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Break Even Funding Ratios for DB Pension Plan Participants

Discussion Paper 04/2011-027

Should I Stay or Should I Go?
Break Even Funding Ratios for DB Pension Plan Participants*

Roderick Molenaar† Kim Peijnenburg‡ Eduard Ponds§

April 3, 2011

Abstract

We analyze whether a low funding ratio of a pension fund can create incentives for individuals to leave this fund and save for retirement on an individual basis. Furthermore, we explore how these incentives differ per age. The recent crisis has led to a large drop in funding ratios of many pension funds, which raises the question whether for a certain funding level the benefits of participating in the pension fund are outweighed by the disadvantages. For the benchmark case we find that the funding ratio needs to be very low, for almost all ages, to give agents motives to leave the pension fund and save via an individual DC scheme. Furthermore the break even funding ratios vary substantially with age and exhibit a U-shaped pattern over the life cycle. Hence relatively young and old cohorts have more incentives to leave the pension fund. However, the benefits of participating in the DB scheme, namely intergenerational solidarity, lower costs, and no conversion risk, are in most cases so high that even for low funding ratios individuals do not have an incentive to leave the fund.

Keywords: Retirement, pension funds, intergenerational risk sharing
JEL classification: D91, G23, H55, J26

*The views expressed here are those of the authors and not necessarily of the institutions with which they are affiliated. We thank Jiajia Cui, Rob van den Goorbergh, Theo Nijman, Ralph Stevens, and Bas Werker for their extensive comments and suggestions. Kim Peijnenburg acknowledges financial support from All Pensions Group (APG). The most recent version of this paper is available at www.kimpeijnenburg.com

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1 Introduction

The recent crisis has reduced the value of the assets of pension funds and, combined with a drop in interest rate levels, has led to a large fall in the funding ratios of many pension funds. Even though at the moment the funding ratios have increased substantially again, this still raises the question whether for certain low funding levels, agents have an incentive to leave the pension fund and instead save for retirement via an individual DC scheme or become self-employed. In the Netherlands, which we use as a baseline case, participation in the pension fund is mandatory, but agents could decide to switch to another job which has another pension fund associated with it. Furthermore, the optimal asset allocation will probably differ in the future due to changes in the age composition of the pension fund. It is likely that the asset allocation of the pension fund will be more in line with the optimal allocation for the older participants if the median participant is older. However life cycle investment theory indicates that the optimal allocation for younger and older individuals differs substantially. Younger agents should prefer to invest more in risky assets because they are more heavily endowed with human capital, which is assumed to be riskless (Cocco, Gomes, and Maenhout (2005))[1]. This human capital will be depleted entirely at retirement and for this reason retirees want to allocate a smaller fraction of their wealth to risky assets. This means that due to the ageing of the population the asset allocation in the pension fund will get more conservative making the investment policy more suboptimal for younger cohorts. Bikker, Broeders, Hollanders, and Ponds (2011) find that Dutch pension funds take the age distribution of the participants into account; an increase in the average age by one year, reduces the equity exposure by 0.5%. The combination of a low funding ratio and a conservative asset allocation can give young cohorts incentives to leave the pension fund and save for retirement individually. We calculate for various ages for which funding ratio the benefits of participating in the pension fund are outweighed by the disadvantages; in other words, we calculate the break even locus.

Participating in a pension fund has various benefits which cannot be obtained otherwise. Intergenerational risk sharing, better access to capital markets, absence of conversion risk when annuitizing, (conditional) indexation instead of a nominal pension, and cost benefits (economies of scale) are several examples of advantages of collective defined benefit (DB) schemes. Via intergenerational risk sharing it is possible to share risks of asset performance, macro longevity risk, and so on, with future generations. Many papers find evidence that intergenerational risk sharing increases welfare substantially (Cui, de Jong, and Ponds (2011) and Gollier (2008)). If there is a surplus or deficit in the funding of the pension plan this can be spread out over current and future generations via adjusting the benefits and/or contributions. Furthermore, in an individual defined

[1] Benzoni, Collin-Dufresne, and Goldstein (2007) assumes that labor income risk and stock market risk is cointegrated in which case equity is a less attractive investment.

contribution (DC) scheme an agent runs substantial conversion risk when he or she wants to buy an annuity with the accumulated pension wealth, where on the other hand conversion risk is absent in a collective DB scheme. In addition, the pension income from a DC scheme is mostly nominal since insurers hardly offer real annuities, because it is difficult to hedge the inflation risk. However, there are also advantages of a DC scheme compared to a DB scheme. Namely the asset allocation in the DB scheme cannot be chosen optimally by the participant, while in the DC scheme an agent can choose an optimal allocation.

There is a trade off between saving for retirement via a DB pension fund and individually. If at some point in the future the funding ratio is low and the asset allocation is suboptimal an agent can have incentives to leave the pension fund and decide to save for retirement individually. In the Netherlands, participation in the pension fund is mandatory when you work in a certain industry or company, however an agent has several ways in which he or she can avoid to partake in that particular fund. Namely changing his or her job, becoming self-employed, or find a similar job in a different country. On the other hand, there are several reasons that could reduce the incentive to leave the job/pension fund which are not quantifiable (bought a house nearby, good career perspectives, and so on). A paper close to ours is by Ewijk and Teulings (2007), who state that young cohorts will have an incentive to leave the pension fund if the intrinsic benefits of participating in the pension fund are less than the negative effect due to underfunding when entering the fund. However, not only a low funding ratio can be a reason to leave the fund, but also a suboptimal asset allocation. We extent on previous research by looking at the combination of both (low funding ratio and suboptimal asset allocation) and determine a break even funding ratio locus. At the break-even point the individual is indifferent between participating in the pension fund or saving for retirement individually.

In the benchmark case, the individual pays uniform contributions to the pension plan during his working life and receives benefits during retirement, according to realistic pension fund rules. We compare this to an alternative scheme where an agent saves for retirement via an individual DC scheme. The DC agent saves a fixed percentage of his wage for retirement and this percentage is equal to the contribution in the collective DB scheme. Furthermore the asset allocation is static and optimal during the working period and at retirement the participant transfers his entire wealth in a nominal annuity.[2]

We find that the welfare gained via the collective DB scheme is so high that only for funding ratios below 35%, in combination with a standard asset allocation of 50% to risky assets, 30-year olds prefer to leave the pension fund. This break even funding ratio differs per age, and exhibit

[2]Many papers find that it is optimal to invest everything in an annuity even if individuals face background risks such as health cost risk (Peijnenburg, Nijman, and Werker (2009)), loads on annuities are high (Mitchell, Poterba, Warshawsky, and Brown (1999)), and agents' have a bequest motive(Davidoff, Brown, and Diamond (2005))

a U-shape. In the Netherlands agents receive an uniform accrual and uniform contribution. Due to the time value of money, a uniform system has the characteristic that the accruals of the young workers are lower than their contributions. Hence the older the agent is, the higher the value of the accruals compared to the contribution that he makes, which gives him incentives to stay in the pension fund. On the other hand, if the funding ratio is low, a relatively higher burden is put on older agents to increase the funding ratio. Namely, the benefits are cut more in absolute terms the older the agent is, since they have more pension rights accumulated. Furthermore, there is less time until retirement to make up for these benefit cuts, which are mostly in the form of low indexation levels. Note that this is due to the specific risk-sharing mechanisms between retirees and workers, which is calibrated to the Dutch case. For a 25-year, 35-year, 45-year, and 55-year old the break even funding ratio are respectively 120%, 10%, 5%, and 65%; U-shaped break even funding ratios. Even though a break even funding ratio of 120% seems high, note that this is when not taking into account the cost differential between a DB and a DC system. When a cost difference of 1% is used, the break even funding ratio for a 25-year old is 55%.

There is some related literature that examines discontinuity risk of pension funds in relation to intergenerational risk sharing. Bovenberg, Koijen, Nijman, and Teulings (2007) find that the welfare gains from intergenerational risk sharing are reduced substantially when the maximum loss transferred to future working generations is sizeably reduced. They calculate the welfare losses for various reductions of discontinuity risk. Teulings and Vries de (2006) discuss the risk of new entrants opting out of the fund in the generational accounting framework. More closely related to our paper, Westerhout (2010) examines how a funded pension scheme can be altered as to make it time-consistent. In contrast to this paper, we take into account discontinuity risk for various asset allocation strategies of the fund and examine which funding ratios makes the agent indifferent between the pension fund, and arranging the pension savings on an individual basis. The paper closest to ours is Siegmann (2011), who determines minimum funding ratios for which an agent is indifferent between joining a DB pension fund or a DC scheme. He examines for which funding ratio a 25-year old is indifferent between entering the pension fund or saving for pension in a DC scheme. We find similar results if the parameters and model setup are approximately the same. We expand on this by examining the incentives also for older cohorts to leave the fund. We find this to be particularly relevant since cohorts nearing retirement also face incentives to leave the fund, not only cohorts just deciding whether or not to enter the fund. The reason for this is that older cohorts face a higher burden when the funding ratio is low, because their pension rights can be reduced substantially and the contribution to the pension fund increases.

The remainder of the paper is organized as follows. In Section 2 we describe the pension fund (DB) and the individual retirement provision (DC). Section 3 contains the model; financial market, labor market, social security pension and taxes, and the method for comparing the pension plan with the individual retirement provision. Section 4 discusses the optimal asset mix of the pension fund. The results are presented in Section 5. Section 6 concludes.

2 Pension fund and individual retirement provision

We will consider a stylized collective pension scheme which we model as a hybrid collective scheme in which both the contribution and benefit levels can fluctuate with the funding rate. The consumption stream during the working years is equal to the net wage minus the contributions payed and consumption during the retirement period are the pension benefits. In Table 1 we show the wage, contribution, taxes, and so on. The gross salary is normalized to one and is constant during working life.

Table 1: Summary of salary, contribution, and taxes

Gross salary	1
Taxes and premium during working life	0.335
II pillar pension premium	0.0585
Gross expected pension income II pillar	0.35
Gross public pension	0.35
Taxes during retirement	0.156

2.1 Pension benefit and contribution rules

In Figure 1 we show the indexation policy for different levels of the funding ratio. The exact rules are included in Appendix A. If the funding ratio is between 140% and 160% full indexation is given. In case the funding ratio is higher than 160%, participants receive bonus indexation. If on the other hand the funding level is between 105% and 140%, agents get only partial indexation. Between a funding ratio of 90% and 105% no indexation is given, hence the pension rights in real terms are decreased with the inflation level. Finally, if the funding ratio is below 90%, the nominal pension rights of the participants are cut. This is necessary to help the pension fund recover.

Furthermore in Figure 2 we present the contribution rules for various funding ratio. If the funding ratio is between 90% and 160% the contribution percentage does not change. However, in case the funding ratio is below this level, extra contribution is levied to help increase the funding ratio. On the other hand, if the funding ratio is above 160% the contribution percentage is reduced, hence both the benefit-receivers and contribution-payers are benefited if the funding level is higher than 160%. The pension liabilities, assets, and the parameters are described in Appendix A.

Figure 1: Indexation/benefit policy

The figure displays the indexation policies for several levels of the funding ratio. The inflation rate is 2%.

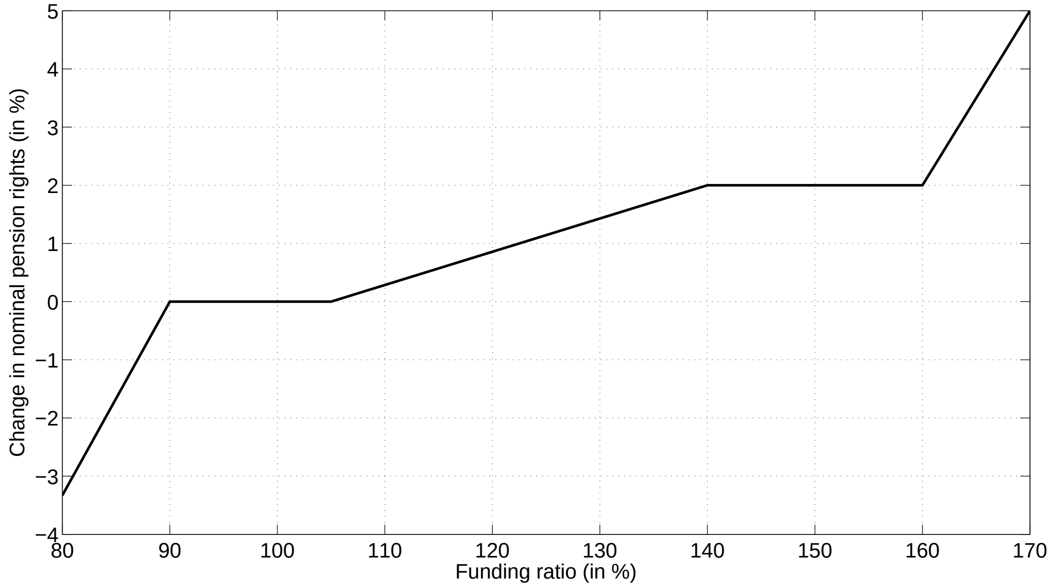
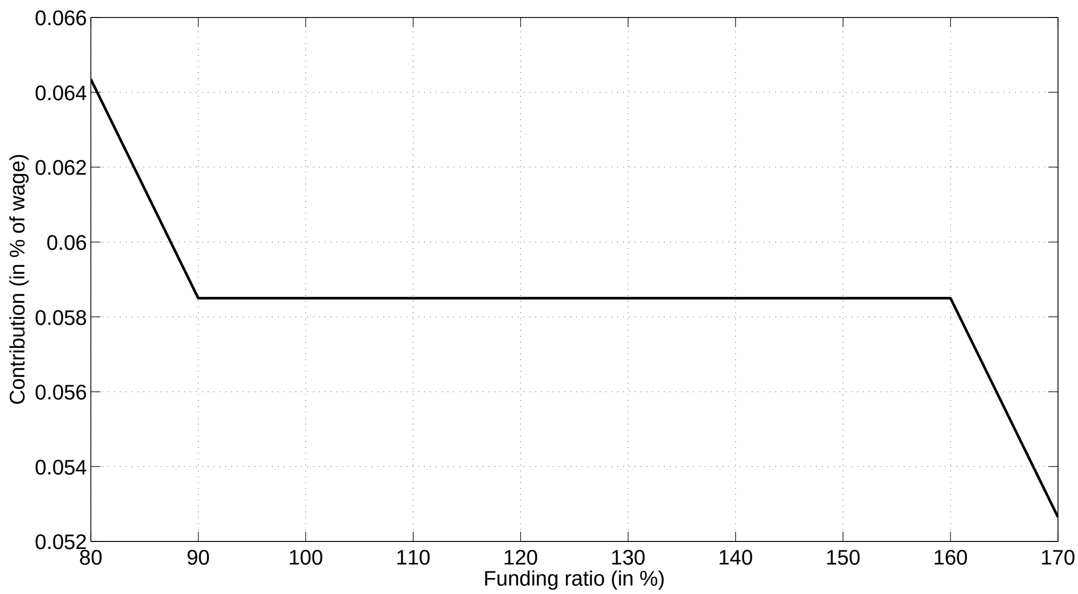


Figure 2: Contribution policy

The figure displays the contribution policies for several levels of the funding ratio. Note that this is the contribution percentage if 50% of the pension income is flat rate public pension and the other 50% is from the pension fund. The contribution is actuarially fair and depends on the allocation to equity.



2.2 Individual retirement provision

An agent can, instead of saving for retirement via the pension plan, save for retirement on an individual basis. For the benchmark case we assume an agent saves a fixed percentage of his wage during working life and then invests the accumulated pension wealth in a nominal annuity at retirement. The agent pays the same contribution as in the pension fund, which is 5.85% if 50% of the pension wealth is via social security and 50% is second pillar pension, and half of the assets are invested in equity (but not half is invested in equity, the DC agent optimizes statically over the asset allocation). If we would assume that a larger part of the total pension income of the individual would come from second pillar wealth, the contribution percentage would be higher than 5.85%. Furthermore the savings of the individual are allocated to a stock and a risk free one year nominal bond and the agent optimizes over the static asset allocation. The individual runs conversion risk in regard to the annuity. The consumption during the working phase is equal to the net income minus contributions and during retirement the agent consumes his entire annuity income.

2.3 Transfer pension wealth from DB to DC

We assume that at every age an agent can decide whether to stay in the DB pension plan or leave and save for retirement individually. Hence in contrast to the previous literature we do not only examine the incentives for young agents to leave the fund, but also the incentives for older agents. In case the agent decides to exit the pension fund, his pension wealth is transferred to the individual DC scheme. The pension wealth transferred are the real pension rights. [3]

3 The model

3.1 Financial market

The asset menu of an investor consists of a riskless one-year nominal bond and a risky stock. The return on the stock is normally distributed with an annual mean nominal return μ_R and a standard deviation σ_R. The interest rate at time $t+1$ equals

$$r_{t+1} = r_t + a_r(r_t - \mu_r) + \epsilon^r_{t+1}, \tag{1}$$

where r_t is the instantaneous short rate and a_r indicates the mean reversion coefficient. μ_r is the long run mean of the instantaneous short rate, and ϵ^r_t is normally distributed with a zero mean and

[3] So for instance, if there are a few years of a low funding ratio, the accumulated rights are reduced. Then these lower accumulated pension rights are discounted with the real rate.

standard deviation σ_r. We use the Vasicek model to calculate the term structure of interest rates. The yield on a risk-free bond with maturity h is a function of the instantaneous short rate in the following manner:

$$R_t^{f(h)} = -\frac{1}{h}\log(A(h)) + \frac{1}{h}B(h)r_t, \tag{2}$$

where $A(h)$ and $B(h)$ are scalars and h is the maturity of the bond.

Inflation is modeled as follows. For the instantaneous *expected* inflation rate we assume

$$\pi_{t+1} = \pi_t + a_\pi(\pi_t - \mu_\pi) + \epsilon_{t+1}^\pi, \tag{3}$$

where a_π is the mean reversion parameter, μ_π is long run expected inflation, and the error term $\epsilon_t^\pi \sim N(0, \sigma_\pi^2)$. Subsequently the price index Π follows from

$$\Pi_{t+1} = \Pi_t \exp(\pi_{t+1} + \epsilon_{t+1}^\Pi), \tag{4}$$

where $\epsilon_t^\Pi \sim N(0, \sigma_\Pi^2)$ are the innovations to the price index. We assume there is a positive relation between the expected inflation and the instantaneous short interest rate, that is the correlation coefficient between ϵ_t^r and ϵ_t^Π is positive.

We consider single-premium immediate life-contingent annuities with real or nominal payouts. Consequently, the annuity income is given by

$$Y = PR_0A^{-1}, \tag{5}$$

where PR_0 is the premium, and A is the annuity factor. Individuals do not face longevity risk hence the annuity factor, A, is just equal to

$$A = \sum_{t=dT}^{D-1} \left(\exp(-tR_0^{(t)})\right), \tag{6}$$

where $R_0^{(t)}$ is the time zero yield on a zero coupon bond maturing at time t. The interest rate term structure that is applied is either nominal or real depending on the type of annuity. The nominal term structure is calculated via equation 2 and the real term structure is the nominal term structure minus expected inflation and minus a risk premium.

3.2 Labor market

The real wage during the working career is constant and riskless with a fixed, exogenous retirement age. We assume individuals cannot get unemployed.

3.3 Social security pension and taxes

In most countries an individual can get a state pension and it is compulsory to participate in this. A certain fraction of income (up to maximum amount) must be contributed to the state pension plan. This first pillar can be supplemented by the second pillar, the occupational pension, which is what we focus on in this paper.

During the working phase the employee pays taxes and premiums (pension plan and social security), while during the retirement the individual only pays taxes. Note that the contributions in the pension fund are set in such a manner that in expectation the individual has approximately the same net income before and after retirement.

3.4 Comparison pension plan and individual retirement provision

We are interested in the welfare gains from participating in the pension plan compared to the optimal individual alternative. Our main goal is to examine whether for a certain funding ratio it is no longer optimal to participate in the pension fund. To be able to do this we need to compare utility from consumption generated via the pension fund and via the individual DC. For this reason we transfer the stochastic consumption streams into a measure; the certainty equivalent consumption. This is the consumption stream you get with certainty, which generates the same utility as the stochastic consumption stream (either via the DB scheme or individual DC). In both cases (DC and DB) the consumption during the working life is equal to the net labor income minus the contributions and the consumption during retirement is equal to the pension income.

The expected lifetime utility for an agent equals:

$$V = \max E_0 \left(\sum_{t=1}^{D} \beta^{t-1} \frac{C_t^{1-\gamma}}{1-\gamma} \right). \tag{7}$$

The CEC follows from:

$$V = \sum_{t=1}^{D-1} \beta^{t-1} \frac{(CEC)^{1-\gamma}}{1-\gamma}. \tag{8}$$

The ratio of CEC of the pension fund and the CEC of the individual DC strategy shows the welfare loss/gain of saving for retirement via the pension fund compared to the individual DC scheme.

3.5 Benchmark parameter in numerical simulation

The risk aversion coefficient, γ, is equal to 5 and the rate of time preference, β, is 0.96. The mean instantaneous short rate is set equal to 4%, the standard deviation to 1%, and the mean reversion parameter to -0.15. The correlation between the instantaneous short rate with the expected inflation is 0.4. We assume a mean inflation of 2%, the standard deviation of the instantaneous inflation rate is equal to 1%, the standard deviation of the price index equals 1%, and the mean reversion coefficient equals 0.165. The mean equity return is 7% and the annual standard deviation is 20%. The real wage income is set equal to unity. The retirement date T is 41 and D, time of death, equals 61. These correspond to an individual who starts working at age 25, retires at 65 and passes away at age 85. In the benchmark case no load and costs are included in the DC or the DB scheme. During the working phase the agent pays taxes plus premiums (pension premium and social security) equal to 33.5%. After retirement the individual does not pay premiums, only taxes equal to 15.6%. These numbers correspond to the taxes payed by a person in The Netherlands with a median income. We abstract from the higher tax rate for agents with a higher income. Taxes are important to take into account, because in the Netherlands the combination of taxes and contributions is chosen in such a way that the *net* income during working life is approximately equal to the *net* income during retirement. The fall of *gross* income is larger at retirement then the fall in *net* income. In the baseline case the individual receives in expectation half of his pension income from the first pillar and the other half from the second pillar.

4 Optimal asset mix for different ages

4.1 Asset liability management

The optimal asset mix of an agent differs per age. In Table 2 we present an Asset Liability Management (ALM) analysis to show the effect of the fraction invested in equity on the funding ratio of the pension fund. First of all, we see that the probability that the funding ratio is below 100% or below 140% is increasing in the fraction allocated to equity. If the allocation to equity is 75% instead of 45%, the probability of having a funding ratio below 100% in 20 years from now, is 13% higher. Note that the contribution is higher when the allocation to equity is lower, because in expectation the return on the pension assets is lower. In conclusion, the risk of underfunding depends highly on the fraction allocated to equity.

The asset allocation of the pension fund in effect determines the entire funding process. The level of the contribution levied is a direct consequence of the asset mix in the pension fund; the higher the fraction invested in equity, the lower the actuarially fair contribution level. Hence there is a trade off between contributions and risk, if a lower contribution level is desired this comes at the cost of increasing the overall risk level of the pension fund. In addition the more risky the asset mix the higher the mismatch risk between the assets and the liabilities is. We see that the certainty equivalent consumption is the highest for the more conservative asset mix.

Table 2: ALM analysis

The median benefits and contributions are in real terms. The target median benefits are 0.35. The certainty equivalent consumption is after taxes and the benefits and contributions are before taxes. The start funding ratio is 140% and the reported numbers are for 20 years later. The contribution changes with the allocation to equity, because, in expectation, less contribution needs to be levied if the equity allocation is higher.

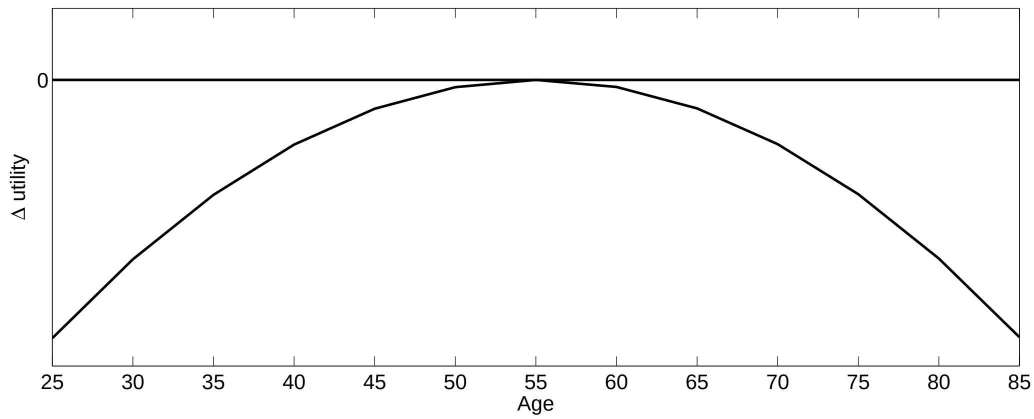
	75% equity	65% equity	55% equity	45% equity
median FR	124%	128%	131%	134%
P(FR$<$140)	62.5%	61%	59%	57%
P(FR$<$100)	27%	23%	18%	14%
median benefits	0.2897	0.3080	0.3256	0.3425
median contribution	0.0459	0.0504	0.0554	0.0608
CEC age 25	0.6135	0.6150	0.6158	0.6160
CEC age 35	0.6135	0.6160	0.6177	0.6187
CEC age 45	0.6150	0.6191	0.6221	0.6239
CEC age 55	0.6209	0.6260	0.6295	0.6314

4.2 Illustration welfare costs per age

The optimal asset allocation of the pension fund is difficult to determine. There is no clearly defined objective function of the pension fund that needs to be maximized. The pension fund exists of many different stakeholders with varying objectives, for instance workers, retirees, and inactive participants. When setting the asset allocation all views need to weighted but it is not directly clear how. One way would be to give everyone in the pension fund, independent of accumulated pension wealth, a vote. In that case the median participant will determine the optimal allocation. However, the accumulated pension wealth can also be taken into account, in effect each participant then has a ”weighted vote”. Bikker, Broeders, Hollanders, and Ponds (2011) find that the asset allocation of the pension fund depends (partly) on the age of the median participant. In Figure 3 we present an illustrative graph of the utility costs for participants at different ages, when the median participant is 55-years old and determines the asset allocation of the pension fund. We see that the welfare costs are zero for the median participant, since the allocation of the fund is in accordance with his optimal asset allocation. Agents older or younger than 55 incur utility losses.

It is conceivable that there are combinations of funding ratios and asset mixes for which transferring from a collective DB scheme to an individual DC scheme is optimal. This will also differ between ages. In the next section we explore the break even combinations of funding ratio and asset mixes for various ages.

Figure 3: Difference in utility due to a suboptimal asset allocation
This graph is for illustrative purposes only. No actual numbers are calculated to determine the exact utility loss.



5 Results: Comparing the pension fund with individual retirement provision

A DB pension fund generates several advantages over the individual DC system. For instance, intergenerational solidarity, lower costs, no explicit conversion risk of the pension wealth, and conditional indexation instead of a nominal annuity. On the other hand the DB system poses the same static allocation on everyone, while in the individual DC an agent can choose the optimal static allocation. More importantly, if the funding ratio is low when the individual enters the fund, the agent has to pay additional premia for the recovery of the funding ratio, while no indexation is given. Hence there is a certain break even funding ratio, where the individual is indifferent between saving for retirement via a pension fund or individually. In this section we are going to present these break even funding ratios for different ages.

5.1 Break even funding ratio for various ages

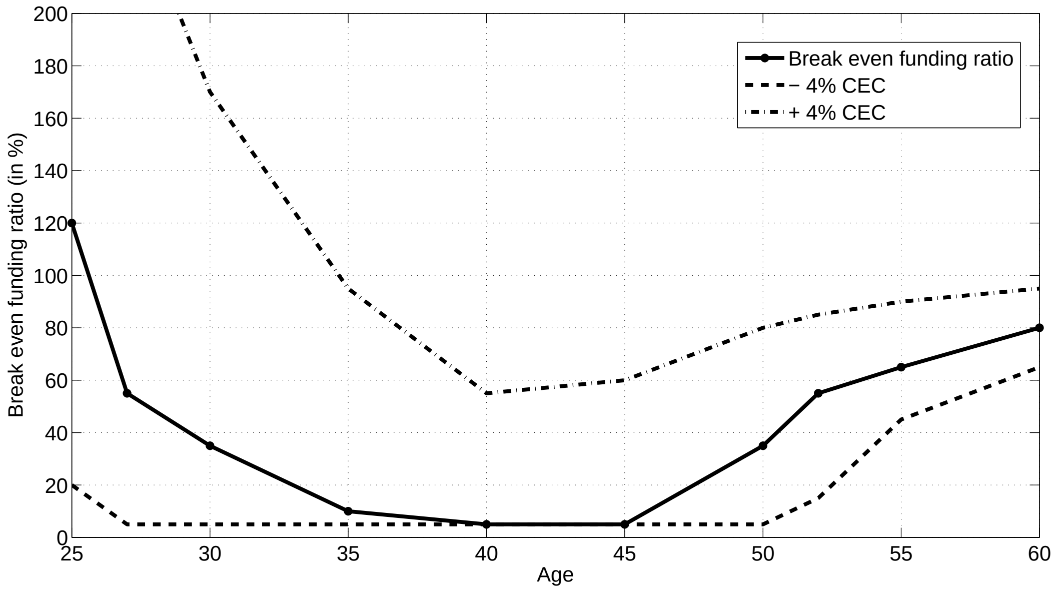
In Figure 4 we show the break even funding ratio as a function of age, if the pension fund invests 50% in risky assets. There are several reasons why the break even locus varies with age namely:

- For older agents, relatively more of the burden of a low funding ratio is put on them. Accumulated pension rights are reduced, while the pension rights are relatively higher for older agents compared to younger participants. On top of this, older agents have less years to make up for the loss of pension rights. Furthermore, the contribution of the agent is increased to help the funding ratio recovery. Hence the *break even funding ratio rises with age*. We label this the ”burden effect”

- Due to uniform accrual/uniform contribution, older agents get a relatively higher accrual compared to their contribution. For instance, when an agent is 60 years old, his contribution is worth less then the accrual he gets. This is illustrated in Figure 5. For this reason older agents have less incentives to leave the pension fund and thus the *break even funding ratio falls with age*. We label this the ”uniform effect”

Figure 4: Break even funding ratios for various ages

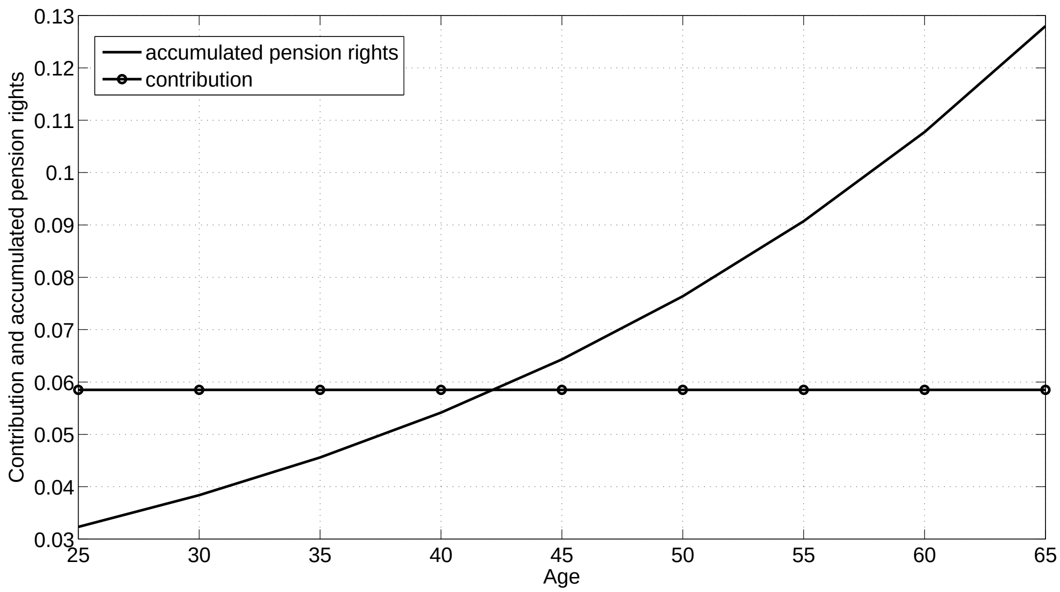
The asset allocation of the pension fund is equal to 50%. The parameters are equal to the benchmark case: 50% social security pension and 50% II pillar, no load, annuity in the DC scheme is nominal, conditional indexation in the DB scheme, 5.85% contribution in the DC scheme, asset allocation both in DB and DC static. At age 25 the +4% locus is not shown, because this is at a very high funding ratio, which would make the figures less easy to read.



In more detail, if the funding ratio is low, more of the burden is put on the agent, the older the agent is. The contributions are increased and pension rights are reduced. Furthermore, older participants have less years until retirement to receive the additional indexation. In contrast, a 35-year old has less incentives to leave the fund: the break even funding ratio is lower for every level of the asset allocation. The uniform-effect goes in the other direction, namely an older individual has more incentives to stay in the pension fund, because he gets a higher accrual compared to his contribution due to the uniform system. A young agents pays a relatively high contribution, while his pension accrual is low. For this reason older agents have an incentive to stay in the fund, hence the break even funding ratio decreases with age. Both reasonings work in opposite directions, which results in the non-monotonic results for the break even funding ratio. Furthermore, we see in Figure 4 that welfare gains and losses increase with age. The 4% loss and gain band around the break even funding ratio gets smaller at higher ages.

Figure 5: Uniform accrual/uniform contribution

This figure illustrates the uniform contribution/uniform accrual system. Agents pay a contribution of 0.0585 per year and receive in return an accrual in pension rights of 0.35/40=0.0087 in every retirement year. This accrual is however discounted and the discounted value of this accrual at every age is displayed in the graph.



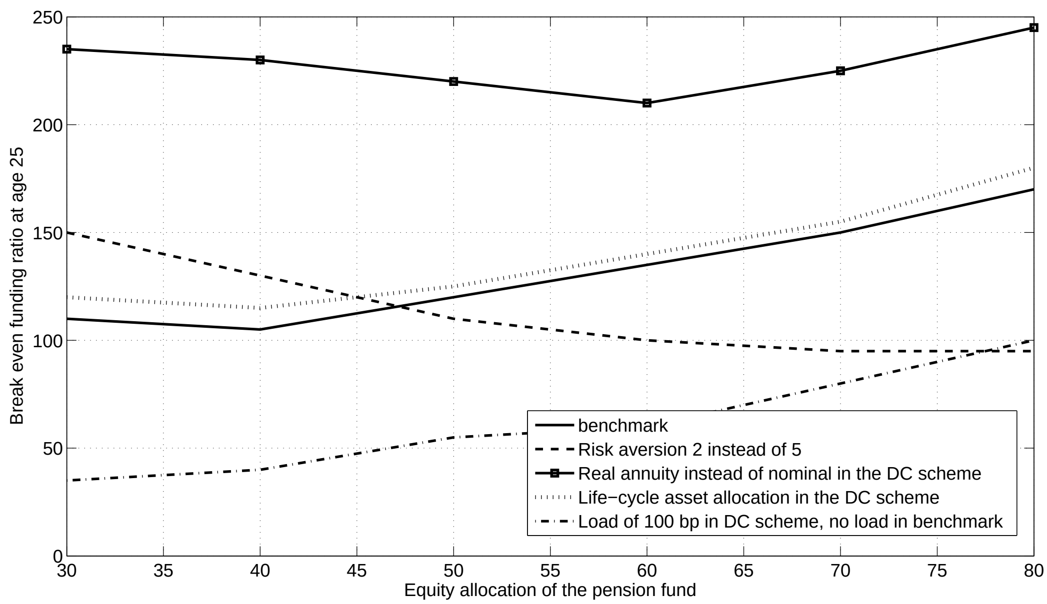
5.2 Break even funding ratio for various parameters

In the near future, the age of the median participant in the pension fund will increase substantially. This can induce pension funds to decrease the investment in risky assets, which is more in line with the optimal allocation for the ageing pension fund. However, this means that the young cohorts will receive a more conservative investment policy, which might be suboptimal. We examine what and how large the effect of a more conservative asset allocation is on the break-even funding ratio. The results can be derived from Figure 6. On the vertical axes we still have the break even funding ratio but on the horizontal axes we now display the equity allocation of the pension fund. For the benchmark case (solid line) where the pension fund invests 50% in the risky asset and the agent is 25-years old, the break even funding ratio is 120%. Furthermore, we see that if the allocation to equity for a 25-year old is reduced from 70% to 40%, the break even funding ratio actually falls from 150% to 110%. Surprisingly, a higher equity allocation induces young agents to leave the pension fund already at a higher funding ratio. The reason is that when the funding ratio is low, agents do not want to take on a lot of risk. When the pension fund invests a higher fraction in equity, there is also a higher chance of the pension fund going bankrupt. In case this happens, we assume the agent cannot get access to another DB pension plan. Hence the only way to capture the benefits of a DB pension plan is to ensure that the pension fund does not go bankrupt.

Figure 6 not only presents the break even funding ratio for different equity allocations of the pension fund, but also robustness tests for various parameters in the model. The dashed-dotted line is the benchmark model but including a 1% load in the DC scheme. We see that if the load in the DC scheme is 100 basis points instead of zero, the break even funding ratio is lower. This is intuitive, since the DC scheme becomes less attractive when the costs are higher. Note that in the benchmark case we do not include a load in the DC scheme, but a load can also be interpreted as the cost difference between a collective DB and an individual DC scheme.

Figure 6: Robustness tests 25-year old: load, real annuity, risk aversion, life-cycle investing in the DC scheme

The parameters are equal to the benchmark case unless stated otherwise: 50% social security and 50% II pillar, 100 bp load, annuity in the DC scheme is nominal, conditional indexation in the DB scheme, 5.85% contribution in the DC scheme, asset allocation both in DB and DC static. The optimal asset allocation in the individual DC scheme is 60% for the benchmark case, 100% if the risk aversion is 2, 50% if no load is included, and 60% if the annuity is real. The life cycle asset allocation is equal to (100 - t*2%). Hence when the agent is 25 years old, 100% is allocated to equity and 20% when he is 65 years old



Furthermore, if the risk aversion is lower (dashed line) an agent prefers a more aggressive investment policy. In the individual DC scheme, he can chose his asset allocation optimally and increases his equity exposure. For this reason the DC scheme becomes more attractive for low equity exposures in the DB scheme, and less attractive for high risk exposures.

In addition, in the benchmark case an agent accumulates a certain amount of pension wealth in the DC scheme and buys a nominal annuity at retirement. In the Netherlands almost no real annuities are available since insurers cannot hedge the inflation risk, because no inflation linked bonds are sold that are linked to Dutch inflation. However if real annuities would be sold the break even funding ratio would be larger, since it would make saving for retirement on an individual basis more attractive.

Surprisingly, the break even funding ratio increases when the equity allocation in the DC scheme decreases with age (life-cycle asset allocation in the DC scheme; dotted-line), compared to a static allocation. Intuitively, a higher equity exposure when young and less equity exposure when old is beneficial. However, when the equity allocation of the pension fund is high and at the same time the funding ratio is low, this increases the likelihood that the fund goes bankrupt. For this reason the break even funding ratio increases due to the life cycle asset allocation, compared to a static allocation.

6 Conclusion

In this paper we examine for which funding ratio levels, agents face incentives to leave the DB pension plan and save for retirement on an individual basis. We find that these break even funding ratios are very low for most agents and that the benefits from participating in the pension plan, namely intergenerational solidarity, cost advantages, no conversion risk, and so on, are high. Furthermore, the break even locus exhibits a U-shaped pattern as a function of age. Hence very young and very old participants have some incentives to leave the fund, while agents at intermediate ages have virtually no reason to leave the fund. The reason for the non-linear relationship between the break even funding ratio and age are two effects which work in opposite directions. On the one hand, (1) the ”burden effect”, which is that most of the burden of a low funding ratio is put on older agents, which ensures that especially older participants face incentives to leave the fund. On the other hand, (2) the ”uniform effect” induces especially young agents to leave, because at these ages the accrual of pension rights is lower than the contributions.

Our results have far-reaching policy implications. In many countries a (partial) shift from first to second pillar is being discussed. However, the incentives for agents to opt out of the pension fund should be (near) zero, to ensure the continuity of the second pillar pension system. We find that agents have little reason to leave a collective DB pension fund and save for retirement via an individual DC scheme as the benefits of the DB are very high, for all ages. Note however that we use the Dutch pension system as a baseline case and the incentives for agents to leave the pension fund can be different for varying second pillar pension system designs.

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A Description of the pension fund

A.1 Benefit and contribution rules

If the funding ratio is below a certain low threshold, negative indexation is given. In that case individuals do not receive indexation and their pension rights are even decreased in nominal terms. Between F_{LL} and F_L no indexation is applied and between F_L and F_H partial indexation. If the funding ratio is between F_H and F_{HH}, retirees receive full indexation. In that case the basis benefit percentage does not change, since we define b_t as the percentage of the real wage. Finally if the funding ratio is higher than F_{HH} then on top of full indexation a bonus benefit is given.

The benefits at time t will consist of a basis benefit percentage plus a part which depends on the funding ratio. The basis benefits, b_b, are a percentage of the real wage. The actual benefit percentage of the real wage at time t, b_t, will be higher or lower depending on the funding ratio.

- if $F_t < F_{LL}$ then $b_t = b_b \left(1 - \zeta_0 \frac{(F_{LL} - F_t)}{F_{LL}} - \pi_t\right)$
- if $F_{LL} \leq F_t < F_L$ then $b_t = b_b(1 - \pi_t)$
- if $F_L \leq F_t < F_H$ then $b_t = b_b \left(1 - \pi_t \frac{F_H - F_t}{F_H - F_L}\right)$
- if $F_H \leq F_t < F_{HH}$ then $b_t = b_b$
- if $F_t \geq F_{HH}$ then $b_t = b_b \left(1 + \zeta_1(F_t - F_{HH})\right)$

where F_{LL}, F_L, F_H, and F_{HH} are threshold levels for the funding ratio. π_t is the inflation rate. If the funding ratio is below a certain low threshold, negative indexation is given. This implies that individuals do not receive indexation and there pension rights are even decreased in nominal terms. Between F_{LL} and F_L no indexation is applied and between F_L and F_H partial indexation. If the funding ratio is between F_H and F_{HH}, retirees receive full indexation. In that case the basis benefit percentage does not change, since we define b_t as the percentage of the real wage. Finally if the funding ratio is higher than F_{HH} then on top of full indexation a bonus benefit is given.

The same structure holds for the contributions, p_t. The contributions consist of a basis part, p_b, and a part that depends on the funding ratio. p_t is a percentage of the real wage:

- if $F_t < F_{LL}$ then $p_t = p_b \max[(1 + \beta_0(F_{LL} - F_t)), 1.5]$
- if $F_{LL} \leq F_t < F_{HH}$ then $p_t = p_b$
- if $F_t \geq F_{HH}$ then $p_t = p_b \min[(1 - \beta_1(F_t - F_{HH})), 0.5]$

Hence the pension contribution depends negatively on the funding ratio. The contribution cannot be less than half of the basis contribution or more than 50% larger than the basis level.

A.2 Pension liabilities and assets

The timing in the model is as follows: at the beginning of the period (a year) the pension fund receives premiums and pays benefits. Subsequently the assets are invested. An individual pays premiums until age $T-1$ and starts receiving benefits at the beginning of period T. He receives the last payments at age $D-1$ and dies at D.

First we need to determine the basis contribution. The basis benefits, b_b, and the basis contribution, p_b are related in a such a manner that the premium covers the costs. This actuarially fair contribution requires that ex-ante every individual pays its own pension. The discount factor we use to calculate the actuarially fair premium depends on the type of pension (nominal or real) and whether it is guaranteed, so several options are possible. If for instance we want to give a pension with a nominal guarantee, we use the nominal term structure to calculate the actuarially fair premium. In the case a real pension guarantee is given the discount factor used is the real term structure. However we assume that no guarantees are given, but the pension fund does have the ambition to index so we discount with the expected real return on the portfolio. This basis premium, p_b, is calculated in the following manner:

$$\sum_{t=1}^{T-1} \frac{p_b}{(1+R^r)^{t-1}} = \frac{1}{(1+R^r)^T} \sum_{t=T}^{D-1} \frac{b_b}{(1+R^r)^{t-T}}. \tag{9}$$

Hence the sum of the discounted benefits received during retirement must be equal to the discounted premiums payed. R^r is the expected real return on the portfolio.

The nominal funding ratio, F_t, is defined as the ratio of the nominal market value of the assets over the nominal market value of the benefits. The market value of the assets changes with the return on the portfolio, but also with the contributions received and the benefits payed. The market value of the assets in nominal terms follows from

$$A_{t+1} = (A_t + \sum p_t^a - \sum b_t^a)(1 + R_t^f + (R_t^e - R_t^f)x_t) \tag{10}$$

where R_t^f is the return on a risk free 1-year nominal bond and R_t^e is the return on equity. p_t^a are the contributions in absolute terms payed by each cohort. The premiums are equal for every age. b_t^a are the benefits in absolute terms received by each cohort, which differ depending on the past benefit policies.

The nominal liabilities at the beginning are equal to the future cash flows discounted with the nominal term structure. We assume there is 1 person per age cohort (i.e. the same amount of participants for each age cohort), then the total target liabilities is equal to the sum of the liabilities for each age cohort:

$$L = \sum_{t=1}^{D-1} L_\tau. \tag{11}$$

A.3 Pension fund parameters

The benchmark pension fund parameters are based on the rules and practices in the Netherlands. We assume that if the funding ratio is below the lowest threshold, F_{LL}, the benefits are lowered in nominal terms. This is reflected in the parameter ζ_0, which is set equal to 0.3. This means that the nominal benefits are lowered in such a manner that the funding ratio in expectation will be approximately equal to about 90% in 3 years. The parameter ζ_1 is set equal to 0.2. Hence if the funding ratio is 10% higher than highest threshold, F_{HH}, the real benefits are increased by 2%. β_0 is equal to 1, hence if the funding ratio is for instance 80%, the contribution is increased by 10%. Furthermore β_1 is also equal to 1. With respect to the asset allocation, the benchmark is 50% in risky assets and the remainder in risk free assets.