Fair Value and Pension Fund Management
N. Kortleve, T. Nijman and E. Ponds (Editors)

CHAPTER 10

Pension Deals and Value-Based ALM

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Abstract

High expected returns for equities do not imply that equities are more attractive. Value-based ALM shows that poor equity returns come in economic bad times and that raising contributions and/or lowering benefits (cutting nominal benefits or cutting indexation) is very expensive in these circumstances. Equities will often outperform the riskless asset and on average *result in cheaper funding and higher benefits, but this is offset by poor times, often even more than offset! Value-based ALM leads to the insight that current stakeholders often lose by taking more risk in the form of investing in equities. Next to that, investing in equities increases the size of 'option surplus' and 'option deficit,' the present value of future surpluses and deficits. Thereby the risk will increase and the sustainability of the pension deal decreases since the future outcome can be very unattractive for one group of stakeholders.*

We will use the new approach of value-based ALM to investigate pension deals ranging from pure defined benefit to pure defined contribution and to asset allocations of 100% in equities versus 100% in bonds. We will show that seemingly attractive pension deals, that have for instance low average contribution rates and high expected surpluses, may have low present values for certain stakeholders. Value-based ALM will show who will gain and loose

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from changing the current pension deal. This information in our opinion will help to construct a more sustainable pension deal.

Value-based ALM adds new information relative to classical ALM in the form of present values of future cash flows, the economic value of future surpluses and deficits as well as stakeholder information, showing the intergenerational solidarity expressed in economic value terms. We think this information should no longer be disregarded and should be included in doing ALM and constructing pension deals in the future.

10.1. Introduction

In the pension industry, Asset Liability Management (ALM) is being used to come to optimal pension deals. Board members of pension plans have to decide what the optimal funding strategy, indexation policy and investment strategy is for the fund, as well as how risks best can be shared over the various stakeholders like members and sponsor. ALM outcomes could suggest to increase contributions in periods of poor investment returns – and for Defined Benefit plans low funding ratios – and to lower indexation or even cut benefits (in the case of Defined Contribution). Within ALM, one looks to the possible distributions amongst others contributions, indexation and funding ratio to form an opinion on the attractiveness of the strategy being considered.

Value-based ALM adds an extra, new dimension by showing the present value – also called economic value – of all decisions about the funding strategy, indexation policy and investment strategy. Using the techniques described in the previous chapters,[2] one can calculate the present value of contributions (conditional), benefits (including indexation) and shortfalls/surpluses for the fund collectively and also for the various stakeholders. This addition leads to at least two types of extra insights, which we will discuss in more detail in Section 10.2. The main conclusions are that economic value will lead to different insights in the attractiveness and sustainability of a pension deal for the pension fund and for its stakeholders.

[2]See chapters of Hibbert *et al.* (2006) and Nijman and Koijen (2006) for technique and Exley (2006) for concepts.

Value-based ALM could thus lead to even better pension deals and risk sharing within pension plans.

An extra reason for applying value-based ALM is the broad shift to fair value that one can notice in (international) accounting standards and in supervision of pension funds and insurance companies.[3] Fair value does not only give relevant information for shareholders, but also for other stakeholders like members and leads to more transparent and easier to understand information about the pension deal. Supervisors are working on frameworks incorporating fair value for both assets and liabilities, making value-based ALM an even more sensible approach.

10.2. Characteristics of value-based ALM

What are the main characteristics of a value-based ALM approach for strategic decision making by a pension fund? As the focus of analysis of value-based ALM is economic value, the analytical framework of this approach will therefore differ from standard ALM. *Classical ALM* usually uses items like the expected value of core variables supplemented with one or more measures of the degree of riskiness of those variables. Classical ALM often makes use of techniques like Monte Carlo simulations to project these distributions and to optimize the strategy of the fund. This output remains useful because it provides insight in the distribution of future possible results. One gets information on the probability of underfunding, the probability of a high contribution rate or probability of a low indexation or no indexation at all, and so on. This will give some idea as to the sustainability of the pension deal in the long run.

Value-based ALM essentially uses the same output of scenario analysis as classical ALM, however the future outcomes are discounted back to the present with an appropriate risk adjusted discount rate. This is realized by discounting with either deflators, risk neutral valuation or pricing kernels (compare the contributions of Hibbert *et al*. (2006), and Nijman and Koijen (2006) *in this volume*).

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[3]Major trends are IFRS (International Financial Reporting Standards) using fair value concepts and supervision in countries in Europe. In the Netherlands the government and supervisor are working on a fair value framework to be implemented January 1, 2007.

The shift from classical ALM to value-based ALM leads to at least two types of extra insights. The first new insight is the value the (financial) market currently attaches to future cash flows. ALM experts looked at averages, shortfalls etc., but disregarded information given by financial markets in the form of the present value of the future cash flows. Since the market is risk averse, one can learn that a deal with low average contributions can have a high present value for these contributions, especially if future contributions can be high in expensive states as often is the case in periods of low investment returns/funding ratios.[4] The opportunity the fund has to increase contributions in economic bad times will have a high present value for the fund. Active members are the ones bearing this risk.

Value-based ALM can calculate the present value of cash flows like contributions and indexation since these cash flows – in the approach we use by making these contingent on the funding ratio – are linked to cash flows of financial titles like equities and bonds. Even if these cash flows are not fixed – like in the situation of conditional indexation based on an indexation ladder (also see Section 10.6.4) – their present value can be calculated using the concept of replicating portfolios (also see Exley (2006) *in this volume*). A pension fund can thus value all options it is holding in the form of all kinds of contribution and/or indexation policies.

In this chapter, apart from giving information about the present value of future cash flows in the form of present value of contributions and benefits, we also use 'option surplus' and 'option deficit,' the present value of future surpluses and deficits. These in our opinion give far more relevant information about the possible future surpluses/deficits than the likelihood and the depth of a possible shortfall or surplus.

The second new insight is that one can look at the stakes of various parties joining the pension fund and that one can see the impact of changing the pension deal on various stakeholders. This will help to formulate a more sustainable pension deal and to avoid that one group, for instance the young members, have to pay up for any shortfall but do not get compensated in getting extra upside at the same time. The new pension deal can have (substantial) negative impact on the present value for certain stakeholders, in our experience this information is an important addition to classical ALM.

As to our knowledge, the paper of Chapman *et al*. (2001) is the first contribution in this field. They apply the approach to strategic decision

[4]Also see Kortleve (2003).

making within a company pension fund organising a defined benefit plan. They model the fund not as a self-contained entity but simultaneously with the sponsoring company. The analysis is focused primarily on transfers of value between the shareholders and the pension fund participants. Ponds (2003b) and Kortleve (2003, 2004) employ the value-based approach to analyse transfers of value between old, young and future members within a pension fund where risk have to be borne primarily by the plan members. One may speak of intergenerational risk sharing that typically can be found in industry wide pension plans (the Netherlands) and public sector pension funds (UK, US, Canada). This contribution primarily is aimed at clarifying the main differences between classical ALM and value-based ALM.

A pension fund is a zero-sum game in economic value terms. A change in the pension fund strategy (for example taking more or less investment risk) does not create economic value, however it may lead to transfers of value between stakeholders. Value-based ALM facilitates in clarifying who gains and who loses in economic value terms from a given pension fund strategy or from a change in the strategy.[5] A pension fund being a zero-sum game in value terms can be a positive-sum game in utility terms. The final section of this chapter discusses implications if one incorporates welfare aspects in the analysis.

10.3. Characteristics of the pension fund

The pension fund has the following features:

1. Pension plan: average-wage plan with indexed liabilities. The indexation may be conditional depending on the content of the Pension Deal. The yearly indexation is aimed to follow the price inflation.
2. Liabilities: the valuation of the indexed liabilities is based on discounting with the real interest rate.[6] The duration of the indexed liabilities is 21 years (at a real rate of 2%). 60% of the participants is pensioner

[5]Assuming stakeholders will not compensate these changes using financial markets. If markets are complete and frictionless markets and there are no transaction costs etc., stakeholders could for instance use derivatives to hedge and offset the impact of the changes.

[6]Almost all Dutch pension plans assume nominal liabilities in accounting for their funding ratio for the new solvency test.

or deferred. The remaining part of 40% comprises the (current and future) active members.

3. Funding ratio: the initial real funding ratio is 100%. The real funding ratio is defined as the ratio of the value of the assets and the value of the indexed liabilities.
4. Contribution rate: the base contribution rate has to meet the economic costs ('cost price') of new liabilities accruing during one year of service based on the relevant discount rate, i.e., the real rate. The funding method is formulated for a going-concern pension fund: the base contribution rate to be asked in the coming 40 years P_t^* is solved from the requirement of a balance between the present value of new accrued liabilities in the coming 40 years and the present value of contributions in the coming 40 years:

   $$P_t^* = \frac{\text{PV new liabilities 40 years}}{\text{PV pensionable wages 40 years}}$$

   Contributions are expressed as a percentage of the pensionable wage income. As the target indexation is linked to the price inflation, the terms in the above formula for the base contribution rate is calculated with the expected real rate. The length of the 40 year period reflects the length of one generation.
5. Asset mix: we consider just two variants in the asset mix: 100% nominal bonds and 100% equities. The duration of the bonds is 5.3 years.
6. Policy horizon: we assume a policy horizon of 15 years.[7] This means that we assume a plan horizon of 15 years. During these 15 years new benefits are being built, benefits will accrue with the indexation being granted, the fund realizes investment returns etc.
7. Risk-bearing:[8] employers (in this chapter) are no risk-bearing party. The involvement of employers with the funding is restricted to paying contributions from gross wage income. Hence, all the funding risks have to

[7]The 15-year period is the length of the recovery period that pension funds in the Netherlands will be given to accumulate the required solvency buffer in case of a solvency deficit.

[8]The spectrum of pension funds shows up a great variety in the nature of risk bearing because the stakeholders are free in making rules as to who should bear the risks in the funding process. However, one may distinguish two basic types. The first one may be found in company pension plans, where it is usually prescribed that the sponsoring firm is solely responsible for the funding position. The second basic form can be found in public sector pension funds and industry pension funds where the funding risks typically are borne by the members collectively.

be borne by current and future members of the pension plan.[9] In Section 10.6 we will discuss four different variants of risk-bearing by the plan members.

10.4. Framework of analysis

The balance sheet of a pension fund in economic value terms will look as the one displayed in Figure 10.1. The represented terms are the economic value expressions at $t = 0$ of the relevant variables at the end of the horizon at $t = T$.

The term ΔInd_T may be negative or positive reflecting either a cut in full indexation or additional indexation above full indexation. The term ΔP_T also may be negative or positive reflecting either a reduction or an extra charge to the cost price contributions. The term R_T is the economic value of

Figure 10.1. Balance sheet pension fund in economic value terms

A_0	L_0
P_T	nL_T
ΔP_T	ΔInd_T
	R_T

where

A_0 = value of assets at $t = 0$

L_0 = value of accrued liabilities (with full indexation) at $t = 0$

nL_T = economic value of new accruing liabilities during the period $t = 0$ to $t = T$ (with full indexation)

P_T = economic value of contributions during the period $t = 0$ to $t = T$ to fund the new accruing liabilities nL_T

ΔInd_T = economic value of additional indexation apart from full indexation during the period $t = 0$ to $t = T$

ΔP_T = economic value of additional contributions apart from full cost price contributions P_T during the period $t = 0$ to $t = T$

R_T = economic value of funding residue at the end of year T

[9]This type of risk bearing is typical for industry pension funds in the Netherlands. There are around 80 industry pension funds in the Netherlands, covering almost 70% of the workers and more than 70% of total assets of Dutch pension funds of around 480 billion Euro (end of 2004). Around 25% of the working force is participant in a corporate pension fund. The remaining 5% of the workers has a defined contribution plan (3%) or no plan at all (2%).

the residue at the end of year T, and it may be either positive or negative as well.

As by definition the economic value of the cost price contributions equals the value of the new liabilities to be built up during the horizon under consideration, i.e., $P_T = nL_T$, and as the initial balance sheet at $t = 0$ is identical to: $A_0 = L_0 + R_0$, we can rearrange terms in the balance sheet of Figure 10.1. to get the fundamental expression below reflecting the nature of a pension fund of being a zero-sum game in economic value terms:

$$-\Delta P_T + \Delta \mathrm{Ind}_T + \Delta R_T = 0$$

where:
$\Delta R_T = R_T - R_0$

This expression also clarifies that a pension fund has three methods of risk management:

1. Intertemporal spreading of risk: a funding surplus or a funding deficit is shifted forward in time. There is no active risk management at all.
2. Contribution adjustments: a funding surplus or a deficit is absorbed by workers via receiving a contribution cut or an extra contribution charge respectively. Total contributions are equal to the cost price contributions plus – some part of – the pension fund residue.
3. Indexation adjustments: the funding risks can be taken up by adjusting the indexation rate so that total indexation is equal to the total aimed indexation plus – some part of – the pension fund residue.[10]

The risk-adjusted discounting provides the economic value of the residue (at $t = T$) of this distribution at $t = 0$, R_T. The term R_T can be split up in two parts: the economic value of the surplus minus the economic value of the deficit.

$$\begin{aligned} R_T &= \text{economic value surplus at } t = T \quad -/- \quad \text{economic value deficit at } t = T \\ &= \text{option price at } t = 0 \text{ of surplus at } t = T \quad -/- \quad \text{option price at } t = 0 \text{ of deficit at } t = T \end{aligned}$$

[10]A fourth method may be reduction of nominal liabilities. Technically this may be processed by allowing negative indexation. The latter is possible within deal 3 (see Section 10.6.3).

The risk-bearing stakeholders have a call on the future surpluses and these surpluses will be distributed amongst them according to the risk-allocation rules of the pension deal in operation. In case of deficits the risk-bearing stakeholders have to make up the funding shortfall. This may be interpreted as if these stakeholders have written a put with an exercise price for the residue of zero, i.e., the economic cost of reinsurance against deficits at $t = T$. One may interpret the economic value of a surplus or a deficit as option premiums. Hence, the economic value of the surplus may be seen as the option premium for a call on the surplus at the end of period T, whereas the economic value of the deficit may be interpreted as the option price for a written put with an exercise price for the residue of zero.

10.5. Economic environment

10.5.1. Assumptions

The model being used for the calculations in this chapter is a modern version of Timbuk1.[11,12] The model is calibrated to the market prices as of December 31, 2003.

The pension fund outlook with respect to the economic future is captured in the expectations and volatility of the core economic variables as displayed in Table 10.1. Note that it is assumed that the wage inflation is equal to the price inflation, so the real growth rate of wages is zero.

10.5.2. Deflators

In this chapter we use deflators to discount the cash flows to arrive at the correct present value of these cash flows. Either deflators, risk neutral valuation or pricing kernels can be used to discount all kinds of future cash flows, including benefits, contributions and asset returns.[13] To get the present value of a financial title, one should multiply the possible cash flows of that title

[11] One can download documentation from http://www.gemstudy.com/FairValueDownloads/Timbuk1.pdf.

[12] For description of these types of models, also see the contributions of Hibbert *et al*. (2006) and Nijman and Koijen (2006) *in this volume*.

[13] See contributions of Hibbert *et al*. (2006) for concept of various approaches and how these approaches are linked to one another.

Table 10.1. Economic outlook

Economic variables	Expected outcome[1]	Standard deviation
Inflation[2]	3.2	1.5
Nominal rate of interest	5.6	1.6
Nominal bonds[3]	5.4	4.7
Real rate of interest[4]	2.0	0.5
Equities	10.8	26.3

[1]Geometric returns.
[2]It is assumed price inflation and wage inflation are the same, i.e., there is no real wage growth.
[3]Duration nominal bonds is 5.3 years, being the duration in the market.
[4]10 year zero rate.

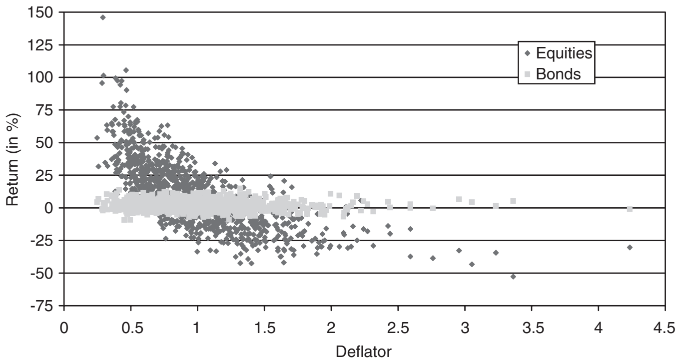
by the corresponding deflators:

$$PV = \Sigma_i CF_i \times p_i \times D_i$$

Where
PV = present value
CF_i = cash flow in state i (assuming 1000 simulations, this can be any of the simulations)
p_i = probability of state i (e.g. 1 out of 1000)
D_i = deflator for state i

Deflators will correct for the equity risk premium relative to risk free assets. In other words, even though equities do show a higher expect return and therefore generate higher cash flows on average than bonds, the present value of 100 Euros in equities is (of course) the same as the present value of 100 Euros in bonds. High cash flows from equities will most of the time be multiplied by low deflators, whereas low cash flows will be multiplied by high deflators, as one can also see from Figure 10.2. The correlation between equity returns and deflators is negative, meaning that on average high equity returns will be multiplied by low deflators and vice versa. So, very poor equity returns of −50% can have a deflator of 3 or even more, whereas very attractive equity returns of +100% have deflators of 0.5 or below. For equities the present value of a cash flow of 100 in poor times can be 10 times as high as in prosperous times. As one can see from the figure, there is hardly any correlation between bond returns and deflators, which means that high bond returns are – on average – not compensated by low deflators and vice versa.

Figure 10.2. Equity and bond returns versus deflators



10.6. Variants in funding strategy and risk bearing

We will discuss four distinctive pension deals. This enables us to show the impact of alternative pension deals on the value of the stakes of the stakeholders. These deals differ as to the contribution policy, the indexation policy, the asset mix and risk allocation.

With the term ‘pension deal’ we mean the contract between the pension fund and the stakeholders that sets out the nature of the pension promise (final pay or average wage, the nature of the indexation policy), the funding of this promise and how the risks in the funding process are allocated (implicit or explicit) amongst the stakeholders. An explicit pension deal has clear rules prescribing who has to pay, when and to what extent in a deficit situation. These rules also set down who will benefit, when, and to what extent in a surplus situation. Below we discuss four examples of explicit deals. The deals investigated are:

Variants in funding strategy and risk bearing

Pension deal	Risk management	Indexation policy	Contribution policy
1. No active risk management	None	Full	Fixed
2. Pure defined benefit	Steering using contributions	Full	Contingent on funding ratio

continued

Variants in funding strategy and risk bearing—Cont'd

Pension deal	Risk management	Indexation policy	Contribution policy
3. Collective defined contribution	Steering using indexation	Indexation accrued rights contingent on funding ratio	Fixed
4. Policy ladder	Using both indexation and contribution to steer	Indexation accrued rights contingent on funding ratio with minimum and maximum	Contingent on funding ratio with minimum and maximum

10.6.1. Deal 1: No active risk management (Spreading risk over time/risk spreading between generations)

Pension deal 1 is characterized by no active risk management at all. There is no aim to correct the course of the funding ratio over time by making use of either the indexation instrument or the contribution policy. Each year the contribution rate is set equal to the cost price to fund new accrued liabilities and every year the indexation follows the actual inflation (see Figure 10.3) This deal has a maximum appeal on spreading risk over time, or in other words on intergenerational risk-sharing. Actually, the pension fund relies on an infinite sequence of overlapping age-cohorts. Table 10.2 reflects the core results in terms of expected values and riskiness of the variables for a mix of 100% bonds and a mix of 100% equities, respectively. This is the usual classical ALM output.

Figure 10.3. Pension deal 1: No active risk management

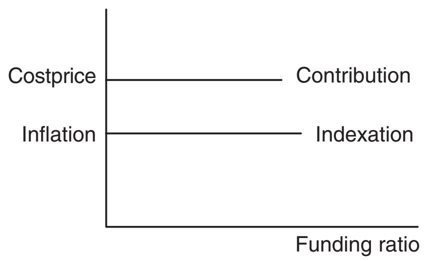


Table 10.2. Classic ALM results deal 1

	MIX = 100% Bonds 2005–2019	**MIX = 100% Equities** 2005–2019
Funding ratio		
average	**99.0**	**180.9**
risk (st dev)	**2.7**	**132.8**
st dev D FR	**1.0**	**45.0**
prob underfunding	**70.4**	**29.7**
Contributions		
average	**21.4**	**21.4**
risk	**1.5**	**1.5**
Relative pension result	**100%**	**100%**
Indexation		
none	**0%**	**0%**
partial	**0%**	**0%**
full	**100%**	**100%**
catch up	**0%**	**0%**

As can be read from Table 10.2, the cost price contribution rate is slightly higher than 21% of pensionable wages. Indexation is always linked to the actual inflation, so the cumulative indexation has a full 100% match with the target indexation. The mix consisting of 100% nominal bond delivers on average a real rate of return of 2% as anticipated in setting the contribution rate. Therefore the funding ratio on average remains stable over time. The volatility in the funding ratio is quite low primarily because of the low risk in the real rate and because of the high correlation between the real rate and the nominal rate. The 100% bonds mix nevertheless will imply some mismatch risk, firstly because the pay-off structure of nominal bonds differs from the growth rate of indexed liabilities as there is no perfect correlation between nominal rate and real rate, and secondly because the duration of the liabilities is much higher than the duration of the bond mix.

The 100% equity mix gives prospect to a higher expected real return compared with the real rate, so the expected funding ratio will increase over time. This investment strategy implies a much higher risk profile for the stakeholders than the investment strategy with 100% bonds. This can be checked with Table 10.2 by looking at the risk measures of the funding ratio that quantify the spreading in the funding ratio, i.e., the standard deviation of the funding ratio itself (almost 133% for equities and just 3% for bonds) and of the change in the funding ratio in one year (45% for equities and just 1% for bonds).

Figures 10.4 and 10.5 show the development of the funding ratio for the two investment strategies.[14] The risky 100% equity strategy leads on average to an increase in the funding ratio, and so to an increasing funding surplus. The funding ratio of the low risky 100% bond strategy remains stable over time.

Table 10.3 shows the results of value-based ALM. The balance sheets reflect economic values. Note that the economic value of the funding residue of both strategies is the same! This is to be explained by the high economic value attached to underfunding and the low economic value of overfunding.

Figure 10.4. Funding ratio in deal 1 with 100% bonds

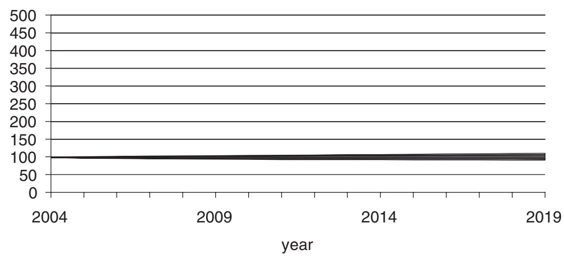
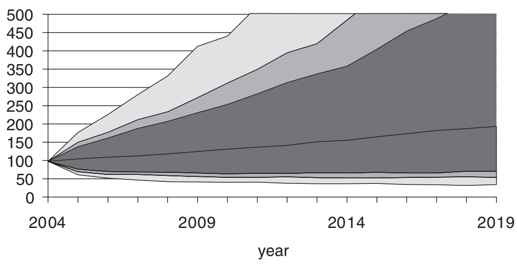


Figure 10.5. Funding ratio in deal 1 with 100% equities



[14]The graphs show the following percentiles of the probability distribution of the funding ratio: 1, 5, 10, 90, 95, 99 and the median.

Table 10.3. Value-based ALM results deal 1

		100% Bonds		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**0**	Additional indexation		**0**
		Change residue (ΔR_T)		**0**
		Option surplus	**4**	
		Option deficit	**−4**	
		100% Equities		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**0**	Additional indexation		**0**
		Change residue (ΔR_T)		**0**
		Option surplus	**50**	
		Option deficit	**−49**	

The 100% equity strategy may lead to a lower probability of underfunding, however when it occurs, underfunding may be sizeable and it most likely will happen in expensive states when stakeholders will not be able and willing to make up for shortfalls. It is very expensive to hedge a situation of underfunding. The deflator method attaches a high present value to outcomes in economic bad times. Deep underfunding typically will occur in bad times. The 100% bond strategy will have less underfunding in bad times, less both in terms of frequency and depth.

Our conclusion is that the assumed attractiveness of equities, as can be read from the classical Table 10.2, is not so attractive when viewed from the perspective of fair value. Equities do not add economic value; they increase the present value of future surpluses as well as the present value of future deficits![15] Fair value shows that taking risk does not increase the present value.

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[15]The higher the volatility, the higher the value of an option price.

10.6.2. Deal 2: Pure defined benefit

The characteristics of deal 2 are in line with a pure defined benefit scheme: indexation is always given according to the promise and the contribution rate is adjusted yearly in order to absorb the risk in the pension fund. The target funding ratio is defined as the 100% funding ratio, this is the situation where the assets A_t are equal to the value of the indexed liabilities L_t, i.e., $A_t/L_t = 100\%$. The contribution rate will be equal to the cost price when the funding ratio is 100%. Any deviation between the actual and the target funding ratio will lead to an adjustment in the contribution rate. There is a cut in case of overfunding, whereas a charge is asked in case of underfunding. Full adjustment of the funding ratio back to the target level in one year will lead to extreme adjustments in the contribution. Therefore the fund aims to reach the full funding situation after 40 years. So the restoration of any deviation of the actual funding ratio from its target level is smoothed out over a period of 40 years. Hence, the additional contribution rate apart from the base rate, P_t^{add}, is calculated as follows (also see Figure 10.6):

$$P_t^{\text{add}} = \frac{\text{Liabilities} - \text{Assets}}{\text{PV pensionable wages 40 years}}$$

The total contribution rate is equal to the sum of cost price contribution rate plus the additional contribution rate:

$$\text{Total Contribution Rate} = P_t^{*} + P_t^{\text{add}}$$

Figure 10.6. Deal 2: Pure defined benefit

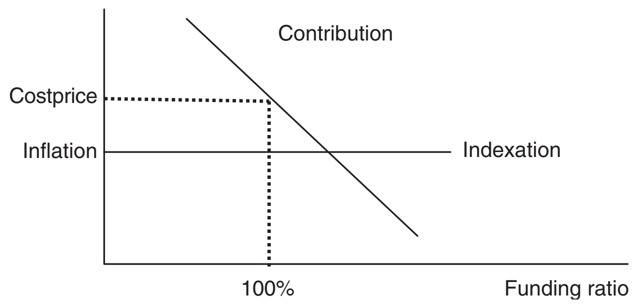


Table 10.4. Classic ALM results deal 2

	MIX = 100% Bonds 2005–2019	**MIX = 100% Equities** 2005–2019
Funding ratio		
average	**99**	**172.7**
risk (st dev)	**2.5**	**118.5**
st dev D FR	**1**	**42.9**
prob underfunding	**68.7**	**29.6**
Contributions		
average	**21.5**	**13.3**
risk	**1.6**	**13.5**
Relative pension result	**100%**	**100%**
Indexation		
none	**0%**	**0%**
partial	**0%**	**0%**
full	**100%**	**100%**
catch up	**0%**	**0%**

The classical ALM results are quite familiar (Table 10.4). The contribution rate in the equity strategy displays on average a downward trend (Figure 10.7). The on average high excess return in this strategy is translated in cuts in the contribution rate. The average contribution rate drops from 21.4% to only 13.3%, though the latter has more dispersion and can be higher than 30% in some more extreme cases. The bond strategy delivers

Figure 10.7. Contribution rate in deal 2 with 100% bonds

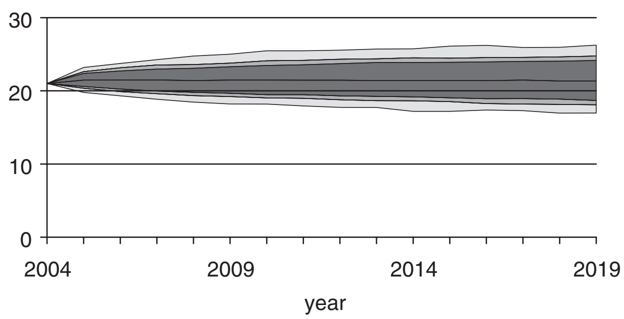
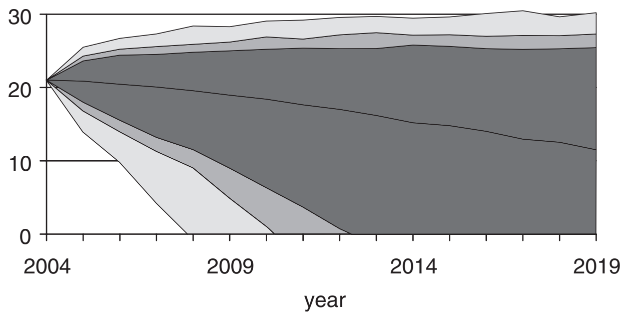


Figure 10.8. Contribution rate in deal 2 with 100% equities



no excess return, so the contribution rate in this strategy equals the cost price contribution rate, which fluctuates depending on the future real rate (Figures 10.7 and 10.8).

When we compare the classical results of deal 2 with deal 1, we note that the variability in the funding ratio has declined somewhat due to the shifting of part of the mismatch risk towards the contribution rate and thus to (future) active members. This may be seen from the value-based results as well (Table 10.5).

The decline in variability of the residue is also reflected in the option values of a surplus or deficit. These values have decreased due to the reduction in the dispersion of the funding ratio. Furthermore, note that the value of additional contributions (cuts as well as charges) is positive, i.e., active workers will pay a higher contribution on balance in economic value terms compared with deal 1. This is easily explained if one recognizes that contribution charges typically will be asked in economic bad times and so these charges may have a high economic value, whereas contribution cuts are given usually in good times and so will have a low economic value. The counterpart is that the economic value of the residue increases. The dispersion in the residue decreases in deal 2 compared with deal 1, and the economic value of the decrease in probability and size of underfunding is – in economic value terms – more valuable than the decrease in probability and size of overfunding.

10.6.3. Deal 3: Collective defined contribution

Deal 3 may be seen as the counterpart of deal 2. The contribution rate is set equal to the base contribution rate and the indexation rate is used as the

Table 10.5. Value-based ALM results deal 2

		100% Bonds		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**2**	Additional indexation		**0**
		Change residue (ΔR_T)		**1**
		Option surplus	**4**	
		Option deficit	**−4**	
		100% Equities		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**2**	Additional indexation		**0**
		Change residue (ΔR_T)		**1**
		Option surplus	**22**	
		Option deficit	**−21**	

instrument to control risk. The indexation rate will be equal to the actual price inflation when the funding ratio is equal to its target level of 100%. Any deviation between the actual funding ratio and the target funding ratio will lead to an adjustment in the indexation rate. The additional indexation is calculated as the ratio of the residue to the present value of the projected liabilities[16] (compare Figure 10.9):

$$\Delta \mathrm{Ind}_t = \frac{\text{Assets} - \text{Liabilities}}{\text{PV projected Liabilities}}$$

Note that to the analogy with deal 2, risk bearing is spread out over current and future members as the restoration of any deviation of the actual

[16]The present value of the projected liabilities is the sum of the present value of the currently accrued liabilities plus the present value of the new liabilities to be accruing in the coming 15 years.

funding ratio from its target is smoothed out over time, over already accrued and newly accruing liabilities.

This deal implies that any deviation of the funding ratio of its target will lead to a deviation between the aimed indexation and the actual indexation. The 100% equity mix on average has a high return and this high return will be given away in additional indexation. In 55% of the cases, the funding ratio is above 100% and so the pension fund pays out more than just full indexation (Figure 10.10). The relative pension result indexation reaches an average value of 205%! The relative pension result is defined as the ratio of the actual pension result to the target pension result. However, the dispersion is also very high as can be seen from Figure 10.11.

When we take notice of the economic value consequences of this deal, then another picture arises. In 38% of the cases during the period under consideration, assets fall below the value of nominal liabilities so then there

Figure 10.9. Deal 3: Collective defined contribution

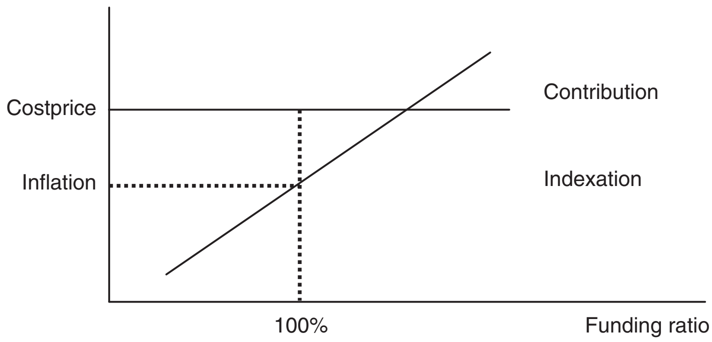
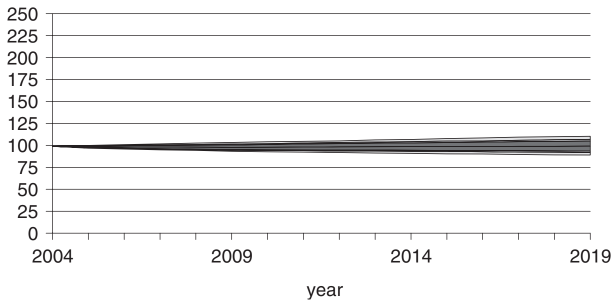


Figure 10.10. Relative pension result in deal 3 with 100% bonds



is negative indexation, i.e., a cut in the accrued liabilities. In 7% of the cases, the value of the assets falls between the value of the nominal liabilities and the value of the real liabilities and so there is room for partial indexation. Indexation cuts and negative indexation will occur in particular during bad times. The economic value of these cuts therefore will be so high that they by far outweigh the economic value of the additional indexation being given in 55% of the cases.

This deal shows up a dramatic difference between classical and value-based ALM (see Tables 10.6 and 10.7). Value-based ALM shows once again

Figure 10.11. Relative pension result in deal 3 with 100% equities

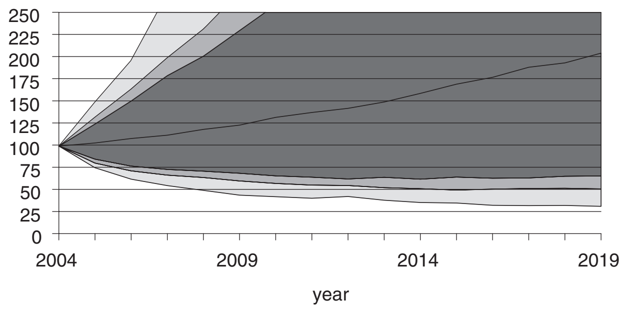


Table 10.6. Classic ALM results deal 3

	MIX = 100% Bonds 2005–2019	**MIX = 100% Equities** 2005–2019
Funding ratio		
average	**100**	**109**
risk (st dev)	**1.1**	**26.9**
st dev D FR	**1.3**	**33.1**
prob underfunding	**49.2**	**41.0**
Contributions		
average	**21.4**	**21.4**
risk	**1.5**	**1.5**
Relative pension result	**100%**	**205%**
Indexation		
negative	**10%**	**38%**
less than full	**43%**	**7%**
more than full	**47%**	**55%**

Table 10.7. Value-based ALM results deal 3

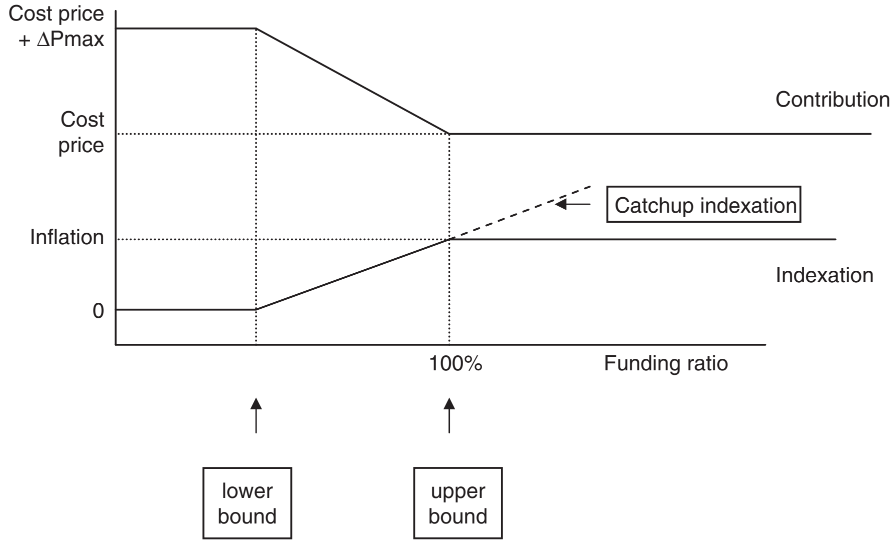
		100% Bonds		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**0**	Additional indexation		**−2**
		Change residue (ΔR_T)		**4**
		Option surplus	**4**	
		Option deficit	**−1**	
		100% Equities		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**0**	Additional indexation		**−2**
		Change residue (ΔR_T)		**4**
		Option surplus	**18**	
		Option deficit	**−14**	

that the extra indexation comes in good times, so the present value of these 55% of the scenarios does not outweigh the other 45%; the present value is the same for the portfolio of 100% bonds and of 100% equities.

10.6.4. Deal 4: Policy ladder

A number of Dutch pension funds recently has introduced a so-called policy ladder, in Dutch '*Beleidsstaffel*' (Ponds, 2003a). We may interpret the ladder as a combination of components of the two preceding deals. The basic idea of the ladder is quite simple. We explain the basic idea with the help of Figure 10.12. Two points are of crucial importance, the upper bound and the lower bound. It is assumed in this chapter that the upper bound is the situation where the real funding ratio is 100%, this is when the assets exactly match the value of the indexed liabilities. The lower bound is the situation where the nominal funding ratio is 100%, i.e., the value of the assets is the same as the value of the nominal liabilities (thus no indexation). The difference between

Figure 10.12. Deal 4: Policy ladder



the upper bound and lower bound is the necessary indexation reserve needed to pay for the future indexation of the accrued liabilities. This indexation reserve can also be expressed as the difference between the value of indexed liabilities (based on the real yield curve) and the value of nominal liabilities (with valuation based on the nominal yield curve).

The contribution rate and the indexation are set along the vertical axis.

Indexation policy: The magnitude of the indexation is related proportionally to the size of the available indexation reserve, this is the difference between assets and nominal liabilities. There is room for full indexation, if and when the value of the assets equals the value of fully indexed liabilities. In this case, the actual indexation reserve matches the required indexation reserve. The indexation rate will be zero when the assets are equal to or even below the present value of the nominal liabilities. The indexation reserve then is actually zero or even negative. Between these points there will be an indexation cut where the size of the cut is related to the actual deficit in indexation reserve. Whenever the value of the assets exceeds the value of indexed liabilities, there is room to provide extra indexation until there is a full catching-up of previously missed indexation.

Figure 10.13. Contribution rate in deal 4 with 100% bonds

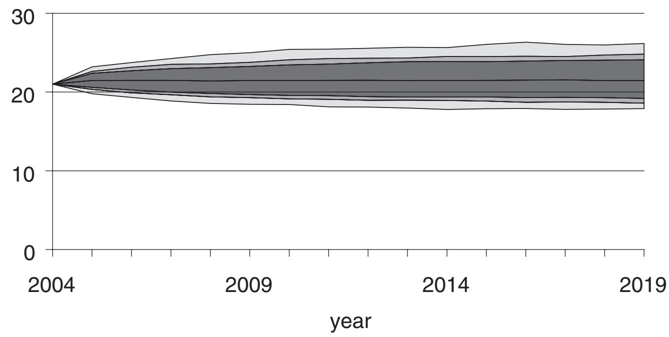
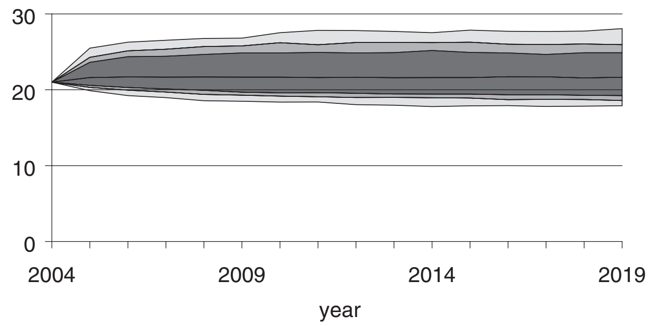


Figure 10.14. Contribution rate in deal 4 with 100% equities



Contribution rate: The contribution rate is set equal to the cost price of the new accrued liabilities of one year of service when the funding ratio is equal to or is higher than 100%.[17] A contribution charge is levied when assets fall short of the indexed liabilities. To the analogy with the indexation cut, the charge will increase when the deficit is increasing. The maximum charge is determined by the annual funding costs in order to build up the required indexation reserve within 40 years (Figures 10.13 and 10.14).

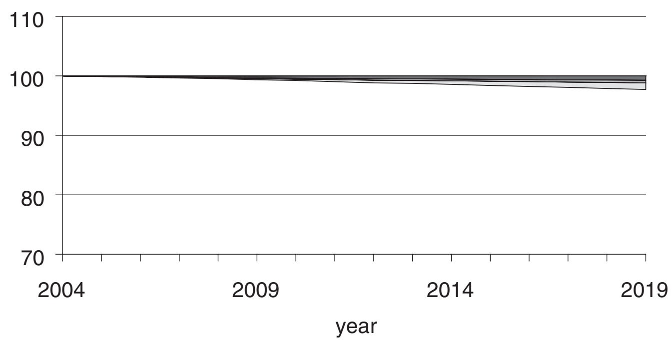
From the classical ALM results we make up that the 100% bonds strategy on average yields a funding ratio of around 100% (Table 10.8). The contribution rate is on average around the cost price level. The median

[17]The pension fund could also decide to cut the contribution below cost price, when the plan is overfunded (i.e., funding ratio is higher than 100%).

Table 10.8. Classic ALM results deal 4

	MIX = 100% Bonds 2005–2019	**MIX = 100% Equities** 2005–2019
Funding ratio		
average	**99.2**	**182.7**
risk (st dev)	**2.5**	**131.8**
st dev D FR	**1**	**45.2**
prob underfunding	**68.4**	**28.5**
Contributions		
average	**21.5**	**21.9**
risk	**1.6**	**2**
Relative pension result	**100%**	**100%**
Indexation		
none	**0%**	**3%**
partial	**32%**	**22%**
full	**49%**	**47%**
catch up	**19%**	**28%**

Figure 10.15. Relative pension result in deal 4 with 100% bonds



cumulative indexation equals 100%, being the result of both indexation cuts and catch-up indexation. The 100% equity mix will lead on average to an ever increasing funding ratio as the expected high equity return cannot be translated in cuts in the contribution rate as in deal 2 or in additional indexation as in deal 3. The average funding ratio is increasingly much higher than 100%.

The value-based ALM results make clear that the 100% equity strategy does not necessarily imply better results in economic value terms. After adjusting the future results for the high risk involvement it becomes clear that the costs of additional contributions and indexation cuts are very high and take away the general believed advantages of risk-taking. The high equity returns turn up in economic times with low deflators and therefore have limited present value, at least lower than their nominal cash flows do imply. The low equity returns coincide with high deflators as well as with higher contributions and lower indexation. So when equities perform poor, the members are hurt by extra payments to the fund and lower pensions out of the fund (Figure 10.15).

Further note that with 100% equities the current stakeholders are losing economic value (compare 100% equities with 100% bonds in Table 10.9). There is an increase of +20 in the value of the future residue in comparison with deal 1. This increase is primarily due to indexation cuts during bad periods for equity investments (note the additional indexation is –16, also

Table 10.9. Value-based ALM results deal 4

		100% Bonds		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**1**	Additional indexation		**0**
		Change residue (ΔR_T)		**2**
		Option surplus	**4**	
		Option deficit	**–2**	
		100% Equities		
Assets (A_0)	**100**	Accrued liabilities (L_0)		**100**
Contributions (P_T)	**90**	New liabilities (nL_T)		**90**
Additional contributions	**6**	Additional indexation		**–16**
		Change residue (ΔR_T)		**20**
		Option surplus	**50**	
		Option deficit	**–31**	

Figure 10.16. Relative pension result in deal 4 with 100% equities

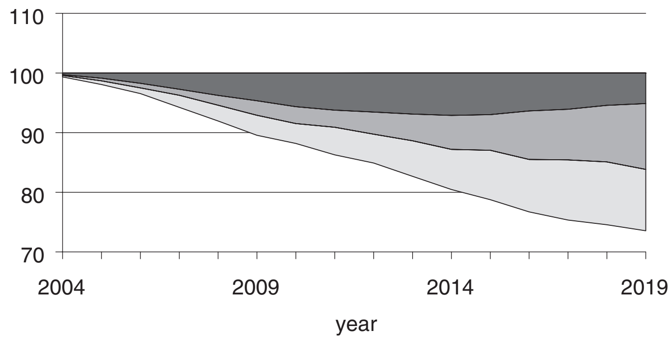
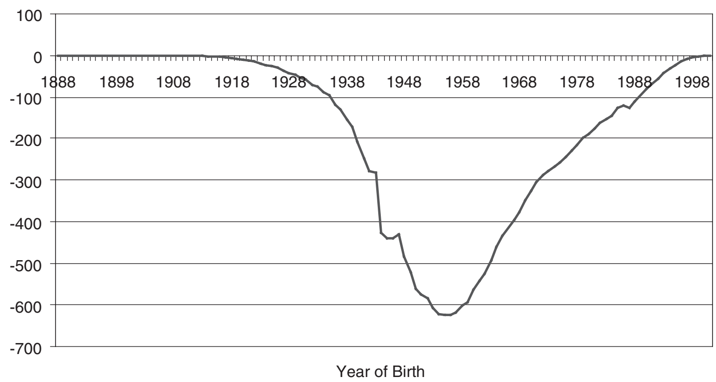


Figure 10.17. Change in economic value per age cohort



see Figure 10.16) and also because of extra contributions during these bad periods (note additional contribution is +6, also see Figure 10.14).

Figure 10.17 clarifies who is paying for this increase in the funding residue. We have displayed the change in economic value per age cohorts when the pension fund steps over from deal 2 (or deal 1 or deal 3) to deal 4. We see that all cohorts lose economic value by this change. The fund collectively benefits, since the present value of the residue increases relative to the previous deals. Future generations will be more willing to join this deal since the present value for them more likely will be positive. Why do current members lose on average? Active workers have to pay additional contributions when the funding ratio falls below the upper bound, however there are no contribution cuts when the funding ratio is higher than the upper bound. So workers pay on balance more contributions in deal 4 compared to Deal 2. There are indexation cuts when the funding ratio falls short of the upper bound. Catch-up indexation is given when the funding ratio is recovered above the upper bound. On balance, cohorts will lose economic value because there will be scenarios where indexation cuts have been passed but catch-up indexation has not been given yet or only partially. Extending the horizon will lead to a decrease in the shortage. The relative reduction in shortage for a specific cohort will be larger the younger a cohort is.

10.7. From value to welfare

An important result of value-based ALM is that it shows that a pension fund is a zero-sum game in economic value terms. This insight may suggest that any pension fund policy only implies transfers of value amongst the stakeholders which do not have any role (cf. Exley, 2004). However this conclusion neglects the welfare aspects of pension funds. Indeed pension funds are potentially welfare-enhancing because pension funds aim to offer retirement income products which are not available in the market.[18] Although the offered insurance may differ amongst the various pension funds, the aim of the different pension deals is to enable the participant to go on with the standard of living before retirement after one is retired. This kind of 'insurance' offers protection against the risk that the purchasing power of pension savings is eroded by inflation and also against the risk that pension savings do not hold pace with the real growth of the economy, i.e., the general standard of living. From the literature, it is well-known that these types of insurance can be organized by intergenerational risk-sharing. Just because the market fails to organize this kind of risk-sharing, pension funds are potentially welfare-enhancing (Gordon and Varian, 1988; Shiller, 1999; Ponds, 2003b). Cui *et al*. (2005) developed a framework wherein pension funds can be evaluated in economic value terms as well as in utility terms. The utility analysis clarifies the welfare aspects of pension funds. They show first that in utility terms a pension fund as a risk-sharing arrangement is more useful than an

[18] Even if markets are complete and stakeholders do have full insight in and understanding of their stakes (i.e., contributions, benefits and indexation), cutting costs, sharing risks and other arguments still seem to favour collective pensions over individual pensions.

individual pension saving program without risk-sharing opportunities (individual defined contribution plan), and secondly that pension deals being performed by pension funds are ranked higher in utility terms the more they contribute to safe and smoothed consumption patterns over the life-cycle of the involved participants. Indeed a pension fund always is a zero-sum game in value terms, however it is potentially a positive-sum game in welfare terms.

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