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A New Approach to Retrieve the Implicit Risk Preferences of the Board of Trustees of a Pension Fund

An ALM Based Pilot Study

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A new approach to retrieve the implicit risk preferences of the board of trustees of a pension fund: An ALM based pilot study

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Abstract

This study aims at retrieving the implicit risk preferences of the board of trustees of a pension fund with reference to several recommendations from commission Frijns. This study builds a stylized pension fund and employs an ALM model to conduct a pilot study in which the board of trustees evaluates various risk and return criteria for five different investment strategies. In addition, this study investigates the impact of different policy instruments – that can be used by the board of trustees – on the risk and return trade-off in terms of the surplus of the pension fund. The results indicate that given a predetermined pension contract the effect of the indexation instrument is found to be the most risk mitigating instrument in terms of the surplus at risk. The pilot study retrieves the implicit risk preferences of a current existing board of trustees. Their evaluation has led to an established investment strategy corresponding to their preferences consisting of 60% equity, 40% fixed income, and an overlay which approximates the duration of the liabilities – achieved through obtaining interest rate swaps.

Keywords: Risk preferences, ALM, pension fund, investment strategy, board of trustees, value at risk

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1 Introduction

1.1 Review

Many pension funds suffered enormously in the aftermath of the credit crisis. In combination with low interest rates most pension funds are still struggling to restore their current funding ratio. This ratio indicates how much assets are available for every euro of pension claims to be paid for a certain point in time and could be seen as a solvency measure. The impact of both the financial market crash and the drop in interest rates on the pension funds' funding ratio is dependent on the characteristics of the fund, such as the maturity or the investment policy of the fund. A general fact though, is that since 1980 most pension funds gradually shifted their investments from fixed income portfolios to portfolios with substantial less fixed income and more equity exposure. The reason for this shift is to benefit from the equity premium generating higher expected returns, and hence, resulting in lower expected costs in terms of the contribution rate. On the other hand, more equity exposure is inherent to a higher risk profile, which consequently results in a higher volatility of the fund's assets. Another important issue – relating to the impact of the interest rate drop – is that since 2007 pension funds are required to value their liabilities based on the prevailing term structure of nominal interest rates.[1] Before 2007, pension funds used a prudential fixed discount rate to value the liabilities. The change in valuation makes the liabilities of a pension fund sensitive to interest changes and therefore more volatile. Notably, a drop in the interest rate raises the present value of the liabilities. And a rise in the interest rate lowers the present value of the liabilities. So, both a higher risk profile and different valuation standards have increased the impact of a shock in the financial market and interest rates on the fund's funding ratio.

In addition, and of a more structural nature, is the issue of ageing. People tend to live longer. In 1998 men and women had a life expectancy at birth of respectively 75.2 and 80.7 years (Centraal Bureau voor de Statistiek [CBS], 2010). In 2009 this was 78.5 and 82.6 years respectively. On the other hand the fertility rate has fallen in 1950 to 1980 from 3 to 1.6 and remained rather constant at this latter level ever since (1.79 in 2009).[2] Thus given an increasing life expectancy (longevity) and a drop in the fertility rate the society is ageing. The problem for pension funds is that, in time, a significantly larger share of the total liabilities belongs to the pensioners in the fund. As a result, this makes pension funds more sensitive towards adverse shocks as there is less time for recovery. And the ability of absorbing adverse shocks by means of contribution raisings also dilutes.

[1] Since 2007 a new regulatory framework was introduced in the pension law that legally binds pension funds to comply with certain financial requirements (Dutch pension act, Pensioenwet [PW]).

[2] The fertility rate is the average number of children born to a woman who lives in her childbearing years.

The increased vulnerability of pension funds is caused by a drop in the interest rates and the crash of the financial markets, plus the structural problem of ageing. Together, this is what makes pension funds more sensitive towards future adverse shocks and therefore solid risk management is requested. This study focuses on those responsible for and trusted with delivering the benefit promised; the board of trustees. In particular, this study brings forward an attempt to retrieve the implicit risk preferences of the board of trustees. The relevance for this attempt is twofold and in a response to a recent report that was submitted by commission Frijns (Frijns, Nijssen, & Scholtens, 2010). This commission was established to investigate the current risk management and investment policy of the Dutch pension sector. First of all, their analysis showed that there is not enough attention for risk policy and investment implementation. The commission argues that the investment policy of most pension funds is still too much return driven. The investment policy should, instead, relate to a fund's objective taking into account the risky liabilities. Secondly, the commission found evidence that the governance needs improvement. The board of trustees is challenged to react to and deal with the aftermath of the crisis. This is a difficult task and requires expertise of the board of trustees. Frijns et al. (2010) believe that the board of trustees should be able to make a trade-off between expected return and what the board considers as acceptable in terms of risk. And this trade-off should be based on the funds' characteristics.

The analysis of commission Frijns has lead to several recommendations that is especially addressed to pension fund trustees. This study accounts for several recommendations in an attempt to retrieve the implicit risk preferences. It first accounts for an investment implementation that coincides with the objective and circumstances of the fund by evaluating several criteria given (ex ante) unknown investment strategies. Secondly, it accounts for trade-off decisions between risk and return, given the pension contract and the fund's risk bearing capacities.

1.2 Research Description

In an attempt to retrieve the implicit risk preferences of the board of trustees this study conducts a pilot study. In this pilot study the board is asked to evaluate several risk and return criteria given a set of investment strategies. The evaluation criteria apply to the financial statement, indexation policy, and contribution level of the fund. Additionally, the investment strategies are unknown so that the board could solely focus on the objectives of the pension fund.[3]

In order to conduct the pilot study it is first necessary to deliver output for the chosen evaluation criteria. Therefore this study builds a stylized pension fund and employs an ALM study to deliver the output. The ALM model is based on the

[3] This "blind selection" of investment strategy was used by Dert (2009, June).

model by Van den Goorbergh, Steenbeek, Molenaar and Vlaar (2010) and briefly discussed in section 3.

The stylized pension fund used in this study is based on a collective defined benefit (DB) pension fund. A pension someone receives can be seen as an (delayed) annuity that pays out a certain level of pay during retirement until that person dies. The annuity level in this study is assumed to be 80% of average pay for someone that works for 40 years. This boils down to a yearly accrual rate of 2%. Furthermore, and contrarily to traditional DB pension funds this study assumes a constant contribution rate. In reality DB pension funds often have the possibility to adjust the contribution dependent on the condition of the fund. This is a so called contribution policy ladder and deliberately discussed by Ponds and Van Riel (2007). The contribution rate in this study is based on a prudential estimation of the long term real median return on assets. This corresponds to a contribution rate of approximately 20%. However, this study does allow for contribution rate alterations dependent on what investment strategy is set in place. So, the constant cost based contribution rate is then adjusted for the expected return of the investment strategy.

Another important issue is whether the annuity (or pension) is indexed. Typically, pension funds grant indexation (raise pension rights with price or wage inflation) when the fund is solvent enough to do so. And one important indicator for its solvency is the funding ratio. Theoretically, it is said that the level of annuity in nominal terms is a guarantee, whereas the intention of providing indexation refers to the ambition of the fund. This is the so called indexation policy ladder (cf. Ponds & Van Riel, 2007). This ladder is of great importance for the level of annuity in real terms and the risk sharing properties between the different cohorts within a pension fund and future generations.[4] The indexation ladder can be viewed as one of the instruments that the board can adjust.

Besides the indexation and contribution instrument the board has two additional instruments that can be used for recovery, risk mitigating, or risk shifting purposes. These are altering the investment strategy and the option of cutting down on nominal pension rights.[5] This latter instrument is not taken into account as there is still no explicit rule that outlines how to cut down on nominal pension rights. One problem for the lack of such a rule is that property rights are still not accurately defined. Moreover, this study particularly focuses on the risk mitigating and risk shifting purposes. The question of how and what instrument to use for

[4] Bovenberg and Nijman (2009) give an overview of the developments and properties of the Dutch pension schemes.

[5] Additionally, for occupational DB schemes it might be that the pension contract specifies that the sponsor deposits an amount of money when the fund is in deficit. This option is also left out in this study.

recovery necessities is thus not incorporated.[6] What risk management should be is rather how and in what degree the different instruments are used to give up upside potential in order to mitigate or curtail downside risk. This study therefore first investigates the effects of the different instruments on the risk of the fund. In particular, the effects of introducing an indexation ladder, altering the contribution rate, and changing the investment strategy on the surplus at risk are shown for different horizons. The surplus at risk is used as a risk indicator for the pension fund. The surplus is defined as the value of the assets minus the liabilities. This is further detailed in the next section.

The investigation of the effects of the instruments can be seen as the backdrop for the pilot study. To retrieve the board of trustees' risk preferences, decisions have to be made with regard to what instruments the board could use. The pitfall of allowing the board to use all the instruments is that it makes the evaluation of the risk and return criteria become very complex. This also applies to the investment horizon and investment strategies. Consequently, the pilot study is based on a stylized pension fund offering an 80% average pay with the ambition – so including an indexation ladder – to index the pension rights. Furthermore, the evaluation only applies to an investment horizon of fifteen years given five different 'stylized' investment strategies. The instruments left are the contribution instrument and the alteration instrument of the (five) investment strategies.

Notably, two factors that might influence the risk preferences of the board are the level of funding ratio and the state of the economy that serves as an input for the ALM model. As mentioned before the focus is not so much how the board copes with a fund in shortfall or deficit, but rather how they evaluate certain risk and return criteria. This justifies starting with a funding ratio of 125% and running simulations applicable to an economy in steady state.

In addition, the pilot study is also conducted among professionals within a real pension administration company. This shows whether their choice of preferences differ from that of the board of trustees.

This study is organized as follows. Section 2 deals with the prevalence of risks among pension funds and the role of the board of trustees. Section 3 briefly introduces the asset liability model. Section 4 presents the results of the ALM model which can be seen as the backdrop for the pilot study. The pilot study with the board of trustees is advanced in section 5. Additionally, section 6 shows the results of the pilot study for the individual responses. The final section concludes.

[6] Dutch pension funds are obliged to hand in a recovery plan when the fund faces a buffer shortfall (long term recovery plan) or a deficit (short term recovery plan). It specifies how the fund in expectations will meet the requirements.

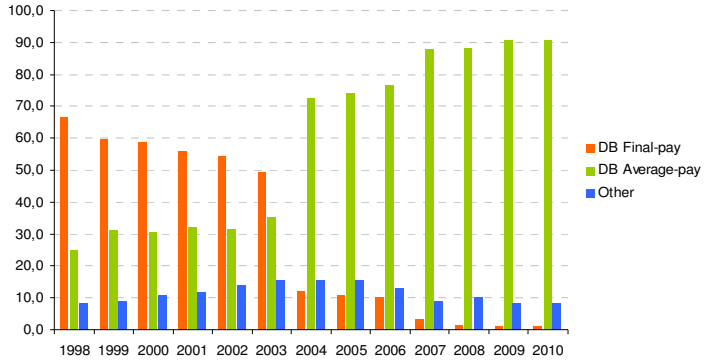
2 The prevalence of risks among pension funds

2.1 The Dutch pension system

In the Netherlands three different pension systems can be distinguished. A first pillar provides a pension on a pay-as-you-go basis to all Dutch residents that have reached the eligible retirement age. This pillar is put in place because of paternalistic reasons – to alleviate poverty and to insure people living in old age. It covers 50% of the total retirement benefits (Börsch-Supan, 2004). The second pillar involves all types of collective pension funds and is mandatory, also explaining the high participating coverage of 90% of the Dutch labour force. The majority of the Dutch labour force is participating within the industry-wide or sector-specific pension funds. If a company offers a better pension deal then it can opt out and usually refers to company pension funds. The second pillar covers 40% of the total retirement benefits (Börsch-Supan, 2004). The third pillar consists of voluntary savings for personal purposes and covers the final 10% of the total retirement benefits. For an elaborated survey of the Dutch pension system this study refers to Bovenberg and Nijman (2009).

The second pillar involves different types of pension plans. Figure 2.1 shows the percentage of active participants in the second pillar sorted by type of pension plan. It can be seen that, to date, 90% of the participants within the second pillar are involved in the so called DB average-pay schemes. As already mentioned by Ponds and Van Riel (2007) most of these DB average-pay plans are characterized by a solvency-contingent indexation policy. This means that these plans have a DB character in the way participants accrue their pension rights and is DC-like because the indexation is contingent on the solvency of the fund and hence a pension result based on the return of investments. This is also called a hybrid DB-DC plan. And this system is applicable to 91,8% of the active participants (De Nederlandsche Bank [DNB], 2010). The traditional DB plans (final-pay) with particularly the contribution policy as the steering device have declined to 1% of the participants. The other schemes consist of combinations of final-pay and average-pay, pure DC schemes, or other undefined pension plans.

Figure 2.1: *Percentage of active participants within the Dutch second pillar sorted by type of pension. The types of pension apply to all three pension funds, namely the company pension funds, the sector-specific pension funds, and the occupational pension funds.*



Source: DNB (2010)

As mentioned in the research description section the accrual rate in this study is 2%. Then, if someone participates for 40 years he or she will receive 80% of his or her average-pay. In contrast to traditional DB funds the contribution steering device in this study is fixed. This means that independent of the solvency of the fund the contribution level will remain constant. This study does, however, allow for different investment strategies. Section 4 provides both the results of a contribution rate that is fixed for all the investment strategies and a contribution rate that is dependent on the investment strategy. In particular, the contribution instrument in this study refers to a contribution rate that is made dependent on the expected return of the investment strategy. In addition, the 2% accrual rate is in the first instance a promised benefit, meaning an unconditional indexation policy. Section 4 also shows the effect of the indexation instrument in terms of the risk-bearing capacity of the fund. The indexation instrument refers to an indexation policy that is contingent on the solvency of the fund. The amount of risk to which a pension fund is exposed is indicated by the surplus at risk and will be explained in subsection 2.3. The next subsection first gives an overview of the risks that are prevalent in the pension product as stylized in this study. A final subsection will briefly describe the role of the board of trustees of a pension fund.

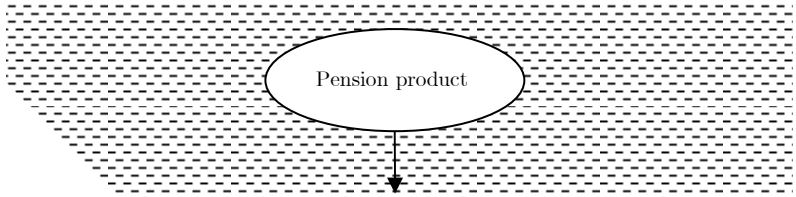
2.2 The prevalence of risks

A pension product can be seen as a financial product that pays out a certain pay during retirement in the form of an annuity. The analysis of this study is first to show the risk and return trade-off, given a set of investment strategies, for a pension deal that provides a guarantee of 80% average-pay during retirement – fully indexed.[7] The results are provided in section 4. This subsection brings forward

[7] The accrual rate is 2%. If someone works for 40 years it then receives 80% of his or her average pay.

the risks that are entailed in such a pension deal. In particular, it shows the risks for which the ALM model accounts for. Moreover, from a balance sheet perspective this subsection describes how different risks influence the balance of a pension fund. The next figure illustrates this.

Figure 2.2: *Factors that determine the value of the assets and liabilities of the stylized pension fund given the pension deal.*



Δ Assets	Δ Liabilities
New contributions (+)	Accrual of new pension rights (+)
Pension payments (−)	Subtraction from pension payments provision (−)
Asset Returns (+/−)	Present value change (+/−)
Δ Deficit	Δ Surplus
Δ Total	Δ Total

The pension product, surrounded by risk (depicted by the dashed area) has its impact on the value of the liabilities and assets of a pension fund. The white triangular area represents the residual risk which cannot be modelled or is not taken into account in the ALM model.[8] A change in the assets is caused by new contributions, pension payments, and asset returns. A change in the liabilities is caused by the accrual of new pension rights, the subtraction from the provision of pension payments, and the change in present value. In turn, this either leads to a change in the surplus or deficit of a fund.

2.2.1 Liability side of the pension fund

Accrual of new pension rights

Each year active participants build up pension rights equal to the accrual rate of 2%. In the first instance this is a guarantee in real terms. The accrual rate is based on average-pay. So, if someone works for 40 years he or she will receive 80% of average-pay in real terms. Later on it is shown that when the accrued pension rights are contingent on the solvency of the fund the 2% accrual rate is in nominal terms and the ambition is to index the pension rights.

Subtraction from pension payments provision

[8] This study excluded longevity and operational risk.

The pension payments provision is the present value of all future pension payments. If pensions have to be paid then this is withdrawn from the pension payments provision. Consequently, the pension payments and subtraction from the pension provision cancel each other out.

Present value change

A very difficult issue for pension funds is to value the long maturity (deferred) annuities. Since 2007 pension funds have to value their liabilities based on the value marked to the market. This means that the present value represents the 'fair' value for which it can be sold on the market. In practice, the present value of the liabilities is calculated by the use of the so called yield curve. This is the term structure of the nominal interest rate at some specific point in time. The yield curve is published each month by the Dutch central bank (DNB). Their calculations are based on the zero coupon swap rates. Figure 2.3 illustrates different yield curves for four different points in time.

Figure 2.3: *Interest rate term structures (zero coupon swap rates) for different points in time.*

Source: DNB (2010)

What can be seen is that over time interest term structures can be different. And this has huge implications for the present value of the liabilities of the fund. Especially, the long duration of the liabilities of a pension fund makes it very sensitive to interest rate changes. The duration of the stylized fund approximates 16. A rule of thumb is that a one percent change in the interest rates causes the liabilities to change in value by 16 percent. This means that if interest rates drop, the liabilities increase and ceteris paribus the solvency of the fund worsens. Figure 2.3 shows that as of 2001 the long interest rate dropped by 2.72 percentage points to the current level of 2.55%. This is a decrease of more than 50% and has made pension funds very vulnerable. In addition, the term structure can also be different

in terms of the shape of the curve. Ultimo June 2008 for instance the short rate lie above the long term interest rate. Compare the short term interest rate of June 2008 with the current short term interest rate (October 2010). The difference in short term interest rate is almost 4 percentage points (74% decrease), which is severe. Moreover, the short term interest rate is very important as the near future payments are weighted more heavily. The sensitivity of a pension funds towards the interest rate, makes the interest rate a crucial risk factor.

Dutch pension funds report their liability value based on the nominal interest rates. This also means that the indexation is left out in the present value calculations. However, the first pension deal is to give unconditional indexation such that each year the pension payments will be raised by the (expected) inflation. To level up with inflation the present value of the liabilities will be higher because incorporating the expected inflation leads to a lower discount rate and therefore to a higher present value. The pension product has an additional risk factor, namely expected inflation risk.

Another risk factor that is important is the risk of longevity. Longevity refers to the fact that people live longer. This means that the pension payments are also extended and hence leading to higher liability values. Specifically, the uncertainty about future survival probabilities has huge implications for the volatility of the future liabilities of a pension fund. Hári, De Waegenaere, Melenberg, and Nijman (2008) investigated the effect of longevity risk on pension annuities and reported a 7% to 8% necessary increase in buffer of initial liability value to reduce the probability of underfunding to 2,5% in five years from now. There is still much debate of how future survival probabilities should be modelled and for this reason this study does not take into account the longevity issue.

To sum up, the most important risk factors that affect the liability side of the pension fund are interest rate, inflation and longevity risk. Each risk factor has implications for the volatility of the liability value. Moreover, this study does allow for interest and inflation risk but excludes longevity risk.

2.2.2 Asset side of the pension fund

New contributions

Each year active participants pay a percentage of their wage that in expectation covers the costs of their future (real) pension payments. As discussed in the previous subsection the present value of these pension payments are exposed to certain risk factors, which cause the pension payments to become volatile. Hence, the contributions that should cover these pension payments also become volatile. To date, it can be seen that the ageing issue – longevity and lower fertility rate – not only harm the pension system based on pay-as-you-go financing but also the funded schemes in the second pillar. Ageing leads to a higher volatility in

contribution rates as people live longer and less active participants are able to cover the increasing pension payments (cf. Bovenberg & Nijman, 2009).

In practice, the Dutch regulatory framework (FTK) requires that the contribution rate should be based on the actuarial costs of new accrued pension rights. On top of that it should contain a buffer (prudence) that covers for administration costs, minimum required buffer costs, and indexation costs. In this study the contribution rate is based on the median long real return on assets. Plus an extra return subtraction that covers for the prudence rule.

Pension payments

The pension payments consist of the monthly payments that are remitted to the debt holders of the fund. The debt holders can be of course the pensioners that build up pension rights, but also those that receive for instance partner pension or those involving in other pension provisions. The payments due are dependent on the pension rights that are built up and the eligibility of receiving pension payments. Again, the pension rights in the first instance are pension rights in real terms. Later on, pension payments are based on nominal (built up) pension rights and grant indexation depending on the solvency of the fund.

Asset returns

The contributions collected are invested in various asset classes that are available in the worldwide financial markets. These investments are inherently exposed to all sorts of market risks. Depending on the asset allocation of a pension fund the exposure towards the market risks is different. The following table gives a classification of the different asset classes that exist in the financial markets. This table is merely for illustrative purposes and not necessarily a strict classification.

Table 2.1: *Asset classifications*

Equity	Stocks (emerging and developed markets)
Real estate	Indirect and direct real estate and infrastructure
Fixed income	Government bonds and credits
Derivatives	Options, futures, swaps, and other exotics
Others	Hedge funds, Private equity, commodities, and innovatives

Each asset class has its own risk and return characteristics for different points in time. Campbell and Viceira (2005) call this the term structure of the risk and return trade-off. For a long term investor such as a pension fund the long run risk dynamics of different asset classes are very important. Moreover and investigated

by Hoevenaars, Molenaar, Schotman, and Steenkamp (2005) is the existence of hedge qualities of the different asset classes against the risky liabilities that are exposed to the real interest and inflation risk as discussed in the previous subsection. This is the so called cross-sectional risk diversification over time. It is primarily important because it minimizes the (real) mismatch risk. Mismatch risk principally occurs when there are no assets available in the financial markets (missing markets) that are able to replicate the risk and return dynamics of the liabilities of a pension fund. Therefore asset classes that do correlate well with the real interest rate properties and inflation risk are important for long term "asset-liability" investors. There do exist real return bonds (ILBs) that are related to the consumer price index in order to ensure these bondholders a real rate of return. This might be a good replicating asset instrument as it correlates with price inflation, however the supply of these index linked bonds is still limited and only hedges against the price inflation. Pension rights, in contrast, are often indexed by wage inflation. Another (regulatory) constraint why real mismatch risk seems inevitable is due to the nominal solvency rules. Dutch pension funds are subject to a solvency test that tests whether a pension fund is still able to meet their nominal guarantees. This slightly induces pension funds to invest or allocate their resources in order to minimize the nominal mismatch risk and this might be suboptimal whereas the goal is to provide pensions in real terms – seeking for a low real mismatch risk. A high mismatch risk does not always mean that there are no assets available that can replicate the liability characteristics, it can also tell something about the willingness of risk taking. Allocating the resources towards risky assets (those that have high volatilities and expected returns) could also lead to larger mismatch risks. A risk averse investor seeks to invest everything in those asset classes that can best hedge against the risky liabilities and thus minimizes the real mismatch risk. A risk seeking investor would invest in more risky portfolios to benefit from higher expected returns and automatically leading to a higher mismatch risk.

This study does take into account the financial market risk along with the market imperfections, such that mismatch risk is present. It does however only take into account the equity asset class, government bonds as fixed income, and interest swaps to hedge against the nominal interest rate. In addition, the equity is hedged against the US dollar currency risk. The asset classes included are further detailed in section 4.

To sum up, the asset side of a pension fund is mainly exposed to the financial market risks. There exist time varying diversification effects between asset classes and within asset classes which are important for the allocation of a pension fund with risky liabilities. The contribution rate is often based on a long term real discount rate. That is, it should be cost based (with some prudence) such that it equals the present value of new accrued pension rights. The pension payments due are mainly exposed to inflation risk and the real interest rate risk that is used to determine the present value of the future obligations.

2.3 Risk sharing, risk taking, and risk preferences

One main advantage of collective pension funds is that all the risk absorbed in the pension contract can be shared among non-overlapping generations. As indicated by Bovenberg, Koijen, Nijman, and Teulings (2007) this is welfare improving. The risk bearing capacity of a fund refers to the fund's degree of risk sharing which, in turn, depends on the composition of the active and non-active participants within a pension fund. Risk taking on the other hand is the amount of risk that, given the risk bearing capacity, a pension fund is accepting. The amount of risk is first of all entailed in the pension product itself. In the first instance, the pension product promises a pension in real terms. This thus also means that the risk absorbed by this contract is also shared by all participants of the fund. In section 4 it will be shown that a pension contract with conditional indexation is exposed to the same prevalent risks but exploited in a different way by possible indexation cuts. From section 4 it will be clear that a pension product with conditional indexation is beneficial in terms of the risk bearing capacity of the fund but harmful in terms of the level of pension to be received by the participant. Secondly, risk taking and therefore accepting an amount of risk is also influenced by the risk tolerance or – and the used terminology in this study – risk preferences of the board of trustees. Assuming the board of trustees acts on the best interests of the participants of the fund it is thus important to make the risks that are entailed in the pension product explicit. By making it more explicit the risk preferences can be established in a more robust way. This study makes the risks explicit by showing what it means in terms of the risk bearing capacities of the fund and the quality of pension payments. This is measured by seven evaluation criteria which will be further explained in the pilot study (section 5). In this way the study attempts to retrieve the implicit risk preferences. This study refers to the *implicit* risk preferences as the preferences following the outcome of the fund given the ex ante preferred investment strategy. Possible and presumably behavioural determinants are not encountered.[9] The level of risk taking is also constraint by certain regulation rules. These rules more or less impose a maximum risk level to be taken. This narrows down the feasible region of the risk preferences and as discussed in the previous subsection also can lead to suboptimal investment strategies as the goal is to provide a real pension but at the same time this goal can be hampered by the solvency requirements under nominal valuation.

The amount of risk taking is indicated by the surplus at risk, which is the subject of the next subsection.

2.4 Surplus at risk

The surplus is the value that represents the difference between the assets and liabilities. Strictly spoken the fund is in surplus when the value of the assets

[9] Such as peer group effects or other effects that might occur when working in a group.

exceeds the value of the liabilities. However, for convenient matters the surplus either refers to a deficit (negative surplus) or to a (positive) surplus. Obviously, a negative surplus represents the value where the value of the liabilities exceeds the value of the assets. The surplus is used as the value that captures the risks of both the liability and asset side of a pension fund and thus entails the total risk a pension fund is taking. Again, this only applies to those risks that are taken into account in the ALM model.

The surplus can be used as the value at risk (VaR) for an indicator of the amount of risk taken. The VaR is a summary statistic that measures the downside risk for the applicable value. It is the amount of value V that will not be exceeded for a certain percentage X in the next N days (Hull, 2008). In the case of the surplus of a pension fund as the applicable value it means: the amount of surplus that will not be exceeded for a certain percentage X in the next N years. The following table summarizes the main pros and cons of the VaR method.

Table 2.2: The *Pros and Cons of the VaR methodology*

Pros	Cons
VaR is an easy interpretable summary statistic, and viewed useful by regulators as well (Basak & Shapiro, 2001).	VaR is an expectation of outcomes given a set of assumptions. The set of assumptions is crucial for the outcome of the statistic (Beder, 1995).
VaR is used as a tool to manage and control risk (Basak & Shapiro, 2001).	The inability to capture exogenous and qualitative risk factors (Beder, 1995).
VaR can be used for different simulation methods. Historical simulations, Monte Carlo simulations, and variance-covariance simulations (Linsmeier & Pearson, 2000).	In most adverse states, VaR risk managers incur larger losses than non-risk managers would (Basak & Shapiro, 2001).

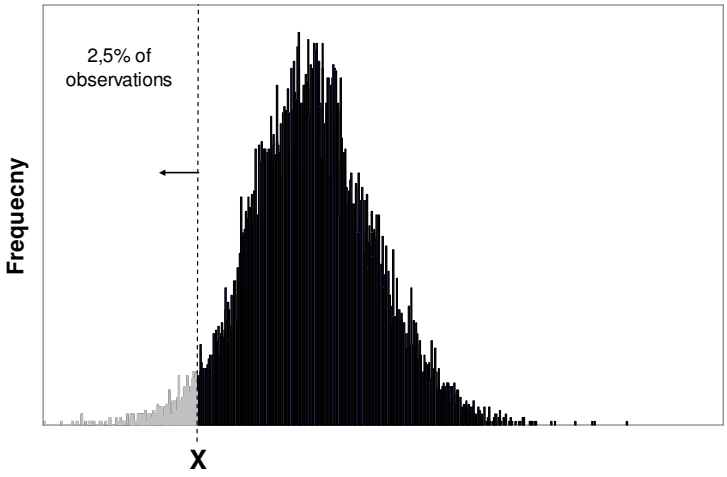
The most important reason of using the VaR method as the applicable risk indicator is primarily due to the easiness of interpretability. Especially in communication with the board it is important to have a risk indicator that can be easily understood. Besides, this study also investigates the effects of the use of different instruments. Using one risk indicator makes the comparison of the effects more convenient. The preliminary results of the ALM study will show the impact of the use of the different instruments on the surplus at risk.

Notably, in the pilot study another value for the value at risk is used. The value applicable to the pilot study is the funding ratio. The funding ratio follows from the value of the assets divided by the value of the liabilities. It shows the ratio of assets that are available to cover the liabilities of the fund. For instance, a funding ratio of 90% thus means that there is only 90 euro cents of assets available for every euro of liabilities to be paid. As the board is not familiar with the characteristics of the stylized fund the funding ratio at risk as the risk indicator is more intuitively appealing.

2.4.1 Method of retrieval of the surplus at risk

The surplus of a pension fund is determined by the value of the assets minus the value of the liabilities. This study projected for each investment strategy 25,000 scenarios that contain the future value of the assets and liabilities. One way to determine the surplus at risk is to look at the distribution of the surplus and find for each investment strategy – given a predetermined probability level – the value of the surplus.

Figure 2.4: *An example of a distribution of the surplus in year 5*



This point represents the value of the surplus that will not be exceeded in 97,5% of the cases. Figure 2.4 depicts for instance the distribution of the surplus in year 5. The cut-off point is determined at the 2,5% quantile. The value of surplus can be smaller than the surplus X in 2,5% of the cases. The surplus, however, is hard to interpret as it does not tell much about the value of the liabilities and assets. Take for instance two possible scenarios that result in the same surplus at risk value. It is very well possible that these two scenarios have different asset and liability values. To make a surplus at risk better interpretable the corresponding funding ratio (the funding ratio at risk) should be depicted together with the surplus value. Therefore this study derived the surplus at risk based on the distribution of the funding ratio. The surplus at risk was derived out of the average value of the assets

and liabilities in the area between the three percent and two percent quantile of the funding ratio distribution. So, for each portfolio for 15 different points in time the mean value of the assets and liabilities were calculated. By subtracting the value of the liabilities from the value of the assets the surplus at risk was determined. And by dividing the liabilities over the assets the corresponding funding ratio at risk was determined.

2.5 The role of the board of trustees

From a principal-agent perspective the board of trustees is the agent and the pensioners and participants of the fund are the principal. This means that the board should act in the best interest of the members (both participants and pensioners) of the fund. The board of trustees is responsible for delivering the pension promised and consists of representatives of the employer and employee. One familiar issue within the principal-agent theory are the agency problems that can arise due to information asymmetry. The members of the fund have very little knowledge in what way their contribution is invested in order to achieve the level of pension promised. The board of trustees are trusted to invest the resources in such a way that is in the best interest of the members of the fund. However, the board of trustees are, in turn, advised by experts that thus also should act in the best interest of the members of the fund. In addition, many pension funds also delegate their resources to professional investor parties. The question arises whether those parties have the same interest as the board of trustees of the pension fund has. The goal for the board of trustees in governing the fund is to reduce the agency problems as much as possible. An important issue is that the board of trustees should create enough 'countervailing power' in order to translate the interest of the members in good decision making, especially with respect to the investment implementation.

3 Asset Liability Model

This section gives a brief introduction of the terminology of asset-liability models in general. Especially, it shows what assumptions underlie the time series models on which an ALM study is based. The final subsection explains the economic variables that are used in the ALM model for this study.

3.1 What is an ALM model?

Most ALM studies can be traced back to the coined work of Kingsland (1982), who understood the relevance of projecting future financial conditions of a pension fund. He actually 'warned' us about the complexity of valuing assets and liabilities. Especially the actuarial rates that are used to calculate the present value of the liabilities can be very sensitive. Moreover, Kingsland (1982) mentioned that increasing equity exposure within pension plans can become lucrative in the sense that expected returns could reduce the costs in terms of the contribution payments. On the other hand his simulation analysis also showed that a mature and well funded pension plan should hold a more conservative investment strategy. In contrast, a young and low funded pension plan could benefit from an aggressive investment strategy because of the potential risk premium and large time of recovery (Kingsland, 1982).

Projecting future financial conditions of a pension fund is what should be the purpose of an ALM model. More specific, projecting future values of the assets and liabilities to "investigate the impact of decisions with regard to investment, contribution, and indexation policy on the various stakeholders of the fund" (Bauer, Hoevenaars, and Steenkamp, 2005, p. 417). ALM studies can therefore be used to determine the optimal investment policies to achieve goals and to meet a fund's future obligations (Mulvey & Ziemba, 1998). This also applies to a fund's current investment policy analysing whether it still can meet the goals and future obligations. Time series models for certain economic variables are required to generate scenarios for future asset and liability values. Economic variables, such as returns on stocks, bonds, inflation, and interest rates thus serve as an input for the ALM model. Later on, the economic variables that are used in this study will be explained. Pension funds can be seen as long term investors, but also need to maintain a relative healthy condition in the short run. It is therefore important that the risk and return dynamics of the economic variables are described accurately by the model. Stochastic scenarios enable to describe the risk and return dynamics of the economic variables and to distinguish between the short and long run investment horizons (Hoevenaars, Molenaar, and Steenkamp, 2003).

3.2 Autoregressive processes

A time series model or process in which an economic variable is linearly dependent on his own lagged value is called an AR(1) process. Noted as,

$$Y_t = \delta + \theta \cdot Y_{t-1} + \varepsilon_t , \tag{3.1}$$

where Y_t denotes a single economic variable, δ a constant, θ (assuming $|\theta| < 1$) is the factor to its lagged value, and ε_t is the error term following a white noise process.[10] A white noise process assumes that it is homoskedastic and views no sign of autocorrelation. The θ factor is important for the smoothness of the process. For a high value of θ it takes longer for the process to return to its mean after a shock has occurred. This process is also called mean reverting. If $|\theta| > 1$ than the process is said to be nonstationary and if $\theta = 1$ the process follows a random walk.

The stochastic process of (3.1) does not completely describe the total dynamics of the economic variable. One of the restrictions of this model is the assumption of stationarity. In this AR(1) model strict stationarity holds that the distribution of Y_t is the same as the distribution of Y_{t-1}. So, the covariance of Y_t with its lagged value does not depend on time. As often only the moments (means, variances, and covariances) of the series are considered and not the total distribution, it is ample to state the moments are independent of time. This is called covariance stationarity. Under this 'weak' stationarity the autocorrelation can be derived as follows

$$\rho_1 = \frac{\operatorname{cov}\{Y_t, Y_{t-1}\}}{V\{Y_t\}} = \frac{\gamma_1}{\gamma_0} , \tag{3.2}$$

where γ_1 is the first-order covariance and γ_0 is the variance of Y_t.

Equation (3.1) and (3.2) roughly describes the stochastic process for a single state variable. As already mentioned there are more economic variables that can help predict future asset and liability values. The process for a single state variable can be augmented by the risk and return dynamics for a whole vector of state variables. This so called first-order vector autoregressive (VAR(1)) system can be described by

$$\mathbf{Y}_t = v + \Theta_1 \cdot \mathbf{Y}_{t-1} + \boldsymbol{\varepsilon}_t , \tag{3.3}$$

where $\mathbf{Y}_t$ is an n-dimensional vector consisting of certain economic variables and $\boldsymbol{\varepsilon}_t$ is independently and identically distributed with $N(0, \Sigma)$.

[10] In this study the notations of Verbeek (2008) are used.

A VAR(1) system as in (3.3) not only includes the correlations of the state variables over time (autocorrelations), it also takes into account possible causal relationships between various state variables (cross-correlations). So, correlations between certain state variables are also based on the state of the world of the other state variables included in the VAR (Hoevenaars et al., 2003). Another study addressing this issue is that of Campbell and Viceira (2005). They explored the implications of the correlation and variance structure of different state variables across time. It is shown that there exists a term structure of the risk-return trade-off for a long term buy-and-hold investor. This means that cross-correlation and variances may be different for different investment horizon and thus very important for the strategic asset allocation of a pension fund. For instance, the real return on equity tends to be less volatile in the long run. And the real return volatility of holding a K bond to maturity is increasing in K (Campbell & Viceira, 2005).

The VAR model used in this study distinguishes from (3.3) in three ways. First of all it takes into account possible future sentiment changes in the financial markets. These so called jumps relate to selling risky assets en masse and at the same time to a drop in the interest rate. Second, the model no longer assumes constant (co-)variances over time, but correlations and variances that are time varying. Especially, the correlation between stocks and bonds over time is of importance as it determines in which way the assets move along with the value of the liabilities. Third, an extra times series is included that better describes the inflation process for the medium run (cf. Van den Goorbergh et al., 2010b). More detailed information about time series models is beyond the scope of this study as the ALM model in this study is merely a component that serves the process of the pilot study. More detailed information about the ALM model used in this study can be found in the paper by Van den Goorbergh et al. (2010a).

3.3 The state of the economy

A fundamental assumption in ALM studies in general is the chosen path of economy. The chosen path of economy is crucial for the risk and return dynamics of the included state variables of the model and thus important for the optimal or current investment strategy of a pension fund. This study assumes an economy that is in steady state. This means that the ALM results apply to the values of assets and liabilities in equilibrium. So, this study retrieves the implicit risk preferences of the board of trustees by establishing an investment strategy that applies to an economy in steady state. The question remains unanswered what the preferred strategy would have been for the path moving towards a steady state, as this path can be viewed as an adjustment path towards the steady state solution.

Table 3.1 shows the characteristics of the annualized steady state parameters used to provide the ALM results.

Table 3.1: *Annualized steady state parameters*

Short term interest rate	Long term interest rate	Equity return	Price inflation	Wage inflation
0.041	0.053	0.072	0.02	0.03

Given these parameters the model generated a set of 25,000 scenarios for various assets available in the financial markets. The selected assets in this study are equity, bonds, and nominal interest rate swaps. These are used to construct three investment baskets which are explained in the next section. Furthermore, the associated term structures of the nominal and real yields have been used to generate the fair values of the (nominal and real) liabilities.

4 Preliminary results

This section brings forward the results of the ALM study. The first subsection describes the objective and circumstances of the stylized pension fund. Subsection 4.2 shows the output for the different investment strategies. Subsection 4.3 will show the effects of the different instruments than can be used by the board of trustees. The final subsection discusses the results of the ALM study.

4.1 Objective and circumstances of the stylized pension fund

Before simulating the scenarios it is important to first define the objective and circumstances of a pension fund. The purpose of this study is to set up a new approach that retrieves the implicit risk preferences of the board of trustees. This study therefore built a stylized pension fund and employed an ALM study to deliver the output. The idea is to present the concept first and develop a default so to make it applicable to actual pension funds. The concept is presented in the pilot study and discussed in chapter 5.

Unconditional indexation

The main objective for a pension fund is to deliver a 'good' pension to the participants of the pension fund. The pension deal in this study refers to someone that builds up pension rights that annuitize 80% of his average pay. This annuity level in real terms translates to raising the pension rights of the participants each year with the realized (wage) inflation. So, no matter the condition of the fund, the pension rights are always being indexed. This unconditional indexation policy is the starting point of this stylized pension fund. Later on, the effects of introducing an indexation ladder will be discussed. In this case pension rights get indexed only if the condition of the fund permits this. Then the level of annuity is more an ambition than a guarantee.

Cost based contribution rate

The starting point for the simulations is based on a fixed prudent contribution rate.[11] The contribution remains constant over time. In practice, however, many pension funds have a contribution policy that is depending on the condition of the fund. This often corresponds to a contribution ladder stating what contribution adjustments have to be made for different funding ratios. Such a contribution policy is left out of this study. Later on, the effects of the contribution instrument

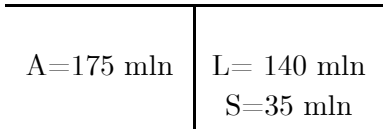
[11] Dutch pension regulations state that the contribution rate should cover the actuarial fair costs for the accrual of new pension rights, the costs of operation costs, costs to preserve the required buffer, and the costs that correspond to the way the fund finances the indexation (cf. Dutch Pension Act, Pensioenwet [PW]).

– a constant cost based contribution that is dependent on the expected return of the investment strategy – will be discussed.

Circumstances

The circumstances of the pension fund in the pilot study refer to the value of the assets and liabilities at the beginning of the simulations. The following figure shows this.

Figure 4.1: Circumstances of the stylized pension fund



This thus shows that the funding ratio is 125% from start. Furthermore, the maturity of the fund is defined by the percentage of the liabilities laid out between the active and non-active participants. For this stylized pension fund the liabilities are allocated equally over the active and non-active participants. This implies that it is a relatively mature pension fund.

Investment Strategies

This study takes into account three baskets of investment strategies. The table below shows the allocation of the three baskets.

Table 4.1: *The three baskets of investment strategies.*

	Basket 1		Basket 2		Basket 3	
Investment strategy	1…	…101	102…	…182	183…	…283
Equity	100%	0%	60%	60%	100%	100%
Fixed income	0%	100%	40%	40%	0%	0%
Duration	0	6	2.4	16	0	16

The first basket consists of equity and fixed income. The equity is a collection of the assets as listed in table 2.1. The fixed income consists of both 5 and 10 year zero-coupon government bonds, of which 80% is allocated to the 5 year government bonds and 20% to the 10 year government bonds. As can be seen in table 4.1 the first investment strategy consists of 100% equity. The allocation towards equity gradually declines to 0% and the allocation towards fixed income gradually runs up to 100% in the last portfolio of the basket (101). Consequently, the duration of this portfolio approximates 6 as shown in the last row of the table. Basket 2 consists of 80 investment strategies with each 60% invested in equity and 40% invested in fixed income. The purpose of this basket is to match the duration of the liabilities of the pension fund. In this stylized pension fund the duration of the liabilities is

approximately 16. Investment strategy 102 has a duration of 2.4. This runs up to approximately 16 in the last portfolio of basket 2. The duration match is achieved by adding interest rate swaps to the investment portfolio. These are 30 year interest rate swaps.[12] The same intuition holds for the third basket. However, basket three allocates 100% towards equity over all 100 investment strategies. This makes the duration of the first portfolio of basket three to start with zero. Then like basket 2, the duration gradually runs up to the point where it approximates the duration of the liabilities (see table 4.1 portfolio 283).

4.2 ALM output for the different investment strategies

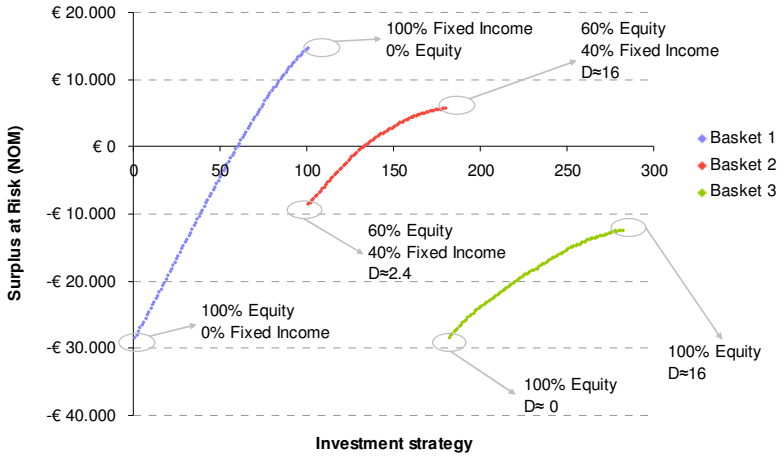
This subsection shows the output of the ALM study that is the backdrop for the pilot study. The first step is to see the differences in risk for the 283 investment strategies without using one of the instruments. This corresponds to an unconditional indexation policy and a fixed prudent contribution rate. As discussed in subsection 2.4 the main risk indicator in this study for the pension fund is the surplus at risk. The surplus at risk is analysed at three different points in time. This is done to show the short and long run effects of the different investment strategies. In addition, the surplus at risk is expressed in nominal terms. Although under unconditional indexation the nominal value is not representing the true story – as it depicts the value of no further indexation from that point in time on – it is, intuitively, worth showing and necessary for comparison of the output when implementing the instruments. Besides, the Dutch regulatory framework (FTK) is based on a nominal framework.

4.2.1 Surplus at risk for the different investment strategies

Figure 4.2 depicts the surplus at risk for the different investment strategies in year 1. The starting point is an unconditional indexation policy with a fixed prudent contribution rate.

[12] The pension fund receives a fixed rate and pays the floating rate (a fixed-for-floating swap).

Figure 4.2: *Nominal surplus at risk in year 1 for the different investment strategies*



The first basket shows a familiar pattern. The allocation of 100% towards equity (portfolio 1) is the most risky one in terms of the surplus at risk. The surplus at risk is nearly -28,5 mln euros. This means that the pension fund investing 100% in equity can end up with a surplus of -28,5 mln euros or worse in 2,5% of the cases. This corresponds to a funding ratio at risk of 83%. The funding ratio is defined as the value of the assets divided by the value of the liabilities. So, for every euro worth of pension rights there is only 83 euro cents of assets available. The risk gradually declines as more is invested in the government bonds. The surplus at risk for fully investing in the government bonds is almost 15 mln euros – a funding ratio at risk of 108%. This is the most riskless investment strategy in one year from now.

The second basket starts with a duration of 2.4 due to the allocation of 60% to equity and 40% to government bonds. At this point the surplus at risk is nearly -9 mln euros – 95% funding ratio at risk. By adding interest rate swaps and thus increasing the duration of the portfolio, clearly has a positive effect on the surplus at risk. The point where the duration approximates the duration of the liabilities the surplus at risk is almost 5.8 mln euros – 104% funding ratio at risk. Despite the duration match of portfolio 182 the investment is not less risky than the investment of 100% government bonds (portfolio 101) which has a duration of 6. This is induced by the equity exposure of 60% in basket 2 versus 0% equity exposure in portfolio 101.

Basket three also exhibits the same effect on the surplus at risk when the duration of the portfolio increases. However, the exposure to equity is 100%, making this basket in total more risky than basket 2. The point where the duration of the liabilities is matched, the surplus at risk is nearly -12,5 mln euros – 92% funding ratio at risk.

Figure 4.3: *Nominal surplus at risk in year 5 for the different investment strategies.*

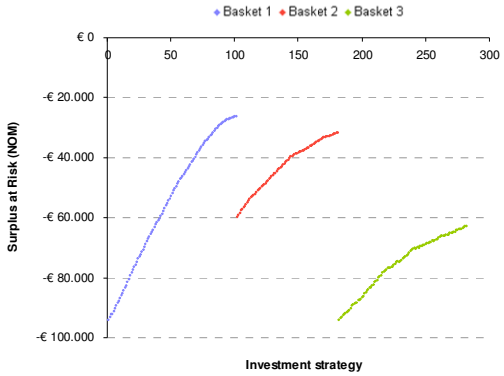
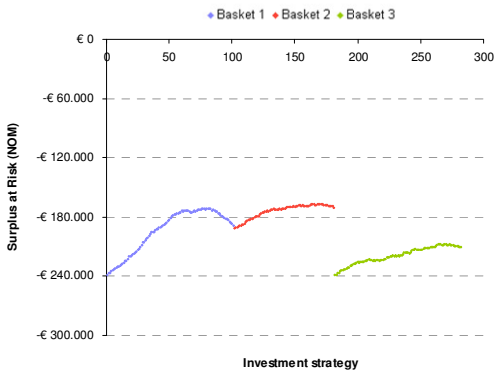


Figure 4.4: *Nominal surplus at risk in year 15 for the different investment strategies.*



Since pension funds are long term investors it is important to see the implications of the different investment strategies in the long run. In addition, the pilot study only focuses on the risk preferences of the board of trustees in the long run. And given the assumption that the economy is in steady state the long term implications are very important. Figures 4.3 and 4.4 show the surplus at risk for the different investment strategies in year 5 and 15.

As can be seen in figure 4.3 the patterns of the three basket are similar to the patterns in figure 4.2. However, the risk of indexing the pension rights unconstrained of the condition of the fund is compelling. In 5 years from now the surplus at risk for an investment of 100% in government bonds (portfolio 101) is -26 mln euros – 89% funding ratio at risk. The surplus at risk for the other baskets is even worse. These numbers indicate that the risk of promising participants a real pension is enormous. As can be seen in figure 4.4 the risk is even more severe when this unconditional indexation policy continues for 15 years long.

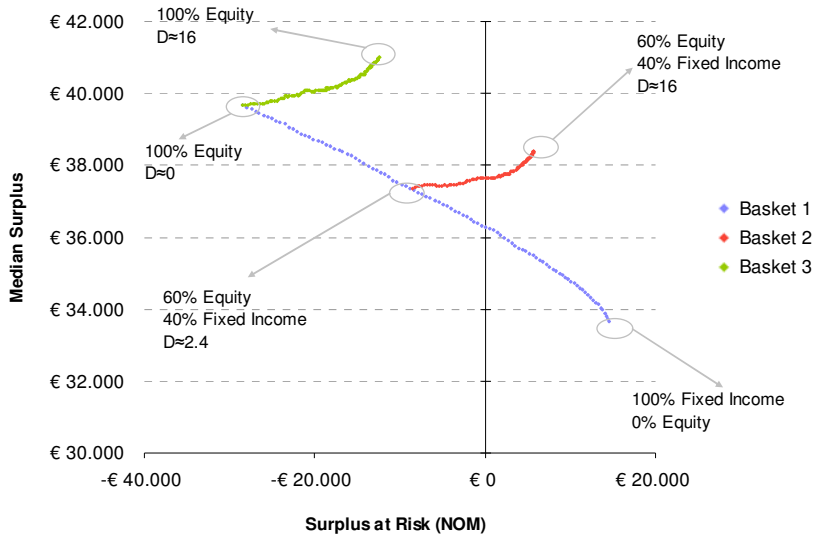
Figure 4.4 shows two additional effects. First, basket 1 is no longer a smooth line. Apparently, up to some level of government bond exposure the surplus at risk increases. One explanation could be that the expected return on the investment strategies with high government bond exposure is simply too low. Moreover, the prudent fixed contribution rate is partially based on an asset mix of 60% in equity and 40% in bonds. So, for several investment strategies that have significant bond exposure this means that the contribution rate is no longer cost based as the expected return of the investment strategies are lower and therefore require a higher contribution rate. Later on, the effects of making the contribution rate dependent on the expected return of the investment are explained. Nonetheless, unconditional indexation is very costly, and in turn, high returns have to be made. This could either be achieved through higher contributions or through other

investment strategies with higher (expected) returns. Second, the lines of both basket 2 and 3 are more 'flat'. The risk reduction by means of duration hedging is less effective for the longer horizon. This is mainly induced by the increasing volatility of the short term interest rate for longer horizons. By adding interest rate swaps the fund agrees to pay a floating interest rate for 30 years long and hence increasing the exposure towards the short term interest rate risk. This will be further discussed in the following subsection.

4.2.2 The risk and return trade-off for the different investment strategies

Figure 4.5 shows the risk and return trade-offs for the different investment strategies in year 1. The objective and circumstances remain the same.

Figure 4.5: *The risk and return trade-off in year 1 for the different investment strategies (in nominal terms)*



The x-axis represents the surplus at risk of the pension fund. The y-axis shows the median surplus in year 1. It can be seen that the investment of 100% in government bonds (basket 1, portfolio 101) has the lowest expected return. The median surplus for this portfolio is nearly 34 mln euros. This means that in 50% of the cases the surplus can lie above or below 34 mln euros. This corresponds to a median funding ratio of 123%. In turn, and mentioned before, this portfolio also has the lowest surplus at risk in one year from now. In contrast, the first investment strategy of basket 1 (100% allocated towards equity) does have the highest surplus at risk but also a higher median surplus in one year from now. The median surplus is more than 39 mln euros – 127% median funding ratio. Basket 1 clearly shows that risk is rewarded.

Basket 2 and 3 do show some interesting pattern. The duration matching is, as seen before, able to reduce the risk in year 1 significantly. In addition, the median

surplus slightly increases as more interest rate swaps are added in both baskets. This is mainly induced by an expected excess return on the interest rate swaps of approximately 1.2% – annualized. Then, based on the 1 year projections and given a risk preference (surplus at risk), adding interest rate swaps does pay off positively due to the additional expected return and duration matching. However, the implication of these swaps is to pay the floating rate for 30 years. So, what does including interest rate swaps implicate for the risk and return trade-off in the long run?

Figure 4.6: *The risk and return trade-off in year 5 for the different investment strategies (in nominal terms)*

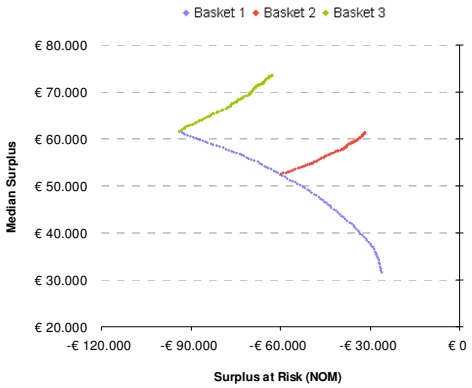
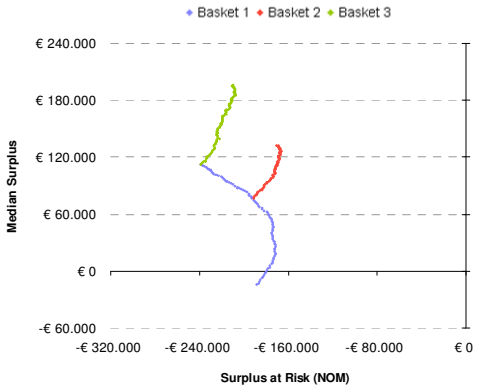


Figure 4.7: *The risk and return trade-off in year 15 for the different investment strategies (in nominal terms)*



Both, figures 4.6 and 4.7 show the risk and return trade-off in respectively year 5 and 15. As can be seen in figure 6 the risk reduction by adding interest rate swaps is still beneficial. Plus, the expected return increases as well as the duration of the investment strategy increases.

Figure 4.7, however, shows the implications for the long run (year 15). First, it supports the explanation for the higher surplus at risk of the strategy investing 100% in government bonds. It turns out that the median surplus is even negative for several investment strategies. The expected return of the portfolios with significant government bond exposure is indeed too low in the long run. The second implication has to do with the duration matching effects in the long run. As can be seen, the excess return on the interest rate swaps does lead to a significant higher expected return in comparison to the portfolios without swaps. On the other hand, the risk of a portfolio including swaps does increase in the long run. The line of both basket 2 and 3 become steeper as the maturity increases. An important issue whether to include swaps or not is explained by the wedge between the nominal 'guarantee' and the ambition of offering a real pension. Boeijen, Kortleve, and Tamerus (2010) argue that it is very difficult to find an investment policy that is consistent with both the ambition of offering a real pension and the guarantee of a nominal pension.

The most important reason to incorporate interest rate swaps is to hedge against the interest rate risk. Typically, the liabilities of a pension fund have a long duration (16 in this case), which also implies that the effect of an interest rate drop by 100 basis points causes the liabilities to rise by approximately 16%. To, more or less, ensure a nominal guarantee it is possible to increase the duration of the assets by adding interest rate swaps, up to the point where it matches the duration of the liabilities. In this way the assets move in the same direction with respect to interest rate changes.[13] As mentioned before, to increase the duration of the asset portfolio it is necessary to buy 30 year interest rate swaps. Long term bonds exist as well, but the advantage of a swap agreement is that the initial costs are zero. For obtaining a bond the bond price has to be paid immediately, which results in a cash outflow for the pension fund. In addition, long term nominal bonds have a relatively restricted supply in comparison to swaps.

However, this section provides the results of unconditional indexation, meaning promising a pension in real terms. In the long run it can be seen that the risk reduction of including interest rate swaps is less effective (see figure 4.7). The reason is that the promise of a real pension calls for substantial returns and a positive correlation with inflation in the long run. This latter is exactly what the interest rate swaps lack. Especially, it is exposed to a lot of expected inflation risk.[14] Literature shows that the predictability of the expected inflation for the short run is significantly better than for the long run (cf. De Jong et al., 2008; Brennan & Xia, 2002). Put differently, the persistence of an inflation shock is very high and future periods of high inflation are harmful to the nominal hedge qualities. Like interest rate swaps, long term bonds are also exposed to expected inflation risk as well. Campbell and Viceira (2005) clearly show that the real return volatility of holding a K bond to maturity is increasing in K. So, nominal interest rate swaps do not seem to be the right investment instrument for the promise of a real pension.

On the other hand, the Dutch regulatory framework (FTK) is based on a nominal framework. The FTK examines whether a fund is solvable enough to meet future nominal pension obligations. This, in turn, contradicts the reason of not incorporating interest rate swaps.

4.3 The effects of the instruments

This section shows the effects of the instruments as discussed before. Additionally, this section only takes into account the long run as the instruments itself have no

[13] Not taking into account the convexity issue implying that two bond portfolios do not always change in value equally by large interest percentage changes.

[14] Besides the expected inflation the real interest rate is also a risk factor for the interest rate swaps as it also determines the nominal interest rate. However, shocks to the real interest rate die out relatively quickly so the dominant risk factor is the expected inflation (cf. De Jong et al., 2008).

time varying effects. Besides, pension funds are long term investors and should focus on the long term risks. Moreover, the pilot study also focuses solely on the long run effects.

4.3.1 The contribution instrument

In the previous sections the contribution rate was based on a prudent fixed contribution rate. This sections shows the results when the (cost based) contribution rate is dependent on the expected return of the investment strategy. This implies that investment strategies with higher expected returns also need lower contribution rates to be able to off set the costs of the new accrued pension rights. In turn, investment strategies with lower expected returns need higher contribution rates. Figure 4.8 depicts the cost based contribution rate for each investment strategy. The cost based contribution rate remains constant over time. It can be seen that all investment strategies in baskets 2 and 3 have a lower cost based contribution rate than the fixed prudent contribution rate. The investment strategies in basket 1 have also a lower cost based contribution rate up to some point (intersection with the fixed rate) where the investment strategies have significant bond exposure and thus resulting in a lower expected return, hence, a higher cost based contribution rate. The reason why the fixed rate contribution rate is relatively high is because of the prudence of the determined contribution rate.

Figure 4.8: *The cost based contribution rate for the different investment strategies.*

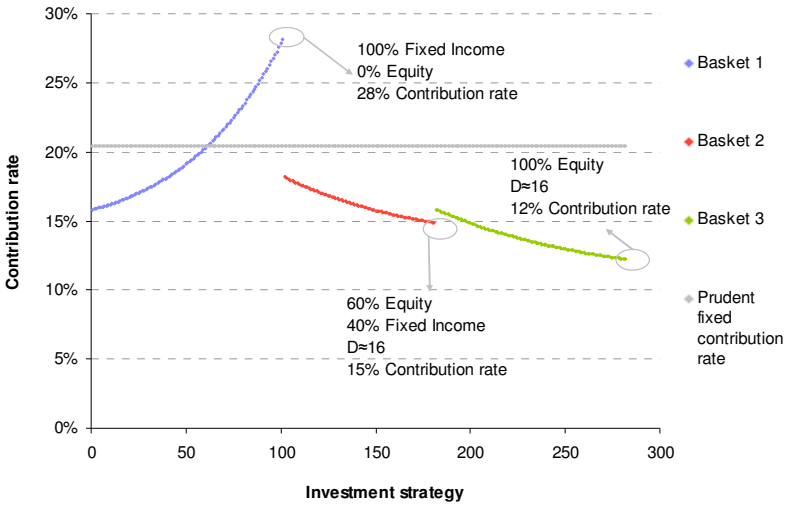


Figure 4.9: *Nominal surplus at risk in year 15 for the different investment strategies with constant cost based contributions.*

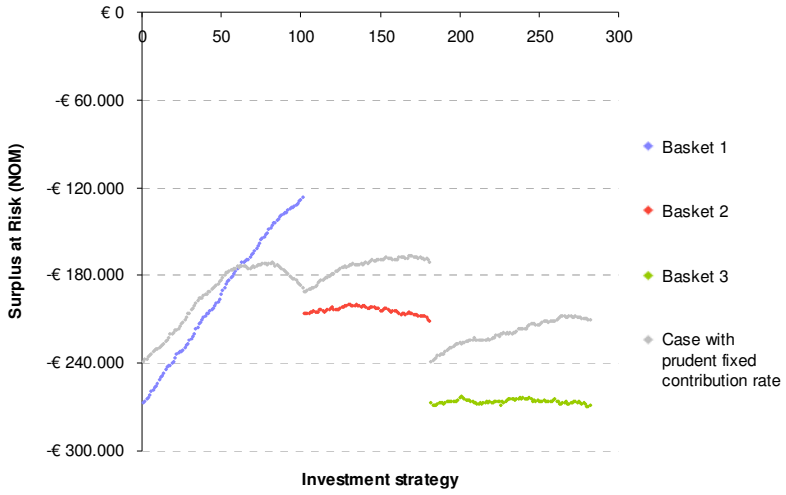


Figure 4.9 shows the baskets only now with a cost based contribution rate depending on the expected return. In terms of the surplus at risk, it can be seen that for basket 2 and 3 the risk is higher. The lines lie below the lines of basket 2 and 3 in the case of the prudent fixed contribution. The explanation for this result is that the adjustable contribution rates of all investment strategies in both basket 2 and 3 are lower than the fixed contribution rate in the previous case. The difference in percentage points between the fixed contribution rate and the adjustable contribution rate is what makes the surplus at risk higher. In addition, the risk of the interest rate swaps in the long run is also more clear as the higher fixed rate somewhat disguised this risk.

Basket 1 shows a similar effect. However, up to some level of government bond exposure the surplus at risk is lower. The expected return of these investment strategies are low and therefore the contribution rates are high (see figure 4.8). The surplus at risk for these portfolios is thus reduced by a higher contribution rate.

Figure 4.10: *The risk and return trade-off in year 15 for the different investment strategies (in nominal terms)*

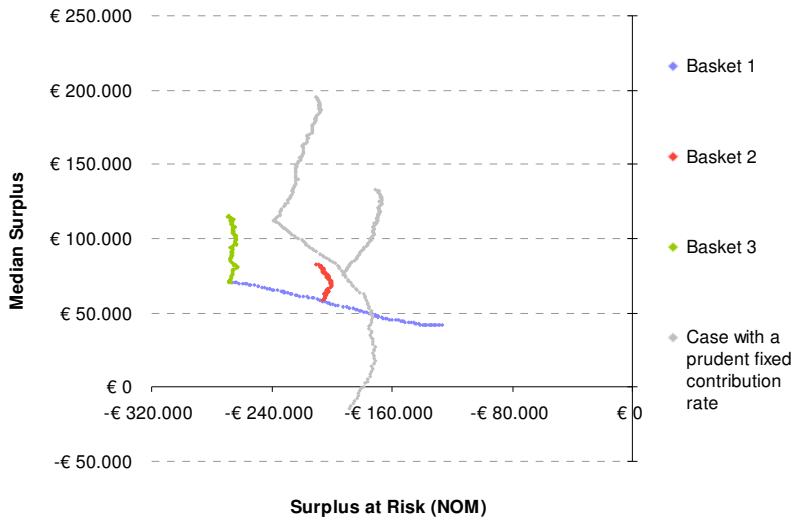
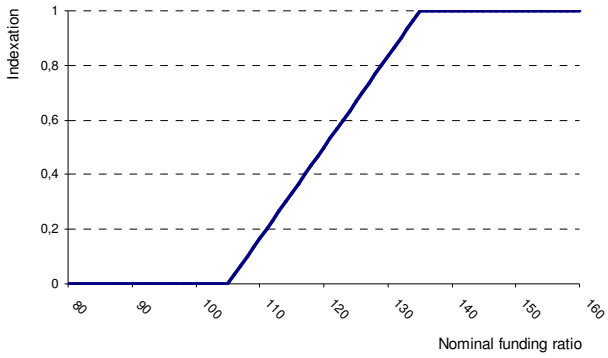


Figure 4.10 shows the risk and return trade-off for the different investment strategies. This graph clearly shows that the difference in contribution rate has an enormous effect in terms of the median surplus. The median surplus in basket 1 is only higher for those investment strategies with significant government exposure resulting in a higher contribution rate than the fixed contribution rate. For both baskets 2 and 3 all the investment strategies have a lower contribution rate than the fixed contribution rate. Therefore, baskets 2 and 3 have a lower median surplus than the previous case.

4.3.2 The indexation instrument

For this section the pension fund has the ambition to index the pension rights only if the condition of the fund permits this. This is simulated using a so called indexation ladder. The ladder for this stylized fund is defined as follows. The pension rights are not being indexed at a nominal funding ratio of 105% and lower. The pension rights are proportionally indexed between a nominal funding ratio of 105% and 135%. Full indexation is provided if the funding ratio is 135% or more. This is illustrated in the graph below.

Figure 4.11: *The indexation ladder*



Furthermore, this section only takes into account the output with the cost based contributions depending on the expected return of the investment strategy. This means that the effects of the prudent fixed contribution rate on a conditional indexation policy is not incorporated.[15] Thus, the following results are based on a pension fund that has the ambition to index the liabilities given a constant cost based contribution rate dependent on the investment strategy.

Figure 4.12: *The risk and return trade-off in year 15 for the different investment strategies with conditional indexation (in nominal terms).*

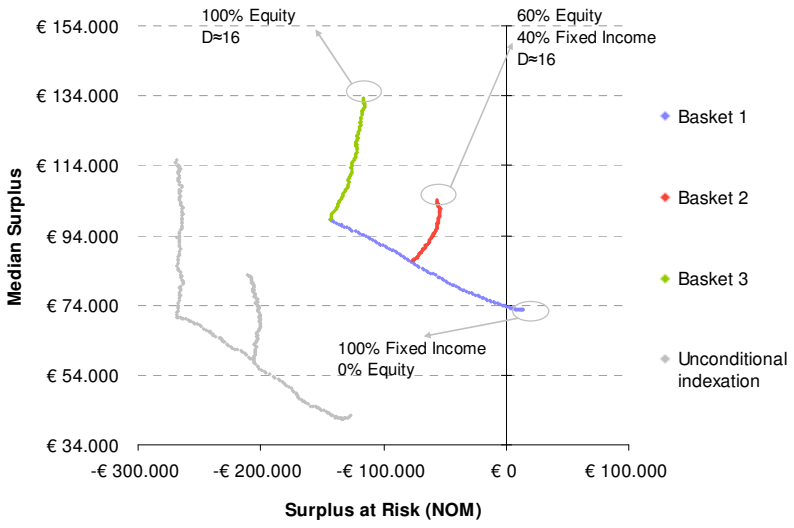


Figure 4.12 shows the risk and return trade-off including the indexation ladder. As can be seen, the risk reduction for the pension fund is huge. The difference in

[15] This effect is investigated though, but the results are not presented as the effect of a fixed prudent contribution rate can be interpreted in a similar fashion as the case with unconditional indexation (depicted in figure 4.10).

surplus at risk for the portfolio of 100% government bonds is almost 113 mln euros. A difference of almost 32% points in funding ratio at risk. For the same portfolio the difference in median surplus is more than 30 mln euros – a difference of 12% points in median funding ratio. In general, for every investment strategy the risk and return trade-off is less harmful for the pension fund than the case of unconditional indexation. This is unambiguously motivated by the fact that unconditional indexation requires high returns. Including the indexation ladder is definitely a mitigating instrument for the risk of the pension fund. However, the pension deal is no longer that the pension rights are guaranteed in real terms. Therefore this instrument exploits the risks that are entailed in the pension deal in such a way that the participants now bear the risk of not receiving indexation.

4.3.3 The investment alteration instrument

Besides the contribution and indexation instrument the board could also alter the investment strategies. Throughout this section the results for the different investment strategies have already been discussed. Therefore a short recapitulation of the implications of the different investment strategies is presented below.

Basket 1

Basket 1 consists of equity and government bonds. In the case the contribution rate is dependent on the expected return of the investment strategy (see figures 4.10 and 4.11), the choice of an investment strategy in basket 1 is then purely a choice of risk preference. The first portfolio of basket 1 is 100% invested in equity and therefore the most risky one. In turn, this portfolio also has the highest expected return. As the exposure towards government bonds increases and the exposure towards equity decreases, the surplus at risk declines. The surplus at risk in year 15 is lowest for the portfolio with 100% invested in government bonds. In turn, this portfolio also has the lowest expected return and therefore the highest contribution rate (see figure 4.8). The contribution rate for this investment strategy is approximately 28%.

Basket 2 and 3

Basket 2 and 3 show the implications of adding interest rate swaps. The effects of entering into swaps can be decomposed into a short run effect and a long run effect. As mentioned before the short run effect clearly has a positive effect on the surplus at risk. Figure 4.2 and 4.3 show that for 1 to 5 year, the risk reduction of entering into swaps is significant. In the long run, however, the risk reduction is less affective. The reason for this is that in the long run the accumulated expected inflation plays an important role. Inflation shocks tend to be very persistent. So, if an inflation shock occurs it also takes a long time to return to its long term mean. And periods of high inflation are bad for the nominal hedge quality of the interest

rate swaps. For the board it is thus very important what their view is on the development of the expected inflation.

4.4 Discussion

This chapter presented the backdrop for the pilot study. It showed the risk and return trade-offs of different investment strategies and the effects of using the indexation and contribution instrument. The pension deal providing a real annuity is by far the most risky in terms of the surplus at risk. An unconditional indexation policy requires high returns and so either high contribution rates are necessary or more risk should be taken to – in expectation – meet the high returns. Alternatively, the pension deal can be readjusted by means of implementing an indexation ladder. This does of course harm the indexation quality of the annuity, but on the other hand makes the pension fund, ceteris paribus, more sustainable. For every investment strategy there is a better risk and return trade-off (in nominal terms) when including an indexation ladder.

Nowadays, most pension funds have the ambition to index the pensions only if the condition of the funds permits this. Therefore, the pilot study in the next section only takes into account the contribution and investment instrument. Besides, the more instruments the board can adjust the more complex the evaluation of the ALM output will be.

5 The pilot study

This section will set up the pilot study as discussed in the introduction section. The main goal is to retrieve the implicit risk preferences of the board of trustees.[16] This was achieved through establishing the risk profile of the pension fund by asking the board of trustees to evaluate several risk and return criteria given 5 different investment strategies. The investment strategies are unknown to the board of trustees. In this way the board could solely focus on the objectives of the fund and is the chosen investment strategy a resultant of the risk preferences of the board of trustees. At the end the investment strategies were revealed and discussed. This section is subdivided as follows. Subsection 5.1 reports the characteristics of the stylized pension fund. Subsection 5.2 will explain the risk and return criteria that were used to retrieve the risk preferences. In addition, this section explains the choice of the different strategies that are presented in the pilot study. Subsection 5.3 discusses the findings of the pilot study. The final subsection concludes and presents recommendations for future research.

5.1 Objective and circumstances of the stylized pension fund

As mentioned in the previous sections the pilot study stylizes a pension fund with defined benefits. The ALM model was configured in such a way that in between there is no employer's deposit and neither the possibility of cutting down on nominal pension rights. There is also no explicit contribution policy, meaning that the contribution rate does not depend on the condition of the fund. The change in the assets and liabilities is then determined by the factors as depicted in figure 2.2.

In contrast to the preliminary result section the pilot study only takes into account the case of conditional indexation. So the objective for the stylized fund is to have the ambition to index the liabilities, only when the condition of the fund permits this. Furthermore, the contribution rate was set at a fixed contribution rate, based on a prudential estimation of the median long term real return on the assets. In addition, for the board of trustees it was also possible to make the contribution dependent on the expected return of the different strategies. This means that investment strategies having a low expected return must be compensated by a higher contribution rate. This shows the effect of a 'save' but expensive strategy or 'risky' but less expensive strategy – in terms of the contribution rate.

The circumstances of the stylized pension fund used in the pilot study are the same as described in the preliminary result section. The horizon of the pilot study however is based on the long term feature of pension funds in general. So, the

[16] The board of trustees for this pilot study has been the board of PPF. This is the Personnel Pension Fund of the Cordares holding. For this pilot study only the representatives of the employees were present.

output for the short run as discussed in the previous section is not provided in the pilot study. The reason is that this study attempts to retrieve the implicit risk preferences of the board given the economy in steady state which makes the long run evaluation more appropriate. The question whether risk preferences of the board of trustees changes – in terms of strategy choices – for different horizons is thus beyond the scope of this study.

5.2 Risk and return criteria

The ALM model produced several output that was used in the pilot study. The output was translated into seven risk and return criteria and tabulated such that the board of trustees could evaluate these criteria. An example of how this was presented can be found in appendix A. The criteria used in this pilot study are the expected funding ratio, level of funding ratio for the 2,5% worst cases, probability of underfunding, probability of buffer shortfall, expected missed indexation, probability of missing indexation, and the contribution rate. In stead of using the surplus at risk as discussed in the previous section the pilot study used the funding ratio at risk as the main risk indicator. The reason for this is twofold. First, the expected funding ratio was used and therefore the matched risk indicator should also correspond to the funding ratio. Second, as the board of trustees was not familiar with the characteristics of the stylized fund the funding ratio at risk is more intuitively appealing as it is expressed in relative terms. The expected missed indexation is the cumulative missed indexation in year 15.

The first two criteria (see appendix A) show the risk and return trade-off of the total pension fund given a predetermined pension deal. How the risk is allocated between the participants and the fund is reflected over the other 5 criteria. Strategies 1 up to strategy 3 clearly show the trade-off effect between risk and return. Strategy 1 has the highest expected return but also the biggest downside risk. Strategy 3 shows a low expected funding ratio return, but a more 'save' strategy as the downside risk is much smaller – in terms of the funding ratio at risk. This can also be seen for the criterion of the probability of underfunding. For strategy 3 this is 12%. However, the probability of buffer shortfall is significantly higher for strategy 3 due to the low expected return. The criteria of the probability of missing indexation and the expected missed indexation reveals to whom the risk is allocated. It can be seen that strategy 3 is clearly more harmful to the participants in terms of the ambition of indexation. The probability of missing indexation is close to 1. Strategies 1 and 2 show similar results for the expected missed indexation. In both cases the missed indexation is 10%. The probability of missing indexation, however, is different. Strategy 1 shows a lower probability of missing indexation. Notably, both indexation criteria clearly illustrates that the height of ambition is inherent to the level of risk taking of the pension fund. A low downside risk in terms of the funding ratio means that the participants have a very large probability of not getting indexed. On the other hand, taking on more risk does in expectation raise the probability of receiving indexation.

The criteria used are a first attempt to retrieve the risk preferences of the board of trustees. There are more conceivable criteria, however, the main purpose is not to seek for helpful criteria, but to retrieve the risk preferences by trading off between the outcome of the different investment strategies. It is interesting though to see whether additional criteria could contribute to the retrieval of risk preferences of the board of trustees. For instance, in this pilot study there is no possibility of an employer's deposit. In practice this could sometimes be applicable. Then, an extra criterion could be the probability of an employer's deposit. For the employers' point of view this could be an interesting criterion. To date, a heavily debated issue is the cut down on nominal pension rights. An interesting criterion could then also be the probability of cutting down on nominal pension rights. Again, this is different for each fund, but the criterion itself can be applied generically for each DB pension fund. Generally, each conceivable criterion should help the board of trustees in decision making and give insight in the trade off between risk and return.

5.2.1 Investment strategy choices

Obviously an evaluation of 283 investment strategies for the board of trustees to consider is unrealistic. Therefore this pilot study selected 5 'stylized' investment strategies. The idea of the chosen investment strategies is to provide the risk and return trade-offs that encourages the board of trustees to explain why one strategy is preferred over another strategy. Additionally, selecting 'stylized' portfolios does create risk awareness in general. The board of trustees gets a good understanding of the risks that are entailed in the pension deal as well as how these risks are allocated. Furthermore, the concept of this approach is then put forward in a way that it can easily be applied for a specific pension fund.

The table below shows the strategies that are selected out of the total 283 investment strategies.

Table 5.1: The allocation of the 5 selected investment strategies

	S1	S2	S3	S4	S5
Equity	100%	60%	0%	60%	100%
Bonds	0%	40%	100%	40%	0%
Duration	0	2.4	6	16	16

For instance, the fourth column shows the asset allocation of strategy 4. This strategy consists of 60% allocated towards equity, 40% towards government bonds, and a duration matching that approximates the duration of the liabilities. Again, in the pilot study these strategies are ex ante unknown to the board of trustees.

5.3 Results

5.3.1 Conditional indexation with a prudent fixed contribution rate

Having explained the objective and circumstances of the stylized fund the next step is to evaluate the risk and return criteria. The first question related to the first criterion, the return of the expected funding ratio. The general idea of this criterion is not to look at return as the return made on the investments only, but the total return of the fund including the costs of the fund. The overall opinion for the board was to end up with a return of at least 10 percentage points higher than the initial funding ratio. That is, an expected funding ratio of at least 135% in 15 years from now. Their motivation was that this is the level of funding ratio where the participants get full indexation. Apparently the strategy the board is willing to choose – in terms of expected return only – is not a maximum return, but a minimum return. This implicated that strategy 2 and 3 were rejected. The second step was to show the total risk of each strategy. Like the total return, the main risk indicator incorporated not only the risks that are entailed in the investments, but the total risk of the pension fund, including the risks that affect the liability side of the pension fund. Then, the same question was asked which strategy the board preferred, only now based on both the risk and return criteria. Strategy 1 was immediately rejected as the 58% level of funding ratio at risk was found to be too low. Strategy 2 and 3 were still rejected as it did not meet the required funding ratio return. Strategy 4 received the most votes. Strategy 5 was also worthwhile to take into account. There was some disagreement between the risk in strategy 4 and 5. For one trustee the level of 70% was acceptable as for the other trustees it was not. The main argument for the risk criterion however was that it is difficult to understand the exact meaning of the number. The board rather wanted to know the total distribution of the funding ratio. Especially, they were interested in the total tail of the distribution in stead of only the cut off point. It would have been more convenient to know about the 'fatness' of the tail. This of course makes sense, as the level of the funding ratio at the cut off point does not 'tell the complete story'. Despite this argument the majority of the board voted for strategy 4.

The final step was to evaluate the rest of the criteria. As all the present trustees represented the interests of the employees the most important criteria were the expected missed indexation and probability of missing indexation. The high probability of missing indexation for strategy 3 confirmed their rejection of strategy 3. So did strategy 1 and 2. There was however still some disagreement between strategy 4 and 5. Strategy 5 was the best option for the participants of the fund in terms of indexation quality. The probability of missing indexation for strategy 5 is the lowest. On the other hand the probability of underfunding for strategy 5 is higher than strategy 4. In the end, the strategy preferred by the board of trustees was strategy 4. So, apparently they were willing to accept a 5%-point higher probability of missing indexation in return for a 4%-point lower probability of underfunding. During the evaluation of the criteria of indexation the board also wanted to know how it will affect the other criteria if the probability of missing

indexation would have been zero. This was not available in the pilot study, but the results are already discussed in the preliminary results section. That is, the probability of missing no indexation translates to an unconditional indexation policy. This remark, however, does show that the board proactively thinks about the trade-off between the indexation quality on the one hand and the risk for the fund on the other hand. An additional result for such a pilot study is thus not only to retrieve the risk preferences of the board of trustees but also to encourage the board to comprehend the risks prevailing within the pension funds in general.

5.3.2 Conditional indexation with contributions dependent on the expected return of the investment strategies

A supplementary part of this pilot study was to show the implications of making the contribution rate dependent on the expected return of the different investment strategies (see appendix A2). The idea was to show that a 'save' strategy also results in higher costs – in terms of the contribution rate. Vice versa, strategies having higher expected returns result in lower contribution rates.

The first step was again to evaluate the expected funding ratio return. Based on the previous requirement, the board still wanted to achieve a funding ratio of at least 135%. This meant that strategy 2 and 3 did not meet their requirement. The next step was to assess the results again, but now based on the results of both the expected return and the funding ratio at risk. Their response was that strategy 1 and 5 were to risky – in terms of the level of funding ratio for the worst 2,5% cases. This would mean that only strategy 4 is an option. However, strategy 3 was revalued. The level of the funding ratio at risk for strategy 3 was for some trustee worthwhile to reconsider. The last step was to evaluate the rest of the criteria. What could be seen immediately was the high contribution rate for strategy 3, 8%-points higher than the cost based contribution rate. On top of that, the high probability of missing indexation was considered to be too high. This leaves strategy 4 as the preferred strategy. However the level of probability of missing indexation for strategy 4 was also considered too high. In comparison to the previous part, the probability of missing indexation is 12% points higher for strategy 4. The contribution rate however is 5% points lower. Despite the lower contribution rate they preferred a lower probability of missing indexation. Hence, strategy 4 with the fixed prudent contribution rate was preferred over strategy 4 with the adjustable cost based contributions. In addition, the level of funding ratio at risk is 9% points lower in the case of adjustable contributions, making it less accepted.

5.4 Conclusions

The goal was to establish a strategy that corresponds to the implicit risk preferences of the board of trustees. Several risk and return criteria have been evaluated and have led to strategy 4 as the preferred strategy. The board of

trustees had a clear objective for the expected funding ratio return. The expected funding ratio return should be at least 135% in year 15. The level of the funding ratio at risk was not very clear. This was mainly due to the lack of the total distribution of the funding ratio. Especially, the board wanted to know the total tail of the distribution. For one trustee the level of 70% was still acceptable. The probability of missing indexation was an important criterion. The board desired a low probability of missing indexation as possible. However, they understood that this was not possible unless the risk for the fund is significantly high. The board did prefer a lower probability of missing indexation in favour of a lower contribution rate. This was found in the comparison between the case of a fixed contribution rate and the case with adjustable contribution rates.

5.4.1 Recommendations

This pilot study can be seen as a first step to retrieve the risk preferences of the board of trustees. Several recommendations can contribute to a more sophisticated approach. First, the need for additional criteria. As already mentioned, there are more conceivable criteria that could be helpful. What these criteria are should be further investigated. The potential criteria should at least show trade-off characteristics and be important for decision making. Second, the funding ratio at risk should be more complete. That is, the total tail of the distribution should be presented. Finally, and most notable, is the perspective or interpretation of the economy. This pilot study used the steady state as the state of economy. However, it is also not unreasonable that a period of high inflation can occur. This, of course, is very important for the results of the criteria. And especially for the portfolio including nominal interest rate swaps. A recommendation for future research is then to incorporate different paths of economy.

6 Pilot study: individual responses

This section provides the results of the pilot study tested on an individual basis. Ten respondents were asked for their preferred choice of strategy given the criteria as discussed in the previous section.[17] The relevance of this section is to see whether the risk preferences of the individual response differ from that of the board of trustees. The difference in comparison to the pilot study with the board of trustees is that the respondents were asked to give their preferred strategy for each additional criterion, starting with the expected funding ratio in year 15. In addition, the respondents were asked to give their preferences based on the choice of three strategies first. The reason for this is twofold. First, strategy 1, 2, and 3 only incorporate equity and bonds, then the choice of strategy is purely a choice of preference for equity and bonds, or both. Second, and more generally, it is easier to choose out of three options than out of five. In this way the respondents could better familiarize themselves with the presented method. For the rest, the procedure is the same as the pilot study with the board of trustees.

6.1 Results

Four cases can be distinguished. First, the choice of preference based on only strategy 1, 2, and 3 plus the fixed prudent contribution rate (figure 6.1). Second, the choice of preference based on only strategy 1, 2, and 3 plus a contribution rate adjusted for the expected return (figure 6.2). Third, the choice of preference based on the 5 strategies plus the fixed prudent contribution rate (figure 6.3). Fourth, the choice of preference based on the 5 strategies plus a contribution rate adjusted for the expected return (figure 6.4).

[17] The respondents included professionals within the APG Company.

Figure 6.1: *Responses for the case of equity and bonds only plus the fixed contribution rate.*

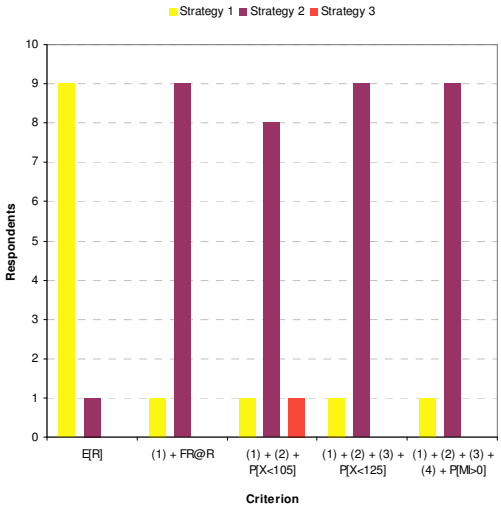
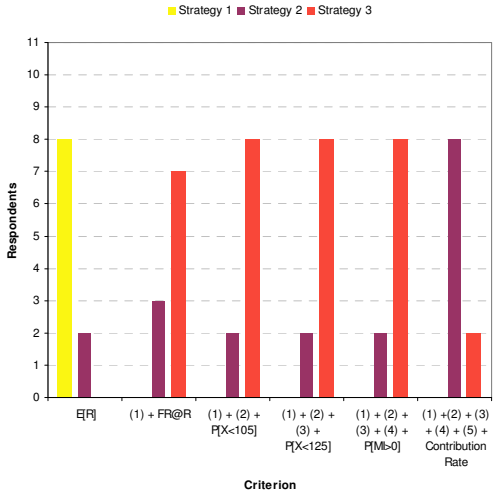


Figure 6.2: *Responses for the case of equity and bonds only plus a contribution rate depending on the expected return.*



$E[R]$ represents the expected return of the funding ratio. $FR@R$ stands for the funding ratio at risk, $P[X<105]$ represents the probability of underfunding, $P[X<125]$ corresponds to the probability of buffer shortfall, and $P[MI>0]$ is the probability of missing indexation.

Figure 6.1 shows the results based on equity and bonds only, plus the prudent fixed contribution rate. The first question was to give their preference for the expected funding ratio in year 15. As can be seen the respondents – except for one – preferred the strategy with the highest expected funding ratio return (strategy 1). The second question was to give their preferences based on the expected return and the funding ratio at risk together. Nine respondents preferred strategy 2. The risk of strategy 1 in terms of the funding ratio at risk was thus found to be too risky. This is a funding ratio at risk level of 58% – in nominal terms (see also appendix A). The third question related to the latter criteria plus the probability of underfunding in year 15. Taking these three criteria into consideration most respondents opted for strategy 2. However, one respondent switched to strategy 3. The fourth question was to give their preference taking into account the probability of underfunding as well. Nine respondents preferred strategy 2. The final question, related to the probability of missing indexation, did not change the preference for strategy 2. One respondent was found to be more risk seeking as he opted for strategy 1 and thus accepting a funding ratio at risk level of 58%.

Figure 6.2 shows the results for the case where the contribution rate is made dependent on the expected return of the different investment strategy. What can be seen is that most respondents opted for strategy 3 up to the point where the contribution rate was revealed. The final question in this case was whether the respondents would still prefer strategy 3 and in turn would accept a contribution

rate that is 8% points higher than the previous case. Only two respondents would accept this level and argued that they rather wanted to have a nominal 'security' than a probability of cutting down on nominal pension rights. The other eight respondents were willing to accept a higher risk profile, but in turn also a lower probability of missing indexation and higher expected funding ratio. They preferred strategy 2.

Figure 6.3: *Responses for the case of the five investment strategies plus the fixed contribution rate.*

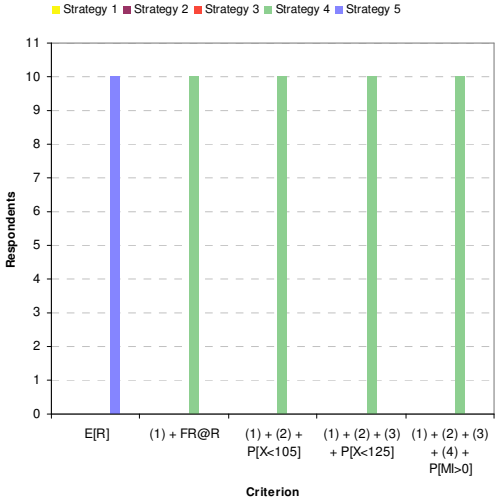
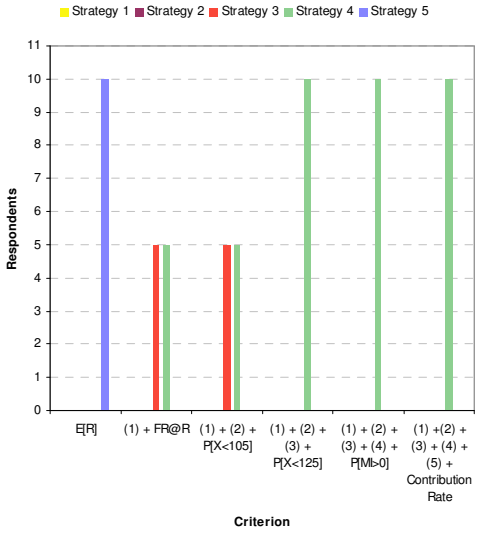


Figure 6.4: *Responses for the case of the five investment strategies plus a contribution rate depending on the expected return.*



$E[R]$ represents the expected return of the funding ratio. $FR@R$ stands for the funding ratio at risk, $P[X<105]$ represents the probability of underfunding, $P[X<125]$ corresponds to the probability of buffer shortfall, and $P[MI>0]$ is the probability of missing indexation.

Figure 6.3 shows the responses with two additional strategies and again a constant contribution rate. So, the respondents were asked the same questions but now based on five different investment strategies. As figure 6.3 depicts, this case does not show any difference between the respondents' risk preferences. Apparently, strategy 4 was found to be the most suitable strategy taking all criteria into account.

Figure 6.4 depicts the results for the five different investment strategies with each a contribution rate depending on the expected return of the investment strategy. Taking into account the first three criteria, five respondents preferred strategy 3 and the other five preferred strategy 4. Especially, the low probability of underfunding in strategy 3 (3%) was compelling for the choice of strategy 3. Adding the criterion of the probability of buffer shortfall caused a switch to strategy 4. Apparently, a probability of almost 50% buffer shortfall in strategy 3 was found to be too high. The criteria of the probability of missing indexation and

the contribution rate did not change the preference for strategy 4. It even made strategy 4 more preferable because of a lower probability of missing indexation and a 13% point lower contribution rate. Compare a 28% contribution rate for strategy 3 and a 15% contribution rate for strategy 4.

6.2 Discussion

On an individual basis strategy 4 is preferred over the other investment strategies. So there is no difference in preference between the professionals and the board of trustees. One explanation for the choice of strategy 4 could be that the trade-offs of strategy 4 dominate all the trade-offs of the other investment strategies. This is also why the respondents were asked to first give their preferences based on only equity and bonds (strategy 1, 2, and 3). Strategies 4 and 5 have the same equity exposure as respectively strategy 2 and 1, but have a higher expected return due to the expected return on the interest rate swaps. In turn, strategies 4 and 5 also have a lower contribution rate. Although the investment strategies are unknown, the choice for strategy 2 in the case of equity and bonds only, and the choice of strategy 4 taking into account all the investment strategies show consistency between the trade-offs. It is, however, and already mentioned in the previous section, hugely important what economic view is applicable for the ALM input. It should be clear that strategy 4 – with incorporation of interest rate swaps – will show different and worse trade-offs when, in stead, a period of high inflation is more likely. Nonetheless, for an economy in equilibrium strategy 4 is the preferred strategy for all respondents. Future research should be conducted to see whether the risk preferences changes when the economy is characterized by a different state.

7 Conclusion

This study attempted to retrieve the implicit risk preferences of the board of trustees. It set up a pilot study to achieve this. This pilot study is conducted with an existing board of trustees that has evaluated several risk and return criteria and established an investment strategy corresponding to their preferences for an economy in steady state.

A stylized pension fund is built and an ALM model employed to deliver the necessary output in constructing the evaluation criteria. The results of the ALM study applied to the instruments that can be used by the board of trustees. In particular, the effects of the investment, contribution, and indexation instrument on the risk and return trade-off of the pension fund are investigated. Given a predetermined pension contract the effect of the indexation instrument is found to be the most risk mitigating in terms of the surplus at risk. However, the consequence of using the indexation instrument is that the pension quality is harmed in terms of a real pension. The investment instrument showed the impact of different investment strategies split up in three investment baskets. The first basket containing equity and fixed income showed a familiar pattern in case the contribution rate is dependent on the expected return (contribution instrument) of the investment strategy. Shifting more towards equity (fixed income) resulted in a higher (lower) surplus at risk but also a higher (lower) expected return. The impact in case of a fixed contribution rate showed that at some levels of fixed income exposure the expected return is negative because for those investment strategies a higher contribution rate is required. Investment baskets 2 and 3 with variation in duration by adding interest rate swaps showed a clear positive effect on the surplus at risk in the short run. In the long run the risk mitigating effect is less affective due to expected inflation risk.

An additional result of the ALM study is that the more instruments the board of trustees can adjust the more complex the evaluation of the ALM output will be. The pilot study therefore only covered five investment strategies and the contribution instrument. The chosen investment strategies are very different in terms of risk and return. Furthermore, the board is asked to evaluate seven risk and return criteria in order to establish a preferred investment strategy. Their implicit risk preferences – given the results of the five investment strategies – has led to the choice of strategy 4, which corresponds to 60% invested in equity, 40% invested in fixed income, and an overlay approximating the duration of the liabilities. The board's implicit preferences applied to an economy in equilibrium.

A supplementary part of this study is the result of the pilot study conducted on an individual basis. Ten professionals are asked to evaluate the same criteria and establish a preferred investment strategy. However, two cases can be distinguished. Only taken into account the three investment strategies of basket 1, most

professionals preferred strategy 2 corresponding to 60% equity and 40% fixed income. Taken into account strategy 4 and 5 of baskets 2 and 3, all respondents preferred strategy 4. This corresponded to the choice of the board of trustees.

Finally, this study provided recommendations for further improvements. Firstly, an extra dimension can be implemented in order to retrieve the implicit risk preferences for another path of economy. Secondly, additional evaluation criteria that show risk and return trade-offs might be helpful for sophistication of this approach.

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Appendix A

Figure A1: *This figure represents the case of conditional indexation with a prudent fixed contribution rate. For each strategy the outcome of seven risk and return criteria are tabulated. Furthermore, the start funding ratio is 125% and this output is applicable to the simulation results in year 15.*

	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Expected Funding ratio	143%	134%	116%	145%	166%
Funding ratio at risk	58%	79%	94%	89%	70%
Probability of underfunding	20%	14%	12%	8%	12%
Probability of buffer shortfall	35%	38%	79%	27%	25%
Expected (cumulative) missed indexation	10%	10%	20%	8%	8%
Probability of missing indexation	50%	57%	94%	43%	38%
Contribution rate	20%	20%	20%	20%	20%

Figure A2: *This figure represents the case of conditional indexation with contribution rates that are dependent on the expected return of the investment strategies. For each strategy the outcome of seven risk and return criteria are tabulated. Furthermore, the start funding ratio is 125% and this output is applicable to the simulation results in year 15.*

	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Expected Funding ratio	135%	130%	126%	135%	144%
Funding ratio at risk	51%	75%	104%	80%	56%
Probability of underfunding	25%	17%	3%	14%	20%
Probability of buffer shortfall	42%	43%	49%	37%	35%
Expected (cumulative) missed indexation	13%	12%	11%	12%	12%
Probability of missing indexation	57%	62%	77%	55%	49%
Contribution rate	16%	18%	28%	15%	12%