Asset Liability Management for Pension Funds

A case study

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Abstract

This paper discusses the practical value of Asset Liability Management (ALM) for "Stichting Pensioenfonds ABP", the Dutch pension fund for civil servants. Given that the pension scheme is a final pay system, the aim of the study is to generate low and stable contribution rates over time without harming the pension fund's solvency. This can be accomplished by adopting integrated investment, contributions and pension indexing policies. Against the background of a predefined risk/return profile (which reflects the risk attitude adopted by the pension fund), the study shows how the various policies should be implemented on an integrated basis in order to ensure that the resulting risk/return profile matches this risk attitude. Provided that this match is achieved, the risk/return profile is defined as being efficient. The study shows that conditional indexing plays an important role in generating efficient risk/return profiles.

Keywords: Asset Liability Management, efficient risk/return profiles

Introduction

Until about ten years ago, ALM was not an issue of any great concern to pension funds. However, the environment has changed rapidly in the past decade and, as a consequence, pension funds in the Netherlands now face a completely different environment which is characterised by 1) individualisation, 2) ageing and 3) fierce competition.

Individualisation is the opposite of solidarity. Solidarity is an aspect that is currently under pressure in Dutch pension schemes. It may no longer be taken for granted that people are willing to pay more for individual insurance than is strictly necessary; as a consequence, low contribution rates have become the focus of attention. However, contribution rates can be lowered (assuming that portfolios are efficient) only by introducing more risky assets. Riskier assets, however, will lead to a higher risk of underfunding and to more volatile contribution rates. A high risk of underfunding would not be accepted either by the pension fund's Board of Directors or by the official regulatory body for the insurance industry (known in Dutch as the 'Verzekeringskamer'). Volatile contribution rates would be disastrous from the viewpoint of government budgetary management. In other words, what people want is low and stable contribution rates without there being any threat to pension fund solvency. How to achieve this with the aid of ALM is the principal theme of this paper.

Another formidable threat facing the pension funds, in addition to individualisation, is ageing. The ageing ratio at ABP, which is defined as the ratio of the present value of acquired rights to the contribution rate, is about 8 and will rise to 10 within seven years. The implication of this ratio is that a 1% shortfall in returns leads to a 8% increase in the contribution rate if this shortfall is financed immediately. Given that a 2% increase in the contribution is the maximum that is acceptable to the government, it is clear that shortfalls can only be offset in part by an increase in the contribution rate. This means that the contribution policy is no longer a suitable instrument for performing major adjustments. Having said this, we shall demonstrate below that ALM does provide the right tools for making an appropriate response.

Finally, competition has become a topical issue in pension land. Ten years ago, no one displayed any great interest in the financial behaviour of pension funds. Safe investment was the adage, and so a lot of money was invested in fixed-income assets. However, pension funds began to increase their investments in equities in the mid-eighties in order to improve their performance and thus enhance their competitive position. Investments in equities increased so rapidly in the nineties that the insurance regulator published guidelines entitled "actuarial principles for pension funds".

The main implication of these guidelines is that pension funds now have to present an ALM study in order to obtain a clean bill of health from the insurance regulator.

All the above-mentioned factors have catapulted Asset Liability Management into a pivotal position within the decision-making process at the Dutch pension funds. This paper explains how ALM is put into practice at ABP.

1 The risk factors within a pension fund

In order to take sound decisions, pension fund managers need of course first to identify and then to quantify the financial risks facing the fund. The first step is to systematically structure these risks. Once this has been done and the fund managers therefore know what the financial risks are, they then need to define the fund's risk attitude. The ALM process is intended to generate risk/return profiles that match the predefined risk attitude. If this match is accomplished, the risk/return profile is efficient. Efficiency is thus generated if the resulting risk/return profile coincides with the predefined risk attitude taken by the pension fund. This may be illustrated diagrammatically as follows:

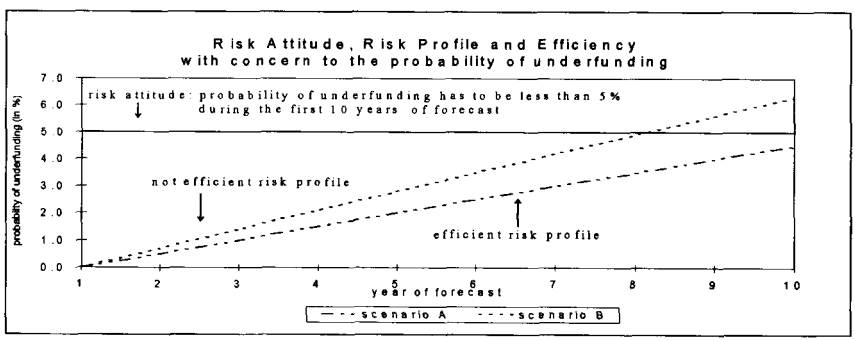

Figure 1 The relation between risk attitude, risk profile and efficiency

In order to generate efficient risk/return profiles, we need to have a stochastic simulation model that describes the assets, liabilities and the relevant ALM component. Kleynen's ALM model[1]

is a model which possesses just such features. This model is used in this paper in order to trace efficient risk/return profiles for ABP.

As we have already said, the first step is to systematically structure risk. This is done by distinguishing the investment risk, wage growth/inflation risk, political risk, actuarial risk and pension financing risk. These various risks may be defined as follows.

The *investment risk* is a measure of the extent to which a pension fund's financial position is sensitive to investment portfolio choices.

The *wage growth/inflation risk* is the result of pension scheme indexing clauses. An indexing clause determines the extent to which general salary measures or inflation lead or leads to changes in pension levels. Indexing clauses are virtually always conditional by nature. The extent to which a pension fund's financial situation is sensitive to changes in the general salary level is called the wage growth risk. The extent to which a pension fund's financial situation is sensitive to inflation is called the inflation risk.

Not only may the aggregate pension change over time, but the level of the basic pension may also be influenced by changes in state pension levels. As most pension schemes are occupational, a change in the level of the basic pension will generally lead to a change in the level of the occupational pension. The extent to which a pension fund's financial position is sensitive to changes in the level of state pension is defined as the *political risk*.

The required fund value is often defined as the present value of the accrued pension benefits of the present population. The required fund value is based on the present demographic and financial structure of the pension fund and the actuarial principles currently applied. These actuarial principles include a range of transition probabilities in relation to survival, disability and dismissal, as well as assumptions about the discount rate and the valuation of assets. These actuarial principles are reviewed and, where necessary, adjusted annually. The *actuarial risk* is defined as the extent to which a pension fund's financial situation is sensitive to changes in the actuarial principles applied.

The fifth risk component identified is the *pension financing risk*. The pension financing risk is something which has to be regarded from the sponsor's viewpoint. The cost of a pension scheme is part of the cost of labour. Operational management demands that contribution rates should be at an acceptable level and remain stable over time, subject to solvency requirements being met at all times.

A pension fund has a number of instruments at its disposal for controlling these risks. These include investment policy (i.e. to control the investment risk), indexing policy (i.e. to control the wage growth or inflation risk), actuarial policy (i.e. to control the actuarial risk) and contribution policy (i.e. to control the level of and fluctuations in this labour cost component). Those utilising these instruments need to bear in mind that they are interactive. An individual analysis of these instruments is therefore not possible in the context of ALM, which requires an analysis of the package as a whole. The following figure illustrates how this works.

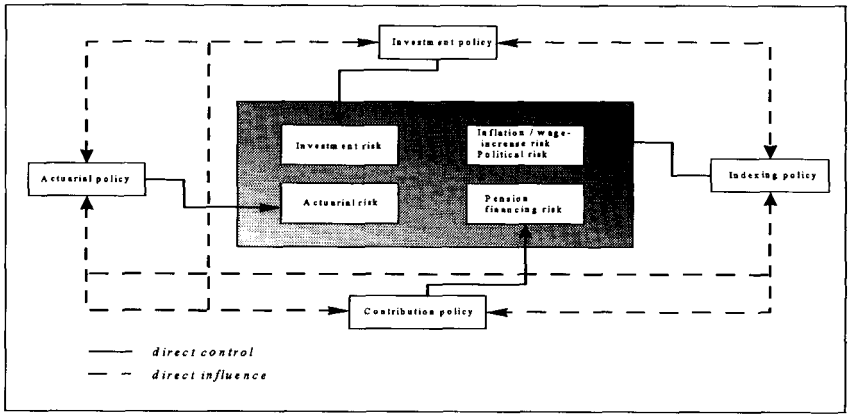

Figure 2 Financial risks within pension funds and the various controlling instruments

Having defined the risk factors in pension funds and explained how they can be controlled, we shall now try and identify the main risk factors for a pension fund. A main risk factor is defined as a risk factor with an elasticity greater than one in absolute terms with respect to the contribution rate. The ALM model is used to carry out a sensitivity analysis in order to distinguish these main risk factors. The results of this sensitivity analysis are presented in the following table.

Table 1 The main risk factors and their impact on the contribution rate

Risk factor	**Change in contribution level (as %)**
Mortality rate decreases by 10%	16
Probability of marriage increases by 10%	14
Future real return decreases by 10%	21
Discount rate decreases by 1% point	166

The results suggest that an inaccurate estimate of mortality rates and probabilities of marriage (which we need to know in order to determine the present value of widows' and widowers' pensions) will have a profound effect on the contribution rate and on the fund's aggregate capital requirement. However, these probabilities do not fluctuate widely from year to year in practice, and a situation is unlikely to occur in which they suddenly change[2]. In short, although the management of probability risk is an important element, it is not one of the principal issues in the field of risk control.

The factors that determine the real returns are the investment return, the level of pension indexing and the trend in the level of the basic pension. The risk factors we thus need to deal with are the investment risk, indexing risk and political risk. Unlike probability risk, these risk factors often change in practice and such changes can have a marked impact on contribution levels.

The easiest problem to manage is the political risk. Because of the uncertainties surrounding the future of state pensions, the basic pension is often set separately from state pensions. This has the effect of eliminating the political risk.

The other two risk factors are far more complex. They often vary over time and in an unexpected direction. The first step in controlling investment risk is the composition of the portfolio. Unfortunately, in order to bring about a low average contribution rate, a high percentage of a fund's capital needs to be invested in equities[3]. In order to achieve stable contribution rates over time, a high percentage has to be invested in fixed-income assets. What fund managers try to do is to take advantage of the anticipated higher returns on equities on the one hand, whilst at the same time mitigating the effects of the correspondingly higher volatility. An additional tool is needed for this, and this is the buffer capital. The book value on which the calculation of the contribution rate is based is equal to the market value of the investments minus the buffer capital. The buffer capital is built up during periods of stock price rises, and decreases during any periods in which stock prices fall[4]. The buffer capital is maximised by the choice of the maximum capital buffer percentage. The higher the percentage chosen, the safer the financial position will be, but the higher the contribution rate will be since the target funding level is defined in terms of the book value. As long as the relative level of the buffer capital does not exceed the maximum buffer capital percentage, only dividend yields will be capitalised in the book value and stock price rises will fill the buffer without

being used to lower contribution rates. The development of the buffer capital may be described diagrammatically as follows:

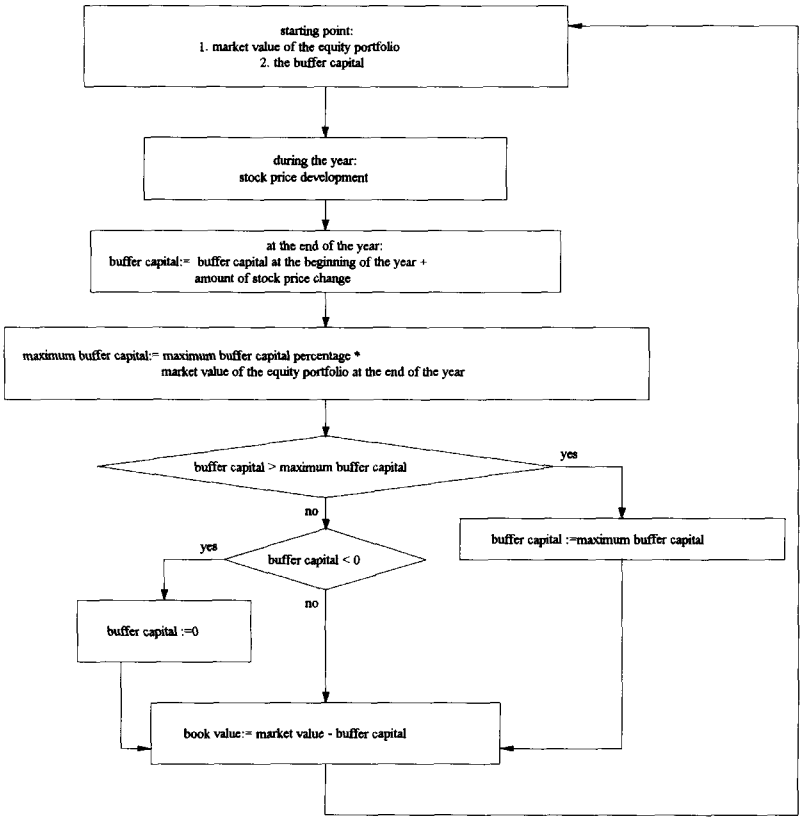

Figure 3 The development of the buffer capital

It is clear that there is a trade-off between the percentage of buffer capital and the corresponding contribution rate. Although high buffer capital percentages lead to relatively stable contribution rates and a safe financial position, they produce relatively high contribution rates at the same time. A low buffer capital percentage leads to relatively low contribution rates on the one

hand, but still generates relatively volatile contribution rates and a relatively unsafe financial position on the other.

Because the pension scheme is a final pay system, general wage rises and a corresponding increase in pension levels affect the real returns. Fortunately, however, pension funds have an instrument for controlling this wage increase risk. As we have already seen, this instrument is called conditional indexing. This paper assumes that a system of carry-back pension indexing is used. This system mitigates or even ignores pension indexing in periods of financial difficulties and provides the necessary compensation in prosperous times[5]. The next section shows that implementing this strategy of carry-back indexing in combination with buffer capital is of crucial importance in generating efficient risk/return profiles.

2 Generating efficient risk/return profiles for ABP

Now we have identified the main risk factors and have defined the instruments we are going to use in order to achieve efficiency, we should like to show how these efficient risk/return profiles are created in practice. As we have already explained, this particular case study focuses on the situation at ABP in the Netherlands. You should bear in mind that, at the outset, 15% of the fund's capital is invested in equities, the funding level is 110% and there is a buffer capital of 30%. However, the strategic level of equity investment may of course differ from the current level. This study assumes that the growth from the current level of 15% to the strategic level will take up a period of five years. This assumption is based on ABP's wish to increase its involvement in equities in a smooth manner without disrupting the stock market[6].

The next step is the definition of the fund's risk attitude. Before we can generate an efficient risk/return profile, we have to define the term 'efficiency'. In this case, efficiency is defined as a situation in which:

1 the contribution rate may not vary over time by more than 2.5% of the contributors' salary,
2 the probability of underfunding may not exceed 5% during the next ten years of forecast,

3 the target funding level is less than 125%, and

4 the buffer capital percentage is less than 35%[7].

We need to work in a stochastic environment in order to measure the probability of underfunding. This environment is created by using a vector autoregressive (VAR) model. This model is shown in the following table:

Table 2 The VAR model

	C as %	p_{t-1}	i_{t-1}	$E_{t-1}(r_t)$	r_{t-1}	r_{t-2}	sp_{t-1}	div_{t-1}	rep_{t-1}	rer_{t-1}	*mean as %*	*std. dev. as %*
s_t	1.91	0.75									*4.5*	*2.4*
p_t	1.05	0.7									*3.5*	*2.1*
i_t	3.25		0.5								*6.5*	*1.9*
r_t	1.53				0.8						*7.6*	*1.5*
sp_t	8.04				-5	5					*8.0*	*21.0*
div_t	0.00			0.26				0.5			*4.0*	*1.0*
rep_t	1.12				-2.5	2.5			0.6		*2.8*	*4.5*
rer_t	0.58									0.9	*5.8*	*0.5*

c constant term
s_t general salary increase in year t
p_t price inflation in year t
i_t short-term (i.e. 3-month) interest rate in year t
r_t long-term (i.e. 10-year) interest rate in year t
sp_t change in stock prices in year t
div_t dividend yield in year t
rep_t change in property prices in year t
rer_t property rental yield in year t

We can use the VAR model to simulate the future. The first analysis we made was to determine efficient risk/return profiles in the event of full (unconditional) indexing. Given the risk attitude adopted by the pension fund, the maximum involvement in stocks was assumed to be 20%. Increasing this percentage would lead to a target funding level (on which the calculation of the contribution rate is based) in excess of 125% and to a maximum buffer capital percentage in excess of 35%. This is a fairly dramatic conclusion. As far as full indexing is concerned, it is not possible to increase the percentage of equities in the portfolio to above 20%. The restrictions described above with respect to the target level and the buffer capital percentage are then violated in order to achieve efficiency.

If we relax the restriction of full indexing and replace it with conditional carry-back indexing, the result is a totally different risk/return profile. Assuming a 20% equity involvement, the target funding level now only has to be 110% and the maximum buffer capital percentage is 10%. Of course, this has consequences for the trend in the contribution rate. These consequences are outlined in the following figure.

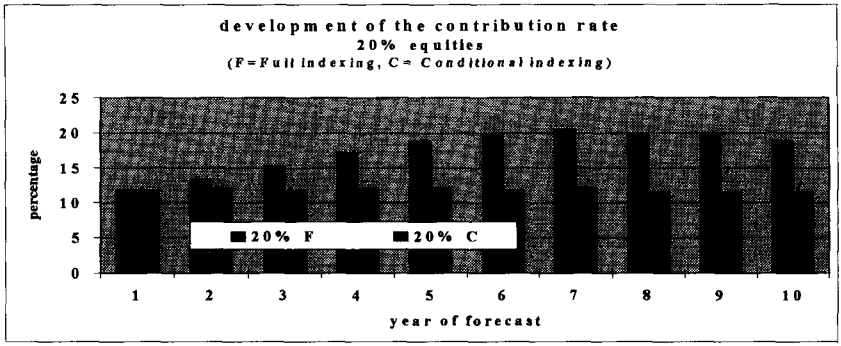

Figure 4 The effect of full and conditional indexing on the development of the contribution rate

As this figure shows, the average contribution level for a situation in which full indexing is guaranteed is much higher than for a situation in which there is conditional indexing. Full indexing leads to a far riskier environment because indexing takes place even in financially difficult times, and this has a direct impact on the financial situation. So, in order to achieve efficiency, the target funding level has to increase from 110% in the conditional case to 125% in the case of full indexing, whilst the buffer capital percentage has to increase from 10% to 35%. The upward movement of the graph of the contribution rate in the case of full indexing is a consequence of the filling of the capital buffer. Because this buffer has to increase from 30% to 35% and the relative involvement in stocks changes every year during the first five years by one per cent, only dividend yields will be used during the first seven years to increase the book value. The stock price gains are used to increase the capital buffer. On average, the capital buffer is filled after seven years, at which point the stock prices gains are used to increase the book value. This then results in lower mean contribution levels.

Our further research takes conditional indexing as a starting point. We looked at the conditions in which efficiency can be generated for a number of different portfolios and the consequences this has for the contribution rate, the pension level, the funding level and the buffer capital percentage. The outcome of this analysis is shown in the following figure and table.

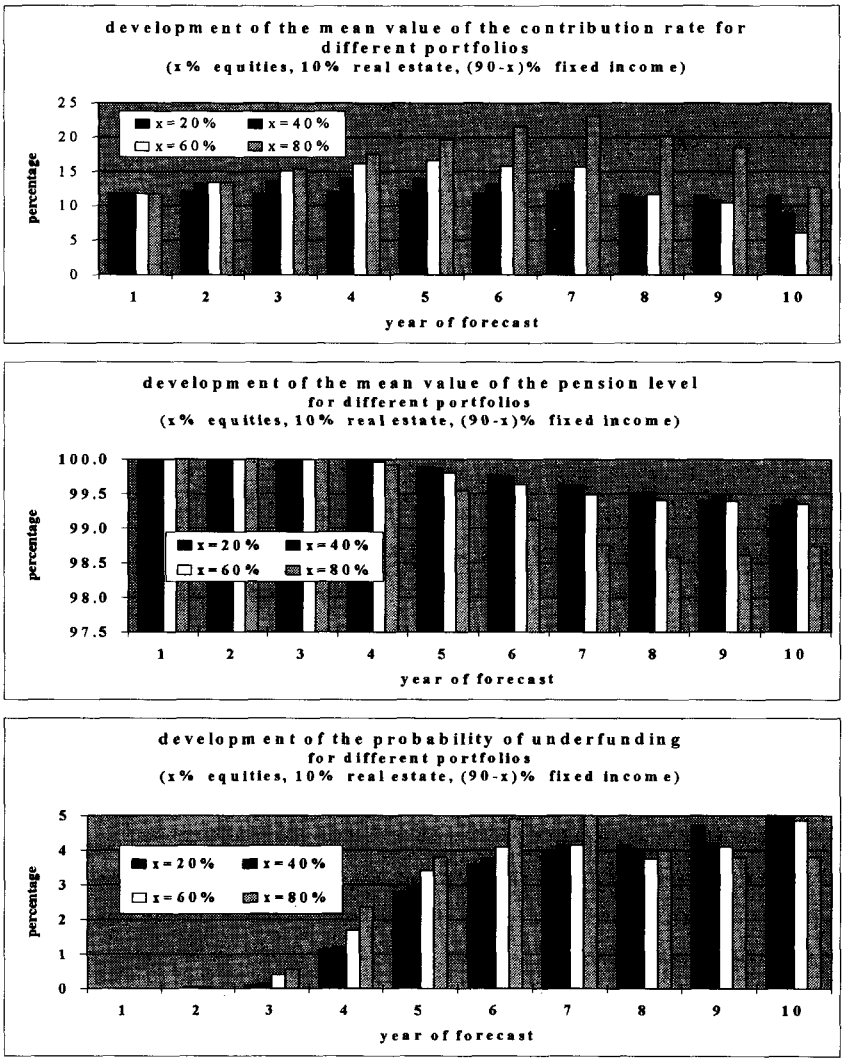

Figure 5 The development of the average contribution rate, the average pension level and the probability of underfunding for different portfolios

Table 3 Target funding level and the buffer capital percentage required in order to achieve efficiency for a number of different portfolios

% of equities in portfolio	Target funding level (as %)	Buffer capital percentage
20	110	10
40	115	15
60	120	20
80	125	30

The most striking fact, based on the above figure and table, is that, given the pension fund's risk attitude, the maximum percentage of investments in stocks is 80%. Larger investments in equities would violate the fund's risk attitude. If we take a closer look at the outcomes for a portfolio 80% of which consists of equities, it becomes clear that this is not an attractive alternative. High average contribution rates and relatively low pension levels are the result. These high contribution rates and low pension levels are a direct result of the need for a high target funding level and a large buffer capital in order to generate efficiency. The consequence is that all the stock price returns are transported to the buffer capital in the short run, so the only source of income is dividend yield. It takes seven years before the effect of investments in equities bears fruit.

If we examine the outcomes of portfolios where the proportion of equities is between 20% and 60%, we may conclude that they look familiar in terms of both average contributions and pension levels. However, there is a trade-off between short-term and long-term effects. Where short-term effects are dominant, only a small percentage needs to be invested in equities. If longer term effects are of more interest, on the other hand, an equity investment representing up to 60% of the portfolio becomes an attractive alternative, especially if the forecast period is extended. It is then clear that a higher involvement in equities produces better results, in terms of both the level of contribution and pension levels.

3 Conclusions

This paper shows how efficient risk/return profiles can be derived for a final pay system in the light of a pension fund's risk attitude. The main conclusions are that, in order to achieve efficiency, carry-back indexing is of primary importance and that a well-balanced combination of portfolio selection, buffer capital and target funding level is required. The ultimate choice of the combination of portfolio composition, target funding level and the size of the buffer capital is a matter of policy, with short-term and long-term effects counterbalancing each other.

[1] Kleynen, R.H.M.A. (1996), *Asset Liability Management binnen Pensioenfondsen*, Thesis: University of Tilburg.

[2] There is an upward trend in mortality rates and probabilities of marriage. For this reason, ABP has launched a study into the creation of probability distributions that vary in time.

[3] See Dert, C. L. (1995), *Asset Liability Management for Pension Funds*, Thesis: University of Rotterdam. Dert shows that, where a portfolio consists entirely of equities, a probability of underfunding of less than 5% can be generated only if the initial funding level is nearly 200%.

[4] The buffer capital can never be negative, however. If the buffer capital fell below zero, the book value would be higher than the market value. In this case, the book value is the same as the market value and the buffer capital is by definition equal to zero.

[5] Once the pension fund's funding level is known, the indexing space (imax) for next year (t+1) can be calculated. Given this indexing space and the value of the general salary measure(s) for year t+1, the carry-back pension index (Δpi) for year t+1 is equal to $\Delta pi(t+1) = \max [\min[\Delta imax(t+1), s(t+1)/pi(t) - 1], 0]$ where $pi(t) = pi(t-1) * (1 + \Delta pi(t))$

[6] ABP has assets of approximately USD 140 billion. Any abrupt change in the composition of the portfolio would undoubtedly affect the stock exchange.

[7] The latter two restrictions have been imposed in order to ensure that the outcomes remain realistic.