given the limited supply of long-term bonds.

Keywords: defined benefit pension funds; fair value versus actuarial discounting; Monte Carlo simulation; asset and liability management; pension liabilities; conditional indexation
JEL Codes: G23, C15, C59, J18

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* Maarten C.J. van Rooij, Economics & Research Division, De Nederlandsche Bank, P.O. Box 98, 1000 AB, Amsterdam (m.c.j.van.rooij@dnb.nl), Arjen H. Siegmann, Free University of Amsterdam, Department of Finance, De Boelelaan 1105, 1081 HV, Amsterdam (asiegmann@feweb.vu.nl), and Peter J.G. Vlaar, corresponding author, Economics & Research Division, De Nederlandsche Bank, P.O. Box 98, 1000 AB, Amsterdam, tel: +31 (0)20 524 3189 (p.j.g.vlaar@dnb.nl). This paper benefited from discussions at seminars at DNB, PVK, ABP and CPB. We are grateful to Jan-Marc Berk, Dirk Broeders, and Peter van Els for useful suggestions and comments on a previous version of the paper. Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

1. Introduction

New rules in financial accounting (IFRS, Basle II, and Solvency II) require the use of market prices in the valuation of financial assets and liabilities of listed companies and financial institutions (marking-to-market). In the Netherlands, market valuation of pension liabilities has become regulatory practice as of 2007 onwards. Until recently, the traditional method of discounting in the Netherlands used a fixed actuarial interest rate, in which the maximum permitted rate was prescribed by the supervisory authority. This maximum permitted actuarial interest rate had remained constant at 4% for pension funds since October 1969. The new regulatory framework (called 'Financieel Toetstingskader' or FTK) stipulates that liabilities have to be marked-to-market. In the international context, the FTK is one of the first regulatory frameworks based on market valuation (see Ambachtsheer (2005)). The current paper focuses on the Dutch situation as case in point of the effects of market valuation.

For unconditional pension rights, the market valuation principle leads to increased transparency and accountability. If the market-value of assets is smaller than the market-value of guaranteed liabilities, the pension fund clearly has a solvency problem. For conditional pension rights, however, the market valuation principle does not lead to higher transparency. The reason is that the target asset level of the pension fund is no longer solely determined by the fund's ambition regarding the pension arrangement it provides, but also by the probability of reaching this ambition. Higher total funding ratios (defined as total assets divided by the market value of both conditional and unconditional pension rights) may in this case either reflect higher asset levels, higher expected returns (e.g. higher interest rates), lower expected indexation or a higher market price for risk taking (e.g. a higher spread between government bonds and junk bonds). Compared to the fixed discount rate method, taking account of changing expected returns probably improves transparency, but this is more than offset by the counterintuitive fact that worsening indexation perspectives, which are clearly not in the interest of the pension fund's participants, also result in higher total funding ratios. If pension fund policy is primarily geared towards reaching high total funding ratios (due to for instance regulation or accounting rules), market valuation of conditional rights might even give rise to perverse incentives for pension funds as policies resulting in a certain but low level of indexation lead to higher total funding ratios than policies with – from the perspective of the participants - better but uncertain indexation outcomes.

In addition, there is a widespread fear - typically found with pension fund boards - that market valuation using the actual term structure of interest rates leads to excessive volatility in funding ratios. If regulators impose solvency requirements in terms of these market-based funding ratios, contribution rates may become much more volatile. For pension fund boards, this could mean tougher negotiations with the sponsor of the pension scheme, and a larger frequency of bad news messages, caused by downward spikes in the discount rate. In addition, from a macroeconomic point of view, it is not desirable that contribution levels will be raised in periods with decreasing interest rates as these periods are also likely to reflect less favorable economic conditions.

In order to circumvent these problems, the FTK allows pension funds to use a smoothed or fixed discount rate to determine annual contribution levels, even though solvency is always to be determined by the prevailing risk-free term structure of interest rates. Moreover, the solvency rules apply to guaranteed (in practice nominal) pension rights only.[1]

Using a simulation model for the Dutch pension sector, this paper analyzes to what extent market valuation indeed leads to higher contribution volatility. We first investigate the impact of the market based solvency rules by comparing a pre-FTK version of the model with an FTK-compatible one, both using a fixed discount rate to determine contributions. Then, several alternatives are presented where the market valuation principle is also applied to the contribution policy and the real funding ratio. Our findings suggest that the consequences of introducing market based solvency rules are fairly small if a fixed rate is continued to be used for calculating contributions. Fully market based contribution policies that ignore the conditionality of indexation lead to much more volatility and substantial frontloading of pension costs. This frontloading (and part of the volatility) can be precluded by adding a fixed mark-up to the discount rate. Volatility can be further reduced by substantially increasing the duration of assets. Smoothing is not to be recommended as volatility remains relatively high, whereas it may lead to undesirable inertia in responding to persistent interest rate changes.

[1] In addition pension funds are required to assess their long-run perspectives and risks periodically in a ‘Continuity Analysis’. This provides additional insights in e.g. the indexation quality of the pension plan.

The paper proceeds as follows. Section 2 discusses briefly the Dutch pension system and the regulation of pension funds. Section 3 provides information on Palmnet, an aggregate asset and liability model for the Dutch pension sector. Section 4 introduces the policy alternatives that we evaluate. Section 5 presents the stochastic simulation results, taking explicit account of the fact that bond yields, returns on stock investments and inflation outcomes are highly uncertain and may progress according to various scenarios. Section 6 contains a discussion of the results and draws conclusions.

2. The Dutch pension system: pension fund policy, regulation and supervision

The pension system in the Netherlands is characterized by three layers or pillars. The pay-as-you-go financed state pension (AOW) constitutes the first pillar. On top of that, over 90% of employees save compulsory for retirement through their employer.[2] The employer makes contributions on behalf of its employees to a pension fund.[3] These retirement savings are capital funded. All other private pension arrangements form the third pillar.

Pension funds play an important role in the Dutch pension system. Total pension fund assets are around € 700 billion (or 130% of gdp) ranking the Netherlands among the highest in the world. The more than 700 pension funds range from very small company funds to large industry-wide funds. There are very few (5%) defined contribution pension (DC) plans, most of them collective. The vast majority (85%) of pension fund members are in a conditional defined benefit (DB) pension scheme, with pension rights based on career average salary payments. This typical DB scheme offers a nominal guarantee as a fraction of current and past wage levels, whereas indexation and pension contributions may fluctuate over time. Indexation is conditional upon a discretionary decision by the pension board. In practice, full

[2] This number is quite high compared to many other developed countries. See Van Els, Van Rooij, and Schuit (2007) for a discussion.

[3] Some employers do not have a pension fund but have a direct agreement with a life insurer. About 10% of Dutch employees build up their pension this way. These retirement plans are primarily of the DC type.

indexation with respect to either wage or price inflation - depending on the terms of the pension contract - will be given if the funding ratio is high enough. Only about 3% of the pension fund participants still build up pension rights linked to their final salary.

The rules of regulation of pension funds have been laid down in the new Pension Act that has been put into force as of 2007 (replacing the old Pension and Savings Funds Act from 1952). The Pension Act is accompanied by a new supervisory regime, the FTK (acronym of the Dutch term 'Financieel ToetsingsKader'). Key elements of the new regime are market valuation – with respect to both assets and liabilities – and risk-based supervision. An important feature of the FTK is the sharp distinction between guaranteed (in practice nominal) pension rights and conditional ones (in practice indexation).[4] No specific rules are imposed with respect to the investment policy of the fund (the 'prudent person principle'), though more risk taking leads to higher required capital buffers.

The funding regulation in the FTK consists of three elements. First, guaranteed rights (or accrued benefit obligations) are discounted using the risk-free term structure of interest rates and should be fully funded. If - in case of a nominal guarantee - the nominal funding ratio falls below 105%, the pension fund reports immediately to the supervisor, De Nederlandsche Bank (DNB, the Dutch central bank). In reporting, the fund should make clear how it will restore the funding ratio to a level above this minimum within at most three years. Second, a pension fund needs to have a solvency buffer on top of the level of nominal liabilities reflecting the riskiness of the assets. The buffer is specified by a target funding ratio that is such that the probability of underfunding (a nominal funding ratio below 100%) within a year is at most 2.5%. If the funding ratio falls below this level, the supervisor requires a recovery plan specifying the pension fund's actions directed to reach the target funding ratio within maximal fifteen years. Third, any conditionality in pension rights should be communicated clearly and consistently. If that is the case, no formal funding rules are prescribed for the

[4] Especially under an average earnings system this distinction is important for members as inflation does not only matter during retirement, but also during the active working career. Van Els, Van den End, and Van Rooij (2004) show that participants value pension security a lot. See also Van Rooij, Kool, and Prast (2007). However, hardly any pension fund gives guarantees on future indexation. The requirement to be permanently fully funded, where liabilities are measured against the prevailing risk-free real yield curve, makes these pension plans extremely hard to handle (Bikker and Vlaar, 2007). Therefore, it is argued that the regulatory and supervisory regime should be adjusted to better reflect real obligations (see e.g. Van Ewijk and Teulings, 2007).

conditional pension rights, except that there must be consistency between pension fund policy, communicated ambitions, and actual indexation.

Under the FTK the cost-effective contribution level contains four elements: costs of guaranteed pension rights, administrative costs, costs of conditional rights, and costs to build up the required solvency buffer. To calculate these costs, pension funds may either use the prevailing yield curve or expected returns, a smoothed version of these interest rates or returns using a smoothing period of at most 10 years, or a fixed value reflecting long-run expected returns (all up to certain prescribed limits). Whatever the method chosen, actual pension contributions generally need to be higher if the solvency buffer is too low (as part of the recovery plan) and can be lower if the funding ratio is high enough to ensure both conditional and unconditional pension rights without endangering the solvency position of the pension fund.

3. The Palmnet model

We use the Palmnet model to evaluate the key results of different pension fund policies in terms of the expected distribution of pension contributions and indexation cuts. Palmnet, an acronym for Pension asset and liability model for the Netherlands, is an ALM model in the spirit of those used by many pension funds to govern their strategic decisions. Although an intensive use of ALM models is encouraged as a result of the new regulation, the view that stochastic models are an invaluable tool for pension funds has long been recognized. Wilkie (1986, 1995) and Boender (1997) provide early examples for the UK and the Netherlands, respectively. Within Palmnet, inflation, interest rates and stock market returns are stochastic variables. Interest rates and inflation are based on a three factor affine term structure model (Vlaar, 2006). The factors represent the short-term interest rate, the expected inflation rate, and risk aversion in the bond market.[5] Stock market returns are log-normally distributed, with

[5] The model is arbitrage-free, incorporates the mutual interaction between interest rates and inflation, produces asymmetry in the levels of interest rates and inflation (no negative nominal rates), and stationary factors (necessary for long-run simulations). The model provides plausible values for both first and second moments of (changes in) interest rates with maturities up to sixty years.

an expectation equal to three percentage points on top of the prevailing five-year interest rate and an annual volatility of 15%. These parameter choices are common in ALM studies and fit within the boundaries prescribed by the FTK.

The Palmnet model is fully FTK-consistent.[6] The nominal term structure is used to calculate nominal liabilities and the nominal funding ratio. The liabilities are derived from the pension rights of pension plan participants divided in 80 age cohorts starting from the age of 21 until 100 years. New pension rights are built up in line with demographic projections of the developments in the total Dutch population from Statistics Netherlands and labor market projections from the Netherlands Bureau for Economic Policy Analysis (or CPB) taken from Van Ewijk et al. (2000). Existing pension rights are reduced due to mortality and conceivably increased due to indexation. The current average duration of nominal liabilities is about 16 years. By explicitly modeling the cohorts and calculating the developments in pension rights using demographic trends, the effects of ageing are automatically taken into account. The ratio of pension liabilities versus the contribution base (about 60% of the total gross wage sum[7]) is projected to almost double from just over five to nine or ten. Thereby, in steering the funding ratio, indexation cuts gain importance relative to contribution steps.

Besides the nominal funding ratio, Palmnet (unlike the FTK) also uses the real funding ratio. This real funding ratio can either be based on a fixed discount rate (usually equal to the expected real return of the asset portfolio), or the real term structure of interest rates (possibly smoothed and/or augmented by a fixed mark-up reflecting the conditionality in indexation). The same discount rate is used to calculate contributions, thereby applying the same valuation for new and existing pension rights. Contributions and indexation depend on both the nominal funding ratio reflecting the ability to guarantee the unconditional rights, and the real funding ratio that is relevant for the indexation ambition. If the solvency position of the pension fund is insufficient the rules for the nominal funding ratio are binding and otherwise - in case of

6 Van Rooij, Siegmann and Vlaar (2004) provide an extensive description of the first, pre-FTK version of Palmnet, in which the nominal funding ratio had no impact on pension fund policy.

7 Pension contributions are levied only on wages above a statutory exemption. This ‘*franchise*’ is generally linked to the level of the AOW benefit.

sufficient funding – policy is determined by the real funding ratio to live up to the indexation ambitions. Table 1 reports the standard policy ladders used in Palmnet.

Table 1 Standard policy ladders used in Palmnet

Funding ratio (in %)	Indexation
Below 105 (nominal)	No indexation
105 (nominal) – 105 (real)	Indexation cut declines linearly
105 (real) – 110 (real)	Full indexation, no compensation of previous cuts
Above 110 (real)	Full indexation, with compensation of previous cuts
	Contributions (% of the contribution base)
Below 105 (nominal)	Based on a 3-year recovery plan given current interest rates, assuming no indexation; maximum increase 5 percentage points per annum
Below 121 (nominal)	Based on 15-year recovery plan; no reduction; maximum increase 3 percentage points
121 (nominal) – 110 (real)	Actual cost; maximum annual change 3 percentage points
110 (real) – 140 (real)	Linear reduction of contribution to zero; maximum annual change 3 percentage points
140 (real) – 175 (real)	Zero contribution (or 3 percentage points lower than last year)
Above 175 (real)	Contribution restitution

Note: Nominal funding ratios are based on the actual nominal term structure of interest rates. Real funding ratios, 15-year recovery plans and contributions are either based on a fixed discount rate equal to the expected long-run real return of a typical Dutch pension fund (2.88%) or on the actual real interest rate, usually augmented by a mark-up to reflect the mean difference between the expected return on a representative portfolio and that of a liability-replicating one.

The critical nominal target funding ratio of 121% reflects the minimal solvency position needed to make sure that the probability of becoming insolvent a year later is at most 2.5%. This value is based on the assumption of an investment mix with 50% bonds (average duration 6 years), and 50% stocks, which is typical for Dutch pension funds. The expected (geometric mean) real return on this portfolio, used to calculate the real discount rates is 2.88%, given an equilibrium short-term interest rate of 4.0% and equilibrium price and wage inflation rates of 2.0% and 3.0% respectively.[8] These numbers are generally considered plausible and are in line with FTK-regulations.

Palmnet simulations run from 2003 (the data have been calibrated using end of 2002 figures) to 2100 to show long-term and short-term effects of various pension fund policies. Note that the starting point reflects a situation with low solvency and thus the short-term effects are indicative of the policy steps needed in a situation in which the pension funds are under stress. In this paper, we focus on the long-term effects of various policy alternatives represented by distributions of the nominal and real funding ratio, contributions and indexation cuts as well as a measure of total contribution volatility. These distributions are derived from 10.000 Monte Carlo simulations.

4. Policy alternatives

As described in Section 2, market valuation in the FTK has two dimensions. First, solvency rules under the FTK are always based on the prevailing market interest rates. Second, pension funds can use market rates to determine their contribution policy, though using a fixed discount rate (here termed actuarial discounting) is also allowed. The six different policy alternatives presented below reflect both dimensions.

Pre-FTK

The first alternative is a benchmark scenario that is not FTK-compatible, where contribution policy only depends on the real funding ratio based on a fixed discount rate. The fixed discount rate is 2.88%, representing the expected real investment return of the pension fund. In this pre-FTK variant the nominal guarantees are not given much attention. Contribution policy is only geared towards achieving the real ambition. In the simulations, this is modelled by ignoring the first step in the contribution policy ladder in Table 1 (so no three-year

8 In order to limit the number of stochastic shocks, we use a fixed markup of 1.0 percentage point over expected price inflation to calculate wage inflation.

recovery plans), and replacing the nominal target in steps two and three by a real target of 105%. 15-year recovery plans are based on the same fixed discount rate.

FTK-Actuarial

In the second alternative, pension funds continue to use a fixed discount rate, but enter the FTK-world where nominal funding ratios trigger recovery plans. The policy ladders presented in Table 1 are in full operation. Regarding 3-year recovery plans, expected returns are based on the assumption that current interest rates remain constant. 15-year recovery plans are based on the long-run expected returns.

Risk-free fair value

The third alternative, 'Risk-free fair value', applies market valuation to the real value of liabilities. That is, including indexation. The problem in a market valuation context that uncertainty regarding indexation should lead to a higher discount rate, and thereby lower liabilities, is circumvented by the (wrong) assertion that indexation is certain. The simulated term structure of *real* interest rates is used for determining the contribution level, the real funding ratio and the expected return in case of recovery plans. Both 3-year and 15-year recovery plans are based on current interest rates.

Augmented: fair value with mark-up

The augmented alternative starts from the risk-free fair value alternative but puts a mark-up on the discount rate used for valuing the indexed liabilities. This represents the conditionality embedded in the pension rights: Indexation is conditional on the financial situation of the fund and thus deserves a risk premium when discounted, which is the markup. The level of the mark-up is the average difference in the expected return between the actual asset portfolio and a liability-replicating one. Notice that this way of calculating the mark-up is not market based as it reintroduces expected returns in the discount rate. The fixed mark-up is however preferred to a market-based one, as from a participant's point of view it is strange to give pension fund sponsors a bonus (in the form of higher discount rates) for a lower probability of indexation.

Augmented and smoothed

The FTK allows for smoothed interest rates or expected returns to be used for determining the contribution policy. Therefore, in this alternative the 10-year average of the real term structure plus mark-up is used to compute the real funding ratio and contributions.

Augmented and duration matched

The interest-rate sensitivity of the nominal funding ratio is driven by the mismatch between assets and liabilities. As explained in Section 3, nominal liabilities typically have a duration of about 16 years under market valuation whereas the assets typically have an average duration of only 3 years.[9] Therefore, the last alternative is one in which the average duration of the assets held by the pension fund is increased to 16 years, matching that of the liabilities. This is modeled by increasing the duration of the bond portfolio to 32 years, as stock market returns are assumed to be uncorrelated with interest rate shocks.

5. Results

This section presents the performance of the alternatives depicted in Section 4, as measured by the level and volatility of contribution, average cut in indexation, nominal and real funding ratio. In discussing the outcomes, we will also refer to the graphical output of the simulations in Appendix A, Figures 1 to 6. The information in the graphs is quite dense. Therefore, we start by providing a detailed explanation of the results presented in Figure 1. This will facilitate the interpretation of the outcomes documented in the remainder of this section.

Panel A (top left) shows the development over time of the entire distribution of the nominal funding ratio. The nominal funding ratio is always computed using the nominal term structure of interest rates. The solid line gives the average value of the funding ratio while the shaded areas present the range of outcomes for 60%, 80% and 95% of the simulations. Hence, one can derive the percentiles of the distributions from the edges of the shaded areas. For

[9] The average 3-year duration follows from the assumptions regarding a 50% bond-50% equity portfolio with an average bond duration of 6 years and no correlation between equity and bond price shocks.

example, the 2.5-percentile is represented by the lower edge of the 95%-area and the 97.5-percentile by the top edge of the 95%-area. Likewise, the 10 and 90 percentiles are represented by the lower and top edge of the 80%-area, respectively.

Panels B (top right) and C (bottom left) show the distribution of the real funding ratio (discount rate mentioned in parentheses) and contributions, respectively, with the same representation of the average and percentiles as in panel A. Panel D (bottom right) shows the dispersion of the cut in per period benefits due to incomplete indexation for the average retiree. It is defined as the difference in percentage points between the actual pension benefit and a benefit that has been fully indexed to wage developments. Two additional lines are included to represent the benefit cuts compared to a wage-indexed pension benefit of an inflation-proof pension and a nominal pension, respectively. The 'inflation-proof' line expresses the benefit cuts that eliminate the real wage improvement (1% per year), but leave the purchasing power unaffected. The 'nominal' line expresses the impact of the maximum cumulated indexation cuts in an average inflation environment (3% wage inflation per year).

The four panels in the Figures represent the four key variables in the analysis: the nominal funding ratio, the real funding ratio, contributions and indexation cuts. Table 2 shows the mean and 10% worst results for these key variables after 5, 25 and 50 years, as well as the standard deviation of the annual changes in contributions. We now discuss the results of the alternatives in the same order as presented in Table 2 and Section 4.

5.1. Pre-FTK

The simulation outcomes for the pre-FTK alternative are shown in Figure 1 and in the first line of Table 2. Most of the time, the pension contract is quite well affordable and very generous. In the very long-run, the mean contribution rate is only about 5% (current pension contributions are about 15% of the gross wage sum at the macro level) while the average benefit cut is only 6%. These positive results are caused by the asymmetric policy ladders used. Negative shocks to the funding ratio lead to extra contributions and/or indexation cuts. Positive shocks only lead to a gradual decrease in contributions while indexation is maximized at 3% on average. Consequently, the average funding ratios increase gradually, far beyond the target funding ratios deemed necessary.

Table 2 Average and worst-case simulation results for key variables
Percentages

	Contribution				Benefit cut[a]			Funding ratio[b]					
	Level			Vol.[c]				Nominal			Real		
Average results After ... years	5	25	50		5	25	50	5	25	50	5	25	50
1 Pre-FTK	15	10	6	1.31	3	7	6	134	151	160	101	117	124
2 FTK-Actuarial	15	11	6	1.38	3	7	6	133	150	160	101	116	124
3 Risk-free Fair value	20	9	3	2.54	5	4	3	140	175	178	83	111	115
4 Augmented	15	11	6	1.72	3	6	5	132	151	159	98	116	124
5 Smoothed	12	12	6	1.49	2	9	6	123	149	159	100	114	124
6 Duration matched	13	8	3	1.48	2	5	4	139	152	163	107	120	130
10 % worst-case results After ... years	5	25	50		5	25	50	5	25	50	5	25	50
1 Pre-FTK	18	17	17		7	23	23	106	108	111	84	90	92
2 FTK-Actuarial	15	16	15		7	24	22	105	109	112	83	90	92
3 Risk-free Fair value	22	26	24		8	14	10	111	133	134	65	83	85
4 Augmented	19	20	19		6	23	21	105	113	116	78	86	89
5 Smoothed	16	20	19		5	27	23	98	111	114	83	87	90
6 Duration matched	17	17	16		5	19	19	115	116	119	88	92	94

Notes: a) Total benefits relative to total benefits in case of guaranteed indexation; b) Assets expressed as a percentage of the required pension provisions in, respectively nominal and real terms. In the first two variants, the pension provisions in real terms are calculated using a fixed discount rate of 2.88%; in the other variants the actual real interest rate is used, possibly smoothed and/or augmented by a risk mark-up. The nominal funding ratio is always computed using the actual nominal term structure of interest rates. c) Negative contributions are set to zero when computing volatility (standard deviation in percentage points).

The probability of receiving a retirement benefit that ends up significantly below an inflation-indexed pension is small in the pension fund policy under consideration (which includes the ambition of wage indexation). In bad scenarios however, the results can still be quite painful with contribution levels of over 17% and benefit cuts of over 23% of the wage indexed pension benefits in the 2.5% worst case outcomes. Moreover, the volatility of pension contributions equals 1.31%, implying that the level of pension contributions may change quickly.

Although the results look quite favorable, it should be realized that the simulations are based on the assumption that the structure and parameters of all stochastic processes are known. In reality this is of course never the case, and history has shown that the standard remedy for this uncertainty – using conservative assumptions – were easily be ignored by pension funds. If overly optimistic assumptions are used for too long, participating in the fund may become unattractive for new members, thereby endangering the continuity of the fund. As continuity is one of the essential assumptions in the simulations, the results shown may be too optimistic.

5.2. FTK actuarial

Under the FTK, the risk of being too optimistic is limited to a large extent as full funding of at least the guaranteed pension liabilities, measured at market rates, is always aimed at. Whereas under the pre-FTK regime too high return assumptions could lead to sustained underfunding, the market-based nominal funding requirements under FTK forces pension funds to realism. Too high discount rates to calculate contributions and real funding ratios lead to a higher probability of nominal funding ratios below 105% which have to result in more aggressive adjustment plans. On the other hand, the focus in solvency regulation on guaranteed (nominal) rights only, might lead to worse indexation outcomes, even though standard contribution policy should take indexation into account.

Comparing the results in Table 2 and Figures 1 and 2, it seems that the impact of the FTK is only minor if the fixed discount rate is maintained. Despite the focus of the FTK on nominal obligations, the indexation result is very similar in most cases, and even slightly better in the worst scenarios. The latter result is due to the more aggressive adjustment plans when the FTK becomes binding in case of nominal underfunding. This is reflected in the contribution results. The 97.5 percentile for contributions under FTK (Figure 2) is about 22%, whereas it is less than 20% in the pre-FTK version (Figure 1). On average, the contribution results are very similar, though slightly more volatile (1.38% against 1.31%). This seems to be an acceptable price for the greater security in guaranteeing unconditional pension rights. Moreover, the simulations show that there is not much conflict between the real ambitions of pension funds and the regulatory framework focusing on nominal obligations.

In the equilibrium situation, the probability of a real funding ratio below 100% is about 1 in 5. Because indexation is conditional, this does not immediately constitute a problem from a regulatory point of view. A 100% real funding ratio is still well above the 121% nominal target ratio (which on average equals a real funding ratio of 91%) and the pension fund sets the contribution on the cost effective level (but it will not fully index annual wage inflation).

For the nominal funding ratio we find that the probability of a deficit (funding ratio < 105%) is around 5%. This number is higher than the 2.5% mentioned in the Pension Act for two reasons. First, the target nominal funding ratio of 121% is calculated such that the probability to decrease within a year from the target value to 100% (and not 105%) is just 2.5%. Second, once a pension fund comes into the danger zone it has 15 years to recover and reach a funding ratio of more than 121%. Clearly, the probability of a fall below the 100% within the recovery period exceeds the 2.5%. In practice, the actual nominal funding ratio can be expected to be lower than the target ratio of 121% in 15-20% of the years.

5.3. Risk-free fair value

The risk-free fair value alternative, where real liabilities are also marked-to-market ignoring the conditionality, does a very bad job for the pension fund: pension contributions are on average 20% in year 5, and contribution volatility is almost twice its level in the fixed discount rate world. In the long-run, the huge implicit buffers, due to the on average very low discount rate (about 1.7% for the most relevant maturities), reduce the average contribution rate to only 3%, but in the 10% worst scenarios contributions exceed 24%. This large dispersion and volatility in contribution rates is due to the volatility of the real interest rates (about 47 basis points for the relevant maturities) which make the cost-effective contribution level extremely volatile. Indeed, contribution volatility and dispersion are entirely due to changes in the cost-effective contribution level. Shortfall contributions are hardly ever necessary. Consequently, changing the asset mix towards a liability replicating portfolio will not reduce the volatility.

The only aspect in this scenario performing well is indexation. Both the average cuts and the worst case indexation results are substantially better in this risk free scenario. The price paid for ignoring the benefits of the equity risk premium is however large, both for the generation that has to build up the implicit buffer and for those that happen to live in an era of low real interest rates.

5.4. Augmented: fair value with mark-up

In the augmented pension fund policy alternative, real interest rates are increased by a fixed mark-up, reflecting the conditionality in the indexation promise. The mark-up substantially reduces the problem of frontloading and contribution volatility. Compared to the fixed discount rate world, volatility remains relatively high though (1.72% compared to 1.38% respectively). There are three reasons for this higher volatility. First, changes in the real term structure of interest rates affect the level of the cost-effective pension contribution level (annual volatility 1.80%). In fact, the 95% percent interval bands of the cost-effective contribution level range from 8% to 22% of gross wages, where in the actuarial world the cost-effective contribution level is more or less fixed (apart from gradual changes within the composition of the labor force and life expectancy projections). Second, as the real funding ratio is calculated using actual real interest rates instead of a fixed discount rate, the volatility of the real funding ratio increases (from 10.7% to 12.4%). This has an impact on both indexation and contribution policies (Table 1). Third, in the 15-year recovery plans, expected returns are determined by current interest rates as opposed to a fixed rate. As the duration of the assets is much lower than the one of liabilities, pension funds are most likely to enter recovery plans when interest rates are low. Expected returns are lower in that case, leading to more aggressive policies under market valuation. As interest rates are in fact mean reverting (though the equilibrium level might change over time), the effective recovery time will consequently be lower than 15 years under market valuation on average.

Apart from the higher volatility, comparison of Figure 4 with Figure 2 reveals that the difference between a fixed and a market-based discount factor are particularly apparent for the 80 and 90 percentiles. Under a fixed rate regime, the contribution level for these percentiles hardly ever exceeds the cost-effective contribution of about 15%. In the market-based regime, the cost-effective contribution in the 20% and 10% worst scenarios is higher (about 17% respectively 19%) but moreover shortfall contributions are higher as well as one does not rely on the mean reversion in interest rates. For the 97.5 percentile the difference between the two is much less as under three-year recovery plans both methods use the same return assumptions (based on current interest rates). Also the mean results are very similar though the average contribution level is somewhat higher in the market valuation case due to the worse timing of contributions (contributions are high when expected returns are low). On the other hand, the more aggressive recovery plans make the performance in terms of indexation slightly better. The implicit costs of market valuation mainly lie in the increased volatility of the contribution rate and a higher probability of painfully high contributions. These characteristics are not in the interest of sponsors and active pension fund participants.

5.5. Augmented and smoothed

Figure 5 displays the simulation results when real interest rates (plus mark-up) are smoothed over a 10-year period. The annual volatility of the discount rate reduces from 47 to only 13 basis points, and, as a result, the contribution volatility reduces to 1.49%. The main problem with this method becomes clear from the top right and bottom left panels in Figure 5. As interest rates were very high in the beginning of the nineties, the 10-year-smoothed rates used to calculate the real funding ratio were still quite high at the end of 2002. Consequently, despite the drop in assets after the stock market crash and the declining interest rates, the financial situation of the fund still looked good. Therefore, in the policy variant the contribution rate even declines in 2003! A few years later, the problematic financial situation became transparent and firm adjustments had to be made. Therefore, the indexation result is somewhat worse for this fund initially. In all, the results seem to indicate that smoothing inherits the worst of two worlds. It reacts too slow to persistent rate declines but gives more volatility than a conservative fixed rate.

5.6. Augmented with duration matched

One important reason why market valuation results in contribution rates that are both more volatile and on average higher is that pension fund liabilities are more interest rate sensitive than their assets are. Consequently, pension funds are most likely to be in deficit if interest rates are low (the opposite is true if a fixed discount rate is used). Therefore, contributions are likely to be high if expected returns are low. In order to improve upon this inefficient timing of contribution investments, Figure 6 shows simulation results for a pension fund that eliminates the duration mismatch between assets and liabilities.

Indeed, the results look much more favorable, both on average and in the extremes. The average contribution level reduces in the long-run to only 3 to 4 percentage points and in 97.5% of all scenarios the contribution level is below 20%.[10] More surprising is that the distribution of benefit cuts also compares favorably to those in previous scenarios. A better duration match between assets and nominal liabilities at the same time improves results for

[10] A very similar picture would result if an actuarial rate would be used instead, though the higher duration mismatch would in that case lead to somewhat higher contribution volatility and slightly less favorable indexation results.

indexation, even though long-term bonds are more inflation-sensitive than short-term ones. This contrasts with the results by De Jong (2007) who finds that 5-year nominal bonds are preferred to 20-year ones. The main difference is that De Jong analyzes a finite (20 year) horizon, whereas we consider an infinite one. Although a positive inflation shock initially hurts more if long-term bonds are held, in the long-run mean returns are not lower, as low returns in one year are compensated by high returns later on.

There are at least three reasons for the relatively good results. First, without the duration mismatch the probability of nominal deficits is much smaller. Therefore, extreme contribution levels and indexation cuts are less likely. Moreover, the nominal target funding ratio, based on the constraint of 2.5% probability of underfunding, is reduced from 121% to 116%. Second, duration matching leads to a more efficient timing of contribution changes. For this reason, the optimal duration of assets should even be much higher than the one for liabilities (Vlaar, 2005). As the duration of liabilities increased from 0 to about 16 by the introduction of the FTK, the optimal duration of assets of Dutch pension funds has substantially increased. Indeed, most pension funds are nowadays considering a duration increase for their assets, though many want to wait till interest rates are at a higher level. Third, the on average somewhat higher yield on a 32-year bond compared to the 6-year one increases the expected portfolio return by 17 basis points. Therefore, the mark-up on real interest rates to calculate contributions and the real funding ratio was also increased to 1.38 percentage points. This in turn reduces the volatility of the cost-effective contribution level slightly (to 1.66%), but the resulting actual contribution volatility remains 10 basis points higher than under a fixed rate.

6. Conclusions

The 2007 Pension Act has introduced market valuation of nominal, guaranteed pension rights in the Netherlands. The current new supervisory practice (FTK) is among the first regulatory frameworks worldwide focusing on market valuation of pension liabilities. The step from actuarial to fair value accounting in calculating funding ratios has potentially a huge impact on pension fund policy. However, the simulation results show that the FTK does not have major implications for pension funds with conditional indexation. There is an increase in contribution volatility due to those occasions in which market-valued nominal funding ratios are binding. This increase is modest, however, because the FTK provides pension funds with the flexibility to set the pension contributions using a fixed discount rate reflecting their long-term ambitions. At the same time, transparency about guaranteed pension rights has increased; at any moment in time it is clear whether the asset portfolio is sufficient to guarantee that nominal pension liabilities can easily be transferred to a third party, if necessary. The relation between market-valued funding ratios and the probability of indexation, though, is much less transparent.

Market valuation of conditional pension liabilities, i.e. the indexation ambition of pension funds is problematic both from the viewpoint of transparency and from an economic perspective. Under fair value, the market-value of pension liabilities increases with the likelihood of indexation, and as a consequence the ratio between market-valued assets and total liabilities will, ceteris paribus, be lower. Therefore, the total funding ratio is not informative about the probability of indexation. Moreover, the simulation results show that if we base pension fund policy on the risk-free market value of wage-linked pension rights, the volatility of contribution rates increases substantially and the required huge, implicit buffers imply a heavy frontloading of pension costs. This is due to the high volatility and generally low level of real interest rates.

The problems of frontloading and contribution volatility can be substantially reduced by using a fixed mark-up over the actual real term structure of interest rates in calculating the cost-effective contribution level and the real funding ratio. Note that by including a mark-up related to the expected returns, although permitted under the FTK-regulation, we deviate from the strict market-value world. Compared to the fixed real discount approach, however, volatility of contributions remains high. Interest rate smoothing, although reducing the volatility somewhat further, is not to be preferred as it reintroduces the risk of not reacting promptly to a prolonged decrease in real interest rates.

A better remedy to reduce the contribution volatility is to match the duration of assets to the duration of liabilities. Although the resulting contribution volatility is still higher than in the actuarial fixed discount rate approach in setting contribution levels, the performance in terms of cumulative benefit cuts and contribution levels in average and worst-case scenario's is clearly better. This is not so much the result of the slightly higher investment returns, although this adds to the attractiveness of the pension fund. Crucial factors are (1) the reduced probability of nominal shortfalls as a result of the duration matching and (2) the improved timing of contribution rises. Moreover, the extension of the asset's duration is also attractive from a macroeconomic point of view as it increases the likelihood that pension contributions are low (high) when interest rates are low (high). This way the scope for countercyclical pension fund policies increases by supporting economic growth in times that the economic situation is likely to be less favorable. Unfortunately, it is not clear to what extent large pension funds will be able to pursue this policy at present given the relatively limited size of the market for bonds with long to very long maturities.

All in all, we can draw a number of conclusions from the simulation results in this paper. First, potential benefits of market valuation come at the price of higher volatility of funding ratios and contributions. Second, the new Dutch regulatory FTK framework for pension funds does not necessarily have much impact on funds that pursue an indexation ambition (conditional on a discretionary decision of the pension fund Board). Third, a stronger focus in regulation on the real value of the pension deal in combination with a strict application of market valuation is unattractive because it leads to a very large frontloading of pension costs and substantially higher contribution volatility. Fourth, it is optimal for pension funds to increase the duration of the asset portfolio considerably.

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Appendix A Graphical summary of simulation results

Figure 1 Simulation results pre-FTK, actuarial real discount rate of 2.88%

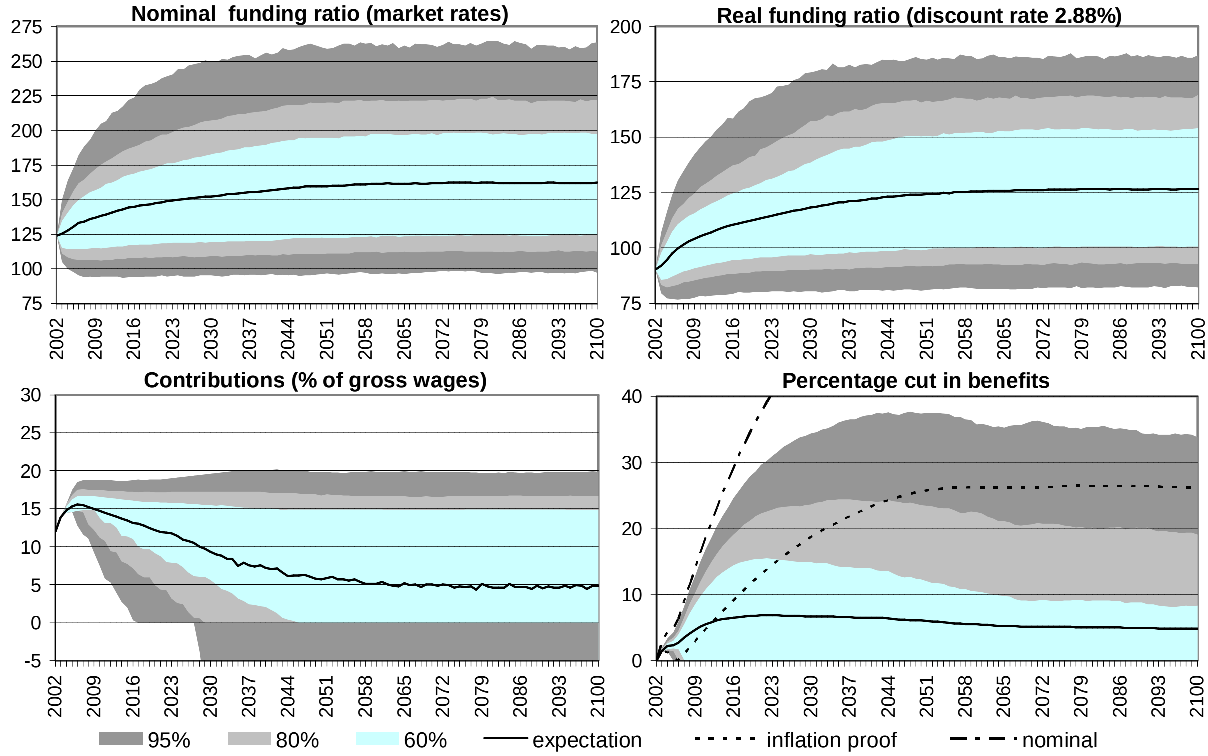

Figure 2 Simulation results for a standard pension fund, actuarial real discount rate of 2.88%

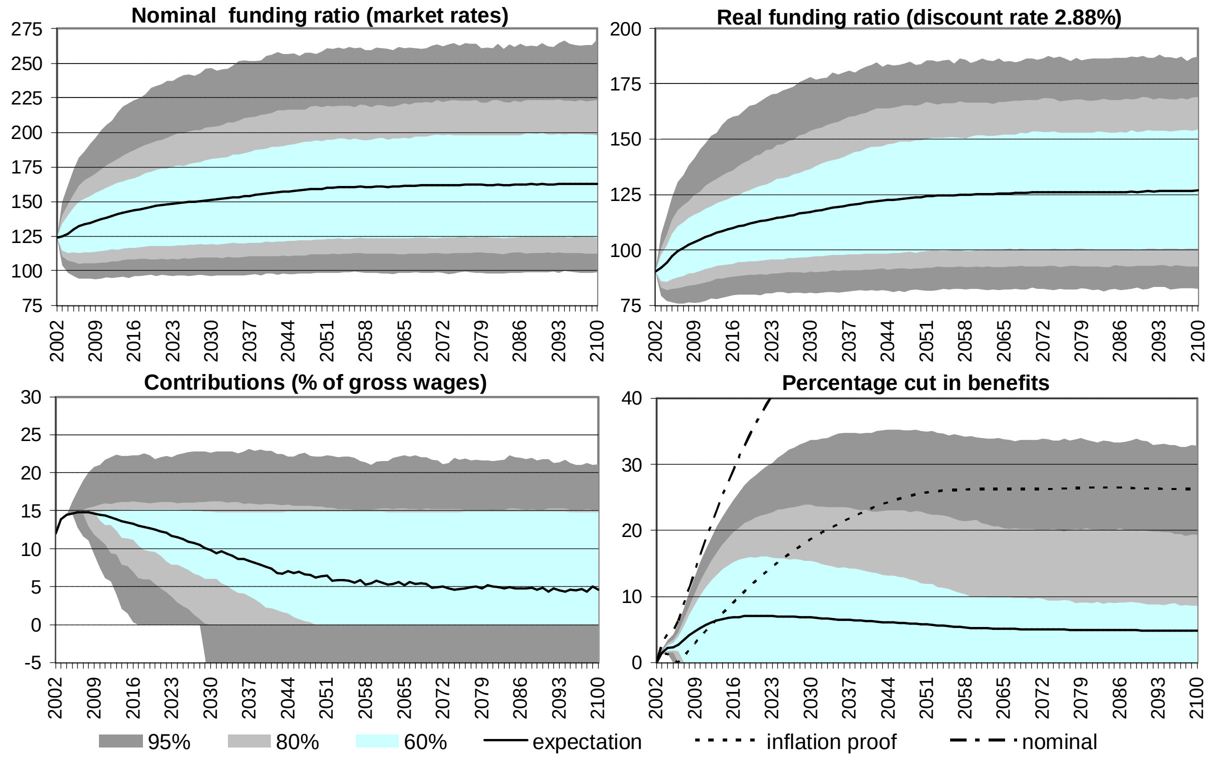

Figure 3 Simulation results under risk-free market valuation

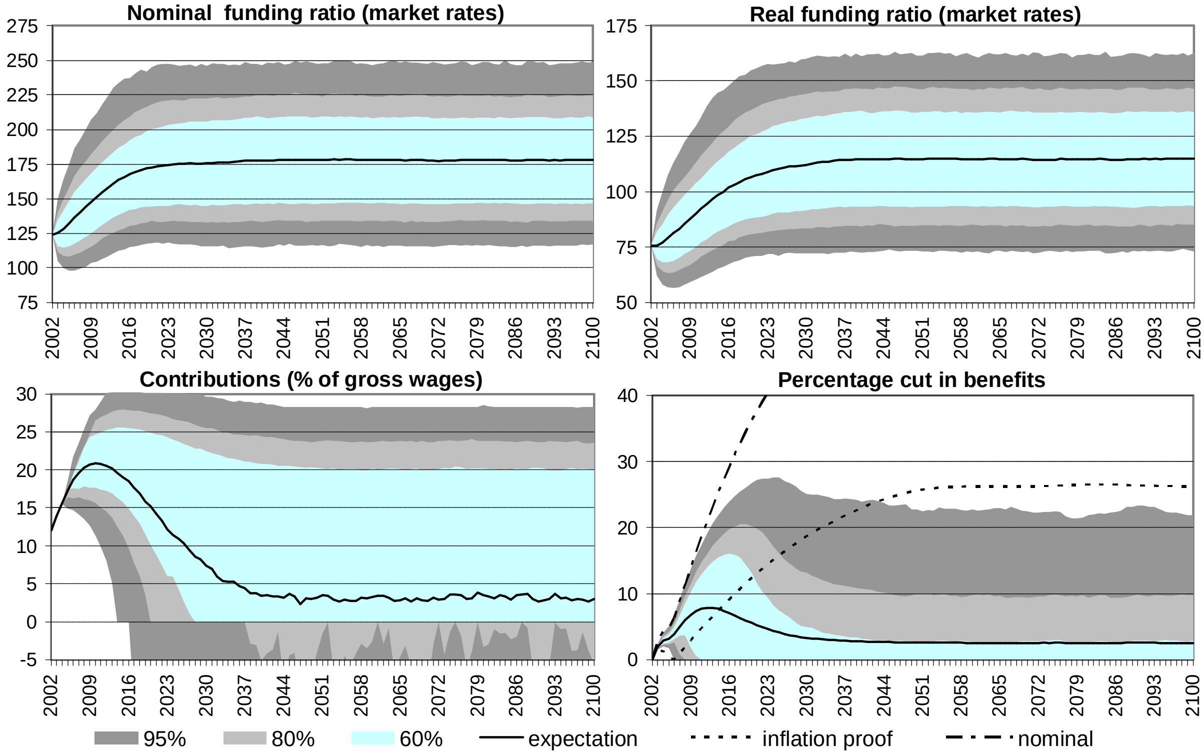

Figure 4 Simulation results under market valuation, augmented to reflect portfolio returns

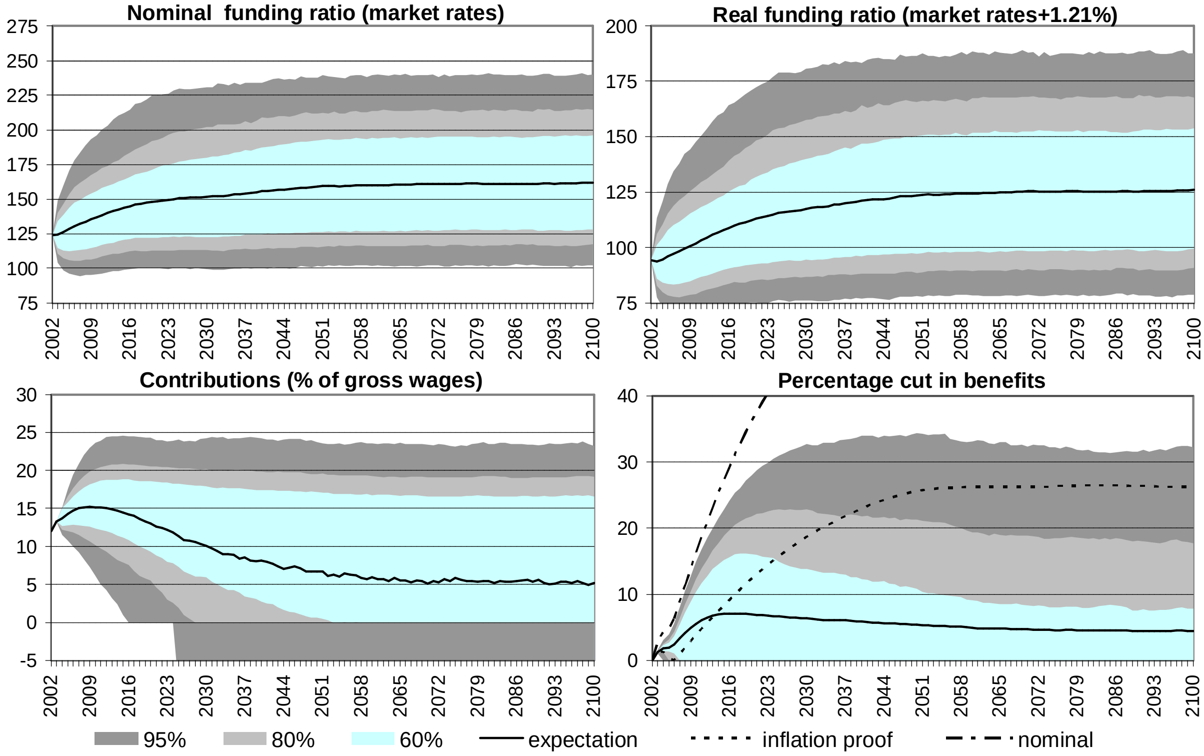

Figure 5 Simulation results under market valuation with 10-year interest rate smoothing

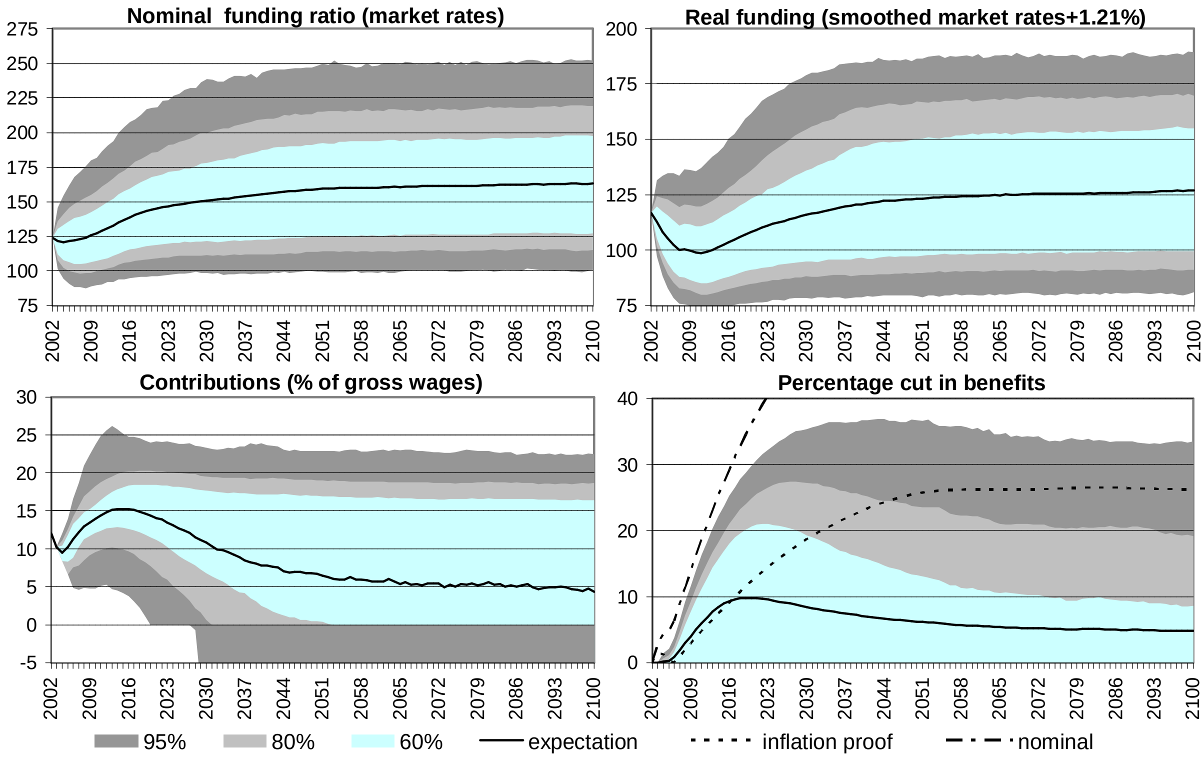

Figure 6 Simulation results under market valuation with duration matching