Network for Studies on Pensions, Aging and Retirement

Netspar THESES

Dirk Blees

Assessing Second Pillar Pensions for Insurance Companies by means of Scenario Analysis

MSc Thesis 2010-049

Assessing second pillar pensions for insurance companies by means of scenario analysis

by

Dirk Blees, BSc

Presented to the Faculty of Economics and Business Administration of Tilburg University for the Degree of Master of Science, as part of an internship at ASR Pensioenen

Tilburg University, Tilburg (Netherlands)

July 29th, 2010

Supervisor: Prof. Dr. Bertrand Melenberg

Assessing second pillar pensions for insurance companies by means of scenario analysis

by

Dirk Blees

Supervisor: Prof. Dr. Bertrand Melenberg
Mentor: Drs. Herman Jongsma, AAG (ASR Pensioenen)

Abstract

This thesis compares eight different pension schemes on a number of features. The schemes are DB, DC and hybrid schemes. For this comparison it uses thousand economic scenarios that differ in terms of stock returns, interest rates and inflation. The results are presented as replacement rates and average costs. For the evaluation we used a mechanism that assigns grades to a number of features. Finally, we make recommendations on the basis of the economic literature and the reports by two Dutch committees.

I am very grateful to Herman Jongsma of ASR Pensioenen for his assistance. He helped me a lot in building the model and gave valuable suggestions on how to improve the thesis. Furthermore I thank Prof. Melenberg for supervising and explaining clearly each time where I was in the process of writing and modelling.

Ik ben veel dank verschuldigd aan Herman Jongsma van ASR Pensioenen. Hij heeft me goed geholpen met het maken van het model en met suggesties teneinde de scriptie te verbeteren. Verder bedank ik Prof. Melenberg voor de begeleiding en het duidelijk aangeven waar ik was in het 'proces' van scriptie schrijven en modelleren.

Index

1. Summary 2

2. Important issues/Overview 4

2.1 Dutch pension system 4
2.2 Focus on second pillar 4
2.3 Differences between Pension Funds and Insurance Companies 6
2.4 Different risks of pension contracts 8
2.5 Legislative developments in the Netherlands 12

3. Literature on pension scheme design 13

4. Contractual specifications 19

4.1 General 19
4.2 Defined Benefit schemes 21
4.3 Defined Contribution schemes 24
4.4 Hybrid schemes 27

5. Scenario analysis 31

5.1 Creating the scenarios 31
5.2 Assessment of the schemes 34
5.3 Discussion of the results 37

6. Sensitivity analysis 41

7. How to select the optimal pension scheme? 47

8. Selecting the 'optimal' pension scheme 50

9. Conclusion 53

10. Recommendations 55

11. Appendix 57

1. Summary

Changes in accounting standards, increased longevity, higher exposure to financial market risk and lower job tenure of employees have led to a change in pension systems. Many employers in the Netherlands have therefore switched from final wage pension schemes to average wage schemes or schemes in which only pension contributions are defined. Hereby the risks are increasingly shifted to the employer.

The immediate cause of writing this thesis are the reports written by two committees (Goudswaard-, Frijns committee) in the Netherlands on how to make the pension system more sustainable in the future. With the publication of the reports, the interest in pensions has increased.

This thesis provides an overview of different pension schemes and the risks involved in these schemes, combined with a review of the economic literature on pension design. These inputs are used in a study of eight pension schemes on pension provision for participants and costs for employers in different scenarios. We generate a thousand economic scenarios that differ in terms of inflation, interest rates and equity returns with periods of 40 years. For each of the scenarios we compare pension provision in the form of a replacement rate and the costs as a percentage of the wage for eight different pension schemes. The schemes range from pure DB schemes such as a final wage pension scheme, to pure DC schemes such as a unit linked pension scheme.

We project outcomes for a 'representative participant' of a pension scheme who works from age 25 until 65. For pension provision we observe replacement rates of the scheme at retirement, for the costs we measure the costs as a percentage of the wage. The projections are presented in the form of expected outcomes (the average of the thousand scenarios), forecast intervals and as probability measures. These probability measures present for example the probability that the replacement rate is below a certain level. We see that the DB schemes provide high and stable benefits, whereas the costs are somewhat high. The final wage scheme shows large variations in costs due to the *past service costs* of the employer. The DC schemes provide stable and low costs, the projected replacement rate depends on the type of DC scheme the participant is in. If the premium is invested fully in stocks, the expected replacement rate is high but unstable. If it is invested in fixed income securities it is low but stable. Also we see that the same result can be obtained by either a DB or a DC scheme, if the premium is the same.

A number of sensitivity analyses show what happens if the earlier made assumptions are different. When for instance life expectancy increases, the costs increase in DB

schemes, whereas in DC schemes the benefit decreases. When we change the career path of the participant, no shocking changes are visible, except for the final wage scheme. This scheme discriminates participants with high wage growth. Furthermore, we change the parameters which we used as inputs for the simulations.

We designed a grading method that assigned grades to each schemes. A grade is given for the level and predictability of the replacement rate, the same for the costs. The criterion is to score 6 or higher on all four elements. By adjusting the scale stepwise, the least negative features will score higher. The DB average wage scheme is the first scheme that is accepted, followed by the nursery plan (hybrid), a lifecycle plan (DC) and a limit plan (hybrid). When life expectancy increases, the average wage schemes scores lower; the costs for the scheme get higher, the scheme is therefore less attractive. When the equity premium decreases, the average wage scheme and the lifecycle scheme perform best.

We concluded that the DB final wage and the DC unit linked schemes give such extreme outcomes that they do cannot be considered good pension schemes. The most attractive schemes are the average wage scheme, the lifecycle scheme and the nursery plan. The relative attractiveness of these schemes depends on the preferences and characteristics of the stakeholders. However, given conclusions from the literature and the reports, the lifecycle feature of the lifecycle- and nursery scheme are attractive for participants. Furthermore, both reports conclude that increased longevity can no longer be paid by employers. Also, more freedom of choice for the participant can be introduced in (partly) DC schemes, which is recommended by the Goudswaard committee. It is important though that this goes in a responsible manner, through clear communication.

Section 2 will give an introduction to the issues that currently play a role in pensions; it demarcates the framework. Section 3 gives an overview of the reports written on the Dutch second pillar scheme and the economic literature. Section 4 describes the contractual specifications of the pension schemes. Section 5 then introduces the scenarios and gives the results for pension schemes. Section 6 presents different sensitivity analyses, while section 7 summarizes the results per pension scheme. In section 8 a grading method is presented and section 9 presents the conclusions of the thesis. In section 10 a number of recommendations based on the reports and economic literature, given the outcomes of our study.

2. Important issues/Overview

This chapter introduces the framework of the thesis; the way it is organized and the themes necessary to clarify the framework of the research.

2.1 Dutch pension system

The Netherlands have a pension system consisting of three pillars. The first pillar is a Pay-as-you-go (PAYG) system, the AOW. In a PAYG system retired people rely on current working generations for pension provision. The first pillar pension is based on years of residence in the Netherlands and is not tied to employment; for each year of residence from age 15 tot 65 the inhabitant accrues 2% of PAYG pension.

The second pillar involves occupational funded schemes provided by the employer. These pensions are organized in pension funds or by an insurance company that administers of the pensions. Both pillars account for respectively 50% and 40% of total pension provision.[1] The third pillar consists of supplementary pensions in the form of annuities that individuals can buy from insurers (10% of provisions).

This thesis will concentrate on second pillar pensions in the Netherlands provided by insurance companies, and will take into account this pillar in isolation. One should notice that conclusions may be different when integrating the results with other pillars.

2.2 Focus on second pillar

Under the new Dutch Pension Act (PW, 2006) an employer is required to choose between making a pension promise or a premium promise. The first is known as a defined benefit system (DB), the latter as defined contribution (DC). A defined benefit pension is characterized by a pension promise, often as a percentage of final or average wages. Under this system an employee accrues a certain percentage per year, for average pay plans often 2.25%, of his pensionable wage. The pensionable wage is the current wage minus an offset for the AOW Pay-as-you-go pension.[2] After servicing a firm for 40 years the employee will have accrued 90% of his average pensionable wage.

A defined contribution system is characterized by a certain contribution by the employer, which makes the valuation a lot easier; it is the market value of the portfolio in which it is invested. Often the employee is given a choice in whether to invest the contributions in a self-selected investment portfolio or lifecycle funds, mostly not in

[1] Source : Börsch-Supan (2004)

[2] This offset is a nominal, fixed amount of salary over which no pension is accrued. Since everyone is expected to receive an AOW pension, the expected AOW payoff is subtracted from the wage, such that the two together replace a certain percentage of final or average wages. The franchise may be different across pension schemes. According to Dutch Fiscal law the minimum offset for 2010 is € 12.674,- for 2% and 2.25% accrual of respectively final and –average pay pension.

individual funds or indices but often in investment profiles (i.e. offensive, neutral, defensive). In DC systems the risk of having inadequate pension provisions is with the employee.

Often pension schemes are not purely DB or DC. Many schemes combine features of both systems in so-called hybrid plans. In section 5, more specific contracts will be introduced to further specify the characteristics of DB and DC plans.

Until recently pension schemes in were mainly DB final pay schemes, where most risks were borne by the employer. Due to some significant changes many employers have shifted their pension schemes from DB to DC. In the United States and United Kingdom this shift was especially pronounced and employees went from DB final pay plans with full inflation indexation to cash balance plans with voluntary contributions. In the Netherlands pension schemes have largely maintained DB (*Ponds and Van Riel, 2007*) although there was a shift from final pay to average pay with conditional indexation. According to *Ponds and Van Riel* this contrast is probably due to differences in governance and the role of unions being important in supporting social solidarity in the Netherlands. **Table 11** in the appendix presents types of pension schemes by number of participants and premiums paid. A shift from final- to average wage pensions is observed in the period 2002-2007. This is the situation for pension funds, for pension schemes at insurance companies the situation is very different. In

Table 12, the number of participants per scheme for insurance companies is presented. The last publication was in 2005. At that moment, almost half of the participants had a DC arrangement. In 1992 only 4.3% had this arrangement.

Several important reasons were at the basis of a worldwide shift from DB to DC. First of all, the exposure of pension plan assets to financial market risk has increased. The shift from book- to market valuation of both assets and liabilities makes that both become more volatile. After the dotcom crisis and credit crisis, low interest rates and low stock markets caused serious solvency problems for DB schemes. Second, increased longevity makes pension promises more expensive for employers. Since participants live on average longer after retirement, an old age pension of the same size (with same replacement ratio) becomes more expensive. Statistics Netherlands (CBS) estimates that in 2050 people will live on average 3 years longer after retirement.[3] When making a DC promise, this risk is borne by the employee. Third, strict reporting standards (IAS19 in the Netherlands, IFRS and earlier RJ271) make DB pensions unfavorable compared to DC schemes. Under new reporting rules financial statements should reflect the fair

[3] Centraal Bureau voor de Statistiek: Levensverwachting naar geslacht, 2008-2050

value of pension promises to the employee. For DB schemes these obligations are more difficult to estimate and fair valuation leads to large fluctuations and unpredictability in Profit and Loss statements. DC schemes provide employers with more stable and predictable returns. A fourth important cause is the decrease in job tenure or increasing job mobility. DB schemes offer a sure income replacement if an employee stays at an employer. Therefore DB is said to distribute from short tenure to long tenure workers. Increasing job mobility makes that employers do not think of employees as long term relations, neither do employees hold the employer responsible for delivering a good pension. One could argue that both groups show greater focus of economic self-interest (*Ross and Wills, 2002*). This is illustrated by for example an increase in people being self-employed.

2.3 Differences between Pension Funds and Insurance Companies

Since a large part of pensions in the Netherlands is provided via pension funds, the majority of the literature focuses on pension provision through pension funds rather than insurance companies. While this thesis focuses on pension provision through insurance companies, this section discusses the key differences and similarities between the two; many arguments are taken from an article by *Broeders, Chen and Koos (2009)* on the evaluation of both institutions.

Pension funds

Pension funds have the institutional form of a trust. The trust is governed by a board consisting of representatives of both employer and employees. In the pension fund participants collectively bear the risk and act as bondholders and shareholders; they have a claim on the equity of the fund (surplus) and the liabilities. The surplus acts as a risk buffer. All generations or cohorts own the pension fund's buffer. Even new generations entering the fund may suddenly own a large gain if the buffer is large or face a loss if the value of liabilities is higher than the value of assets (underfunding). Currently, the claims that individuals have on the surplus are not well defined. The employer or sponsor of the plan typically bears no risk if the plan is underfunded.

Often, the contract that participants have is a DB arrangement based on average salary, with inflation indexation conditional on the funding status. This so-called conditional indexation is determined ex-ante and is often illustrated in a policy ladder (table 2). No indexation is given when the nominal funding rate is a 100% (assets equal liabilities) while full indexation is provided when the funding ratio is around 130%. In between indexation rises proportional to the funding ratio.

An important feature of pension funds is that they can share risks between generations. Due to this so-called *intergenerational risk sharing*, young generations can for instance bear some risk of people who are almost retiring. Hereby the older generations are not fully dependent on the economic situation upon retirement. The younger generations agree upon this, since they assume also to benefit from risk-sharing when they retire.

The guarantee of a pension at retirement is ambiguous. A severe drop in the funding ratio below 100% may lead to discounting of the benefits (*afstempelen*) to restore the funding level. Another option is that the contributions are raised to increase assets.

Pension funds usually charge uniform contribution rates; an equal percentage of pensionable wage. This leads to intergenerational transfers within the fund, since young people pay more than the actuarial cost price and old people pay less (*Boeijen et al., 2007*).

Assets of pension funds typically have large mismatch risk; assets and liabilities are not perfectly matched. Pension funds generally have a large share of their assets in stocks. A portfolio that does not match liabilities is riskier, but does have a higher expected return. Asset allocation of pension funds is often linked to the funding ratio. When the funding ratio is high the fund is allowed to invest more in equities, while a low ratio requires a somewhat more conservative asset mix.

Pension funds are allowed by the Dutch Financial Assessment Framework (FTK) to have a one year probability of underfunding of 2.5%. If this probability is higher or if the fund is in a situation of underfunding, pension funds should hand in a recovery plan with a horizon of three years at the regulator.

Insurance companies

Insurance companies that take the form of incorporations provide annuities to the pensioner. Other than pension funds, they operate on a for-profit basis. The participants are bondholders of the insurance company; they have a claim on the insurer's debt, external shareholders own the equity of the company.

The pension contract that an individual has with an insurance company is different from a contract with a pension fund. The contract provides the participant with an explicit guarantee, for example a premium based on average salary, which can have the potential of profit sharing. Roughly two ways of profit sharing exist. If the insurer makes a profit higher than the interest rate on which the premium is based (currently 3%), this can either flow back to the employer in the form of a premium discount or it can be

used to index the pension rights of the employee. Profit sharing will be discussed into more detail in section 5.

The premium paid to the insurer is a premium based on actuarial principles; it distinguishes between ages and gender. During the time of the contract, usually 5 or 10 years, these tariffs are fixed. In general an increase in tariffs is only possible when closing a new contract.

The asset portfolio of insurers often shows less mismatch risk than that of pension funds. This indirectly has to do with the explicit guarantee it has towards its participants. Furthermore it depends on the type of profit-sharing agreement the insurer has with an employer.

Insurance companies are subject to stricter regulation than pension funds. The one year probability of underfunding should not become larger than 0.5%, if this is violated a recovery plan of three months has to be made.

2.4 Different risks of pension contracts

Investment risk

Investment risk in a pension contract is the risk that the pension assets in which the premium is invested do not generate a return that is sufficient to provide a pension. In DB plans this risk is typically borne by the insurer. Because of this guarantee the insurance company mainly invests in fixed income securities. In DC plans the investment risk is often for the employee since he is the owner of the assets acquired with the premiums. However, the distinction is not that simple. If under a DB scheme the assets generate a low return every year the participant will never have the benefit of profit sharing, hereby he is also subject to investment risk. And if in a DC scheme the premium payments are directly used to buy pension rights in the form of a deferred annuity, the individual has a nominal guaranteed pension which is not subjective to investment risk.

Interest rate risk

Interest rate risk in a pension contract is mainly present in the conversion of the pension accrual to a life-annuity. In DB plans interest rate risk is borne by the insurer since it guarantees a pension payment. In DC plans this risk is mainly for the employer since he is the owner of the assets. The interest rate risk can be decreased by spreading the purchase of pension entitlements over a larger period. Often also the assets are held in bonds of same maturity as the annuity, such that they are both equally sensitive to interest rate risk (i.e. value of assets goes up together with price of annuity, same

annuity can be purchased) However, if an individual chooses to receive a certain capital at the pension date with which he can buy an annuity at each insurer, this interest rate risk is rather large. To illustrate how the price of a life annuity is related to the interest rate, please refer to **Figure** 8 of appendix.

Longevity risk

A risk that is often absent in financial contracts is longevity risk. Longevity risk can be separated into two categories. Idiosyncratic- or individual longevity risk is the risk that an individual lives long and has acquired insufficient funds to provide a decent pension for this period. This risk is easily diversified when many individuals pool this risk. Secondly, macro-longevity risk is the risk of a whole population or subgroup living longer. This risk is especially important in a pension contract. In a DB pension plan the risk of living longer is borne by the insurance company and the employer. The employer has made the promise of providing the employee with a certain pension as long as alive, and insures this at an insurance company. If suddenly life expectancy rises, the prices of annuities rise. The price of an annuity is the discounted sum of cash flows at each age weighted by the probability of reaching this age plus some mark-ups for costs and risks. If longevity increases the annuity price increases. In DC plans the longevity risk is mostly borne by the individual who receives a premium as percentage of salary. The annuity that can be purchased at retirement is again sensitive to shocks in longevity; higher longevity results in a lower pension. If the premiums of the individual are immediately annuitized (used for purchase of pension rights in the form of a deferred annuity) exposure to longevity risk is lower.

Inflation risk

Inflation can severely erode the value of accrued pension rights. When pension accruals are never or rarely indexed, the purchasing power of a pension can drop substantially. How inflation can erode pension rights can best be illustrated with an example. With an average inflation of 2%, prices will have doubled in 36 years, for 3% inflation this is 23 years. This means that a pensioner of 65 has only half of his current purchasing power left when he is 87 if his pension is never indexed to 3% inflation.

It is important to distinguish between wage- and price inflation. Usually pensions are indexed to wage inflation in the accrual phase and to price inflation after the pension date.

In a DB final pay pension, inflation risk is borne by the employer since wages tend to grow with inflation. When the employee retires or leaves the firm the employer can still provide full indexation, but he typically chooses to index on the basis of profit sharing.

Under DB average pay and DC plans, pension rights do not rise with inflation. The employer can choose to provide indexation when the participant is active and/or when inactive. Indexation through profit-sharing seems nice with average inflation and returns of respectively 3% and 6% for example, however if inflation is high during periods of low returns, indexation is incomplete. With conditional indexation on the basis of profit sharing, inflation risk is borne by the employee.

There are ways to hedge against inflation risk. One possibility is to invest in assets that have so-called natural hedging features; assets of which returns tend to have a positive correlation with inflation, for example commodities or real-estate. However, one should notice that these hedges are not perfect, because this correlation is not complete. Another way is to invest into inflation linked products, for example bonds with payoffs linked to inflation, but there are several problems concerning these products. First, the payoff may be linked to price inflation (CPI), while you would like to have it indexed to wage inflation of a specific sector. Second, the market for these products is far from complete; often the market for these products is illiquid and only limited maturities are available.

Wage path risk

Wage path risk concerns the risk of a decrease in standards-of-living after the pension date. If an employee is a career-maker; has as steep earnings profile, more pension is needed to keep the same standard of living when retired. DB final pay schemes offer standard of living insurance to the employee; this risk is for the employer. Under average wage and DC schemes, employees do not have this insurance.

Pension transfer risks

In the Netherlands an employee has the legal right to transfer his accrued pension rights from the pension scheme of his old employer to the scheme of his new employer when changing jobs. This may or may not be attractive, depending on the attractiveness of schemes in terms of arrangement (final pay, average pay etc.), indexation policy, funding or solvency status and the investment policy. It also may be easier for an employee to have his whole pension administered in one scheme.

If the employee decides to transfer the value of his pension accruals to the new employer, the employer is obliged to adopt this value and transform it into its own pension scheme. This is called ingoing value transfer (*inkomende waardeoverdracht*). In some cases there can be a considerable risk involved for employers in these transfers. This risk has to do with the difference between the standard rate based on the market interest rate (*standaardtarief*) with which the transformation has to be done, and the

fixed interest rate (*rekenrente*) that insurers use to calculate the premiums for pensions. The reason that all employers are obliged to use the standard rate is to ensure that under any transfer the employee keeps the same pension rights.

A risk for employers that have DB arrangements (make a pension promise) is that if for ingoing transfers the standard rate used to calculate an employee's pension is higher than the fixed interest rate on which the insurer calculates his premium. The standard rate for 2010 is 4.122%[4], while the fixed interest rate that insurance companies currently use is 3%. In order to provide the employee with a 'fair' pension, the employer has to pay for the difference in this case. For an outgoing transfer the employer receives money when the market based tariff is higher than 3%. If the market based standard rate is lower than 3%, or when insurers increase the rate used to calculate premiums over this rate the situation is of course the opposite. Employers with DC arrangements do not have this effect since the market value of the portfolio can just be transferred.

To illustrate the potential risks for employers an example: a 40 year old male employee wants to transfer an amount of €100,000 to his new employer with a DB arrangement and will only purchase old age pension. With a rate of 4.122% a conversion factor 4.304 applies for a forty year old man that retires at 65, which results in a pension of €100,000/4.304= €23,234. For an employer to purchase this amount of pension at an insurance company that uses a 3% rate, a factor of 6.953 applies.[5] The price of a €23,234 yearly pension costs €23,234*6,953= €161,546. The employer has to pay €61,546 for the employee to have a fair pension.

When on average the same number of employees enter and leave the company, the net result will be quite small. However, if a company is growing and more people enter, this negative effect for the employer can become quite large.

Note concerning risk

An important note concerning risk is that from the individual point of view it may sound negative to be exposed to investment and interest rate risk. However, there is also an upside potential involved. If an individual has a pension capital guaranteed at retirement, it will never have full benefits if returns are very high.

[4] The standard tariff is determined per ultimo year for the next year and is fixed for that year. This rate will be the market interest rate of October 1st of maturity 25.
[5] ASR Pensioenovereenkomst 2008

2.5 Legislative developments in the Netherlands

In the context of comparing and assessing second pillar pension schemes, it is important to briefly mention some recent legislative developments concerning pension provisioning.

In 2006, the Pension Act (PA) was introduced in the Netherlands with the objective of safeguarding pension provisions for participants. The act is based on the following principles: transparency, access and supervision. The most important parts for the purpose of this thesis are the pension agreement and the execution agreement. The pension agreement concerns the agreement between employer and employees. Under the new PA this agreement should explicitly in the form of a pension agreement, capital agreement or a premium agreement; employer and employees agree on respectively a certain pension at retirement, a certain capital at retirement or a certain premium. The execution agreement states the responsibilities that the employer and the executor (pension fund or insurance company) have in providing a safe pension.

A new element in the Pension Act was added in 2008 on the duty of the executor (*zorgplicht*) with unit linked policies in which participants can invest themselves. It is stated that the insurance company has to take care of the investment. Since an insurance company is expected to have more expertise about investments than most individuals, the insurer is obliged to offer certain investment profiles that individuals can choose to invest in. The individual is not obliged to invest in these profiles and can choose to 'opt-out' and invest the premiums himself.

Another important aspect in Dutch pension law is the Law concerning Equal Treatment. This law demands that all employees are treated equally by the employer. In the Netherlands an employer is not required to offer a pension scheme to its employees, although if a pension is offered, it should be the same for all employees of the same occupation. This in contrast to pensions in the United States, where employees can make voluntary contributions and participation is sometimes linked to tenure.

3. Literature on pension scheme design

After the introduction of the previous themes to demarcate the areas in which this study operates, the next section provides a brief overview of the literature on how a funded pension system should be designed. It starts with the conclusions of the Frijns- and Goudswaard reports on the sustainability of the Dutch pension system from which we take the parts that are important for our purpose, especially for pensions in the insurance industry. There after it provides the outcomes and ideas of (international) literature on pension scheme design. Since much of these studies are about the United States pension system, the conclusions are not always relevant however the intuition and the reasoning may still be useful.

Reports committees

The first report called 'Pensions: Uncertain certainty'[6] was presented on January 19 by the Frijns Committee. The report focuses mainly on investment policy, risk management and governance of pension funds in the Netherlands. Ageing of the population makes that the pension system has become more vulnerable; the premiums as a percentage of the liabilities of the fund are decreasing and can therefore hardly be used anymore as a policy instrument. Pension funds are also taking more risk since higher returns are needed to cover the increasing liabilities. This made that pension funds are increasingly exposed to financial market risks. The committee thinks that pension funds should become more aware of the risk they are exposed to and that more attention should be paid to risk management. Another recommendation of the committee is that the 'real' numbers (in terms of purchasing power) should be leading as opposed to the nominal numbers which are now the leading objective. Although the findings of the committee suggest that some elements should be changed as to how pension funds operate, the findings do not really add to the discussion of which pension scheme is desirable.

Another interesting recommendation of the committee concerns the Pension Act. The committee suggests that the Pension Act should leave room for changes in the 'liability structure'; there should be more explicit assignment of risks to different groups. The argument is that a distinction can be made between different age groups. An example of this would be a system in which young and old participants have different exposure to equity risk. This is an interesting recommendation as we will see in the literature section.

[6] Commissie Frijns (2010), Pensioen: Onzekere zekerheid.

The report written by the Goudswaard committee is called: 'A strong second Pillar'.[7] The committee states that the Netherlands have a balanced pension system although the costs of the funded pensions are increasing. Statistics Netherlands have estimated that pension costs will rise from 12.7% to 17.2% of salary in 2025 (this is for pension funds). These high costs will have an impact on the competitiveness of the Netherlands internationally.

Due to aging, growing life expectancy and financial risk exposure it has become harder to manage risks; employers do not want to bear more risks, therefore more risk is shifted to the participants. To maintain the collectivity and solidarity, choices have to be made concerning ambition, certainty and costs of pensions. The committee gives concrete examples of what can be done to achieve this.

For the purpose of the assessment of pension contracts some of these points or suggestions are important. Arguments such as lower pension accrual may be good from a policy point of view, but not in particular when testing which scheme is best for stakeholders, since it would apply to each scheme. Below the suggestions of the committee are presented.

Suggestions to lower the ambition level:

- Lower accrual: means a lower pension, independent of the scheme the participant is in.
- Rising the retirement age with life expectancy as is the plan for the first pillar such that there are more years to accrue pensions and fewer years left to consume pensions. Here is a possibility to control the risk of too high costs for the employer. However the law has first to be changed to achieve this. In section 6 we will test pension schemes on shocks to longevity to examine the effect on costs and pension provision.
- Topping the pensionable wage such that participants only accrue entitlements or premiums over a maximum amount of pensionable wage. This is an attractive option for the employer to control costs and also possible under current laws. Another option is to limit the DB pensionable wage and have the remainder contributed in a DC system.

[7] Commissie Goudswaard (2010), Een sterke tweede pijler, naar een toekomstbestendig systeem van aanvullende pensioenen.

- Lowering the waiver of premium in case of disability, hereby lowering the premium paid for the same entitlements but introducing the risk of not getting a full pension when disabled.

Suggestions to close the expectations gap:

- More complete contracts. This argument holds especially for pension funds since, as mentioned in section 2, the claim on the profit is not fully specified.
- Simplify the pension contracts. Since many participants have no idea of the pension scheme they are in or to what risks they are exposed.
- Better communicate to the participants what the entitlements and risks are. For example by giving insight into the purchasing power of the pension or the risk of the pensions falling short.
- Introduce more freedom of choice, give participants the choice of whether they want to take risk or have a guarantee.

To deal with uncertainty:

- Shift longevity risk and investment risk to participants. This will result in a lower pension if life expectancy increases or when returns are low.
- Risk differentiation among ages (or actives/inactives). The idea is that young people want to take more risk to capture return and old people want to safeguard their accrued pension. This is most relevant for pension funds since rights are not guaranteed, but also for DC schemes in which participants have a choice in how to invest their assets. Lifecycle investing will be further introduced in the literature overview.
- Introduce more possibilities for indexation or inflation protection. Possibilities to cope with inflation were discussed in section 2. Although inflation protection is considered an important element in the improvement of pension we do not consider any inflation hedging in the scenarios since these hedges are imperfect.

Literature

The specific characteristics of the Dutch pension system and the approach chosen in this thesis to examine different pension schemes limits the amount of research that can be used to build upon. Much of the research focuses on pensions in the United States which is different from pensions in the Netherlands. In the United States a great deal of individual pension provision is accrued in individual accounts. These so called 401(k)

accounts allow individuals to voluntarily save under a favorable tax regime. The old age pension achieved by saving in this account is dependent on the investment returns.

Also, most publications base their conclusions on empirical methods through which they compare actual pension provision of DB and DC plans. Others take the more theoretical approach of maximizing utility functions to assess the attractiveness of DB and DC. This thesis takes a different approach, namely a scenario analysis. Some of the methods and conclusions used in literature are mentioned below.

Poterba et al. (2007) argue that many have studied DB and DC risks, but only few have compared the schemes. They state that the accumulation in DC plans depends on financial market returns, whereas DB accumulations depend on the participant's labor market experience and to plan parameters. They use historical data to test pension provision of both schemes and find that mean and median pension accruals are higher for DC than for DB when some equity is involved in the DC plan. Two other empirical studies suggest that DC plans are favorable to most workers. *Samwick and Skinner (2004)* use data from the Survey of Consumer Finances and generate synthetic earnings histories to evaluate DB and DC wealth accumulation. The results show that for many individuals, DC plan accumulations are likely to be higher than those of DB. *Schrager (2005)* uses data from the Panel Survey of Income Dynamics (PSID) on earnings and job change. Because of job turnover increased in the 1990s, DC plans are likely to be more attractive to DB plans for many workers.

Bodie, Marcus and Merton (1988) perform a utility maximization and find that although nominal DB guarantees have no longevity and interest rate risk, the scheme suffers from return and inflation risk. This means that if there is no (or limited) room for inflation indexation the pension provision may prove to be low. Also, DB schemes limit the risk-return possibilities since they force individuals to save in the form of deferred life annuities, whereas in some DC plans the contributions are invested in equities. The authors state that the advantage of DB is the predictability of the replacement rate, DC schemes perform best in periods of high inflation uncertainty. They suggest combining the best features of both schemes, for example a DC scheme with a DB guarantee. *Balcer and Sahin (1979)* compare DB and DC plans in a lifecycle setting, recognizing that earnings uncertainty and job transitions have an important effect on the accumulated wealth of DB plan participants.

The results of the mentioned literature suggest that DB plans are not necessarily desirable because of stable benefits. It seems that DC schemes have on average higher returns and that, based on utility maximization, individuals seem to desire some

exposure to equity. However, the approach taken in these publications is rather different than the one taken in this thesis. Furthermore, each of the publications may use different definitions of DB and DC, which makes the comparison to the schemes that we test difficult.

A publication that is interesting for purpose of this thesis is that by *Blommestein, Janssen, Kortleve and Yermo (2009)*. They use Monte Carlo simulations based on historical estimates of mean, variance and correlation of inflation, stocks and bonds to predict outcomes of different pension schemes. Although they focus more on the risk sharing properties of different pension schemes provided by pension funds, the outcomes are useful. They analyze the tradeoff between funding ratio and replacement rate as measures for contributions and benefits for different schemes (traditional DB, DB with conditional indexation, cash balance plan, collective DC and DC). The output of the scenarios is presented in tables with scenario paths and projections of replacement- and funding ratios at a certain age. Especially the evaluation of the replacement ratio is interesting, that of the funding ratio somewhat less since this is no appropriate indication for contribution risk in insurance contracts which charge different premiums.

The authors state that risk manifests itself in funding ratios and replacement ratios. The relative attractiveness of each scheme depends on the risk aversion of the participant. As other studies conclude, they state that DB schemes with complete indexation are not necessarily the most attractive to participants. Although these plans provide stable and predictable benefits, the contributions can become too high and unpredictable which ultimately results in net wage risk for the participant.

So, for pension funds DB schemes have volatile funding ratios (i.e. uncertainty for actives), while DC schemes have volatile replacement ratios (i.e. uncertainty for the retired). So, generally a hybrid scheme would be desirable. According to the authors 'conditional indexation plans offer high levels of predictability of replacement rates, and have a low risk of higher contribution rates to correct underfunding'.

Ponds and Van Riel (2007) do a similar kind of study (ALM) to simulate the funding ratios of a representative Dutch pension fund for a fully indexed DB, a collective DC and a conditional indexed DC scheme. The outcomes show a similar result, namely that the conditionally indexed plan has both the contribution and the indexation instrument, such that there is less uncertainty in the funding rate, and stable indexation.

An important element in pension asset allocation that should be touched upon is the lifecycle portfolio theory developed by *Bodie et al. (1992)*. This theory suggests that the optimal allocation of wealth of an individual changes over the lifecycle; younger people should invest riskier than old people. Firstly because their accrued pension is only a small part of their total wealth consisting of financial- and human capital, secondly because they have a greater capacity to absorb investment risk by changing savings- and working behavior *(Molenaar et al., 2008)*. The lifecycle approach suggests that young individuals invest more in equities to diversify risk between human capital and financial capital. Later in their career participants should decrease the proportion of equities and purchase less risky bonds to safeguard their pension since all their wealth is in financial capital.

In DB pension plans in the Netherlands there is currently no age based differentiation, this is impossible under the Law concerning Equal Treatment. In insurance contracts there is one uniform asset mix for all participants of the contract. These assets are invested in relatively low risky assets to safeguard the 3% guarantee. Some DC plans do facilitate lifecycle investing in schemes where the asset mix can be chosen by the participant. In the Netherlands the profiles in so called unit linked schemes have to be in the form of lifecycle funds; a decreasing equity proportion and an increasing part in government bonds. Other schemes do not have this feature. For more information on the asset allocation of different schemes we refer to the next section.

Overview

Both the committees conclude that the current pension system is not sustainable in the long run. Adjustments should be made in the costs, ambition and certainty of the pension plan. Since the costs for employers are increasing and cannot rise much further, the choice is to either lower the ambition or have more risk. Both reports offer alternative ways in which this can be done.

The conclusions from the literature suggest that DB plans are not always favorable to DC plans. Hybrid schemes are best able to spread the risks. Both the reports and the literature opt for a lifecycle feature in the pension scheme. Via age based differentiation risks can be addressed more in line with the needs and wants of the individual.

4. Contractual specifications

4.1 General

After the issues discussed in the overview and literature, this section will further specify pension contracts that currently exist (at ASR Pensioenen or other insurance companies) and alternative contracts. Per pension contract we will discuss what the characteristics of the scheme are with respect to premiums charged, pension accruals, and pension provision. The key elements that apply for each scheme will be discussed in the way they are used in the scenario simulations in section 5. This does not necessarily mean that schemes cannot be arranged alternatively (e.g. we use price inflation to compute indexation, one could also use wage inflation). For the sake of surveyability of the results we only take into account the old age pension of the participant, not of the spouse or orphans pension etc.

We discuss only the features of standard contracts used for small and medium enterprises, not custom-made contracts for large corporate clients. Those contracts are typically larger in size and have more involvement of the employer as to how the assets are invested and profit sharing. To ensure comparability of the respective schemes we consider only the standard contracts.

Pensionable wage

An important figure for calculating pension contracts is the pensionable wage. This is the ongoing wage minus the AOW offset. The pensionable wage is the sum over which a certain percentage of pensions are accrued (DB) or over which a premium is specified (DC). The AOW offset increases yearly with inflation.

Fixed interest rate

Pension insurance contracts are often calculated on the basis of a fixed 3% interest rate (*rekenrente*). This is the minimum return that insurance companies are expected to generate in the future. This percentage is determined taking into account the risks that pension administrators are exposed to. In our calculations we use a 3.5% fixed rate.

Market interest rate

When the participant receives an endowment at retirement, he is obliged to purchase a life annuity. The price of the life annuity is dependent on life expectancy and the market interest rate or term structure of interest rates. Although a term structure is a better representation of the market interest rate, we use the so called u-rate (*u-rendement*) to calculate the price of these annuities. This u-rate is also used to calculate profit sharing

and is a good estimate for an interest rate since it is the average yield on a portfolio of government bonds with durations of 2 to 15 years. The u-rate is widely used by insurance companies to calculate the price of annuities.

Single premium and costs

The premium that is charged for a certain pension or endowment is calculated on the basis of a single premium; the amount that is needed to provide the participant with one euro of pension or capital at the pension date. For DB schemes this is a deferred life annuity, for DC schemes the single premium is a deferred life endowment since it provides the participant with a certain sum of money upon retirement. These actuarial premiums are increasing in age, since each executive year fewer years are left to generate a return, and are higher for women than for men since women live longer.

A distinction is made between the gross- and net single premium. The gross premium includes mark-ups for costs (administration, remittance) while the net premium is free of costs. The gross single premium is what is charged, the net single premium is what is actually invested. Furthermore a gross premium can include a mark-up for disability risk during the accumulation phase. This mark-up is charged yearly for the purchase of a pension and insures against disability of the participant. When the participant becomes disabled the employer and the participant are relieved from contributions for the remaining years until the pension date, while the participant will still accrue premiums or pension rights. The gross premium without disability mark-up is charged for example for the purchase of indexation or when transferring pension accumulations from one employer to the other. Since these purchases are not considered to be premiums, the disability mark-up is not included.

The premiums that are charged in the contracts in section 6 are taken from an ASR agreement, for completeness the formula to compute gross premiums is given in the appendix.

Mortality result

Within each contract an estimate of mortality is taken into account when setting premiums. Given a certain mortality table it is estimated that a certain percentage of the participants dies within the next year; the mortality rate. This percentage is therefore included as a discount in the premiums. Since unit linked contracts do not use any rate to calculate future claims, this mortality result is given yearly as additional return to survivors.

Profit sharing

An important element in the pension contract is the arrangement concerning profit sharing. The employer has to specify this ex-ante in the contract. The insurance company shares the profit that is generated in excess of the 3% interest on which the premiums are calculated. The u-rate minus three percent minus a cost mark-up is taken as a measure for profit that can be shared. The employer can choose to either receive this profit as a discount on premiums or as indexation of the employees' pension rights.

Inflation indexation

Although the excess profit is often used for inflation indexation, the two are not tied. An employer can promise to fully index pensions with inflation every year, independent of excess interest. Basically the employer has four options:

- Full indexation: the excess interest goes to the employer who has to purchase inflation indexation for his employees. This can be a fixed 2% or the CPI of the previous year
- Indexation conditional on profit sharing maximized to Consumer Price Inflation (CPI): indexation with a maximum of the price inflation is purchased with the excess interest. The remainder of the profit is often used for indexation of previous or future inflation (catch-up indexation) or goes as a discount to the employer
- Indexation conditional on profit sharing: excess interest is used to purchase indexation (here there is no catch-up indexation)
- Profit as a discount on the premium to the employer

The employer can distinguish between active and inactive employees when making an indexation commitment. He can promise to fully index the employee's pension to inflation when active, and conditional on profit sharing when inactive. In this way the employer avoids high costs for employees that have already left.

4.2 Defined Benefit schemes

Defined benefit schemes are characterized by the commitment of a certain pension payment by the employer. The employer makes a commitment and insures this at the insurance company. According to the Act concerning Equal Treatment a pension should be the same for men and women (with similar occupation). Since premiums are higher

for women than for men, an employer pays more for the pension of a female employee than for that of a male employee.

Final wage

When an employer commits to provide the employees with a final wage pension, employees receive a pension as a percentage of final pensionable wages. For the maximum accrual rate of 2% for final pay schemes, the employee's pension will be the following:

*Pension = years of service * 2% * final pensionable wage*

The total amount an employer has to purchase per year consists of two parts. The first part is the year purchase (accrual (2%) * pensionable wage). The second part is called the past service. The latter is the amount needed to compensate for the employee's wage increase in that year. Since a pension based on a percentage of last year's wage was purchased and the commitment of the employer is to pay this percentage over this year's wage, the employer has to contribute an additional amount. This effect is illustrated in **Figure 1**.

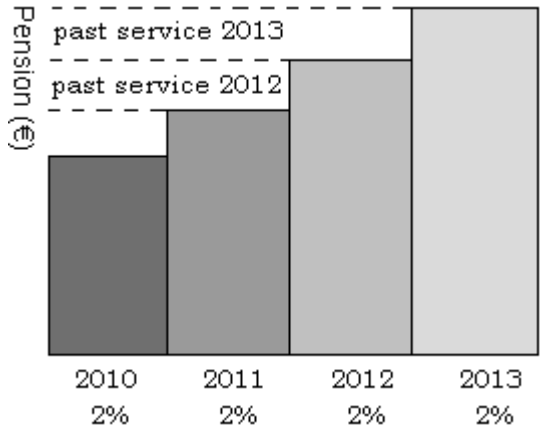


Figure 1 Pension accrual under the final wage scheme

If the pensionable wage rises each year, the promised pension increases accordingly. Since a pension based on the last year's pensionable wage is insured, the employer needs to do a *past service entitlements*. The longer the tenure of the employee at the company and the higher the wage increase, the higher this back service. The graph illustrates that if an employee is a 'career maker' who stays with the same employer, the past service can become quite expensive for the employer that made this promise.

The cost for the year purchase (the grey areas) is calculated using the gross single premium in the following way:

*Year purchase = pensionable wage * accrual (2%) * gross single premium*

The cost for the past service entitlements is calculated using the gross single premium without the disability mark-up in the following way:

*Past service = past service * accrual (2%) * increase in pens. wage * gross single premium*

For ASR Pensioenen the single premium for defined benefit schemes is the premium that should be paid to provide the participant with one euro of deferred annuity at age 65 calculated on a fixed 3% rate and a life table. If the return is higher than 3% the profit will be shared with either the employer or the employee.

Average wage

When the employer commits to provide the employee with an average wage pension, the employees receive a pension of a percentage of average pensionable wages. For the maximum of 2.25% yearly accrual for average wage schemes, the pension at pension date (year n) will be:

*Pension = 2.25% * pensionable wage* y_1 *+ 2.25% * pw* y_2 *+ … + 2.25% * pw* y_n

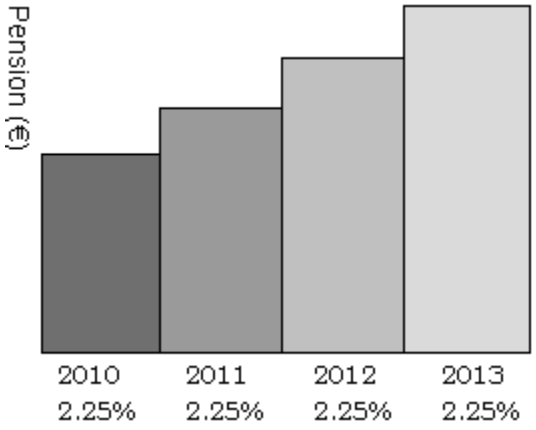


Figure 2 Pension accrual under the average wage scheme

Per year the pension purchase for average wage is calculated with the gross single premium:

*Year purchase = pensionable wage * accrual (2.25%) * gross single premium*

Under average wage schemes the pension costs increase when the participant is a 'career maker' but to a lesser extent; there is no past service for the employer **(Figure 2)**. The costs are more controllable for the employer.

Profit sharing

When the excess interest (above the 3% minimum) goes to the employer in the form of a discount it is simply subtracted from the yearly purchase. This is done each year. If the excess profit goes to the employees it is used to purchase new pension rights. The amount of indexation is dependent on the total liability the insurance company has to the participant. The total liability is the present value of the pension obligations in the future. The total liability is indexed by the percentage excess profit of that year. This amount divided by the gross premium yields the extra pension the participant gets.

If the employer has committed to index pension rights yearly with CPI or with a fixed percentage, he first receives the excess interest in the form of a discount. Whether there is excess interest or not, the employer has to purchase indexation in the form of new pension rights based on the total liability.

4.3 Defined Contribution schemes

The commitment of the employer is different in a defined contribution scheme. Instead of defining a certain pension at the date of retirement, the premium is defined. The premium is defined as a percentage of the pensionable wage (wage minus AOW offset) and is directly invested for the participant.

When setting premiums for DC arrangements several laws are interacting, this results in two different ways of setting premiums. First, according to the Act concerning Equal Treatment the contribution for men and women has to be equal in a DC scheme. Second, the Pension Act requires that the accrual is uniform over ages. Third, according to fiscal law there are limits as to how much of a wage can be set aside for pensions since these are tax-deductible. These laws make that either the premium (as percentage of pensionable wage) is equal over all ages, or that the expected accrual is the same over all ages. The second means that the premium must be increasing in age to obtain the same outcome. To ensure that this Act is lived up to by employers and insurers, the Dutch Ministry of Finance provides a list (*premiestaffel*) with the maximum defined premiums for all ages (**Table 3**). In the figure we see that the employer can choose to pay either increasing premiums or fixed premiums. The premiums are net premiums as percentage of pensionable wage. The increasing scheme is designed to provide a young employee who works for 35 years and has a normal wage path with a similar pension accrual as under an average pay pension scheme.[8] This is an estimate based on a 4% expected return. The fixed scheme is set at the level of the youngest cohort in order to

[8] Dutch Ministry of Finance: beschikbare-premieregelingen en premie- en kapitaalovereenkomsten van 21 december 2009 Nr. CPP2009/1487M

avoid that young employees accrue too much pension, although this premium is rather low for older employees.

Age	Premium	
20-24	5.0%	5.0%
25-29	6.1%	5.0%
30-34	7.4%	5.0%
35-39	9.0%	5.0%
40-44	11.0%	5.0%
45-49	13.4%	5.0%
50-54	16.5%	5.0%
55-59	20.4%	5.0%
60-64	25.5%	5.0%
65	0.0%	0.0%

Table 1 table of the DC premiums as percentage of the pensionable wage for an increasing and a flat scheme.

Since the values in the table are net premiums that have to be invested for participants, the gross premium is higher because of the cost mark-ups.

The premium is invested for the employee to result in a certain pension or capital at the retirement date. Like in DB schemes, the employer decides what kind of scheme his employees are in, although the way this premium is converted into a pension differs per scheme and per insurance company. This is not the case for DB schemes. The different manners in which the defined premium results in a pension will now be discussed.

Deferred life endowment

The employer can decide to have the premium directly converted into a guaranteed endowment or capital at the pension date if the participant is still alive. The contribution of the employer multiplied by the gross single premium is the endowment that the participant will receive when alive at retirement. The premiums of the guarantee are based on the currently ongoing minimum interest rate of 3% and are specified as the premium that has to be paid in order to provide the participant with one euro of endowment at retirement. Since the endowment is guaranteed the premiums are invested in relatively low risk assets with a yield of u.

At retirement, the participant receives the endowment he has accumulated at the insurance company. With this endowment the participant has to purchase a direct life annuity at any insurance company. The price of the annuity is dependent on life expectancy and on the market interest rate (here: u-rate).

We assume that for schemes in which a life annuity should be purchased it is only possible to purchase a nominal annuity. Annuity prices will be different for each insurance company because of different life tables, profit margins and risk measures.

Unit linked scheme

Instead of having a guaranteed endowment for the participant at retirement, the employer can let his employees decide themselves on how to invest the premium. The return made on the premium is linked to 'investment units'. The unit linked policy provides no guarantee to the participant; the capital at retirement is fully dependent on investment returns. Due to the new legislation, insurance companies are obliged to offer lifecycle funds for which the participant knows how his money is invested (i.e. defensive, neutral, offensive). The profiles will have life-cycle features such that the participant invests riskier when young and has a small amount (or zero) invested in equity when he retires. The participant is not obliged to invest according to these profiles and can choose to 'opt-out'. An example of the 'neutral' investment profile currently used at ASR Pensioenen is provided in **Table 2**. At the moment a new scheme is developed in which the proportion invested in equity decreases to zero at retirement.

Years until retirement	>15	15 to 7	7 to 3	3 to 1	<1
stocks	55%	40%	30%	20%	10%
real estate	10%	5%	5%	5%	5%
fixed income	35%	55%	65%	75%	85%

Table 2 An example of an ASR investment profile for a DC scheme.

Since there is no guarantee involved, there is no additional profit sharing in unit linked policies; the profit sharing is already incorporated in the return. The return on investments minus a cost mark-up is the yearly return. The capital at retirement should be used to purchase a direct life annuity (the same as for endowment insurance).

Direct annuitization

Whilst unit linked policies and life endowment guarantees annuitize capital at retirement date, the premiums can also be directly annuitized into a pension. Instead of making a pension dependent on one conversion at the retirement date, the annuitization risk (longevity and interest rate risk) is spread over all years. The yearly premium is used to purchase a deferred life annuity that starts at the retirement date. For the scenario calculations in section 5 we calculate the price of the deferred life annuity on the basis of both the u-rate and the fixed 3% rate. When pension rights are

purchased against market rates there is still interest rate risk for the participant, only now it is spread. When the rights are purchased against the 3% fixed rates the pension is more secure for the participant, if there is excess interest the participant will benefit from profit sharing.

The direct annuitization construction may seem like a DB pension scheme since it also results in a certain pension at retirement, though the commitment of the employer is a premium. The premiums are certain and predictable for the employer; when a pension becomes more expensive the employer does not bear the full cost. The accrued pension is less certain for the employee, although more certain than under an endowment- or unit linked policy.

Combinations

The three DC possibilities can be combined in any form that is desired. Many insurers offer schemes in which the employer pays a premium with which the participant can either purchase a life endowment or a unit linked policy, or a scheme in which the participant can directly annuitize the premium. Though these plans are a combination of schemes, they are not considered hybrid schemes, since the commitment of the employer is still a premium.

Often the participants can switch from unit linked to the other two, however if the premium is converted into an endowment or an annuity it usually cannot be converted back into a unit linked policy.

An attractive option could be to introduce a lifecycle component in such a scheme. For example a combination of a unit linked scheme that decreases in proportion with an increasing component that directly annuitizes the premium.

4.4 Hybrid schemes

As for the definition of a hybrid schemes there are many possibilities. The definition we use of a hybrid scheme is a scheme that combines features of both DB and DC, so in some way it should include a pension promise and a premium promise. Others define a hybrid plan as a pension plan in which 'the benefits depend on the accumulation of either predetermined or free contributions, and which imposes a redistribution of risk' (*Baumann, 2005*). This definition treats schemes somewhat different since it would consider any scheme that is not purely investing assets for the participant to be a hybrid scheme. For instance, a guaranteed endowment would already redistribute some risk away from the participant and would therefore be a hybrid plan. We focus explicitly

on the promise done by the employer which is in the case of a deferred life endowment the premium.

Furthermore, in insurance contracts pension rights cannot be cut if the insurer is insolvent, contrary to pension fund underfunding. Therefore the defined benefit is certain. Schemes that combine DB and DC features will now be discussed.

Nursery plan

The basic feature of a nursery plan is that the scheme starts with a DC phase and then shifts to a DB phase. This can be designed in different ways. The arrangement is impossible to realize under current law in the Netherlands, because the scheme distinguishes between different ages or between short- and long-tenure employees. Although under current law it will not be possible to introduce such a scheme, we will test the scheme to see whether it has some beneficial features because of the attention in literature for age-differentiation in collective pension contracts *(Ponds and Van Riel, 2009)*.

A nursery scheme is said to reward long-tenure employees with more stable DB pension *(Blommestein et al., 2009)* and is therefore called a nursing plan. This crucially depends on what the underlying agreements are concerning the DC and DB scheme. If the DB scheme has very poor conditions while the DC system has a guarantee with upward potential of profit sharing, this may not be the case. These schemes are often executed in the United States.

Nursery plans can also have a lifecycle feature of investing more risky when young while safer when old. Again this depends on the underlying assumptions of both schemes, but it could be offered through combining a Unit Linked DC scheme in which the participant can invest (partially) in equity with an average wage DB plan.

The transition can be made immediately at a certain age or can be phased-in gradually. For the assessment of the nursery plan in the scenario analysis we use the gradual transition as illustrated in **Table 3**.

The transition is such that a participant will never have a full DB or DC pension accrual but always a combination of the two. The DB part has the same characteristics as the average wage scheme with conditional indexation, while the DC part is the same as the unit linked policy explained earlier.

Age	DB	DC	DC premium
15-25	10%	90%	5.00%
25-30	20%	80%	6.10%
30-35	30%	70%	7.40%
35-40	40%	60%	9.00%
40-45	50%	50%	11.00%
45-50	60%	40%	13.40%
50-55	70%	30%	16.50%
55-60	80%	20%	20.40%
60-65	90%	10%	25.50%
65	0%	0%	0.00%

Table 3 The DB and DC component of the nursery scheme as percentage of pensionable wage devoted to both schemes.

Floor-offset plan

A floor-offset or underpin plan will provide the participant with the maximum of a defined benefit and defined contribution plan. Or: 'A floor-offset plan is a hybrid plan that provides a defined benefit floor which could be offset by the annuity that can be purchased with the balance of a defined contribution account.'[9] It is a put option that is in the money if the DC return is lower than the DB guarantee. The employer writes this option to the employee and has to pay the difference when this option is in the money. The scheme appears to have desirable features for the participant since it guarantees a basic pension with an upward potential. However, for the employer there are some issues for the employer. First, the DB guarantee would oblige the employer to make a reservation for the employee in case the option expires in the money. This would make pension expenditure more volatile and unpredictable. Another reason why an offset-floor scheme is unattractive is that the employer will restrain the employee in his investment choices. Since the employer provides a guarantee he will want the employee to invest risk avoiding, such that the expected return on the individuals assets will not be that high. A third issue is the level of the guarantee. If the guarantee is set too low it will not have value for the employee, whereas when it is set to high it will be just a defined benefit scheme for the employer. In the United States these schemes actually exist, the guarantee is a specified percentage of the pensionable wage.

[9] Complete Guide to Human Resources and the Law, 2010 Edition Dana Shilling | Wolters Kluwer Law & Business | Aspen Publishers.

Since setting the level of the guarantee determines whether the scheme is DB or DC like, we do not consider the scheme an executable pension scheme for insurance companies. Therefore we do not analyze the scheme in the scenario projections.

DB limit, DC above

Another combination of defined contribution and a defined benefit plan is a limited defined benefit scheme with a defined contribution component for the pensionable wage above this limit. Typically this limit is set at 70% of the WIA-limit in the Netherlands. This limit (€48.716 in 2010) is the maximum wage up to which someone is insured against disability when working. When a person is disabled he receives 70% of his last wage up to this limit. For this reason the same limit is chosen for the defined benefit component. Above this limit a defined contribution scheme applies, often designed in a way that gives the participant a choice in how to invest the pension premiums. The idea behind this scheme is that it gives the employee a stable 'basic' pension and that the employer only has to promise a pension up to this limit. Thereafter only a premium is paid.

For the purpose of calculating the outcome of this scheme in different scenarios we thus use 70% of the WIA limit, which increases yearly with inflation. The DB scheme applies for the part of the pensionable wage below this level. We assume a similar 2.25% of average wage accrual as in the regular DB scheme. Over the remainder of the pensionable wage the premium for the DC component is calculated. Here we assume the same net premiums as in **Table 3**.

The degree to which a participant is dependent on a DC type pension depends on the wage level and the wage path. If the wage is low and/or the wage path is flat and the pensionable wage never gets higher than the 70% WIA-limit, the participant accrues no pension in the DC component. On the contrary, if the employee is a career maker with a high starting wage a larger part of the pension will come from the DC part.

5. Scenario analysis

5.1 Creating the scenarios

Data

The assessment of different pension schemes will be done on the basis of 1000 Monte Carlo scenarios that differ in terms of projected interest rates, inflation and stock returns. Each scenario is simulated for the coming forty years. Estimating expectations on the basis of historical data resulted in extreme estimates; equity returns from 2000 to 2010 were negative, whereas from 1990 to 2010 the returns were largely positive. Since this makes working with historical estimates rather subjective, we take the parameters of the Dutch Central Bank (DNB) which show more similarity with the values we find in the literature, for instance in *Ponds, Van Riel (200?)* and *Blommestein et al. (2009)* that do a similar scenario study. These averages for stock returns, inflation and interest rates are the values that pension funds are obliged to use under the Financial Assessment Framework (FTK or *Financieel Toetsings Kader*). These parameters should be used to calculate premiums and for recovery plans. The parameters are based on long term historical averages. Recently, the Minister of Social Affairs and Employment determined a new set of parameters which are lower than the actual ones. This was mainly due to the advice of the Don Committee[10] according to whom the current parameters where too high. Since the old parameters are still in place we use these values. The standard deviations and correlations are estimated historically. The properties of the parameters are listed in **Table 4**.

	mean	Stdev	Correlation		
interest rate	0,045	0,019	1	0,568	-0,013
inflation	0,02	0,015	0,568	1	-0,215
equity return	0,075	0,14	-0,013	-0,215	1

Table 4 Characteristics of the input variables of the scenarios

We assume that the long term estimate for the interest rate of the Dutch Central Bank is an appropriate estimate for the u-rate we use to calculate the profit sharing of the pension contracts. After generating the scenarios we fixed the outcomes and used the same 1000 scenarios for each analysis to obtain a fair comparison. In **Figure 3** one of the scenarios is presented.

[10] Commissie Don, Advies betreffende parameters pensioenfondsen van 21 september 2009

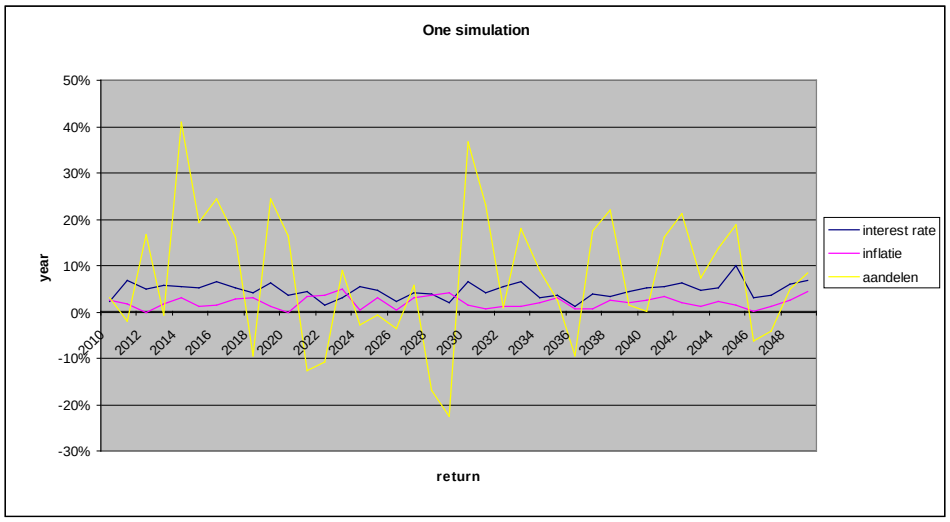


Figure 3 One of the thousand Monte Carlo Simulations

Generating the scenarios

To generate the scenarios we assume that the variables we use follow a *Geometric Brownian Motion*. The variables will be described later. A Brownian motion is a model that is often used to explain a random motion. The process of the Brownian motion is given by the following stochastic equation:

$$dY = \mu Y\,dt + \sigma Y\,dW \qquad (1) \qquad \text{Baz, Chacko (2004)}$$ [11]

This formula indicates that the price or value of a variable follows a trend (μYdt); the model assumes that the value will move up by the expected return or average growth rate (μ) over a certain time period (dt). However, this will not go smoothly; the trend will be hit by random shocks (σYdW), in which σ is the volatility of the variable represented by the standard deviation, and dW is the so called Wiener increment. This term can also be written as $\sigma\varepsilon\sqrt{dt}$; it is a random shock in the form of a normal distribution ($\varepsilon = N(0,1)$) multiplied by the standard deviation and the square root of the time period. We can rewrite equation (1) in the following way:

$$dY/Y = \mu\,dt + \sigma\,dW \qquad (2) \qquad \text{Baz, Chacko (2004)}$$

We define a new function $F(Y_t,t) = log(Y_t)$ so that we can apply *Itô's lemma*[12] which yields:

$$dF(Y_t,t) = dlog(Y) = (\mu - \sigma^2/2)dt + \sigma W \qquad (3) \qquad \text{Baz, Chacko (2004)}$$

[11] Calculations 1 - ? are taken from: Jamil **Baz**, George Chacko (2004) *Financial Derivatives: Pricing, Applications, and Mathematics*, Cambridge University Press, p. 12-14,

[12] Ito's lemma is often used to find the differential of s stochastic process such as a Geometric Brownian Motion. The identity one can use to obtain a function of the stochastic process is the following: $dF=(dF/dX)dX+1/2(d^2F/dX^2)dt$

This allows for an explicit derivation of the path of the price or index. By integrating equation (3) from 0 to T, one obtains:

$$log(Y_T) - log(Y_0) = (\mu - \sigma^2/2)T + \sigma (W(T) - W(0)) \quad (4) \quad \text{Baz, Chacko (2004)}$$

such that:

$$Y_T = Y_0 \exp((\mu - \sigma^2/2)T + \sigma (W(T)) \quad (5) \quad \text{Baz, Chacko (2004)}$$

In our simulations we simulate on a yearly basis so T=1, and since $W(0) = 0$ and $W(T) = \varepsilon\sqrt{T}$ and the equation becomes:

$$Y_T = Y_0 \exp(\mu - \sigma^2/2 + \sigma \varepsilon) \quad (6) \quad \text{Baz, Chacko (2004)}$$

Y_T is the value (or price) of the variable at time T, Y_0 is the value at t=0, therefore the log return is $log(Y_T/Y_0)$ which we approximate by $(Y_T-Y_0)/Y_0$ or Y_T/Y_0-1 such that the formula of the realized return on equity, the price inflation or the interest rate becomes:

$$Y_T/Y_0-1 = \exp(\mu - \sigma^2/2 + \sigma \varepsilon) - 1 \quad (7)$$

This process we can easily simulate since we have the means (μ) and standard deviations (σ) of the three variables. The shocks ($\varepsilon \sim N(0,1)$) we simulate by taking random draws (from 0 to 1) in Excel, from which we take the standard normal inverse in order to obtain a normal distribution.

Since we simulate returns on equity, inflation and interest rates for one year ahead the variable Y takes the form of a stock index, a price index and the future value of a fixed income investment. The return on equity is the change in the stock index minus 1 (S_1/S_0-1), inflation is the change in the price index minus 1 (P_1/P_0-1). For a return of a fixed income investment (R) we also represent the variable in the form of an index which is the future value of a fixed income investment:

$$R_T = (1+r)^T \qquad \text{thus: } R_0 = 1,\ R_1 = 1 + r_1$$

in which r is the mean interest rate; we simulate $R_1/R_0-1 = r$. The μ is respectively the mean return on equity, the mean inflation rate and the mean interest rate and σ is the standard deviation.

We bring the correlation into the draws by multiplying the vector of the simulations with the transpose of the *Cholesky decomposition*[13] of the correlation matrix.

[13] The Cholesky decomposition is the decomposition of a positive-definite matrix (say A) into a lower triangular matrix (L) and its conjugate transpose (L'), and it is the square root of a matrix.

Assumptions

The fact that we use a Geometric Brownian Motion to simulate the three variables is not completely consistent with most simulations in the literature. Whereas the GBM is often used for explaining movements in stock prices, different models are often used to generate inflation and interest rates. Other publications often use an Ohrstein-Uhlenbeck process to simulate the interest rate or inflation. These type of models have the feature that the variables can be mean reverting; in the long run these rates tend to converge to there long run average, which is often argued to be a feature of interest rates and inflation. Due to time- and technical constraints we chose not to focus on developing the most accurate model to generate the variables, but to spend the time on the assessment of the pension schemes. Also we think that since we simulate on a yearly basis the influence of the mean reversion would be rather small.

One feature of the interest rate is that it cannot get negative; in our simulations this is possible. We correct therefore by not allowing negative interest rates.

We assume that the time series of inflation, interest rates and equity returns we used are approximately stationary. This means that the mean, standard deviation and correlation are assumed to be constant over time.

We assume also that the random variables we generate are log normally distributed. In other words: we assume that the log of the random variables we simulate ($log(Y_T/Y_0)$) is normally distributed. The distribution of the variables will then be more skewed to the right; the distribution will have a long tale at the right side of the mean.

Since we have taken the long term interest rate of the Dutch Central Bank as a measure for the u-rate we assume that this interest rate is valid for all maturities; we assume a flat term structure.

5.2 Assessment of the schemes

For each of the 1000 scenarios we generated we compute projections for the old age pension of various pension schemes. We used the scenario approach because it shows not only the expected outcome of the schemes, but it is also able to reproduce and visualize the risks of a pension scheme. Since equity has higher expected return than interest rates, a unit linked scheme logically has higher expected pension provision. But how likely is it that unit linked pension provision falls below that of an average pay scheme for example? Or what is the probability that pension provision falls below a certain amount? A scenario analysis is very well able to answer these questions.

Furthermore, a scenario analysis accurately shows the path dependency of for example stock returns.

We project outcomes for a representative male participant. The participant starts working at age 25 and has zero pensions accrued at the moment of entrance. The participant will retire at age 65 and works for the full 40 years. Under an average pay scheme with 2.25% accrual the individual is expected to obtain a pension of 2.25%*40 = 90% of his average wage. The old age pension is obtained by adding up the first pillar (AOW) pension, of which we assume the participant has accrued 100%, and the pension from the insurance company in the form of the different schemes. We present only the second pillar pension, since including the AOW pension would give a distorted view of the characteristics of the pension schemes, since it is the same for each scheme. This would underestimate for instance the variance or 'riskiness' of the pension schemes since the AOW part has no variance.

The wage path of the participant is assumed to be similar to the average wage path used by the Dutch Ministry of Finance to calculate the premium tables. These tables assume an inflation rate of 2% and real wage increases of employees from 3% to 0%. We assume that the participant always gets inflation indexation plus the real wage increase, which leads to the wage path given in **Table 5**. In section 6 we will look at pension schemes under different wage paths.

Wage path	
age 25-35	inflation (%) + 3%
age 35-45	inflation (%) + 2%
age 45-55	inflation (%) + 1%
age 55-65	inflation (%) + 0%

Table 5 The wage pattern of the participant: we assume the wage is always indexed to inflation plus a real percentage which is dependent on age.

The wage inflation is the same as the price inflation we use in the scenarios. The starting salary of the employee is €25.000. The AOW offset (€12.000 in 2010) and the WIA-limit (€48.000 in 2010) both are indexed to inflation if it is positive. If inflation is negative, both stay at the value of the previous year.

The life table we use for the computations of the market based premiums and the result on mortality is *collectief 2003*, a table that is widely used by insurance companies that is based on mortality of the reference group. In section 6 we will change the assumptions with respect to life expectancy to see the influence of shocks in longevity.

To obtain the gross premiums we used the formula in the appendix. The mark-ups that are taken from a standard contract of ASR Pensioenen and have the following values (**Table 6**).

Markups for calculations	
remittance	2%
disability	3.5%
provision	6%
administration	5%

Table 6 Mark-ups assumed for each pension scheme.

For each scenario we project the outcomes of the eight schemes presented in **Box 1**. The first four are schemes that ASR Pensioenen offers, the other schemes are alternatives.

An important note of our analysis is that we compare the nominal pension provision of different schemes at the retirement age (65). For all schemes the pension is nominal except for the schemes that have a DB element with conditional indexation. The pension at the retirement age in those schemes has the potential of indexation in later years if there is excess profit. To fairly compare the arrangements we correct the average wage pension at retirement so that it becomes a nominal annuity.

We present the projections of the old age pension in the form of replacement rates (as percentage of final salary). The replacement rate is defined as second pillar old age pension as a percentage of the final wage. Since we are examining second pillar pension schemes we present only the replacement rate of the second pillar. In our model the replacement rate of the first pillar pension (AOW) is a fixed 0.28 or 28% for each scenario, since the AOW is not dependent on the parameters. If one adds the replacement rates the overall replacement rate is obtained. This replacement rate is better comparable to estimates in the literature (for example as overall replacement rates in a countries' pension systems, also *Blommestein et al. (2009)*) but one has to be careful with the underlying assumptions.

Box 1. Eight pension schemes

1. A *final wage* scheme of 2% yearly accrual where profit sharing goes as a discount to the employer (DB)
2. An *average wage* scheme of 2.25% yearly accrual with indexation of accrued rights conditional on profit sharing (DB)
3. A *guaranteed life endowment* with the net single premiums taken from table 1. A pension in the form of a life annuity is purchased against the market interest rate at that moment (DC)
4. A *unit linked* scheme with net single premiums taken from table 1. The final balance is used to purchase a pension in the form of a life annuity against the market interest rate at that moment (DC)
5. A scheme that *directly annuitizes* the premium payments. The premium for the deferred life annuity that starts paying at age 65 is calculated with the interest rate/u-rate at that year (DC)
6. A *nursery scheme* that combines the average wage scheme and the unit linked scheme (scheme 2 and 4) in a fashion we that is described in section 4. The DB part is increasing in age, while the DC part is decreasing. (hybrid)
7. A *limit scheme* similar to scheme 2 with a unit linked scheme above this floor similar to scheme 4 (hybrid)
8. A scheme that combines a unit linked scheme with a scheme that directly annuitizes, in a life cycle fashion the same as for the nursery scheme (6). The participant starts with 90% of the premium in unit linked and 10% to directly annuitize. We will call this scheme the *lifecycle scheme*. (DC)

5.3 Discussion of the results

The projected outcomes of the replacement rate for the different schemes are presented in **Figure 4.** The 'mean' estimate is the expected outcome of the respective pension scheme, the 5% and 95% are the boundaries of the 90% forecast interval; 5% of the scenarios end up above the 95% boundary, another 5% end-up below the 5% boundary. We observe that the results stroke with the expectations one has based on the parameter values. When we plug-in the parameter values in the model, the same mean is obtained. The log normality of the variables results in the fact that the 95% boundary lies much further from the mean than the 5% boundary.

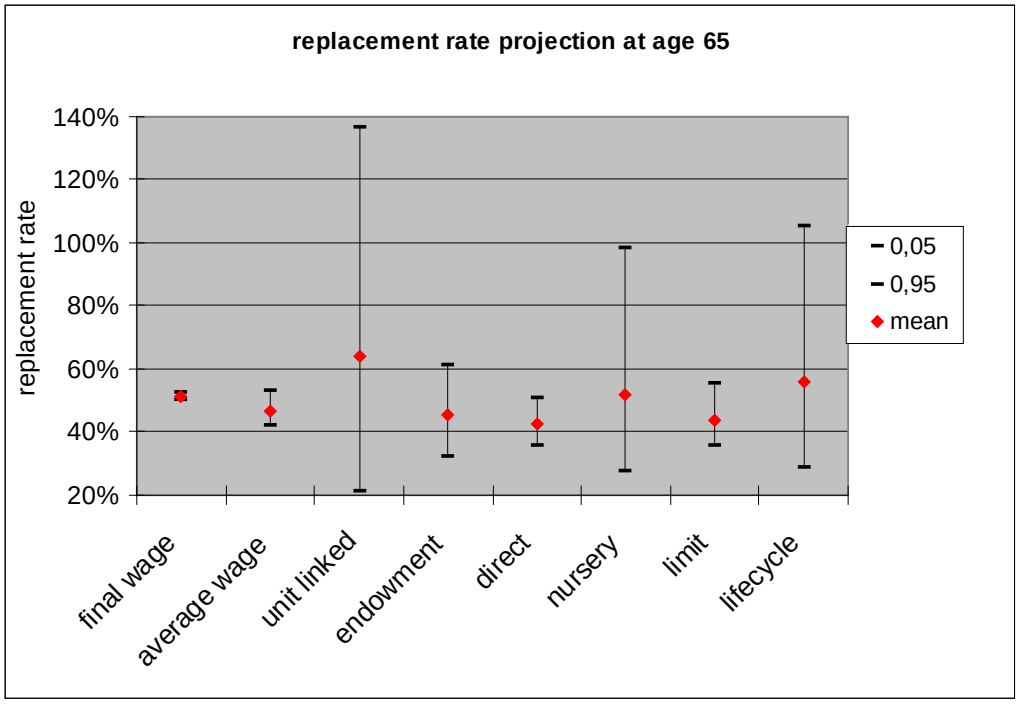


Figure 4 Projected replacement rate and 90% confidence interval for eight pension schemes at age 65.

The defined benefit plans provide stable replacement rates. The *final wage* pension plan provides the most stable replacement rate; over a 40 year period the participant each year accrues 2% of his final wage. The replacement rate of the second pillar is 51%. Together with the 28% first pillar pension this ads up to 80% percent (79% due to rounding errors) which is exactly 40 years with 2% accrual. The replacement rate of the *average wage* plan is somewhat lower and less stable; the instability is caused by the conditional indexation. Although there is some uncertainty in this DB plan, it is less risky than the pure DC schemes (e.g. the 5% boundary is higher).

Of the DC schemes the *unit linked* plan has the highest expected replacement rate because of the high expected return of equity. The risk of this scheme is also higher because of the investment returns. The *unit linked* plan for example has a 5% probability that the replacement rate is lower the 21%. The *life endowment-* and the *direct annuitizing* scheme have lower expected replacement rates since assets are invested in fixed income securities. Therefore they are characterized by lower risk. As we expected the scheme that directly annuitizes is less risky than the endowment scheme since it spreads the interest rate risk of the conversion over multiple years. The *lifecycle* scheme logically has a projected outcome that is less risky than that of the unit linked scheme but more risky than the directly annuitizing scheme. In **Table 7** we see the expectation and the 5% and 95% boundaries of the projections for the *lifecycle* scheme

and for the two components separately. The direct annuitizing component has a very predictable replacement rate between 16% and 22% with 90% certainty. The unit linked component on the contrary is very unpredictable (between 7% and 65%).

	Lifecycle	UL	direct
5%	24%	7%	16%
mean	46%	28%	18%
95%	85%	65%	22%

Table 7 Replacement rate lifecycle scheme split into the *UL* and *direct* part

The projections for the *limit* scheme are not very different from that of the average wage plan. This is due to the fact that the DC part is small because of the modest career effect of the participant. When the pensionable wage sooner reaches the limit the DC part would get larger accordingly. The *nursery plan* that combines the average wage DB plan with the unit linked DC plan clearly gives a result that is the average of both; it has an expected replacement rate of 52%.

Table 8 numerically presents the expected projections for the pension schemes based on the scenario projections; the expected value is the same as that of the 'mean' replacement rate in **Figure 4.** Furthermore the figure gives three probability measures that are more intuitive than the 90% forecast interval. *Pr(rr<30%)* is the probability that the replacement rate is lower than 30% of salary. We see that for the *unit linked* scheme and the *nursery plan* there is quite some risk to whether the replacement rate is lower than 30%; there is a probability of respectively 17% and 13% that the replacement rate is lower.

Replacement rates	DB final wage	DB average wage	DC unit linked	DC endowment	DC direct	Hybrid nursery	Hybrid limit	DC Lifecycle
Expected	51%	47%	64%	46%	43%	52%	44%	56%
Pr(rr<30%)	0%	0%	17%	3%	0%	13%	0%	7%
Pr(rr<40%)	0%	1%	34%	27%	30%	40%	31%	32%
Pr(rr>50%)	96%	19%	51%	30%	8%	37%	15%	45%

Table 8 Expected replacement rate at age 65 and probability that this rate is lower than 30%/40% or higher than 50%.

As an indication of the costs of the pension schemes we show the cost in the year that the participant is 44 years old. The results are presented graphically in **Figure 5.** This measure is sort of an average cost for the employer if the age of the personnel is uniformly distributed. Although this measure is not a perfect indication for the costs, it shows the variance in costs for the employer over different scenarios.

The figure indicates that almost all schemes have constant costs. The only scheme that is unpredictable in terms of costs is the *final wage* scheme. This is due to the effect of inflation. Although the final wage pension is not indexed to inflation, the wages are. Inflation normally has no effect on the costs when it is expressed as a percentage of the wage. Since the costs and the wages rise by the same percentage, the cost as a percentage of the wage remains the same. However, the past service costs in the final pay scheme makes that the costs become more volatile; in the high inflation scenarios the effect of the past service is amplified. We see that within the 90% forecast interval pension costs at age 44 can fluctuate between 11% and 21% of wages.

The schemes that are defined benefit or have a DB element have higher costs than the DC schemes. The *lifecycle* scheme combines two DC arrangements and therefore has the same costs.

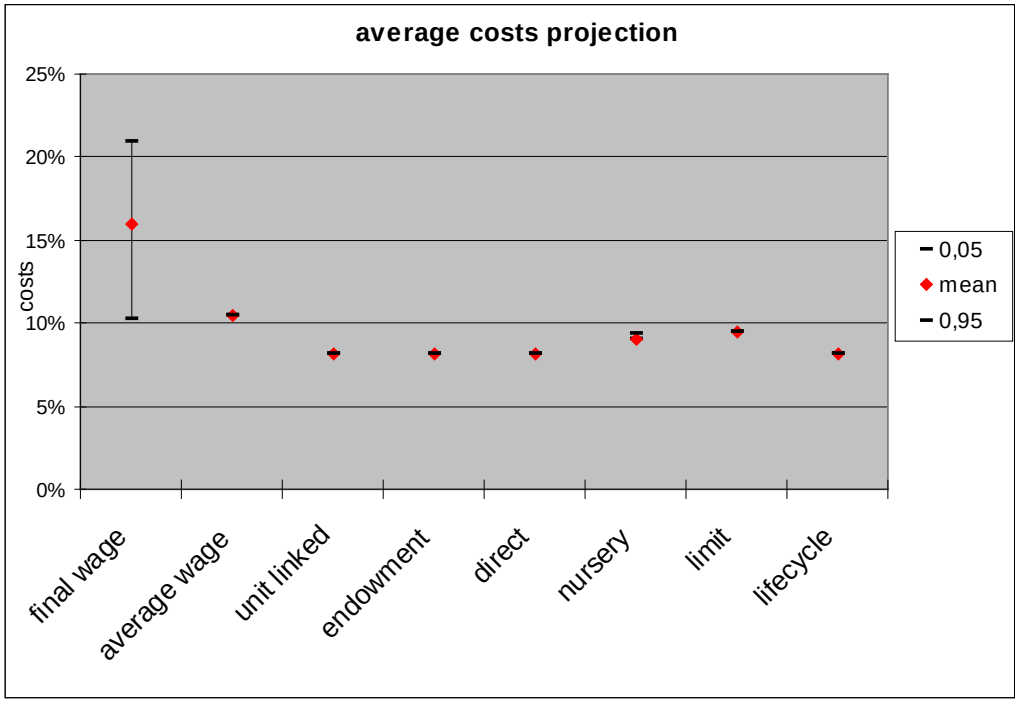


Figure 5 Projected average costs and 90% confidence interval for eight pension schemes.

Based on parameter values we put in the model, the outcome is like one would expect; the classic risk-return trade-off. The risk increases with the level of the expected replacement rate. The risks of the schemes are manifested in the 90% forecast interval. **Table 8** presents the results in a way that is convenient for participants by giving the probability of ending up below a certain replacement rate. If a participant does prefer not to have the risk of a replacement rate below 30%, clearly the *average wage* and the *direct annuitizing* scheme are preferable.

6. Sensitivity analysis

Although the results of the scenarios in section 5 give a good indication of what participants can expect from a pension scheme, the results are quite straightforward since all are based on average inputs. DB schemes have high and stable replacement rates, but are more expensive. Equity linked plans have high expected replacement rates but are rather risky. In this section we will perform a so-called sensitivity analysis on the outcomes in section 5. We will further change the parameters to see what happens to each pension scheme if there are shocks. Since the population is ageing and life expectancy seems to keep on increasing, it may be valuable to see the effects and risk of this. Moreover, we assumed a straightforward career path, but what happens if wages grow faster or slower? Does this make a pension scheme more or less attractive? Another important element is that we base our parameters on estimates that are taken from the Financial Assessment Framework and assume constant mean and variance, but there may also be parameter risk. When we historically estimated the data, means and variances turned out to be far from constant.

Consecutively, we will test the schemes to shocks in longevity, different wage patterns and shocks to the long term averages of stocks, inflation and interest rates. We will change each variable *ceteris paribus*.

Increased longevity

As mentioned earlier, one of the reasons why employers switch from DB to DC schemes is longevity risk. Our scenarios assume that the survival probabilities of the participants are that of the life table we use. But what happens if individuals live longer? We run the 1000 scenarios for adjusted life tables in which the participants live on average 2, 4 and 6 years longer. The tables were obtained by shifting the cumulative survival probability. The parallel shifts in the graphs are just arbitrary shocks are not intended to simulate actual longevity risk. Though these shifts do not allow for longevity shocks during the 40 year period, we think these shocks give a good estimate of what happens to pensions (i.e. replacement rates, costs, predictability) if people live on average 2, 4 or 6 years longer.

In 2009, Statistics Netherlands published the historical average life expectancy for the Netherlands until 2006.[14] The average life expectancy of men in the Netherlands was 75.1 for the period 1996-2001, for the period 2001-2006 this was 76.4; in five years men lived on average 1.3 years longer (0.24 increase per year). For the period of 1976-

[14] Statistics Netherlands, Historische overlevingstafels voor Nederland

2006 the average life expectancy increased with around 0.173 years per year. If we project the trend of the 2001-2006 into the future, the 2 year increase in life expectancy is realized in the 2009-2014 period. The four year increase in 2017-2021 and the six year increase in 2025-2031.

What happens concretely in our model when people live longer is that the life annuities and life endowments become more expensive in DC arrangements and the premiums of insurance companies increase for DB arrangements. For the unit linked policies also the result on mortality as discussed in section 4 changes.

Table 13 and **Table 14** of the appendix show the projected replacement rates and projected costs for a 44 year old employee for different life expectancies. The 'standard' life expectancy is that of the *collectief 2003* life table. Both tables present the new projections and the change in the projection with respect to the standard case.

The difference between DB and DC schemes is perfectly illustrated in the two tables. When people live longer the replacement rate for final wage scheme remains unchanged. For the *average wage* scheme the replacement rate even increases slightly. This is caused by the correction we made for the inflation indexation. Since the pensioner enjoys more years of (conditional) indexation, the pension is higher when it is converted into a nominal amount. The costs on the other hand increase substantially for the DB schemes; if people live on average two years longer, pension costs increase by 9.4%. We also observe that though the employer has no investment or inflation risk with *average wage* schemes, he bears the longevity risk.

For DC schemes it is exactly the other way around. The costs are fixed at 8% of wages whereas the expected replacement rate decreases if people live longer. The investment risk, inflation risk and longevity risk is borne by the individual. The hybrid schemes spread the longevity risk almost evenly; for the nursery plan the cost increase is almost the same decrease in the replacement rate.

In **Figure 9** of the appendix we see the forecast interval for each pension scheme when longevity increases. We see that for the DB schemes the intervals stay almost the same. In the DC schemes however, the intervals shift downward if life expectancy is higher. For the nursery scheme the lower bound seems to be stable whereas the mean and the upper bound are lower.

Since we do not know what will happen to longevity, we take of 250 scenarios of each of the four life tables (basic, +2, +4 and +6). In this way longevity risk is incorporated in the model; there is a 25% probability that life expectancy stays the same, 25% probability that it will grow by 2 years, etc. The results of this sensitivity are presented

in **Figure** 10. Logically for DB schemes the expected replacement rates decrease and for DC the costs increase.

In DB schemes the longevity risk is borne by the employer; if people live on average two years longer, the costs increase almost 10%. In DC schemes this risk is borne by the participant; if people live on average two years longer the expected replacement rate decreases. The attractiveness of DB schemes for the participant is not so much caused by the level of the expected replacement rate, since with the right premiums the same result can be achieved in a DC scheme. The attractive feature of a DB scheme is that if longevity increases the benefit does not drop.

Different wage patterns

Next we will look the replacement rates for different wage patterns. The standard wage pattern we used is presented in **Table 5**. As said it is the average wage pattern that an individual has according to the ministry of finance. Instead of having this wage pattern, we see what happens to our results if the participant has a different wage pattern. Although we change the growth percentages we assume the evolution of the wage remains the same; the wage grows fastest at the start of the career, this growth slows gradually. The starting wage is €25.000 for each wage path. In **Table 15** of the appendix we see the third pattern that is the standard wage path. In the first pattern the wage grows much faster.

The replacement rate for the *final wage* scheme is much higher if the wage growth is high. This is surprising since the pension at retirement is always the same percentage. However, the 2% yearly accrual is expressed as a percentage of the pensionable wage, whereas we express the replacement rates as a percentage of the final wage in which the AOW-offset is still included. The higher the final wage, the smaller is the share of the AOW-offset, since it is the same for each of the patterns. As discussed in section 2 the final wage scheme benefits the career maker.

For all other schemes the replacement rate is higher the flatter the wage path, except for the *limit* scheme. The reason for this lies in the shape of the wage path which is growing but diminishing. For diminishing but growing wage curves the following applies: the steeper the wage path, the smaller the average wage is relative to the final wage. Therefore the replacement rate of the average wage plan is lower for the participants that have steep career paths. For the DC scheme this is more or less the same since the premiums are expressed as a percentage of the pensionable wage.

For the scheme with the *limit* scheme the replacement rate increases if the wage grows faster but only moderately. This has to do with the combination of the two schemes and

the level of the limit. For different combinations, for example a lower limit, the outcome could be different too.

In **Figure 11** the expectation and forecast intervals for eight different pension schemes are presented, the first estimate being the standard case. For the schemes that have equity exposure the interval widens if the wage grows faster; the scheme is more risky for steeper wage paths, although the lower bound is stable. The *average wage* scheme, the *endowment guarantee* and the *directly annuitizing* scheme have stable intervals; they are equally risky for all wage paths. The *limit* scheme is less risky if wage growth is lower. This is caused by the fact that a smaller part is invested in equity in the DC component. From the figure one can immediately see that the final wage plan is not always optimal; if participants have flat (or decreasing) paths the average wage plan is clearly to be preferred. Even the lower bound of the *average wage* scheme is higher than the replacement rate of the *final wage* scheme.

One should notice that the AOW first pillar replacement rate is not a fixed 28% anymore. When the wage path was fixed the first pillar pension was always the same percentage of the final wage. When the wage path changes this is not the case. If the final wage is higher than in the standard case, the AOW is always a smaller share of the final wage, if it is lower a larger share.

For the costs in **Table 16** of the appendix, we see that for each scheme the costs (as percentage) are highest for the highest wages. *The final* wage scheme is very expensive if the participant has a high wage. Other schemes are also more expensive but the ranges are less extreme.

Generally speaking the *final wage* scheme discriminates participants with flat wage profiles. Also this scheme is very expensive for steep wage profiles. Other schemes tend to benefit participants with flatter wage profiles, but only modestly. The risk of being in the lowest 5% of the projections is stable but the expected replacement rate increases. One can conclude that the wage profile of the participant is not really an issue in choosing a pension scheme since its effect is the same in each scheme except for the *final wage* scheme.

Parameter changes

An important test is to see what happens to replacement rates if the parameters are not as we expected. For example if the equity returns are lower than we expected. In

Figure 12 of the appendix we see the expected replacement rates for *different equity premiums*. Since we assume long term interest rates of 4.5% the equity premium is 3%, which is common in literature. However if the equity premium would be lower in the future, the replacement rates of the schemes with an investment component will decrease. The standard deviations of the parameters we leave unchanged. We see that for the schemes without equity investment the replacement rate does not change. For a *unit linked* scheme the expected replacement rate is around 10% (53.8%) lower if the equity premium is 1% lower, and almost 20% (45.8%) if it is 2% lower. Very roughly the expected replacement rate of the *unit linked* plan changes with 10% if the equity premium changes 1%. For the *nursery plan* and the *lifecycle* scheme this is around 7%.

In **Figure** 12 of the appendix it is clearly visible that the intervals for the schemes that have no investment component do not change. For the other schemes the interval widens and also the lower bound rises for a higher equity premium. For equity returns of 6.5% the expected replacement rate is lower and the risk of a lower pension increases compared to 7.5% returns. Costs do not change as a result of different equity premiums.

When varying the equity premium, nothing happens to the schemes in which assets are invested in fixed income securities. If one *changes the interest rate* the results of (almost) all schemes will change. For schemes of which premiums are calculated on the basis of a variable rate the premiums will change, for schemes that use a fixed rate the profit sharing will change. We test the schemes with different interest rate values (we change the mean of the interest rate) and assume that the equity premium remains 3%. Since the equity premium is fixed, the return on equity changes as the interest rate changes.

From the projections in **Figure 13** we see that only for the *final wage* scheme the projections remain unchanged. Since the premium is calculated on a fixed 3% rate and the excess profit goes to the employer as a discount, old age pension is unchanged. For the other schemes holds that replacement rates go up if the interest rate goes up. Since also equity returns increase, the *unit linked* replacement rate increases.

An important notice is that also the participants in a DC *average wage* scheme are subject to interest rate risk because of the profit sharing potential. If the average interest rate is 3.5% instead of 4.5% the expected replacement rate of the average wage

scheme is 43% instead of 47%, even though the scheme has a fixed 3% rate. Expected replacement rates are almost the same for the *average wage* scheme as for the endowment guarantee only the risk is lower because of the fixed 3% rate. The risk of the *direct annuitizing* scheme is lower since the interest rate risk is spread.

Costs do not change as a result of different interest rates; the DB schemes are calculated with fixed rates and the DC schemes have fixed premiums.

7. How to select the optimal pension scheme?

By means of the scenarios and stress tests we quantified the expectations and risks of eight pension schemes. Instead of just comparing expected outcomes of the schemes for the participant and the employer, we tried to actually visualize how large the risks are that are involved and who is taking the risk. Although the tables and illustrations give an insight into what participants and employers can expect from a pension scheme, the relative attractiveness of a scheme depends on the preferences of both parties. Risk seeking participants will clearly prefer a unit linked scheme over a direct annuitizing scheme because of the high expected return. As indicated in the *Goudswaard* report, a pension scheme is always a trade-off between low costs, ambition and risk which all three together are impossible. This was also clearly visible in our results; the ideal pension scheme does not exist.

Given the recommendations of the committees and the issues we discussed in the literature we will review the results of section 5 and 6 in order to come to one or a few schemes that are preferable.

Clearly the DB *final wage* scheme is preferred by participants because of the high and stable benefits; together with the first pillar pension a replacement rate of 80% of the final wage is guaranteed. Although this result is somewhat flawed since the employee has a term of 40 years at the same employer, which is a little unrealistic. For the employer however the scheme is highly undesirable because of the high and unpredictable costs; at age 44 the 90% forecast interval of the pension costs ranged between 10% and 22% of the wage. Since the past service costs increase and become more unpredictable over the career of an employee, this leads to large fluctuations in the profit and loss statements of the employer. Furthermore, the final wage scheme discriminates participants with steep wage paths (career makers) over those with flat wage paths. Given the large shift away from final wage schemes in the Netherlands and abroad we think that the *final wage* scheme is not a suitable pension scheme under the current socioeconomic circumstances.

The DB *average wage* plan provides the participants with a rather high and stable replacement rate, although there is still uncertainty concerning profit sharing. Even though the scheme has a defined benefit, the participant still bears some investment risk (the part above the 3.5%). Though in our projections the scheme has a higher expected outcome than the DC schemes that also invest in fixed income securities, the costs were also higher. In principle the same result can be obtained by lowering the accrual percentage of the average wage scheme; the costs will be lower, as will be the

replacement rate. The attractive feature for the participant is that the employer and the insurer bear the longevity risk; as people live longer the benefit remains the same. For the employer the rising pension costs are unattractive; costs increase by 27% if people live on average 4 years longer. The *Goudswaard* committee proposes to shift the longevity risk to the employees to keep pension costs under control.

In the *guaranteed life endowment*, the *direct annuitization*-, the life cycle- and the *unit linked* scheme (the DC arrangements) all had constant costs of 8% of the pensionable wage at age 44. For these schemes the risks are borne by the participants. When longevity increases, the old age pension decreases by approximately 17%. For the four schemes, the replacement rate projections were very different. The least risky *direct annuitization* scheme has almost no investment risk since it invests in fixed income securities. Although there is interest rate risk, this risk is spread since each year the premium is annuitized. The outcome of this scheme is rather low, but predictable for the participant. An advantage of the scheme is that every year a participant can see exactly what pension rights he has built up until that moment. The expected replacement rate is 46%.

In the *guaranteed endowment* scheme a a life endowment is purchased at 65. The total endowment is converted into an old age pension at retirement and is therefore exposed to large interest rate risk. The replacement rate varies between 32% and 61% with a confidence level 90%.

The *unit linked* scheme is by far the most risky scheme since all assets are invested in equity (in our scenarios). The investment- and interest rate risk make that the returns are very unpredictable for the participant, although the expected replacement rate is high. Investing a part of the premium in equity may be attractive in order to generate returns, but fully investing the premium in equity will not provide any security for the participant. We saw that the probability of having a replacement rate lower than 30% is 17% for this scheme.

In the *lifecycle* plan, part of the premium is invested in equity and a part is directly annuitized. According to the *lifecycle principle* the equity part decreases over the lifetime while the annuitized part increases; younger participants prefer more equity to generate return and are better able to overcome shocks (through additional savings for example) if the returns turn out to be too low. Unfortunately the effect of this cannot be made clear since the model just predicts replacement rates at retirement. What we do show in **Table 7** is the projected replacement rate of each of the components; the equity part has very volatile replacement rates between 7% and 65% (with 90% confidence), whereas

the annuitized part has stable replacement rates between 16% and 22%. The effect of higher longevity is not incorporated in these figures.

The *nursery plan* has a large part in DC for a young participant and a large part in DB for an older participant, also according to the *lifecycle principle*. Both the costs and the benefits of the scheme are in between those of the *average wage*- and the *unit linked* scheme.

The results for the *limit* scheme are somewhat harder to interpret, since the outcome depends on the level of the floor. If the pensionable wage does not reach this limit, the outcome is the same as for the *average wage* scheme. The scheme could be a good alternative since it provides everyone with a basic pension up to a certain wage. Above this limit, the scheme good be made flexible, such that the participant can decide on how to design this part in terms of risk and expected return. But then the question is where to set the limit? And the DB part can be achieved by replacing it for DC scheme with higher premiums, although then longevity risk is borne solely by the participant.

8. Selecting the 'optimal' pension scheme

After discussing the results it has become clear what the basic features of each scheme are. As expected, the 'ideal' pension scheme does not exist; it is always a choice between ambition, certainty and low costs of which at most only two can be realized. If the objective is to have a pension scheme with low costs but high ambition, the consequence is that the outcome of the scheme is risky.

It is obvious that some schemes drop out because they have very unfavorable consequences for either employer or employee. The final wage scheme has such high and unpredictable costs for the employer and the unit linked scheme has too much uncertainty for the employee. This is also illustrated by the large shift away from final wage schemes and the legislative developments around unit linked schemes in order to protect the participants. For the remaining schemes it depends on the preferences and characteristics of the employer and employee which scheme they will prefer. Financial literacy for instance is an important factor in this. If the participants do not understand the pension product and do not see the risks of, for example, a life cycle product, it may be better to provide them with a low pension with high certainty.

As a test to select the most desirable pension scheme(s), we created a grading tool on the basis of which we grade the schemes on a number of features. As we presented the results, a number of issues appeared to be important. We assess the level and predictability/certainty of the replacement rate and the costs. We take the mean as an estimate for the level and the standard deviation as an estimate for the predictability of both the costs and the replacement rate.

For each of the four elements (replacement rate mean/standard deviation, costs mean/standard deviation) we take the maximum- and minimum estimate which get assigned a 10 (i.e. the highest replacement rate) and a 0 (the lowest replacement rate). In between the grade is based on the relative distance from the maximum and minimum; if the replacement rate is exactly in between, the scheme scores 5. However, if we do this on a linear scale, there is no scheme that scores higher than 6 on all 4 elements (**Table 9**). Therefore we shift the range as is illustrated in **Figure 6**, such that the low outcomes become somewhat higher. When the range is centered on 6, a score of initially 2.5 then becomes a 4. When it is centered on 8, even a scheme that initially scored 0 becomes a 6. The number in the middle of the range we call the center.

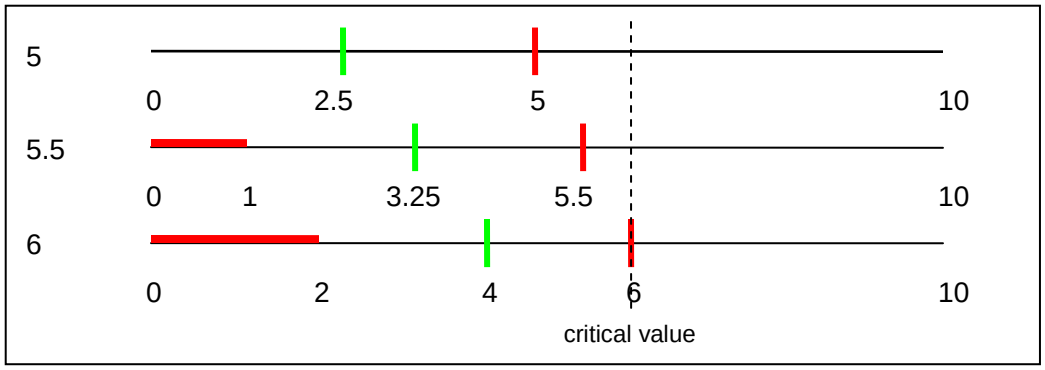


Figure 6 Scale for assigning grades: the scale moves right as the center moves right, the critical value is 6.

Center: 5.0	final wage	average wage	unit linked	endow ment	direct	nursery	limit	lifecycle
rr level	9.0	7.0	10.0	1.2	0.0	6.0	3.5	5.8
rr stdev	10.0	9.2	0.0	7.8	9.0	3.9	8.6	3.6
costs level	0.0	5.7	10.0	10.0	10.0	8.3	6.9	10.0
costs stdev	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 9 The scores of the eight schemes on 4 criteria around a center of 5: No scheme score 6 or higher on all criteria

Center: 5.4	final wage	average wage	unit linked	endow ment	direct	nursery	limit	lifecycle
rr level	9.1	7.2	10.0	1.9	0.8	6.3	4.1	6.2
rr stdev	10.0	9.3	0.8	8.0	9.1	4.4	8.7	4.1
costs level	0.8	6.1	10.0	10.0	10.0	8.4	7.1	10.0
costs stdev	0.8	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 10 The scores of the eight schemes on 4 criteria around a center of 5.4: The average wage scheme scores higher than 6 on all criteria

We see that for a center of 5 there is no scheme that scores 6 or higher on all requirements. For a center of 5.4 the *average wage* scheme scores higher than 6 on all four (**Table 10**). When further increasing the center we observe (not in the table) that at 6.8 the *nursery plan* is approved, at 6.9 the *lifecycle* scheme and at 7.0 the *floor plan*. All schemes except for the *final wage* schemes score 10 on the predictability of the costs, since the schemes have constant costs.

We do the same for the outcomes we obtained in the sensitivity analyses. For the sensitivity with higher longevity (**Figure** 10) there is still no scheme that scores higher than 6 on all elements for a center of 5. The first scheme that does this is again the *average wage* scheme for a center of 6.3. This is much higher than the 5.4 in the base case; the scheme is less attractive when life expectancy is high. This is intuitive since we saw in the sensitivity analysis that the costs of the *average wage* scheme become

higher, as a result of the higher life expectancy. Furthermore the *nursery plan* is accepted at value 6.8, the *lifecycle* scheme at 6.9.

We also grade the sensitivity with a lower equity premium. We assign grades to the scheme with mean equity returns of 6.5% instead of 7.5%. With a center of 6.8 the average wage scheme is accepted, directly followed by the *lifecycle* scheme which is accepted at 6.9.

Based on the grading method we use, the *average wage* scheme, the *nursery plan* and the *lifecycle* scheme perform best in the sense that they have the least extreme outcomes. The *average wage* scheme is initially the first scheme that scores 6 or higher on all criteria, however if one includes longevity risk or parameter risk the scheme gets closer to the other two and is sometimes not even the best option anymore. Although the grading method is a simple representation of the 'real world', we think it can very well illustrate what would be a desirable outcome when both employers and employees would bargain on implementing a pension scheme. Although there are no weights or preferences included, we think that in reality always one of the two groups (employers or employees) will find each of the four categories important.

9. Conclusion

The DB schemes proved to have very stable benefits. The *final wage* scheme had a fixed replacement rate (51%) since the excess profit was shared with the employer in the form of a discount. The *average wage* scheme had high and stable benefits (with 90% confidence between 43% and 48%), although there was some uncertainty due to profit sharing. The costs of the scheme were fixed but still high. The DC schemes all had low and fixed costs, which is attractive for the employer. Replacement rates of the four schemes ranged form very low but predictable (*direct annuitization*) to very high but risky (*unit linked* with 100% in equity). The *endowment guarantee* and the *lifecycle* scheme gave outcomes in between. The *nursery* plan gave an outcome similar to the *lifecycle* scheme. The *limit* scheme gave an outcome that was close to that of the *average wage* scheme, this was due to the fact that the pensionable wage did barely exceed the limit.

The scenarios gave a good insight into what participants and employers can expect from which pension scheme and into the risks involved. Complementary, we produced a number of sensitivity analyses that were meant to give further insight into what happens to the schemes if we adjust the assumptions we made. We adjusted life expectancy with 2, 4 or 6 years more on average and we took scenarios in which the increase in life expectancy is uncertain. Higher longevity resulted in higher costs for the DB schemes and lower pension for the DC schemes. If we would live on average six years longer, the costs would increase by 27% percent in DB schemes, or the pension would be around 17% lower in DC schemes.

We also changed the wage path of the participant with respect to the base case. This did not result in very large changes in any scheme except for the *final wage* scheme, which was very favourable to 'career makers'. Ultimately, by changing the parameters we have shown what happens if for instance the interest rates are lower on average or the equity premium is lower.

Although the results give good insight into what the expectations and risks are of various schemes, the 'optimal' outcome depends on the preferences and characteristics of employer and employees. Furthermore, the results clearly illustrate that the ideal pension scheme does not exist; it is always a trade-off between having low costs, ambition and certainty.

As a way to choose the most favourable pension scheme based on the results we presented a grading method that assigned grades to the level and predictability of the replacement rate and costs. The criterion for a scheme to be accepted is to score 6 or

higher on all four elements. The *final wage-* and *unit linked* scheme are considered to be very unattractive; this is also illustrated by the recent developments. For the basic scenarios, the *average wage* scheme is most favourable, followed by the *nursery plan* and the *lifecycle* scheme. For the scenarios with longevity risk the *average wage* scheme still performs best, although the *nursery* and *lifecycle* scheme are a lot closer. This is intuitive since the costs of the average wage increase if life expectancy is higher. For the scenarios with lower equity returns the *average wage* scheme performs best, immediately followed by the *lifecycle* scheme.

Overall, based on the grading method the DB *average wage* scheme, the DC *life cycle* scheme and the hybrid *nursery* scheme are the most attractive pension schemes.

10. Recommendations

After presenting the results and grading the pension schemes, the most difficult task is to give an opinion on which pension scheme to choose for the future. As stated earlier, this crucially depends on the preferences and characteristics of the stakeholders. However, with the findings from the reports and the literature we will try to give a qualitative vision. We will concentrate on the *average wage-*, the *nursery-* and the *lifecycle* scheme.

One common argument from both the reports was to close the expectations gap and to better communicate this to participants. This is of course most evident for the riskier schemes since, when the scheme is in a bad scenario, the participants should know about this. Also the argument to be more aware of the risk coincides with this. For the schemes that are exposed to equity risk it can be communicated in the form of figures we presented. It may be that participants are not able to understand the risks. We think that when offering a pension scheme, the employer should carefully take into account the characteristics of his employees.

Another argument of many authors is to introduce age-based differentiation or lifecycle investing. The *lifecycle* plan and the *nursery plan* both accommodate this idea; they expose younger participants to more equity risk than older participants. The *average wage* scheme is not able to do this since it is not allowed to do so by the Act concerning Equal Treatment. Unfortunately the benefit of lifecycle investing is not visible in our results; this would require a utility analysis. However, even without this it is obvious that a young participant is better able to overcome large shocks than an older participants who is about to retire.

The Goudswaard committee also opts for more freedom of choice. This is a feature that can be best addressed the *lifecycle* scheme if for instance the proportions are flexible. With freedom of choice the participant is better able to adapt the pension scheme to his own circumstances. However, one should be careful with freedom of choice. Recently we have seen that people had their pension invested fully in equity. In the scenario projections we can see what the results can be when there is an adverse shock. However, in carefully selected profiles this is an option.

Both reports say the same about longevity risk. Increases in life expectancy can no longer be borne by the employers. The costs will simply become too high for the Netherlands to maintain competitive internationally. A scheme that is fully DC is the best solution for this problem.

On inflation risk our results where indecisive. The reason for this is that we compared the pension at age 65. Since the wage was always indexed by inflation, inflation risk was very small or absent.

Also we assumed a career of forty years without switching jobs. In reality employees have multiple jobs. For the participant the results will not change in terms of replacement rates if they have the same scheme for each job. Only the final wage will give a lower result in case of a salary increase. For the employer it is better to have DC scheme because of the value transfer risk we discussed in section 2.

If the employer and employees want to share the risks evenly the nursery plan is the ultimate compromise. Given the shift from DB to DC schemes at insurance companies, we foresee that lifecycle schemes will gain more popularity in the future. This can be in the form of a hybrid scheme or a DC lifecycle scheme. In the DC scheme all risks are shifted to the participant. To maintain some solidarity between employers and employees, a hybrid scheme can be a good alternative.

As ways to extend or improve this study we suggest some issues we also mentioned in the text. First, one could improve the model by assuming different stochastic processes for inflation and interest rates. By for instance recognizing mean reversion processes, the predictions will probably become more accurate. However, it is still a model trying to simulate many variables and making many assumptions, so it will always have assumptions that do not meet reality. Second, we suggest a to extend the study by showing also inflation risk. Since the wage is always indexed in our model this risk was almost absent. By for instance comparing pensions (i.e with or without indexation) at a later age, this risk will be illustrated. One could do this for instance for the schemes that performed best in our model. Third, we think that more asset classes can be included in the model. Often unit linked schemes are invested in funds offered by the sponsor (for ASR this was Fortis Investments) and also real estate or hedge funds are included. As the goal of this thesis was to give insight into pension schemes this was to complicated, however, if such a study is performed for one or two schemes, the results will become more accurate.

11. Appendix

Formulas

$$\text{Gross premium} = \text{Net premium} \times \frac{(1+\text{admittance})}{(\text{adm. costs}) \times (1-\text{disability})}$$

Tables

Table 11

	Final wage	Average wage	Combination	Fixed sum	DC
year	nr. of participants as percentage of total				
2002	54.3	31.6	6.8	1.1	2.4
2003	49.3	35.4	8.6	0.9	2.3
2004	12	72.6	8.6	1	2.3
2005	20.6	74.1	8.1	0.9	3.1
2006	10.2	76.6	7.6	0.9	3.7
2006	7.4	79	7.8	0.9	3.8
2007	3.1	84.7	1.1	0	4.9

Source: DNB pensioenmonitor 2008. Numer of participants as percentage of total for pension funds

Table 12

	Final wage	Average wage	Combination	Fixed sum	DC
year	nr. of participants as percentage of total				
1995	69.2	14.7	8.0	0.6	4.3
1999	58.6	10.9	5.7	0.4	14.6
2002	43.4	10.2	11.5	0.0	25.7
2005	21.2	19.2	4.8	0.1	49.6

Source: Statistisch Bulletin december 2006, *"levensverzekeraars stille kracht in tweede pijler pensioenstelsel"*, DNB, blz. 25-35. Het Verzekerings-Archief 4-2007. Number of participants as percentage of total for insurance companies.

Table 13

	final wage	average wage	unit linked	endowment	direct	nursery	limit	lifecycle
standard	0.51	0.47	0.64	0.46	0.43	0.52	0.44	0.56
+2	0.51	0.47	0.59	0.43	0.40	0.49	0.43	0.52
(%change)	*0.0%*	*0.8%*	*-7.5%*	*-6.8%*	*-5.8%*	*-5.0%*	*-1.4%*	*-7.6%*
+4	0.51	0.48	0.55	0.40	0.38	0.47	0.43	0.48
(%change)	*0.0%*	*1.7%*	*-13.7%*	*-12.4%*	*-10.8%*	*-9.1%*	*-2.5%*	*-13.8%*
+6	0.51	0.48	0.52	0.38	0.36	0.45	0.42	0.45
(%change)	*0.0%*	*2.5%*	*-18.9%*	*-17.0%*	*-15.1%*	*-12.6%*	*-3.5%*	*-19.0%*

Replacement rates of eight pension schemes for the 'standard' life table and for increases in life expectancy of 2, 4 and 6 years. The numbers in italic are the respective deviations from the standard case.

Table 14

Life table	final wage	average wage	unit linked	endowment	direct	nursery	limit	lifecycle
standard	0.16	0.10	0.08	0.08	0.08	0.09	0.09	0.08
+2	0.17	0.11	0.08	0.08	0.08	0.09	0.10	0.08
(%change)	*9.4%*	*9.4%*	*0.0%*	*0.0%*	*0.0%*	*4.4%*	*8.7%*	*0.0%*
+4	0.19	0.12	0.08	0.08	0.08	0.10	0.11	0.08
(%change)	*18.5%*	*18.5%*	*0.0%*	*0.0%*	*0.0%*	*8.6%*	*17.2%*	*0.0%*
+6	0.20	0.13	0.08	0.08	0.08	0.10	0.12	0.08
(%change)	*27.3%*	*27.3%*	*0.0%*	*0.0%*	*0.0%*	*12.7%*	*25.4%*	*0.0%*

Average costs of eight pension schemes for the 'standard' life table and for increases in life expectancy of 2, 4 and 6 years. The numbers in italic are the respective deviations from the standard case.

Table 15

Wage path	final wage	average wage	unit linked	endowment	direct	nursery	limit	lifecycle
5%4%3%2%	0.655	0.427	0.555	0.425	0.391	0.449	0.453	0.485
4%3%2%1%	0.598	0.452	0.600	0.445	0.412	0.486	0.454	0.524
3%2%1%0%	0.513	0.469	0.639	0.457	0.427	0.520	0.436	0.559
2%1%0%-1%	0.385	0.473	0.666	0.454	0.430	0.545	0.418	0.583

Replacement rates of eight pension schemes different wage paths. The third row is the wage path we assumed (real wage increases of 3% in the first ten years, 2% in the second, etc.)

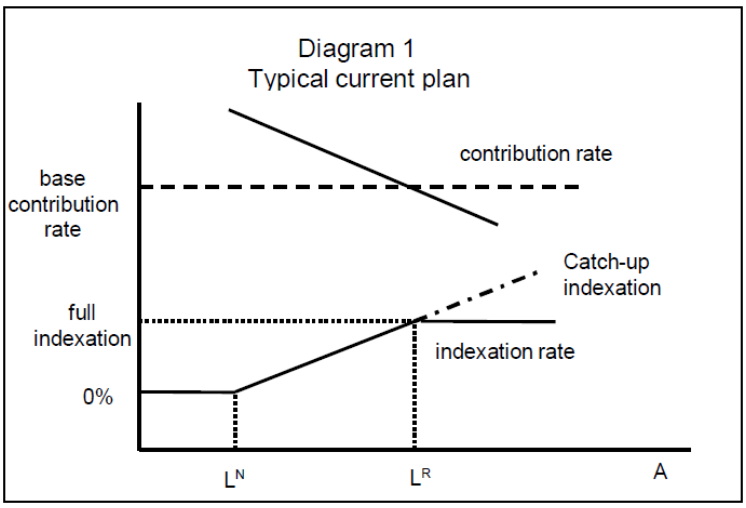
Table 16

Wage path	final wage	average wage	unit linked	endowment	direct	nursery	limit	lifecycle
5%4%3%2%	0.231	0.124	0.096	0.096	0.096	0.107	0.105	0.096
4%3%2%1%	0.197	0.115	0.089	0.089	0.089	0.100	0.101	0.089
3%2%1%0%	0.160	0.105	0.081	0.081	0.081	0.091	0.095	0.081
2%1%0%-1%	0.121	0.092	0.071	0.071	0.071	0.079	0.085	0.071

Average costs of eight pension schemes different wage paths. The third row is the wage path we assumed (real wage increases of 3% in the first ten years, 2% in the second, etc.)

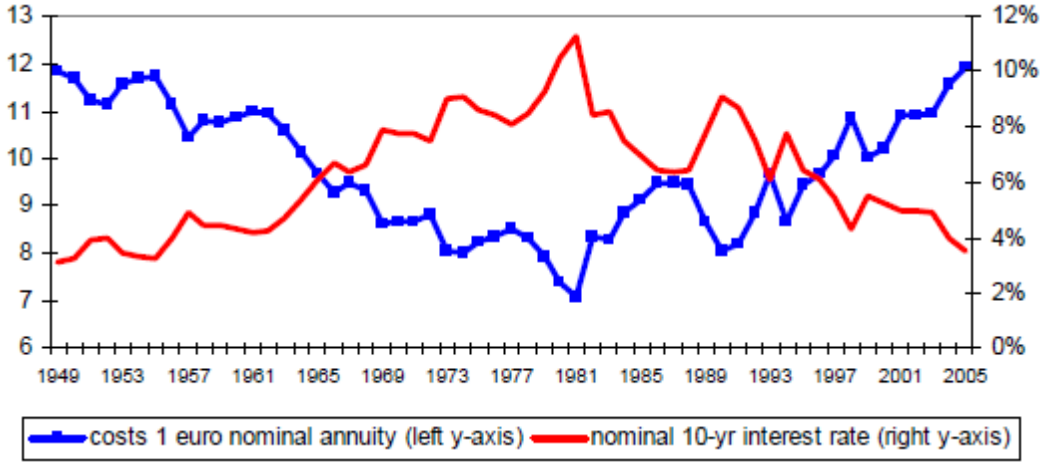
Figures

Figure 7



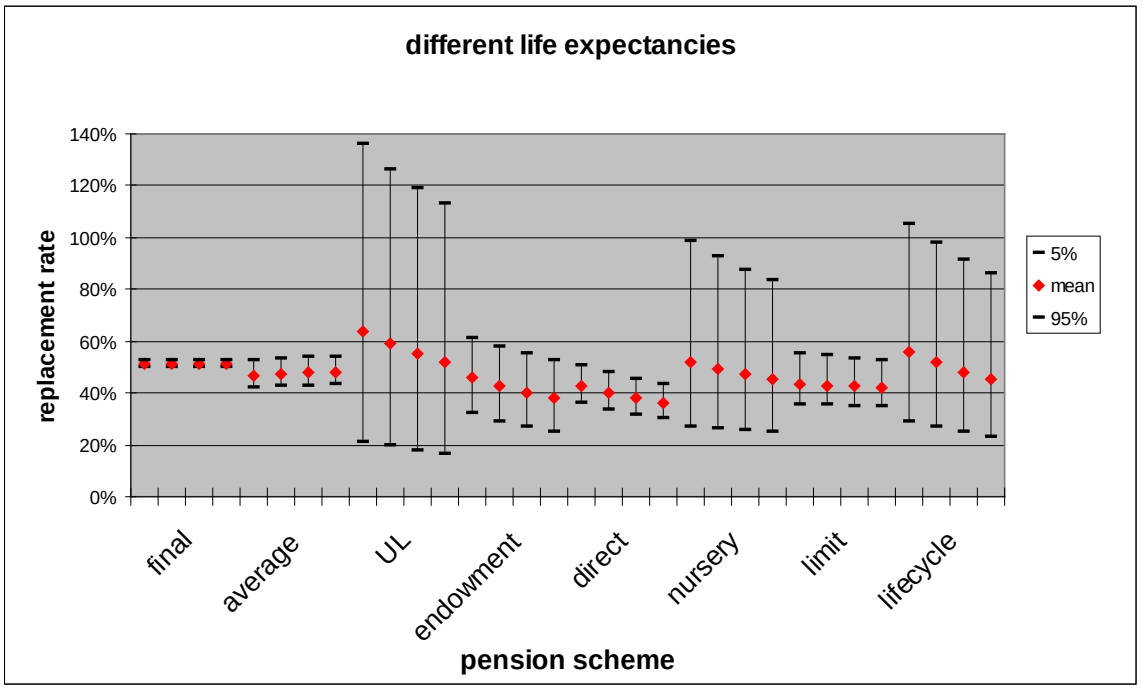
Indexation policy of pension funds. Source: Ponds. van Riel (2007)

Figure 8



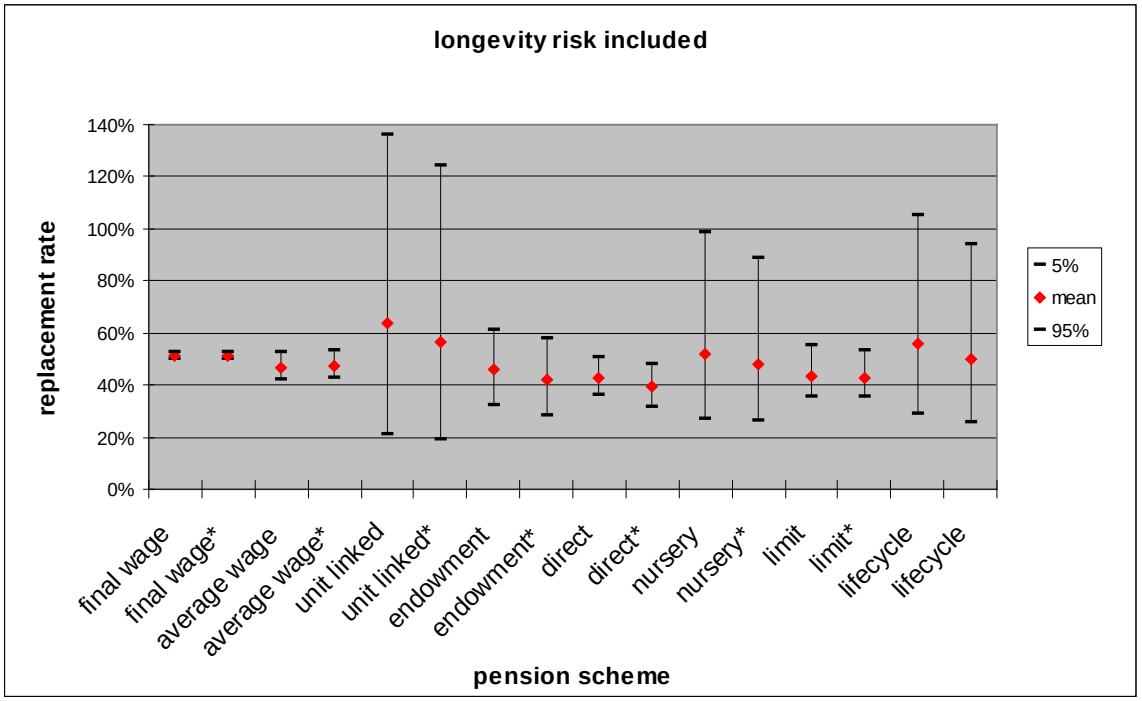
The nominal interest rate and the price of one euro nominal annuity are inversely related. Source: Ponds. van Riel (2007)

Figure 9



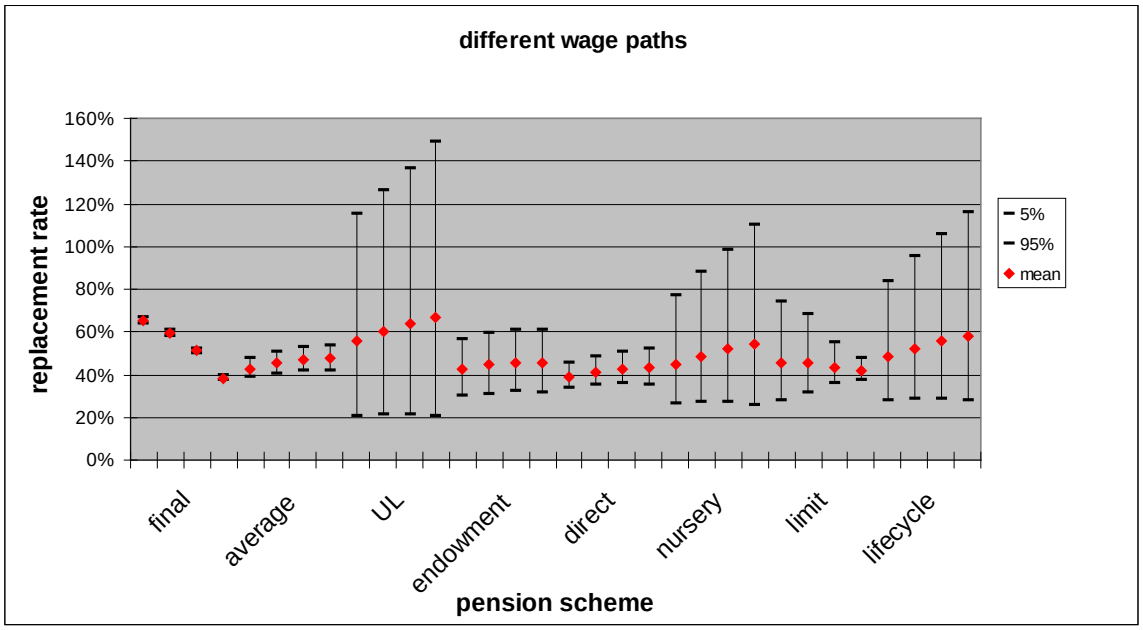
Expectation and forecast interval for 8 different pension schemes and different life expectancy.

Figure 10



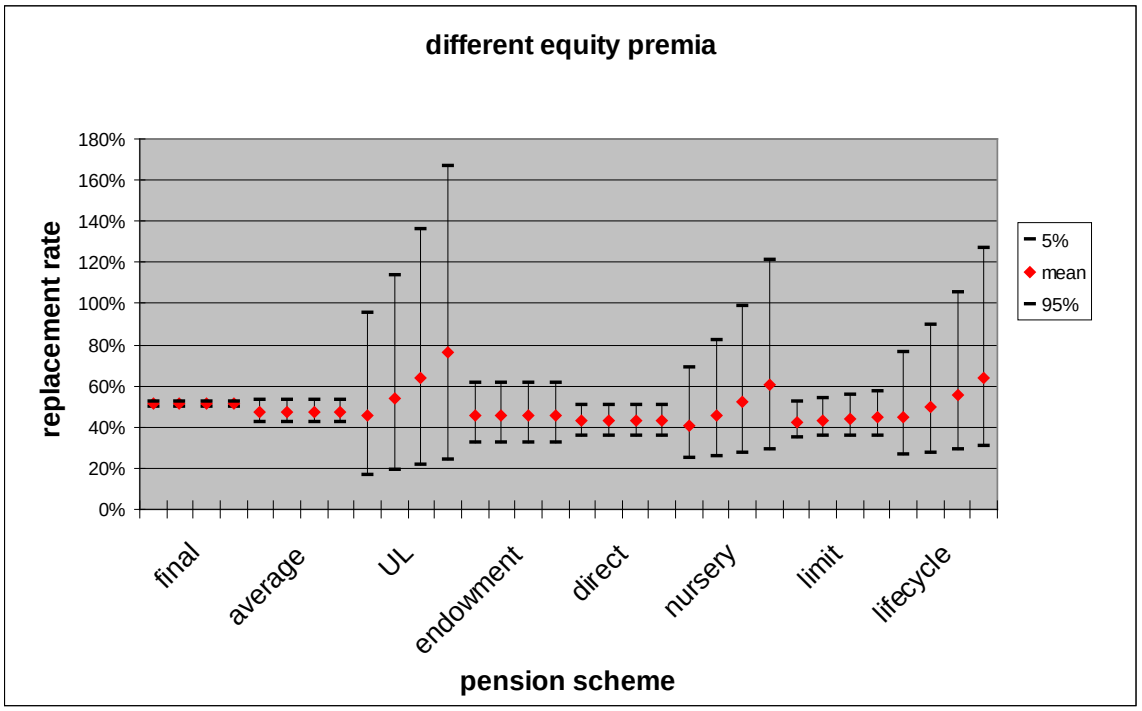
Expectation and forecast interval for 8 different pension schemes, the first estimates being the standard case, the second are the scenarios with longevity risk.

Figure 11



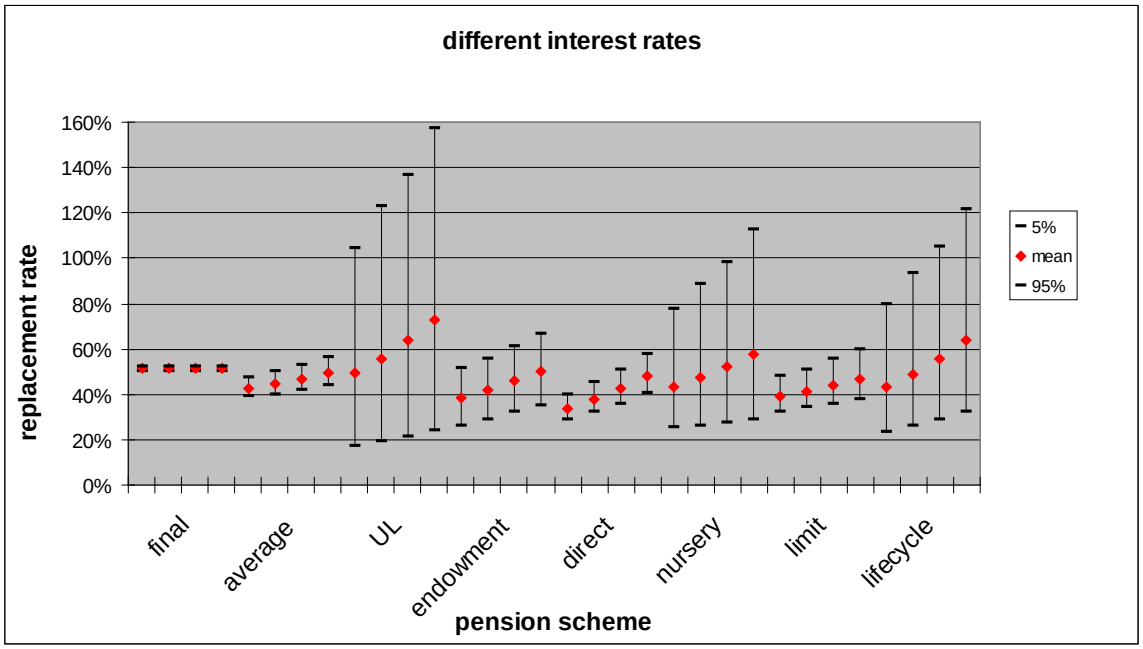
Expectation and forecast interval for 8 different pension schemes and different wage paths.

Figure 12



Expectation and forecast interval for 8 different pension schemes and different equity premiums, the premium changes with steps of 1%.

Figure 13



Expectation and forecast interval for 8 different pension schemes and different interest rates, the interest rate changes in steps of 0.5%.

References

Balcer, Yves. and Sahin, Izzet. 1979. *"A Study of Private Pensions in Ontario."* Institute for Research on Poverty Discussion Paper. University of Wisconsin – Madison.

Baumann, R. (2005) *"Hybrid Pension Schemes: Risk Allocation and Asset Liability Optimization."* PhD Thesis, University of St. Gallen. Difo-Druck GmbH, Bamberg.

Baz, Jamil. and Chacko, George. (2004*) "Financial Derivatives: Pricing, Applications, and Mathematics*," Cambridge University Press, p. 12-14

Blommestein. Hans & Janssen. Pascal & Kortleve. Niels & Yermo. Juan. 2009. *"Evaluating the Design of Private Pension Plans: Costs and Benefits of Risk-Sharing."* OECD Working Papers on Insurance and Private Pensions 34. OECD. Directorate for Financial and Enterprise Affairs.

Bodie. Zvi & Marcus. Alan J. & Merton. Robert C.. (1988). *"Defined Benefit versus Defined Contribution Pension Plans: What are the Real Trade-offs?."* NBER Chapters. in: Pensions in the U.S. Economy. pages 139-162 National Bureau of Economic Research. Inc.

Boeijen T.A.H.. C. Jansen. C.E. Kortleve en J.H. Tamerus (2006). *"Leeftijdsolidariteit in de doorsneepremie."* in Kosten en baten van collectieve pensioensystemen

Börsch-Supan, (2004). "*Global Aging – Issues, Answers, More Questions,"* Sonderforschungsbereich 504 Publications 07-28, Universität Mannheim und Sonderforschungsbereich, Univerisity of Mannheim

Molenaar R.. Munsters R. en Ponds E.H.M. (2008). *"Differentiatie naar leeftijd in de financiering van collectieve pensioenen."* NEA-paper. Netspar.

Ponds. E.H.M. & Riel. B. van. (2007). *"The Recent Evolution of Pension Funds in the Netherlands: The trend to Hybrid DB-DC Plans and Beyond."* Open Access publications from Tilburg University urn:nbn:nl:ui:12-387570. Tilburg University.

Ponds. E.H.M.. & Riel. B. van (2009). "*Sharing risk: The Netherlands' new approach to pensions."* Journal of Pension Economics and Finance. 8(1). 91-105.

Poterba. James & Rauh. Joshua & Venti. Steven & Wise. David. (2007). *"Defined contribution plans. defined benefit plans. and the accumulation of retirement wealth."* Journal of Public Economics. Elsevier. vol. 91(10). pages 2062-2086. November

Ross. David. and Wills. Lester. (2002). *"The shift from defined benefit to defined contribution retirement plans and the provisioning of retirement savings."* The Pensions Institute. UK.

Samwick. Andrew A. & Skinner. Jonathan. (2004). *"How Will 401(k) Pension Plans Affect Retirement Income?."* American Economic Review. American Economic Association. vol. 94(1). pages 329-343. March.

Schrager. Allison. (2006*). "A Life-Cycle Analysis of the Decline of Defined Benefit Plans and Job Tenure."* Columbia University Working Paper.