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How to Share the Pain of the Pension Crisis?

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How to share the pain of the pension crisis?

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Abstract

This thesis investigates the current crisis among pension funds and concentrates on the one hand on how to recover and on the other hand on what the future of the Dutch pension sector should look like. Concerning the crisis, it investigates whether postponing intervention in the pension rights of participants (i.e. also include negative indexation) leads to a skewed distribution of sharing the pain among generations. The results show that postponing intervention leads at least to a very skewed distribution of the pain after two years. After the current crisis has been solved a new pension system needs to be thought of. Such a new contract should be explicitly defined such that participants (and pension fund's management) know beforehand what to do in times of crisis. This research tries to contribute to this discussion by introducing (amongst others) an innovative framework of anticyclic supervision. The results of this framework are very good. No drawbacks can be found. The research concludes with a critical assessment of the supervision on the pension sector by DNB. Finally this research is a call for the implementation of less risky investment mixes by pension funds. The results show that common investment mixes of pension funds (of about 50% in equity) should be adapted to less risky mixes like 20% in equity.

Contents

1. Introduction

September 15, 2008: The fall of Lehman Brothers marked the definite end of a booming worldwide economy and at the same time it marked the beginning of the financial credit crisis. Before this date there already was a housing crisis in the United States, but the fall of a bank this stature caused a domino effect and it inevitably led to a worldwide financial crisis. Stock markets dropped enormously, the American and European central banks lowered the interest rates to nearly zero percent and some banks were even brought under public ownership. In an attempt to save the world economy, governments around the world invested billions of euros to keep the economies alive.

Despite all these efforts the world trade collapsed and almost all Western economies ended up in a recession. Right now most economies are not in a recession anymore, but there is still a lot of uncertainty about the future. Some analysts think that there will be a double dip, which means that after a short rise, the economies fall again. Developed economies find themselves at a crossroads. Either they invest billions in their economy again (like the United States) or they start restructuring their budgets (like most European countries).

As the title suggests, this paper will not concentrate on the financial crisis, but it does look at one of the victims in the Netherlands. After the dot-com crisis in the early years of this millennium, the credit crisis resulted in the second crisis for Dutch pension funds in a decade. Due to the fall in stock markets and the extremely low interest rates, the nominal funding ratio (the value of the assets divided by the value of the liabilities) of most pension funds dropped enormously. Many funding ratios even dropped below the legal minimum of 105%. In 2009 stock markets rose again and so did the funding ratios of many funds.

When a pension fund's funding ratio drops below the legal minimum, it needs to hand in a recovery plan at the Dutch Central Bank (DNB, supervisor of the Dutch pension sector). This plan should describe how the fund expects to recover to more healthy funding ratios within a prespecified period. Due to the even further lowered interest rates in 2010 the funding ratios of some pension funds got (after the short rebound in 2009) worrisome low again, which can have the consequence that these funds need to intervene in the entitlements of the participants. One of the possibilities is to cut nominal rights.

Many Dutch citizens always thought that their pension savings were guaranteed in real terms. After the dot-com crisis they found out that indexation wasn't guaranteed at all, so the common beliefs appeared to be false. For many people the belief however remained that their savings were nominally guaranteed. Right now, pension funds are scared to cut nominal rights, because then again people find out that what they thought to be sure, isn't so sure anymore. Moreover funds think that by taking such severe measures right now the foundations of the Dutch pension system will break down.

Then it is October 20 2010: 'The Dutch pension system is the best in the world' according to the Melbourne Mercer Global Pension Index (Mercer, 2010). But why are so many pension funds in trouble then right now? Can this solely be explained by the credit crisis or are there also other more structural problems? These fundamental questions don't seem to be the main subject of debate. Most people are scared that their pensions will be cut, but forget to look at the fundamental questions sketched above. The politics did try to investigate the fundamental problems. In the beginning of 2009 the former Minister of Social Affairs Donner appointed two committees to find out what went wrong and whether the current system is still sustainable (Frijns, Nijssen, & Scholtens, 2010; Goudswaard, Beetsma, & Nijman, 2010).

After the publication of these reports, a large discussion started in the newspapers, the House of Representatives and among social partners (in the Netherlands labor unions and employer unions are together called social partners, and together they are responsible for the pension funds) about how to solve the problems. Most importantly the two committees state that the problems are not only occurring due to the financial crisis, but that there are also structural problems. Most importantly the demographic developments have as a consequence that people die at an ever increasing age, which is of course great for everyone, except for the pension funds. The expected remaining lifetime for someone aged 65 has increased to about 19 years right now compared to about 14.5 years in 1950 (according to Statistics Netherlands). This means that in order to attain a (what participants call) good pension more risk needs to be taken (if the retirement age remains the same), because this leads to higher expected returns. At the same time however higher expected returns are not attained for free, the uncertainty increases as well and thus the entitlements of participants become less certain.

Moreover the committees note that pension savings were in fact never completely certain although participants thought so. Consequently pension funds made in fact a mistake by communicating to participants that built-up pension rights were certain. The only thing they can do right now is that they explain in an honest way that there are problems and that there is a possibility that things turn out to be less certain than they expected.

Finally the two committees pointed out that more of the risks a pension fund faces, should be covered by the participants. Therefore social partners came with an agreement about the future of the Dutch pension system in the summer of 2010 (Stichting van de Arbeid, 2010). In short, they want an increase of the retirement age linked to increases in life expectancy and a new pension deal that gives more risk to the participants. This contract should be explainable. What in any case may never happen again is that participants believe their rights are certain when they are not. There is a call for explicitly defined pension contracts. Such a contract describes for each possible future scenario what will happen. Social partners are working on more concrete agreements (results are expected in the beginning of 2011) about how such a contract should look like. All in all it will for sure lead to a pension that is described in a more uncertain way.

Summarising, a unique combination of events has come together at this point in time. Funding ratios are extremely low and at the same time the ageing of the population will peak within a few decades. This combination may be unique but at the same time it can in some way be called lethal for pension funds. As long as pension funds continue to pay out 100% of the entitlements, the money-box (i.e. the value of the assets) keeps on declining, even when fairly good investment returns are achieved. This theory is the theory of ‘Sinking Giants’. Unless there will be explicit adjustments of pension contracts, the young will pay the price of the crisis (Kocken & Potters, 2010).

A quote of prof. dr. Lans Bovenberg (Director of Netspar, a renowned Dutch pension institute) is the following (at the hearing of pension funds at the House of Representatives of 3-11-2010): "You cannot buy a guarantee right now for something that will take place in more than twenty years from now. So pension funds cannot guarantee anything to their participants, the only thing a fund can do is to give everyone his fair share." This notion is the essence of this research. Pension funds should distribute their assets fairly among their participants. But how to define fair? For financial products (like pensions) financial fairness is often used. Financial fairness implies in essence that everyone has to receive what he has paid for. There are of course also other ways of defining fairness. When looking at a tax system for example, there are people who are in favour of a progressive tax system and there are people who are in favour of a flat tax system. This latter example of fairness is difficult to implement in a pension fund setting and it also requires ideological assumptions. Therefore this thesis uses financial fairness as measure for fairness.

Pension funds should first of all recover from the current crisis in such a way that all participants get their fair share. Afterwards it is important to go to a new kind of pension contract that already implies a more fair distribution of the shares in good and in bad times. The content of this thesis is therefore alike. It starts by looking at questions that arise from the current crisis and continues with a search for a better pension deal. It is important to note that providing a fair solution to participants is not uniquely determined, there are many ways in which participants can get their fair share.

Before going to the actual research there needs to be a basis. The start is the key concept that is necessary to find out what the actual value of a pension is for participants. This concept is named value-based Asset Liability Management (ALM). Chapter 2 gives an elaboration; in short value-based ALM is a tool that can be used to compute the fair value of a pension contract. Moreover it serves as a tool to see what the effects for different generations are.

Because this research tries to give answers about future developments for pension funds, it is necessary to create a fictitious pension fund. This pension fund is then in the remainder of this thesis used as a basis for the results. As many people have found out during the last few years, a pension fund's solvency is very dependent on interest rates, stock prices, inflation rates and many other factors. The three factors mentioned are also the factors that are considered in this research. Modelling these variables makes it possible to generate economic scenarios that serve as a basis for the results found in later chapters. Chapter 3 gives both the description of this economic environment and the assumptions of the fictitious pension fund considered.

In order to recover from the underfunding situation of many pension funds, many measures can be thought of. Indexation cuts and raises in contribution rates are often mentioned. Chapter 4 gives a summary of the most common recovery measures. Moreover a fairly new instrument is also mentioned, namely age specific indexation.

Some funds are trying to delay the execution of severe recovery measures. Some experts (like the authors of the previously mentioned 'Sinking Giant') however claim that by postponing the measures the young generation pays the price of the crisis. The argumentation is that by continuing with paying full pensions to the retirees, they in fact get paid (for some part) from the contributions of the working participants. This means that the young generation pays the price for the old on a kind of pay-as-you-go basis. Now the social partners come back in the picture, adjustments in the pension contracts are necessary to avoid this trap, but such changes often take a while before they have been effectuated by social partners. Moreover some pension funds are trying to postpone taking actions due to the argumentation mentioned before. Chapter 5 investigates the validity of the proposition that postponing hurts the young and if so it tries to find out how much they are hurt. In other words Chapter 5 investigates what the price of delaying (i.e. waiting) is.

Another part of Chapter 5 tries to find out empirically if other contracts would have done better over the last 10 years. This means that new contracts are tested empirically to find out what would have happened to the solvency of a fund. Then Chapter 6 looks at the discussion about a new pension contract. It approaches this discussion in an innovative way by introducing a new concept for pension contracts. In brief it means that the requirements for the nominal funding ratio are adapted to the occurring economic environment by using an anticyclic framework (i.e. anticyclic supervision). Chapter 6 evaluates what the consequences for different generations will be if this contract is introduced today and tries to find out if it does a better job for the participants.

Finally Chapter 7 has a critical look at the assessment of recovery plans by DNB. This chapter ignores the discussions in the chapters before about a new pension contract, but evaluates whether the assessment by DNB is done in a correct way.

In the conclusion the major topics of this thesis are summarized. Moreover recommendations for future research on this subject are presented.

2. How to value a pension contract?

2.1 Value-based Asset Liability Management

Pension funds are facing all kinds of risks on both the assets side and the liabilities side. The most important ones are interest rate risk, inflation risk and longevity risk. Classical Asset Liability Management (ALM) is the technique often used by pension funds to manage these risks. The basic idea behind ALM is that by choosing the asset mix in a strategic way, the risks can be managed. The following is an example of completely deleting the interest rate risk in an of course hypothetical financial market. A pension fund has to value the future liabilities by using the actual interest rates. If interest rates go up, the value of the liabilities will go down and the other way around. On the other hand a fund often holds bonds in its asset portfolio. In this case, if the interest rates go up, the price of the bonds will go down and thus the value of the assets will go down. Now if the bonds are chosen in such a way that the interest rate sensitivity (the degree of the change in price as a response to a change in interest rates) is the same as the sensitivity of the liabilities, the risk will cancel out. This is a small example of how ALM can work.

In other words by using ALM a fund searches for the optimal ratio of the assets and the liabilities, subject to the financing conditions. In fact a fund balances the choice between ambition, contributions and the level of risk (Kortleve, 2004).

Because the situation for pension funds isn't as easy as sketched in the example above, ALM needs a tool to identify and manage the risks. This tool is a stochastic model that tries to predict the future value of the assets and liabilities. Usually, there are different models for the future values of stocks, interest rates, inflation rates and mortality rates. By generating thousands of scenarios a general picture can be made to see what the consequences for the fund are. Although a model can never completely predict the future, it does give an indication of the current state of the fund. The scenarios can be used to generate probabilities of for example underfunding and indexation. Furthermore you can try different policies to see how they affect these probabilities.

This thesis will (amongst others) look at the effects of different recovery plans on specific generations (young, old). To investigate this, classical ALM is not enough, because it cannot be used to find out what value people attach to a contract. Thus another concept is needed, namely value-based ALM. Value-based ALM is in fact quite similar to classical ALM, because it uses the same scenarios to predict future economic outcomes. However, in classical ALM one only looks at the possible future outcomes (and paths towards these outcomes), but not at the economic value of these outcomes. So it only finds the probabilities of underfunding and no indexation and ignores the economic value attached to it. For example, classical ALM ignores that the economic value of indexation in bad times is higher than in good times. Value-based ALM does judge this by not only looking at the expected outcome but also including the uncertainty. It discounts future outcomes in an appropriate way. Standard option theory (like risk neutral valuation) can be used for the calculation.

Another advantage of value-based ALM is that you can look at the consequences of policies for different stakeholders. In fact a change in pension fund strategy does not lead to a gain in economic value, because every increase in expected value will be offset by a higher risk (Ponds, 2004). In other words, the sum of all claims always needs to be equal to the total level of assets. The way the pension deal is constructed, determines the value of the claim of each participant. So policy changes lead, by definition, to changes in the value of the stakeholders and may thus lead to transfers in economic value between different stakeholders (Ponds, 2008). This latter notion will be used in this thesis, to find out what the consequences for different generations are of several recovery plans.

All in all different recovery plans will also be compared using classical ALM, to find out what the probabilities of underfunding are.

2.2 Explanation risk-neutral pricing

Risk neutral valuation is a very useful tool in modern asset pricing theory. First the very basics of this concept. In almost all modern economic theory it is assumed that people are risk averse, which can be explained by for example playing a game using a die. If the numbers 4, 5 or 6 turn up one wins €1 and if the numbers 1, 2 or 3 show up one loses €1. If someone is asked the question whether he would like to play this game, he would probably say he doesn't want to. In expectation it doesn't matter what to do, but there is a chance of losing. The fact that this person doesn't want to compete in the bet, shows that he is risk averse. He would want to receive an additional payment in order to compete (a so called risk premium). The assumption that people are risk averse sounds pretty reasonable in this context, although there will always be people who are risk loving (or risk neutral).

Now for the pricing of derivatives it is necessary to incorporate the risks in order to find the price of the derivative. However, it turns out, assuming absence of arbitrage (meaning in simple words that you cannot make a profit out of nothing), that you can also compute the expectation using adjusted probabilities, called risk-neutral probabilities. In a more technical way this theory is stated as follows:

A market as specified by a collection of asset price-processes $\{Y_i\}_t$ (with *t* being time and *i* being the selected asset) is free of arbitrage if and only if, given any Numéraire *N* (an asset price-process with strictly positive pay-off) there is a measure Q (depending on *N*) which is equivalent to the real-world measure (meaning that any event that has a positive real-world probability also has a positive Q probability and the other way around). This measure will be such that for all relative price processes the following holds (cf. Schumacher, 2008):

$$\frac{Y_t}{N_t} = E_t^Q\left[\frac{Y_T}{N_T}\right]$$

To give some intuition behind this statement an example used in classes of prof. B. Werker is used. Assume there exists another world identical to the one right here, except for one thing: the citizens here are risk-averse and the citizens over there are risk-neutral. Now say there is a derivative that is traded in both worlds (with the same probability distribution). Due to what has been said in the previous paragraphs the asset will have a lower price over here than in the other world. However the relative price (relative to the Numéraire) will be the same in both worlds. This means that risk preferences do matter for the absolute price of a derivative, but not for this price relative to a Numéraire.

The equation above also holds for all combinations of asset price-processes, so also derivatives. Say that we have *k* processes X_t that describe future states of the world, named the state variables. Then we can use risk neutral valuation to value contracts that depend on these states, so in a technical way: we can value all contracts $F(X_T)$ (i.e. the pay-off of such a contract should be a function of the state variables). For this thesis this is of course of importance because this theory can be used to price the value of a pension contract. The state variables for the hypothetical pension fund are the interest rates, stock prices and inflation rates. Simulating the values of these state variables using risk neutral probabilities, then gives the possibility to value the pension contract. The value of the contract can then be approximated by the following equation (named *C*):

$$\frac{C_t}{N_t} \approx \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{F(x_T^i)}{N_T^i}$$

Of course this value can be calculated for different contracts and for different generations. What is very important is that the pension contract is fully described for all possible states of the world. So in any situation it has to be clear what will be done with the pension payments, contributions and indexation. Note that if this were also true in the real world, recovery plans (as handed in at DNB by many Dutch pension funds) aren't needed anymore, because participants and funds already know beforehand what will be done with the contract in each situation.

3. Market and pension fund settings

In order to being able to draw conclusions in this thesis, it is necessary to make assumptions on the characteristics of the market and pension fund. In the next few paragraphs, these assumptions are addressed.

3.1 Economic model settings

It is necessary to have an economic scenario generator to forecast future equity prices, bond prices and inflation rates. Using these values also the value of the liabilities and assets can be calculated and thus the funding ratio of the fund. In this section the models used to predict future outcomes are discussed.

Equity price model

In order to forecast future stock prices the most common stochastic differential equation to price stocks will be used, namely the one also used by Black & Scholes (Black & Scholes, 1973). This implies that stock prices follow a lognormal process, with W_t a Brownian Motion and S_t the stock price:

$$dS_t = \mu \, S_t \, dt + \sigma_S \, S_t \, dW_{S,t}$$

Term structure model

The model that will predict the future interest rates and inflation rates will be the model of Vasicek (Vasicek, 1977). Vasicek uses a mean-reverting process to predict future interest rates. The process used is as follows (with r_t the nominal short interest rate):

$$d\, r_t = a\,(b - r_t)\, dt + \sigma_r \, dW_{r,t}$$

This model to forecast future short rates also sets the complete term structure. Moreover the inflation rate is assumed to be fixed. Of course there are models that incorporate stochastic inflation rates, but this can be an extension for future research. Table 1 shows the chosen parameter values. Note that the parameter value for the inflation rate, indicates the wage inflation rate and not the price inflation rate. This choice is made, because pension funds want to provide a pension that is indexed in terms of wage. The value of 2.5% is chosen in line with historical data.

The values in table 1 are chosen in a quite arbitrary way. The parameters that are most common in the literature are approximately equal to the values used in this thesis. Of course, increasing for example the expected increase in stock prices with one percent would also have been reasonable, but choices have to be made.

Parameters	Meaning	Corresponding values
μ	The expected increase in stock prices	0.07
σ_S	The randomness in stock prices	0.20
a	The mean-reversion parameter for nominal short interest rates	0.15
b	The long-term average short interest rate	0.04
λ	Market price of risk	-0.15
σ_r	The randomness in interest rates	0.01
r_0	The initial nominal short interest rate	0.025
Inflation rate	The fixed wage inflation rate	0.025

Table 1: Chosen parameter values for economic model. Note that the value of the short interest rate at time 0 is chosen at 2.5% in case of looking at the current crisis. When looking at the new pension contract (Chapter 6) an initial short rate of 4% is used.

3.2 Pension Fund settings

The simulation of a pension scheme requires settings about how the modelled pension fund works. This section consists of two parts. First of all it is necessary to look at the assumptions underlying the simulation; afterwards the adjustable parameters are discussed.

Assumptions:

- The fund uses a time period of one year. This means that active participants and retirees pay and receive their payments at the beginning of each year.
- Participants enter the fund at an age of 25. After 60 years they die at a deterministic age of 84. This assumption ignores the death probabilities, but does incorporate the increasing life expectancies that occur in the Netherlands.
- The composition of the fund is the same as the composition of the Dutch labor force according to the Centraal Bureau voor de Statistiek (Statistics Netherlands) and evolves alike. (Statistics Netherlands, 2010)
- Participants retire at the age of 65. This means that at the beginning of that year they receive their first pension payment.

- The salary of all participants is equal and is increased with a fixed percentage every year. This percentage is based on historical data provided by Statistics Netherlands.
- Pension rights are increased with an accrual of 2.5% every year (unless recovery measures are taken).
- The pension fund can invest in zero coupon bonds and in stocks. Moreover a fixed proportions investment policy is used.
- The pension fund starts with an initial funding ratio that will not change during the first year. This means that the first new payments are done at the beginning of the second year.

Adjustable parameters:

- The maturity of the bonds (results in this thesis are obtained with a maturity of 10 years).
- Percentage to be invested in stocks and bonds (unless mentioned differently the results are found with an investment mix of 50% in stocks and 50% in bonds).
- The number of simulations (up to a maximum of about 1,000 to 10,000 due to computer restrictions). Unless mentioned differently the results in this thesis are found using 10,000 scenarios.
- The time period that will be simulated.
- The parameters for the models of Vasicek and Black Scholes mentioned in the previous paragraph.
- Initial funding ratio.
- The premium level and its thresholds when conditional contribution is selected.
- Which policy to use each period (i.e. these policies will be discussed in the next chapter).
- Initial short interest and inflation rate. This initial inflation rate stays the same over time, so by choosing the initial rate, the inflation for the complete simulation horizon is set.

4. Policies

In order to recover from the pension crisis, pension funds can use different policies. This section gives a summary of measures one can think of. Recovery policies of pension funds can consist of combinations of these measures. The contracts that are considered in this thesis are described in detail in Appendix B.

4.1 Why are structural measures necessary?

The current funding ratios of many funds are below the legal minimum of 105%. Pension funds must always have a funding ratio of more than 105%, if not they have to recover within 5 years (more on this in Chapter 7). Using an initial funding ratio of 90%, the following happens to the funding ratio of a pension fund as described in the previous chapter. This pension fund gives full indexation to its participants every year and uses a contribution rate of 17% independent of the occurring funding ratio.

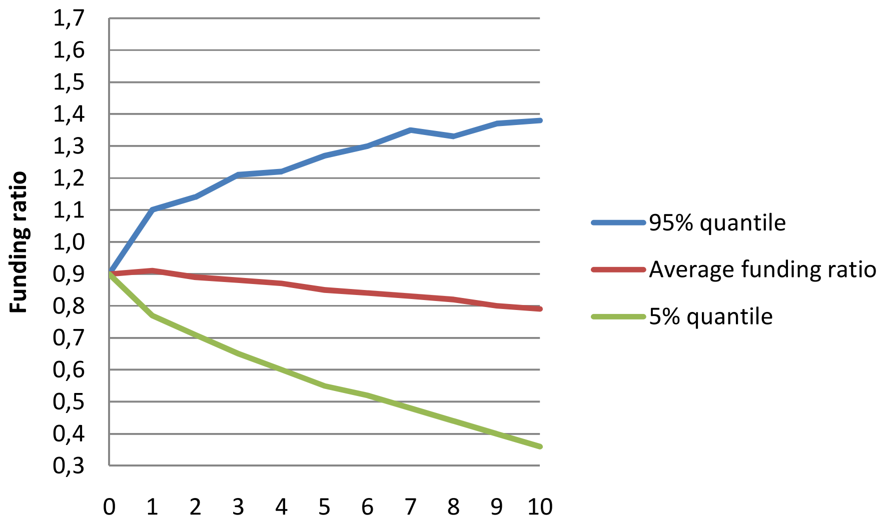

Figure 1: An illustration of the average, 5% probability and 95% probability funding ratios using a simulation with 1000 scenarios. The pension fund's characteristics are described in Chapter 3. This specific pension fund gives full indexation and uses a constant contribution rate of 17%.

Obviously the pension fund does not reach the 105% in 5 years by far. The worse case scenarios give funding ratios that are even much lower, like less than 40% after 10 years. This picture shows that it is necessary for pension funds to intervene.

4.2 Possible structural measures to increase funding ratios

Contribution of the sponsor

A first possible recovery measure for some (not all funds have a parent company) pension funds is a donation from its sponsor. Royal Dutch Shell has for example deposited a part of its profit in the pension fund. In case of the largest fund of the Netherlands, ABP, this would mean that the government should donate billions of euros. There are some political parties that say that this is justified by the fact that the Dutch government took billions of euros away during the nineties.

In general however, this recovery measure is not fully reliable, because not all companies are able to give an additional contribution. For the Dutch government it would be almost impossible in this time of economic crisis. Moreover bad times for pension funds often emerge in times of a bad economic environment, which means that companies also have hard times and have no additional money to donate to its pension fund.

Conditional contribution

The conditional contribution instrument works as follows. If the funding ratio of the pension fund is below a certain threshold (say 105%, which is the minimum funding ratio according to the Dutch legislation) the contribution rate will go up in a linear fashion as shown in the next figure. Note that it is possible to select an upper bound for the rate, say 25% and a lower bound of say 15%.

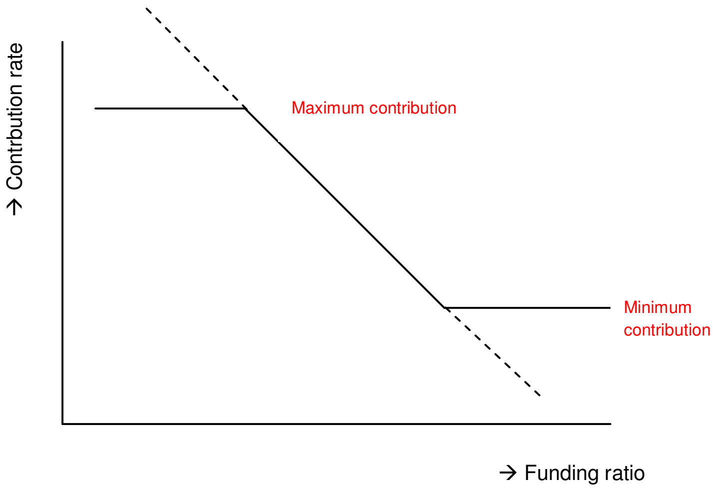

Figure 2: Illustration of a conditional contribution rate.

Note that conditional contribution only hurts the active part (the working participants) of the fund. This can be defended by saying that the working force still has a possibility to cover the losses, whereas the retirees are (as the word says) already retired and thus have no chance of requiring an extra income anymore.

It is generally thought that the ‘contribution instrument has gotten blunt’. This can be explained due to the aging effect of the society. In fact the total amount of contributions that comes in every year in the Netherlands is only about 27 billion euros (not that much compared to the total asset value of more than 750 billion euros). This actually means that an increase of the contribution rate with 10 percentage points (just once) causes an increase of just 0.4 percentage point in the funding ratio. Including that increasing the contributions always comes in bad times, due to the bad economic environment at the time such an instrument is needed (low interest rates, recession, bad equity returns etc.), the first sentence of this paragraph is justified (Stichting van de Arbeid, 2010).

Furthermore increasing contributions can have unintended effects for the national economy. Costs of personnel go up for the employers and that can be bad for the employment in a country. Secondly it can have bad effects for the competitiveness of the firms that are located in the Netherlands and that are thus bounded by these rules.

Conditional indexation

Many funds have already used conditional indexation since the pension crisis after the internet bubble in 2001. It works as follows. As long as the funding ratio stays above a certain threshold (say 140%, which in general means a real funding ratio of about 100%), full indexation is given to all participants. If the funding ratio gets below this threshold, only partial indexation is given. Furthermore negative indexation (cutting the nominal rights) can be incorporated. This would mean that when the funding ratio gets below a threshold (say 105%) the rights are cut in a linear fashion. Or in a picture, see figure 3.

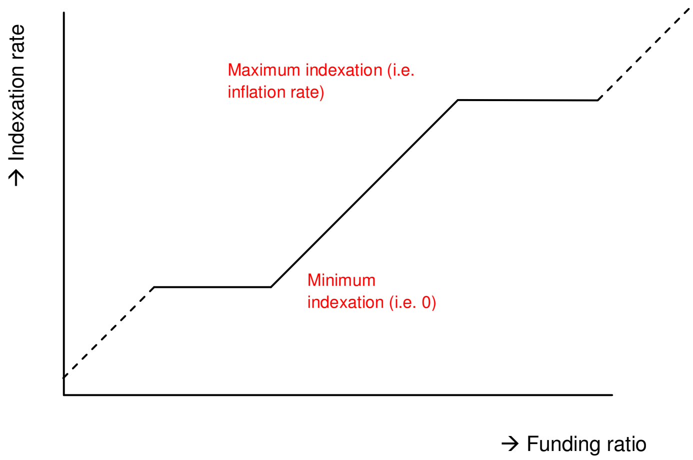

Figure 3: Illustration of *conditional indexation.*

A combination of conditional indexation and contribution

Because it is generally thought that the previous two instruments on their own are not enough to recover from the current problems, a combination is also possible. This contract would look as follows:

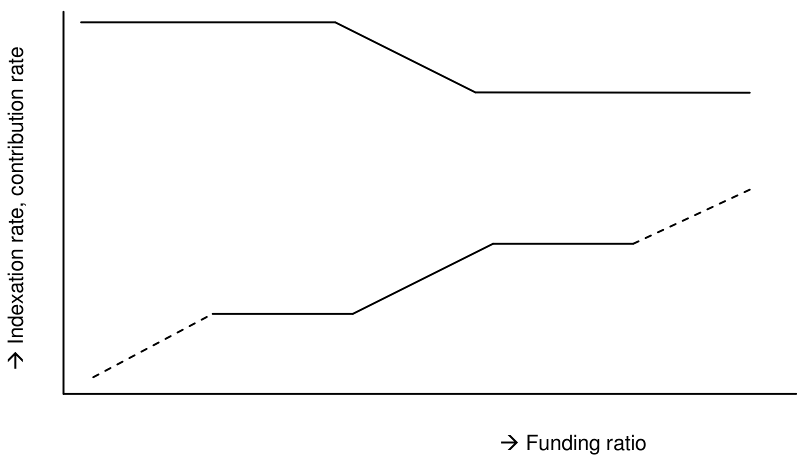

Figure 4: Illustration of a combination of conditional indexation and conditional contribution.

The effect of using this policy, will be significant relative to doing nothing. Giving no indexation to participants has an effect of 2.5% on the rights that are accumulated by participants. Whereas increasing the contributions will have a smaller effect, due to the 'blunt contribution instrument' as argued previously. When simulating the pension fund the development of the funding ratio will look as in figure 5. The remainder of this thesis names this contract as 'Combination'. Note that in this contract negative indexation is also taken into account.

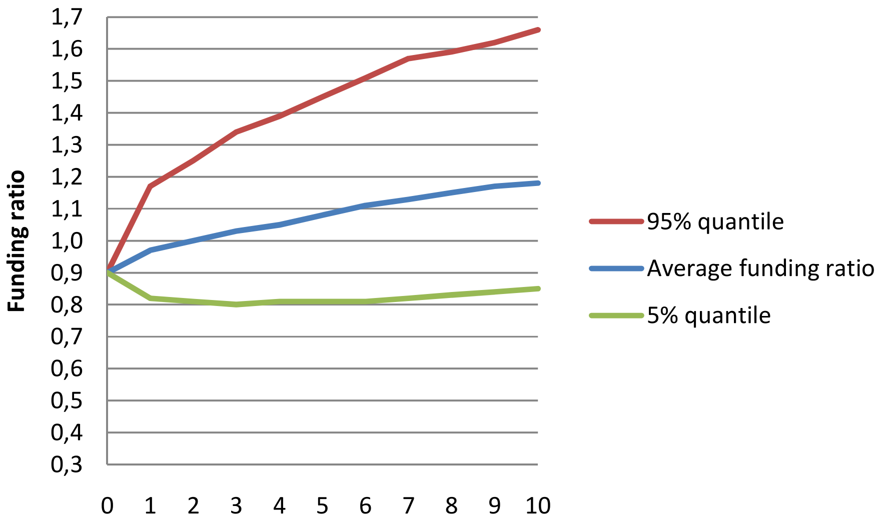

Figure 5: An illustration of the development in funding ratio using a combination of conditional indexation (including negative indexation) and contribution (1000 scenarios).

Age specific indexation

Another less common way to recover is using age/cohort specific indexation (amongst others brought forward before by Molenaar & Ponds, 2009; this thesis uses a concept that is alike, but not completely the same because of programming advantages). Due to the fact that the young have a longer period until their retirement than the old, it can be reasoned that the young can cope with cuts in rights in a better way than the old. In other words the young are able to face more risk than the old. The young simply have a much longer time to recover. They could for example make additional savings. Moreover it is possible for them to benefit from future upward movements in the financial markets.

All measures mentioned in the previous paragraphs approach all generations in an equal way. Conditional indexation for example implies that all generations benefit in the same way from positive events, but are also hurt in the same way when bad times occur. 'In the same way' means that all generations receive for example an indexation cut of 1%. Although this seems very fair, the reasoning in the latter paragraph suggests that this is in fact not that fair at all. Following this logic, the young should benefit more from positive events, but should also suffer more in bad times. Age specific indexation can be an answer to this reasoning. It uses the same notion as the conditional indexation instrument described before. However for the young the path will be much steeper than for the old. In a figure it would look as shown in figure 6.

In figure 6 it can be seen that there is a turning point. This point indicates the point at which there is no indexation and no negative indexation given. For now we choose this point at the legal minimum funding ratio of 105%. Moreover figure 6 shows that the young are faced to more risk than the old. However, also the old can face negative indexation. The formula that describes the slope is given by:

$$2 \cdot \frac{Funding\ ratio - Lower\ bound}{Upper\ bound - Lower\ bound} \cdot \left(fixed + variable \cdot max\left(\frac{65 - age}{65 - 25}, 0\right)\right)$$

'Fixed' describes the percentage of indexation that all participants face. 'Variable' describes the percentage that is age specific. Moreover the formula shows that all retirees are treated the same way. The fixed percentage is chosen at 0.3 in this thesis. Moreover the lower bound is for now chosen at the legal minimum of 105% and the upper bound at 140% (approximately equal to 100% real funding ratio).

Criticasters will probably claim that too much of the risk is given to the participants in this way. There is however an important element in this context, namely the risk declines towards retirement. So if a participant reaches his retirement the risks have become very small. This means that there is some kind of intergenerational solidarity, because the young cover more of the risk in the hope (and relying on) that the next generation will do the same for them. Note that it would be much more expensive for an individual to buy this contract on his own (amongst others due to transaction costs).

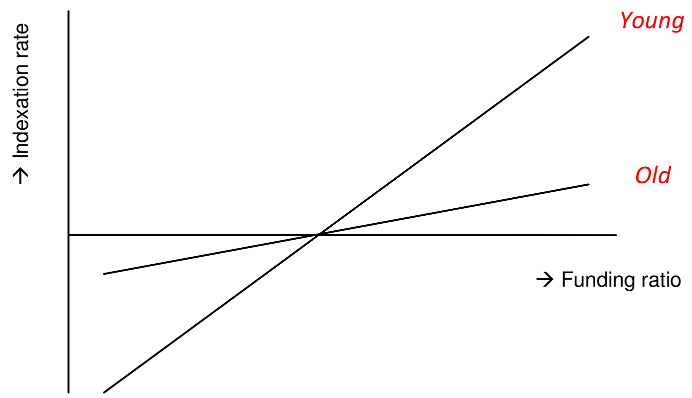

Figure 6: Illustration of age specific indexation. The horizontal line indicates no indexation. The part below this line indicates negative indexation.

Reviewing this policy on the basis of its consequences for the development in funding ratio, it will just like the combination policy have a positive effect on the funding ratio. It might have a smaller effect due the fact that the young suffer the hardest, but they have not yet built up that many rights. Therefore a uniform cut in nominal rights has a larger effect than a cut just for the young. This latter notion is of course not completely the case for this policy, but it does indicate why the development of the funding ratio will be a little bit steeper for the Combination contract. Figure 7 shows the outcome.

Increasing the retirement age

Note that although an increase of the retirement age is not discussed in this thesis, it is a recovery option that can strengthen the health of the pension funds. On average a gradual increase (increasing the retirement with one month every year, up until the age of 67) of the retirement age will cause an increase of about 10 percentage points in funding ratio after 5 years (Nissen, 2009). It is not discussed in this thesis because the fairness of this policy cannot be caught in the model that will be used in this thesis. The model used assumes a fixed life expectancy that is equal for all generations. Research however shows that life expectancies have increased a lot during the last few decades (although there are large differences between different socio-economic groups) and it is expected to increase even further. The focus in this thesis will lie on the policies mentioned before.

There is however one aspect worth mentioning. In the reports of the Committees Goudswaard en Frijns and also in the agreement between social partners, it is claimed that the retirement age should increase with the life expectancy. If you would do it in a fair way, this is however not true. The ratio between the working lifetime (accumulation phase) and the retirement receiving time (decumulation phase) should more or less stay the same. Not exactly equal to the ratio, because there will also be additional returns on the additionally accumulated capital which means that if the retirement age would be increased in an actuarially fair way it would be done in such a way that even less than the ratio remains constant. For the current political discussion it is however also important to note that the retirement age has remained equal for the last fifty years, so it can be argued that first a huger step needs to be made to a more (financially) healthy retirement age.

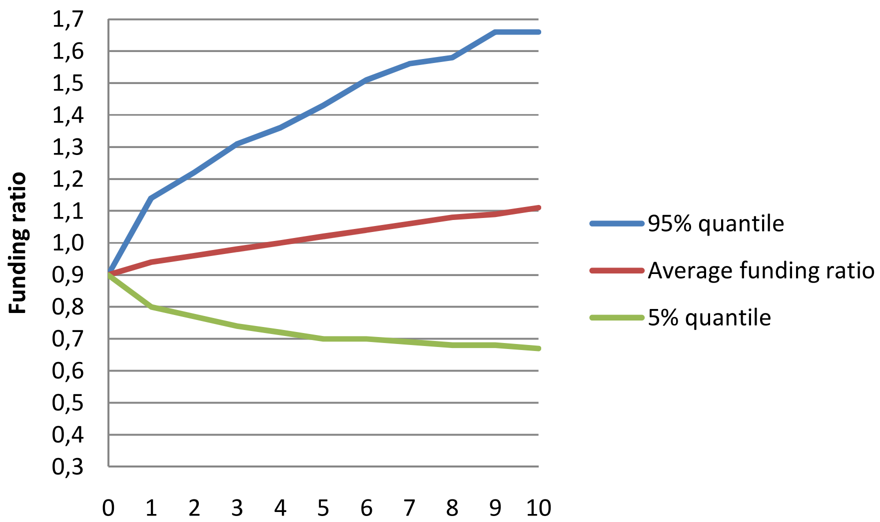

Figure 7: Development of the funding ratio and its quantiles when using age specific indexation (1000 scenarios).

4.3 Current pension crisis

As shown in section 4.1 doing nothing at all (i.e. just giving indexation) is not an option for the pension funds to recover from the current crisis. Therefore most pension funds already use conditional indexation and conditional contribution to recover. They however ignore the possibility of cutting nominal rights. They even seem to try everything to avoid taking this dramatic measure. This contract (i.e. the contract that ignores negative indexation) is named 'Doing nothing' in the remainder of this thesis.

Figure 8 shows the results of the Doing nothing contract for the funding ratio. The figure shows that in expectation the funding ratio will increase over time, but at a very (too) slow rate. Moreover the 5% quantile shows that there is a threat of dropping towards extremely low funding ratios.

When looking further, there is even a possibility of negative funding ratios. When the fund is simulated for more than 20 years ahead (which is necessary for the next chapters), there are scenarios in which the value of the assets turns negative. This can happen due to the fact this contract is not fully described. When things turn out to be very bad, this means that the fund cannot cover the shocks. In reality of course it is not possible to attain a negative amount of assets, but in the model used it can. Moreover in reality a fund would take more severe measures when ending up with a funding ratio of for example 40%. It is however clear that a contract that is not explicitly defined beforehand, is not a sustainable option. In such a contract, participants are not aware of the risks they are facing. Moreover the measures that will be taken in case of deep crisis (say a funding ratio of 40%) will always be ad hoc measures, because they are not thought of before the crisis. Finally, because the funding ratio can turn negative, economic values do not have any significant meaning for this contract.

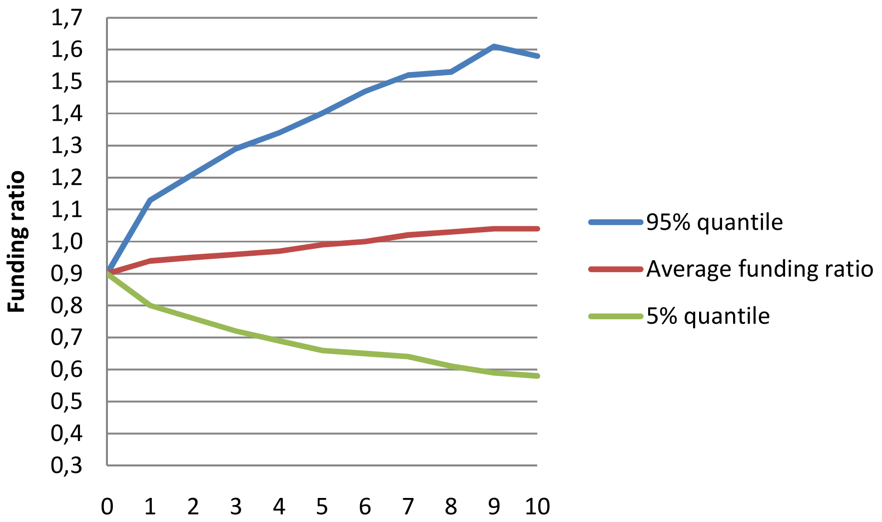

Figure 8: The development of the funding ratio for the 'Doing nothing' contract.

4.4 Outlook

This chapter showed a lot of different measures and combinations of measures to recover from the low funding ratios. As mentioned before, Appendix B shows the explicit descriptions of all contracts considered in this thesis. A more detailed outlook for the remainder of this thesis: Chapter 5 compares the Doing Nothing and Combination contract. Chapter 6 compares the Age-specific indexation contract, the Combination contract and a New pension deal (this latter contract will be discussed in section 6.1).

5. The pain of waiting

The previous chapter described different measures one can think of to recover from the current crisis. This chapter looks at two things. In the first part the current system is considered together with the current crisis. In other words, this part uses empirical data of stock prices and interest rates to find out which pension contract would have performed best in terms of solvency. The second part of this chapter looks at the problem of postponing to intervene by pension funds and tries to quantify if and so when this will lead to a skewed sharing of the pain over the generations.

5.1 Empirical survey

This section looks at data of the past 10 years to find out what would have happened to the funding ratio of funds if they would have used a contract that is more flexible in assigning (negative) indexation. The fund starts with a funding ratio of 122%, which was the funding ratio of the largest Dutch pension fund the Algemeen Burgerlijk Pensioenfonds (ABP) in 2001. For the development in interest rates, the term structures given by DNB are used. For the development in stock prices the Eurotop-100 index (given by DNB as well) is used. Finally wage inflation follows the data given by the 'Centraal Bureau voor de Statistiek' (Statistics Netherlands).

Using these data a comparison between the real situation of ABP, the Doing nothing contract and the Combination contract is made. The results are given in figure 9.

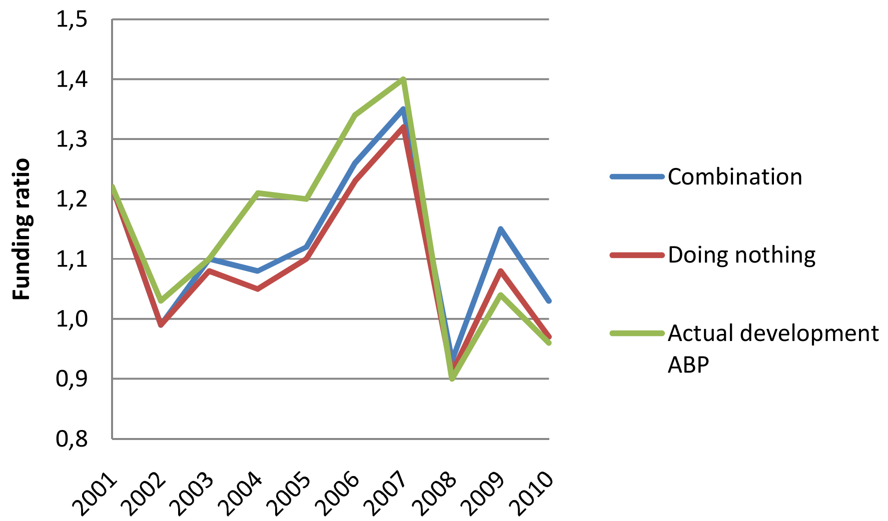

Figure 9: Empirical analysis for the Combination and Doing nothing contract compared to the actual development in funding ratio of the largest Dutch pension fund ABP. Data of the actual developments in interest rates, stock returns and inflation are used. The funding ratio in 2001 is equal to 122% which was the funding ratio of ABP in 2001.

The actual development of the funding ratio of ABP is somewhat different than for the Combination and Doing nothing contract. Differences can have several causes; examples are other asset choices (the replicated contract uses stocks and bonds and no other investments like real estate or private equity), other investment mixes (replicated contract uses a 50/50 mix in stocks and bonds), but also small differences in the composition of the fund can play a role. The general trends are however alike.

The contract that was previously described as the contract currently used by pension funds (i.e. the Doing nothing contract) shows the largest similarities with the actual development of ABP. It is interesting to see that the Combination contract would have caused a current funding ratio of 104% instead of the 97% of Doing nothing. The figure can be seen as a scenario analysis of the Combination and Doing nothing contracts and it is therefore good to see that the Combination contract does a better job in terms of solvency.

Of course this better funding ratio comes at a price: there have been indexation cuts and also cuts in nominal rights for all participants. The effects on the purchasing power are given in table 5. The table shows that during the chosen period cumulative wage inflation equalled 23%. The combination contract gives a cumulative indexation of -2.3% and the doing nothing contract an indexation of 3.3%. In total this means that losses of 25% in purchasing power have occurred in this scenario using the Combination contract and still the funding ratio is only 104%. This shows once more that there really are problems for the pension funds.

Moreover note that a cut in nominal rights consists of two parts. The first part consists of not correcting for wage inflation (i.e. no indexation). The second part consists of the negative indexation that comes on top of the first part. Table 5 suggests that participants should worry more about the relative effect of the first part than of the second part. Namely, giving no indexation caused a drop in purchasing power of 20%, whereas the negative indexation on top 'only' caused another 6%.

	Cumulative development over the years:		
Year	**Wage inflation**	**Indexation for Combination**	**Indexation for Doing nothing**
2001	1,000	1,000	1,000
2002	1,036	0,980	1,000
2003	1,065	0,984	1,002
2004	1,079	0,985	1,002
2005	1,086	0,986	1,003
2006	1,108	0,998	1,014
2007	1,145	1,016	1,030
2008	1,182	0,974	1,030
2009	1,216	0,982	1,033
2010	1,230	0,976	1,033

Table 2: The development of indexation for the participants when a Combination or Doing nothing contract is used. The values correspond to the scenario of figure 9, which means that the realized data are used. The column 'Wage inflation' describes the cumulative wage inflation since 2001.

5.2 The pain of waiting

The previous chapter described different measures one can think of to recover from the current crisis. This section investigates what the 'pain of waiting' is. Many pension funds are lobbying at DNB and the

Dutch government to postpone taking measures during this crisis, because these measures can be very painful for the participants. The 'Pain of waiting' describes this postponing and it will be investigated after how long this will result in a skewed distribution of sharing the pain over the generations. Note that in the previous chapter it is shown that the system that excludes negative indexation (starting in the current situation of funding ratios lower than 100%) is not sustainable.

Pension funds try to postpone taking measures, because one of the possible measures is cutting nominal rights of the participants. Many participants always believed that their nominal rights were ensured and pension funds also communicated this, so in a sense the funds are scared and reluctant to make clear that the beliefs of the participants are not right.

A comparison is made between a pension fund that does undertake action and a fund that does 'nothing'. More specifically it is investigated what the impact of postponing intervention is, by comparing the Combination contract and the Doing nothing contract (both described in the previous chapter). Using value-based ALM the economic value of the pension contract is calculated for each age-cohort. Tables 3 and 4 show the consequences of waiting for *x* (i.e. 0, 1 … 5) years relative to acting immediately. In other words, this means waiting for *x* years before introducing a contract that does incorporate negative indexation (i.e. Combination contract). Important for the review of value-based ALM is that the simulation is done for the complete lifetime of all participants. This means that the 84-year old already dies in the first year, whereas the 25-year old is followed for 60 years. The economic value for a 25-year old can thus be seen as the value for someone who newly enters the fund.

Table 3 shows what the effects for the contributions are and table 4 shows what the effects for the benefits are. The results are quite in line with what experts are claiming in the newspapers, namely that waiting will harm the young and will be beneficial for the elderly. Although the result is not surprising, it is worth discussing whether it can be called fair that by postponing to intervene, a 50 years old pays 4% more and receives 2% less relative to acting immediately while at the same time a 75 years old has an economic value that is 7% higher (and because he is retired, he does not have to pay any contributions anymore). This results in large differences. After 1 year the results are not yet that bad, but in the current crisis, measures have already been postponed for at least a year and pension funds actually want another delay. As of postponing for more than 2 years the problem starts to become more striking.

The turning point lies somewhere between the age of 55 and 60 (when looking at total economic value). Participants younger than this age are harmed by postponing the problem whereas the participants older than this age gain by postponing. For a hardliner it would be clear that if the pension funds want to provide a fair solution to all participants, they should undertake action as soon as possible, because otherwise the young will pay the price of the current crisis. Following this logic Minister Donner was right when he urged that the pension funds had to undertake immediate action in August 2010. However the logic could also be turned around. After 2 years of waiting the young are not yet harmed that much, whereas the old benefit quite a lot. Therefore the reasoning could also be that the pension funds should be treated in a relatively soft way. Moreover this solution also provides the funds a possibility of being lucky. This would occur if during the years of waiting the economic environment changes in a positive way for them. In any case a first conclusion should at least be that intervening should not be postponed for more than two years.

Secondly, it is very important to note that the young have negative total economic values for both acting immediately and postponing the problem. This means that if a pension were a normal contract these participants would want to receive a premium in order to participate in the contract. So it is very important to note that the young will in any case pay the price of the current low funding ratios. This suggests that immediate action should be taken in order to make the pain of the young as small as possible, but this discussion might be too difficult to explain to participants (especially for the retirees who then see their rights being cut). The final conclusion should therefore *at least* be that the problems should not be postponed for more than 2 years (as argued above).

The question that remains is why the young suffer when the problem is postponed. An obvious reason is that by postponing to intervene the young will be facing prolonged higher premiums. This has of course an effect on the economic value for these age-cohorts, because the old don't pay premiums anymore. In other words, the old receive their benefits at a lower price (i.e. contribution) than the young. But more importantly the 'Sinking giant' theory is also a reason for the suffering of the young. The old get for some part paid by the contributions of the young, which means that even with fairly high investment returns, the fund stays in trouble. To recover from such a situation the old should need to pay some part of the price as well.

	Relative differences for benefits after *x* years of waiting:					
Age	**0**	**1**	**2**	**3**	**4**	**5**
25	1,00	1,00	0,99	0,99	0,99	0,98
30	1,00	1,00	0,99	0,99	0,99	0,98
35	1,00	1,00	0,99	0,99	0,99	0,98
40	1,00	1,00	0,99	0,99	0,98	0,98
45	1,00	1,00	0,99	0,99	0,98	0,98
50	1,00	1,00	0,99	0,99	0,98	0,98
55	1,00	1,00	1,00	0,99	0,99	0,99
60	1,00	1,00	1,00	1,01	1,01	1,02
65	1,00	1,01	1,02	1,03	1,04	1,05
70	1,00	1,01	1,02	1,03	1,04	1,05
75	1,00	1,02	1,03	1,04	1,05	1,07
80	1,00	1,02	1,04	1,05	1,06	1,07
84	1,00	1,03	1,03	1,03	1,03	1,03

Table 3: The relative economic values corresponding to postponing intervention. This table shows the effects for the benefits. The column '0 years of waiting' indicates the contract that does take negative indexation into account in case of low funding ratios as of year 0. The column '2 years of waiting' denotes the consequences of waiting for 2 years (before introducing the Combination contract) relative to 0 years of waiting and so on. Not all age cohorts are depicted but the effects for someone aged 39 are similar to the effects for someone aged 40.

	Relative differences for contributions after *x* years of waiting:					
Age	**0**	**1**	**2**	**3**	**4**	**5**
25	1,00	1,00	1,01	1,01	1,02	1,02
30	1,00	1,00	1,01	1,01	1,02	1,02
35	1,00	1,01	1,01	1,01	1,02	1,02
40	1,00	1,01	1,01	1,02	1,02	1,03
45	1,00	1,01	1,01	1,02	1,02	1,03
50	1,00	1,01	1,02	1,02	1,03	1,04
55	1,00	1,01	1,02	1,03	1,04	1,04
60	1,00	1,01	1,02	1,03	1,03	1,03
65	-	-	-	-	-	-
70	-	-	-	-	-	-
75	-	-	-	-	-	-
80	-	-	-	-	-	-
84	-	-	-	-	-	-

Table 4: The relative differences in economic values for the contributions. The interpretation is similar to table 3. As of the age of 65 participants do not pay any contributions anymore. Therefore these rows are empty.

6. Search for a better pension contract

The previous chapters concentrated on the current pension crisis, but as has been said in the introduction, after solving these problems, pension funds will have to find a new (explicitly defined) pension contract. This chapter searches for such a contract. First of all a new kind of pension contract is brought forward in section 6.1. It uses some of the ideas that can be heard from the social partners (like giving more risk to the participants) combined with new ideas. Afterwards a few pension systems (including this new pension contract) are compared. In Chapter 4 it was already shown that the Doing nothing contract does not provide a sustainable solution. Therefore the Doing nothing contract is neglected in this comparison. Only explicitly defined contracts are considered.

6.1 New fair pension deal

As mentioned before, the pension contracts that are currently used by funds are not fully described, because it is not clear what has to be done when funding ratios drop or increase enormously. Therefore social partners are right now busy searching for a new pension contract/deal. The 'Pensioenakkoord' (the agreement presented by social partners in the spring of 2010) describes a contract that gives more (some say all, for example Van Wijnbergen, 2010) risk to the participants. However they haven't yet further elaborated on what such a contract would really look like. This section does look at this question. A new pension deal is considered that uses a policy that gives more risk to the participants, but is also innovative in a sense that it uses new concepts of determining the amount of rights that are built up. It still uses the funding ratio as the instrument to determine the solvency of a pension fund. However, also other determinants are used to define the situation of the fund.

First of all age specific indexation is applied to the building of rights of all participants. This means that the young cover more risk than the old. As has been described in Chapter 4 this applies to good and to bad times.

Secondly the new pension deal considered uses a concept of shifting solvency requirements that are applied in an anticyclic fashion. As will be further mentioned in Chapter 7, Dutch pension funds have to obey the 'Financieel Toetsingskader' (Financial Assessment Framework). This framework is independent of the economic environment a pension fund faces. The new pension deal that is considered in this section does however take the economic environment into account. People attach more value to positive outcomes in bad situations than in very good situations. This idea can be used by relaxing solvency requirements in times of recessions and tighten the requirements in times of booming economies. Moreover in times of booming economies it should be possible for funds to attain higher returns, so you can and maybe even should be stricter. If a fund in such times reaches low funding ratios, it means that there definitely are problems.

In a normal (non-hypothetical) economy one could define the health of the economic environment by for example looking at growth in Gross Domestic Product (GDP). The model used in this thesis is however not capable of determining growth in GDP. There are only two stochastic variables that describe future states of the world, namely stock prices (and thus returns) and interest rates. The question now is how to determine what kind of economic environment a fund faces. Some research shows that low stock prices are correlated to low GDP growth and some research shows that low interest rates indicate low economic activity.

The question is which one to use in this thesis. When applied, there are hardly any differences for the funding ratio and because there are arguments in favor of both, the choice is arbitrarily made for interest rates in the remainder of this thesis. If interest rates are significantly higher than average (note that the Vasicek model is used in this thesis), pension funds have to meet more stringent requirements and the other way around. More specifically in case of significantly higher interest rates pension fund should have a funding ratio of at least 120% and 90% in times of low interest rates. Significant is in this context defined as the events that can only occur with a probability of less than 10% on each side of the distribution. Unlike how pension funds are usually approached (independent of the economic environment) this framework does take the economic environment into account. In the remainder it is called anticyclic supervision.

The consequence of the anticyclic supervision for the specific policy in the new pension deal considered is that age specific indexation is used just like it has been described in Chapter 4. The difference however is that the upper and lower bound in the formula of Chapter 4 are adapted to the economic environment, in other words they will take values that are adapted to the values mentioned in the previous paragraph (i.e. in positive environment: lower and upper bound increase with 15 percentage points; in negative environment: lower and upper bound decrease with 15 percentage points).

The contract described (i.e. the contract using anticyclic supervision and age specific indexation) in the previous paragraphs is called 'New pension deal' in the remainder of this thesis. The reasoning behind this contract is that the young are able to take more risk than the old. Moreover anticyclic supervision should make sure that participants are not hurt in times in which they already face a lot of problems due to bad economic environments. The detailed description of the new pension deal is given in Appendix B (just as a detailed description of all other contracts considered).

6.2 Performance measures

This chapter searches for an explicitly defined pension deal that provides a good contract for all participants. Because it is necessary to give an answer to this question on the basis of arguments, it is necessary to define the parameters on which the answer will be based (called performance measures in the remainder). The choice of such performance measures is arbitrary. The measures in this thesis are:

- Effects on solvency. In other words, how sustainable is the system?
- Welfare analysis:
    - What is the ability of the pension system to provide a certain level of welfare?
    - How is the performance of the system in terms of smoothness of payments during retirement?
- Are there any choices for participants in the pension contract considered?

In the next sections the performance measures mentioned above are investigated. Differences in economic values are also considered in order to find out whether there are large transfers of economic value from one generation to another when a new contract is introduced.

6.3 Effect of new contract on solvency and economic values

This section looks at the first performance measure. First, a comparison between the New pension deal and the age specific indexation contract is made on the basis of this measure. Recall that the new pension deal also uses age specific indexation, so when comparing the New pension deal and age specific indexation, the differences between these two contracts can only be caused by the effect of the anticyclic supervision. The consequences for the funding ratio are given in figure 10. The differences are negligible, both for the average funding ratio as for the quantiles. This is very striking, because the anticyclic supervision implies that in bad times solvency requirements are loosened. So an obvious consequence would be that the lower quantile will decrease, but this appears to be not true. Apparently the more stringent requirements in times of good economic environments do their job well. So the anticyclic policy works well in terms of solvency.

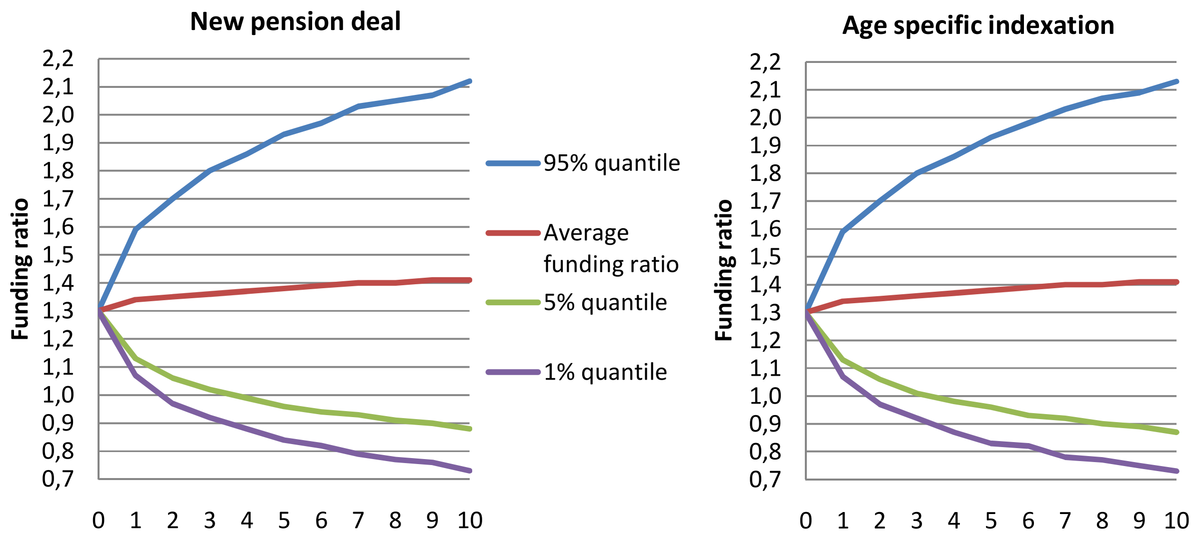

Figure 10: Development in funding ratio when starting at a nominal funding ratio of 130%. The left figure shows the New pension deal and the right figure shows the Age specific indexation contract. As can be seen the differences for all quantiles are negligible.

Table 5 shows the economic values for the different age cohorts. The differences are so small that hardly anything can be said about the effects. Almost all participants receive more, but they also have to pay more. Apparently the anticyclic supervision seems to have little effect on the economic values for all age cohorts. However this does not mean that introducing anticyclic supervision has no effect at all on the participants.

Now the New pension deal and the Combination contract are compared. The consequences for this comparison on the funding ratio are given in figure 10. Table 6 depicts the differences in economic value. The average funding ratio develops in a similar way for both contracts, just as the quantiles. Only the 1% quantile for the new pension deal shows that there is a small possibility of larger losses for this contract. This can be caused by both the anticyclic supervision and age specific indexation. In age specific indexation, the young face more risk but at the same time they have not built up too many rights yet. In bad times this has the consequence that it is more difficult to recover. Recall from the previous section that the anticyclic supervision had no effect on the solvency there, so the differences for the 1% quantile are probably caused by age specific indexation.

	Economic value benefits			Economic value contributions		
Age	NPD	ASI	Relative	NPD	ASI	Relative
25	49,00	48,78	1,005	47,95	47,97	1,000
30	54,19	53,73	1,009	43,95	43,99	0,999
35	59,92	59,23	1,012	39,50	39,53	0,999
40	66,72	65,83	1,014	34,50	34,52	0,999
45	75,23	74,19	1,014	28,89	28,89	1,000
50	86,03	84,92	1,013	22,60	22,59	1,000
55	99,84	98,76	1,011	15,68	15,64	1,003
60	117,59	116,64	1,008	8,13	8,11	1,002
65	140,48	139,75	1,005	-	-	-
70	114,69	114,21	1,004	-	-	-
75	83,30	83,06	1,003	-	-	-
80	45,36	45,30	1,001	-	-	-
84	9,69	9,68	1,001	-	-	-

Table 5: The effects for the economic values for both the benefits and the contributions when comparing the new pension deal (NPD in the table) and Age specific indexation contract (ASI in the table). The differences are negligible. Note that the total economic values are about equal.

The economic values for participants older than age 60 decrease with the introduction of the new pension deal. The losses in benefits are about 1% to 2%. Whereas for the participants younger than 55 it results in an increase for both the contributions and the benefits. The increases in benefits are however larger than the increases in contributions, so it has a positive effect for the young generation.

All in all the differences for the total economic values are very small, so there are no large transfers of economic value from one generation to another. Introducing anticyclic supervision and age specific indexation relative to uniform indexation among participants only has small effects on the solvency of the fund (only the 1% quantiles differ).

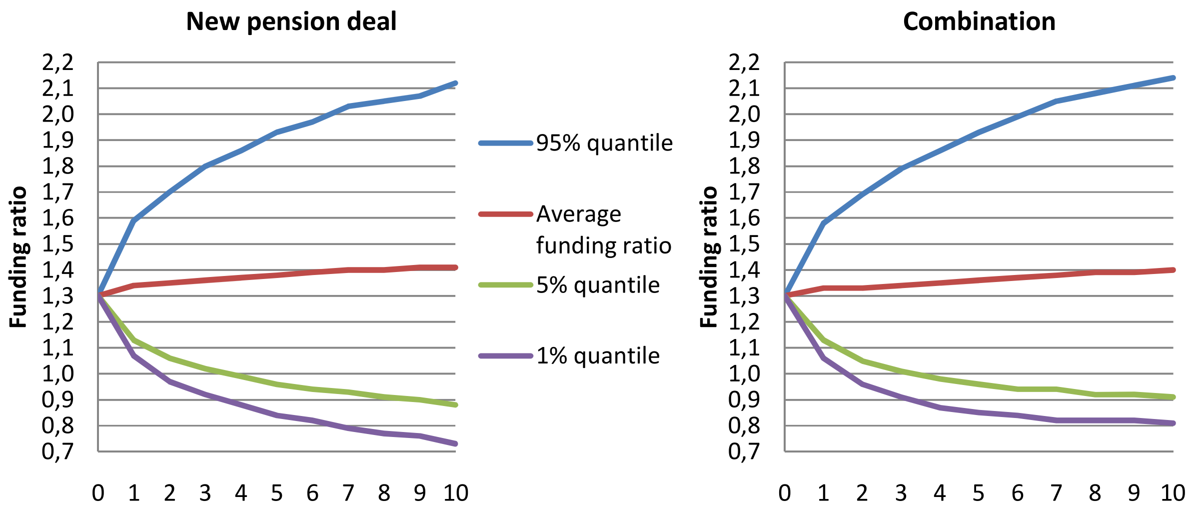

Figure 11: The development in funding ratio for the 'New pension deal' on the left and the 'Combination' contract on the right.

	Economic value benefits			Economic value contributions		
Age	NPD	Combi	Relative	NPD	Combi	Relative
25	49,00	47,71	1,03	47,95	47,05	1,02
30	54,19	52,58	1,03	43,95	43,23	1,02
35	59,92	58,12	1,03	39,50	38,94	1,01
40	66,72	64,85	1,03	34,50	34,09	1,01
45	75,23	73,50	1,02	28,89	28,62	1,01
50	86,03	84,97	1,01	22,60	22,47	1,01
55	99,84	100,12	1,00	15,68	15,62	1,00
60	117,59	119,83	0,98	8,13	8,11	1,00
65	140,48	143,90	0,98	-	-	-
70	114,69	117,38	0,98	-	-	-
75	83,30	85,20	0,98	-	-	-
80	45,36	46,23	0,98	-	-	-
84	9,69	9,77	0,99	-	-	-

Table 6: The effects for the economic values for both the benefits and the contributions when comparing the new pension deal (NPD in the table) and Combination contract (Combi in the table). Summarizing, the young get more in the New pension deal but also pay more, whereas the old get less.

6.4 Welfare analysis

This section tries to find out which contract does best in terms of welfare. First, it is important to note that measuring welfare is very hard. A possibility could be to use a utility framework. Choosing risk profiles and utility functions that represent the real preferences of individuals is however very hard and maybe a bit artificial. This thesis therefore tries to express criteria more directly in terms of what actually happens to participants during retirement. The purchasing power of participants can for instance be a way to define welfare. This can be done by looking at the actual payments that are done during retirement. By dividing these payments by the occurring salary in that specific period, the purchasing power can be expressed. This ratio shows the comparison between the pension payments and the salary someone would have earned if he would have kept working. Note that in the model used all participants earn the same salary and that this salary increases with wage inflation every year. In other words, the ratio of the pension payments and the salary (from now on called replacement rates), gives an indication of the amount of welfare a retiree receives. Replacement rates can differ quite a lot in different scenarios, but by computing it for each simulated economic scenario, expectations and probabilities of specific amounts of welfare can be found.

The pension fund is simulated for the whole lifetime of all participants that were present in the first year. This means that also for the 25-year old the replacement rates are calculated. Obviously the uncertainty for the younger age-cohorts is much higher than for the old. Table 7 shows the results for the new pension deal, the age specific indexation contract and the combination contract respectively. The 95% column shows the replacement rates that occur with 95% probability and the 50% column denotes the replacement rates that occur with 50% probability. Note that these numbers represent the average replacement rates during retirement. Dependent on economic circumstances payments can be adjusted and therefore replacement rates can vary during retirement. If for example the funding ratio is very low (say 90%) the Combination contract cuts nominal rights and thus the replacement rate declines in such a year.

	New pension deal		Age specific indexation		Combination	
Age	**95%**	**50%**	**95%**	**50%**	**95%**	**50%**
25	0,46	0,95	0,46	0,96	0,45	0,94
30	0,45	0,92	0,45	0,92	0,43	0,91
35	0,46	0,87	0,46	0,88	0,43	0,88
40	0,48	0,83	0,48	0,84	0,43	0,86
45	0,50	0,81	0,51	0,80	0,46	0,84
50	0,55	0,79	0,56	0,79	0,49	0,84
55	0,61	0,79	0,61	0,79	0,55	0,85
60	0,68	0,82	0,69	0,82	0,63	0,88
65	0,77	0,86	0,78	0,86	0,74	0,92
70	0,82	0,89	0,83	0,89	0,8	0,94
75	0,88	0,92	0,88	0,92	0,87	0,96
80	0,94	0,95	0,94	0,95	0,95	0,98
84	0,98	0,98	0,98	0,98	0,95	0,98

Table 7: An illustration of the average replacement rates during retirement corresponding to the contracts mentioned. The 95% column denotes the average replacement rates during retirement that occur with 95% probability. The numbers indicate the replacement rates that occur on average during retirement (in other words, averaged over time).

Table 7 shows that the differences between the new pension deal and age specific indexation contract are very small, so nothing can really be said about which of these two does a better job. When comparing the Combination contract and the New pension deal, it seems that the New pension deal offers more certainty, while at the same time the Combination contract offers more upside potential. It is however difficult to draw any conclusions, so another method needs to be thought of.

So how should welfare be defined in a pension context? One could say that an individual tries to make a trade-off between the ambition and guarantee of his pension (Timmermans, 2010). The ambition indicates the payments this individual would like to receive during retirement and the guarantee indicates the minimum amount of payments he wants to receive. In the context of this paper the term guarantee can be confusing, because it cannot be guaranteed, it is therefore named subsistence level in the remainder of this thesis. It is a trade-off between ambition and subsistence because trying to reach a higher ambition means that more risk needs to be taken and thus the probability of low replacement rates increases as well. Note that very high levels can only be attained at very high contribution rates.

How can the foregoing be applied to this research? It is possible to define a minimum level of replacement rate (i.e. subsistence level) an individual wants to receive and find out in how many percent of the cases this goal is reached. The same can be done for the ambition level. The replacement rates described in the previous paragraphs show a level of welfare in real terms. Choosing a level of ambition and guarantee will always be arbitrary, because each individual may choose a different ambition and guarantee. The ambition level in this thesis is chosen at 100% and the subsistence level at 70%. Table 8 shows the probabilities for the three pension contracts to attain the ambition and the subsistence level. Because the choice for a certain level of replacement rate is arbitrary, figure 12 shows the probability to attain different levels of replacement rates in a graph for the new pension deal and the combination contract. Due to graph limitations the results are only given for a 30, 50 and 70 years old, but this gives a good indication of the results for all age cohorts (Appendix C shows elaborate results).

	New pension deal		Age specific indexation		Combination	
Age	**Subsistence**	**Ambition**	**Subsistence**	**Ambition**	**Subsistence**	**Ambition**
25	0,72	0,48	0,72	0,48	0,74	0,45
30	0,71	0,44	0,70	0,44	0,73	0,42
35	0,69	0,39	0,69	0,39	0,72	0,39
40	0,67	0,35	0,66	0,35	0,71	0,36
45	0,66	0,30	0,66	0,29	0,70	0,32
50	0,67	0,23	0,68	0,23	0,71	0,28
55	0,73	0,15	0,74	0,16	0,76	0,24
60	0,88	0,10	0,90	0,09	0,85	0,20
65	1,00	0,06	1,00	0,05	0,98	0,15
70	1,00	0,03	1,00	0,03	1,00	0,10
75	1,00	0,01	1,00	0,01	1,00	0,05
80	1,00	0,00	1,00	0,00	1,00	0,00
84	1,00	0,00	1,00	0,00	1,00	0,00

Table 8: The probabilities of reaching an ambition of 100% (i.e. during retirement an average replacement rate of 100%) and a subsistence level of 70% for the different pension contracts.

When looking at both table 8 and figure 12, the first obvious observation is that the young face more uncertainty than the old. Recall the quote from prof. dr. Lans Bovenberg in the introduction and it is clear that due to the longer time period the young will face by definition more uncertainty. At the same time it is important that the old don't face too much uncertainty, because they are not able to cover possible losses anymore. It is therefore good to see that for all three contracts the subsistence level is (almost) surely achieved for the retirees. This comes of course at the price that the probabilities of achieving the ambition are very small. The Combination contract gives the old the highest probability to achieve the ambition.

It is also worth attention that there is a decrease in probabilities (for both ambition and subsistence and also for all three contracts) from the 25 year old to the 50 year old. It is explainable that the probability of achieving the ambition lowers, but it is difficult to explain why the probability of reaching the subsistence level drops that much to increase again as of the age of 55. Maybe these age cohorts face a too large amount of risk that they have not enough time to recover from, whereas the very young still have a longer period to recover. Finally note that the young do have fairly large probabilities of receiving their ambition and subsistence level in all three contracts. They even have fairly large probabilities of attaining more than 100% of the occurring salary. One could say that there is no reason to have such large probabilities on the upside. This could therefore indicate that the chosen investment mix (50/50) is too risky. This question is addressed in section 6.7.

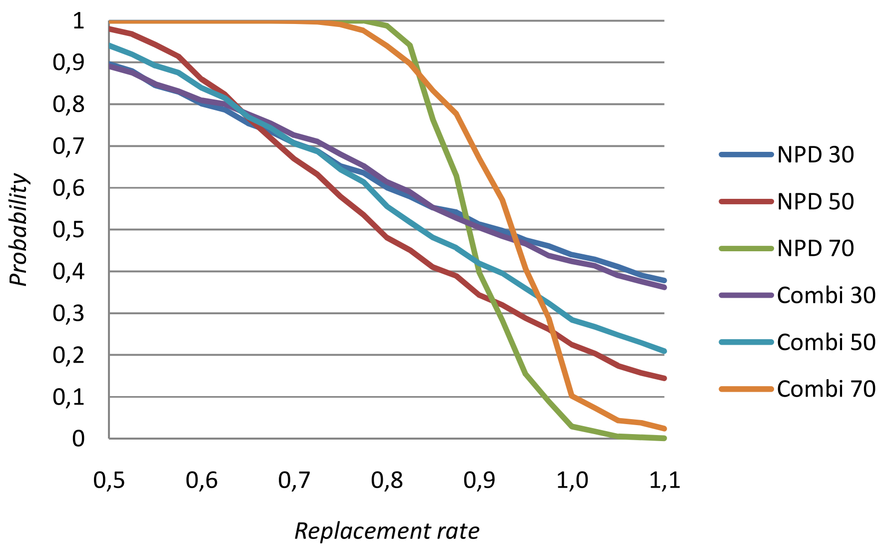

Figure 12: A graphical illustration of the probability to attain a certain average replacement rate during retirement. NPD 70 indicates the effects for a participant aged 70 in the New pension deal and analog for the other abbreviations (with Combi indicating the Combination contract).

6.5 Smoothness of pension payments

Finally, it is often claimed that agents want to smooth their consumption pattern over time (Ando & Modigliani, 1963). For this research this can be investigated by looking at the smoothness of the payments during retirement for the three contracts considered. Table 9 shows what the average volatility is during retirement for different age cohorts. It is obvious that the uncertainty for the young is much greater than for the very old, because they have a much longer way to go until they retire and consequently the economic environment can change much more.

Although not surprising, the New pension deal and Age specific indexation contract show the lowest volatility in pension payments during retirement. Only for the 80-years old the volatility is slightly higher, the reason is unclear. The lower volatility using age specific indexation is not surprising because the age specific indexation policy makes sure that the amount of risk declines with the age of the participant. In the Combination contract all participants cover the same amount of risk. Therefore payments can vary much more during retirement in the Combination contract.

Average volatility during retirement:			
Age	**Combination**	**New pension deal**	**Age specific indexation**
25	0,18	0,08	0,08
30	0,16	0,07	0,07
35	0,14	0,06	0,06
40	0,12	0,06	0,06
45	0,10	0,05	0,06
50	0,10	0,06	0,06
55	0,09	0,06	0,06
60	0,08	0,07	0,06
65	0,08	0,07	0,07
70	0,06	0,06	0,06
75	0,04	0,04	0,04
80	0,01	0,02	0,02
84	0,00	0,00	0,00

Table 9: An illustration of the average volatility during retirement for the three contracts considered. The volatility is expressed in terms of replacement rates and averaged over the different scenarios.

Although volatility is a parameter that is used very often to define uncertainty, it is not the best parameter for this purpose. For example, a pretty stable but steady decreasing path can give the same volatility as a very unstable but on the long term flat path. In terms of pension payments, the last situation would be better for the participants, because people want to smooth consumption. When there is a steady decreasing path of income, this is not possible. A way to incorporate the latter in this thesis is by computing returns on replacement rates and find out what they look like. If they are for example on average negative, this means that the average path decreases during retirement.

Moreover as mentioned before, participants seem to be scared for cuts in pension payments (with a difference for indexation cuts and nominal cuts). Literature describes this phenomenon as loss aversion. Kahneman & Tversky were the first and most prominent researchers that proposed this (Kahneman & Tversky, 1979). The claim is that people attach higher values to losses than to gains. If this has to be incorporated in this research it is however necessary to define what this higher value is. Again literature gives a possible answer to this with the number 2.25 (Kahneman & Tversky, 1979). This seems to be arbitrary and it of course is, but it is often used in common research. It means that a loss is valued 2.25 times higher than a gain.

When the foregoing is applied to this research it means that returns on replacement rates are calculated and then it is evaluated whether such a return is positive or negative. The return is defined as $\frac{X_{t+1}-X_t}{X_t}$ with X_t the replacement rate in year t. If the return is negative it is multiplied by 2.25 and if it is positive it remains equal. The results can be used to measure the quality of a pension system in terms of smoothness of pension payments. Note that this way of measuring smoothness is completely new and there can be debate about the quality of the measure. The reasoning before gives it a good basis however.

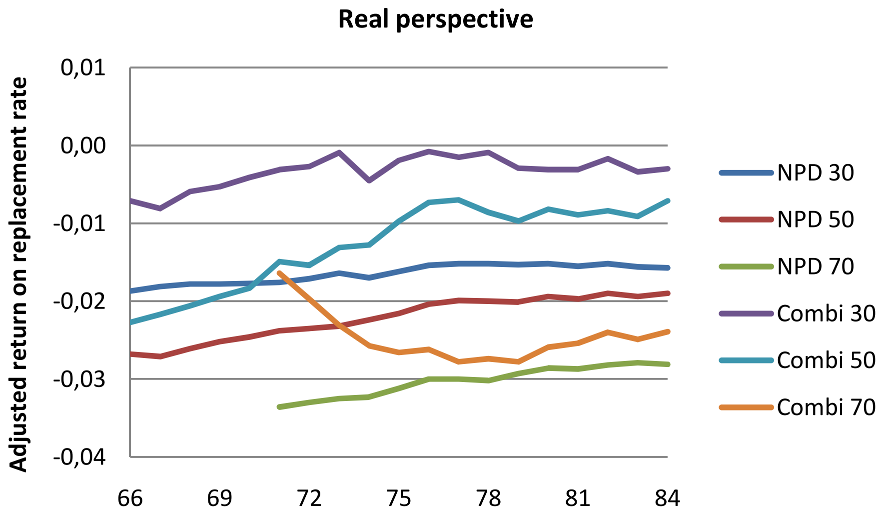

Figure 13: An illustration of the average adjusted returns on replacement rates during retirement. They are adjusted in a 'Kahneman & Tversky' fashion, which means that losses are valued higher than gains. This figure uses a negative return in real terms as the definition of a loss. Note that the figure starts at the age of 66 due to the fact that at the age of 65 no return can be calculated yet.

Figure 13 shows what the results are for different age cohorts. Note that the foregoing is applied, so a loss is valued 2.25 times higher than a gain. But what is considered a loss? In this figure a loss is described as a negative return in real terms. So if no full indexation is granted this is valued as a loss. There can be discussion about this choice, because there is doubt about how good people are at valuing inflation. Therefore figure 14 shows similar results but then in a nominal perspective. This means that only returns that indicate a nominal cut are treated as a loss and therefore multiplied by 2.25. Note that the numbers in the figures indicate the average adjusted returns on replacement rates during retirement. This means that both figures show replacement rates that are expressed in real terms (so relative to the occurring salary in a specific period). The only difference is that the figures have a different definition of a loss.

When comparing the two figures it is of course obvious that the real figure will show more negative outcomes than the nominal figure. The differences are quite large, which indicates that in both contracts a lot of indexation cuts occur.

More importantly, almost all returns are on average negative during retirement seen from the Kahneman & Tversky perspective. This means that apparently the cuts are not offset by times of positive returns. This could be an indication that people value their payments pattern as decreasing during retirement. In the context of smoothing the pattern of pension payments of participants, this is not a good sign. There can however also be discussion about how bad this is. It is not necessarily a bad thing to have decreasing income later in life, due to fewer expenses in this period. Solely looking at the argument of a smooth pattern of pension payments, it is however not a good sign.

Furthermore it is interesting to note that the differences between generations aren't very small. These differences can solely be caused by the situation a fund faces. Apparently this situation improves over time, because a 30-years old has a better perspective than a 70-years old.

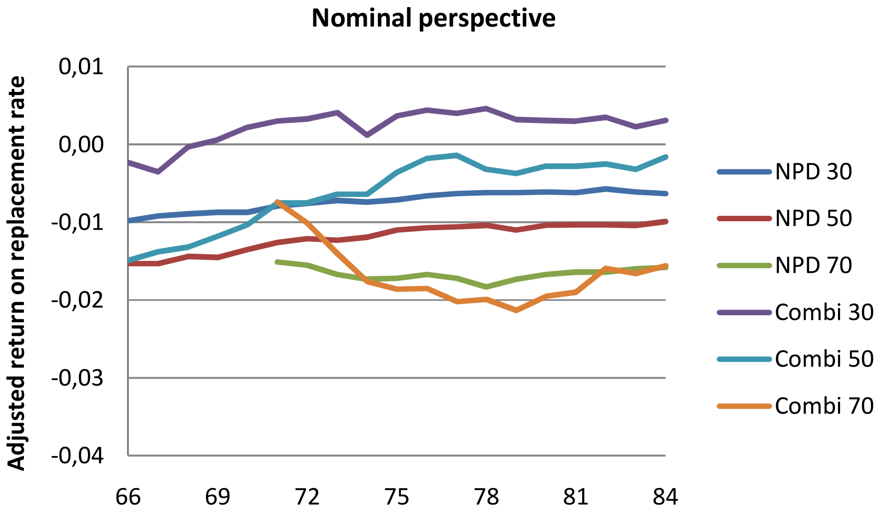

Figure 14: An illustration of the average adjusted returns on replacement rates during retirement in a nominal perspective. This means that a return is considered as a loss (and therefore multiplied by 2.25) when it is a nominal cut.

When comparing both contracts, the Combination contract has higher average adjusted returns during retirement, which means that the pattern of pension payments is more flat and probably gives fewer high cuts. This can be explained by the fact that in the New pension deal, older participants face less risk. This has the drawback that often only partial indexation is granted and therefore the average adjusted return on replacement rates will be lower. All in all, when the Kahneman & Tversky measure is used as a sign of quality of a pension contract, the Combination contract would definitely do the best job. Due to the age specific indexation policy one would expect the New pension deal to do better, but this turns out to be different. The New pension deal apparently needs some adjustments.

6.6 Which contract is best?

Section 6.2 formulated performance measures that would be used to evaluate the different pension contracts. The previous sections looked at the consequences for the solvency and for the welfare of participants. Now the different performance measures are used to see which contract does the best job.

First of all, there cannot be found any significant differences between the New pension deal and the Age specific indexation contract on any of the performance measures. The conclusion therefore is that introducing the anticyclic supervision is worth considering. Apparently the anticyclic framework does its job very well.

In terms of solvency the Combination contract does a slightly better job than the New pension deal. The worst case scenarios (i.e. 1% quantile) are better than for the New pension deal. For all other quantiles the differences are very small.

Then, the welfare analysis. The New pension deal does best in terms of assuring a certain level of replacement rates. The combination contract however gives a higher upside potential, with fairly large probabilities of attaining relatively high levels of welfare. The second measure concerning welfare was the ability to provide a smooth pattern of payments. The new pension deal provides the scheme with the lowest volatility of payments during retirement and therefore is the best contract in this sense. The Combination contract ensures a flatter pattern of pension payments in the Kahneman & Tversky perspective though.

Finally, the last performance measure mentioned is the amount of choices that can be made by participants in a specific contract. When looking at the Combination contract, no choices what so ever can be made, because there is a uniform policy for all participants. For the New pension deal it is also difficult, but not impossible. When looking at the formula that describes the slope of age specific indexation (described in Chapter 4), it is possible for participants to choose the 'fixed' and 'variable' level. If all participants choose 100% fixed this however results in the pension system that is now occurring, namely a system that provides guarantees. It is however not an awkward assumption to assume that this will not happen. There are differences in risk profiles between participants; so one participant might want to choose full exposure to shocks in financial markets and another might want to choose no exposure. Another way to incorporate choice in the New pension deal could be to let people choose their age. This might sound strange, but it can be very useful, because it is very good to interpret. Someone aged 40 may then for example choose a more risk seeking contract by selecting age 35 or 30. It would of course be good for the pension fund to give participants a range of what could be possible ages to select (for example 10 years younger or older).

Concluding, it is in any case clear that the New pension deal gives more choice possibilities to participants.

All in all, none of the contracts considered does best on all performance measures. The New pension deal does best in terms of providing a subsistence level of welfare, providing a smooth pattern of payments during retirement and in terms of choice possibilities for participants. The Combination contract does the best job for the solvency, in providing a higher (desired) level of welfare and for the Kahneman & Tversky smoothness.

6.7 Effects of implementing a less risky investment mix

All previous results were found by using an investment mix of 50% in stocks and 50% in bonds. The results in the welfare analysis (section 6.4) showed large upside potentials with fairly large probabilities (more than 40% for a participants aged 30) of attaining replacement rates higher than 100%. This might suggest (also suggested in other papers, like (Timmermans, 2010)), that the investment mix of 50% in stocks and 50% in bonds is too risky. This mix is however a pretty good reflection of the investment mixes actually applied by pension funds. This section looks at the effects of applying a less risky mix of 35% in stocks and 65% in bonds.

Figures 15, 16 and 17 show the results for the solvency and welfare analysis. Note that the results are only given for the Combination contract and New pension deal, because the previous sections showed that the differences between the New pension deal and the Age specific indexation contract are negligible.

The effect of applying this new investment mix on the average funding ratio is small. In case of the 50/50 mix, the average was about 3 to 4 percentage points higher. However the upside and downside potential have become much smaller for the new mix. The upside potential is more than 20 percentage points lower after 10 years and more importantly the downside risk (i.e. 1% quantile) is 10 to 15 percentage points higher. Concluding, the effects on the solvency are large and seem to be better for the sustainability of the pension funds. Moreover the differences between the Combination contract and New pension deal are very small.

Then, the effects on the welfare analysis. The probabilities of attaining very high replacement rates have declined a lot, with more than 10 percentage points for the 30 years old as the maximum. At the same time by applying a less risky investment mix, the participants will have higher (almost) assured levels of replacement rates. Figure 16 shows that the Combination contract now does a better job in both ensuring a certain level of welfare and giving the potential to reach higher levels. This is very different from the case in which an investment mix of 50/50 is used.

When looking at the average volatility of pension payments during retirement in table 10, the results have also turned upside down. For both contracts the average volatility has gone down, but it has gone down much more for the Combination contract than for the New pension deal. Still, for most age cohorts the New pension deal ensures a more smooth consumption pattern. However, for the very old, the Combination contract now does the best job (note that these deviatons are very small).

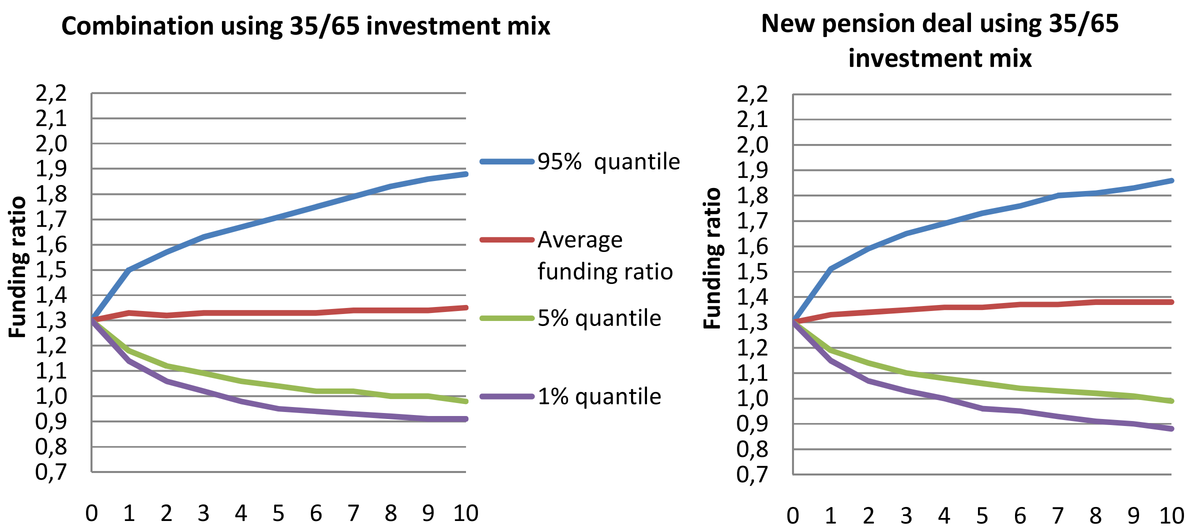

Figure 15: The effects for the solvency when implementing an investment mix of 35% in stocks and 65% in bonds. The left figure shows the Combination contract and the right figure shows the New pension deal.

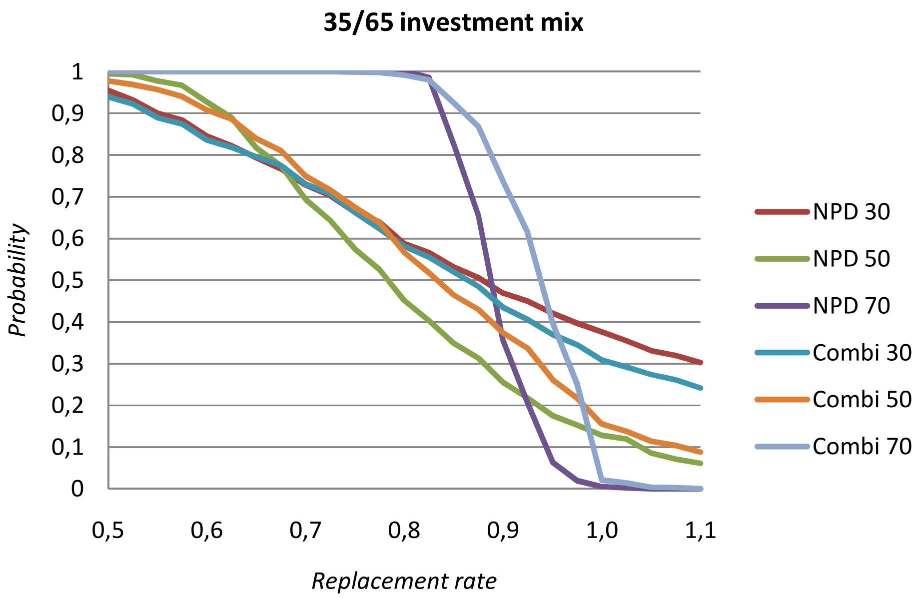

Figure 16: A graphical illustration of the probability to attain a certain average replacement rate during retirement. This graph is found by implementing an investment mix of 35/65 instead of 50/50. NPD 70 indicates the effects for a participant aged 70 in the New pension deal and analog for the other abbreviations (with Combi indicating the Combination contract).

Finally, figure 17 gives an illustration of the pattern of pension payments seen from a nominal perspective (because this seems to be most realistic) in the Kahneman & Tversky way described before.

The deviations during retirement and between age cohorts have become much smaller. The fact that for all cohorts the lines lie below zero indicates that when looked at the pattern from the Kahneman & Tversky perspective the average return on replacement rate will be negative.

	Average volatility during retirement:	
Age	Combination	New pension deal
25	0,09	0,05
30	0,08	0,05
35	0,07	0,04
40	0,06	0,04
45	0,06	0,05
50	0,06	0,05
55	0,06	0,06
60	0,06	0,06
65	0,06	0,07
70	0,04	0,06
75	0,03	0,04
80	0,01	0,02
84	0,00	0,00

Table 10: The effects of implementing an investment mix of 35/65 on the average volatility of pension payments during retirement. The volatility is expressed in terms of replacement rates and averaged over the different scenarios.

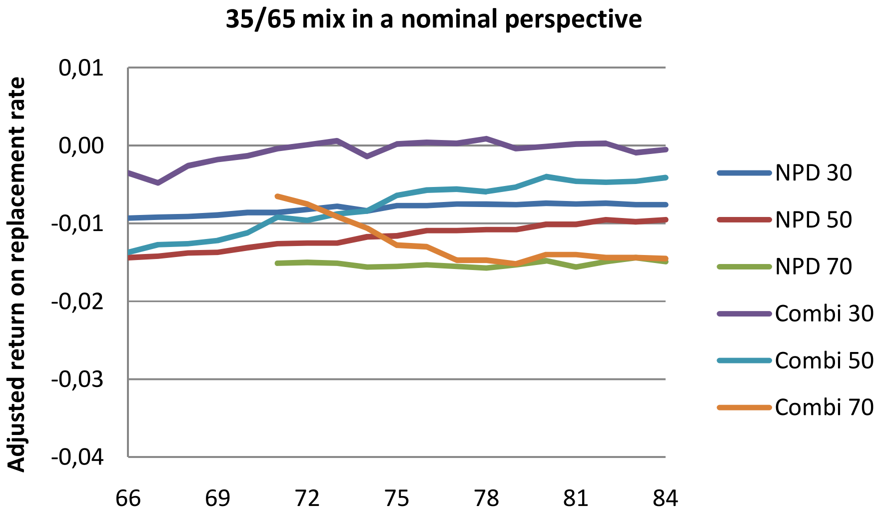

Figure 17: Illustration of the average adjusted (in a Kahneman & Tversky way) returns on replacement rates during retirement in a nominal perspective.

Concluding, the result for which contract does the best job using this less risky investment mix turned around. The Combination contract does best in ensuring a certain level of welfare and giving a potential higher replacement rate level. The New pension deal does best in ensuring a smooth pattern of pension payments during retirement. The differences for the solvency are negligible, which shows once more that the anticyclic supervision seems to work.

Concluding, the results seem to be a call for less risky investment mixes. The solvency of the funds improves, the welfare of the participants improves (when ignoring the high upside potentials in the case of a 50/50 investment mix) and finally the smoothness of payments during retirement improves.

All in all the results might even suggest going one step further in implementing less risky investment mixes. Therefore figures 18,19 and 20 show similar results as before but then for an investment mix of 20% in stocks and 80% in bonds. The results are very striking, as they suggest that an investment mix of 20% in stocks and 80% in bonds is even better than the 35/65 mix. Especially the outcome for the replacement rates is striking. If a 20/80 mix would be implemented, participants give up a part of the upside potential in order to get more certainty about possible negative outcomes. Note that if an even less risky investment mix is used, the figures start to worsen again, because then a replacement rate of 1 cannot be attained anymore at all. Of course, the models used in this research are not completely replicating the real situation pension funds face, but they do give an indication. When pension funds have investment mixes of 50% in stocks and 50% in bonds, a conclusion is that in any case that is too risky.

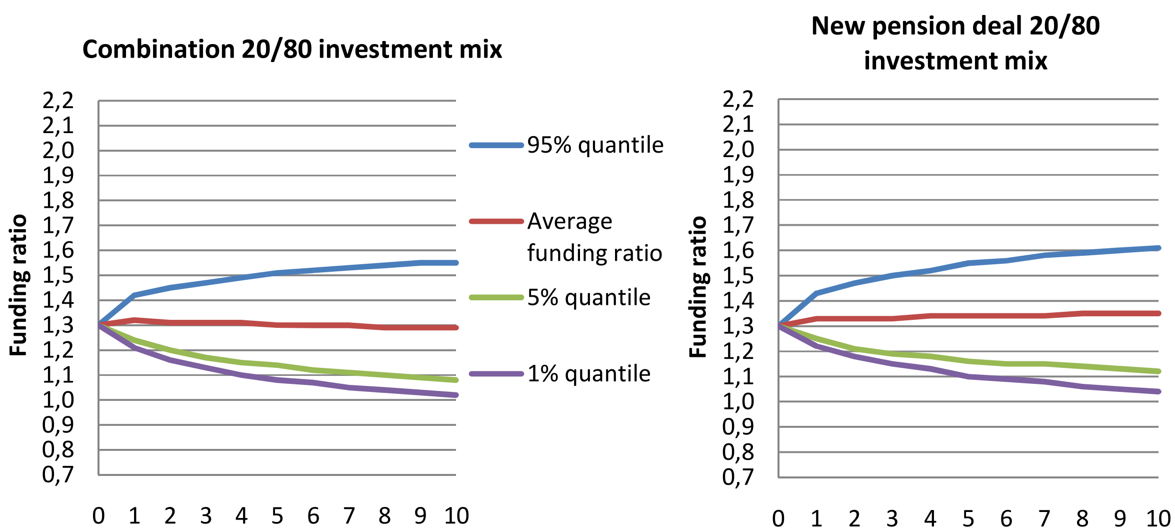

Figure 18: The effects for the solvency when implementing an investment mix of 20% in stocks and 80% in bonds. The left figure shows the Combination contract and the right figure shows the New pension deal.

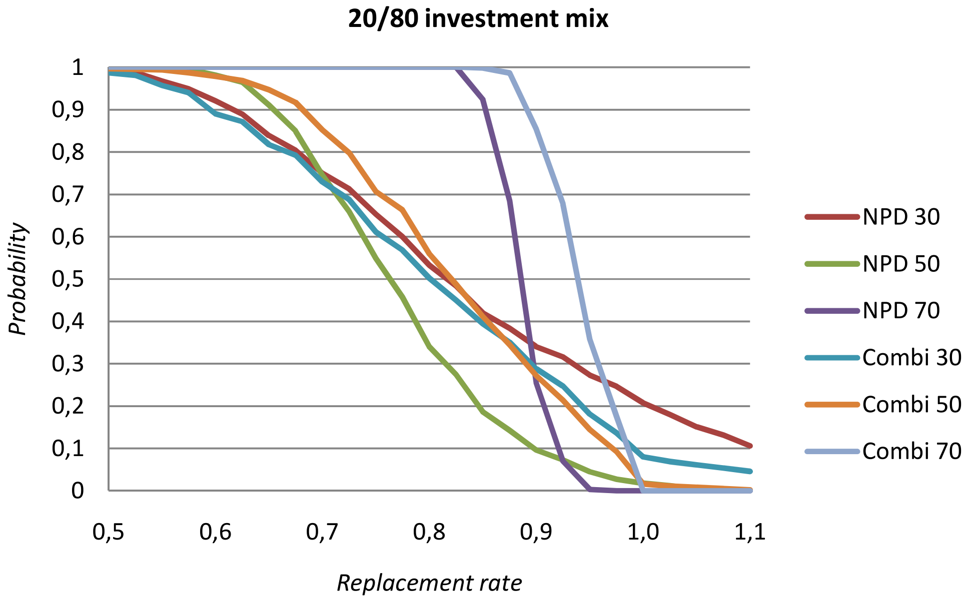

Figure 19: A graphical illustration of the probabilities to attain a certain average replacement rate during retirement. The results are found for implementing an investment mix of 20% in stocks and 80% in bonds.

Another remarkable observation is that the average volatility during retirement is now lower for the Combination contract than for the New pension deal. Moreover the New pension deal now does a better job in terms of solvency than the Combination contract. It is unclear why this is the case, because the reasoning before suggests that the Combination contract always has a higher volatility during retirement and a better solvency position.

Finally, the differences between the two contracts in patterns of pension payments have gotten very small. In general, the expected adjusted pattern will be decreasing during retirement for both contracts. The deviatons have become much smaller due to the less risky investment mix.

	Average volatility during retirement:	
Age	Combination	New pension deal
25	0,04	0,05
30	0,04	0,05
35	0,04	0,05
40	0,04	0,05
45	0,04	0,05
50	0,04	0,05
55	0,05	0,06
60	0,05	0,07
65	0,05	0,07
70	0,04	0,06
75	0,02	0,04
80	0,01	0,02
84	0,00	0,00

Table 11: The effect of implementing an investment mix of 20% in stocks and 80% in bonds for the average volatility of pension payments during retirement. The volatility is expressed in terms of replacement rates.

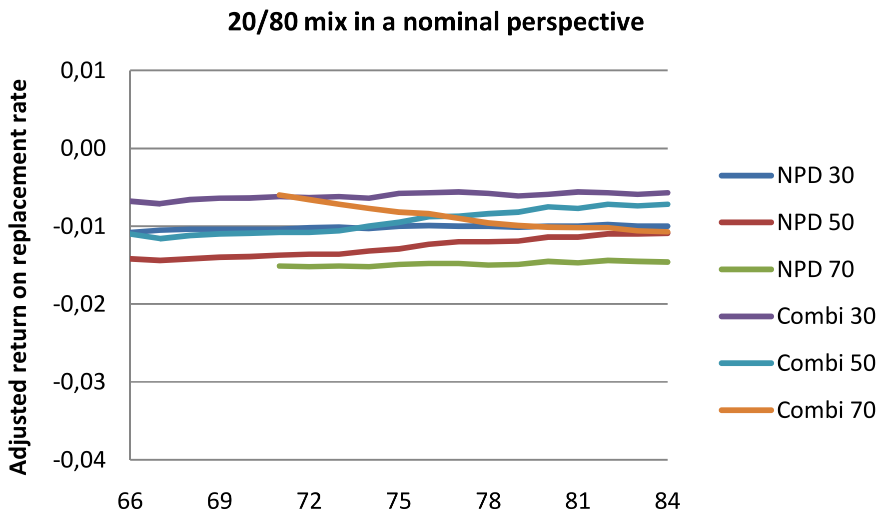

Figure 20: Illustration of average adjusted (in a Kahneman & Tversky way) returns on replacement rates during retirement seen from a nominal perspective.

7. Adjustments in the assessment of the recovery plans by DNB

Dutch pension funds are bounded by the supervision of the Dutch Central Bank (DNB). DNB has the responsibility for the stability of the Dutch pension sector, therefore it has to examine whether the pension funds meet the requirements that are set in the law. In the first section this current legislation is discussed. Afterwards it is evaluated how this works out when funds end up in trouble.

This chapter ignores the discussion in the previous chapter. It concentrates on how the situation is right now. So there is no new pension contract yet and pension contracts are not yet fully described. Note once more that if pension contracts would be fully described, recovery plans wouldn't be necessary at all. This underlines the necessity of introducing a new pension contract. It will increase the understanding of the pension sector. Anyhow, the assessment of DNB cannot remain the same after the new pension deal is introduced.

7.1 Current legislation (Financieel Toetsingskader)

As mentioned before, the Dutch pension funds have to obey the "Financieel Toetsingskader" (FTK). The most important part of the FTK is that all items (so both the assets *and* the liabilities) on the balance sheet of a pension fund should be valued through market value. Formerly pension funds used an actuarial valuation for interest rates. This rate was always the same regardless what happened to the term structure of interest rates. But nowadays pension funds have to use the term structure that is given by DNB every year (DNB uses the swap market). Therefore the funding ratio of pension funds got more volatile. If the interest rates go up, the value of the liabilities goes down and the other way around. In technical terms a pension fund's solvency needs to meet the following two requirements (with fr_t the funding ratio at time t):

1. $P\,[fr_{t+1} < 100\%] < 2.5\%]$*;* If not, the pension fund should recover within fifteen years.

2. $fr_t > 105\%$*;* If not, the pension funds should recover within 3 years. This means that $E\,[frt+3] > 105\%$. However the Minister of Social Affairs and DNB have the possibility to relax this period in case of exceptional events. In a letter to the House of Representatives in February 2009 (Donner, 2009) Minister Donner of Social Affairs used this possibility in order to extend the period of three years to five years.

After the fall of Lehman Brothers in September 2008 stock markets fell and interest rates went down a lot. The average funding ratio of Dutch pension funds was about 137% in June 2008 and fell rapidly to 95% at the end of the year (De Nederlandsche Bank, 2010). In case of such underfunding pension funds need to hand in recovery plans at the DNB. The next paragraphs continue on these recovery plans.

7.2 Assessment DNB of recovery plans

Figure 21 gives an illustration of the technique used by DNB to assess recovery plans. The figure displays a fund that has a funding ratio of 85% in year 0. DNB expects this to be 105% again within 5 years. In a recovery plan a fund specifies measures that will lead to an expected funding ratio of at least 105% in year 5. In this figure this expected path is said to be linear. But what happens to a fund if the funding ratio drops towards for example 75% in the first year? Then according to DNB the fund needs to inform the participants that if the situation does not improve (i.e. the funding ratio has to get back to the recovery path), their rights will be cut in the next year in such a way that the fund gets back to the expected path.

It can be questioned if this should be the approach of the Dutch Central Bank. When a fund hands in the recovery plan, it already knows by definition (due to the uncertainty in the value of the assets and the liabilities) that the truth will be different. It can of course happen that the situation of the fund worsens. Suppose that the situation in the figure would occur in year 4, then suddenly the measure needs to be taken within one year in order to get back to the expected path. In the words of Dick Sluimers (President of APG) DNB should therefore assess pension funds more like "supertankers" and less like "speedboats" (a quote at the hearing of Dutch pension funds at the House of Representatives, November 3, 2010). A possible better way to assess the fund could be to ask a new recovery plan from the fund, with undoubtedly more severe *but gradual* measures. This recovery plan should then lead to an *expected* recovery within again 5 years. This latter notion is the main message of this paragraph. It is argued that the expected funding ratio at a prespecified moment in time should not be leading in the decisions that need to be made by a fund. The future situation of a fund is by definition uncertain. When looking at the fluctuations in funding ratios during the last year, it can be seen that there are drops and increases of ten percentage points each month. Therefore DNB should not force funds to cut rights on the basis of these day to day changes.

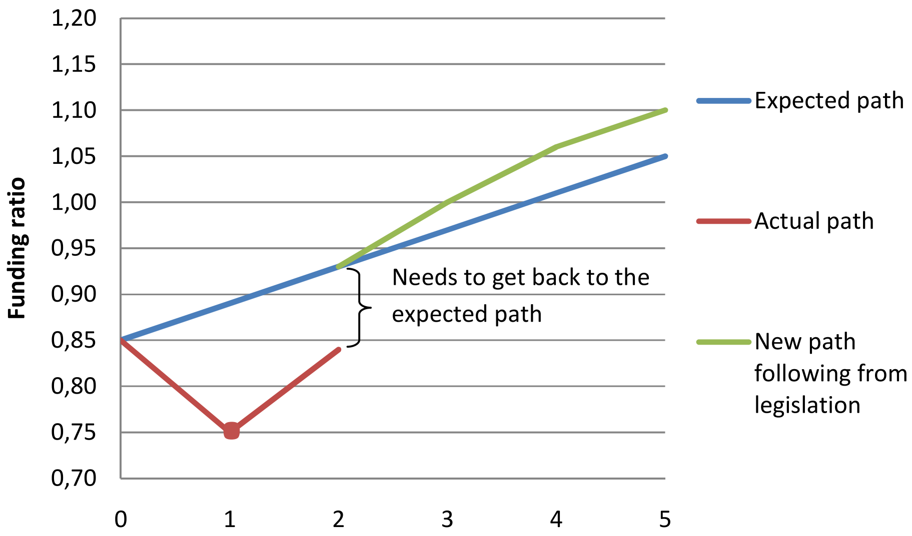

Figure 21: Illustration of how DNB assesses recovery plans. In this example the pension fund should inform their participants in year 1 that if the situation does not improve, rights need to be cut in year 2. In this example this also actually happens in year 2. The green line displays a possible path after the rights have been cut. Note that there is also a possibility that the funding ratio will again drop below the expected path. In that case the same approach is used.

By letting a fund hand in a new recovery plan when it ends up in deeper trouble, there is a risk that the fund keeps postponing the problem and as found out in Chapter 5 this is not a good thing for all participants. Finding a solution to the problem of postponing is very difficult. It is obvious that postponing the problem should not be an option (see Chapter 5), but at the same time a pension fund should not be assessed as it is done now. The problem consists of two parts. On the one hand a fund should not be assessed on the basis of daily rates. In order to find a good answer to that part it would be necessary to create an additional model (a hyper model) that enables the supervisor to find out if an occurring situation is extraordinary or not. Using this model it would then be clear if the assessment is done on the basis of a daily rate or a more structural rate.

The second part of the problem is that a fund should be handled in a softer way than sketched above. A fund needs to get back to its expected path (which is by definition not certain). An answer to this part can be to encourage pension funds to take more gradual measures instead of taking fast and less soft measures.

7.3 Incorporating mean-reversion of interest rates in the recovery plans

In the previous section one inappropriate element of the legislation is brought forward. In this paragraph another important issue concerning the legislation about recovery plans is considered.

The requirements in the FTK do not take a bad economic environment into account. Many economists claim that interest rates are extraordinarily low at the moment (like prof. dr. S. van Wijnbergen), but there also other economists who say that nothing can be said about any forecasts for the interest rates. They often refer to the situation in Japan, where interest rates have stayed low for more than a decade. DNB seems to follow this logic. The policy of DNB is that pension funds should use the occurring term structure at the moment of writing their recovery plan for the evaluation of the future funding ratios. It could be an option to see if a model for future term structures can be incorporated to include future changes in interest rates (De Jong & Pelsser, 2010). Recovery plans show an *expected* recovery path. In such a path pension funds are allowed to use expectations about the returns on their asset side (so also bond returns), but they are not allowed to use expectations about the development of their liabilities. Including a model to do incorporate these expectations could therefore be of added value for the recovery plans of pension funds.

The paper of Pelsser and De Jong suggests to use a mean-reverting process for the term structure. In this way funds can incorporate a possible growth in long-term interest rates. Note that this model would also mean that in times of high interest rates, the interest rates in the long run are implied to go down. The reason for imposing a mean-reverting element on the interest rates is that empirical research has shown that historical data indicate mean-reverting properties of interest rates (Wu & Zhang, 1996).

The most famous interest rate model that uses a mean-reverting process is the Vasicek model. Recall from Chapter 3 that the formula for the evolution of the short rate is given by:

$dr_t = a(b - r_t)\,dt + \sigma\,dW_t$, with W_t a Brownian Motion

When looking at expectations the Brownian Motion will of course drop out. Moreover the drift term is linear. Therefore it is the case that if the current interest rate, the long term average interest rate *b* and the mean reversion factor *a* are known, it is clear what will happen to the interest rates in expectation in a few years. This can be used in recovery plans in order to cope with the (some say extraordinary) situation right now. It can probably be called a compromise between the people who say that it cannot be claimed that the interest rates are low right now (for example Minister Donner) and the people who do claim that interest rates are historically seen very low (for example Wijnbergen, 'DNB blundert bij pensioentoezicht', 2010; and Sluimers, 'Lage rente vertroebelt blik op pensioenfondsen', 2010). Anyhow, in case of low interest rates (relative to the average *b*) it will make the funding ratio go up when looking at forecasts of for example 5 years. Figure 22 gives an example of the difference between the approach brought forward here and the approach used by DNB. After 5 years this new proposed policy will give a benefit for the funding ratio of about 5 percentage points in this specific example. This can make the difference for funds when they have to meet the conditions of the FTK.

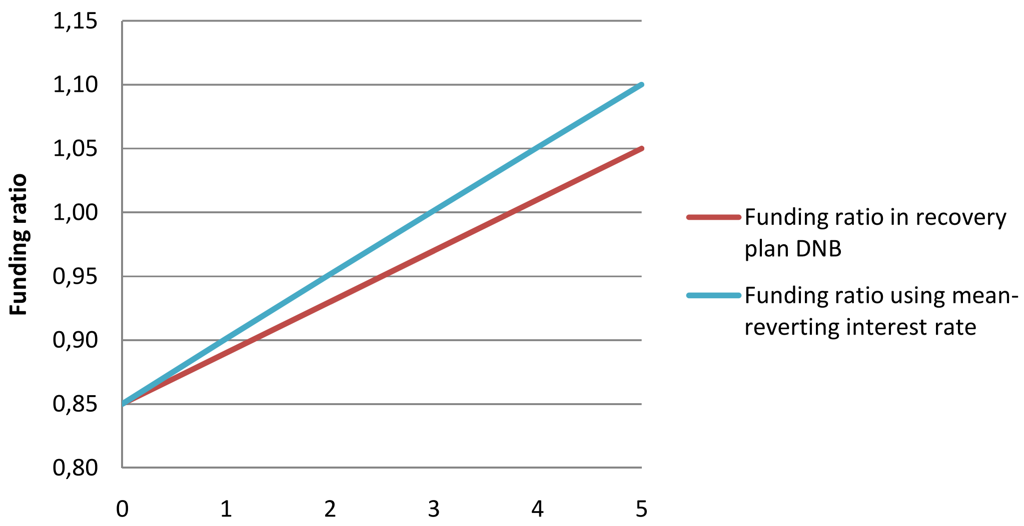

Figure 22: Illustration of the difference between funding ratios when using the current term structure for interest rates for the next 5 years (red line) and using a Vasicek model with a mean-reverting parameter of 0.15 (blue line), an initial interest rate of 2.5% and a long-term average interest rate of 4%.

8. Conclusion & Recommendations

8.1 Conclusion

This thesis investigated the current crisis among pension funds and concentrated on the one hand on how to recover and on the other hand on what the future of the Dutch pension sector should look like.

First of all, the current crisis among pension funds was investigated. This thesis tried to quantify what the effect is of postponing taking negative indexation into account. The contract most pension funds claim to have now is a contract that excludes negative indexation (i.e. they claim to provide nominal guarantees). This contract is compared to a contract that does use negative indexation using value-based ALM. It turns out for the economic values that with each year of waiting to intervene the young pay relatively more contributions and receive relatively less benefits, whereas the old receive relatively more benefits (and at the same time they do not have to pay any contributions anymore). Up to two years of waiting the effects do not seem to be too unfair yet with differences of 3-4%, but as of waiting for more than two years the effects start to result in differences of 10% and more in economic values between generations (note that the current pension crisis started two years ago). The conclusion therefore is that taking negative indexation into account should at least not be postponed for more than two years, because otherwise the young will have to pay the pain of the crisis.

Concerning the pension crisis, the assessment of recovery plans by DNB is also considered. On the one hand it is argued that DNB should not base its assessment on daily rates. Secondly it is argued that DNB should encourage pension funds to take more gradual measures to recover instead of encouraging sudden measures. Moreover pension funds should be allowed to take into account their expectations about future values of the liabilities. Right now they are only allowed to do this for the value of the assets.

Secondly, this research looked at the future of the Dutch pension system. The 'Pensioenakkoord' contained an open end with a call for a new explicitly defined pension contract. This research tried to contribute to the discussion about such a new pension contract. It introduced an innovative framework of anticyclic supervision. This means that the supervisory is more stringent in times of a good economic environment and the other way around. The results are very good. Introducing the anticyclic supervison has hardly any effect on the solvency nor on the average replacement rates during retirement. In other words, no drawbacks have been found and therefore it could be good to incorporate it in a new pension contract.

Furthermore the introduction of age specific indexation is considered. Results show that the policy used in this thesis needs some adjustments. A drawback of age specific indexation is in any case that it has less recovery power. The young face more risk, but have not built up too many rights yet and can therefore not cover very large shocks. An age specific indexation policy does give participants more choice possibilities. An interesting suggestion is to let participants choose their 'age'. This might sound strange, but it has an impact on the risk profile and it is very easy to interpret for participants.

This thesis also introduced a new way to measure the quality of a pension system. Literature indicates that agents want to smooth their consumption pattern over time. Moreover literature and the current pension crisis have shown that agents are scared of losses (in terms of pensions: nominal cuts). By combining these two notions a new performance measure is introduced that gives an indication of the quality of a pension system.

Finally, one of the most striking conclusions of this research is that the typical investment mixes of Dutch pension funds are too risky. Most pension funds have investment mixes of about 50% in equity and about 50% in bonds. By looking at the distribution of replacement rates it however becomes visible that there are relatively large probabilities of very low replacement rates and relatively large probabilities of replacement rates higher than 110%. When introducing an investment mix of 20% in equity and 80% in bonds, this distribution would improve a lot. Moreover it would ensure a better solvency position (when starting in a non-crisis situation).

8.2 Recommendations for future research

There are some recommendations for future research. First of all, in any modelled setting there are model limitations. Future research might include randomness in inflation rates, a more realistic model for interest rates and equity or incorporate more investment opportunities for a pension fund's asset mix. This can also be used to test the riskiness of the investment mixes of pension funds.

Future research could also be dedicated to the anticyclic supervision. This research found no drawbacks of introducing the framework. It could however be interesting to find out if it would really be beneficial for participants. This could be tested in a more psychological setting in order to find out if a cut in bad times is worse than a cut in good times. Moreover it often turns out that cuts in good times are very hard to implement and this has the consequence that anticyclic frameworks fail to do their job (for example Keynesian governmental budget plans). A good way to prevent this should be thought of. In any case the supervisor needs to be strict.

Besides anticyclic supervision, future research concerning a new explicitly defined pension contract could also be dedicated to contracts that consider a dynamic asset allocation. Dynamic asset allocations can be used to ensure certain levels of welfare (for example using a collar approach like Timmermans, 2010). This kind of approach hasn't yet been investigated in very realistic economic settings. This research also showed that the age specific indexation policy considered still needs some adjustments. Future research might consider different concepts and compare them to a uniform policy.

Finally, the assessment of DNB could be programmed in order to make a quantitative comparison between DNB's policy and explicitly defined pension contracts. This comparison can lead to an answer about what would be better for participants. This research claimed that it would be better for participants (and the fund's management) to know beforehand what will happen to the savings in each possible scenario. The last chapter introduced the suggestion to use a hyper model to evaluate whether the assessment of DNB is done on the basis of day-to-day changing rates or on the basis of a structural rate.

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Appendix A: Simulation

Simulation of economic environment

There are three state variables in the economic world considered in this thesis. Stocks, interest rates and (wage) inflation rates. They evolve as described below and are simulated by using Euler discretization.

$$dX_t = d\begin{pmatrix} S_t \\ r_t \\ I_t \end{pmatrix} = \mu_X(t, X_t)dt \ + \ \sigma_X(t, X_t)dW_t = \begin{pmatrix} \mu \, S_t \\ a\,(b - r_t) \\ 0.025 \end{pmatrix} dt + \begin{pmatrix} \sigma_S S_t \\ \sigma_r \\ 0 \end{pmatrix} d\begin{pmatrix} W_{S,t} \\ W_{r,t} \\ 0 \end{pmatrix}$$

$$Y_t = \pi\,(t, X_t) = \begin{pmatrix} S_t \\ r_t \\ I_t \end{pmatrix}$$

Each period starts by paying benefits to the retirees and receiving the contributions of the working participants. Moreover the returns on bonds and assets are collected using the selected investment mix. Then the new value of the liabilities is calculated by discounting all future cash flows back to the occurring moment. Depending on the contract selected (more on this in Appendix B), rights are adapted and the funding ratio is calculated.

The economic value of the contract is calculated by simulating the state variables in a risk-neutral setting. In other words (cf. Schumacher, 2008), with λ the market price of risk and N the Numéraire as described in Chapter 2:

$$dX_t = (\mu_X - \sigma_X \lambda_N)\,dt + \sigma_X\,dW_t \ \text{ with } \lambda_N = \lambda - \frac{\sigma'_N}{\pi_N}$$

The economic value of the contract is then approximated as described in Chapter 2.

The simulation only gives the nominal short rates, but the investment mix of the pension fund also consists of zero-coupon bonds. Because the Vasicek model is used for the development in interest rates, the nominal short rate gives the complete term structure and thus bond prices for all maturities. The complete term structure is also necessary to calculate the value of the liabilities. The formula that is used to calculate the complete term structure is as follows (P(t,T) indicates the price of a zero-coupon bond at time t with maturity T, β represents the *risk-adjusted* long term average short interest rate):

$$P(t,T) = exp\left[-\left(\left(\beta - \frac{\sigma^2}{2a^2}\right)(T-t) + \left(r_t - \beta + \frac{\sigma^2}{a^2}\right)\frac{1-e^{-a(T-t)}}{a} - \frac{\sigma^2}{2a^2}\frac{1-e^{-2a(T-t)}}{2a}\right)\right]$$

The standard rule for calculating the interest rate from a bond price, now gives the term structure of interest rates:

$$R(t,T) = \beta - \frac{\sigma^2}{2a^2} + \left(r_t - \beta + \frac{\sigma^2}{a^2}\right)\frac{1-e^{-a(T-t)}}{a\,(T-t)} - \frac{\sigma^2}{2a^2}\frac{1-e^{-2a(T-t)}}{2a\,(T-t)}$$

Assumptions necessary for replication results:
Below are all assumptions that are necessary to replicate the results in this thesis.

- The composition of the pension fund starts with the composition of the average Dutch working force in 2010 and evolves according to the expectations of Statistics Netherlands. In the case of looking at a young or old pension fund, the fund starts with the composition that can be called old for example (i.e. more participants in the older age cohorts) and evolves towards a fund that is more average (according to Statistics Netherlands).
- The maturity of zero coupon bonds is chosen at 10 years. The bonds are refreshed each period in order to make sure that the maturity remains equal.
- In the simulation a starting funding ratio can be selected. The value of the assets is then set in such a way that the funding ratio will equal the chosen value.
- In the hypothetical economy all people earn the same salary, which has the consequence for the pension fund that all working participants pay the same amount of contributions.
- Each period the new assets value is computed by adding the gains (or losses) from the investments policy and adding the residue of contributions and pension payments to the old assets value.
- The term structure of interest rates that is used for the computation of bond prices is the same as the term structure used to discount future payments (i.e. calculating the value of the liabilities).
- When computing quantiles, all scenarios are sorted from very bad to very good (i.e. in the case of funding ratios: from low funding ratios to very high funding ratios). For example, the 5% quantile is found by looking at the 500th sorted scenario in the case of a simulation of 10000 scenarios.
- Replacement rates are calculated by comparing the pension payment and the occurring salary in a specific period. The ratio of the two expresses the replacement rate.
- Economic values are found by using the expression in Chapter 2. Each period the ratio of a payment and the Numéraire is taken. Then they are summed and finally the average is taken. This is done for each cohort separately.
- For the Kahneman & Tversky figures the return on replacement rates is first calculated (by $\frac{X_{t+1}-X_t}{X_t}$). In the case of a real perspective, the return is multiplied by 2.25 in case it is negative. In the nominal perspective it is multiplied by 2.25 in case it is less than -2.5% (the wage inflation rate).

Appendix B: Detailed description pension contracts

This appendix gives a detailed description of how all pension contracts considered work in detail.

Doing nothing:

Funding ratio (fr)	Consequence for contributions	Consequence for rights
fr < 105%	Increased with: $\min\left(0.05, \frac{1.05-fr}{5}\right)$	No indexation
105% < fr < 140%	Remains equal	$\frac{fr-1.05}{1.4-1.05} \cdot inflation$
140% < fr < 190%	Remains equal	Full indexation
fr > 190%	Remains equal	Full indexation + $\frac{fr-1.9}{3}$

Combination:

Funding ratio (fr)	Consequence for contributions	Consequence for rights
fr < 105%	Increased with: $\min\left(0.05, \frac{1.05-fr}{5}\right)$	Cut with: $\frac{1.05-fr}{5}$
105% < fr < 140%	Remains equal	$\frac{fr-1.05}{1.4-1.05} \cdot inflation$
140% < fr < 190%	Remains equal	First recovery indexation (in case of negative indexation before, with a recovery period of 3 years) and full indexation.
fr > 190%	Remains equal	Full indexation + $\frac{fr-1.9}{3}$

Age specific indexation:

The age specific indexation contract follows the formula already given in Chapter 3 to determine the new rights of participants. The formula is as follows:

$$2 \cdot \frac{Funding\ ratio - Lower\ bound}{Upper\ bound - Lower\ bound} \cdot \left(fixed + variable \cdot max\left(\frac{65 - age}{65 - 25}, 0\right)\right)$$

The lower bound and upper bound are set at fixed rates of 1.05 and 1.40 respectively. For the contributions the same concept is used as for the previous two contracts.

New pension deal:
The new pension deal uses the same formula as the age specific indexation contract, but the difference now is that the lower and upper bound move along with the economic environment. The table below shows how it works.

First recall that interest rates follow the following process: $dr_t = a\,(b - r_t)\,dt + \sigma\,dW_t$

Short interest rate (r_0)	Lower bound	Upper bound
$r_0 < b - \sigma \cdot 1.28$	90%	125%
$b - \sigma \cdot 1.28 < r_0 < b + \sigma \cdot 1.28$	105%	140%
$r_0 > b + \sigma \cdot 1.28$	120%	155%

The number 1.28 might look strange, but the choice has to do with the normal distribution implied by the Brownian Motion. The effect of choosing this parameter value is that an interest rate that can only occur with 10% probability on both tails indicates a different economic environment. The only difference for the contribution rates is that also for this choice the new upper and lower bound are used. So in a good economic environment participants already have to pay additional contributions when the funding ratio is for instance 115%.

Appendix C: Details of welfare analysis

Due to graph limitations the results in Chapter 6 are not given for more age cohorts. The tables below show the result for the New pension deal, the Age specific indexation contract and the Combination contract respectively. The first two tables show that the differences between the new pension deal and the age specific indexation contract are very small. The first and third table show results that are in line with the figures in Chapter 6 (using a 50/50 investment mix).

New pension deal:

Desired level\age	25	30	35	40	45	50	55	60	65	70	75	80	84
0,50	0,89	0,90	0,90	0,92	0,94	0,98	1,00	1,00	1,00	1,00	1,00	1,00	1,00
0,55	0,85	0,85	0,85	0,87	0,90	0,94	0,99	1,00	1,00	1,00	1,00	1,00	1,00
0,60	0,81	0,80	0,81	0,80	0,81	0,86	0,95	1,00	1,00	1,00	1,00	1,00	1,00
0,65	0,76	0,75	0,75	0,74	0,73	0,77	0,85	0,98	1,00	1,00	1,00	1,00	1,00
0,70	0,72	0,71	0,69	0,67	0,66	0,67	0,73	0,88	1,00	1,00	1,00	1,00	1,00
0,75	0,67	0,65	0,63	0,61	0,59	0,58	0,60	0,71	0,99	1,00	1,00	1,00	1,00
0,80	0,63	0,60	0,58	0,54	0,51	0,48	0,48	0,54	0,81	0,99	1,00	1,00	1,00
0,85	0,59	0,55	0,52	0,48	0,44	0,41	0,38	0,39	0,53	0,76	1,00	1,00	1,00
0,90	0,54	0,51	0,48	0,43	0,39	0,34	0,29	0,27	0,30	0,40	0,70	1,00	1,00
0,95	0,50	0,48	0,43	0,38	0,34	0,29	0,22	0,18	0,16	0,15	0,17	0,48	1,00
1,00	0,48	0,44	0,39	0,35	0,30	0,23	0,15	0,10	0,06	0,03	0,01	0,00	0,00
1,05	0,45	0,41	0,36	0,32	0,25	0,17	0,12	0,05	0,02	0,01	0,00	0,00	0,00
1,10	0,42	0,38	0,34	0,29	0,22	0,14	0,08	0,03	0,01	0,00	0,00	0,00	0,00

Age specific indexation:

Desired level\age	25	30	35	40	45	50	55	60	65	70	75	80	84
0,50	0,89	0,89	0,91	0,93	0,95	0,98	1,00	1,00	1,00	1,00	1,00	1,00	1,00
0,55	0,85	0,85	0,85	0,87	0,90	0,95	0,99	1,00	1,00	1,00	1,00	1,00	1,00
0,60	0,81	0,80	0,81	0,81	0,82	0,87	0,96	1,00	1,00	1,00	1,00	1,00	1,00
0,65	0,76	0,76	0,74	0,74	0,74	0,77	0,85	0,99	1,00	1,00	1,00	1,00	1,00
0,70	0,72	0,70	0,69	0,66	0,66	0,68	0,74	0,90	1,00	1,00	1,00	1,00	1,00
0,75	0,67	0,65	0,63	0,60	0,59	0,57	0,60	0,73	0,99	1,00	1,00	1,00	1,00
0,80	0,63	0,60	0,58	0,54	0,50	0,48	0,48	0,53	0,84	1,00	1,00	1,00	1,00
0,85	0,58	0,56	0,53	0,48	0,44	0,41	0,39	0,39	0,54	0,79	1,00	1,00	1,00
0,90	0,54	0,51	0,47	0,42	0,39	0,35	0,28	0,26	0,29	0,38	0,73	1,00	1,00
0,95	0,50	0,48	0,43	0,39	0,34	0,28	0,22	0,17	0,15	0,14	0,15	0,48	1,00
1,00	0,48	0,44	0,39	0,35	0,29	0,23	0,16	0,09	0,05	0,03	0,01	0,00	0,00
1,05	0,45	0,40	0,36	0,31	0,25	0,17	0,12	0,05	0,02	0,01	0,00	0,00	0,00
1,10	0,42	0,37	0,33	0,28	0,21	0,14	0,08	0,03	0,01	0,00	0,00	0,00	0,00

Combination:

Desired level\age	25	30	35	40	45	50	55	60	65	70	75	80	84
0,50	0,90	0,89	0,88	0,88	0,90	0,94	0,97	0,99	1,00	1,00	1,00	1,00	1,00
0,55	0,85	0,85	0,85	0,85	0,86	0,89	0,95	0,99	1,00	1,00	1,00	1,00	1,00
0,60	0,82	0,81	0,81	0,81	0,82	0,84	0,89	0,97	1,00	1,00	1,00	1,00	1,00
0,65	0,78	0,78	0,76	0,76	0,76	0,77	0,83	0,92	1,00	1,00	1,00	1,00	1,00
0,70	0,74	0,73	0,72	0,71	0,70	0,71	0,76	0,85	0,98	1,00	1,00	1,00	1,00
0,75	0,69	0,68	0,65	0,64	0,63	0,64	0,68	0,78	0,93	0,99	1,00	1,00	1,00
0,80	0,64	0,61	0,60	0,58	0,56	0,56	0,60	0,68	0,84	0,94	1,00	1,00	1,00
0,85	0,59	0,55	0,53	0,50	0,48	0,48	0,50	0,56	0,70	0,83	0,98	1,00	1,00
0,90	0,53	0,51	0,48	0,46	0,43	0,42	0,42	0,45	0,54	0,67	0,85	1,00	1,00
0,95	0,49	0,47	0,43	0,40	0,37	0,36	0,33	0,32	0,35	0,41	0,53	0,91	0,91
1,00	0,45	0,42	0,39	0,36	0,32	0,28	0,24	0,20	0,15	0,10	0,05	0,00	0,00
1,05	0,42	0,39	0,36	0,33	0,29	0,25	0,19	0,14	0,09	0,04	0,01	0,00	0,00
1,10	0,39	0,36	0,33	0,29	0,26	0,21	0,16	0,11	0,05	0,02	0,00	0,00	0,00

Appendix D: Sensitivity analysis

This thesis used models to forecast future economic scenarios. Of course these scenarios do not correspond to the real world and different assumptions may cause differences for the conclusions drawn in this thesis. Therefore this sensitivity analysis concentrates on two parameters/assumptions that might cause differences that are unexpected (when for example choosing a higher expected return on equity the results will not be surprising). The first one is the mean reversion parameter implied by the Vasicek model of interest rates. The second assumption deals with the composition of the hypothetical pension fund. Note that all results found in this sensitivity analysis are obtained by looking at the Combination contract.

Effect of changing the mean reversion parameter

This thesis used a value of 0.15 for the value of the mean reversion parameter a. The next figures show the most common results of this thesis after changing the value of a to 0.08. This means that it takes longer for the interest rates to revert back to the mean. The following figures show the results on the solvency and the welfare analysis. The results are quite in line with what could be expected, namely that it will increase the uncertainty.

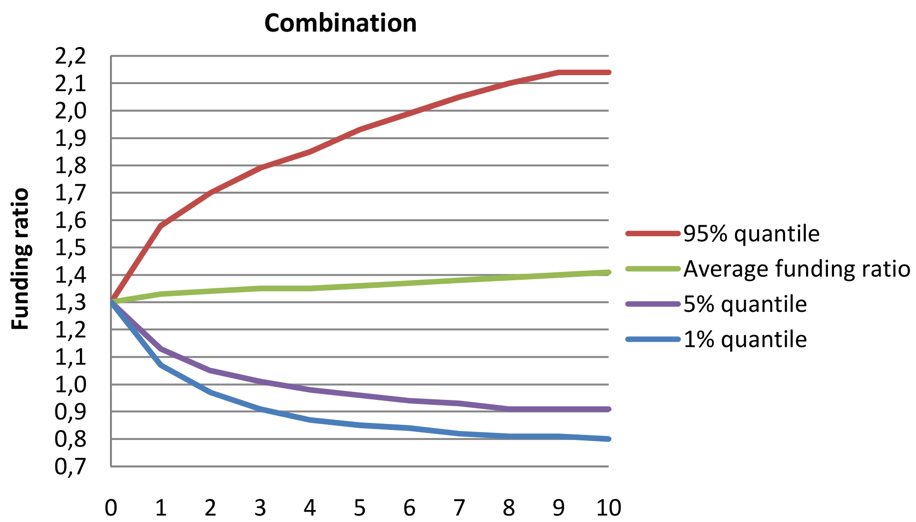


Figure 23: Effect on solvency for Combination contract when implementing different mean reversion parameter.

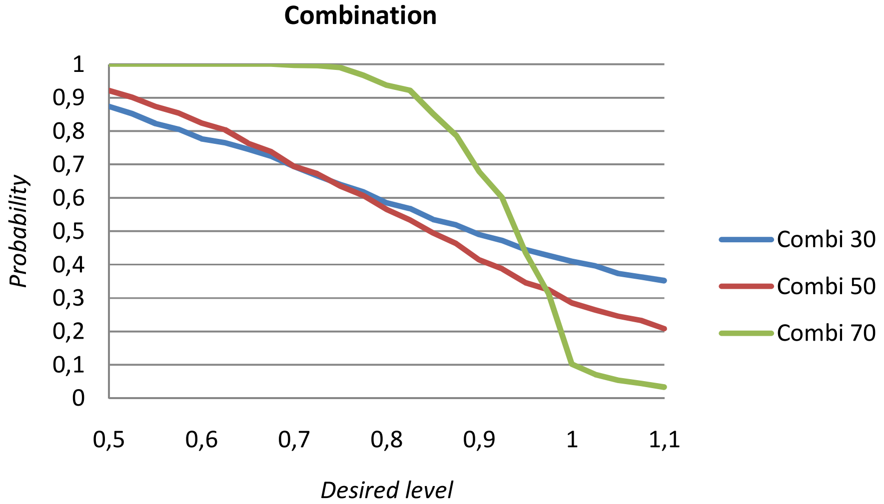


Figure 24: Effect on welfare picture when implementing a different mean reversion parameter.

Age	Average volatility during retirement
25	0,20
30	0,18
35	0,16
40	0,14
45	0,12
50	0,10
55	0,09
60	0,09
65	0,08
70	0,06
75	0,04
80	0,01
84	0,00

Table 12: Effect on average volatility during retirement when implementing a different mean reversion parameter. The results are found for the Combination contract.

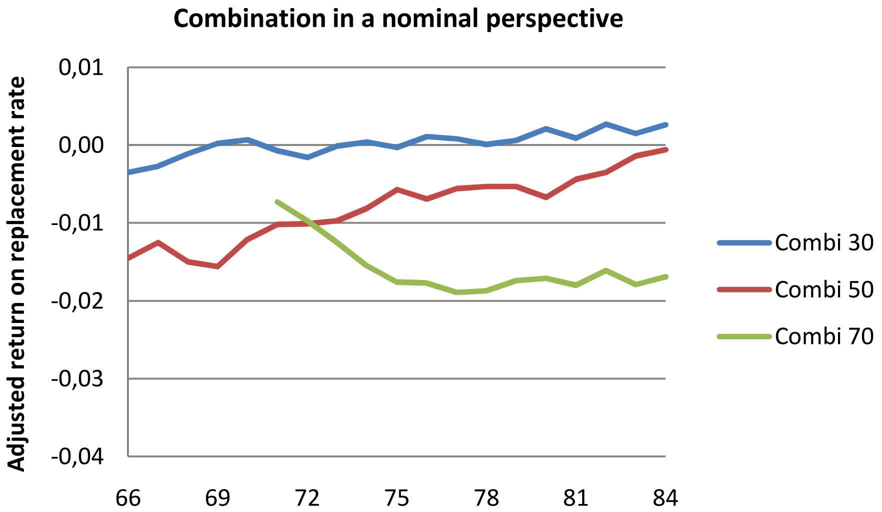


Figure 25: Effect on Kahneman & Tversky picture after implementing a different mean reversion parameter.

Effect of young/old fund:

The results found in this thesis are based on a pension fund that has a composition according to the average Dutch working force. There are however differences between pension funds. Some pension funds have relatively many old participants (i.e. retirees) and some have relatively many working participants. The following figures show the results of using different compositions. The average fund that is used in this thesis amounted to about 40% of the rights for the retirees. The young and old fund have 32% and 49% of the rights for retirees respectively.

The differences are not very large between the funds. The effects on solvency are in favor of the old fund, which is obvious because older participants have more recovery power than young (more rights). This also means that for the young fund the younger participants have a somewhat less positive welfare picture. All in all the results do not differ very much.

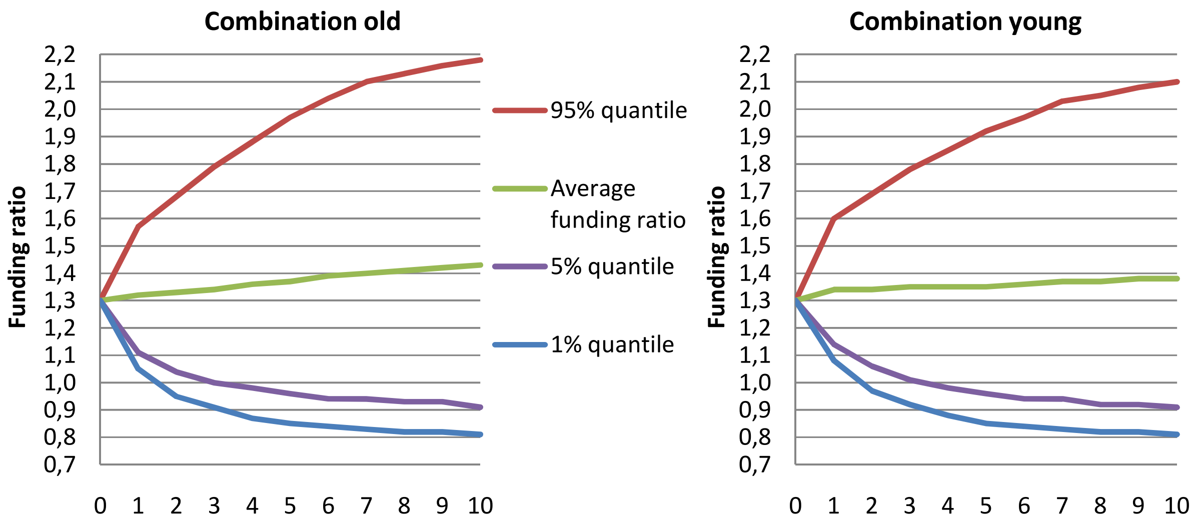


Figure 26: Effect on solvency for different pension fund compositions.

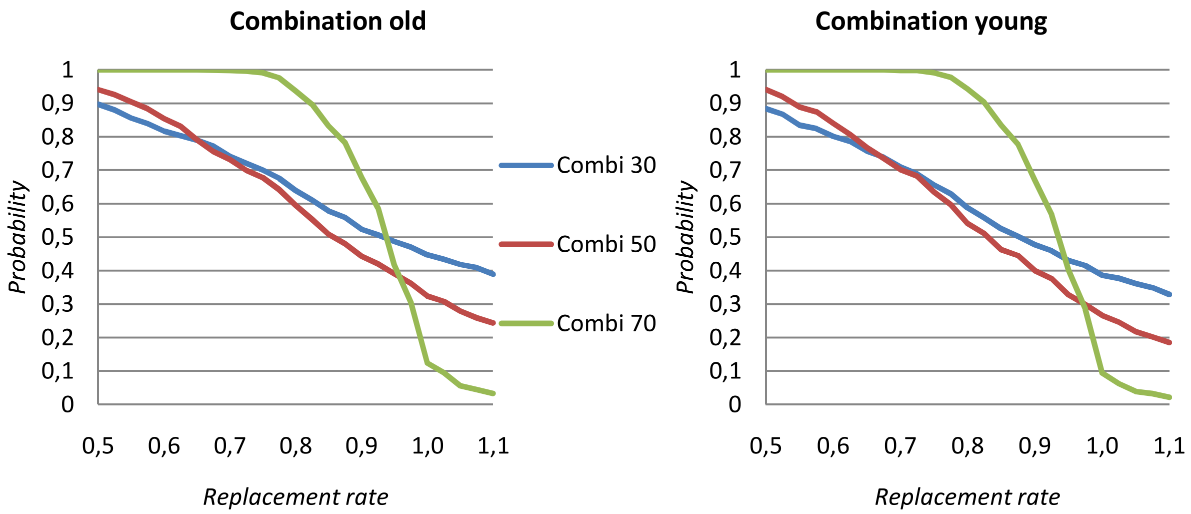
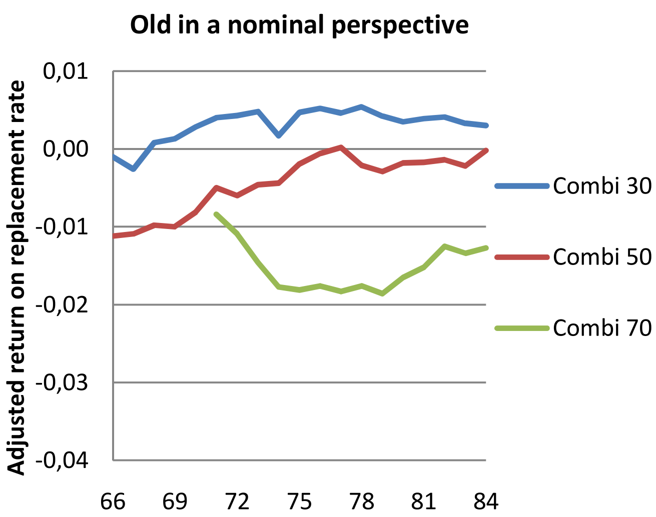


Figure 27: Effect on welfare picture for different pension fund compositions.

Age	Average volatility during retirement: Old	Young
25	0,19	0,16
30	0,18	0,15
35	0,15	0,12
40	0,13	0,10
45	0,11	0,09
50	0,10	0,09
55	0,09	0,08
60	0,09	0,08
65	0,08	0,08
70	0,06	0,06
75	0,04	0,04
80	0,02	0,01
84	0,00	0,00

Table 13: Effect on average volatility during retirement for different pension fund compositions.



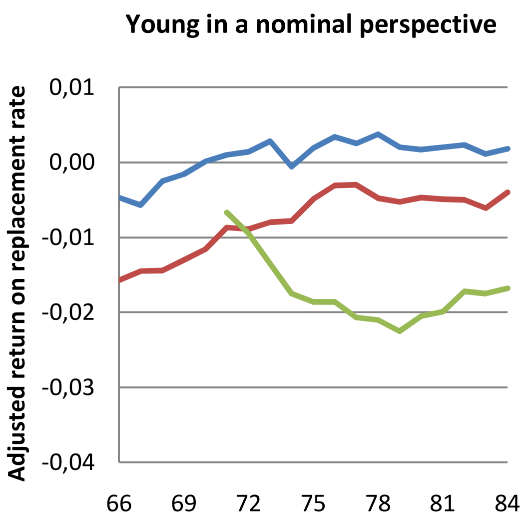


Figure 28: Effect on Kahneman & Tversky figure for different pension fund compositions.