Increasing life expectancy at pension funds

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Abstract

The increasing life expectancy of the Dutch population is an upcoming problem in the Dutch pension world. The costs of the Dutch pension system will increase to very high levels if no measures are taken. The increase of the AOW age is the first step taken by the government. The pension funds have to adapt to this change. The Social Partners have reached an agreement which includes two methods to take measures for the increasing life expectancy at pension funds and to adapt to the increasing AOW age. In this master thesis the two methods are modeled and discussed. We will look at the impact of both methods on a younger fund and an older fund. Results show that the costs for pension funds will be reduced by using one of the methods for both funds.

Contents

1 Introduction

In October 2010 the Dutch pension system is selected to be the best pension system of the world by researchers of the University of Melbourne (Australian Centre for Financial Studies & Mercer, 2010). Good points that are noticed by the researchers are the facts that 90% of the Dutch employees are accruing pension benefits, the amount of the pensions and the tenability of the pensions. Also the Dutch Central Bank (DNB) is seen as a good supervisor for the Dutch pension funds and takes measures in time.

This news about the Dutch pension system comes just in a period full of discussion about the system and the pension funds. The economic crisis and the increasing life expectancy have a lot of consequences for the pension world. The costs for pension funds are increasing continuously and they become less resistant against financial shocks. Last years the dangerous situation of pension funds is a hot item.

1.1 Problem description

Although the Dutch pension system is the best of the world there are also comments about the system. According to the researchers the Dutch pension system needs a better protection, a higher retirement age and more labor participation of older people (Australian Centre for Financial Studies & Mercer, 2010). These are important points for our pension system which is always on the move.

The Dutch pension system consists of three pillars (Ministerie van Sociale Zaken en Werkgelegenheid, 2009). The first pillar, which is introduced in 1957, is called the AOW (social security benefit for elderly) and is arranged by the government. The second pillar consists of pensions for employees enabled by their employer. These pensions are arranged by pension funds which are related to the employer and the working sector. The third pillar is an individual pillar, people have the possibility to take a life insurance or to invest. These are possibilities for people who think their accrued first and second pillar pension benefits are not sufficient.

Last years the economic crisis, the increasing life expectancy and the ageing of the population bring on problems in the Dutch pension system (Goudswaard et al., 2010). Not only the second pillar pensions but also the AOW get into danger because of the large amount of costs. The government has arranged the committee Frijns to research the risk management and investment policy of pension funds (Frijns et al., 2010), and the committee Goudswaard to check the future proofing of the second pillar pensions (Goudswaard et al., 2010).

The first measures the government is taking to save the AOW is an increase of the AOW age. In 2020 the AOW age will increase to 66 and from 2025 on it will be 67. Through this agreement the AOW payments will start at a higher age and therefore take place for a shorter period. This will decrease the costs of the AOW. If the retirement age of the second pillar will remain 65, there would arise a gap between the AOW age and the retirement age. For participants it will be very difficult to understand and to take measures. The question now is how pension funds will respond to the increasing AOW age and what the consequences will be of the potential measures.

1.2 Research description

In June 2010 the Social Partners reached a pension agreement about the pensions in the second pillar. With this pension agreement they not only want to establish the premium costs for the employers and employees but they also want to make the pensions more stable with respect to increasing life expectancy and financial shocks. Therefore the retirement age has to be adapted to the increasing AOW age. In the pension agreement the Social Partners have described two methods to implement the increasing life expectancy in the second pillar.

In both methods the retirement age follows the new AOW age. In the first method the level of the pension payments will remain the same but the retirement age will follow the increasing AOW age which means the payments start later. The liabilities and provisions will be adapted to these changes and therefore will decrease for the second pillar just as the first pillar. In the second method the retirement age will also be the same as the new AOW age. Besides that the total pension ambition will be the same for participants of a fund with the same accrued pension benefits and depends on a chosen retirement period. A couple of years before a participant reaches its retirement age, the monthly pension payments will be recalculated. The recalculated amount of the payments depends on the age specific remaining life expectancy at that moment. One of these methods will be chosen to incorporate the increasing life expectancy from 2011 on.

In this master thesis we are going to model the two methods of the pension agreement which are described above. After modeling these methods, we will have a look at the impact for pension funds if they will use one of these methods. To look at the impact for different pension funds we will compute the methods for two different pension funds with the software of Ortec Finance. Also at the end we will give an advice which method we prefer.

The first pension fund is a fund with relatively young and high educated participants. Because the participants are young, the increasing retirement age will be applied to the largest part of the participants. The participants of the second pension fund are older which means that there are more accrued benefits and the pension agreement will have less impact because there are more participants who are retired before 2020. This pension fund has more participants and the participants are lower educated. In comparison to the first pension fund the remaining life expectancy of these participants at the age of 65 is lower. Besides the impact of the two pension agreement methods for each fund, a comparison will be made between the two funds.

1.3 Overview

Before the modeling and implementation of the two pension agreement method, first we will have a look at the situation of pensions in The Netherlands. In chapter 2 an introduction to the Dutch pension system is given. After that the recent developments of the Dutch pension system are described: the increase of the AOW age and the agreement of the Social Partners. The reason for the agreement of the Social Partners, the problems of the second pillar pensions, and possible solutions are described in the same chapter.

In chapter 3 longevity risk, an important problem for pension funds, is described. A summary of literature about longevity risk is given. To manage this longevity risk the Social Partners came to an agreement which includes two different methods.

The liabilities of pension funds using these two methods are modeled in chapter 4. The first model shows the pension liabilities of an old age pension as they are modeled nowadays.

The second and third model show the liabilities of an old age pension with the methods of the pension agreement. For each model an example is attached to explain the model and the changes according to the pension agreement.

The results of this master thesis are computed with the Asset Liability Scenario system of Ortec Finance. A description of this system is given in chapter 5. Before we could compute any results, extra programming work have to be realized in the system. The adaptations are also described in this chapter.

Chapter 6 shows the results of the three models described in chapter 4. First we will have a look at the impact of the pension agreement methods at the old age pension for both pension funds. After that we will look at the impact if we will use the pension agreement also for other pension types like a widowers pension. With these results we can make an evaluation of the impact for a whole pension fund.

A summary, the conclusions and recommendations are given in the last chapter.

2 Pensions in The Netherlands

In this chapter an overview of the Dutch pension system is given. After that the agreement of the government about the increasing AOW age is described with corresponding comments. The problems of the second pillar and the solutions of different researchers are also discussed. In the last section the agreement of the Social Partners, to take measures for the second pillar pensions, is described.

2.1 The Dutch Pension System

In 1957 the minister of Social Affairs and Public Health introduced the first pillar, the AOW. This is a social security which provides elderly a minimum income. Every person who has lived in The Netherlands for 40 years, between the age of 15 and 65, receives monthly payments from the age of 65 until death. The amount of the payments depends on the living status. People who live together receive a lower payment than single people. Yearly the amount of the payments is secured by the government. This AOW system is a so called pay-as-you-go (PAYG) scheme. The costs of the AOW payments are financed by the working people, they pay wage taxes and income taxes to provide the AOW (Ministerie van Sociale Zaken en Werkgelegenheid, 2009).

Instead of the first pillar, the second pillar is a private pension with compulsory participation. Most companies are joining a pension fund related to their working sector, have an own pension fund or are related to an insurer to provide their employees a supplementary pension. There are 630 different pension funds in The Netherlands which provide pensions for more than 8.5 million people. Together the total value of the assets of all pension funds is more than 700 billion euro (Goudswaard et al., 2010). The second pillar is called a funded pension scheme (Ministerie van Sociale Zaken en Werkgelegenheid, 2009). The pension payments are financed by premiums which are paid by the employers and employees during their working period. Employers pay a large part of the premiums for their employees. The smaller employees' part of the premium is restrained from their salary. The level of the pension payments depends on the salary, accrual percentage, number of worked years of the employee and the pension plan. Before 2002 most of the pension funds had a final pay system, since 2002 most of the funds have switched to an average pay scheme.

Besides the AOW and the supplementary pensions, people also have the possibility to save money by themselves. Self-employed people or people with a pension gap (if you have not accrued enough pension benefits for your retirement period) have other possibilities like life insurances, annuities or investments to save (extra money) for their retirement.

2.2 Increasing AOW age

The AOW age of 65, determined in 1957, was at that time based on the remaining life expectancy of people aged 65. During the years the remaining life expectancy of 65 year old people increased (Bovenberg et al., 2006). Nowadays women have a life expectancy of 86 if they are 65 and men of the same age have a life expectancy of 83. According to the prognoses the life expectancy will further increase the upcoming years, which we can see in figure 1[1]. This results in a lot of discussions about the AOW age. The longer the people live the longer

[1] www.abvakabofnv.nl/PDF/bondsraad/dossier-aow1/244975

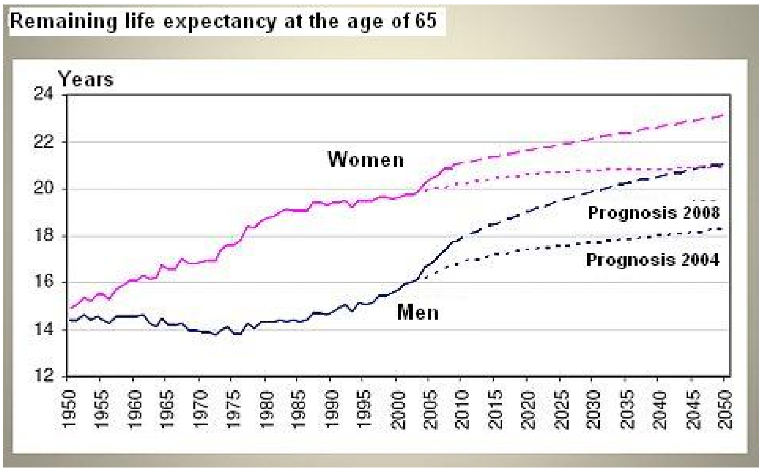

Figure 1: Remaining life expectancy at the age of 65

they will receive AOW payments and the more expensive it will be. If the life expectancy increases with one year, the AOW liabilities increase with at least 3% (Biffis & Blake, 2009). The AOW costs would rise from 4.7% of GDP in 2006 to 8.8% of GDP in 2040 (Bovenberg & Gradus, 2008). From the eighty years on there have been discussions to increase the AOW age which decreases the period of AOW payments.

Not only the increasing retirement period but also the labor shortage will be a growing problem in the future. The post-war baby-boom generation retires from 2010 onwards. This means the number of retirees will increase a lot from this moment and the labor force will reduce substantially. Nowadays 24.6% of the population is retiree, in 2040 this will be 48.8% (Goudswaard et al., 2010). For the Dutch pay-as-you-go AOW scheme this means a radical change in the proportions between the labor force and the retirees. The labor force has to finance the AOW payments of the retirees, the larger the costs of the AOW the more taxes working people have to pay. An increase of the AOW age will increase the labor force and will decrease the payment period which reduces the problems.

In October of 2009 the government reached an agreement about an increase of the AOW age (Sociale Partners, 2010). In 2020 the AOW age will increase to 66 and in 2025 it will further increase to 67. These changes are announced ten years before the increase will take place, that way people have the possibility to prepare themselves for these changes. People who are born before 1955 are 65 years old before 2020, this means that their AOW age remains 65. For people who are born in 1955, 1956, 1957 or 1958 the AOW age will increase to 66. This means they will reach the AOW age in 2021, 2022, 2023 or 2024. From 2025 onwards the AOW age will be 67, this has consequences for every person born after 1958. People have the possibility to receive AOW payments before their AOW age. For every year they force their payments, the payments decrease with 6.5% (Sociale Partners, 2010). With these adaptations the government tries to get the costs of the AOW payments under control.

There is a lot of criticism about the law amendment for the new AOW age. Besides the increasing life expectancy of the Dutch people, the difference in life expectancy between lower and higher educated people increased with seven years. The number of years people are living without disabilities also increases but people get chronic illnesses at a younger age (Bruggink et al., 2009). Besides criticism about the healthiness of people, it is also difficult for older employees in the Netherlands to get a job. It is not very attractive for employers to sign on old people.

By means of the higher AOW age, people have to work longer but are there enough possibilities for older people to get a job? The position of the older employee is very uncertain. During the economic crisis a lot of people have lost their job. Mostly these are the older employees in an organization because they are too expensive and not very productive for the employer. The longer employees have to work the more expensive they will be and the more difficult their position in the labor market (Buevink, 2009).

The difference in life expectancy between social economic groups is increasing. Lower educated people have more health problems than higher educated people. The higher educated people live longer and also they live longer without disabilities (Bruggink, 2009). Nowadays the AOW age is the same for all people, even the queen and other people with a large amount of capital receive it. Therefore it is a solidarity based system but it is also seen as an unfair system. Lower educated people have to work as long as higher educated people but they can enjoy their AOW for a shorter period. In fact the lower social economic groups pay for themselves and the higher educated people (Bovenberg et al., 2006). Also the question arises if lower educated people are available to work until their 67th birthday or are they unable to work because of their disabilities. Despite these differences the AOW age remains the same for all people in The Netherlands.

2.3 Problems and solutions of the second pillar pensions

The second pillar is a large and important part of the Dutch pension system. The first and second pillar together are mostly the total income of a Dutch retiree. The ambition of the Dutch retirement system is that retirees receive a total income (including AOW) of 70% of their last received salary. Before the economic crisis the pension seemed to be a guarantee for all people (Goudswaard et al., 2010). The pensions payments of pension funds were certain payments and almost every year there was indexation to compensate inflation. Sometimes participants even do not have to pay premiums, then there was talk of a premium holiday. The funding ratios of the pension funds, this is the market value of the assets divided by the market value of the liabilities, were increasing every year. The buffers of pension funds rose. The growing value of the assets was the most important reason of these increasing funding ratios. The investment portfolios of pension funds consisted of a large part of risky stocks and the rest of riskless bonds. At that time the stock exchanges had high values and there seemed to be less risk. No employee was worried about his pension after retirement.

During the first economic crisis, the Dotcom crisis at the begin of the twentieth century followed by terrorist attacks at September 11, 2001, the interest rates and the value of assets decreased dramatically. This has a lot of consequences for the pension funds. The provision needed to guarantee the pension payments is based on the future cash flows (liabilities) discounted with the interest rate. The larger the interest rate the lower the provision, the smaller the interest rate the higher the needed provision. Because of the crisis the value of the needed pension provision increased but the value of the assets decreased. This means the funding ratios have declined and the buffers of the pension funds disappeared fast. To maintain the same guaranteed pension ambition, measures had to be taken.

Because of this crisis the premiums are increased by pension funds to the cost covering contribution and the final pay schemes are switched to conditionally indexed average pay schemes.

Indexation is no longer guaranteed but is dependent of the funding ratio of the pension fund. This results in not fully guaranteed pension payments. The full guaranteed pension ambitions of pension funds are no longer possible, these are too expensive (Goudswaard et al., 2010).

In 2008-2009 the second financial crisis, the credit crisis, started with the collapse of Lehman Brothers. During this crisis the carefreeness about the pensions left. The funding ratios decreased further to problematic low values. They even decreased below a level of 100% which means that there is underfunding. Therefore there occurs more and more questions about the resistance of the second pillar. The system does not look very shock proof. The pension ambition and the indexations are in danger.

Reduction of indexation and recovery premiums are current measures to maintain the pensions and increase the funding ratios. Just as for the first pillar also for the second pillar the problem of the increasing life expectancy of Dutch people arises. The longer the people live the longer pension funds have to pay pension payments and the more a pension contract will cost. On the long term pensions will become very expensive for pension funds.

The increasing life expectancy also changes the composition of Dutch population. During the years the proportion between the retirees and the labor force will change which we have already mentioned in section 2.2. The ageing of the population has negative effects for pension funds, it decreases the shock resistance of pension funds. The part of the fund which is paying premiums will decrease but the people who receive pension payments will increase. If there are financial shocks they can be catched by increasing premiums but because of the smaller working population the effect of larger premiums will decrease.

To test whether the second pillar is future proof and which measures can be taken for a better second pillar pension, a lot of research has been done. The government has instituted the committee Goudswaard to research a future proof second pillar pension system. To retain the pension ambition in these problematic period, the premiums have to increase from 13% of the salary to 17% in 2025 (Goudswaard et al., 2010). This would be very problematic for the labor market and the Dutch competition position. The conclusion of the committee Goudswaard is therefore that the contribution has reached its maximum and that pension funds have to look for other measures to cope with the increasing costs of the second pillar pensions.

People are still thinking they will receive the pension ambition of 70% of their last received salary at their retirement. In reality this could be much lower because of the reduction of indexation. There is a gap between the expectations of the participants about the level of their pension payments and the reality. The committee Goudswaard concluded that the second pillar with the current pension ambition and the supposed guarantees is not future proof because of the earlier discussed reasons. They also looked at possible solutions to make it future proof.

The first solution of the committee Goudswaard is to decrease the pension ambition. This can be done in different ways. The Social Partners (employer and employee organizations) can decrease the accrual percentage. If people work the same period, the pension ambition will decrease. People can decide to work longer for the same ambition. Another option is to maximize the pension base. The pension base is the part of the salerary (salary minus franchise) over which pension benefits can be accrued. People with a high salary can only accrue pension benefits over a part of their pension base instead of their whole pension base. Mostly these people have enough money for their retirement period.

The second solution is an adaptation to the increasing life expectancy. The retirement age can be increased to incorporate the higher life expectancy. This option looks like the same as the increasing AOW age. With this adaptation the Dutch pension system remains future proof.

This solution will be discussed in this master thesis.

For the last solution of the committee Goudswaard the guarantees which are promised to participants are reduced. The risks of the pension fund, like investment risks, are shared with the participants. The pension benefits become 'soft' instead of 'hard'. This means there are less unconditional benefits, benefits which are totally guaranteed, but there are more conditional, soft, benefits. This results in decreasing risk for pension funds and therefore the pension ambition can be maintained. There can be made differences between groups of participants. Younger people have more time before they reach their retirement age and therefore they can take more risk than older people. The differentiation can be done in different ways, for example indexation of benefits of younger people can be connected to investments and the indexation of pension benefits of older people to wage or price inflation. For this solution there have to be made good agreements between the Social Partners and pension funds. The conditional rights have to be explained clearly to participants.

Besides the research of the committee Goudswaard, the AG (Actuarial Association) has published the report 'The AOW on the move' (Van den Bosch et al., 2010). In this report the consequences of the increasing AOW age for the second pillar pension are discussed. If the retirement age will stay at 65 but the AOW increases to 66 in 2020 and 67 in 2025, there would arise a gap. In that case people will become a retiree at the age of 65 and from that moment receive pension payments of the second pillar, from their pension fund, but their AOW payments will start two years later, at age 67. In the report three ways of thinking are discussed to solve the problem of the gap.

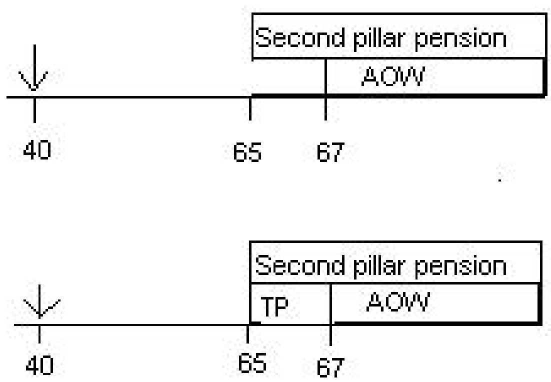

Figure 2: First solution 'De AOW in beweging'

The first way is compensation of the gap. Participants get the possibility to accrue a temporary pension which pays out between 65 and 67. In this way participants can keep their retirement age of 65. An example for a person who is 40 years old nowadays, is showed in figure 2. The figure above represents the current situations with the gap and the one below shows the situation with the temporary pension (TP). The amount of the compensation will be different for the participants because the AOW payments are larger for singles than for married people. For older people it will be more expensive to compensate the gap, they will have a shorter period to accrue the temporary pension. Participants with a high income will have to compensate a relatively smaller gap, therefore the extra costs will be smaller for them.

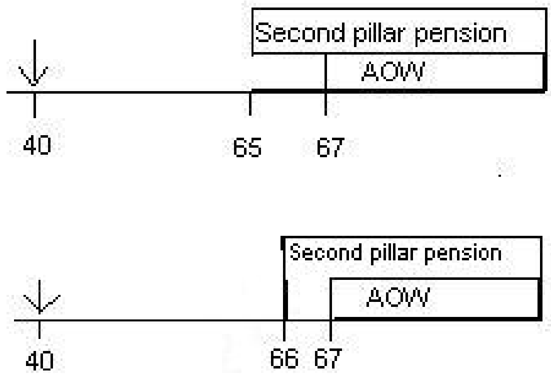

Figure 3: Second solution 'De AOW in beweging'

In the second way no measures are taken to close the AOW gap. Participants can take measures by themselves, a possible solution is to work longer. If they work longer the pension payments will start at a higher age and therefore these payments will have a higher value. These higher pension payments can be used to compensate the gap. Figure 3 shows what will happen in this situation for a person of 40 years old. Younger people, year of birth 1959 or later, have to work longer to compensate the gap than older people because the older people have a lower AOW age. Also with this method, people with a higher income have to compensate a relatively smaller amount and therefore they have to work shorter than people with lower incomes.

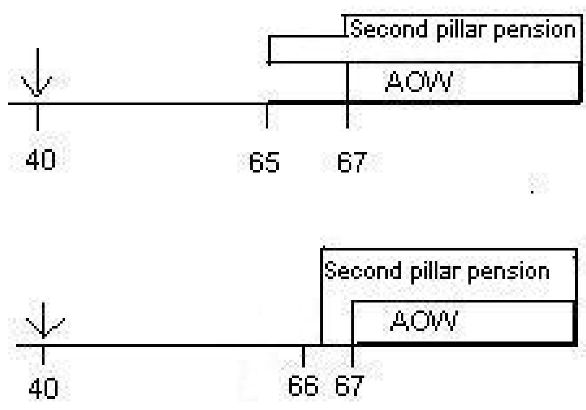

Figure 4: Third solution 'De AOW in beweging'

The last way is to connect the retirement age to the AOW age. At the moment the AOW age changes the retirement age also changes, for already accrued pension benefits the payments will start at 65 and the new accrued benefits will pay out from the new retirement age, see figure 4 the picture above. Participants can choose a retirement age lower than the AOW age through exchanging the accrued pension benefits to payments which will start at a lower age. The figure 4 also shows this. Just as the other two methods, younger people and people with lower incomes have to work longer to close the gap.

Bovenberg also has an opinion about a new pension contract, he describes it in 'To new pension contracts' (Bovenberg, 2004). Premiums that have already been paid by active participants have to be accrued for their own pension. Every generation accrues its own pension capital from which pension payments can be paid out from the retirement age on. Besides that the risk sharing between the pension fund and the participants has to be explained clearly. Funds have to explain that they need buffers to capture financial shocks and they can not use it for premium reduction.

2.4 Pension agreement Social Partners

In June 2010 the Social Partners reached an agreement (Sociale Partners, 2010) to change the second pillar pensions. The Social Partners consist of employers and employees, they are represented by the employers' associations like VNO-NCW and MKB Nederland and the labor unions like FNV and CNV. The goal of this agreement is to make the pensions more up to date and future proof. The second pillar pensions are connected to the first pillar pensions and therefore these two pillars have to be adapted to each other. The increasing AOW age of the first pillar has consequences for the second pillar. As discussed earlier, the problems of the first pillar like the increasing life expectancy and the ageing of the population are also problems for the second pillar.

During the decision making process about the pension agreement the following aspects were important (Sociale Partners, 2010). The first point are the costs for employers and employees which have reached a maximum and cannot increase any further. The second point are the expectations of the participants. Nowadays the expectations of people about the value of their pension payments are mostly higher than the payments they will really receive from their retirement age on. As we have noticed already from the report of the committee Goudswaard. The pension agreement has to decrease this difference. Participants have to understand their pension contract and know what they can expect. Just as now, the solidarity has to stay in the new contract. The individual possibilities for employees have to develop in a way that is clear for the participants. The costs to implement the new pension agreement have to be low. Besides that the increasing AOW age has to be implemented to the second pillar pensions. As already mentioned, these two pillars have to be adapted to each other. To implement the same increasing retirement age as the increasing AOW age, changes in the labor possibilities are needed. There have to be more possibilities for employees to work until the new retirement age. For employees with an intensive physical job, replaceable work has to be available that they can do until retirement.

Without any adaptation the pension liabilities will increase continuously for pension funds because of the increasing life expectancy. The goal of the Social Partners is to take measures in that way that the pension ambition will be kept at the same level. If people will live one year longer they have to work 6 to 8 months longer to receive the same pension ambition (Goudswaard et al., 2010). From 2011 on the pension calculating age will be adapted to the new AOW age to catch on the increasing life expectancy. The life expectancy of a pension fund mostly differs from the national life expectancy. For some funds this means an increasing retirement age will not be enough or too much to keep the pension ambition at the same level. If the increasing retirement age is not high enough the accrual percentage has to be decreased to keep the same pension ambition. For funds with participants whose life expectancy increases slower than the national life expectancy, the pension ambition decreases. This extra budget can be used for indexation, a larger buffer against shocks or a lower retirement age. The Social Partners introduce two methods which can be chosen by pension funds to incorporate the increasing life expectancy. It is not clear if these methods will be applied to all accrued pension benefits or only to new accrued pension benefits. Probably they can only be applied to new accrued benefits because of legislation.

In the first method the pension calculating age is similar to the announced increased AOW age. This method is the same as the last option which is discussed in 'The AOW on the move' (Van den Bosch et al., 2010). From 2011 on the pension calculating age will be 66 and from 2015 it will be 67. Just as the new AOW age, the increasing pension calculating age is not for everybody but depends on the year of birth. If the AOW age will increase more next years, the pension calculating age will also increase. The amount of the pension payments will remain the same but the net present value of the pension liabilities will be calculated with the new pension calculating age. The pension calculating age will increase one year in 2011 and 2015 and therefore the pension payments will start one year later. These changes will result in a one year shorter retirement period and therefore pension funds will need smaller provisions to guarantee the payments. This method will likely be used only for pension benefits which are accrued from 2011 on. This method is based on solidarity because the change will have different consequences for different age categories.

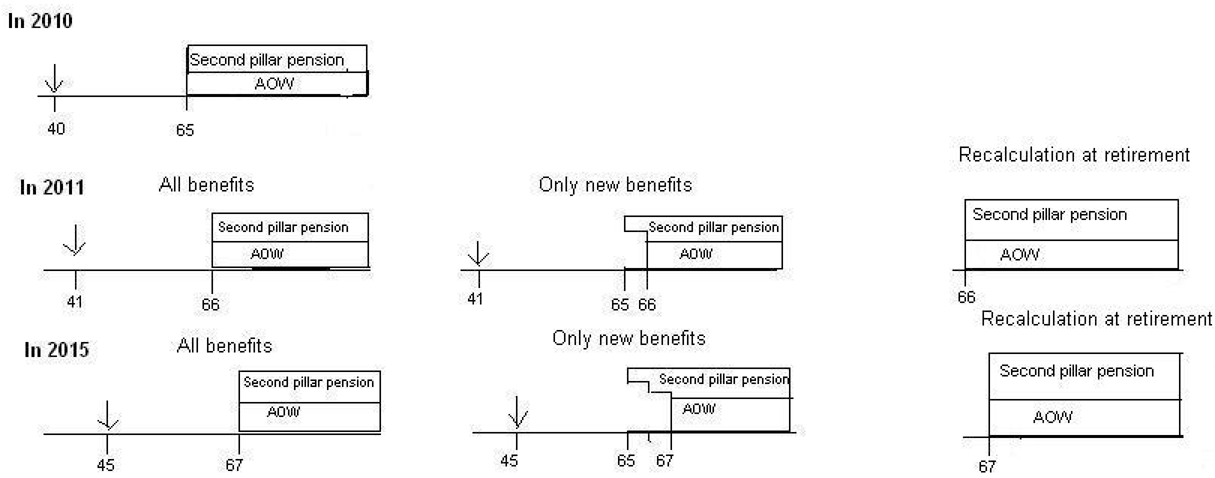

Figure 5: Pension agreement method 1

Figure 5 shows an example for a person with age 40 in 2010. In 2010 the AOW age and pension calculating age both are 65. In 2011, when the person is 41 years old, the AOW age and also the pension calculating age increases to 66. In the left figure of 2011 all accrued pension benefits will start from 66 and the level of the payments remains the same. In the middle figure of 2011 we can see what happens if only the new accrued pension benefits will start from 66 and the old ones from 65. The right figure shows that the accrued pension benefits of 65 can be actuarial recalculated to age 66 at retirement which means they get a higher value. The figure below, represents the situation in 2015 when the AOW age and pension calculating age increases to 67.

The second method is based on the life expectancy of employees from their retirement age on. The pension calculating age of this method is the same as in the first method. The total pension ambition will be the same for participants of different age categories and is based on the forfaitary period. The amount of the annually pension payments is determined at the retirement age (or for example at age 60) and depends on the real estimated age specific retirement period at that time. The later a person is born the longer his estimated retirement period will be because of his higher life expectancy. Every fund has its own forfaitary payment period which is the same for all participants and represents the retirement period of a person who is 65 in 2010. This period will be the same over time. At a certain age, probably this will be at 60, the pension ambition with the forfaitary period will be actuarial recalculated to a pension ambition with the real estimated retirement period. During the recalculation the total pension ambition stays the same. This means the pension payments can become smaller or larger dependent on the fact the real estimated retirement period is longer or shorter than the forfaitary period. Every age category receives another amount of pension payment dependent on the real estimated retirement period. Just as the first method this will probably only the fact for pension benefits accrued from 2011 on. Instead of the first method, the changes in pension provision in the second method will be gradually. This method is more fair than the first method because the pension payments of the different age categories are based on their own life expectancy.

Figure 6 is an example to show the pension benefits before retirement. We take a forfaitary period of 15 years. Also for this example we take a person which is 40 in 2010. If the second method is applied to all accrued benefits the calculation with the forfaitary period start immediately, as we can see in the left picture of 2010. If it is only applied to new accrued benefits from 2011 on, nothing will change in 2010. From 2010 or 2011 on, the pension ambition and the pension provision is based on the accrued benefits paying out over the forfaitary period of 15 years, which starts at the pension calculating age 65. In 2011 the AOW age and pension calculating age switch to 66. The left figure of 2011 shows the results if the method is applied to all accrued benefits. Than the pension payments will start at 66 and the forfaitary period will be from 66 until 81. In 2015 the AOW age and pension calculating age are both increased to 67, which results in a forfaitary period from 67 to 82. The right figures show what will happen if the method is only applied to the new accrued benefits from 2011 on and the other benefits are not changed.

The recalculating at retirement if method 2 is applied to all accrued pension benefits is shown in figure 7. In this example we take a participant with a retirement age of 67 and a forfaitary period of 15 years. Before retirement the participant has accrued pension benefits. The pension provision the fund provides to guarantee the pension benefits is based on this forfaitary period. The total pension ambition according to pension payments of €25,000 per year is €375,000. The pension ambition with the real estimated retirement period has to be the same. If the real estimated retirement period will be 16,5 years the pension payments have to decrease to €22,727 to keep the pension ambition at the same level.

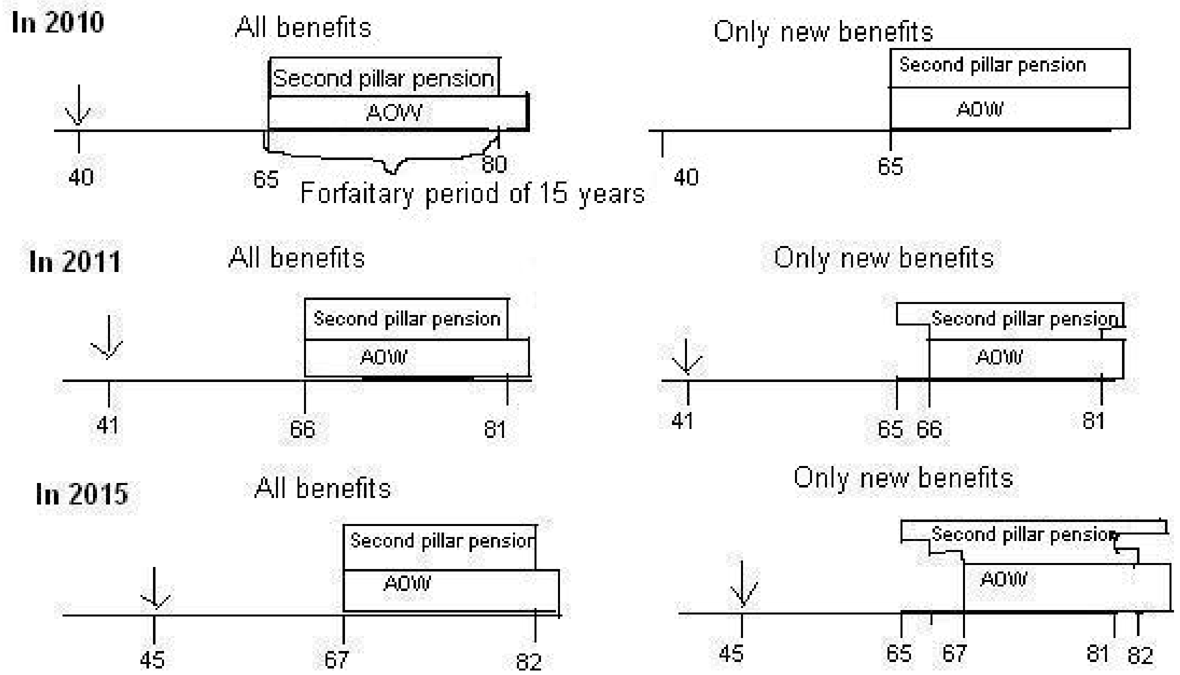

Figure 6: Pension agreement method 2 before retirement

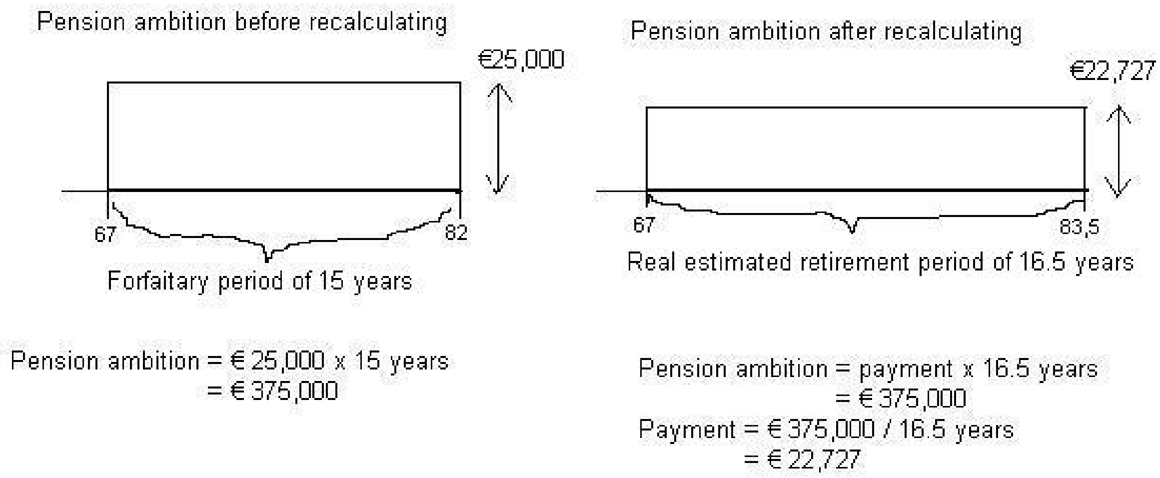

Figure 7: Pension agreement method 2: recalculation at retirement

3 Longevity Risk

Longevity risk is the uncertainty in future changes in mortality rates (De Waegenaere et al., 2010). Interest rate risk and asset returns are seen as the most important source of risk for pension funds because the consequences of these risks are immediately visible. Longevity risk is a more abstract risk and the effect is not immediately noticeable (Madsen et al., 2010). Despite of this, longevity risk is a very important one for pension funds and has to be taken into account.

Pension payments start at the retirement age and take place until the death of the participant. The age at which people die is estimated with mortality rates. The smaller the mortality rates, the longer people live and the longer pension benefits have to be paid out. With the mortality rates pension funds can make an estimation of the retirement period. The provision, which is needed to guarantee the pension benefits, is calculated with the help of this estimated retirement period. For every generation estimations are made for the age at which people on average die. This means for every generation the needed pension provision is different. The more uncertainty about the future mortality rates the more uncertainty about the estimated retirement period and the corresponding pension provision. If the mortality rates change, the estimated provisions are not up to date to the real mortality rates anymore. Last years it turned out that the real mortality rates are lower than the predicted ones (Actuarieel Genootschap, 2010). People have a higher life expectancy than predicted in the past. In figure 1 we can see this, the remaining life expectancy prognose in 2004 over 2004 to 2008 was smaller than the realized remaining lifetime in that period. The reduction of the mortality rates is underestimated. The prognose of 2008 gives a higher remaining life expectancy than the one of 2004. This will bring on problems to pension funds, they provide too less pension provision to guarantee the pension liabilities. Therefore the mortality rates and longevity risk are important factors for pension funds.

Wong-Fupuy & Haberman (2004) give a review of the recent developments of mortality trends in the UK and US. In their paper there are three characteristics observed about mortality rates: the relationship between mortality rates and time is log-linear, the improvements of the life expectancy according to age and time are decreasing and there is an increasing trend in the relative rate of mortality changes over age. Lee & Tuljapurkar (1997) suggest two reasons for the decreasing trend in the improving life expectancy. The first one is the fact that reducing mortality at younger ages has more impact on the improvement of the total life expectancy than a decrease of the mortality at an older age. In developed, western countries the mortality rates of young people do not change much anymore but only the mortality rates at older ages decrease. This explains the fact that the increase of the life expectancy diminishes during the years. In the beginning of the twentieth century mainly the infectious deceases have been reduced (Tuljapurkar & Boe, 1998) and in the more recent times mainly the number of chronic diseases decreased (Goss et al., 1998). The last one is concentrated on older people and therefore reduces the mortality rate at older ages.

To model the future mortality rates a projected age pattern as well as a good measure for uncertainty are needed (Wong-Fupuy & Haberman, 2004). It is hard to define such a measure. In official projections there are alternative scenarios generated to cover uncertainty. The modeling of future mortality rates is based on extrapolation of methods but also on the opinion of experts about future life expectancy. Experts suggest there is a biological limit for life expectancy and future improvements of life expectancy are impossible (Wong-Fupuy & Haberman, 2004).

Future reductions in mortality are only possible by developments in the medical field, less violence and pollution and an improved lifestyle (no cigarettes and alcohol). As Wong-Fupuy & Haberman (2004) conclude, the shape of the trend of the mortality rate is not totaly objective, it depends on past mortality trends and a personal opinion.

In Madsen et al. (2010), the Dutch mortality rates are discussed. Looking at the mortality rates, the past century the Dutch mortality has improved in a log-linear trend which is quite predictable. But the question is: will this trend continue over time? For example, the author states that if the life expectancy increases with three years in one decade, a funding ratio of 120%, using assumptions which are typically actuarial, will decrease to 100%. However, this conclusion depends on the fund structure, the asset portfolio and the economic situation. To observe the life expectancy trend, there are two types of life expectancy: the statical life expectancy and the dynamic life expectancy. The difference between these two is the fact that in the formula of the dynamic life expectancy a time parameter is added. This means that the change of future life expectancy is also dependent on the time. The remaining life expectancy will increase more the first years than over 50 years (De Mik, 2010). Therefore the dynamic life expectancy increases faster than the statical one.

Not only the gender and year of birth of a person are factors to determine the life expectancy but also wage, education and place of residence. Life expectancy is not the same for the whole Dutch population. As already mentioned in section 2.2 there are differences in life expectancy between social economic groups. The composition of the participants of a pension fund results in a fund specific mortality table. In Van Doorn & Jager (2010), social-economic, geographic and fund specific factors on life expectancy are determined. For each individual a personal scaling factor can be used to calculate an accurate pension provision. This scaling factor depends on the life expectancy factors and the amount of the pension benefits. For people with a relative larger amount of pension benefits, a higher life expectancy has more impact on the pension provision than people with relative lower pension benefits. With the help of postal codes the social economic factor can be determined. In this way a better approach of the needed pension provision can be made and pension funds can manage their risks better. This method is not yet realized at Dutch pension funds, but in the UK there are already made distinctions between postal codes (Van Doorn & Jager, 2010).

In the paper of De Waegenaere et al. (2010) two sources of mortality risk are distinguished namely the individual mortality risk and the longevity risk. The individual mortality risk, also called micro longevity risk, is the risk that the life expectancy of an individual person differs from the life expectancy based on the given mortality rates. Longevity risk, also called macro longevity risk, is the risk caused by the uncertainty of the future mortality rates. De Waegenaere et al. (2010) show that longevity risk is very important because it is non-diversifiable. When the number of participants become larger, the individual mortality risk of a pension fund is diversifiable but the longevity risk remains. This means that the pension liabilities have to include a longevity risk premium and pension funds have to manage this longevity risk.

Furthermore in the paper of De Waegenaere et al. (2010) there are three ways to quantify longevity risk. In the first method, which is analyzed by Olivieri (2001), the longevity risk is quantified by the effect on the pension fund's distribution of the present value of the future payments. Another method is to look at the probability of underfunding for the pension fund, this is done by Hari et al. (2008). They show that if risk in remaining lifetime is the only source of risk, there is a substantial amount of risk for pension funds. In the last method and also considered to be the best one, the effect on the probability of ruin is determined. This is also computed by Olivieri (2001).

In Hari et al. (2008) the impact of longevity risk at the funding ratio is discussed. Longevity risk becomes relatively less important for the funding ratio when there is more market risk, meaning that a larger fraction of the investment portfolio is invested in risky assets. For a Dutch pension fund with 500 participants, considered by Hari et al. (2008), the standard deviation of the funding ratio over five years is 3.7% of the expected value of the funding ratio. In this example only the micro and macro longevity risk are included, there is no market risk. For a larger fund the micro longevity risk decreases, this results in a standard deviation of 2.9%. If there is also parameter risk the standard deviation increases to 5.8% for a small fund and 5.3% for a large fund. If a pension fund, which is funded, wants to reduce the probability of underfunding caused by longevity risk to 2.5% over five years, it has to take a buffer of 7%-8% of the value of the liabilities (Hari et al., 2008). Another option to hedge longevity risk is buying longevity bonds, but this option only reduces macro longevity risk.

Hari et al. (2008) also determined the relative importance of longevity risk if market risk is also included. Results of different investment portfolios in this paper show that investments risk becomes relatively more important for the funding ratio if the proportion of stocks in the investment portfolio increases. The uncertainty about the value of stocks is higher than the uncertainty of bonds. Therefore the more stocks in the portfolio, the higher the investment risk. This reduces the relative importance of longevity risk (Hari et al., 2008). Hari et al. (2008) conclude that longevity risk is very important for the funding ratio if market risk is not present.

4 Modeling pension liabilities of an old age pension

4.1 Model of the liabilities with the normal method

Without the pension agreement the retirement age would be kept at 65 for all people. To calculate the net present value of the nominal liabilities at the end of year T, for pension funds that have an average pay scheme, the next formulas are used:

$$L_T^{nom} = \sum_{n=1}^{N} \sum_{j=max\{0,r_{n,T}-a_{n,T}\}}^{Z-a_{n,T}} \frac{(A_{n,0}\prod_{s=1}^{T}(1+i_s) + \sum_{t=1}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\prod_{k=a_{n,T}}^{a_{n,T}+j} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} \quad (1)$$

$$r_{n,T} = 65 \quad \text{for} \quad T \geq 0 \quad \forall n = 1,..,N$$

$$I_s = \begin{cases} 1 & \text{if} \quad t+1 > T \\ 1+i_s & \text{if} \quad t+1 \leq T \end{cases}$$

N = number of participants
$a_{n,T}$ = age of participant n at time T
$r_{n,T}$ = retirement age of participant n at time T
I_s = indexation factor at time s
i_s = price inflation at time s
Z = highest possible age of the mortality table
$A_{n,0}$ = accrued benefits of participant n ultimo time 0
$c_{n,t}$ = accrual percentage of the pension of participant n at time t
$B_{n,t}$ = pension base of participant n at time t
$p_{k,T+(k-a_{n,T})}$ = survival probability of age k at time $T+(k-a_{n,T})$
$R_T^{(j)}$ = interest rate at time T with duration j

The retirement age $r_{n,T}$ would be 65 for all T with $T=0$ in 2009 and for all participants n. For people younger than the retirement age, first they have to reach their retirement age before they can receive a pension. It will take $r_{n,T}-a_{n,T}$ years for participant n at time T to reach his retirement age. There are also participants that have already reached the retirement age, for them the payments start immediately. The index j represents the expected payment period. It starts in the year a person reaches his retirement age or immediately, $T+max\{0,r_{n,T}-a_{n,T}\}$, and ends at maximum in the year there are no survival possibilities for this person, $T+(Z-a_{n,T})$. Mostly this is in the year the person reaches the age of 119 (Z=119) because mortality tables end at that age. In every year, every possible value of j, the possibility that the person is still alive is used to calculate the expected pension payments in that year. If a person dies before that age, the payments are zero.

The amount of the pension liabilities depends on the number of years a person already has accrued pension liabilities and his pension base. $A_{n,0}$ represents the already accrued pension benefits at the end of 2009. The new accrued pension benefits from 2010 on are represented by $c_{n,t}B_{n,t}$. The pension base $B_{n,t}$ is the annual wage of an employee reduced with the social security offset. If the wage increases, the pension base also increases. Most pension funds have an average pay scheme therefore this is used in the modeling. With this agreement participants every year accrue pension benefits with a percentage $c_{n,t}$ of their current pension base. Every year the pension benefits are indexed with the price inflation i_s. The product of indexations shows that the indexations will start one year after the pension benefits are accrued $(t + 1)$ until now (T). If the pension benefits are accrued in year T, than $t + 1 > T$, there will not yet be any indexation $(I_s = 1)$. The total pension benefits are a summation of accrued benefits over the years. In most pension schemes there is a maximum total accrual percentage, 80% or a maximum number of accrual years, 40. If this maximum is reached, participants can not accrue more pension benefits. This can be implemented with a restriction at $c_{n,t}$. To calculate the net present value of the liabilities, the pension benefits are discounted with $R_T^{(j)}$.

For every year pension liabilities have to be paid out, the probability that a person will reach this year is calculated with the survival probabilities $p_{k,T+(k-a_{n,T})}$. The mortality probabilities are arranged in a mortality table with the mortality probability $q_{k,T+(k-a_{n,T})}$ for a specific age in a specific year. Therefore the survival probability $p_{k,T+(k-a_{n,T})} = 1 - q_{k,T+(k-a_{n,T})}$ has two indexes. The first one, k, represents the age of the participant. The second index, $T+(k-a_{n,T})$, represents the year in which the age k will be reached. The probability a person will be alive in year $T + j$ is calculated by the probability the person will survive from now on until year $T + j$. This is calculated by the product of the survival probabilities from the current age $a_{n,T}$ in year T until the age $a_{n,T+j}$ in year $T + j$. For the calculation of the whole fund, the net present value of the liabilities of all participants is summed up.

4.2 Example of the model of the normal method

To illustrate the formula of section 4.1, we take an example of a pension fund with 7 male participants. The following assumptions are made: participants start accumulating pension benefits from the age of 25 when they have a pension base of €10,000, the accrual percentage is 2% per year and every year the wage and also the pension base increases with €1.000. The pension benefits are indexed yearly with the price inflation, which we set at a level of 2% (requirement of DNB). Furthermore we assume that the participants will stay at the employer and the pension fund in the years up to retirement. Every participant has his birthday at the first of January. The essential information of the participants ultimo 2009 is summarized in the following table:

Participant number n	Year of birth	Age $a_{n,0}$	Pension base $B_{n,0}$	Accrued benefits $A_{n,0}$
1	1945	64	50,000	33,690
2	1947	62	48,000	30,460
3	1950	59	45,000	25,993
4	1955	54	40,000	19,493
5	1960	49	35,000	14,077
6	1965	44	30,000	9,643
7	1970	39	25,000	6,098

To calculate the provision ultimo $T = 1$, some parameters of the model change. The age of the participants is increased with one year. Also the pension base of the participants is increased with €1.000 and they have accrued 2% more benefits. This is not the case for participant 1 who reaches his retirement age at $T = 1$. After filling in the data of the participants at $T = 1$, this is the formula:

$$L_1^{nom} = \sum_{j=max\{0,r_{1,1}-a_{1,1}\}}^{Z-a_{1,1}} \frac{(A_{1,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{1,1}B_{1,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{1,1}}^{a_{1,1+j}} p_{k,1+(k-a_{1,1})}}{(1+R_1^{(j)})^j} +$$

$$\sum_{j=max\{0,r_{2,1}-a_{2,1}\}}^{Z-a_{2,1}} \frac{(A_{2,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{2,1}B_{2,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{2,1}}^{a_{2,1+j}} p_{k,1+(k-a_{2,1})}}{(1+R_1^{(j)})^j} +$$

$$\sum_{j=max\{0,r_{3,1}-a_{3,1}\}}^{Z-a_{3,1}} \frac{(A_{3,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{3,1}B_{3,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{3,1}}^{a_{3,1+j}} p_{k,1+(k-a_{3,1})}}{(1+R_1^{(j)})^j} +$$

$$\sum_{j=max\{0,r_{4,1}-a_{4,1}\}}^{Z-a_{4,1}} \frac{(A_{4,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{4,1}B_{4,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{4,1}}^{a_{4,1+j}} p_{k,1+(k-a_{4,1})}}{(1+R_1^{(j)})^j} +$$

$$\sum_{j=max\{0,r_{5,1}-a_{5,1}\}}^{Z-a_{5,1}} \frac{(A_{5,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{5,1}B_{5,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{5,1}}^{a_{5,1+j}} p_{k,1+(k-a_{5,1})}}{(1+R_1^{(j)})^j} +$$

$$\sum_{j=max\{0,r_{6,1}-a_{6,1}\}}^{Z-a_{6,1}} \frac{(A_{6,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{6,1}B_{6,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{6,1}}^{a_{6,1+j}} p_{k,1+(k-a_{6,1})}}{(1+R_1^{(j)})^j} +$$

$$\sum_{j=max\{0,r_{7,1}-a_{7,1}\}}^{Z-a_{7,1}} \frac{(A_{7,0}\prod_{s=1}^{1}(1+i_s) + \sum_{t=1}^{1}(c_{7,1}B_{7,1}\prod_{s=2}^{2}I_s))\prod_{k=a_{7,1}}^{a_{7,1+j}} p_{k,1+(k-a_{7,1})}}{(1+R_1^{(j)})^j} +$$

The values of $a_{n,1}$, $A_{n,1}$, $c_{n,1}$ and $B_{n,1}$ can be filled in with the help of the table and the assumptions. The retirement age $r_{n,T}$ is 65 for all values of n and T in the normal method. The value of 119 is taken for Z, because this is highest possible age in the AG mortality tables 2010-2060 which are used in this example. Instead of an interest term structure, we use a fixed interest rate of 4%.

$$L_1^{nom} = \sum_{j=65-65}^{119-65} \frac{(33,690 * 1.02)\prod_{k=65}^{a_{1,1+j}} p_{k,1+(k-65)}}{(1.04)^j} +$$

$$\sum_{j=65-63}^{119-63} \frac{(30,460 * 1.02 + 0.02 * 49,000 * 1)\prod_{k=63}^{a_{2,1+j}} p_{k,1+(k-63)}}{(1.04)^j} +$$

$$\sum_{j=65-60}^{119-60} \frac{(25,993 * 1.02 + 0.02 * 46,000 * 1) \prod_{k=60}^{a_{3,1+j}} p_{k,1+(k-60)}}{(1.04)^j} +$$

$$\sum_{j=65-55}^{119-55} \frac{(19,493 * 1.02 + 0.02 * 41,000 * 1) \prod_{k=55}^{a_{4,1+j}} p_{k,1+(k-55)}}{(1.04)^j} +$$

$$\sum_{j=65-50}^{119-50} \frac{(14,077 * 1.02 + 0.02 * 36,000 * 1) \prod_{k=50}^{a_{5,1+j}} p_{k,1+(k-50)}}{(1.04)^j} +$$

$$\sum_{j=65-45}^{119-45} \frac{(9,643 * 1.02 + 0.02 * 31,000 * 1) \prod_{k=45}^{a_{6,1+j}} p_{k,1+(k-45)}}{(1.04)^j} +$$

$$\sum_{j=65-40}^{119-40} \frac{(6,098 * 1.02 + 0.02 * 26,000 * 1) \prod_{k=40}^{a_{7,1+j}} p_{k,1+(k-40)}}{(1.04)^j}$$

The mortality rates of the AG of 2010-2060 are used to calculate the pension provision per participant and the total pension provision. Besides the provision in 2009 and 2010, we also want to know the changes in the provision the next years. We calculate the pension provision for $T = 0$ until $T = 6$ to see the changes in the pension provision over time. We assume $\forall\ T = 0, .., 6$ that the participant is still alive otherwise there is no pension provision needed anymore.

i	L_0^{nom}	L_1^{nom}	L_2^{nom}	L_3^{nom}	L_4^{nom}	L_5^{nom}	L_6^{nom}
1	416,127	446,680	443,331	439,303	434,553	429,101	422,760
2	345,561	381,871	421,854	452,463	449,093	445,002	440,153
3	261,196	288,809	319,146	352,473	389,179	429,512	459,130
4	161,764	179,460	198,867	220,147	243,504	269,135	297,302
5	97,131	108,486	120,959	134,658	149,681	166,164	184,233
6	55,495	62,667	70,570	79,274	88,847	99,375	110,947
7	29,256	33,662	38,553	43,972	49,965	56,580	63,873
Total	1,366,531	1,501,635	1,613,282	1,722,290	1,804,821	1,894,868	1,978,398
Increasing%		9.89%	7.44%	6.76%	4.79%	4.99%	4.41%

Participant 1 and 2 will reach their retirement age in respectively $T = 1$ and $T = 3$. From that time the pension payments will start and the pension provision decreases. There will be no new pension benefits accrued. The accrued pension benefits only increase because they are indexed for price inflation yearly.

When we take a look at participant 3, 4, 5, 6 and 7 we can see that there is a smaller provision needed for younger participants. They have accrued pension benefits over a shorter period, they have a lower wage and pension base and a smaller probability to reach the age of 65. During the years the total accrual percentage and wage will increase and also the probability that participants will reach their retirement age will increase. This means that the pension fund will need more provision to guarantee the pension benefits. If we take a look at the pension provision for participant 3 at $T = 1$ we get a value of €288,809. Participant 4 will have the same accrued pension benefits and age at $T = 6$ as participant 3 at $T = 1$. But the pension provision for participant 4 will be higher, €297,302. This can be explained by the fact that participant 4 has a better life expectancy. The probability that participant 3 will reach his retirement age at $T = 1$ is 0.9467 but participant 4 will have a probability of 0.9543 to reach his retirement age at $T = 6$. This shows the survival probabilities increase over time.

If we take look at the increase of the total pension provision over time we can see that the increasing percentage decreases over time. As we have seen earlier the pension provision of participant 1 and 2 decreases when they reach their retirement age. This has also consequences for the total pension provision. We can see this at $T = 2$, from these years on the pension provision of participant 1 decreases and therefore the total pension provision increases less. The same happens at $T = 4$ for participant 2.

4.3 Model of the liabilities with pension agreement method 1

In the first method of the pension agreement the retirement age in the second pillar pension scheme will be the same as the new announced AOW age. People who are born before 1955 will reach their retirement age in 2019 or earlier. Their retirement age will stay at 65. In 2011 there will be announced the retirement age will increase to 66 from 2020 onward. This increase in the AOW age has consequences for people born in 1955 or later. From 2011 on a pension calculating age of 66 instead of 65 is used to calculate the net present value of the accrued pension liabilities. Depending on the way the method will be implemented by the government, the new retirement age will either be introduced for all the accrued liabilities or only for new accrual. In our model we are looking at results per year. Therefore we assume all participants have their birthday on the first of January. This means people born before 1955 have reached the age of 57 or higher on January 1, 2011. For this age category nothing will change, the retirement age and pension calculating age will be the same as before.

In 2015 the second increase of the retirement age will be announced. From 2025 on the retirement age will be 67. People born between 1955 and 1958 have reached their retirement age of 66 in 2024 or earlier and therefore this second change has no consequences for them. From 2015 on the pension calculating age of 67 is used to calculate the net present value of the liabilities of people born after 1958. These people have reached the age of 56 or lower in 2015. Therefore we can say these changes do not have any consequences for people who are 57 years or older in 2015.

First we will look at the model if method 1 is applied to all accrued pension benefits (2). And the other formula (3) shows the net present value of the nominal liabilities for pension funds if method 1 is only applied to new liabilities:

$$La_T^{nom} = \sum_{n=1}^{N} \sum_{j=max\{0,r_{n,T}-a_{n,T}\}}^{Z-a_{n,T}} \frac{(A_{n,0}\prod_{s=1}^{T}(1+i_s) + \sum_{t=1}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\prod_{k=a_{n,T}}^{a_{n,T+j}} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} \tag{2}$$

$$Ln_T^{nom} =$$

$$\sum_{n=1}^{N} \sum_{j=max\{0,65-a_{n,T}\}}^{Z-a_{n,T}} \frac{(A_{n,0}\prod_{s=1}^{T}(1+i_s) + (c_{n,1}B_{n,1}\prod_{s=2}^{max\{2,T\}} I_s))\prod_{k=a_{n,T}}^{a_{n,T+j}} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j}$$

$$+\sum_{n=1}^{N} \sum_{j=max\{0,r_{n,T}-a_{n,T}\}}^{Z-a_{n,T}} \frac{(\sum_{t=2}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\prod_{k=a_{n,T}}^{a_{n,T+j}} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} 1_{\{T\geq 2\}} \quad (3)$$

$$I_s = \begin{cases} 1 & \text{if} \quad t+1 > T \\ 1+i_s & \text{if} \quad t+1 \leq T \end{cases}$$

$$r_{n,T} = 65 \quad \text{if} \quad T = 0 \quad \forall n = 1,..,N$$

$$r_{n,T} = \begin{cases} r_{n,T-1} & \text{if} \quad a_{n,T} \geq 57 \quad T > 0 \\ pa_T & \text{if} \quad a_{n,T} < 57 \quad T > 0 \end{cases}$$

$$pa_T = \begin{cases} 65 & \text{if} \quad T = 1 \\ 66 & \text{if} \quad 2 \leq T \leq 5 \\ 67 & \text{if} \quad T \geq 6 \end{cases}$$

pa_T = retirement age at time T following the pension agreement of the Social Partners (Sociale Partners, 2010)

Before the adaptations, in 2009 ($T = 0$) and 2010 ($T = 1$), the retirement age is still 65 for all people. In 2011 ($T = 2$) the net present value of the liabilities of people born in 1955 and later changes because of their new retirement age of 66. This retirement age is kept until 2014. In 2015 ($T = 6$) the net present value of the liabilities of people born in 1959 and later changes because of their new retirement age of 67. The changing retirement age is represented by pa_T. With the increase of the retirement age $r_{n,T}$ with one year, the pension payments and therefore the index j will start one year later.

If the pension agreement methods are applied to all accrued pension benefits, the net present value of the all accrued liabilities will be recalculated with the new retirement age. If the methods will only be applied to new accrued pension benefits, the net present value of the liabilities will change from 2011 on, only for the new accrued benefits. Therefore the formula is separated in two part. The first part is the net present value of the already accrued benefits, the pension calculated is 65. In the second part there are only new accrued benefits ($c_{n,t}B_{n,t}$) and the retirement age changes according to pa_T. Participants who have not accrued the maximum total accrual percentage at the age of 65 and have to work until 66 or 67, now have the possibility to accrue pension benefits until their retirement. This means they have the possibility to accrue a higher amount of pension benefit. For pension funds with older participants the increasing retirement age will not influence many people.

4.4 Example of the model of pension agreement method 1

For this example we have a look at the same pension fund as in the example for the normal method. The data are the same, but now we are using the model of the pension agreement method 1. This means that retirement ages of the participants change during the years:

Participant number n	$r_{n,0}$	$r_{n,1}$	$r_{n,2}$	$r_{n,3}$	$r_{n,4}$	$r_{n,5}$	$r_{n,6}$
1	65	65	65	65	65	65	65
2	65	65	65	65	65	65	65
3	65	65	65	65	65	65	65
4	65	65	66	66	66	66	66
5	65	65	66	66	66	66	67
6	65	65	66	66	66	66	67
7	65	65	66	66	66	66	67

Participant number 1, 2 and 3 keep the same retirement age and therefore also the same pension provision for all T. For the other participants the AOW age increases and also the pension payments of the second pillar start later. At $T = 0$ and $T = 1$ the retirement age of 65 is still used as the pension calculating age which results in the same provision as the normal method. At $T = 2$ the retirement age of participant 4, 5, 6 and 7 increases with one year. This means all accrued pension benefits or only the pension benefits of $T = 2$ will be calculated with the new retirement age. This results in the following formula for the net present value of the pension liabilities at $T = 2$ if method 1 is only applied to new accrued benefits:

$$Ln_2^{nom} = \sum_{j=0}^{119-66} \frac{(33,690 * 1.02^2) \prod_{k=66}^{a_{1,2+j}} p_{k,2+(k-66)}}{(1.04)^j} +$$

$$\sum_{j=65-64}^{119-64} \frac{(30,460 * 1.02^2 + 0.02 * 49,000 * 1.02 + 0.02 * 50,000 * 1) \prod_{k=64}^{a_{2,2+j}} p_{k,2+(k-64)}}{(1.04)^j} +$$

$$\sum_{j=65-61}^{119-61} \frac{(25,993 * 1.02^2 + 0.02 * 46,000 * 1.02 + 0.02 * 47,000 * 1) \prod_{k=61}^{a_{3,2+j}} p_{k,2+(k-61)}}{(1.04)^j} +$$

$$\sum_{j=65-56}^{119-56} \frac{(19,493 * 1.02^2 + 0.02 * 41,000 * 1.02) \prod_{k=56}^{a_{4,2+j}} p_{k,2+(k-56)}}{(1.04)^j} +$$

$$\sum_{j=66-56}^{119-56} \frac{(0.02 * 42,000 * 1) \prod_{k=56}^{a_{4,2+j}} p_{k,2+(k-56)}}{(1.04)^j} +$$

$$\sum_{j=65-51}^{119-51} \frac{(14,077 * 1.02^2 + 0.02 * 36,000 * 1.02) \prod_{k=51}^{a_{5,2+j}} p_{k,2+(k-51)}}{(1.04)^j} +$$

$$\sum_{j=66-51}^{119-51} \frac{(0.02 * 37,000 * 1) \prod_{k=51}^{a_{5,2+j}} p_{k,2+(k-51)}}{(1.04)^j} +$$

$$\sum_{j=65-46}^{119-46} \frac{(9,643 * 1.02^2 + 0.02 * 31,000 * 1.02) \prod_{k=46}^{a_{6,2+j}} p_{k,2+(k-46)}}{(1.04)^j} +$$

$$\sum_{j=66-46}^{119-46} \frac{(0.02 * 32,000 * 1) \prod_{k=46}^{a_{6,2+j}} p_{k,2+(k-46)}}{(1.04)^j} +$$

$$\sum_{j=65-41}^{119-41} \frac{(6,098 * 1.02^2 + 0.02 * 26,000 * 1.02) \prod_{k=41}^{a_{7,2+j}} p_{k,2+(k-41)}}{(1.04)^j}$$

$$\sum_{j=66-41}^{119-41} \frac{(0.02 * 27,000 * 1) \prod_{k=41}^{a_{7,2+j}} p_{k,2+(k-41)}}{(1.04)^j}$$

For participant 4, 5, 6 and 7 the pension benefits are divided in the part which is accrued until 2011 with indexation and the part accrued in 2011. For the first part we need a provision for a retirement age of 65 and for the second part a provision with a retirement age of 66. The pension provision at $T = 2$ is smaller with this method, as we expected beforehand. At $T = 6$ the gap between the pension provision of the normal method and method 1 will increase further for participant 5, 6 and 7 because they are younger than 57 in that year. Table 7 in the appendix shows a comparison between the results of the normal method and pension agreement method 1. Also the results of the first method applied to all accrued benefits are given in this table.

Participant 1, 2 and 3 will have retirement age 65, their retirement age does not change with pension agreement method 1. For people whose retirement age increases we can see the pension provisions with method 1 are smaller. If we take a look at the results if pension agreement method 1 is applied to all accrued pension benefits, we can see the higher the pension provision the larger the gap will be. The gap between the two methods will remain the same from $T = 2$ until $T = 5$. For the total pension provision we can see that the gap increases during the years. This can be explained by the fact that during the years the part of the total pension provision which is needed for the younger people ($n = 3, .., 7$) increases and the part for the elderly ($n = 1$ and $n = 2$) decreases. This explains the increase of the gap for the total fund. At $T = 6$ the total gap increases with 1.37% because of the announcement of the increasing retirement age. This second change has no effect for participant 4 and therefore the gap is smaller than the gap at $T = 2$ (1.90%).

If the first method is only applied to new accrued pension benefits the impact is smaller. Instead of the results discussed above, we can see that in this situation the younger the participant the larger the impact. Younger people have not yet accrued a lot of pension benefits. The part of pension benefits accrued in 2011 will be a larger part of the total accrued pension benefits for a younger person than for an older person. Because in this situation it has only impact on the new accrued benefits, the impact will be larger for younger participants. During the years the amount of the accrued pension benefits from 2011 on will increase and therefore the gap will also increase.

4.5 Model of the liabilities of pension agreement method 2

The second method of the pension agreement is an addition to the first method. Just as in the first method the retirement age is the same as the new announced AOW age. Besides that the amount of the payments after retirement depends on the expected remaining lifetime at retirement. Every pension fund determines its own forfaitary period which represents the expected remaining lifetime for a participant who reaches the age of 65 in 2010. Before a participant reaches his retirement age the provision for his pension benefits is based on this forfaitary period. Pension funds take into account that every participant who reaches his retirement age will be alive as long as the forfaitary period. When the participant actually reaches his retirement age his pension benefits are recalculated. If his expected remaining lifetime at that moment is longer than the forfaitary period his pension payments per year will be reduced. This happens in such a way that the total pension ambition will be the same as the total ambition with the forfaitary period. To model this pension agreement method we make a distinction between the pension provision of participants who have not yet reached their retirement age and retirees. Below the formulas for the net present value of the nominal liabilities for the second method applied to all accrued benefits (4) and only to the new accrued benefits (5) are given:

$$La_T^{nom} =$$

$$\sum_{n=1}^{N} \sum_{j=r_{n,T}-a_{n,T}}^{r_{n,T}-a_{n,T}+FP-1} \frac{(A_{n,0}\prod_{s=1}^{T}(1+i_s) + \sum_{t=1}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\prod_{k=a_{n,T}}^{r_{n,T}-1} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} 1_{\{a_{n,T}<r_{n,T}\}} +$$

$$\sum_{n=1}^{N} \sum_{j=0}^{Z-a_{n,T}} \frac{(A_{n,0}\prod_{s=1}^{T}(1+i_s) + \sum_{t=1}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\frac{FP}{\ddot{a}_{r_{n,T}}}\prod_{k=a_{n,T}}^{a_{n,T}+j} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} 1_{\{a_{n,T}\geq r_{n,T}\}} \quad (4)$$

$$Ln_T^{nom} =$$

$$\sum_{n=1}^{N} \sum_{j=max\{0,65-a_{n,T}\}}^{Z-a_{n,T}} \frac{(A_{n,0}\prod_{s=1}^{T}(1+i_s) + (c_{n,1}B_{n,1}\prod_{s=2}^{max\{2,T\}} I_s))\prod_{k=a_{n,T}}^{a_{n,T}+j} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} +$$

$$\sum_{n=1}^{N} \sum_{j=r_{n,T}-a_{n,T}}^{r_{n,T}-a_{n,T}+FP-1} \frac{(\sum_{t=2}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\prod_{k=a_{n,T}}^{r_{n,T}-1} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} 1_{\{a_{n,T}<r_{n,T}\}} 1_{\{T\geq 2\}}$$

$$\sum_{n=1}^{N} \sum_{j=0}^{Z-a_{n,T}} \frac{(\sum_{t=2}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}} I_s))\frac{FP}{\ddot{a}_{r_{n,T}}}\prod_{k=a_{n,T}}^{a_{n,T}+j} p_{k,T+(k-a_{n,T})}}{(1+R_T^{(j)})^j} 1_{\{a_{n,T}\geq r_{n,T}\}} 1_{\{T\geq 2\}} \quad (5)$$

$$I_s = \begin{cases} 1 & \text{if} \quad t+1 > T \\ 1+i_s & \text{if} \quad t+1 \leq T \end{cases}$$

$$r_{n,T} = 65 \quad \text{if} \quad T = 0 \quad \forall n = 1,..,N$$

$$r_{n,T} = \begin{cases} r_{n,T-1} & \text{if} \quad a_{n,T} \geq 57 \quad T > 0 \\ pa_T & \text{if} \quad a_{n,T} < 57 \quad T > 0 \end{cases}$$

$$pa_T = \begin{cases} 65 & \text{if} \quad T = 1 \\ 66 & \text{if} \quad 2 \leq T \leq 5 \\ 67 & \text{if} \quad T \geq 6 \end{cases}$$

FP = forfaitary period determined by the pension fund
$\ddot{a}_{r_{n,T}}$ = actuarial factor at the retirement age

The first part of the formula La_T^{nom} represents the pension provision for active participants. The current age of these participants is smaller than their retirement age therefore they are selected by the indicator $1_{\{a_{n,T} < r_{n,T}\}}$. For these people the pension funds take into account they have to pay from the year the participant will reach the retirement age ($r_{n,T} - a_{n,T}$) and it takes place for the length of the forfaitary period ($r_{n,T} - a_{n,T} + FP - 1$). The probability that a participant will reach his retirement is the product of the survival probabilities until his retirement age $\prod_{k=a_{n,T}}^{r_{n,T}-1} p_{k,T+(k-a_{n,T})}$.

The other part of the formula La_T^{nom} represents the pension provision for retirees. The payments for these category start immediately ($j = 0$) and ends when there are no survival probabilities ($Z - a_{n,T}$), just as in the normal method and method 1. The amount of the pension payments depends on the life expectancy of the participant at the retirement age. For the recalculation at retirement the actuarial factor $\ddot{a}_{r_{n,T}}$ is used. This factor represents the costs of a contract which pays one euro every year from the retirement age until death. For the retirement age of 65 this means (Gerber, 1997):

$$\ddot{a}_{65} = \sum_{t=1}^{\infty} \frac{{}_tp_{65}}{(1+R)^t}$$

Where ${}_tp_{65}$ represents the probability that a person of 65 will survive t years.

The accrued pension benefits are recalculated at the retirement age with the quotient of the forfaitary period and the actuarial factor at retirement. If the actuarial factor is the same as the forfaitary period the pension payments remain the same. If the actuarial factor is larger than the forfaitary period, the quotient becomes smaller than one which results in smaller pension payments.

The goal of this method is that the pension ambition of people with similar accrued pension benefits is the same. The following formula shows the situation if method 2 is applied at all accrued pension benefits.

$$(A_{n,0}\prod_{s=1}^{T}(1+i_s)+\sum_{t=1}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}}I_s))*FP=\overline{PP_i}*\ddot{a}_{r_{n,T}}$$

$\overline{PP}$ = the fixed nominal pension payment
The real pension payments are determined at retirement when $\ddot{a}_{r_{n,T}}$ is known.

$$\overline{PP_i}=(A_{n,0}\prod_{s=1}^{T}(1+i_s)+\sum_{t=1}^{T}(c_{n,t}B_{n,t}\prod_{s=t+1}^{max\{t+1,T\}}I_s))*\frac{FP}{\ddot{a}_{r_{n,T}}}$$

This calculated fixed nominal pension payment has to be paid by the pension fund to the retiree during the retirement period. This method is a fair one because the generation of a participant and the corresponding expected remaining lifetime at retirement determines the pension payments.

The forfaitary period and also the actuarial factor used for recalculation are dependent of the mortality tables and the interest rate. There have to be clear rules to determine these two periods. For example using an interest rate of 3% in combination with the AG 2010-2060 mortality tables for men gives us a forfaitary period of 14.76 years and an interest rate of 4% a forfaitary period of 13.50 years. As we can see the interst rate has a lot of impact at the forfaitary period. To determine the forfaitary period of a fund, the proportions of men and women in the fund are used. The forfaitary period of a pension fund is then calculated by the next formula:

$$FP=pm*FP_{men}+pw*FP_{women}$$

pm = proportion men in the pension fund
pw = proportion women in the pension fund

According to pension agreement method 2 the forfaitary period of the pension fund is calculated one time for a person of age 65 in 2010 and remains the same during the years. As we have seen the forfaitary period depends of the mortality table. If the fund specific mortality table of a pension fund changes, the forfaitary period will also change. This means that pension funds will not have the same forfaitary period during the years. This can become a problem in using this method.

4.6 Example of the model of pension agreement method 2

For this example we will look at the same pension fund as before. There are three participants who reach their retirement age in our example. Participant 1 will reach his retirement age at $T=1$, participant 2 at $T=3$ and participant 3 at $T=6$. The forfaitary period of the pension fund is based on its mortality tables, the AG 2010-2060 mortality tables for men, and is 13.50 years. This forfaitary period is calculated by using a person who reaches his retirement age in 2010 and an interest rate of 4%, this is the same interest rate as used for the discounting of the future liabilities in our example. Because participant 1 reaches his retirement age in 2010 ($T=1$), the value of $\ddot{a}_{65}$ for this participant is the same as the forfaitary period which means the value of his pension payments will not change. The value of $\ddot{a}_{65}$ for participant 2 is higher than the forfaitary period, it is 13.66. The pension payments of this person will be actuarial recalculated at $T = 3$. If method 2 is applied to all accrued pension benefits it will be done for all pension payments, otherwise it will only be done for the amount of the pension payments accrued in 2011 and later. The same happens for participant 3 who has an $\ddot{a}_{65}$ of 13.88. As you can see the remaining lifetime from 65 year on increases every year. For participant 4 the actuarial factor is determined by $\ddot{a}_{66}$, because these payments start one year later the factor is smaller. And for participants 5, 6 and 7 $\ddot{a}_{67}$ represents the actuarial factor. Because the model determines the pension provision per year, we will use the rounded forfaitary period of 14 years to calculate the pension provision. For the recalculation at retirement the exact forfaitary period of 13.50 years is used.

To show how the model of pension agreement method 2 works, we will look at the net present value of the nominal liabilities for the fund at $T = 6$ if the method is applied to all accrued pension benefits. At that time there are 3 retirees and 4 actives.

$$L_6^{nom} = \sum_{j=r_{4,6}-a_{4,6}}^{r_{4,6}-a_{4,6}+FP-1} \frac{(A_{4,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{4,t}B_{4,t}\prod_{s=t+1}^{max\{t+1,6\}} I_s))\prod_{k=a_{4,6}}^{r_{4,6}-1} p_{k,6+(k-a_{4,6})}}{(1+R_6^{(j)})^j} +$$

$$\sum_{j=r_{5,6}-a_{5,6}}^{r_{5,6}-a_{5,6}+FP-1} \frac{(A_{5,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{5,t}B_{5,t}\prod_{s=t+1}^{max\{t+1,6\}} I_s))\prod_{k=a_{5,6}}^{r_{5,6}-1} p_{k,6+(k-a_{5,6})}}{(1+R_6^{(j)})^j} +$$

$$\sum_{j=r_{6,6}-a_{6,6}}^{r_{6,6}-a_{6,6}+FP-1} \frac{(A_{6,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{6,t}B_{6,t}\prod_{s=t+1}^{max\{t+1,6\}} I_s))\prod_{k=a_{6,6}}^{r_{6,6}-1} p_{k,6+(k-a_{6,6})}}{(1+R_6^{(j)})^j} +$$

$$\sum_{j=r_{7,6}-a_{7,6}}^{r_{7,6}-a_{7,6}+FP-1} \frac{(A_{7,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{7,t}B_{7,t}\prod_{s=t+1}^{max\{t+1,6\}} I_s))\prod_{k=a_{7,6}}^{r_{7,6}-1} p_{k,6+(k-a_{7,6})}}{(1+R_6^{(j)})^j} +$$

$$\sum_{j=0}^{Z-a_{1,6}} \frac{(A_{1,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{1,t}B_{1,t}\prod_{s=t+1}^{max\{s+1,6\}} I_s))\frac{FP}{\ddot{a}_{r_{1,6}}}\prod_{k=a_{1,6}}^{a_{1,6}+j} p_{k,6+(k-a_{1,6})}}{(1+R_6^{(j)})^j} +$$

$$\sum_{j=0}^{Z-a_{2,6}} \frac{(A_{2,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{2,t}B_{2,t}\prod_{s=t+1}^{max\{s+1,6\}} I_s))\frac{FP}{\ddot{a}_{r_{2,6}}}\prod_{k=a_{2,6}}^{a_{2,6}+j} p_{k,6+(k-a_{2,6})}}{(1+R_6^{(j)})^j} +$$

$$\sum_{j=0}^{Z-a_{3,6}} \frac{(A_{3,0}\prod_{s=1}^{6}(1+i_s) + \sum_{t=1}^{6}(c_{3,t}B_{3,t}\prod_{s=t+1}^{max\{s+1,6\}} I_s))\frac{FP}{\ddot{a}_{r_{3,6}}}\prod_{k=a_{3,6}}^{a_{3,6}+j} p_{k,6+(k-a_{3,6})}}{(1+R_6^{(j)})^j}$$

Now the ages, the retirement ages, forfaitary period and $\ddot{a}_{r_{n,T}}$ for the retirees can be filled in.

$$L_6^{nom} = \sum_{j=66-60}^{66-60+14-1} \frac{27,433 \prod_{k=60}^{66-1} p_{k,6+(k-60)}}{(1.04)^j} +$$

$$\sum_{j=67-55}^{67-55+14-1} \frac{20,703 \prod_{k=55}^{67-1} p_{k,6+(k-55)}}{(1.04)^j} +$$

$$\sum_{j=67-50}^{67-50+14-1} \frac{15,079 \prod_{k=50}^{67-1} p_{k,6+(k-50)}}{(1.04)^j} +$$

$$\sum_{j=67-45}^{67-45+14-1} \frac{10,456 \prod_{k=45}^{67-1} p_{k,6+(k-45)}}{(1.04)^j} +$$

$$\sum_{j=0}^{119-70} \frac{37,941(\frac{13.50}{13.50}) \prod_{k=70}^{a_{1,6+j}} p_{k,6+(k-70)}}{(1.04)^j} +$$

$$\sum_{j=0}^{119-68} \frac{36,468(\frac{13.50}{13.66}) \prod_{k=68}^{a_{2,6+j}} p_{k,6+(k-68)}}{(1.04)^j} +$$

$$\sum_{j=0}^{119-65} \frac{34,364(\frac{13.50}{13.88}) \prod_{k=65}^{a_{3,6+j}} p_{k,6+(k-65)}}{(1.04)^j}$$

The results of pension agreement method 2 applied to all accrued pension benefits and only to new accrued benefits are shown in table 7 in the appendix. Participant 1, 2 and 3 will have retirement age 65, their retirement ages will not change with method 1 and 2. As we have seen in the example for method 1, the first method will have no impact on them. But the pension provision for these three people will change by using pension agreement method 2. As we can see the pension provision before retirement is a lot smaller with method 2 than with the normal method. This can be explained by the fact there is used a forfaitary period which is smaller than the real expected remaining lifetime at retirement because the forfaitary period is an annuity. At retirement we can see the pension provision increases a lot. From that moment on the pension provision is calculated with the real mortality rates, just as for the normal method and method 1, and therefore the gap is not very large. The small gap can be explained by the fact that the amount of the pension payments is recalculated at retirement.

If we take a look at the results for method 2 only applied to new accrued pension benefits we can see that the impact is larger for younger participants, just as we have seen for method 1. The gap increases during the years, it does not remain the same which is the effect if the method is applied to all accrued benefits. If all benefits are recalculated with the forfaitary period it will have the same effect every year. If only new accrued pension benefits are recalculated the effect increases during the years when the accrued benefits from 2011 on become a larger part of the total accrued pension benefits. In the situation that method 2 is applied to all accrued benefits we can see that the gap increases in 2011 ($T = 2$) and 2015 ($T = 6$), this increase is not as much as for method 1. The pension calculating age increases with one year in these years, this has only effect on the pension provision for participants who have not yet reached their retirement age and are younger than 57 (participant 5, 6 and 7 and participant 4 only in 2011). It means that the forfaitary period starts one year later for these people but the period remains 14 years. The probability that the participant will reach the retirement age decreases and therefore the gap increases a bit.

5 Implementation pension agreement

5.1 Description ALS

The Asset Liability Scenario system (ALS) is a system which is developed by Ortec Finance. The system is used to perform ALM studies for pension funds with the help of scenario analysis. With an ALM study a pension fund gets more knowledge about the risks and profit of its pension plan. Besides that, the impact of alternative strategies, pension policies and economic developments can be evaluated. With the results of the alternatives, pension funds can make better decisions about pensions, premiums, indexation and its investment policy. The ALS system is divided in 5 modules: the liability module, the economic module, the financing module, the investment module and the ALM module.

The first one, the liability module is the most important one for the analysis of the pension agreement. In this module the participant file with all information about the current participants (age, birth date, status, wage etc) is imported. Besides that there are transient tables with disability probabilities, dismissal probabilities, company growth probabilities, mortality probabilities, career lines etc which have to be established by the pension fund because they are fund specific. With this information the development of the participants file is simulated. For every participant a life cycle is simulated: in which year he will retire, if he becomes disabled or dismissed, the development of his wage, the year he will die etc.

Besides that, the different pension types of the pension fund are added in the liability module. For every pension type the pension base, the pension accrual, the pension benefit, the funding method and the conversion possibilities are determined. To calculate the corresponding net present value of the liabilities of each pension type, a couple of parameters are needed. The mortality table, age corrections, the marriage frequency table, the interest term structure and administration costs are important to determine the net present value of the liabilities per person. Together with the life cycles of the participants the pension benefits, pension payments and premiums can be calculated for the whole fund.

The second module is the economic module. In this module the future economic scenarios for the inflation, the returns on different investment categories, the value of different currencies, yield curves and credits are simulated. A VAR-model is used in this module and the scenarios are based on historical data.

The next module is the financing module. The agreement regarding indexation and contribution payments are defined in this module. Also the FTK (Dutch regulatory framework) settings to test the pension policy against the FTK rules are added in this module. This regulation obliges a minimum funding requirement for pension funds. If this requirement is not met, the pension fund has to introduce recovery measures.

The investment module shows the composition of the investment portfolio. All investment categories are added in this module together with the adjustment possibilities and characteristics per investment category.

The last module, the ALM module, combines all forgoing modules. Per ALM variant the information of all modules is used to make risk analysis. After calculating an ALM variant numeric overviews of results of all simulated scenarios are possible. Examples of results are indexation, return on assets, premiums, costs, funding ratio etc. With these results a risk decomposition can be made to identify the main risk drivers. After that, the pension fund can decide to change its policy to minimize risks.

5.2 Implementation method 1

To implement the pension agreement method 1 in ALS we have made adjustments in the programming code. In the current ALS model there are two locations where the retirement age is used. The first one is in the life cycle and the second one is in the pension provision. At both locations the retirement ages of the participants are adjusted to the AOW age.

The life cycle simulates the development of the status of the participants. The retirement age of participants is needed to switch the status of living participants from active or early leaver to retiree at their retirement age. The retirement age used in the life cycle is determined from the participant file. To apply the retirement age of the pension agreement in the simulation of the life cycles, the retirement ages of the participants are adjusted in the participant file.

The retirement age is also used to calculate the pension provision of the pension fund. The increasing retirement age means that the pension payments start later and participants who have not reached the maximum total accrual percentage at age 65 can accrue pension benefits until their new retirement age. In the screen of the definition of the pension benefit, 'pension accrual stops at age' and 'the retirement age of new participants' is increased from 65 to 67 (figure 28 in the appendix). Besides that there is added an extra option for the norm retirement age which is used to calculate the pension provision. This new option 'Retirement age according to pension agreement' (figure 28) refers to a table with the announced retirement age per calendar year (figure 29). Just as pa_T in the model. Besides the table with the adjusted retirement ages a new window is added for the 'starting age' which has to be 57 (figure 29). The retirement age of a participant only changes to the new retirement age if the participant is younger than 57 at that moment, otherwise it will remain the same. The option is also added at the real retirement age which means the age at which a participant really retires.

5.3 Implementation method 2

For this method there are also made adjustments in the programming code of ALS. The retirement ages according to this method are the same as for method 1 therefore the adaptations of method 1 are also used for method 2. There are however two more adaptations needed to calculate the correct pension provision and pension payments. The first adaptation is needed for the pension provision for participants who not yet reached their retirement age. Their pension provision is based on the forfaitary period. The second adaptation is the actuarial recalculation at the retirement age. These adaptations are made in the screen for the tarives (figure 30). The information filled in in this screen determines the factor which is used for the pension provision. The pension provision in ALS is calculated by the pension benefits times this factor.

The pension provision of participants younger than their retirement age is calculated by the fact that if they will reach their retirement age the pension fund will have to pay out as long as the forfaitary period. After retirement the normal mortality probabilities are used to calculate the pension provision. To implement this adaptation we have made an extra mortality table which is used to calculate the pension provision before retirement (figure 30). The new mortality table has the next values:

$$qn_{t,a_t} = \begin{cases} q_{t,a_t} & & \forall t & a_t \leq rn_t - 1 \\ 1 & \text{for} & t = 0, ..., 10 + FP & a_t = 65 + FP \\ 1 & \text{for} & t = 11 + FP, ..., 15 + FP & a_t = 66 + FP \\ 1 & \text{for} & t \geq 16 + FP & a_t = 67 + FP \\ 0 & \text{otherwise} & & \end{cases}$$

$$rn_t = \begin{cases} 65 & t = 0, ..., 10 \\ 66 & t = 11, ..., 15 \\ 67 & t \geq 16 \end{cases}$$

a_t = age at time t
rn_t = the new AOW age at time t
qn_{t,a_t} = the new mortality table with mortality probabilities at time t for age a_t
q_{t,a_t} = the original mortality table with mortality probabilities at time t for age a_t

According to the model, for the pension provision of participants who have not yet reached their retirement, pension funds take into account they have to pay out pension payments to these people from their retirement age of 65 as long as the forfaitary period. For the mortality table this means that these people will die at the age of $65 + FP$. The people with retirement age 65 will reach this retirement age in 2019 ($t = 10$) or earlier and the pension payments will end in the year $2019 + FP$ ($t = 10 + FP$). For the group of participants with retirement age 66 the pension payments will start one year later which means the forfaitary period will start at age 66 at $t = 12, 13, 14$ or 15. The youngest participants will reach their retirement 67 at $t = 17$ or later.

The second characteristic of this method is the actuarial recalculation at retirement. Therefore the exact forfaitary period of the pension fund and the actuarial factor of the participant are needed. The exact forfaitary period of the pension fund can be filled in in the tarives screen (figure 30). This is needed for the recalculation factor. The actuarial factor $\ddot{a}_{r_{i,t}}$ is determined with the original mortality table. The programme recalculates the pension payments at retirement with the recalculation factor.

6 Results

6.1 Data description and assumptions

To observe the impact of the two different methods of the pension agreements we will use specific information of two different pension funds. The two pension funds are clients of Ortec Finance. For the liability, financing and investment modules we will use the fund specific variants. For the economic module we will use the same variant for both funds, this is the Ortec economy with starting point december 2009. The assumptions used in this economy are shown in figure 31 in the appendix. This section shows a further description of the fund specific data and the assumptions we have made.

The first pension fund is a company pension fund and consists of 787 participants. The largest part of the participants is active (474 participants) or early leavers (305 participants). Active people are the current employees of the company. Early leavers are people who have worked for the company but nowadays they are not working there anymore. They have left the company before their retirement age and have accrued a part of their pension at the corresponding pension fund. For these participants no new pension benefits will be accrued.

This is a very young pension fund, the average age of the participants is 34.9 and there are only 3 retirees in 2009. This means that the AOW age will increase for almost all participants. For 766 participants (97.3%) the AOW age will increase to 66 and for 739 participants (93.9%) it will further increase to 67 in 2015. The majority of the participants (73.4%) are men. Most of the participants are high educated which means a high yearly fulltime salary of the active participants (€49,258). Higher educated people have mostly done a study at a university and therefore they start working at a higher age. Also for this reason most of the participants have not already been in this pension fund for a long time.

This fund has an average pay scheme with an accrual percentage of 2.00% over a maximum of 40 years. Participants accrue their second pillar pension from the age of 21. The salary will yearly increase with the price inflation. The already accrued pension benefits of the actives and non actives are conditionally indexed with the price inflation. The mortality probabilities are fund specific for men and women, according to experiences the participants of this fund will live longer than an average Dutch person. Therefore the mortality probabilities of this fund are smaller than the ones representing the Dutch population. The company is expected to grow 3% every year, this means the number of fulltime equivalents will increase with 3% per year. The data set of 787 participants is not very large, to make the calculations more exact the data set is exaggerated with a factor 20.

There are different kinds of pensions for participants of this pension fund. The first one is the old age pension. The second one is a widowers pension which is 70% of the old age pension. At the pension age the participants have the possibility to exchange a part of their pension for a widowers pension. According to the model of this pension fund every married participant chooses for this exchange possibility. The last pension form is the defined contribution pension, this is an investment account which is paid out at retirement.

At the end of 2009 the funding ratio of the fund is 103.5%. The premium participants and employers together have to pay is the cost covering premium. In 2009 the premium is 13% of the salary of the participant.

The second pension fund is a sector fund, therefore it is a much larger fund which consists of 12,601 participants. The composition of the participants differs a lot from the first fund. More

	Fund 1	Fund 2
Number of participants	787	12,601
- Actives	474 (60.2%)	2,802 (22.2%)
- Retirees	3 (0.4%)	1,761 (14.0%)
- Early leavers	305 (38.8%)	6,683 (53.0%)
- Widowers	3 (0.4%)	1,149 (9.1%)
- Disabled people	2 (0.2%)	206 (1.7%)
Impact AOW age to 66	766	7,162
Impact AOW age to 67	739	6,397
Average age	34.9	50.1
Percentage men / women	73.4% / 26.6%	82.1% / 17.9%
Average fulltime salary of actives	49,258	27,224
Funding ratio	103.55%	100.9%
Net premium	13.0%	14.1%

Table 1: Overview of characteristics of fund 1 and fund 2 at the end of 2009.

than half of the participants are early leavers (6,683 participants) and only 22.2% are actives (2,802 participants). Furthermore the rest of the participants are retirees (1,761 participants), widowers (1,149 participants) and disabled people (206 participants). Besides the difference in the composition of the participants also the age and education level differs a lot. The average age of this pension fund is 50.1 years which is much higher than we have seen for the first fund. This difference can be explained by the fact that there are a lot of retirees and widowers. This means that the increase of the AOW age to 66 will have impact on 7.162 (56.8%) participants, the second increasing will have impact on 6397 (50.8%). Also in this fund the majority of the participants are men (82.1%). The participants are lower educated which means a lower average fulltime salary of actives (€27,224).

The participants accrue an average pay pension from the age of 18 years with an accrual percentage of 1.75% per year and a total maximum of 100%. The salary is expected to increase yearly with the wage inflation. The already accrued benefits of the actives are conditionally indexed with the wage inflation and the benefits of the non actives with the price inflation. The mortality probabilities are also fund specific for men and women, they are both higher than the mortality probabilities of the first fund. The sector remains at the same number of fulltime equivalents.

Also in this fund there are a couple of different pension forms. There is an old age pension which consists of a premium free part and two old age pensions with different accrual percentages (1.75% and 0.486%). There is also a temporary old age pension for participants who want to stop working at an earlier age. Instead of the first fund, in this fund the widowers pension is accrued with an accrual percentage of 1.118%.

The second fund has a funding ratio of 100.9% at the end of 2009. The active participants and the employer together have to pay 14.1% of the salary in 2009. This premium is a cost covering contribution.

6.2 Results old age pension with pension agreement method 1

In this section we will take a look at the results of pension agreement method 1 for the two pension funds with only an old age pension. We will look at results by using their own mortality tables and using the AG mortality tables 2010-2060. The fund specific tables assume an adjustment of the AG tables 2005-2050 to better represent the fund specific mortality based on historical experience. The AG tables 2010-2060 represent the most up-to-date mortality of the Dutch population. According to the new AG 2010-2060 tables people will live longer than with the AG tables of 2005-2050. These tables show the impact of the increasing life expectancy. For fund 1 the mortality probabilities of the new AG tables are even smaller than the probabilities of fund specific mortality applied to the AG tables of 2005-2050.

Besides that we will show results if the pension agreement will be applied to all accrued pension benefits and if it only will be applied to pension benefits which are accrued from 2011 on. To evaluate pension agreement method 1 we will look at the pension provision and pension payments.

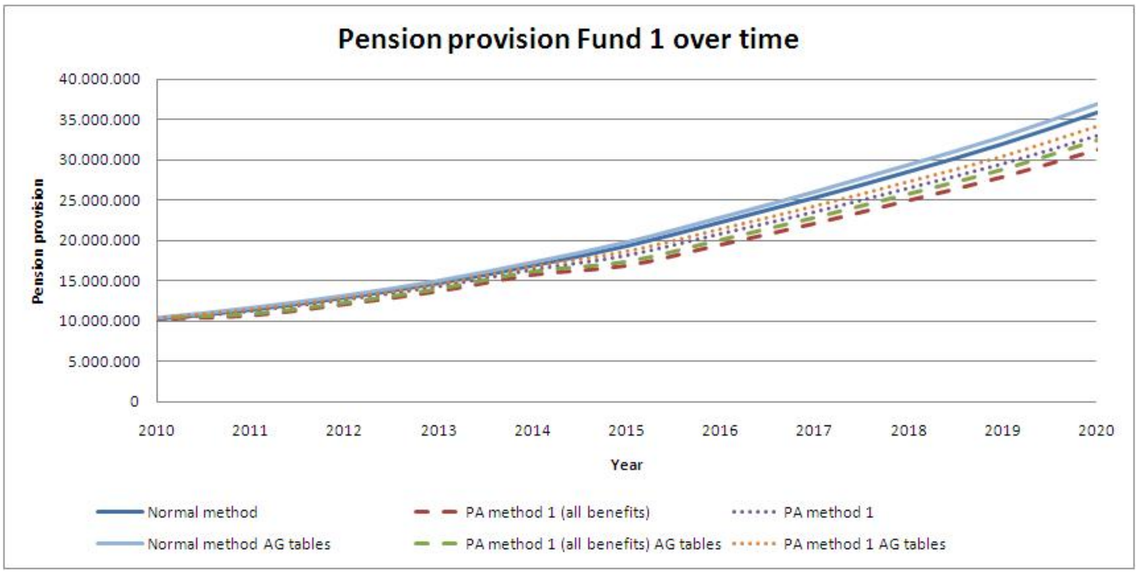

Figure 8: Pension provision with pension agreement method 1 for Fund 1 with only the old age pension.

First we will look at the pension provision of the old age pension without exchange possibility (figure 8). In the appendix, table 8 also represents the results, it shows the changing percentages of method 1 over time. There is only a small difference between the pension provision with the fund specific mortality tables and the AG tables. Because the mortality tables of the second variant are smaller, participants will live longer according to the most up-to-date mortality rate which means a higher pension provision is needed.

As we can see the pension provision in year 0 is the same for the normal method and method 1. This is because the pension benefits of all participants are imported from the participant file. As already mentioned in section 5.2, to change the retirement age for method 1 another participant file is needed. The small difference of the pension provision in year 1 (-0.27% and -0.09%) can be explained by different simulations of the participant life cycles.

In year 2 (2011) we can see a difference of 1.38% between the pension provision of the normal method and method 1 applied to new accrued benefits for the fund specific mortality tables. If we use the AG tables the difference will be 1.68%. As already mentioned in section 5.2, this is the impact of the announcement of the increase of the AOW age. In 2015 the next announcement of the increase of 66 to 67 results in another decrease of the pension provision for the pension fund. The difference between the methods increases to 5.99% for the fund specific mortality tables and 5.72% for the AG tables. If method 1 will be applied to all accrued pension benefits, the impact will be larger, 12.56% for fund specific tables and 12.08% for the AG tables.

From 2027 on we can see the gap between the methods decreases in both situations (table 8). This transition point can be explained by the fact that the part of the retirees in the total participant file increases. The part of the participants who is retiree increases from 0.4% in 2009 to 5.0% in 2034. If method 1 is applied to all accrued benefits, from the moment a participant has reached his retirement age the pension provision is the same for method 1 as for the normal method. This is because the level of the pension payments remains the same. Only if the participant has accrued 2% or 4% more pension benefits the pension provision from the retirement age on will be a bit higher. If the first method is only applied to new accrued benefits, for retirees with a retirement age higher than 65, the pension provision will be a bit higher than for the normal method. The already accrued benefits will be actuarial recalculated at retirement which means a higher level of payments if the payments start at age 66 or 67 instead of 65 (figure 5). For these recalculated benefits a higher pension provision is needed than for the normal methods. This also explains the smaller change for method 1 only applied to new accrued benefits.

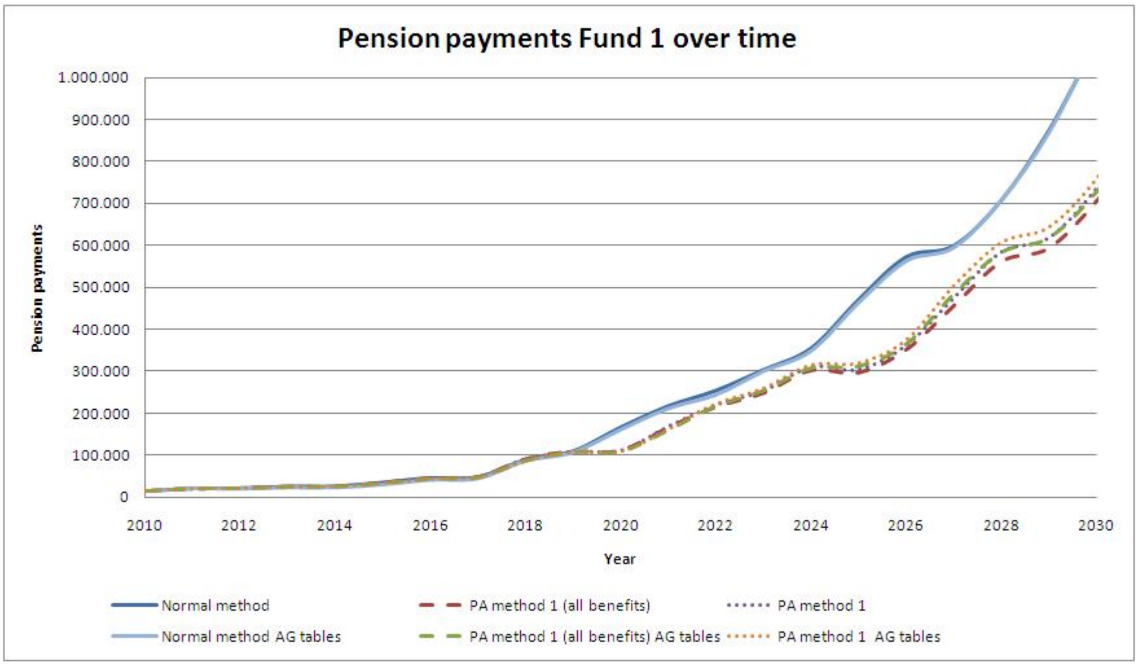

Figure 9: Pension payments with pension agreement method 1 for Fund 1 with only the old age pension.

We will also look at the pension payments of the old age pension of pension fund 1 in figure 9 (table 9). These graphes are not very fluent but they show shocks at some moments, this can be explained by the fact that there are not many retirees in this fund. From 2020 the impact at the pension payments is clearly visible. In 2020 and 2025 there will be no new retirees which means no extra pension payments in comparison with the expected payments in 2019. The small increase of the pension payments in 2020 in comparison with 2019 can be explained by the indexation of the pension benefits. In 2019 there will be 19 retirees according to the simulations, in 2020 there would be 3 new retirees but with the new retirement ages they would retire one year later. These participants have been active for a longer time than the first retirees and therefore they will have higher pension benefits. From 2020 on there are less retirees according to the normal method because the payments start at the age of 66 instead of 65. In 2025 there is a new shock, in that year there also will be no new retirees. From that moment the retirement age is 67 which means the number of retirees reduces again.

As we can see there is not much difference in the payments according to method 1 applied to all accrued benefits (-36.89% for fund specific tables in 2025) or only to new benefits (-35.30%). Because this is a young fund the largest part of the pension benefits of people who retires in 2021 or later are accrued after 2010. Therefore the impact on the pension payments is more or less the same for this fund. The pension payments according to the AG mortality tables are higher than the payments with the fund specific tables because of the higher life expectancy. This is the same as we have seen for the pension provision.

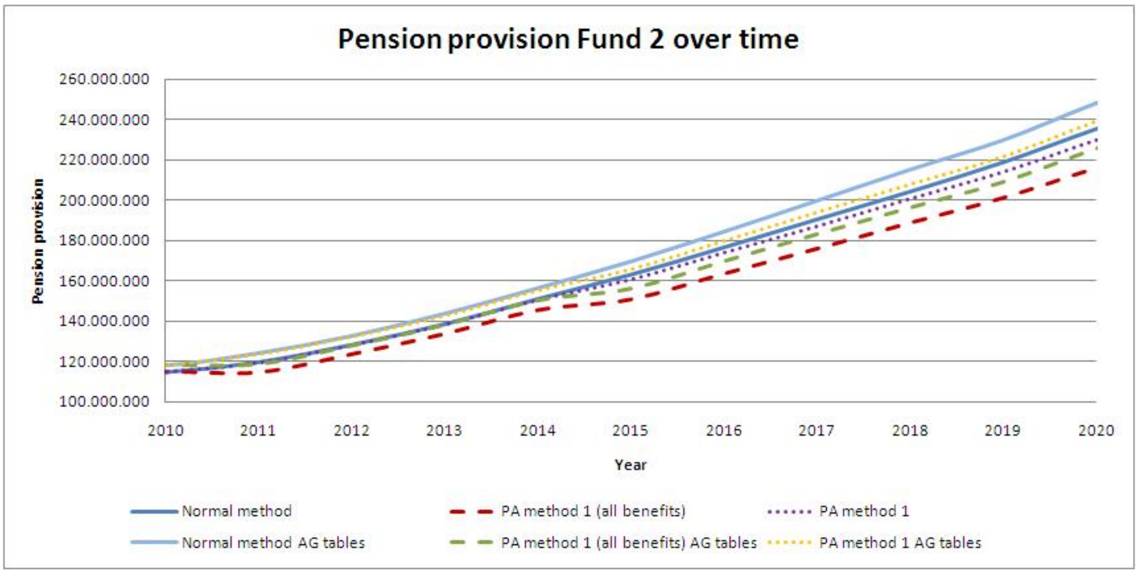

Figure 10: Pension provision with pension agreement method 1 for Fund 2 with only the old age pension.

Now we will have a look at the results for fund 2, the fund with older participants. Also for this fund we take a look at the results using the fund specific tables and the AG tables 2010-2060. As already mentioned the fund specific mortality probabilities of this fund are larger than the probabilities of an average Dutch person. The fund specific mortality rates are also higher than the new AG tables and therefore the pension provision with fund specific tables is smaller. Figure 10 shows the pension provision of this fund. In 2011 we can see the first decreasing of the pension provision. Because the change in AOW age has only impact on 56.84% of the participants, the impact on the pension provision is smaller than for fund 1. On the other hand the participants of fund 2 are older than those of fund 1 which means that fund 2 will have to start paying pension payments earlier than fund 1. For example for a person born in 1960 the payments will start in 2027 but for a person born in 1980 they will start in 2047, both at the retirement age of 67. This means that the probability the first person will reach its retirement age is larger than for the second, younger person. Therefore the needed pension provision changes more for the first, the older person. We can conclude that in proportion to the impact of the increasing AOW age for one participant of fund 1, the impact of one participant of fund 2 will be larger. The results in table 10 in the appendix also show this if the pension provision for all accrued benefits would be recalculated in 2011. The impact for fund 2 is ($\frac{4.22}{6.28}$ 100% =) 67.20% of the impact of fund 1 with the fund specific tables and ($\frac{4.04}{6.41}$ 100% =) 63.03% with AG tables. The part of the participants of fund 2 for who the AOW will increase is ($\frac{56.84}{97.33}$ 100% =) 58.40% of the part of the participants of fund 1. Therefore it has more impact for fund 2.

If the pension agreement is only applied to new accrued benefits the opposite happens. In that case we see the gap is a lot smaller (-0.19% and -0.17%) for pension fund 2. This can be explained by the fact there are also a lot of early leavers in this fund who will not accrue new pension benefits and the older people already accrued the largest part of their pension benefits. Therefore there are less new accrued pension benefits in comparison with fund 1. Also when we take a look at the ratio of difference of the impact for all benefits or only new benefits ($\frac{\Delta all}{\Delta}$). We can see that the impact on older participants is smaller in the situation that method 1 is only applied to new accrued benefits. For fund 1 this ratio is on average from 2010 to 2034 1.81, but for fund 2 the difference is much larger, the ratio is on average 6.05. The gap between the pension provision of the normal method and method 1 increases until 2027, from 2027 on the gap decreases, we have seen this already for fund 1. For the second fund the part of retirees increases from 14.0% in 2009 to 30.0% in 2034.

The results of the pension payments for fund 2 are shown in figure 11. As we can see the pension payments of fund 2 show a more fluent growth because of the larger and older number of participants. In 2020 the pension payments will be 12.38% and 12.26% (table 11) smaller with pension agreement method 1 applied at new accrued benefits instead of the normal method. This gap is a lot smaller than we have seen for fund 1. As already mentioned the number of retirees of pension fund 2 is larger. With the normal method there would be 47 new retirees in 2020 and there already are 3364 retirees in 2019, this is a smaller part of the retirees than for fund 1. In 2025 the gap increases further to 18.14% and 17.71%. If method 1 is applied to all benefits the gap will be a bit larger especially on the long term.

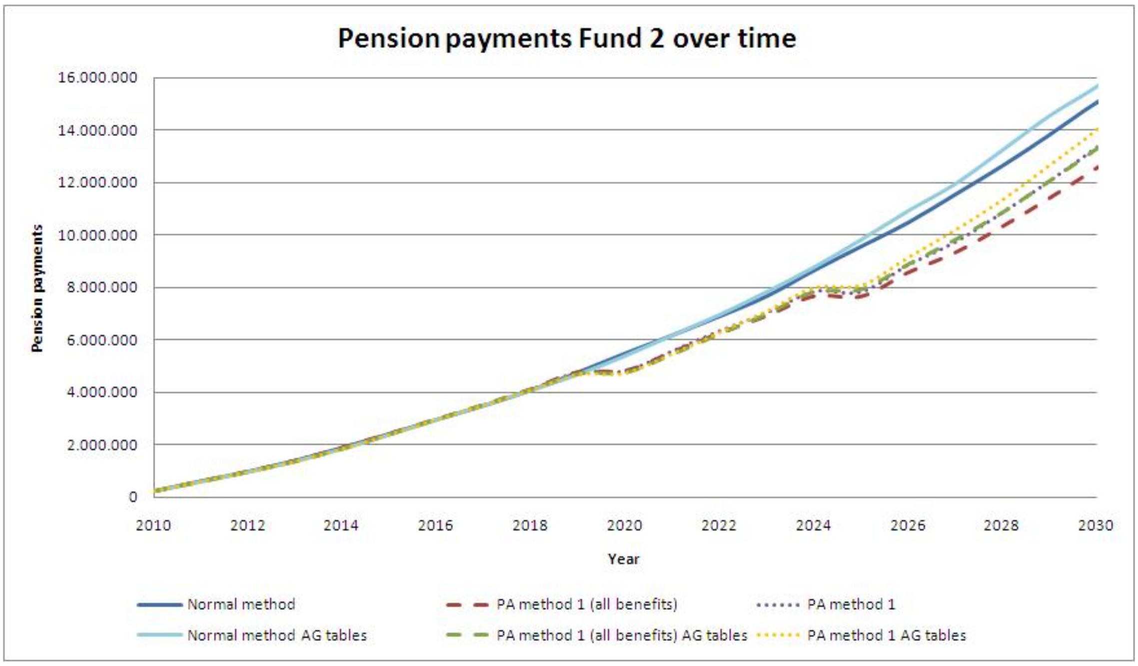

Figure 11: Pension payments with pension agreement method 1 for Fund 2 with only the old age pension.

6.3 Results old age pension with pension agreement method 2

In this section we will discuss the results of pension agreement method 2. Because there are no strict rules to determine the forfaitary period we will use a forfaitary period of 15 years to calculate the results for the two pension funds. To compare the results of both funds we take the same forfaitary period for both.

First we will look at the results of the pension provision of fund 1 with only the old age pension in figure 12. The first important point we can conclude is the fact that pension agreement method 2 applied to all accrued benefits gives more or less the same pension provision for fund 1 with fund specific and AG mortality tables. This can be explained by two reasons: the forfaitary period which is used is the same for the fund specific tables as for the AG tables and there are not many retirees. The largest part of the participants is not yet a retiree. As we have seen in section 4.6 the pension provision of these participants is determined with the forfaitary period. Only for retirees the provision for the pension payments for their remaining lifetime is based on the real mortality table. The only difference in pension provision for participants who are not yet a retiree with the fund specific tables and the AG tables is caused by the different probability that participants reach their retirement age.

In table 12 in the appendix a total overview of the results is attached. The pension provision needed according to the second method is a lot smaller than the pension provision according to the normal method. If we will apply method 2 to all accrued benefits they will already be recalculated in year 0 which means from that moment on a smaller pension provision. If the method is only applied to new accrued benefits we will see a smaller change from 2010 on. The gap between the methods is the largest for the pension provision with AG tables. The remaining lifetime according to the new AG tables is larger than for the fund specific tables. Just as for

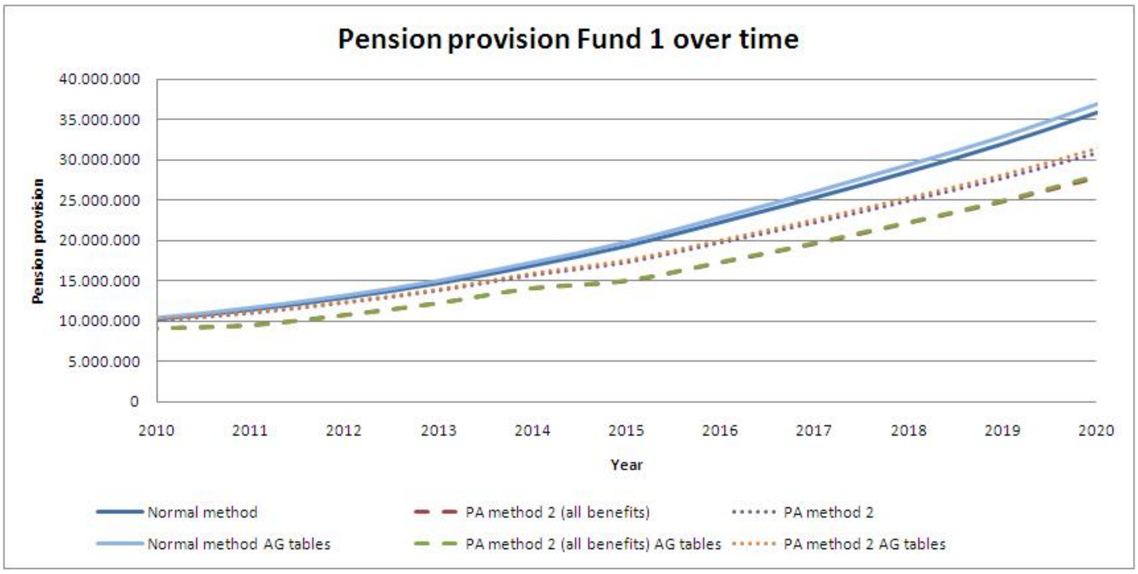

Figure 12: Pension provision with pension agreement method 2 for Fund 1 with only the old age pension.

pension agreement method 1 the gap clearly increases in 2011 and 2015.

If the method is applied to all accrued benefits the gap decreases from 2020 on, if it is only applied to new benefits we can see the gap increases further. As we have noticed earlier the participants become older and the number of retirees increases during the years. From the retirement age on the real mortality tables are used to calculate the pension provision which is the same as using the normal method but for another amount of pension payment. When the proportion of retirees increases, the gap decreases. We have seen this already in the example of section 4.6 where the gap decreases for participants who retire. In table 12 we can also see this in the situation that method 2 is applied to all accrued benefits. If the method will only be applied to new accrued benefits it will have less effect if participants will reach their retirement age because only for a small part of their benefits the pension agreement method is applied.

We use the same forfaitary period the next 25 years, this means the real remaining lifetime will differ more from the forfaitary period during the years. Only the increasing retirement age to 66 and 67 decreases the remaining lifetime of participants after retirement. The ratio between the effect of method 2 only applied to all accrued benefits and to all benefits is on average 1.96 for the fund specific mortality tables, which is only a bit larger than for method 1.

The next results which are discussed are the pension payments according to pension agreement method 2. In figure 13 we can see the impact of pension agreement method 2. Before 2020 the pension payments differ a couple of percentages of the payments according to the normal method. Because the number of retirees and the amount of payments are relatively small and fluently the first years, the pension payments of both methods differ during the first years just as we have seen for method 1. The difference in the situation that method 2 is applied to all accrued benefits is bit a larger because of the recalculation of the pension payments from 2010 on. The actuarial factor at retirement is a bit larger for both mortality tables than the forfaitary period of 15. This can be concluded from table 13 because the gap of the pension payments of this method is a bit larger than the gap of method 1. This means that the pension payments

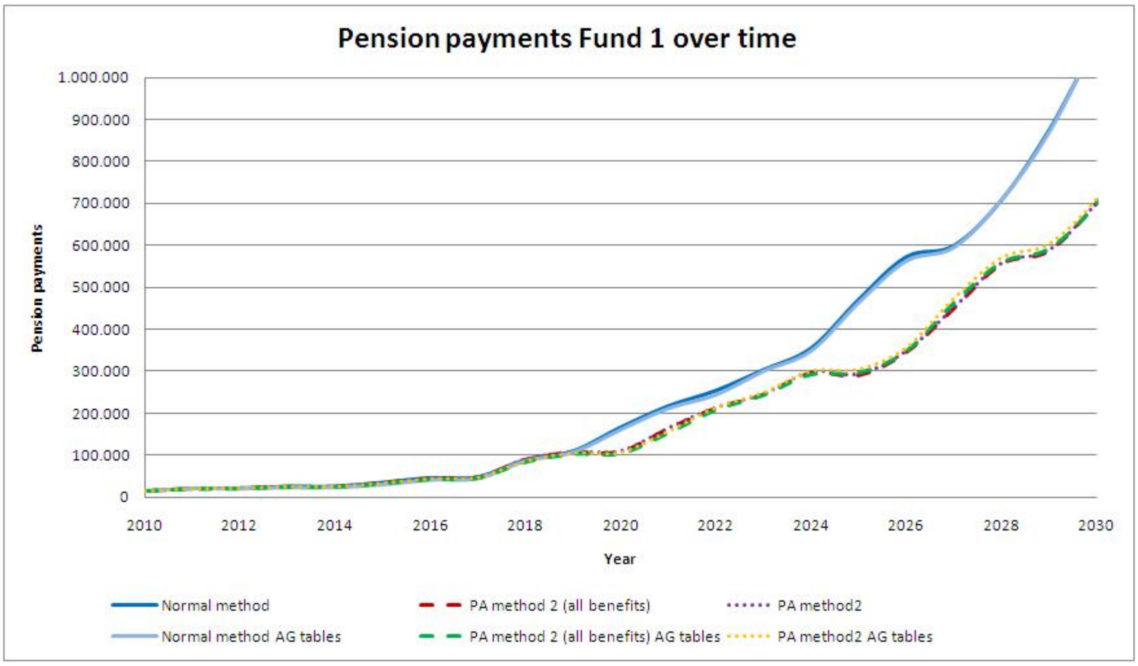

Figure 13: Pension payments with pension agreement method 2 for Fund 1 with only the old age pension.

from retirement would be smaller than the pension payments according to the normal method. In 2020 en 2025 there will be no new retirees which increases the gap, as we have already seen in the results of pension agreement method 1.

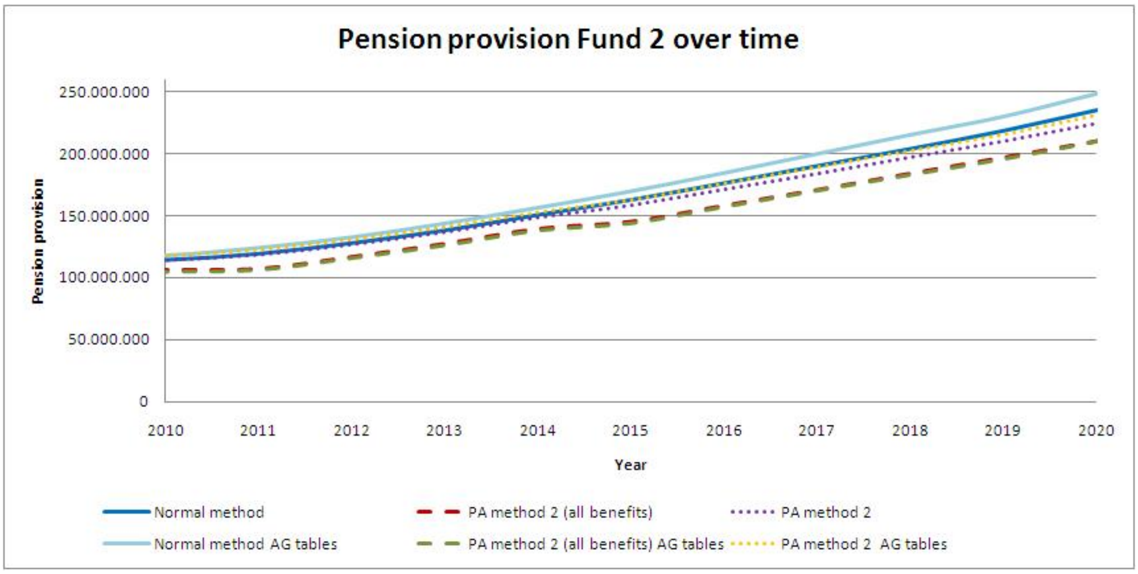

Figure 14: Pension provision with pension agreement method 2 for Fund 2 with only the old age pension.

Now the results for fund 2 will be discussed. In figure 14 it is clear that the pension provision according to method 2 applied to all accrued benefits differs a lot from the normal method. Furthermore the shocks in 2011 and 2015 are clearly visible. Because this is an older fund with more retirees we can see that the gaps between the pension provision of the normal method and pension agreement method 2 are smaller than we have seen for the first fund in both situations. The more retirees the smaller the gap as we have seen in the example of section 4.6. Besides the number of retirees we know that the active participants of fund 2 are older than the actives of fund 1. For both funds the forfaitary period is 15 years which means a larger gap in expected remaining lifetime between the forfaitary period and the actuarial factor for younger participants. Also the remaining lifetime for a person who retires in 2010 is smaller for a person of fund 2 than for fund 1. Therefore the second method will also have less impact for fund 2 in comparison with fund 1 for active participants. As we will look at the second method applied to new accrued benefits the differences will be -2.69% and -4.01% in 2015 (table 14 in the appendix). Just as for method 1 the difference between method 2 applied to only new accrued benefits and to all accrued benefits is larger than for fund 1. The ratio over 2010 until 2034 is 6.16 for the fund specific tables.

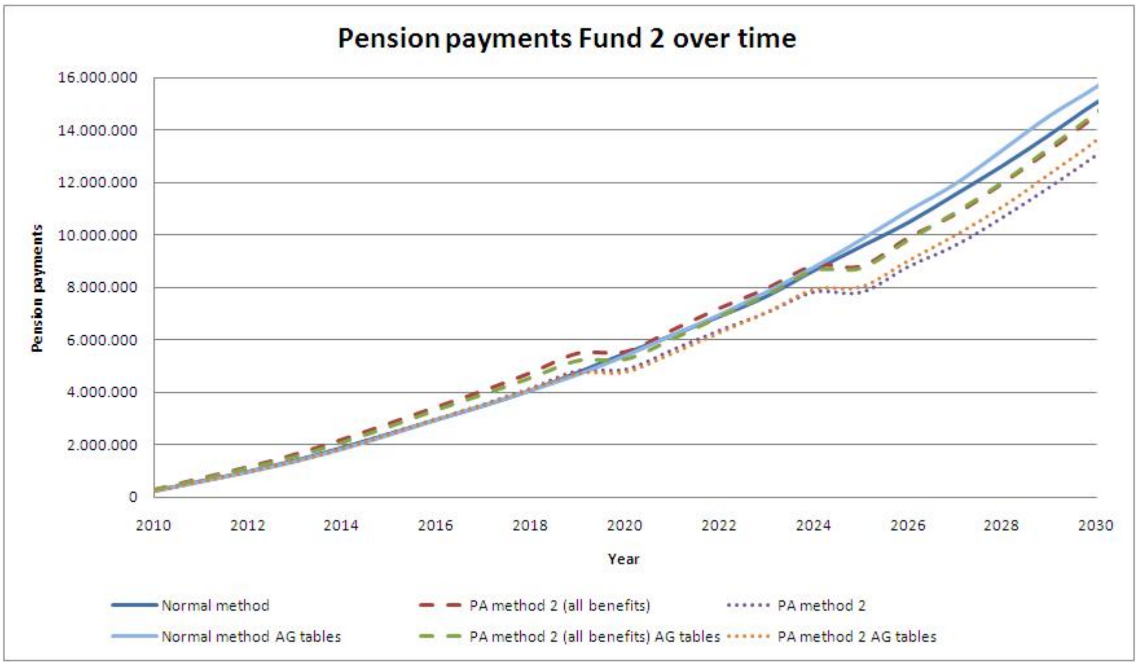

Figure 15: Pension payments with pension agreement method 2 for Fund 2 with only the old age pension.

The pension payments of fund 2 are shown in figure 15. An obvious point we can see immediately is that the pension payments increases the first 15 years by using this method for all accrued benefits in comparison with the normal method. In contrast with the other method and the other fund this will be negative for this fund with only an old age pension. During the years there are a lot of participants in this fund who will reach their retirement age. At the moment these participants will reach their retirement age, the calculated actuarial factor is smaller than 15. For example a man who reaches his retirement age in 2010 will have an actuarial factor of 13.13 years and a woman 14.03 years by using the fund specific mortality tables and an interest rate of 4%. The used forfaitary period is 15 years and is therefore 1.14 /1.07 times the actuarial factor. This means that the recalculated pension payments of these participants will be 14% / 7% higher than the pension payments with the normal method. The actuarial factor according to the AG tables will be larger than the one according to the fund specific rates. Therefore the recalculated pension payments with the AG tables will be a bit of lower than the one with the fund specific mortality tables. This results in a smaller effect for method 2 using the AG tables. If the second method is only applied to new accrued benefits the effect is very small, 0.03% and 0.02% in 2010, because only a small part of the pension payments will increase.

6.4 Results for all pension types of pension fund 1

In this section the results for the whole pension plan (not only the old age pension but also the other pension types) of fund 1 are discussed. Because the pension agreement will probably only be applied to new accrued pension benefits from 2011 on, we will only show these results. First we have a look at the progress of the pension provision.

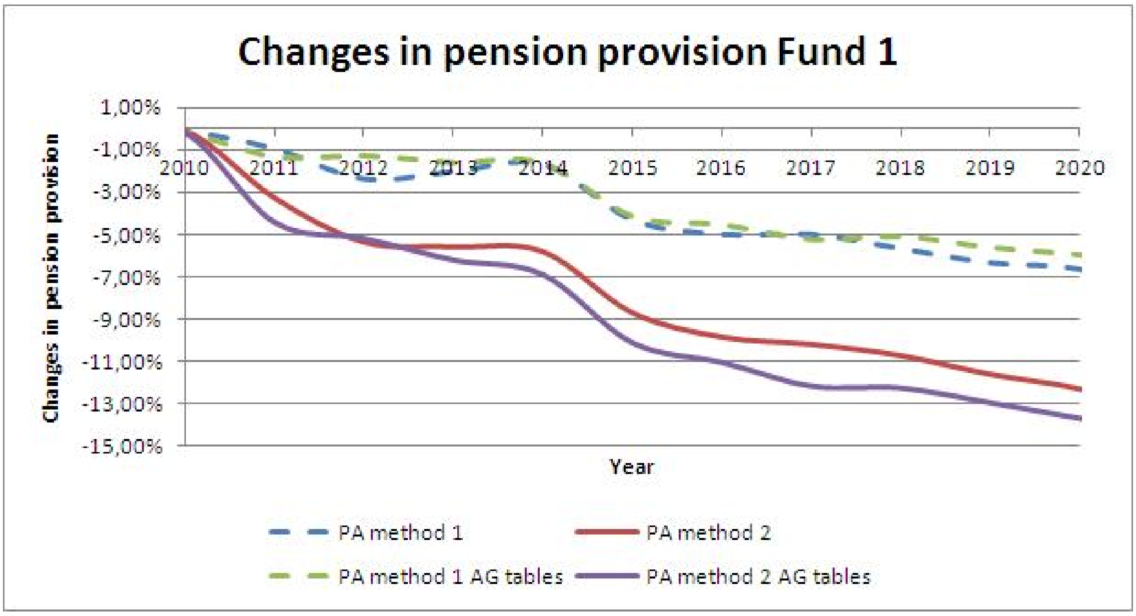

Figure 16: Changes in pension provision of pension fund 1.

Figure 16 shows the changes of both methods in comparison to the pension provision using the normal method. In 2011 we can see the pension provision of both methods is smaller than the normal method. For pension agreement method 2 the changes are larger, this method has more impact, as we have already seen in section 6.3. The gap increases slowly during the years, in 2015 the second increase of the AOW age is announced which means a higher pension calculating age. At that moment the gap makes a jump for both methods. During the years the increase of the gap continues. Over time the gap of method 2 with the AG tables is larger than the gap for the fund specific tables. As we have seen earlier this can be explained by the fact that people will live longer according to the new AG tables. If the forfaitary period of 15 years is used to calculate the pension provision, the difference between the remaining lifetime according to the mortality table and the forfaitary period is the largest for the AG tables.

The changing of the pension provision has a lot of impact on the funding ratio. This ratio shows the net present value of the assets divided by the net present value of the liabilities. The decreasing pension provision therefore results in an increasing funding ratio. Figures 32, 33 and 34 in the appendix show the funding ratio and its uncertainty for the normal method and both pension agreement methods applied to new accrued benefits, using the fund specific mortality tables. The red line shows the average funding ratio over all 1000 simulations, the yellow lines are the scenarios. The larger the yellow cloud around the average line, the larger the uncertainty about the funding ratio. The cloud above the average line is larger then the cloud below. This means the scenarios with a larger funding ratio than the average are more distributed than the scenarios below the average funding ratio. For all methods we can see an increasing funding ratio in the beginning, after a couple of years the increase stops and the funding ratio decreases slowly. For both pension agreement methods we can see a small shock in 2015 when the pension calculating age increases to 67, this has a positive effect on the funding ratio. At that moment the pension provision for all accrued pension benefits from 2011 on will be recalculated with the pension calculating age of 67 instead of 66. In 2011 the pension calculating age is already increased to 66, this effect is not so large because it has only impact on pension benefits accrued in 2011.

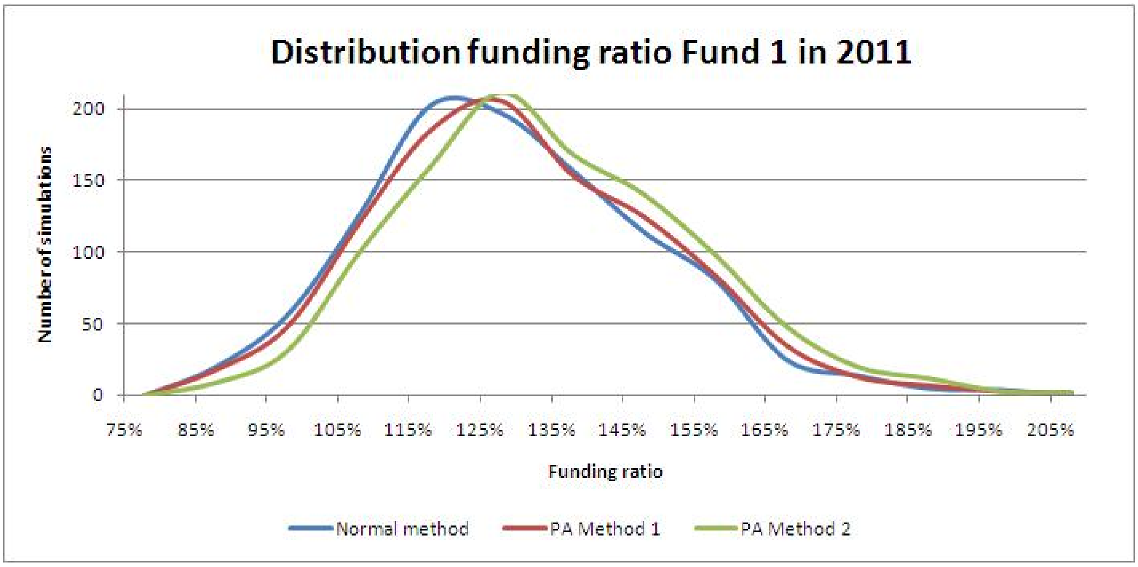

Figure 17: Distribution funding ratio of fund 1 in 2011.

As we have seen, the increasing pension calculating age in 2011 and 2015 have a lot of impact at the funding ratio. Therefore we will have a look at the distribution of the scenarios of the funding ratio in 2011 and 2015 for the same methods as above. Figure 17 shows the results for 2011. The distributions of the funding ratios of the pension agreement methods are a bit more to the right side, the red and green line are mostly on the right side of the blue one. This means the simulated funding ratios have higher values. As we can also see the funding ratios of the three methods are not normally distributed. The scenarios with a higher funding ratio are more distributed, the tail on the right side is longer than the left one. Therefore we can conclude that all distributions are skewed to the right. We have seen this already in the figures 32, 33 and 34 where the cloud above the average line is bigger than the one below. The funding ratios are distributed between 75% and 205%.

	Normal Method	PA Method 1	PA Method 2
Average	124.55%	125.92%	129.55%
Sigma	19.74%	19.95%	20.13%
25% percentile	110.79%	112.44%	115.62%
Median	122.51%	123.89%	127.55%
75% percentile	137.61%	139.65%	142.85%
Prob (Funding Ratio<90%)	0.027	0.024	0.014
Prob (Funding Ratio<100%)	0.094	0.081	0.056
Prob (Funding Ratio<105%)	0.161	0.143	0.101
Prob (Funding Ratio<124.55%)	0.537	0.505	0.433

Table 2: Overview of the characteristics of the funding ratio distribution of fund 1 in 2011.

In table 2 we can see an overview of the characteristics of the funding ratio distributions in 2011. The average funding ratio increases by applying one of the pension agreement methods. The standard deviation increases also a bit which means more uncertainty. The median of the simulated funding ratios has a lower value than the average, this also shows the skewness to the right. The probability of underfunding in 2011, Prob (Funding Ratio<100%), decreases with both methods of the pension agreement. Furthermore we can see that the probability that a simulated funding ratio is smaller than the average funding ratio according to the normal method, Prob (Funding Ratio<124.55%), is smaller for both pension agreement methods.

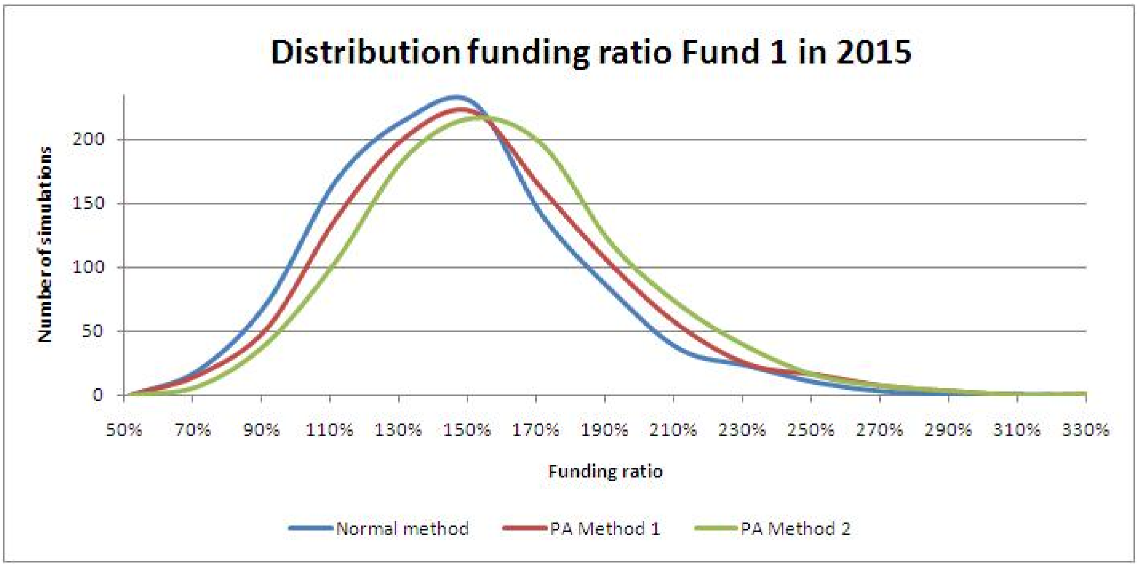

Figure 18: Distribution funding ratio of fund 1 in 2015.

The distribution of the funding ratios in 2015 is shown in figure 18. In comparison to 2011 the interval of the values is increased which means more uncertainty about the funding ratios. In 2015 the values of the simulated funding ratios are between 50% and 330%.

	Normal Method	PA Method 1	PA Method 2
Average	136.64%	143.12%	149.67%
Sigma	36.71%	38.41%	37.89%
25% percentile	110.91%	116.32%	122.94%
Median	133.96%	140.37%	147.30%
75% percentile	157.54%	165.46%	172.16%
Prob(Funding Ratio<90%)	0.081	0.065	0.039
Prob(Funding Ratio<100%)	0.151	0.115	0.077
Prob(Funding Ratio<105%)	0.191	0.153	0.107
Prob(Funding Ratio<136.64%)	0.543	0.459	0.388

Table 3: Overview of the characteristics of the funding ratio distribution of fund 1 in 2015.

Table 3 also shows the larger intervals of the funding ratios, because the standard deviation is almost two times the standard deviation of 2011. The percentiles show the same effect, there is a larger gap between the 25% percentile, the median and the 75% percentile. In 2015 the probability of underfunding is larger than in 2011 because of the larger uncertainty. The gap between the average funding ratio of the two pension agreement methods and the normal method is larger in 2015 than in 2011. This can be explained by the decrease of the pension provision in 2015 (figure 16).

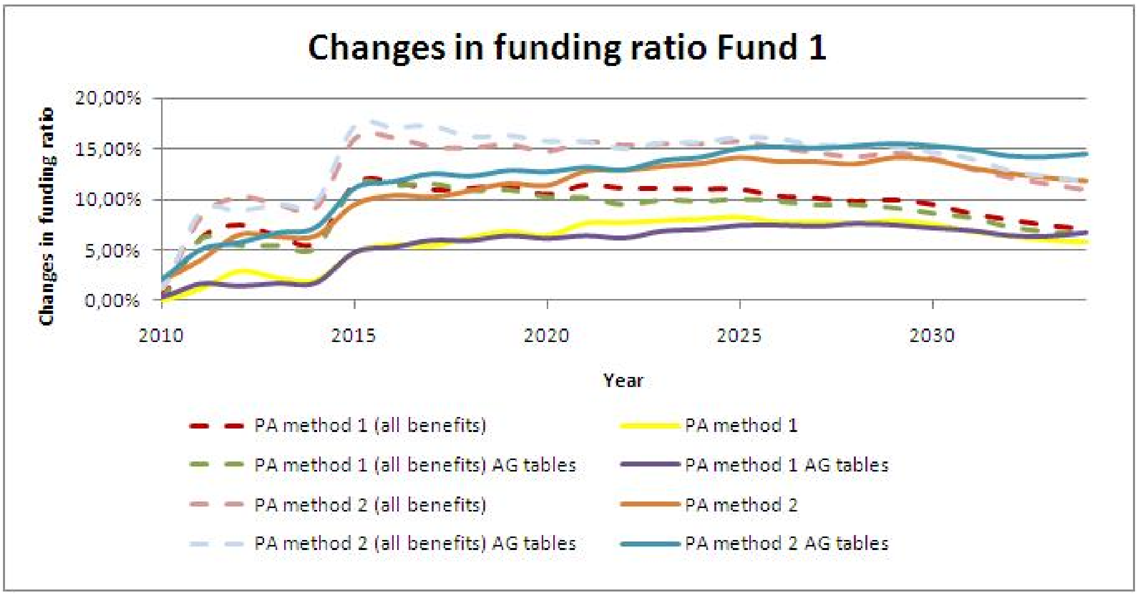

Figure 19: Changes in funding ratio of pension fund 1.

For pension funds it will have many impact if the pension agreement methods will be applied to all accrued pension benefits or only to new accrued pension benefits. Figure 19 shows the impact on the funding ratio for both methods in both situations. As we have seen already in the figures of the distribution of the funding ratio it will increase over time. If both methods are applied to all accrued pension benefits the impact will be larger mainly in the first years. The size of the increasing differs per pension method. Looking at the impact in the situation that the pension provision for all accrued pension benefits are recalculated, the pattern looks like the same for both methods. In 2011 and 2015, the gap between the funding ratio of the normal method and the pension agreement methods increases. If we look at the results when the methods are only applied to new accrued benefits, the increases in 2011 and 2015 are smaller. In the beginning both methods will have more effect when they are applied to all accrued pension benefits but on the long term the gap decreases. Because this is a young fund most pension benefits will accrue in the upcoming years, the pension provision for these new benefits will be calculated with the pension agreement methods in both situations.

As already noticed the funding ratio depends on the net present value of the liabilities and the net present value of the assets. The percentage of the increase of the funding ratio is therefore connected to the decreasing percentage of the pension provision in figure 16. The change of the funding ratio is only caused by the change of the liabilities, the value of the assets will remain the same. The impact of method 1 at the pension provision is around -6% in 2020 and -13% for method 2. The funding ratio will increase with almost these percentages. The larger the initial funding ratio, the smaller the effect of the decreasing pension provision will be at the funding ratio. For a large funding ratio also indexation will take place, because of indexation the funding ratio will not increase further.

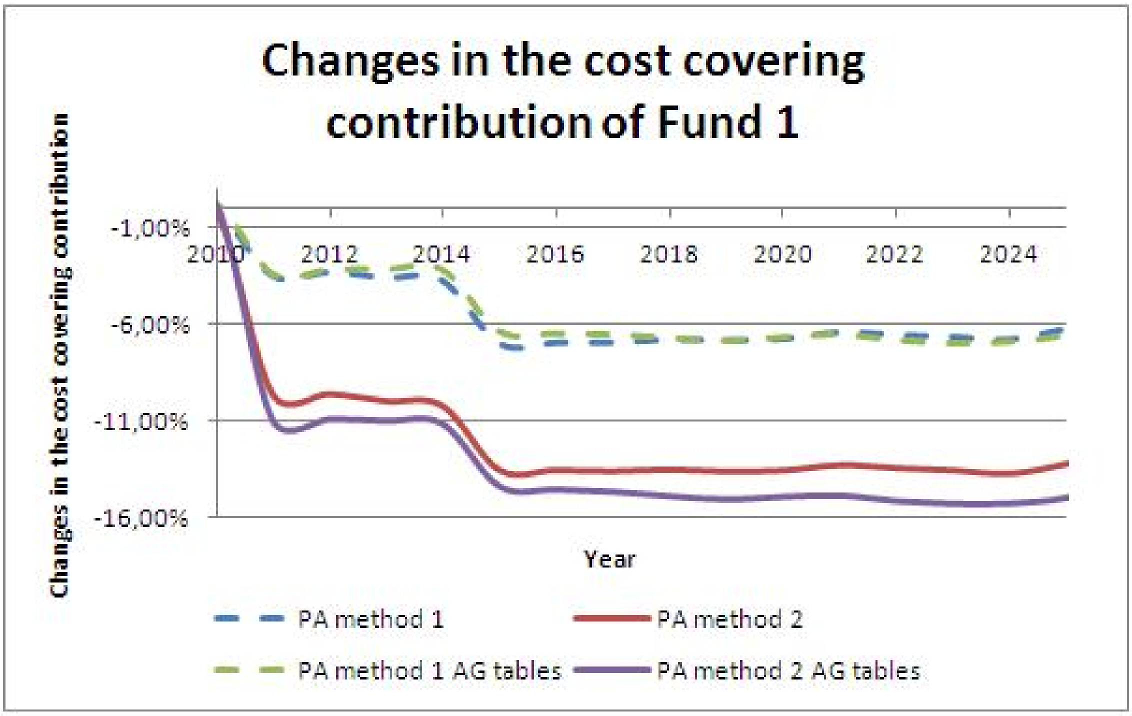

Figure 20: Changes in the cost covering contribution of pension fund 1.

The changes in the cost covering contribution during the years are shown in figure 20. As we can see the pension agreement methods have a large impact on the contribution. Because of the increasing retirement age, the total costs for the pension fund decrease. The shocks in 2011 and 2015 are clearly visible. As we have also seen in the figure of the funding ratio, the second method has the most impact.

	Normal method	PA method 1	PA method 2
Solvability			
Mean Nom. MV. Funding ratio	129.5%	136.0%	141.8%
Prob. Funding ratio < 105%	23.5%	18.2%	12.8%
Prob. Funding ratio < 100%	18.1%	13.8%	9.0%
Prob. Funding ratio < 90%	10.1%	7.2%	4.2%
Premium			
Mean net premium	14.9%	14.8%	14.6%
FTK cost covering contribution	19.2%	18.1%	16.8%
Prob. Cost covering contribution < net premium	0.0%	0.0%	6.1%
Increments			
Mean given indexation actives	2.0%	2.0%	2.0%
Mean given indexation inactives	1.4%	1.6%	1.7%

Figure 21: Results of the pension agreement methods applied to new accrued benefits for pension fund 1.

Another important result of the methods of the pension agreement would be the improved financial situation of the pension funds. Figure 21 is an overview of the averages over 15 year. Applying pension agreement method 1 or 2 for new accrued pension benefits, the funding ratio will increase. This means a higher average value over 15 years and for both methods the probability of underfunding decreases. As we have already seen the cost covering contribution will decrease for both pension agreement methods. In almost all simulations the cost covering contribution will be larger than the net premium, because the maximum net premium of the pension fund is 15%. For participants the indexations of their pension benefits is also an important point. The more indexation they get the better their buying power will be. If participants receive no indexation in a year, their buying power will decrease because of price inflation. For this pension fund the indexation of inactives (retirees and early leavers) increases a bit.

6.5 Results for all pension types of pension fund 2

Just as for pension fund 1 here are the results for pension fund 2 if both methods of the pension agreement are only applied to new accrued pension benefits.

Figure 22 shows the changes of the pension provisions with both methods applied to new pension benefits. The pattern looks like the same as the changes in pension provision for pension fund 1 (figure 16). Only the gaps are smaller than for fund 1, as we have seen earlier for the results of only the old age pension. The effect of the pension agreement methods for the whole pension plan is larger than we have seen for only the old age pension.

Further we are going to look at the distribution of the funding ratio over time. In the appendix we show the distributions for the three methods: the normal method (figure 35), method 1 (figure 36) and method 2 (figure 37) applied to new accrued pension benefits using the fund specific mortality tables. During the years the uncertainty of the funding ratio increases. The simulated funding ratio with a value larger than the average funding ratio are more distributed

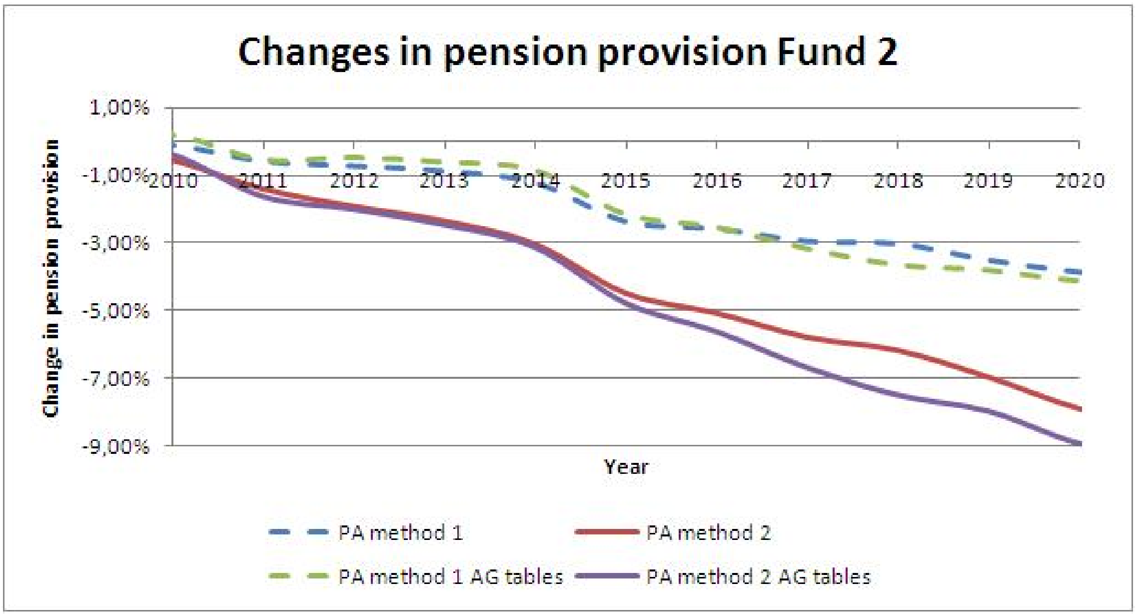

Figure 22: Changes in pension provision of pension fund 2.

than the ones with lower values. This phenomenon we have also seen for pension fund 1. At the end we can see for some scenarios very high funding ratios. These scenarios are connected to extreme economic scenarios.

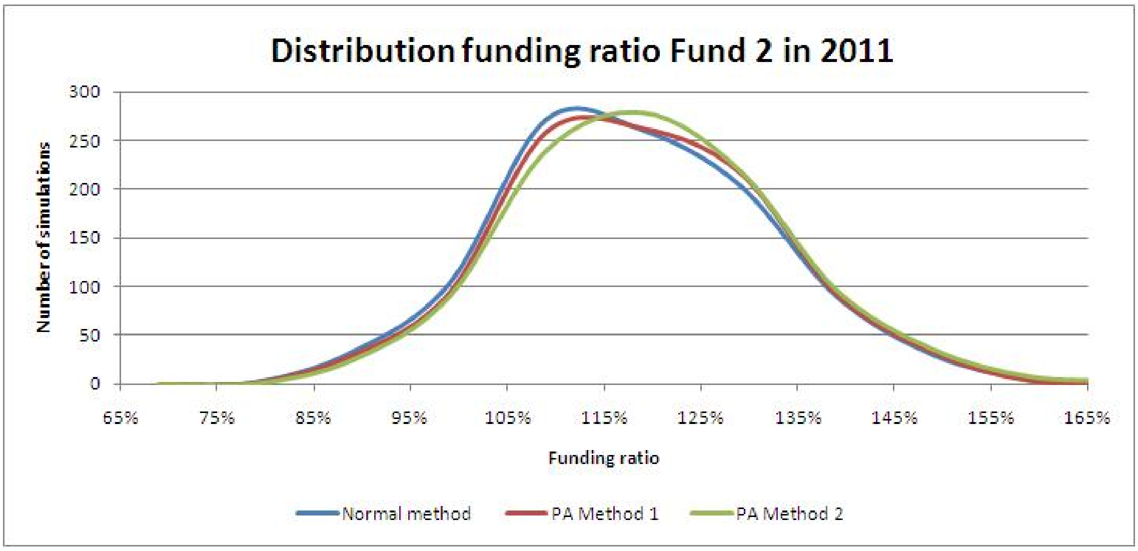

Figure 23: Distribution funding ratio of fund 2 in 2011.

Also for this fund we will discuss the distribution of the simulated funding ratios. Figure 23 shows the distributions in 2011. The simulated funding ratios are between 65% and 165%, a smaller interval than for fund 1. The simulated funding ratios of method 1 and 2 are a bit higher than the one corresponding to the normal method. The red and green lines are mostly a bit higher on the right side than the blue ones.

	Normal Method	PA Method 1	PA Method 2
Average	113.13%	113.92%	114.69%
Sigma	13.71%	13.79%	13.81%
25% percentile	103.81%	104.51%	105.25%
Median	112.20%	113.01%	113.79%
75% percentile	121.66%	122.47%	123.26%
Prob(Funding Ratio<90%)	0.039	0.035	0.034
Prob(Funding Ratio<100%)	0.158	0.145	0.131
Prob(Funding Ratio<105%)	0.282	0.262	0.239
Prob(Funding Ratio<113.13%)	0.524	0.501	0.477

Table 4: Overview of the characteristics of the funding ratio distributions in 2011.

Table 4 shows an overview of the average, standard deviation, percentiles and probabilities. In this table we can see that the average funding ratio will increase by using one of the two methods of the pension agreement. Also the percentiles show that the whole distribution of the funding ratios will have larger values than the one with the normal method. In comparison to the first fund the increase of the average funding ratio and the uncertainty are smaller. When we take a look at the probability of underfunding, Prob (Funding Ratio<100%), it decreases.

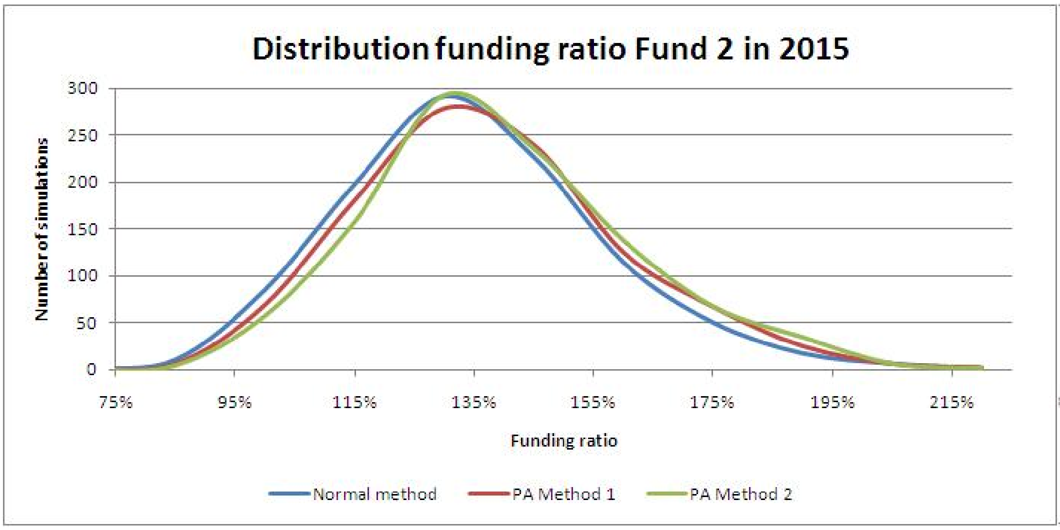

Figure 24: Distribution funding ratio of fund 2 in 2015.

Now we are going to look at the situation in 2015. As we can see in figure 24 the simulated funding ratios are distributed over a larger interval, 75% until 215%. This interval is also smaller than the one we have seen for fund 1. These funding ratios are also not normally distributed but skewed to the right, just as in 2011.

Also in table 5 we can see that the average funding ratio increases with both methods of the pension agreement and the uncertainty increases. The probability that a simulated funding ratio of method 1 or 2 is smaller than the average funding ratio with the normal method is less than 0.5. This means that more than half of all simulated funding ratios with a pension agreement method will be larger than the normal average funding ratio.

	Normal Method	PA Method 1	PA Method 2
Average	127.11%	129.89%	131.89%
Sigma	21.27%	21.82%	21.92%
25% percentile	112.54%	114.59%	116.71%
Median	125.07%	127.63%	129.40%
75% percentile	140.15%	143.15%	144.97%
Prob(Funding Ratio<90%)	0.025	0.018	0.011
Prob(Funding Ratio<100%)	0.095	0.075	0.063
Prob(Funding Ratio<105%)	0.139	0.118	0.100
Prob(Funding Ratio<127.11%)	0.535	0.493	0.452

Table 5: Overview of the characteristics of the funding ratio distributions in 2015.

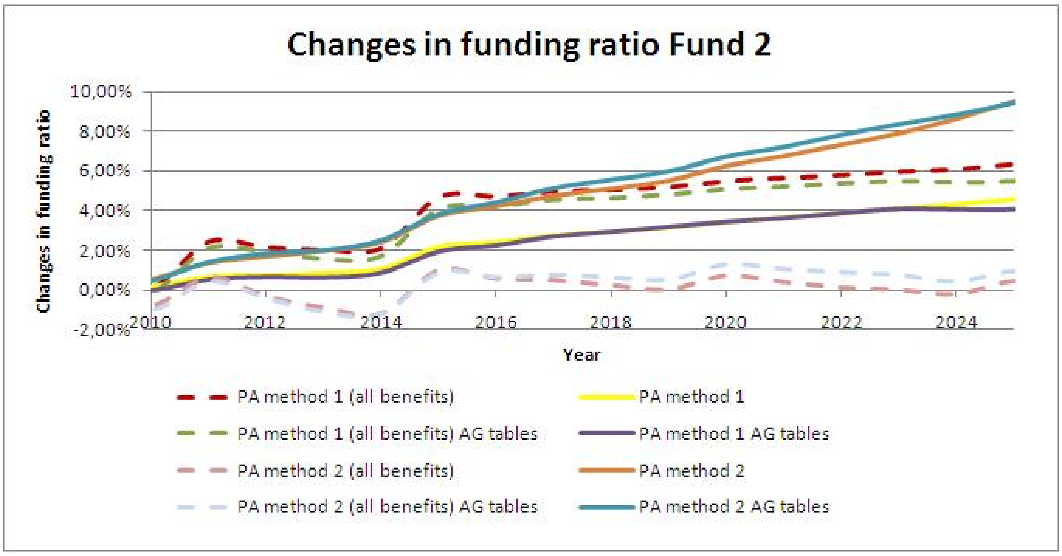

Figure 25: Changes in funding ratio of pension fund 2.

Also for fund 2 we will have a look at the impact of the pension agreement on the funding ratio if it will be applied to all accrued pension benefits. Figure 25 shows the results. The funding ratio of pension fund 2 is 100.9% in 2009. During the years the funding ratio increases as we have seen in figure 36 and figure 37 in the appendix. The size of the increase differs per pension method. Looking at the impact in the situation that all accrued pension benefits are recalculated, the patterns look like similar. If pension agreement method 2 will be applied to all accrued pension benefits it will not have a very positive effect for example in 2014. In figure 15 we have already seen that the pension payments will increase the first years by applying method 2 at all accrued benefits. This will also have impact on the funding ratio. If the second method is only applied to new accrued benefits it will have a positive impact. For method 1 the impact is smaller. At a total level we can see that the impact of all methods is smaller than for fund 1.

The impact of the pension agreement for new accrued benefits on the cost covering contribution is shown in figure 26. Both methods show a lower contribution than the contribution according to the normal method. During the years the gap increases and it is not very stable.

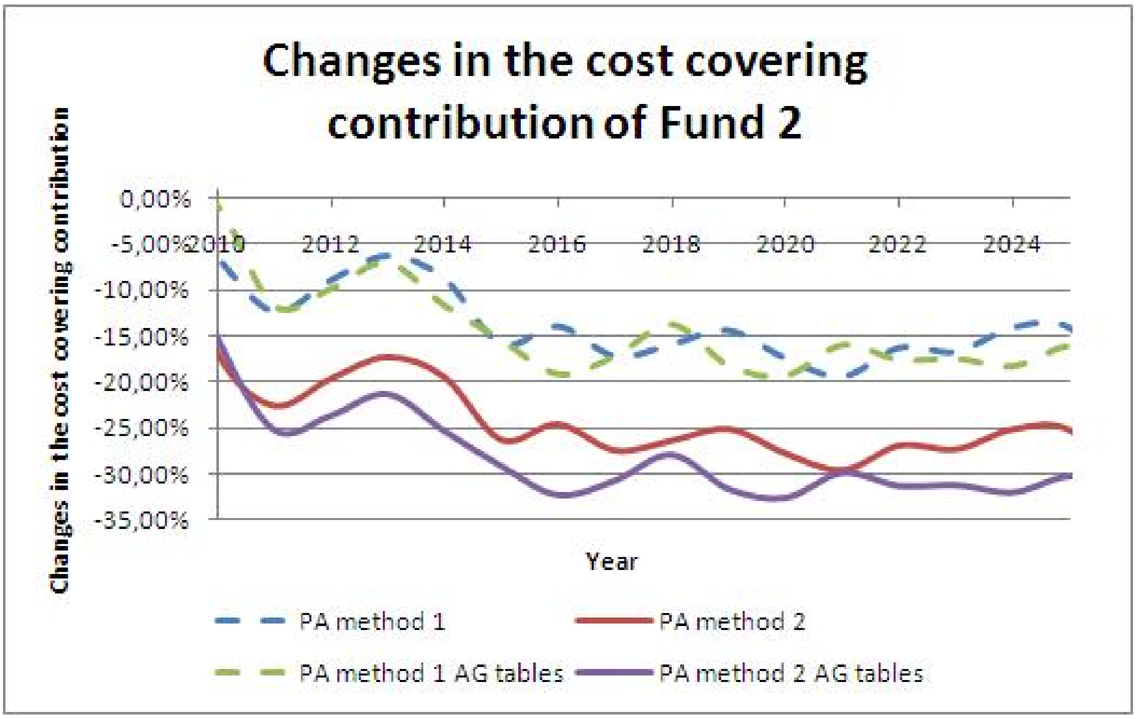

Figure 26: Changes in the cost covering contribution of pension fund 2.

	Normal method	PA method 1	PA method 2
Solvability			
Mean Nom. MV. Funding ratio	128.0%	131.2%	134.0%
Prob. Funding ratio < 105%	16.4%	14.3%	12.1%
Prob. Funding ratio < 100%	10.1%	8.5%	6.7%
Prob. Funding ratio < 90%	2.8%	2.1%	1.5%
Premium			
Mean net premium	14.3%	13.8%	13.4%
FTK cost covering contribution	9.6%	8.3%	7.3%
Prob. Cost covering contribution < net premium	87.0%	91.0%	99.4%
Increments			
Mean given indexation actives	2.9%	3.0%	3.1%
Mean given indexation inactives	1.9%	1.9%	2.0%

Figure 27: Results of the pension agreement methods applied to new accrued benefits for pension fund 2.

Figure 27 gives an overview of the average results over 15 years. First we will have a look at the solvability of the fund with the three different methods. Pension agreement method 2 results in the highest average funding ratio. Also the risks of this method, the probability of underfunding, are the lowest for this method. The mean net premium and cost covering contribution decreases by using one of the two pension agreement methods. For the second method the net premium is almost in all scenarios higher than the cost covering premium. We can say that for this method the costs are the lowest and the risk that the net premium is too low to cover all costs, is very low. With the pension agreement methods the indexation for actives as well as inactives increases a bit. This is an improvement for all participants.

7 Summary, conclusions and recommendations

In this master thesis the increasing life expectancy is the central point. The longer people live the higher the costs for the AOW and the second pillar pensions will be. Two other problems which arise from the increasing life expectancy are the ageing of the population and the resistance of pension funds against financial shocks. These problems and the bad financial positions of pension funds brought on a lot of discussion about the future proofing of the Dutch pension system.

The government came with the first measure to save the first pillar pensions: an increase of the AOW age to 66 in 2020 and 67 in 2025. In response to this the Social Partners reached an agreement in June 2010. With this agreement they want to make the second pillar pensions more future proof and respond to the increasing AOW age. Not further increasing pension costs and a stable premium are the main goals of the Social Partners. The changes of the agreement have to be clear for participants, that way that the expectations about their pension at retirement will not be incorrect. Besides this agreement, there are also discussions nowadays to change the pension contract and make the pension benefits partly unconditional and partly conditional. These measures will decrease the pension costs further. The two different methods presented in the pension agreement are modeled in this thesis. We have looked at the consequences of both measures for two different pension funds in two situations. The consequences are discussed for a couple of variables.

The first and most important one is the pension provision, which is the net present value of the pension liabilities. The initial value is much larger for fund 2 than for fund 1 because the fund is larger and has older participants. During the years the pension provision increases for both funds because of the increasing pension liabilities and higher age of participants. The introduction of the pension agreement methods will lead to lower future pension provisions than the current method. If the methods are applied to all accrued pension benefits it will have more impact on the short term than applying it to only new accrued benefits from 2011 on. In the last situation only the new accrued pension benefits from 2011 on will be valued according to the new retirement age and the old accrued ones will be valued at the old retirement age of 65. In 2011 and 2015, the years in which the announcements of the increase of the AOW age will take place, we can clearly observe the impact of both methods. The decrease of the pension payment period has a significant impact on the pension liabilities and therefore also on the pension provision.

We can also conclude that the impact of the methods depends on the composition and the development of the pension fund. First we take a look at method 1, where the retirement age is adapted to the announced increased AOW age. If we look at the situation that method 1 is applied to all accrued pension benefits the impact for an older participant whose retirement age increases is larger than for a younger participant whose retirement age increases. The total impact is larger for the younger fund, but if we only look at the part of the participants whose retirement age increases, the impact is larger for the older fund. If we take the situation that method 1 is only applied to new accrued benefits, the opposite happens: it has relatively more impact for a younger fund. For most of the younger participants the new accrued benefits are a larger part of their total accrued benefits than for older people. Therefore the difference between the pension agreement methods applied to all accrued benefits and only to new accrued benefits is the largest for the oldest fund.

In pension agreement method 2, the increasing retirement age as well as the recalculation with the forfaitary period brings on changes in the pension provision. If method 2 is applied to all accrued pension benefits the recalculation of the pension provision according to the forfaitary period starts immediately. This only happens for provisions of people who have not yet reached their retirement age in 2009. In the situation that the second method is only applied to new accrued benefits the recalculation starts in 2011. The impact of the change of the pension provision depends on the forfaitary period used. This period is determined using the mortality rate and a fixed interest rate. The chosen interest rate has a lot of impact on the forfaitary period. Therefore the changes of the pension provision are also very dependent on the chosen interest rate. The larger the interest rate the smaller the forfaitary period and the larger the impact.

To look at the impact of method 2 we can make a distinction between the pension provision before retirement and from retirement on. It could be that method 2 has a positive impact on the pension provision before retirement but a negative impact on the provision after retirement. If the forfaitary period is smaller than the expected remaining lifetime at retirement for people who have not yet reached their retirement age, this will result in a decrease of the pension provision for these participants. For people who reach their retirement, the pension provision will decrease if their remaining lifetime annuity at retirement is larger than the forfaitary period. In this situation their pension payments will be reduced which means a smaller corresponding pension provision. If the remaining lifetime annuity at retirement is smaller than the forfaitary period the pension payments and also the provision will increase. The total impact is the combination of the impact on retirees and on actives and the proportions of both groups.

In our results we have used a forfaitary period of 15 years and fund specific mortality tables. For the youngest fund, fund 1, we have seen that the total impact of method 2 is positive, the pension provision decreases with method 2. This is mainly a result of the large part of participants who have not yet reached their retirement age. Their pension provision decreases because the forfaitary period is smaller than the expected remaining lifetime at retirement. For the small number of retirees the recalculated payments are larger than the original ones. This has a negative impact for fund 1 but because this is a very small part of the total fund the impact of method 2 on the whole fund is positive. For fund 2, the fund with older participants, the same happens for retirees and for participants who have not yet reached their retirement age as for these participants in fund 1. Because of the higher age of the participants and the other composition of the fund the total impact is smaller. The participants of fund 2 are not only older than the ones of fund 1 but also their remaining lifetime at retirement is smaller. For participants who reach their retirement this means a larger gap between the forfaitary period and the annuity at retirement. For participants who have not yet reached their retirement age the gap between the expected remaining lifetime at retirement and the forfaitary period will be smaller. The part of retirees is larger than for fund 1 and the participants who are not yet a retiree are older than for fund 1. Also for this method we can conclude that the difference between the impact of method 2 only applied to new accrued benefits and to all benefits is larger for the oldest fund.

We have also looked at the pension provision if the AG 2010-2060 mortality tables are used instead of the fund specific ones. For both funds the fund specific mortality rates result in a lower life expectancy. The life expectancy of the second, lower educated, fund is smaller with the fund specific tables than the one of the first fund. In the normal method there is a larger amount of pension provision needed if the AG 2010-2060 tables are used. The increasing retirement age of method 1 has relatively less impact on the provision according to the AG tables. The impact of the second method depends on the forfaitary period. As we have explained above it can have positive or negative impact for the pension provision. The pension provision for participants who are not yet retired decreases more, but the payments for participants who retire from 2010 on will increase less than with the fund specific tables. Over all the impact on the pension provision is larger for the AG tables than for the fund specific tables.

Besides the impact of both methods on the pension provision it has also impact on the pension payments. The impact is larger for the younger fund for both methods in both situations. This can be explained by the fact that there are not yet many retirees before 2020. The participants who retire in 2020 in the normal method are a larger part of the total number of retirees than for the older fund. As we have noticed earlier the part of the participants whose retirement age will change is smaller for the older fund. Looking at the difference between the impact if method 1 is applied to all benefits or only to new benefits, we can conclude that the difference is larger for the older fund. This is the same as we have seen for the pension provision and can be explained by the fact that the older participants accrue less new pension benefits than the younger participants. For pension agreement method 2 the impact for the younger fund is also larger. The part of the retirees who get a recalculated pension payment is larger for this fund than for the older fund. For the younger fund the difference between the second method applied to all benefits and to only new benefits is larger than for fund 2 just as for method 1.

The changes of the pension provision and pension payments have also impact on other variables. The next variables are also discussed in this master thesis: the funding ratio, the cost covering contribution, the probability of underfunding and indexation. Because of the change of the pension provision the market value of the liabilities decreases and therefore the funding ratio increases for both pension agreement methods. The decreasing pattern of the pension provision corresponds with the increasing pattern of the funding ratio. The higher funding ratio also results in a smaller probability of underfunding which is positive for pension funds. If we have a look at the probability of underfunding in 2011, 2015 and over a period of 15 years, we can conclude that the probability of underfunding is significantly smaller with both pension agreement methods.

The indexation of pension liabilities depends on the funding ratio, the higher the realized funding ratio the larger the possibilities for indexation of accrued pension benefits. Pension funds distinguish between the indexation for actives and inactives. Looking at the average indexation percentages over 15 years, we can see it is an improvement for actives as well as for inactives. This variable shows the positive impact of the pension agreement methods for participants. Besides a larger indexation percentage both methods also have impact on the cost covering contribution. As we have seen the amount of the pension provision and the pension payments decreases (with exception of the payments of method 2 applied to all accrued benefits for fund 2). This means the total costs for the pension fund decrease. The cost covering contribution decreases for both pension agreement methods.

We can conclude that both pension agreement methods have a significant impact on pension funds. Both methods are effective to implement the increasing life expectancy of the participants. The goals of the pension agreement, not further increasing costs for pension funds, a premium at a stable level and more resistance against financial shocks are realized with both methods in the upcoming years. For pension agreement method 1 the retirement age has to increase further after 2025 to keep the pension costs at the same level. The life expectancy will also increase further from that moment. In pension agreement method 2 the further increase of the life expectancy is already implemented by the recalculation of the pension payments at retirement. Therefore this method is more effective over time. On the other hand the impact of method 2 depends much on the chosen forfaitary period.

For the two pension funds we have discussed, we have seen that the impact depends on the question what will be done with the already accrued pension benefits. For an older fund with participants who have already accrued the largest part of their pension benefits, the impact will be a lot smaller if the pension agreement will not be applied to already accrued benefits. Also the current age of the participants influences the impact of the methods. Only for participants born from 1955 on, the retirement age will increase and the retirement period will decrease. For older participants the increasing retirement age has no impact. The impact of the second method will also depend on the fund specific increasing life expectancy. The larger the increase of the life expectancy, the more impact it has.

The decreasing costs for pension funds will be visible from 2011 on in the pension provision and funding ratio and from 2020 on in the pension payments. For a pension fund with participants who live relatively larger than a normal Dutch person, the increasing retirement age will probably not enough to catch on the increasing costs of the increasing life expectancy. In the second method the fund specific increase of the life expectancy is implemented by the recalculation of the pension payments at retirement. Mainly for a pension fund whose participants live relatively longer than the average Dutch person, the second method will be more effective. Because of the stable pension ambition over time, the costs of the pension payments will not increase further when the life expectancy increases.

As a results of the decreasing costs, the funding ratio will increase and the probability of underfunding will decrease. This improves the financial situation of pension funds. The increase of the funding ratio has also a positive impact for participants. The indexation of pension benefits increases and the net premium decreases. According to both pension agreement methods, the pension payments will start one year or two years later. For participants it means that they have to work longer before the pension payments start. In case of the second method, the pension payments of participants can be reduced at retirement, dependending on the remaining lifetime at retirement and the chosen forfaitary period.

The determination of the forfaitary period is a difficult point in method 2. The idea of the same pension ambition for different generations with the same accrued pension benefits is a good idea, it is a fair solution. But the use of a stable forfaitary period over time is a discussion point. Changes in the interest rate and mortality tables have a lot of impact on the forfaitary period. Because the forfaitary period is determined with an interest rate it is smaller than the expected remaining lifetime. With this method the provision before retirement, calculated with the forfaitary period, is a lot smaller than with the expected remaining lifetime. It results in a large increase of the pension provision at retirement when the provision is calculated with the real mortality tables instead of the forfaitary period. We can conclude that the provision of pension funds with the second method is underestimated before retirement. If the forfaitary period will not change during the years and the retirement age will not increase further, the pension payments will decrease more and more because of the larger life expectancy annuity over time. The buying power of the retires will decrease than, which is not very good for the economy.

Besides the questions about the determination of the forfaitary period, we can also ask ourselves the question how to communicate this method to participants. The recalculation of the amount of the pension payments at retirement will result in a lot of questions. People know the amount of pension payments they will receive at retirement, or a couple of years before. If this amount is lower than they expected, there is only less time to accrue extra benefits in the third pillar.

The adaptation to the increasing AOW age is a good point. It is easier for people to understand that the pension payments and the AOW payments start in the same year, and this year is increased to 66 and later to 67. If the methods are only applied to new accrued pension benefits, the recalculation of already accrued benefits have to be explained clearly to participants.

Over all we can conclude that pension agreement method 2 is more effective and fair over time. The chosen forfaitary period is a critical point in this method. The recalculation of the pension payments at retirement, to keep the same pension ambition, is a fair solution for different generations. The calculation of pension benefits for participants who have not yet reached their retirement, results in an underestimated pension provision.

References

Actuarieel Genootschap (2010). Prognosetafel 2010-2060.

Australian Centre for Financial Studies & Mercer (2010). Melbourne Mercer Global Pension Index.

Biffis, E. & Blake, D. (2009). Mortality-Linked Securities and Derivatives. *Discussion Paper PI-0829, The Pensions Institute, Cass Business School.*

Bovenberg, L. (2004). Naar nieuwe pensioencontracten. *OCFEB Research Memorandum.*

Bovenberg, L. & Gradus, R. (2008). Dutch policies towards ageing. *European View*, *7(2)*, 265–275.

Bovenberg, L., Mackenbach, J., & Mehlkopf, R. (2006). Een Eerlijk en Vergrijzingsbestendig Ouderdomspensioen. *Economische Statische Berichten*, *91(4500)*, 648–651.

Bruggink, J.-W. (2009). Ontwikkelingen in (Gezonde) Levensverwachting naar Opleidingsniveau. *Bevolkingstrends: statistisch kwartaalblad over de demografie van Nederland / Centraal Bureau voor de Journalistiek*, *2009(4)*, 71–75.

Bruggink, J.-W., Garssen, J., Lodder, B., & Kardal, M. (2009). Trends in Gezonde Levensverwachting. *Bevolkingstrends: statistisch kwartaalblad over de demografie van Nederland / Centraal Bureau voor de Journalistiek*, *57(1)*, 60–66.

Buevink, J. (2009). Later met pensioen? *Opinieblad Forum VNO-NCW*, *7*, 26–30.

De Mik, H. (2010). Het is tijd voor een nieuwe levensverwachting. *AENorm Special*, *66*, 29–32.

De Waegenaere, A., Melenberg, B., & Stevens, R. (2010). Longevity risk. *De Economist*, *158(2)*, 151–192.

Frijns, J., Nijssen, J., & Scholtens, L. (2010). Pensioen: onzekere zekerheid. Technical report, Commissie Beleggingsbeleid en Risicobeheer.

Gerber, H. (1997). *Life Insurance Mathematics*. Springer.

Goss, S., Wade, A., & Bell, P. (1998). Historical and projected mortality for Mexico, Canada and the United States. *North American Actuarial Journal*, *2(4)*, 108–126.

Goudswaard, K., Beetsma, R., Nijman, T., & Schnabel, P. (2010). Een sterke tweede pijler - Naar een toekomstbestendig stelsel van aanvullende pensioenen. Technical report, Commissie Toekomstbestendigheid Aanvullende Pensioenregelingen.

Hari, N., De Waegenaere, A., Melenberg, B., & Nijman, T. (2008). Longevity Risk in Portfolios of Pension Annuities. *Insurance: Mathematics and Economics*, *42*, 505–519.

Lee, R. & Tuljapurkar, S. (1997). Death and taxes: Longer Life, Consumption and Social Security. *Demograpy*, *34*, 67–81.

Madsen, C., Crom, S., & Tsang, M. (2010). Longevity Risk - Source and Mitigation. *AENorm Special*, *66*, 40–43.

Ministerie van Sociale Zaken en Werkgelegenheid (2009). Het Nederlandse pensioenstelsel.

Olivieri, A. (2001). Uncertainty in Mortality Projections: An Actuarial Perspective. *Insurance:Mathematics and Economics*, *29*, 231–245.

Sociale Partners (2010). Pensioenakkoord voorjaar 2010. *Stichting van de Arbeid*.

Tuljapurkar, S. & Boe, C. (1998). Mortality change and forecasting: How much and how little do we know? *North American Actuarial Journal*, *2(4)*, 13–47.

Van den Bosch, J., Kullen, P., Damen, F., & Boeijen, T. (2010). De AOW in beweging - verhoging van de AOW leeftijd en de gevolgen voor de pensioenen in de tweede pijler. *AG&AI Werkgroep "AOW en Vergrijzing"*.

Van Doorn, R. & Jager, A. (2010). Het belang van sociaal-economische kenmerken van een populatie voor langlevenrisico: hoe postcodes gebruikt kunnen worden om overlevingsgrondslagen nauwkeurig vast te stellen. *De Actuaris*, *18(1)*, 32–34.

Wong-Fupuy, C. & Haberman, S. (2004). Projecting Mortality Trends: Recent Developments in the United Kingdom and the United States. *North American Actuarial Journal*, *8(2)*, 56–83.

A Results of the examples of the pension agreement methods

n	method	L_0^{nom}	L_1^{nom}	L_2^{nom}	L_3^{nom}	L_4^{nom}	L_5^{nom}	L_6^{nom}
1	normal	416,127	446,680	443,331	439,303	434,553	429,101	422,760
1	PA 1 all	416,127	446,680	443,331	439,303	434,553	429,101	422,760
1	PA 1	416,127	446,680	443,331	439,303	434,553	429,101	422,760
1	Δ all	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	Δ	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	normal	345,561	381,871	421,854	452,463	449,093	445,002	440,153
2	PA 1 all	345,561	381,871	421,854	452,463	449,093	445,002	440,153
2	PA 1	345,561	381,871	421,854	452,463	449,093	445,002	440,153
2	Δ all	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	Δ	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3	normal	261,196	288,809	319,146	352,473	389,179	429,512	459,130
3	PA 1 all	261,196	288,809	319,146	352,473	389,179	429,512	459,130
3	PA 1	261,196	288,809	319,146	352,473	389,179	429,512	459,130
3	Δ all	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3	Δ	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4	normal	161,764	179,460	198,867	220,147	243,504	269,135	297,302
4	PA 1 all	161,764	179,460	184,474	204,214	225,879	249,655	275,784
4	PA 1	161,764	179,460	198,316	218,971	241,619	266,449	293,713
4	Δ all	0.00%	0.00%	-7.24%	-7.24%	-7.24%	-7.24%	-7.24%
4	Δ	0.00%	0.00%	-0.28%	-0.53%	-0.77%	-1.00%	-1.21%
5	normal	97,131	108,486	120,959	134,658	149,681	166,164	184,233
5	PA 1 all	97,131	108,486	112,342	125,065	139,018	154,326	158,583
5	PA 1	97,131	108,486	120,564	133,813	148,328	164,238	179,209
5	Δ all	0.00%	0.00%	-7.12%	-7.12%	-7.12%	-7.12%	-13.92%
5	Δ	0.00%	0.00%	-0.33%	-0.63%	-0.90%	-1.16%	-2.73%
6	normal	55,495	62,667	70,570	79,274	88,847	99,375	110,947
6	PA 1 all	55,495	62,667	65,601	73,693	82,591	92,378	95,672
6	PA 1	55,495	62,667	70,289	78,673	87,884	98,004	107,367
6	Δ all	0.00%	0.00%	-7.04%	-7.04%	-7.04%	-7.04%	-13.77%
6	Δ	0.00%	0.00%	-0.40%	-0.76%	-1.08%	-1.38%	-3.23%
7	normal	29,256	33,662	38,553	43,972	49,965	56,580	63,873
7	PA 1 all	29,256	33,662	35,862	40,902	46,477	52,630	55,150
7	PA 1	29,256	33,662	38,357	43,552	49,291	55,619	61,358
7	Δ all	0.00%	0.00%	-6.98%	-6.98%	-6.98%	-6.98%	-13.66%
7	Δ	0.00%	0.00%	-0.51%	-0.95%	-1.35%	-1.70%	-3.94%
Total	normal	1,366,531	1,501,635	1,613,282	1,722,290	1,804,821	1,894,868	1,978,398
Total	PA 1 all	1,366,531	1,501,635	1,582,611	1,688,112	1,766,790	1,852,604	1,907,233
Total	PA 1	1,366,531	1,501,635	1,611,859	1,719,248	1,799,946	1,887,923	1,963,690
Total	Δ all	0,00%	0,00%	-1.90%	-1.98%	-2.11%	-2.23%	-3.60%
Total	Δ	0,00%	0,00%	-0.09%	-0.18%	-0.27%	-0.37%	-0.74%

Table 6: Example of pension provision with pension agreement method 1.

n	method	L_0^{nom}	L_1^{nom}	L_2^{nom}	L_3^{nom}	L_4^{nom}	L_5^{nom}	L_6^{nom}
1	normal	416,127	446,680	443,331	439,303	434,553	429,101	422,760
1	PA 2 all	351,691	446,680	443,331	439,303	434,553	429,101	422,760
1	PA 2	416,127	446,680	443,331	439,303	434,553	429,101	422,760
1	Δ all	-15.48%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	Δ	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	normal	345,561	381,871	421,854	452,463	449,093	445,002	440,153
2	PA 2 all	288,320	318,615	351,975	447,104	443,774	439,731	434,939
2	PA 2	345,561	381,871	419,780	452,304	448,935	444,845	439,998
2	Δ PA 2 all	-16.56%	-16.56%	-16.56%	-1.18%	-1.18%	-1.18%	-1.18%
2	Δ PA 2	0.00%	0.00%	-0.49%	-0.04%	-0.04%	-0.04%	-0.04%
3	normal	261,196	288,809	319,146	352,473	389,179	429,512	459,130
3	PA 2 all	214,276	236,928	261,816	289,156	319,269	352,356	447,653
3	PA 2	261,196	288,809	317,283	348,484	382,772	420,361	458,692
3	Δ PA 2 all	-17.96%	-17.96%	-17.96%	-17.96%	-17.96%	-17.96%	-2.72%
3	Δ PA 2	0.00%	0.00%	-0.58%	-1.13%	-1.65%	-2.13%	-0.10%
4	normal	161,764	179,460	198,867	220,147	243,504	269,135	297,302
4	PA 2 all	129,737	143,929	152,040	168,309	186,166	205,761	227,296
4	PA 2	161,764	179,460	197,076	216,321	237,371	260,397	285,626
4	Δ PA 2 all	-19.80%	-19.80%	-23.55%	-23.55%	-23.55%	-23.55%	-23.55%
4	Δ PA 2	0.00%	0.00%	-0.90%	-1.74%	-2.52%	-3.25%	-3.93%
5	normal	97,131	108,486	120,959	134,658	149,681	166,164	184,233
5	PA 2 all	76,575	85,526	91,023	101,331	112,636	125,039	78,835
5	PA 2	97,131	108,486	119,585	131,723	144,981	159,473	174,062
5	Δ PA 2 all	-21.16%	-21.16%	-24.75%	-24.75%	-24.75%	-24.75%	-28.19%
5	Δ PA 2	0.00%	0.00%	-1.14%	-2.18%	-3.14%	-4.03%	-5.52%
6	normal	55,495	62,667	70,570	79,274	88,847	99,375	110,947
6	PA 2 all	43,197	48,779	52,487	58,961	66,081	73,911	78,835
6	PA 2	55,495	62,667	69,547	77,087	85,342	94,384	103,420
6	Δ PA 2 all	-22.16%	-22.16%	-25.62%	-25.62%	-25.62%	-25.62%	-28.94%
6	Δ PA 2	0.00%	0.00%	-1.45%	-2.76%	-3.95%	-5.02%	-6.78%
7	normal	29,256	33,662	38,553	43,972	49,965	56,580	63,873
7	PA 2 all	22,559	25,956	28,429	32,425	36,844	41,722	45,035
7	PA 2	29,256	33,662	37,816	42,393	47,430	52,963	58,442
7	Δ PA 2 all	-22.89%	-22.89%	-26.26%	-26.26%	-26.26%	-26.26%	-29.49%
7	Δ PA 2	0.00%	0.00%	-1.91%	-3.59%	-5.07%	-6.39%	-8.50%
Total	normal	1,366,531	1,501,635	1,613,282	1,722,290	1,804,821	1,894,868	1,978,398
Total	PA 2 all	1,126,354	1,306,414	1,381,101	1,536,588	1,599,321	1,667,621	1,735,354
Total	PA 2	1,366,530	1,501,635	1,604,418	1,707,615	1,781,384	1,861,523	1,943,001
Total	Δ PA 2 all	-17.58%	-13.00%	-14.39%	-10.78%	-11.39%	-11.99%	-12.28%
Total	Δ PA 2	0.00%	0.00%	-0.55%	-0.85%	-1.30%	-1.76%	-1.79%

Table 7: Example of pension provision with pension agreement method 2.

B Implementation pension agreement methods

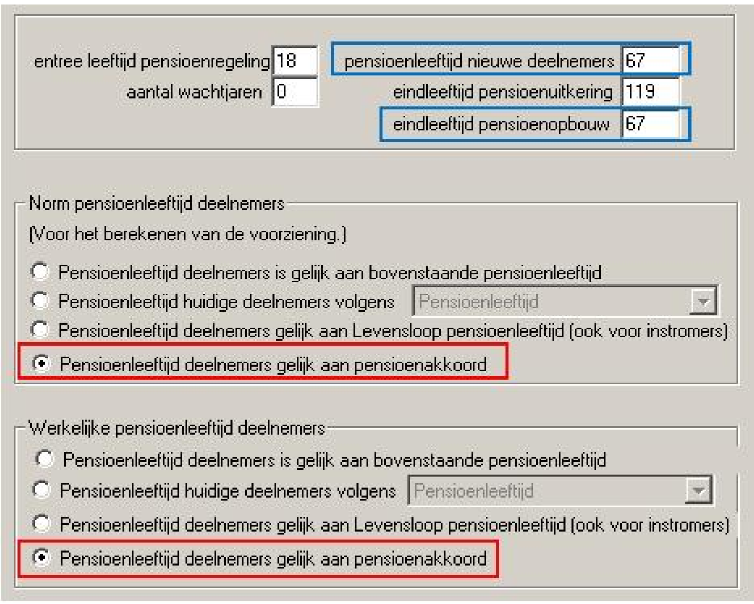

Figure 28: Retirement age according to pension agreement method.

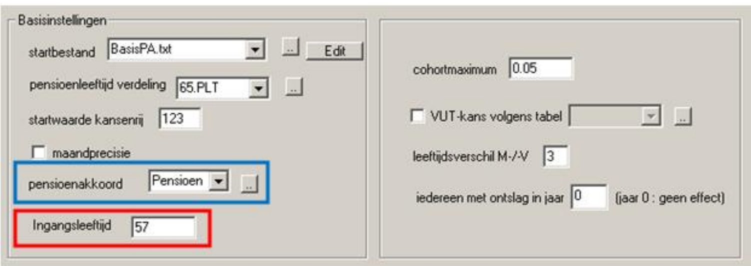

Figure 29: Table with the announced retirement age and starting age.

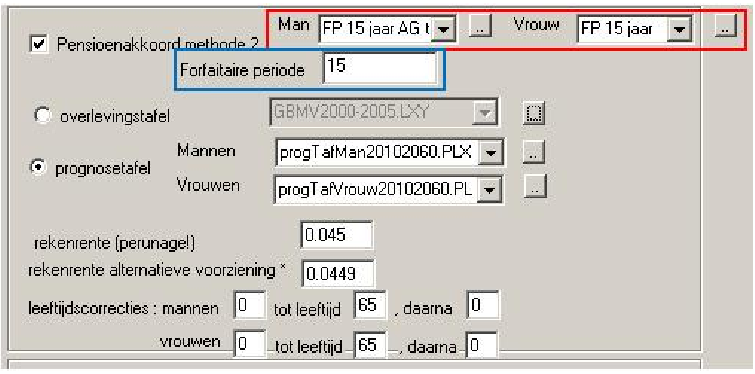

Figure 30: Extra mortality table and the exact forfaitary period.

C Economic assumptions

	NL/Europe	US	Japan	UK	Switzerland	EM	Euro zone
Price inflation	2.00%	2.00%		2.00%	1.50%	2.00%	2.00%
Wage inflation	3.00%	3.00%		3.00%	2.50%		
Break-even inflation (1 year)	2.00%	2.25%	1.00%	2.25%	1.50%	2.25%	2.00%
Break-even inflation (10 year)	2.25%	2.50%	1.25%	2.50%	1.75%	2.50%	2.25%
Nominal interest rate (1 year)	3.30%	3.55%	2.30%	3.55%	2.80%	3.55%	3.30%
Nominal interest rate (10 year)	4.30%	4.55%	3.30%	4.55%	3.80%	4.55%	4.30%
Nominal FTK rate (10 year)	4.50%						
Equity	8.00%	8.25%	7.00%	8.25%	7.75%	12.55%	
Indirect real estate	7.00%	7.25%					
Direct real estate	6.00%	6.25%		6.25%	5.75%		
Commodities		6.30%					
Hedge Funds: FoF		6.05%					
Hedge funds: market neutral		5.55%					
EM debt						2.50%	
Private equity: Venture capital	11.80%						
Private Equity: Buyouts	7.55%						
Infrastructure	7.90%						
Gold		5.95%					

Figure 31: Economic assumptions used in the Ortec economy with starting point december 2009.

D Results of the pension agreement methods only for old age pensions

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2009	9,425,309	0.00%	0.00%	9,685,427	0.00%	0.00%
2010	10,213,948	-0.27%	-0.27%	10,482,424	-0.09%	-0.09%
2011	11,368,937	-6.28%	-1.38%	11,706,620	-6.41%	-1.68%
2012	12,862,938	-6.35%	-1.83%	13,226,054	-6.76%	-2.40%
2013	14,653,804	-6.76%	-2.61%	15,071,895	-6.74%	-2.72%
2014	16,832,724	-6.71%	-2.89%	17,342,071	-6.55%	-2.85%
2015	19,267,325	-12.56%	-5.99%	19,839,972	-12.08%	-5.72%
2016	22,212,873	-12.48%	-6.39%	22,897,413	-12.06%	-6.17%
2017	25,261,882	-12.64%	-6.96%	26,075,380	-12.20%	-6.72%
2018	28,483,722	-12.48%	-7.09%	29,431,812	-12.24%	-7.04%
2019	31,921,191	-12.78%	-7.67%	32,914,934	-12.29%	-7.35%
2020	35,802,622	-12.85%	-8.01%	36,938,595	-12.08%	-7.39%
2021	39,786,111	-12.92%	-8.30%	41,012,023	-12.00%	-7.51%
2022	44,318,900	-13.00%	-8.59%	45,684,633	-12.08%	-7.79%
2023	49,114,431	-12.90%	-8.67%	50,678,718	-12.00%	-7.89%
2024	54,298,921	-13.05%	-8.99%	56,008,722	-12.12%	-8.17%
2025	60,033,031	-13.00%	-9.13%	61,955,638	-11.97%	-8.19%
2026	66,120,253	-12.91%	-9.18%	68,238,086	-11.77%	-8.14%
2027	72,590,553	-12.94%	-9.35%	74,988,025	-11.78%	-8.27%
2028	79,555,822	-12.80%	-9.36%	82,259,576	-11.77%	-8.41%
2029	87,022,158	-12.65%	-9.33%	89,953,477	-11.62%	-8.38%
2030	94,917,474	-12.30%	-9.11%	98,230,067	-11.59%	-8.49%
2031	103,701,080	-12.16%	-9.11%	107,258,458	-11.41%	-8.44%
2032	113,199,892	-11.87%	-8.95%	117,101,916	-11.30%	-8.47%
2033	123,140,728	-11.55%	-8.76%	127,555,040	-11.07%	-8.36%
2034	132,857,777	-11.29%	-8.61%	137,677,459	-10.77%	-8.17%

Table 8: Pension provision with pension agreement method 1 for Fund 1 with only the old age pension.

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2010	14,726	0.00%	0.00%	14,648	0.53%	0.53%
2011	21,082	-1.07%	-1.07%	21,007	-0.72%	-0.72%
2012	21,842	-0.23%	-0.51%	20,479	5.37%	5.09%
2013	25,706	-0.23%	-0.44%	23,367	8.11%	7.89%
2014	26,143	-3.08%	-3.25%	23,387	10.16%	9.97%
2015	35,440	-1.58%	-1.71%	30,632	10.59%	10.44%
2016	46,257	-0.69%	-0.81%	41,571	7.39%	7.26%
2017	48,558	0.50%	0.36%	45,089	5.72%	5.58%
2018	89,523	1.93%	1.84%	86,960	0.38%	0.30%
2019	110,271	-0.71%	-0.75%	107,445	0.31%	0.27%
2020	166,921	-33.06%	-33.09%	161,552	-32.34%	-32.36%
2021	217,709	-23.44%	-22.32%	211,959	-24.36%	-23.37%
2022	254,440	-15.23%	-13.37%	244,455	-10.95%	-9.00%
2023	303,833	-18.16%	-16.34%	300,670	-15.37%	-13.54%
2024	355,544	-14.84%	-12.68%	349,150	-11.76%	-9.61%
2025	471,040	-36.89%	-35.30%	463,907	-32.66%	-31.01%
2026	573,010	-38.52%	-36.77%	563,246	-35.14%	-33.34%
2027	599,448	-23.81%	-20.65%	595,652	-18.63%	-15.30%
2028	708,117	-20.62%	-17.42%	708,280	-17.52%	-14.21%
2029	874,333	-32.03%	-29.23%	869,532	-28.84%	-25.89%
2030	1,084,327	-34.88%	-32.07%	1,088,212	-33.05%	-30.20%
2031	1,274,757	-32.89%	-29.72%	1,286,145	-30.92%	-27.71%
2032	1,614,514	-33.29%	-30.15%	1,624,371	-31.03%	-27.87%
2033	1,930,031	-34.01%	-30.96%	1,939,746	-31.74%	-28.69%
2034	2,208,597	-26.67%	-23.31%	2,230,521	-25.17%	-21.84%

Table 9: Pension payments with pension agreement method 1 for Fund 1 with only the old age pension.

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2009	112,860,992	0.00%	0.00%	117,002,832	0.00%	0.00%
2010	114,585,723	0.21%	0.21%	117,727,877	0.53%	0.53%
2011	119,617,244	-4.22%	-0.19%	123,902,275	-4.04%	-0.17%
2012	128,230,803	-3.61%	-0.19%	132,426,214	-3.30%	0.00%
2013	138,521,253	-3.49%	-0.16%	143,497,096	-3.65%	-0.48%
2014	150,960,517	-3.65%	-0.31%	156,158,019	-3.67%	-0.50%
2015	163,081,145	-7.53%	-1.50%	169,421,094	-7.77%	-2.09%
2016	176,550,845	-7.38%	-1.49%	184,148,640	-7.77%	-2.26%
2017	190,461,550	-7.62%	-1.79%	199,546,082	-8.15%	-2.71%
2018	204,234,856	-7.56%	-1.73%	214,970,933	-8.63%	-3.23%
2019	218,785,401	-8.05%	-2.18%	229,603,276	-8.91%	-3.41%
2020	235,358,097	-8.23%	-2.34%	247,972,907	-8.98%	-3.49%
2021	250,521,794	-8.47%	-2.49%	264,778,352	-8.94%	-3.38%
2022	267,754,414	-8.74%	-2.77%	283,616,968	-9.18%	-3.63%
2023	284,455,659	-8.64%	-2.69%	303,034,433	-9.30%	-3.79%
2024	302,017,620	-8.78%	-2.85%	320,666,224	-8.71%	-3.18%
2025	321,272,166	-8.98%	-3.05%	340,637,567	-8.14%	-2.62%
2026	340,223,656	-8.97%	-3.09%	360,269,334	-7.87%	-2.36%
2027	360,167,392	-9.25%	-3.38%	381,015,195	-7.73%	-2.24%
2028	379,124,447	-8.83%	-3.00%	403,246,017	-7.56%	-2.10%
2029	398,858,083	-8.57%	-2.81%	424,091,850	-7.41%	-2.04%
2030	418,569,943	-8.12%	-2.43%	444,198,039	-7.01%	-1.69%
2031	439,605,355	-7.60%	-2.02%	467,385,108	-6.57%	-1.37%
2032	464,167,531	-7.33%	-1.91%	491,870,535	-6.31%	-1.24%
2033	490,070,604	-7.23%	-1.99%	517,184,035	-6.15%	-1.26%
2034	515,030,193	-7.37%	-2.29%	542,978,407	-6.04%	-1.28%

Table 10: Pension provision with pension agreement method 1 for Fund 2 with only the old age pension.

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2010	248,405	0.00%	0.00%	247,590	0.00%	0.00%
2011	632,549	0.00%	0.00%	610,962	-0.02%	-0.02%
2012	997,353	0.45%	0.03%	980,811	0.40%	0.01%
2013	1,416,802	0.30%	-0.16%	1,381,740	0.22%	-0.22%
2014	1,910,975	0.30%	-0.11%	1,858,472	0.45%	0.05%
2015	2,437,735	0.51%	0.16%	2,402,381	0.53%	0.17%
2016	2,981,254	0.50%	0.10%	2,974,786	0.67%	0.28%
2017	3,516,730	0.88%	0.49%	3,524,746	0.36%	-0.04%
2018	4,102,971	1.03%	0.64%	4,096,374	0.47%	0.08%
2019	4,788,078	0.20%	-0.14%	4,701,391	0.35%	0.01%
2020	5,512,916	-12.11%	-12.38%	5,413,902	-11.98%	-12.26%
2021	6,204,376	-10.29%	-9.77%	6,198,936	-11.86%	-11.44%
2022	6,924,751	-9.25%	-8.11%	6,979,338	-10.64%	-9.62%
2023	7,694,991	-9.85%	-8.26%	7,852,195	-10.95%	-9.47%
2024	8,675,747	-11.37%	-9.40%	8,788,798	-10.79%	-8.94%
2025	9,588,940	-19.94%	-18.14%	9,837,445	-19.37%	-17.71%
2026	10,504,160	-18.19%	-15.47%	10,938,180	-18.69%	-16.23%
2027	11,577,984	-19.19%	-15.76%	11,970,924	-17.87%	-14.68%
2028	12,669,701	-18.29%	-14.14%	13,257,404	-18.03%	-14.29%
2029	13,858,331	-17.48%	-12.78%	14,566,288	-17.13%	-12.93%
2030	15,088,794	-16.63%	-11.38%	15,678,042	-15.20%	-10.43%
2031	16,100,898	-14.76%	-9.05%	16,970,315	-13.23%	-8.10%
2032	17,251,065	-12.17%	-6.02%	18,365,466	-12.88%	-7.39%
2033	18,613,417	-12.19%	-5.79%	19,753,681	-13.13%	-7.43%
2034	20,211,081	-13.25%	-6.64%	21,326,012	-11.89%	-5.98%

Table 11: Pension payments with pension agreement method 1 for Fund 2 with only the old age pension.

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2009	9,425,309	-11.11%	0.00%	9,685,427	-13.68%	0.00%
2010	10,213,948	-10.49%	-1.57%	10,482,424	-12.85%	-1.71%
2011	11,368,937	-16.01%	-3.58%	11,706,620	-18.60%	-4.43%
2012	12,862,938	-15.82%	-4.74%	13,226,054	-18.65%	-6.01%
2013	14,653,804	-16.07%	-6.08%	15,071,895	-18.52%	-7.06%
2014	16,832,724	-16.09%	-6.88%	17,342,071	-18.41%	-7.87%
2015	19,267,325	-21.95%	-10.41%	19,839,972	-23.98%	-11.30%
2016	22,212,873	-22.01%	-11.29%	22,897,413	-24.09%	-12.32%
2017	25,261,882	-22.22%	-12.22%	26,075,380	-24.28%	-13.32%
2018	28,483,722	-21.93%	-12.58%	29,431,812	-24.19%	-13.93%
2019	31,921,191	-22.09%	-13.32%	32,914,934	-24.10%	-14.47%
2020	35,802,622	-22.21%	-14.00%	36,938,595	-23.98%	-14.92%
2021	39,786,111	-22.08%	-14.48%	41,012,023	-23.73%	-15.31%
2022	44,318,900	-22.08%	-14.95%	45,684,633	-23.71%	-15.80%
2023	49,114,431	-21.95%	-15.19%	50,678,718	-23.59%	-16.09%
2024	54,298,921	-22.00%	-15.63%	56,008,722	-23.60%	-16.51%
2025	60,033,031	-22.03%	-16.10%	61,955,638	-23.50%	-16.90%
2026	66,120,253	-21.90%	-16.29%	68,238,086	-23.29%	-17.03%
2027	72,590,553	-21.79%	-16.52%	74,988,025	-23.15%	-17.26%
2028	79,555,822	-21.56%	-16.60%	82,259,576	-23.05%	-17.50%
2029	87,022,158	-21.43%	-16.80%	89,953,477	-22.92%	-17.74%
2030	94,917,474	-21.06%	-16.74%	98,230,067	-22.83%	-18.01%
2031	103,701,080	-20.90%	-16.88%	107,258,458	-22.63%	-18.12%
2032	113,199,892	-20.57%	-16.90%	117,101,916	-22.46%	-18.31%
2033	123,140,728	-20.29%	-16.88%	127,555,040	-22.24%	-18.38%
2034	132,857,777	-19.84%	-16.76%	137,677,459	-21.77%	-18.25%

Table 12: Pension provision with pension agreement method 2 for Fund 1 with only the old age pension.

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2010	14,726	0.00%	0.00%	14,648	0.53%	0.53%
2011	21,082	-3.31%	-1.24%	21,007	-3.39%	-0.94%
2012	21,842	-2.47%	-0.68%	20,479	2.62%	4.86%
2013	25,706	-2.13%	-0.60%	23,367	5.35%	7.67%
2014	26,143	-5.01%	-3.41%	23,387	7.33%	9.76%
2015	35,440	-3.11%	-1.86%	30,632	7.54%	9.95%
2016	46,257	-2.22%	-0.97%	41,571	3.97%	6.61%
2017	48,558	-1.03%	0.23%	45,089	2.32%	5.01%
2018	89,523	0.51%	1.49%	86,960	-3.40%	-1.01%
2019	110,271	-2.74%	-1.52%	107,445	-4.13%	-1.51%
2020	166,921	-34.39%	-33.59%	161,552	-35.31%	-33.55%
2021	217,709	-24.66%	-23.98%	211,959	-27.69%	-25.76%
2022	254,440	-16.38%	-15.78%	244,455	-14.77%	-12.50%
2023	303,833	-19.17%	-18.65%	300,670	-19.00%	-17.03%
2024	355,544	-16.55%	-15.67%	349,150	-16.17%	-13.87%
2025	471,040	-38.17%	-37.50%	463,907	-35.99%	-34.23%
2026	573,010	-39.54%	-39.09%	563,246	-38.21%	-36.72%
2027	599,448	-24.81%	-24.43%	595,652	-22.23%	-20.46%
2028	708,117	-21.38%	-21.09%	708,280	-21.01%	-19.41%
2029	874,333	-32.70%	-32.50%	869,532	-31.86%	-30.55%
2030	1,084,327	-35.27%	-35.19%	1,088,212	-35.75%	-34.65%
2031	1,274,757	-33.13%	-33.09%	1,286,145	-33.55%	-32.46%
2032	1,614,514	-33.34%	-33.36%	1,624,371	-33.51%	-32.53%
2033	1,930,031	-34.03%	-34.06%	1,939,746	-34.16%	-33.25%
2034	2,208,597	-26.72%	-26.74%	2,230,521	-27.83%	-26.86%

Table 13: Pension payments with pension agreement method 2 for Fund 1 with only the old age pension.

	Fund specific mortality tables			AG 2010-2060 mortality tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2009	112,860,992	-8.84%	0.00%	117,002,832	-12.89%	0.00%
2010	114,585,723	-7.34%	-0.10%	117,727,877	-11.02%	0.05%
2011	119,617,244	-10.47%	-0.70%	123,902,275	-14.24%	-1.01%
2012	128,230,803	-8.97%	-0.90%	132,426,214	-12.53%	-1.16%
2013	138,521,253	-8.12%	-1.05%	143,497,096	-12.15%	-1.90%
2014	150,960,517	-7.65%	-1.37%	156,158,019	-11.60%	-2.22%
2015	163,081,145	-10.96%	-2.69%	169,421,094	-15.08%	-4.01%
2016	176,550,845	-10.42%	-2.84%	184,148,640	-14.70%	-4.44%
2017	190,461,550	-10.29%	-3.29%	199,546,082	-14.75%	-5.17%
2018	204,234,856	-9.89%	-3.32%	214,970,933	-14.90%	-5.86%
2019	218,785,401	-9.94%	-3.86%	229,603,276	-14.80%	-6.21%
2020	235,358,097	-10.68%	-4.51%	247,972,907	-15.43%	-6.83%
2021	250,521,794	-10.46%	-4.90%	264,778,352	-15.06%	-7.10%
2022	267,754,414	-10.49%	-5.44%	283,616,968	-15.03%	-7.69%
2023	284,455,659	-10.27%	-5.60%	303,034,433	-14.95%	-8.16%
2024	302,017,620	-10.22%	-6.18%	320,666,224	-14.17%	-8.01%
2025	321,272,166	-11.01%	-6.96%	340,637,567	-14.22%	-8.15%
2026	340,223,656	-10.67%	-7.24%	360,269,334	-13.66%	-8.19%
2027	360,167,392	-10.80%	-7.89%	381,015,195	-13.36%	-8.50%
2028	379,124,447	-10.18%	-7.81%	403,246,017	-13.03%	-8.75%
2029	398,858,083	-9.70%	-7.83%	424,091,850	-12.66%	-8.93%
2030	418,569,943	-9.02%	-7.67%	444,198,039	-12.03%	-8.86%
2031	439,605,355	-8.41%	-7.45%	467,385,108	-11.42%	-8.72%
2032	464,167,531	-8.03%	-7.39%	491,870,535	-11.22%	-8.88%
2034	515,030,193	-8.03%	-8.07%	542,978,407	-10.77%	-9.19%

Table 14: Pension provision with pension agreement method 2 for Fund 2 with only the old age pension.

	Fund specific survival table			AG 2010-2060 survival tables		
Year	Normal method	Δ all benefits	Δ	Normal method	Δ all benefits	Δ
2010	248,405	15.84%	0.00%	247,590	12.95%	0.00%
2011	632,549	16.18%	0.03%	610,962	12.98%	0.02%
2012	997,353	16.64%	0.14%	980,811	13.34%	0.15%
2013	1,416,802	16.32%	0.09%	1,381,740	12.86%	0.04%
2014	1,910,975	16.13%	0.31%	1,858,472	12.75%	0.46%
2015	2,437,735	16.16%	0.75%	2,402,381	12.48%	0.72%
2016	2,981,254	15.97%	0.84%	2,974,786	12.34%	0.95%
2017	3,516,730	16.22%	1.42%	3,524,746	11.68%	0.70%
2018	4,102,971	16.16%	1.74%	4,096,374	11.50%	0.94%
2019	4,788,078	15.02%	1.10%	4,701,391	11.08%	0.99%
2020	5,512,916	0.86%	-11.29%	5,413,902	-2.60%	-11.40%
2021	6,204,376	3.14%	-9.13%	6,198,936	-2.43%	-11.06%
2022	6,924,751	4.41%	-7.86%	6,979,338	-1.13%	-9.69%
2023	7,694,991	3.74%	-8.30%	7,852,195	-1.53%	-9.85%
2024	8,675,747	1.97%	-9.64%	8,788,798	-1.47%	-9.51%
2025	9,588,940	-7.91%	-18.35%	9,837,445	-10.98%	-18.20%
2026	10,504,160	-5.57%	-16.15%	10,938,180	-10.07%	-17.28%
2027	11,577,984	-6.51%	-16.91%	11,970,924	-9.08%	-16.27%
2028	12,669,701	-5.31%	-15.65%	13,257,404	-9.20%	-16.21%
2029	13,858,331	-4.25%	-14.51%	14,566,288	-8.20%	-15.08%
2030	15,088,794	-3.16%	-13.35%	15,678,042	-6.05%	-12.86%
2031	16,100,898	-0.94%	-11.08%	16,970,315	-3.88%	-10.59%
2032	17,251,065	2.05%	-7.94%	18,365,466	-3.58%	-10.11%
2033	18,613,417	1.98%	-7.72%	19,753,681	-3.92%	-10.14%
2034	20,211,081	0.75%	-8.66%	21,326,012	-2.62%	-8.66%

Table 15: Pension payments with pension agreement method 2 for Fund 2 with only the old age pension.

E Simulated funding ratios

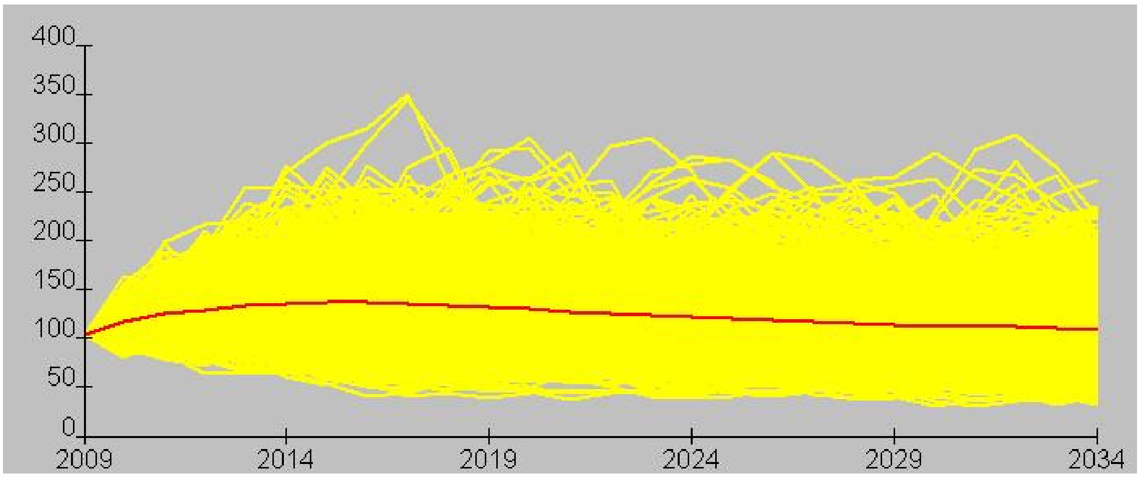

Figure 32: Funding ratio of pension fund 1 with the normal method.

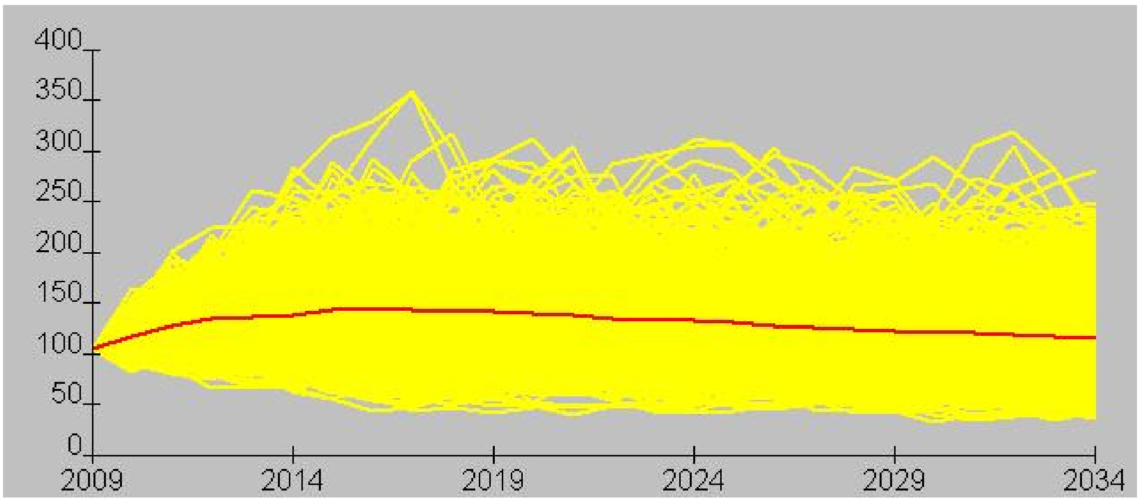

Figure 33: Funding ratio of pension fund 1 with pension agreement method 1.

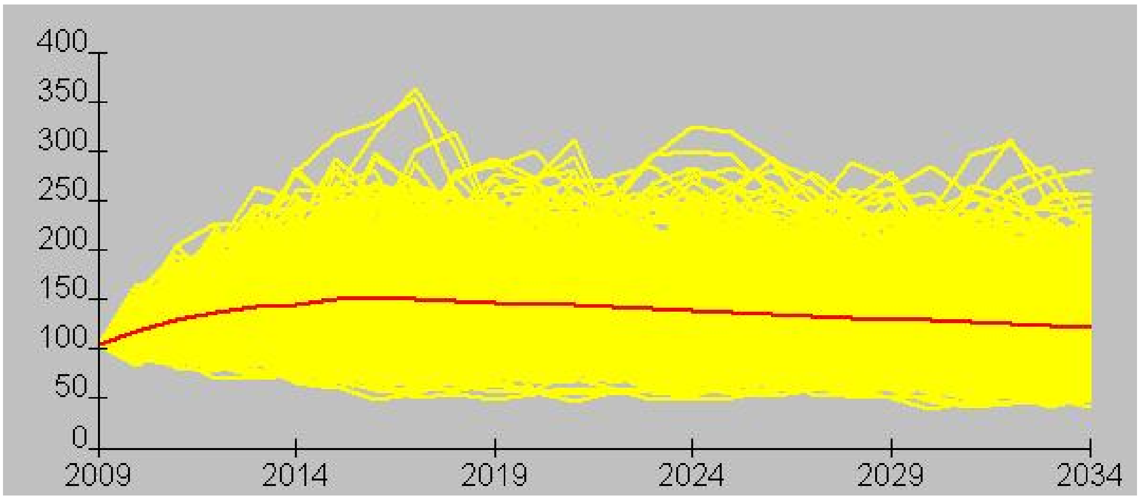

Figure 34: Funding ratio of pension fund 1 with pension agreement method 2.

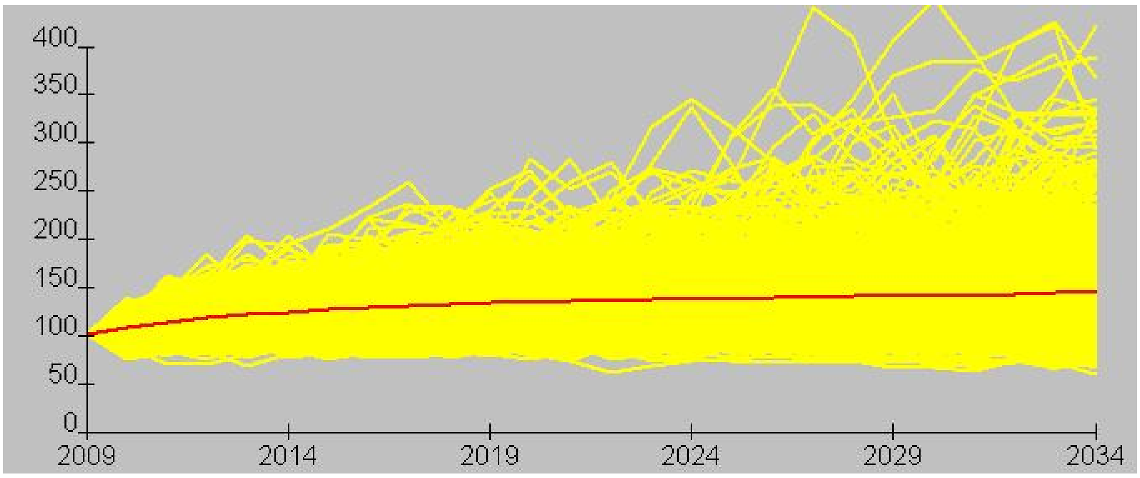

Figure 35: Funding ratio of pension fund 2 with the normal method.

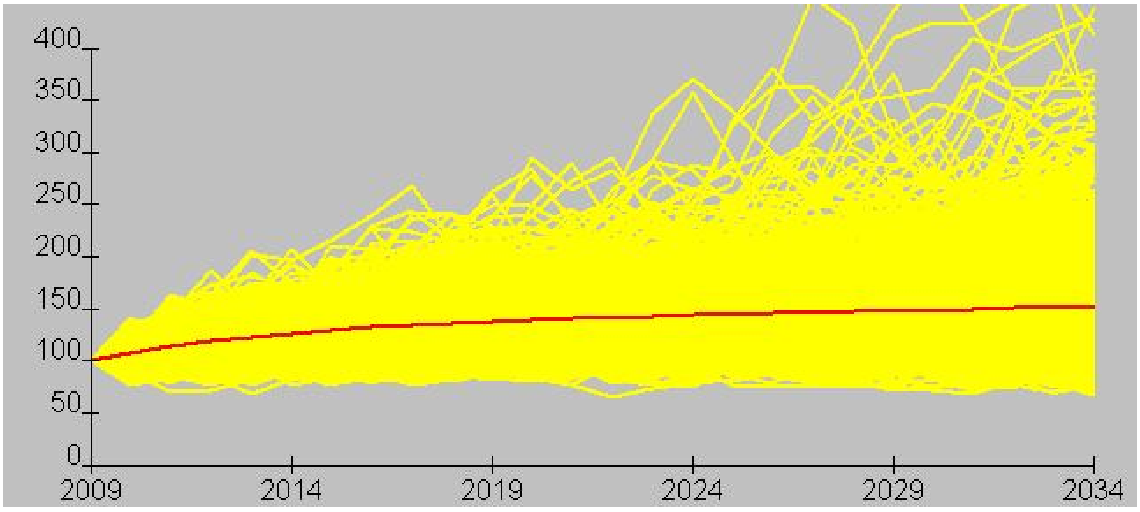

Figure 36: Funding ratio of pension fund 2 with pension agreement method 1.

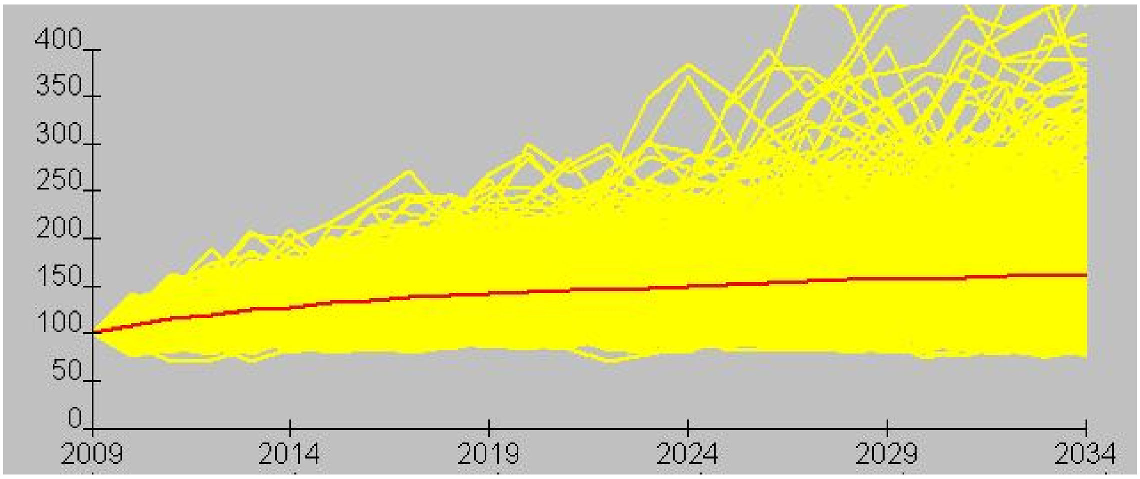

Figure 37: Funding ratio of pension fund 2 with pension agreement method 2.