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From Average Pay DB to Collective DC

Defining the Risk Transfer

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From Average Pay DB to Collective DC: Defining the Risk Transfer

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TABLE OF CONTENTS

Introduction

Considerable risk bearing by the employer has been a very common feature in Dutch single employer pension schemes over the decades of their existence. Employers provided defined benefit schemes in which participants knew in advance what replacement rate of final wage they would get after retirement. The share of employer risk was reduced when at the start of the century many pension schemes moved to average pay DB schemes, in which correction of accrued pension rights for inflation depended on the performance of the pension fund. A few years later, some employers even shifted completely away from risk bearing in their pension funds. They moved to CDC – Collective Defined Contribution. The form of these new pension contracts was similar to average pay DB schemes. However, in a CDC the employer only paid a fixed contribution rate annually and was not financially involved in the pension fund in any other way.

At this point, a few employers were already offering individual DC schemes. However, they represented only a very small share. Collective schemes covered the vast majority of employees and were based on either complete risk bearing by the employer or risk sharing between employers and employees. Now, suddenly, a new pension scheme type appeared that combined a collective scheme with defined contributions. And some very large single employer pension funds moved to this new scheme type. Responses from the field to this development were in general not very positive. Some thought CDC schemes would in practice turn out to be average pay DB schemes, since the employers would not let their employees down if the schemes were to face severe distress. Others thought CDC was just a step in between for these pension funds before they moved to individual DC schemes.

A few years after the first CDC schemes were introduced, a second stock market crash within a decade caused severe financial blows for employers running collective DB schemes. While these employers saw contribution rates rise and would possibly even be requested to provide additional financial support, their interest for the concept of Collective DC schemes grew. For advocates of collective schemes that contain risk sharing between employers and participants, alarm bells began to ring. The group of advocates for CDC grew as well. Employers were unable to provide additional financial support, since the economic downturn hurt them as well, and participants were furious about possible right cuts, because they thought accrued rights were guaranteed retirement income. CDC provided cost security to employers and openness about the conditionality of accrued rights to participant. These features suddenly became very attractive. A renewed discussion about employer risk taking in pension funds arose. In these circumstances, this thesis was written. It moves back a few years into the past, when CDC was introduced and embraced by a couple of large single employer pension funds. It will provide an analysis of the transition from DB to CDC that was made and relates this to the current situation, to see what the analysis can teach us in the risk distribution between employers and participants in pension funds in general.

1. Context and Motivation

1.1 Origins of CDC

Traditionally, most pension plans in the second pillar of the Dutch system are Defined Benefit schemes. These collective pension plans are characterized by pre-defined retirement income levels for participants and flexible employer contributions that adjust to what is needed to support these retirement income rights. DB pension plans are organized around certain occupational groups, specific industries and individual employers (OECD, 2009). The latter type, a DB pension plan offered by a single employer, is particularly interesting. In this case, a single company alone bears the financial risk of providing the accrued retirement income rights to all participants. In case of an economic downturn, which affects not only pension fund's investments but may also harm the performance and reliability of its sponsors, the single employer pension plan is likely to be very vulnerable.

Single-employer pension plans in the 20th century

Before the stock market downturn in 2000-2001, most employers offering their own pension plan to employees offered final pay DB schemes. In such a scheme, participants annually build up a certain percentage of their final wage. Accrued benefits are paid out by the pension fund after retirement until death. These benefits grow along with wage inflation annually. Soaring returns on the financial markets made it possible for companies to provide such benefits while paying fairly low contribution rates into the pension funds. Contractually, there was no obligation to let the accrued rights of participants grow with wage inflation each year. However, in practice, no indexation cuts were applied. After all, funds were abundant. This picture dramatically changed when stock market turbulence during the early 21st century revealed the risky nature of final pay DB pension plans.

Single employer pension plans after 2000-2001

The generous and relatively cheap single employer pension plans that had experienced a golden era during the final decades of the previous century revealed the other side of the coin when the new century arrived. Stock prices experienced free falls, which caused the value of pension fund's assets to drop. Contribution rates had to increase to make up for it, while the sponsors of single employer pension plans were often facing difficult times themselves too. Worries about the sustainability of existing pension plans began to arise (Mertens and Oerlemans, 2003). A new pension plan design that became increasingly popular and was embraced by many employers, both those involved in industry wide pension funds as well as employers providing their own pension plan, was the average pay DB plan.

Within a few years, this new interpretation of the Defined Benefit pension plan had taken over as the majority of final pay DB schemes switched to average pay. There are two important changes with respect to final pay DB. First, as the term suggests, benefit accrual is now based on an individual's average wage, rather than the final wage. This saves costs particularly on career makers with steep lifetime salary curves (Ponds and Van Riel, 2007). Furthermore, and perhaps more importantly, the conditionality of indexation with wage is made explicit, as it depends on the funding ratio. The option to give no or less than full indexation on benefits provides pension funds with the possibility to recover much faster from negative shocks. However, an important element that remained even in the average pay DB was the support of nominal accrued rights by employer cost flexibility. While the average pay DB contract seemed sufficient as a solution for industry wide pension funds, the single employer pension plans were about to face another issue that forced them to reconsider their pension plans again.

New accounting rules

While the early 21st century may have exposed the risky nature of DB pension plans to the sponsor companies, new accounting rules caused this risk to be exposed in the companies' annual reports as well. From 2005 onwards, companies listed on the stock market were obligated to report under International Financial Reporting Standards (IFRS) rather than under Dutch GAAP (Generally Accepted Accounting Principles). Under these rules, companies sponsoring single employer DB pension schemes were obligated to incorporate the performance of their pension fund in the annual report. These rules were aimed at providing more openness about the financial risks for the company involved in running such a pension scheme (Mertens and Oerlemans, 2003). The new rules were particularly problematic for companies who had a pension fund that was relatively large compared to their own operations. The only way to be exempt from this rule, was to make employers' costs independent of pension fund performance, so that performance risk of the pension fund was no longer in the hands of the company. Contributions had to be fixed to provide cost certainty. This naturally conflicted with the concept of Defined Benefit plans, in which rights given to participants are to be supported financially by the employer. An obvious solution would seem to offer Defined Contribution pension plans instead of Defined Benefit plans. And indeed, some single employer pension plans did switch to DC plans (Swinkels, 2006). However, this switch implied a complete shift of all pension fund performance risks to the single employee. Since Dutch companies have a long and deeply rooted tradition of collective pension plans, this step was one bridge to far for some. Ana alternative was provided by a fairly new concept, the Collective Defined Contribution (CDC) pension scheme.

The rise of CDC

In the period 2004-2005, a couple of large Dutch single employer pension funds made the transition to a Collective Defined Contribution pension plan. Among them were Akzo

Nobel, SNS Reaal, VolkerWessels and Arcadis (Swinkels, 2006). The basic outline of the newly adopted CDC pension plans is very similar to the average pay DB. Participants accrue nominal rights annually in an average pay plan. And like in a DB, indexation of these rights depends on the funding ratio of the pension fund. However, while in a DB pension plan nominal rights are still given and only indexation is conditional, the independence of costs from performance implies that even nominal rights are conditional in a CDC. When the pension fund faces severe distress, nominal right cuts are the only way to recover.

Another essential difference is that the contribution rate is fixed, at least over 5-year periods, to provide sufficient cost certainty. And even when renegotiated, the new contribution level should only be based on future expectations of economic and actuarial factors, rather than on the current performance and funding ratio of the pension fund, like in a DB pension plan. Additional financial support in the form of lump sum payments is not allowed (Oerlemans and Tielman, 2006a). Neither are lump sum withdrawals from the fund. This ensures that the employer moves away from all performance risk, so that the company can be exempt from the obligation to report pension fund performance in its annual reports. This strong withdrawal of the employer from the pension contract is a major step away from the traditional DB contract, in which the employer is strongly involved as his cost level depends on the funds’ performance.

The companies who decided to make the transition to CDC compensated participants with higher contribution rates in trade for the higher risks and lump sum payments to provide good start funding ratio’s for the new pension schemes. The birth of the first collective pension contracts where performance risks were fully in the hands of participants was a fact. But the discussion was just about to get started.

1.2 Literature Review

The introduction of the first Collective DC schemes attracted the attention of many in the Dutch pension sector. The absence of the employer as income security provider in the new pension contracts caused discussion and concern among experts in the field. The DB contract on which the second pillar of the Dutch system heavily relies is based on retirement income rights given by the employer to the employee. Even without unconditional indexation, the employer support of nominal rights is still a very valuable one. This also implies a strong interest of the employer in guarding the stability of the pension fund. What are the consequences of the employer retreating from this role in the pension contract?

In a paper on the role of the employer in CDC pension contracts, Beetsma, Mahieu and Slager (2007) express their opinion that if the employer retreats from his position as a risk bearer in the pension contract, he should also give up or at least significantly decrease his role in the decision making process. In this way, control over the pension fund is in the hands of those who face the consequences of decisions in the end (Beetsma, Mahieu and Slager, 2007). This may seem like a reasonable proposition at first. However, the employer may play a significant role in maintaining the stability of the pension fund not only financially, but also by supporting expertise in the decision making process. It may be so that the employer, in order to watch over the quality of the pension plan he is offering to his employees, would like to continue to be involved.

An interesting question that arises is whether companies that chose for a transition to CDC were really looking for a way to retreat from their responsibility for the pension fund, or whether they were simply looking for a way to be exempt from reporting their pension fund in the annual report. Swinkels (2006) performed a study among 24 Dutch companies that form the AEX, the main stock market index for the Netherlands, to see whether he could discover a pattern to clarify what companies were attracted to the option of changing their pension fund into a (C)DC fund. He found that new rules for calculating liabilities implemented in 2006, that obligated pension funds to incorporate interest rate volatility, played an important role for pension funds who chose for a (C)DC scheme. These rules were projected to possibly cause considerably higher cost volatility for DB schemes. Cost stability was also found to be an important factor for single employer pension funds (Swinkels, 2006).

The study by Swinkels (2006) further showed that the pension funds that moved to CDC were among the funds that were the largest relative to the size of the company itself. This obviously results in higher vulnerability to pension fund performance. However, IFRS rules were found to be the main reason to switch away from DB schemes. So, it was not in the first place the impact of cost volatility on the company itself that caused them to abandon DB schemes, it was the obligation to report these risks that caused them to change to (C)DC schemes (Swinkels, 2006). The obvious question arises what the implications of this new contract are for the pension funds and in particular their participants.

As Oerlemans and Tielman (2006a) indicate, while the trade off for employers is quite clear (a higher contribution rate as a price for cost certainty) the participants' trade off is far less clear. Furthermore, this stakeholder group tends to lack sufficient knowledge to understand the implications and defend its own position (Oerlemans and Tielman, 2006a). Illustrative is a survey by Oerlemans and Tielman (2006b) conducted within the Dutch pension sector opinions with respect to CDC. Even though they found that 78% thinks CDC is a suitable solution for single employer pension plans and even 55% thinks that it is also suitable for industry wide funds, also more than half (55%) does not find CDC a full equivalent for DB plans. As much as 73% of respondents think participants do not understand the risk transfer involved in a transition from DB to CDC (Oerlemans and Tielman, 2006b). It thus seems that, although people in the Dutch pension sector feel CDC can provide a solution for particularly single employer pension plans, they also recognize that some negative aspects for participants are involved.

Ponds and van Riel (2007) use an Asset Liability Management framework to compare stylized versions of a traditional final pay DB scheme, an average pay DB scheme and a CDC scheme over a time period of 20 years. They find that contribution volatility is, quite obviously, zero for a CDC, while average annual contribution rate changes are 2.6% for an average pay DB and 3.2% for a final pay DB. However, the probability that participants receive less than 80% cumulative indexation is 15% in a CDC as opposed to 9% in an average pay DB and, again obviously, 0% in case of the final pay DB. Furthermore, the chance of underfunding is 2% in an average pay DB versus 5% in a CDC and 11% in a final pay DB (Ponds and van Riel, 2007). These numbers provide a good indication of the benefits from employer risk taking for the participants and for pension fund stability in an average pay DB versus a CDC. Both benefit outcomes for participants and pension fund stability are higher in an average pay DB. This indicates to some extent the price paid for cost stability.

It is often questioned to what extent participants in CDC funds were truly aware of the implications when their pension fund changed the contract. Even though participants may not be aware of their new risk position, Oerlemans and Tielman (2006c) indicate labour unions as their representatives were initially hesitant. Companies managed to convince them by offering large lump sums to settle the deal. The question, they emphasize, remains whether these lump sums embodied a fair price for the risk transfer involved in moving to CDC (Oerlemans and Tielman, 2006c). Intuitively, it can be understood that although lump sum payments at the point of transition may cover for negative shocks during the first years after the transition, depending on the financial performance of the fund, in the long run a higher contribution rate is needed to shelter participants from the downside risk.

In order to what kind and size of financial compensation is needed quantitative research on the risk transfers when moving between different types of pension schemes is needed. Few academics so far have attempted to value changes in the risk position of participants when making transitions between DB, CDC and DC. One example is a comparison of a stylized DB and DC plan by De Haan (2008). He shows, using the Monte Carlo simulation method that, in order for a DC to deliver the same level of security with respect to the pension benefit level, the contribution rate would have to be approximately 2.45 times higher. He points out that, even though CDC is different from DC, because risk sharing among participants themselves remains, the retreat of the employer as a financial risk bearer from the pension contract has a significant impact on the pension benefit security level provided by such a pension scheme (De Haan, 2008).

A study that has attempted to value the role of the employer as a risk bearer specifically was done by Hoevenaars, Kocken and Ponds (2009). They applied the option pricing method to value employer risk taking in an average pay DB. Hoevenaars, Kocken and Ponds (2009) found that the value of employer risk bearing for rights accrued in the past is 12% of nominal rights. Furthermore, they calculated what the value of the employer’s risk in the DB contribution rate, that pays for newly accrued rights for participants, is. Hoevenaars, Kocken and Ponds (2009) calculated a risk premium on top of the cost covering level of the contribution rate varying between 40% and 50% of the cost covering rate, depending on the funding ratio of the pension fund. Naturally, these values depend on the asset allocation.

The asset mix used in this analysis was a 50-50 spread of assets over bonds and equity. (Hoevenaars, Kocken and Ponds, 2009).

The studies by De Haan et al. (2009) and Hoevenaars, Kocken and Ponds, even though they use very different methods, suggest the difference between DB and CDC is much smaller than the difference between CDC and DC. This view is supported in a paper by Simons (2008), who herself is the Director of the SNS Reaal pension fund. She describes a CDC as an average pay DB, with the only differences being fixed contributions and an explicit option to cut nominal benefits in extremely bad scenarios. A DC on the other hand, she describes as completely different, since no future benefits but only contributions are awarded. These contributions apply to individual employees who choose their own asset mix and in the end also bear all the risk individually, including additional annuitization risk at the point of retirement. She believes that risk sharing among participants creates significant advantages for participants in a CDC scheme over a DC scheme (Simons, 2008).

Additional explanation may be needed to clarify the benefits from collectivity presented by Simons. Although risk sharing is generally accepted to be a benefit from pooling in insurance type contracts, collective pension funds can take these benefits to another level, by also allowing participants to share risks across generations. Some generations may accrue benefits during more favourable times than others. In a DC, this matters a lot for future pension benefits. When an individual saves for retirement during good times, benefits can be much higher than in a DB contract. During bad times, the benefit level may be much lower. Even more so, the interest rate at the point of retirement constitutes significant annuitization risk. In a CDC, participants accrue rights as a share of their salary, like in a DB. And like in a DB, this may be indexed with wage inflation, resulting in a maximum benefit level equal to a certain target percentage of wage. This implies that during good times, the pension fund can build up buffers. These buffers can then be used during bad times. Furthermore, in case bad returns lead to some underfunding, this does not directly lead to right cuts. Assuming returns will be better in the future, the value of rights can be retained at reasonable funding ratios as the pension fund will recover over time. Since the group of participants will be different over time, as some participants enter and others die, risk is shared across generations. This can potentially lead to large gains in future pension income security for participants (Bonenkamp and Westerhout, 2010). Furthermore, like in a DB, employees remain participants in the pension fund even after retirement. This means they do not face annuitization risk at any single point in time, which embodies an important risk reduction as well. The collectivity of CDC's thus improves future income security with respect to DC.

Academic research on the gain of intergenerational risk sharing was executed by Gollier (2008). He compared the performance of traditional DC schemes versus first-best and second-best funded collective pension schemes in an overlapping generations model. He found the gains of intergenerational risk sharing to be equivalent to a 1.5% percentage point increase in the annual return on retirement savings in the first-best scheme. In the second-best scheme, solvency constraints were taken into account and the gain was reduced to 0.5-1.0 percentage points (Gollier, 2008). Over the long term time spans during which individuals participate in a pension scheme, the eventual gains are then substantial. The gains of intergenerational risk sharing are also supported in an analysis by Cui, de Jong and Ponds (2005).

In conclusion, previous literature seems to support the view that CDC pension schemes have some important risk reducing advantages over DC plans. Especially in the light of the existing tradition of collective pension plans in the Netherlands, CDC is regarded as the favourable option compared to DC. However, the discussion on how CDC compares to DB is still wide open. Benefits, in particular for employers sponsoring their own pension plan, in terms of cost certainty as well as with respect to accounting standards seem obvious. However, the effects on participants after a transition from a DB to a CDC scheme are less clear. In this field, there is still a great need for additional research.

1.3 Research Question

Recently, new economic turmoil has sparked the search for new pension plan solutions again. After doing away with final pay plans that contained unconditional annual indexation, employers operating average pay DB plans have even begun to question the sustainability and affordability of the nominal rights they provide to their employees. And not only companies sponsoring their own pension plans are looking for ways to cope with risks involved in pension schemes, even industry wide pension funds are considering options which will involve significant reductions in the risk share of employers. Not surprisingly, interest in the CDC pension contract is growing among employers as well as pension experts.

Another factor that causes focus on DC-like plans is the introduction of EU-wide regulations that allow the creation of pan-European pension funds. While employers in the Netherlands have traditionally taken on considerable risks within the pension plans they offer to their employees, this is not the case in many other countries. These countries could however provide an interesting export market for second pillar pension plans. So, if Dutch financial institutions are interested in developing foreign markets, they should start looking for pension deals that do not involve the employer in performance risk. However, the Dutch expertise on collective pension plans could provide an important competitive advantage in conquering new markets abroad. CDC combines both absence of employer risk in the pension fund’s performance and the benefits of collectivity. Therefore, CDC schemes have also drawn the attention of Dutch financial institutions with an ambition to open up international markets.

While decades of experience have shown the strong and weak points of both DB and DC schemes, CDC is still a relatively new concept. While the differences between CDC and the average pay DB scheme it derives from are conceptually clear, the implications of these changes in practice, especially for participants, are not sufficiently clear yet. It seems obvious that the CDC contract exposes the participants to more risk than a DB. However, what really matters in the end, is what this means in terms of their future pension benefits. Also in the light of using CDC as an inspiration for developing new pension contracts, it is important to know what factors in the contract cause the greatest risk transfers and which tools could be effectively applied by the pension fund to compensate for the riskier position of participants. The main research question that will be analysed in this thesis will be:

Main research question:
What does a transition from an average pay DB scheme to a CDC scheme mean for participants in terms of their risk position and outcomes?

No previous research so far has given a comprehensive answer to this question yet. And in the light of the likelihood that in the near future the number of CDC- or CDC-like pension contracts will grow within the Netherlands, perhaps in the international market as well, it is of great importance that more clarity on this topic is provided.

As mentioned before, the two key elements in a CDC contract that are different from an average pay DB contract are the fixing of the contribution rate and the elimination of the option to make additional payments to the pension fund in case of insufficient funds. It would be interesting to know exactly which changes in the contract cause the greatest risk transfer. Employers may consider implementing either one to reduce their risk position without fully retreating from their risky involvement. The first sub-question is then:

Sub-question 1:
What risk transfers are involved in specific elements of the CDC contract?

The changes in the pension contract that shift more risk towards participants may to some extent be offset. Various tools could be applied for this purpose. One change that was implemented by companies that implemented CDC was an increase of the contribution rate at the point of transition. In DB schemes, the contribution rate is commonly determined by calculating the actuarially fair costs of newly accrued rights, including a solvability buffer. In a CDC scheme, the danger for the participants that the contribution rate will not be sufficient in the long run to cover their accrued rights is greater, so an extra premium for this risk should be added. Furthermore, companies have made extra lump sum payments at the point of transition, which in effect increases the funding ratio at the starting point of the CDC scheme. This may already provide some buffers for future underperformance. Another factor that could be changed by a pension fund when moving to a CDC scheme is decreasing the risk of the asset mix. A less risky asset mix decreases participants' risk in a direct manner.

It is valuable to know whether these tools are effective in compensating for the increased risk position of participants. The second sub-question is then:

Sub-question 2:
What tools are most effective in compensating for the riskier position of participants?

It is likely that results concerning the effects of a transition from average pay DB to CDC are in some respects different given the characteristics of the pension fund and its situation at the point of transition. It is important to know what these differences are, since this would provide valuable information on under which circumstances a transition to CDC would involve a smaller or greater risk transfer. A possible factor of influence with respect to the characteristics of the pension fund is the fund's population. Circumstantial factors of influence may be the funding ratio at the point of transition. The third sub-question is therefore:

Sub-question 3:
What internal and external factors influence the size of the risk transfer?

Answering these questions will provide new and improved insights in what happens to the risk position of pension fund participants when the employer decides to implement a CDC pension scheme. These answers can provide useful information to participants and pension funds facing a possible transition to CDC. Additionally, lessons drawn from the analysis of CDC schemes can be used in the search for new pension solutions, both within the Dutch pension sector, as well as for international markets.

The remainder of this thesis is structured as follows. First, the theoretical background of the CDC concept will be explored in chapter 2. Then, chapter 3 will describe the Monte Carlo scenario simulation model applied to the current analysis. Chapter 4 extends on the exact scenario simulations that will be executed using the model, including what results will be derived from this. The results will be presented in chapter 5. Chapter 6 derives practical implications from these results and applies a practical view as well by incorporating interviews held with experts from CDC pension funds. Chapter 7 concludes.

2. Theoretical Background

2.1 Defining CDC

Although companies in the Netherlands that made a transition to CDC made some important changes to their pension contract at the point of transition and a large risk share was shifted to participants at that point in time, this is not to say that there are no pension plan solutions in between average pay DB and CDC. In theory, a continuum of pension solutions is possible ranging from the employer bearing all the risk, like in a pure DB with guaranteed indexation, to the single participant bearing full risk, like in an individual DC scheme. In the context of the research question however, it is essential to define rather precisely what is considered a CDC scheme and what is not.

In practice, this is not always clear. For example, DSM is a company that decided to fix the contributions it pays into its pension fund and refrain from any commitments to make additional payments in case of underfunding. However, they did maintain the right to withdraw funds in case of a very high funding ratio. On the basis of this, DSM is not officially qualified as a (C)DC scheme under IFRS standards and they are not exempt from the obligation to incorporate their pension fund in their annual reports. However, since DSM retreated from bearing any downside risk in its pension fund, it is still often stated as an example of a CDC scheme (Swinkels, 2006). While many experts in the field have expressed their opinion on CDC and its implications, no comprehensive definition of a CDC has been presented so far.

2.1.1 The accountant's view

Since IFRS accounting rules were an important motivation for some companies to move their pension fund to CDC, clear guidelines for accountants who decide on the qualification of a fund as a CDC are needed. A project group of legal and accounting experts laid down the ground rules for this. They have determined that in a CDC, the contribution rate is fixed over at least a 5-year period, no additional payments can be made and contribution rate discounts and restitutions to the sponsor company are not allowed. Hence the reason why DSM is not officially a CDC fund. Furthermore, when the contribution rate is renegotiated, only economic and actuarial factors should play a role in setting the new level. The funding ratio cannot be of influence, so that the contribution rate in no way depends on the performance of the pension fund (Bergman et al., 2007). The guidelines that were laid down by the project group provide the accounting framework within which CDC contracts can be set up.

2.1.2 The legislator's view

While accountants were mostly concerned with determining what the form of the CDC contract should be, the role of the supervisory institution, in this case De Nederlandsche

Bank (DNB), is mostly concerned with making sure the contract is exercised correctly. DNB thus guards the quality of the pension fund's operations. One of DNB's roles is to make sure contributions paid into pension funds by employers cover the value of newly accrued rights. The annually accrued rights are usually determined in the pension contract. Since the contribution rate in a CDC is fixed over at least 5 years, this implies the cost covering contribution rate calculated when the contribution rate is renegotiated requires an additional premium to cover for the possibility that the cost covering contribution rate will increase over the period during which the contribution rate is fixed. Furthermore, DNB's task is to make sure pension funds have sufficient assets to cover rights they have distributed to participants. When a pension fund is planning on moving to CDC, the accrued rights should be sufficiently covered before the pension fund can change the contract. This implies the pension fund should not face a nominal funding shortage or a buffer shortage. If it is short on funds, a lump sum contribution should be made at the point of transition to make sure the CDC starts off with sufficient funds for accrued rights including the by DNB required buffer. Furthermore, DNB keeps an eye on when nominal right cuts are needed. In this respect, like a DB, a CDC should cut nominal rights when it faces severe underfunding. The difference being that in a DB, additional funding provided by the sponsor can be requested as well. DNB makes sure that both a CDC will not refrain from cutting nominal rights when needed, as well as that a CDC will not cut nominal rights if not needed (Schuit, 2006).

2.1.3 Risk analysis

The accountant's and legal rules for CDC pension schemes are helpful in laying down an economic definition for CDC pension schemes. In economic terms the pension contract can be described by the way in which it distributes the various risks involved among stakeholders. In order to specify this risk distribution, the various types of risk need to be specified first. A pension fund typically copes with the following main types of risks:

Investment risk

While all the pension fund's assets could be invested in a risk-free manner, this would lead to high contribution rates in order to reach a certain target income level. Therefore, pension funds typically engage in risk taking to increase returns on investments and pay higher benefits at lower costs. A rule of thumb here is that over the typical pension savings duration of 40 years, a 1% higher annual return leads to 30% lower costs in a DB, or a 30% higher return in a DC. Investment risk influences the funding ratio by changing the value of assets in a direct manner. It may influence the contribution rate in case pension funds choose expected returns as the discount factor to calculate the value of newly accrued nominal rights. The value of newly accrued nominal rights is the base for setting the contribution rate in both DB and CDC pension contracts.

The formula below shows the calculation of the costs of newly accrued rights in year t in case it is based on expected returns:

$$C_t = \sum_{i=1}^{N} \sum_{j=h_{i,t}}^{M-a_{i,t}} \frac{N_{i,t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{(1+R_t)^j}$$

C_t	represents costs for newly accrued rights payable in year t
N	represents all participants in the pension fund
$\sum_{i=1}^{N}$	sums up for all participants in the pension fund
M	represents the participant's maximum age (expected age of death)
$a_{i,t}$	represents the age of individual i in year t
$h_{i,t}$	represents the number of years until retirement of individual i in year t
$\sum_{j=h_{i,t}}^{M-a_{i,t}}$	sums up over the (expected) years the participant still has to live, from the year of retirement, hence the (expected) retirement years.
$N_{i,t}$	represents the accrued rights of individual i over year t
$\prod_{k=a_{i,t}+1}^{a_{i,t}+j}$	represents the life table with all probabilities that the individual will live another j years (obtained multiplying all $p_{k,t}$ from $a_{i,t} + 1$ until $a_{i,t} + j$)
$p_{k,t}$	represents one year survival probabilities (survival probability until age k given age k-1)
R_t	represents expected returns on the asset mix
$(1+R_t)^j$	represents the discount rate for rights payable in j years, determined by the expected return on assets over j years.

The expected return R_t is based on past performance and therefore realized returns will affect this value. In case it increases, the costs of newly accrued rights will increase and vice versa, which influences the level of the contribution rate. Hence, investment risk is important to pension funds through its effect on the funding ratio by determining the volatility of assets. However, it may also influence the volatility of the contribution rate in case expected returns are used as a discount factor.

Interest rate risk

Investment results influence the assets of the pension fund in a direct manner and therefore the effect of investment risk on the volatility of the funding ratio is straightforward. Interest rate risk on the other hand is linked to the value of liabilities in a more complicated manner. The interest rate functions as a discount factor for calculating liabilities. The formula below shows the calculation of nominal liabilities in year t for a standardized collective pension fund:

$$L_t^{nom} = \sum_{i=1}^{N} \sum_{j=h_{i,t}}^{M-a_{i,t}} \frac{B_{i,t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{\left(1+Y_t^j\right)}$$

L_t^{nom}	represents nominal liabilities in year t
N	represents all participants in the pension fund
$\sum_{i=1}^{N}$	sums up for all participants in the pension fund
M	represents the participant's maximum age (expected age of death)
$a_{i,t}$	represents the age of individual i in year t
$h_{i,t}$	represents the number of years until retirement of individual i in year t
$\sum_{j=h_{i,t}}^{M-a_{i,t}}$	sums up over the (expected) years the participant still has to live, from the year of retirement, hence the (expected) retirement years
$B_{i,t}$	represents the total of accrued rights of individual i until year t
$\prod_{k=a_{i,t}+1}^{a_{i,t}+j}$	represents the life table with all probabilities that the individual will live another j years (obtained multiplying all $p_{k,t}$ from $a_{i,t} + 1$ until $a_{i,t} + j$)
$p_{k,t}$	represents one year survival probabilities (survival probability until age k given age k-1)
$\left(1+Y_t^j\right)$	represents the discount factor for rights payable in j years, determined by the term structure of interest rates.

The nominal yield of zero coupon bonds is determined by the term structure of interest rates. Hence, when the term structure increases, the value of liabilities will decrease and vice versa. The interest rate is used as the discount factor for liabilities. Through liabilities, the interest rate influences the funding ratio of a pension fund. Since pension funds are obligated to use the most recent term structure of interest rates in the calculation of their liabilities, interest rate volatility heavily affects the status of pension funds, even when assets and the undiscounted value of liabilities are constant.

The interest rate may also influence the contribution rate in case it is used to calculate the value of newly accrued rights instead of the expected return. In this case, the formula for calculating the costs of newly accrued rights in year t looks as follows:

$$C_t = \sum_{i=1}^{N} \sum_{j=h_{i,t}}^{M-a_{i,t}} \frac{N_{i,t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{\left(1+Y_t^j\right)}$$

Here, the expected return is replaced by the term structure of interest rates as the discount factor.

Longevity risk

Life expectancy of participants determines the period over which benefits need to be paid. As the formula for nominal liabilities shows, an increase in expected longevity of participants will increase the value of liabilities and thus will negatively affect the funding ratio. Shocks in expected longevity cause shocks to the funding ratio. Both formulas for costs of newly accrued rights show longevity risk also affects these and thus longevity risk also influences contribution rates.

(Wage) inflation risk

Inflation risk does not play a role in determining the nominal value of liabilities. However, it is essential for the real value of liabilities. Real liabilities are nominal liabilities corrected for expected future inflation. The formula for calculation of real liabilities in year t is a shown below:

$$L_t^{real} = \sum_{i=1}^{N} \sum_{j=h_{i,t}}^{M-a_{i,t}} \frac{B_{i,t} \frac{I_{t+j}}{I_t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{\left(1+Y_t^j\right)}$$

I_t	represents the price or wage index at time t, depending on whether the pension scheme provides price- or wage-level indexation.
I_{t+j}	represents the price or wage index in j years
$\frac{I_{t+j}}{I_t}$	represents the price or wage increase factor in j years

The formula is similar to the calculation of nominal liabilities, except that the value of accrued rights is increased to make sure benefits maintain their real value over time. The real liabilities formula shows that higher inflation increases the value of real liabilities and thus decreases the real funding ratio. The correction for inflation can be implemented directly by applying a real discount factor rather than a nominal factor, which is only based on the interest rate as in the calculation of nominal liabilities. The formula can be rewritten as follows:

$$L_t^{real} = \sum_{i=1}^{N} \sum_{j=h_{,si}}^{M-a_{i,t}} \frac{B_{i,t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{\left(1+Y_t^{real,j}\right)}$$

Where:

$$1+Y_t^{real,j} = \frac{1+Y_t^j}{1+\Pi_{t,t+j}^{average}}$$

And:

$$1+\Pi_{t,t+j}^{average} = \frac{I_{t+j}}{I_t}$$

While pension funds usually calculate their liabilities as nominal values, since these are the actual rights they have given to employees, a lot can be said for presenting real liabilities and a corresponding real funding ratio as well. An influential critical report by Frijns, Nijssen and Scholtens (2010) argues pension funds should report in real terms, since this more clearly reflects the value of accrued future benefits to participants. In the end, it is not the amount of euro's they get after retirement that matters, but what they can buy for it. In particular since a large share of Dutch pension funds have real funding ratio's significantly below 100%, participants should be more informed about the consequences of this situation and pension funds should be far more open about this, according to Frijns, Nijssen and Scholtens (2010).

Some pension funds already incorporate a provision for indexation in the contribution rate. If so, the costs of newly accrued rights are increased with a factor that indicates the partial provision for indexation. The formula for newly accrued rights with provision for indexation is presented below:

$$C_t = \sum_{i=1}^{N} \sum_{j=h_{i,t}}^{M-a_{i,t}} \frac{N_{i,t}\theta \frac{I_{t+j}}{I_t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{\left(1+Y_t^j\right)} + \sum_{i=1}^{N} \sum_{j=h_{i,t}}^{M-a_{i,t}} \frac{N_{i,t}(1-\theta)\frac{I_{t+j}}{I_t} \prod_{k=a_{i,t}+1}^{a_{i,t}+j} p_{k,t}}{\left(1+Y_t^j\right)}$$

The factor θ can take a value from 0 to 1, indicating to what extent an employer incorporates provisions for indexation. If 0, the employer only pays for newly accrued nominal rights. If 1, the employer pays for the real value of newly accrued benefits. This may be more suitable in a pure or final pay DB where indexation is unconditional. Of course, the term structure of interest rates in the formula could be replaced by expected investment returns.

Intergenerational risk sharing

Intergenerational risk sharing is a mechanism that compensates for the aforementioned forms of risks. Collective pension schemes can benefit from this. Assuming low or negative asset returns will be compensated by positive asset returns in the future, accrued benefits can still be paid out in case of underfunding, since the funding ratio will recover in the long run. In case of overfunding, assets are not fully used to increase accrued rights. The maximum increase is full indexation for inflation. Excess assets can then be used to compensate for low or negative asset returns in the future. This mechanism creates redistribution among various generations of participants.

2.1.4 Employer risks

As stated in the CDC accountant guidelines, economic and actuarial factors can be taken into account when renegotiating the 5-year contribution rate. DNB regulations state contribution rates should be based on the value of new rights, implying economic and actuarial factors have to be taken into account in setting the contribution rate. This implies the employer still bears some small share of the investment, interest rate and longevity risk, only to a far lesser extent than in an average pay DB. His risk is now only based on the volatility of expectations for these factors, not on realized values. In a CDC the employer does not bear the effects of investment, interest and longevity risks on previously accrued benefits that form the liabilities of the fund. Through liabilities these risks influence the funding ratio, which cannot be taken into account in setting the contribution rate. Inflation risk plays a role if some provision for future indexation is paid for in the contribution rate. Depending on whether this is or is not the case, the employer can take some inflation risk. Furthermore, as explained before, the employer should put an additional component on top of the contribution rate to compensate for volatility of the value of newly accrued rights over the period during which the contribution rate is fixed. An additional risk premium may also be added to compensate for the fact that in a DB situation, the contribution rate may increase to provide additional financial support for a low funding ratio. It seems fair that such a risk premium should be incorporated. The contribution rate may be set for longer time periods than the minimum of 5 years, which reduces the risks the employer takes. It even may be fixed for a period that is not pre-determined. It should however be specified in the contract under which circumstances the contribution rate will be adapted (Bergman et al., 2007).

2.1.5 Participant risks

After defining the risks the employer bears, it follows that the rest is allocated to participants. They thus bear the lion's share of investments, interest rate, inflation and longevity risks. The volatility of the value of the pension fund's assets and accrued rights is completely in their hands. The volatility of the value of benefits that are yet to be accrued is to some extent shared with the employer. Since a CDC is a collective pension contract, the participants benefit from intergenerational risk sharing. From the described distribution of risks, the following definition of a CDC scheme can be derived:

A CDC scheme is a collective pension contract in which the employer's costs are independent of past performance and depend solely on future expectations.

In terms of risk distribution, a CDC scheme can e defined as follows:

A CDC scheme is a pension contract in which the participants collectively bear all risks involved in pension fund performance, while risks that cause volatility of costs for new rights are shared with the employer.

2.2 The DB-DC risk distribution spectrum

The previous section defined the distribution of risk among participants and the employer in a CDC. It would however be useful to obtain a clearer picture of the risk position of CDC compared to alternative pension plans. In principle, all pension contracts can be positioned by their distribution of risks among stakeholders. In this way, their relative position with respect to each other can also be determined. To make the position of CDC in the risk distribution spectrum more explicit, it is compared to some other common forms in the second pillar of the Dutch pension system.

2.2.1 Pension scheme types

The following types of pension schemes will be compared to CDC to identify the relative risk position of CDC.

Pure DB

The pure DB is a collective scheme that pays benefits as a percentage of final wage. Accrued benefits are unconditional including indexation. Benefits thus maintain their purchasing power and the relative wealth of the retirees remains constant. The contribution rate is flexible to support accrued rights and indexation. Additional lump sum transfers from and to the employer are possible as well.

Final pay DB

The final pay DB is the collective pension scheme that used to be common in the Netherlands by the end of the last century. Benefits are accrued as a percentage of final wage, hence they are increased with wage growth annually. Indexation is not contractually unconditional for inactives and retirees, but there is no explicit link between indexation cuts and the funding ratio. Historically, full indexation was practically always given in this scheme. The contribution rate is flexible to support accrued rights and indexation for actives. Additional lump sum transfers from and to the employer are possible.

Average pay DB

The average pay DB is post-2000 the most common collective pension scheme form in the Netherlands. Benefits are accrued as a percentage of current wage, leading to a career average benefit level. Although maintaining the real value of benefits is a goal for the pension fund, indexation of accrued nominal benefits with inflation is conditional and depends on the funding ratio. The contribution rate is flexible to support accrued nominal rights. Additional lump sum transfers from and to the employer are still possible.

Fixed contribution DB

A fixed contribution DB functions is like an average pay DB, except for that the employer's contribution rate is fixed. Lump sum transfers from and to the employer are still present. This scheme type may be attractive for employers who wish to pay a predictable cost level, yet are not willing to give up a certain minimum income guarantee for their employees and thus will still provide additional funding if needed.

No Lump Sum DB

A no lump sum DB functions like an average pay DB, except for that lump sum transfers from and to the employer are abandoned. The contribution rate is still flexible in order to support accrued nominal rights. This scheme type is may be attractive for employers who are too weak as sponsors to afford additional lump sum payments. It is also the typical form for an industry wide average pay DB fund.

Collective DC (CDC)

A CDC is structured similar to an average pay DB. However, in a CDC all rights, even nominal accrued rights, are conditional. Changes in the value of all benefits, both upward due to indexation and downward due to right cuts thus depend on the funding ratio. The employer's contribution rate is fixed and no extra lump sum payments or funds withdrawal by the employer are allowed. Thus, severe underfunding will automatically lead to the cut of nominal rights, since no extra financial support by the sponsor is present.

Pure DC

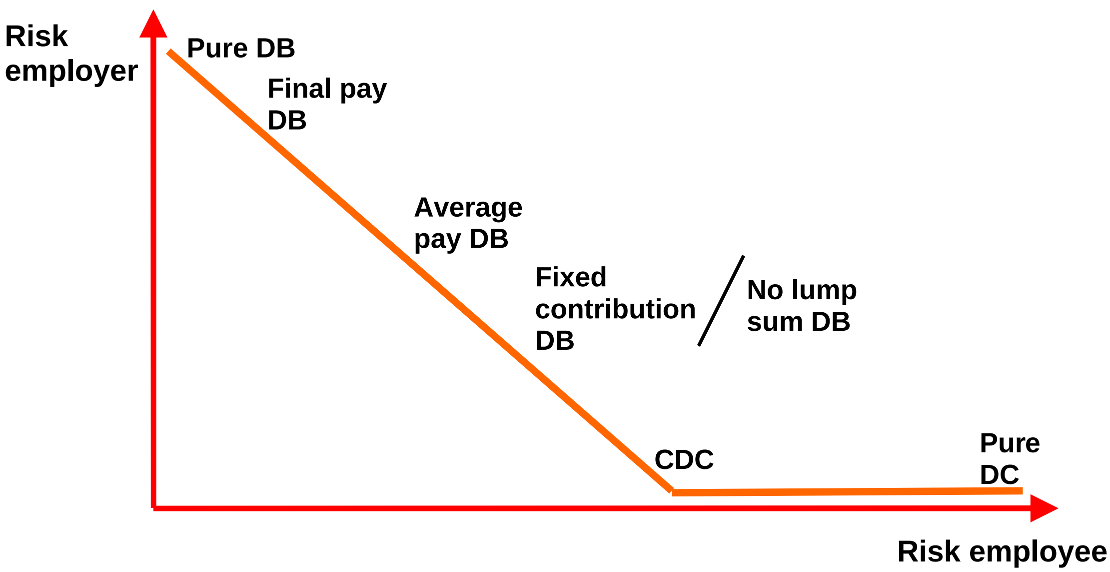
A DC scheme is an individual pension scheme in which the employer's contribution rate is fixed. Contributions may be invested according to the individual's personal preferences. The total value of invested contributions is turned into an annuity at the point of retirement. The benefit level thus depends on investment results and the rate at which this can be annuitized at the point of retirement.

2.2.3 Positioning pension schemes

While the main types of risk a pension fund faces have been discussed separately, they can be captured collectively by a single factor, namely mismatch risk. The mismatch risk in this case is the risk that invested contributions from the employer (assets) in the pension fund do not match the value of the retirement income rights accrued by participants (liabilities) (Van Gaalen, 2004).

It is important to note that bearing mismatch risk translates to different kinds of risk in practice for employers and employees. For employers, mismatching of assets and liabilities leads to cost volatility. For employees, this leads to benefit volatility. By translating both to mismatch risk, they can be compared. Calculating mismatch risk for the various pension scheme types is outside the scope of the current analysis. However, it is a useful concept to present a theoretical comparison of the risk distribution in different pension schemes, so that they can be positioned relative to each other. A continuum of distributions between participants and the employer can be assumed to exist in theory. The graph presented below represents mismatch risk allocated to the employer on the y-axis. The employee's share of mismatch risk is represented on the x-axis.

The approximate position of the described pension scheme types are indicated within the graph. Approximations of risk redistributions when moving from one scheme type to another are indicated by the distances between pension schemes on the line.



The graph shows that obviously, all mismatch risk is in the hands of the employer in a pure DB. The employer does however benefit from the collective form of the pension fund. In case of underfunding, additional payments are not immediately necessary when the pension fund recovers in the long run. The pension fund can be underfunded as long as recovery can reasonably be assumed. Also, buffers can be built up during good times. Since in a final pay DB indexation is not contractually guaranteed, some small share of mismatch risk is allocated to participants. A big leap is taken when moving to average pay DB, especially in terms of the reduction of mismatch risk for the employer. It decreases further in a fixed contribution DB and a DB without lump sums, where the employer only accepts mismatch risk in case of severe underfunding (fixed contributions) or up until a certain maximum contribution rate (no lump sums). In a CDC, employer mismatch risk is almost completely eliminated. The only risk is in the effect of unexpected shocks on the contribution rate, which can only be changed every 5 years or more. Moving further, employer's mismatch risk is reduced to zero.

Participants' benefits are fully guaranteed and thus they face no mismatch risk in a pure DB. Conditional indexation, especially when explicitly linked to the funding ratio of the pension fund, significantly increases participants' mismatch risk. As contribution rates are fixed in a fixed contribution DB and as lump sums are given up in a DB without lump sums, participants' mismatch risk increases further. In a CDC, all rights are conditional as both contribution rates are fixed and lump sums abandoned. Mismatch risk is now almost completely in the hands of participants, except for the fact that the fixed contribution rate can be adjusted for changes in the cost covering level every 5 years. When moving from CDC to DC, intergenerational risk sharing is no longer possible and annuitization risk is added. This makes the mismatch risk for participants in a DC even larger than the mismatch risk for the employer in a pure DB. At a point just past CDC, where the employer has transferred all mismatch risk to the participants, the total participants' mismatch risk is at the level of the employer's mismatch risk in a pure DB. In a pure DC, participants have individual accounts and are often required to choose their own asset mix. The lack of scale and pooling benefits and the participants' limited knowledge and rationality increase mismatch risk even further. The graph indicates that some considerable risk reducing gains are involved in moving to a collective pension scheme.

When focusing on the transition from average pay DB, the graph shows the transfer of mismatch risks when moving from average pay DB to CDC is still substantial. Although this theoretical analysis gives some intuitive idea of risk transfer to participants when moving between pension schemes, a meaningful analysis of the move from average pay DB to CDC involves a quantitative analysis of this specific transition. This analysis will thus focus on specifying the section of the graph between average pay DB and CDC. The applied research method for this analysis is presented in the next chapter.

3. Research Method

3.1 Method choice

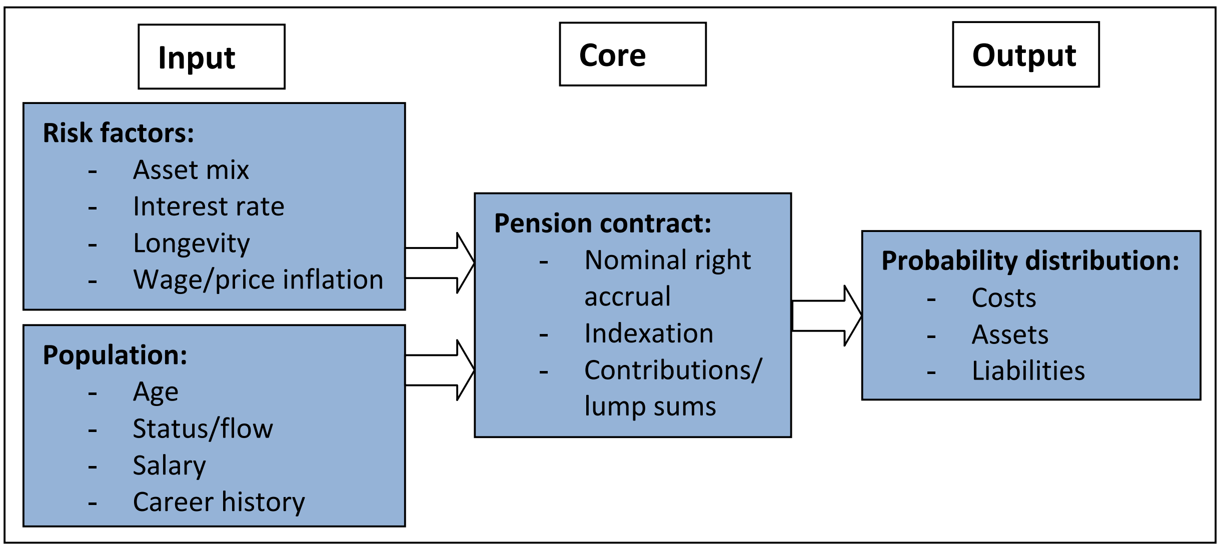
There are a few different ways in which a comparative analysis of risks in an average-pay DB and a CDC could be presented. In order to choose the right one, it is important to define first in what form the outcomes should be presented. The research questions focus on the participant's perspective of the issue. This makes some methods more useful than others. What matters for participants, are results in terms of their expected benefit level and its volatility. Hence, a method that can present probability distributions for the value of retirement income would be desirable for the purpose of analysing participant's risk. In particular, participants care about the downside of the probability distribution, which reflects the income security they derive from the pension scheme.

The volatility and distribution of outcomes for the participant's retirement income depend on the underlying risk factors. These risk factors, investment risk, interest rate risk, longevity risk and inflation risk, were described in the previous chapter. They influence the participant's retirement income through the setup and decision rules of the pension fund. While the distribution of possible outcomes for participants in pension schemes is unknown, historical data, general standards and regulatory standards do provide information to predict the distribution of possible outcomes for the risk factors. This information can be used to produce the desired probability distributions for retirement income. A common method for such purposes is the Monte Carlo simulation model.

3.2 The Monte Carlo simulation model

In a Monte Carlo simulation model the known distribution of one or more risk factors is used to produce possible scenarios and probability distributions of scenarios for this variable itself or some other variables that logically depend on the risk factors. What is needed for this is a computing program that is capable of generating random numbers. By translating random numbers to a corresponding position in the given distribution of the risk factor, possible outcomes of this factor can be generated. When a large number of scenario simulations of the risk factors are executed, the distribution of these outcomes will be exactly what was given as input. That is, using the standard normal distribution as input for scenario simulation, many simulations of possible outcomes will lead to a standard normal distribution of the output. The exact same thing can be done with the risk factors facing the pension fund. Subsequently, the simulation of the risk factors can be linked to the characteristics and form of the pension fund, to see how this translates into retirement income levels for participants. Using a large number of simulations, it will than be possible to find the distribution and volatility of retirement income levels, given the predefined pension fund. By applying this method to pension funds with different contract types, the outcomes for these schemes can be compared and evaluated.

Linsmeier and Pearson (1996) analysed Monte Carlo simulation as a tool for measuring outcome volatility when it is influenced by various risk factors. The specific strength of using Monte Carlo simulation is that it is easy to change the assumptions used and run the model again to test for any effects of alternative specification (Linsmeier and Pearson, 1996). Scenario simulation is extensively applied by pension funds themselves, by using Asset Liability Management models. These ALM-models are used to support decisions with respect to for example the contribution rate and the choice of the asset mix. However, ALM-models generally focus on predicting probability distributions with respect to the funding ratio and employer's costs involved, not to produce probability distributions for the retirement benefits of participants. However, a well-structured scenario simulation model of a pension fund has the potential to evaluate outcomes from different perspectives. So, the concept can also be used for evaluating participants' outcomes. The remainder of this chapter extends on the scenario simulation model of a stylized pension fund applied to the current analysis. It is somewhat like a simplified version of classic ALM-models. The basic structure is depicted in the scheme below.



3.3 Input

The input of the simulation model consists of two main elements, namely risk factors and the population of the pension fund. As explained before, computerized simulation is applied to the risk factors, which will result in various possible scenarios for the pension fund. However, before these outcomes can be exposed to the rules laid down in the pension contract, it is also necessary to define the characteristics of the population. This determines the position of the pension fund at the start of the simulation.

3.3.1 Risk factors

The current model will only apply investment risk to the simulation model, while keeping the other risk factors fixed. Only one risk factor is chosen, since simulating multiple risk factors would make it much more complicated to trace causality in the results. Furthermore, as stated before, all types of risk can be described by one single factor, namely mismatch risk. They all cause cost volatility for the employer, funding ratio volatility for the pension fund and retirement income level volatility for participants. Hence, the effects of adding more risk factors to the model are comparable to having a greater risk in a single risk factor. In case the applied single risk factor of investment risk underestimates the total risk within the pension fund, this will lead to an underestimation of the results. They would turn out to be even more pronounced in practice.

Investment risk

The interesting characteristic of investment risk in a pension fund is that to a great extent, it is a choice factor. By selecting a certain asset mix the pension fund accepts the corresponding investment risk. The choice of investment risk interacts with outcomes that are important to the main stakeholders, employers and participants. Hence, the choice of the asset mix is related to cost volatility for the employer, to the extent to which he is a risk bearer. It is related to retirement income volatility to the extent to which the participants are the risk bearers.

The table below first shows correlations between the three asset types that are considered for composing the asset mix: stocks, bonds and real estate. These parameters are set in Dutch regulations for financial institutions, the FTK.

	Stocks	**Bonds**	**Real Estate**
Stocks	1	0.5	0.75
Bonds	0.5	1	0.5
Real Estate	0.75	0.5	1

Source: DNB (2009) - Toelichting beoordelingsmethodiek portefeuillerendement herstelplannen

The asset mix selected for the simulation model is a standard mix for pension fund analysis. Furthermore, it was previously applied in a comparison of DB and DC schemes in a paper by De Haan (2008). Since this analysis fits in the same line and should be comparable, the same asset mix is selected. However, the expected returns are somewhat adjusted downwards, according to a renewed version of Dutch financial institution regulations (FTK) with respect to parameters used for ALM calculations (Ministry of SEA, 2010). As in the analysis of the Monte Carlo simulation tool for measuring risky outcomes by Linsmeier and Pearson (1996), the distribution of asset returns is assumed to be normal. (Egan, 2007) shows that, while the normal distribution has a bad fit for daily returns, its fit improves considerably for longer time frames. Already for 3-month return rates, the fit is acceptable (Egan, 2007). The asset mix applied to the simulation model is presented in the table below.

	Average Return (nominal)	**Average Return (real)**	**Standard Deviation**	**Mix Share**
Bonds	4.5%	1.5%	8.8%	50%
Stocks	8.3%	6.3%	25%	40%
Real Estate	7.3%	5.3%	15%	10%
Asset Mix	*6.3%*	*4.3%*	*13.95%*	

Source: Ministry of SAE. FTK Parameters 2011.

To make sure the asset mix stays stable over time the asset mix is rebalanced annually.

Interest rate risk

The interest rate has only become an important risk factor quite recently. Before 2006, pension funds calculated their liabilities using a fixed discount rate of 4%, based on a long term average for interest rates. Since 2006, Dutch regulations for financial institutions (FTK) made it obligatory for pension funds to use the current term structure of nominal interest rates for valuing liabilities. This caused a dramatic increase in the volatility of funding ratios, since a 1% drop in the nominal interest rate causes a 16% drop of the funding ratio. As interest rates indeed did drop sharply after the financial crisis of 2008, in an attempt by central banks to kick-start the economy, protests against these new rules became stronger. Experts in the field thought it was unreasonable that long term liabilities should be valued using a term structure of interest rates that could change daily. The discussion whether to stick with current rules, go back to the old fixed discount rate or use at least some longer term average is by far not settled yet. This model will stick to old rules and use a fixed discount rate for valuing liabilities of 4%. Hence, there is no interest rate risk involved in the model.

Nominal interest rate = 4%

Inflation risk (price)

The importance of inflation risk for a pension fund depends on its indexation ambitions. Price inflation itself has been rather stable over the past years, especially after the introduction of strict EU rules. The important thing with respect to inflation risk for participants is whether it can be compensated for by indexation. This usually has to be paid out of investment return. Especially as long as inflation volatility is limited, the purchasing power of accrued rights depends much more heavily on investment returns. This and the fact that inflation does not directly influence pension fund performance, since performance is usually valued using nominal parameters, motivates the choice to leave out inflation risk and fix the price inflation rate at 2% in the simulation model. This percentage is based on standards laid down in the FTK.

Inflation rate (price) = 2%

Longevity risk

Changes in the expected lifetime of participants can indeed cause major shocks to pension funds. Of course, pension funds take into account expected increases in longevity. However, when longevity turns out to increase faster than expected, this will cause a downward adjustment of the funding ratio. This longevity risk affects pension funds by incidental shocks. It is therefore hard to define a distribution for longevity risk, which makes this particular kind of risk unsuitable for simulation. The table below presents the expected lifetime and mortality table used in the simulation model.

	Average life expectancy	**Average remaining retirement**
25-74 yrs	80	15
75-84 yrs	85	5

Since a complicated structure for mortality rates is unlikely to contribute much to the validity of the current analysis while making the model more complicated, a simple structure is used. Half of the participants will die at age 75 and half at age 85, leading to an average lifetime of 80 years. The lifetime for the half of the population that survives past 75 years is 85 years.

3.3.2 Population

In order to be able to determine the position of the pension fund at the start of the simulation, the population and its characteristics need to be known. What should be predetermined is the size of the population and their status (actives, inactives and retirees). For the simulation itself the population flow between status groups needs to be defined. Age, career history and past salary levels of the population at the start point need to be set as well.

The population is assumed to be stable in both size and composition over time. It is defined over 10-year age groups. Within these age groups, participants are assumed to be uniformly distributed. Participant flows between status groups only occur at the age group boundaries. Flows into the active status are possible at ages 25, 35, 45 and 55. Flows from the active to the inactive status can occur at ages 35, 45 and 55. Flows from the active or inactive to the retired status can only occur at age 65. Every participant is assumed to retire at this age. The number of participants in all status groups and the probabilities for each participant of flowing to another group at the 10-year intervals can be found in the tables below.

Age group	Active	Inactive	Retired
25-34	12.5		
35-44	12.5	6.25	
45-54	12.5	12.5	
55-64	12.5	18.75	
65-74			31.25
75-84			15.675
Total	*50*	*37.5*	*46.925*

From/To	A 25-	A 35-	A 45-	A 55-	I 35-	I 45-	I 55-	R 65-	R 75-	Death
Inflow	1.25	0.625	0.625	0.625						
A 25-34		0.5			0.5					
A 35-44			0.5			0.5				
A 45-54				0.5			0.5			
A 55-64								1		
I 35-44						1				
I 45-54							1			
I 55-64								1		
R 65-74									0.5	0.5
R 75-84										1

As can be seen, it is assumed that half of the population within an active age group becomes inactive, hence moves to another company, when changing age groups. Inflow rates are adjusted to ensure a stable population over time. This simplified population structure provides the possibility to easily adjust assumptions about the population and run simulations with alternative compositions. A more sophisticated structure would also be much more complicated to control, while the additional advantages to the validity of the model are questionable. The given distribution of the population over the status groups implies an active/retired ratio (dependency ratio) of 1.066. There is a great variety in these ratios for actual funds in the Netherlands. Taking CDC funds, the dependency ratio for SNS Real is close to 3, whereas for Akzo Nobel it is close to 0.25. The population in the model keeps the middle. From the presented population number and flows, the career history of all participants can be derived as well. Tenure with the company may vary from 10-40 years. Furthermore, it is possible to derive exactly during which years of their life participants were active. The tables below present these numbers.

Active	**Career Start**				

Age	25	35	45	55	Total
25-34	12.5				12,5
35-44	6.25	6.25			12,5
45-54	3.125	3.125	6.25		12,5
55-64	1.563	1.563	3.125	6.25	12,5

Inactive	Active						
Age	**25-34**	**25-44**	**25-54**	**35-44**	**35-54**	**45-54**	**Total**
35-44	6.25						6.25
45-54	6.25	3.125		3.125			12.5
55-64	6.25	3,125	1.5625	3.125	1.5625	3.125	18.75

Retire	Active										
Age	**25-34**	**25-44**	**25-54**	**25-64**	**35-44**	**35-54**	**35-64**	**45-54**	**45-64**	**55-64**	**Total**
65-74	6.25	3.175	1.563	1.563	3.125	1.563	1.563	3.125	3.125	6.25	31.25
75-84	3.175	1.563	0.782	0.782	1.563	0.782	0.782	1.563	1.563	3.175	15.13

The final factor that still needs to be predetermined for the start position of the pension fund is the salary structure. By knowing the past salaries of participants, the previously accrued benefits can be defined, which form the liabilities at the start of the simulation. The FTK parameter for wage inflation is 3%. Wage inflation is somewhat higher than price inflation, which implies welfare growth. Furthermore, wage is assumed to depend on seniority. In the Netherlands, individuals tend to earn more by virtue of being older. The model assumes a wage premium of 0.5% per age year. The base wage, excluding the age premium, is set at 30,000 for the year 0, the starting year of the simulation. The wage structure in the pension fund then looks as follows:

Salary = 30000*(1,03^t)*(1+0,005*age(years))

The salary is equal to the pensionable wage, the wage from which the base for calculating nominal right accrual will be derived.

3.4 Core

The core of the simulation model is formed by the pension contract that lays down the rules needed for operating the pension fund. The rules developed in this paragraph have been checked by a professional actuary. The pension contract rules that need to be defined for the current analysis are right accrual rules, indexation rules and contribution rate rules. Two different pension contracts will be defined, namely the average pay DB and the CDC pension contract. In order to ensure comparability between the outcomes of both separate scenario simulations, both pension contracts will be the same, except for the rules that need to be different in order for a pension contract to qualify as CDC. Given the previously laid down definition of a CDC and the rules determined by supervisory instances, two elements will be different in the CDC contract:

- The contribution rate is fixed for 5-year periods and is based on the cost covering level of the contribution rate.
- No lump sums are from or to the employer allowed. This implies that in financial distress, facing an extremely low contribution rate, the pension fund will have to implement nominal right cuts.

These adjustments ensure employer costs are independent of pension fund performance and the CDC complies with regulations set both by the accountant and the supervisory institution, DNB. In the following, the pension contract for the average pay DB will first be laid down. Afterwards, the adjustments for the CDC pension contract will be presented.

3.4.1 Nominal right accrual

Nominal rights are the pension rights given to participants by the pension fund. Every year, employees, who form the active group within the pension fund, build up new rights based on their salary. Indexation given on accrued rights in the past are also part of nominal rights. The amount of nominal accrued rights represents the value of participant's pension rights in terms of today's price level. Compensation for future indexation is conditional on the funding ratio in average pay DB schemes. To determine annual accrual of new nominal rights, first the share of wages from which rights can be accrued needs to bet set. This is the so called pension base. Then, the accrual rate determines what percentage of the pension base becomes a nominal pension right annually. The pension base is determined by taking the pensionable wage, which was defined in the previous paragraph, and deduct a franchise level from it. This franchise level is calculated using the benefit level given by social security, the first pillar in the Dutch pension system, to a married individual. This is a standard amount in the Netherlands. The 2010 level of social security is multiplied by 10/7 to determine the franchise level in year 0, which is a commonly used rule in pension funds.

Franchise = 10/7*Social security benefit level (married)

Furthermore, social security is assumed to be adjusted each year with wage growth. In this way, franchise levels for years before as well as during the simulation years can be determined. Then, for all these years, the pension base can be set.

Pension base = Pensionable wage (salary) - Franchise

In the Netherlands, the legal maximum for nominal right accrual in average pay schemes over the pension base is 2.25%. This level is chosen for nominal right accrual in the simulated pension contract. It implies nominal accrued benefits after a full career of 40 years are 88% of the average wage.

Accrued benefits (annual) = Pension base*2.25%

The nominal right accrual rules defined can be used to determine the rights previously built up in the pension fund. These form the start level of liabilities. For this purpose, it is assumed that before the start of the simulation, accrued benefits were always indexed with wage inflation, which is 3%. This corresponds to the final pay DB pension contracts that were usually in place at least until the change of the century.

3.4.2 Indexation

Indexation is given at the end of the year, when the passed year's performance can be evaluated. Whether indexation can be given and how much is also defined in the pension contract. Usually, this is done by setting an indexation policy ladder. This policy ladder determines indexation of accrued benefits given the nominal funding ratio of the pension fund. A pension fund can choose whether to provide only indexation for price inflation, if funds are sufficient, or to set the maximum indexation rate at the level of wage inflation. Indexation with wage inflation may be the preferred option in order to maintain relative welfare for retirees rather than real welfare only. In the pension contract applied for the simulation model, the maximum indexation rate is wage inflation. The complete indexation policy ladder for the average pay DB scheme is displayed in the table below.

Funding ratio	**Indexation**
>105% Real	Full + Catch up
100%-105% Real	Full
105% Nominal-100% Real	Partial (linear)
< 105% Nominal	None

Below a nominal funding ratio of 105% the pension fund faces a funding shortage according to the FTK regulations and is required by DNB to set up a recovery plan which will bring the funding ratio back to 105% within 3 years (although this period was recently extended to 5 years, 3 years is the standard). This is the so called short term recovery plan. In this case, the pension fund will not provide any indexation of accrued benefits. The FTK regulations have also set a required solvability buffer for pension funds. The rule here is that they should have a buffer such that the probability of facing underfunding within one year is less than 2.5%. The required buffer for the simulated pension fund can then easily be calculated, given that the only risk factor is investment risk, which is normally distributed with a standard deviation of 13.95%. The t-value for the 2.5% probability level is 1.96. The solvability buffer is now given by:

Solvability buffer: $t(P<0.025)*\sigma_{mix}$= 27.35%

The required funding ratio including the solvability buffer is then 127.35%. Whenever the pension fund is facing a lower funding ratio it also needs to set up a recovery plan, since it is facing a solvability shortage. However, in this long term plan recovery can take place over a period of 15 years.

When the funding ratio increases above 105%, indexation will increase linearly with the funding ratio. This linear increase is set such that indexation will be full at the nominal funding ratio that is equal to a 100% real funding ratio. A 100% real funding ratio implies funds are not only sufficient to cover the value of nominal liabilities, they also cover their real value, hence they are sufficient to keep the welfare level of benefits constant. This welfare level can be defined in two ways. Welfare can be kept constant in terms of purchasing power, implying the goods basket that can be bought from benefits is constant. Welfare can also be kept constant in terms of the income status relative to the rest of the population. As stated, the current pension funds' purpose is to provide indexation with wage inflation. Hence, having sufficient funds for providing full indexation on accrued benefits, a 100% real funding ratio, implies having sufficient funds to provide indexation with wage inflation. For calculating real liabilities, the nominal discount rate of 4% in the calculation of nominal liabilities is replaced by a real discount rate that corrects for intended annual indexation with wage inflation of 3%. The real discount rate is then given below.

Real discount rate: (1+Nominal discount rate)/(1+Wage inflation)-1 = 0.97%

Full indexation is only given when the real funding ratio is at least 100%, since this will make sure current indexation does not come at the cost of future indexation. In case the funding ratio is not sufficiently high to give full indexation, this missed indexation can still be given later. Whenever the real funding ratio is higher than 105%, catch up indexation can be given to compensate participants for previously missed indexation. The rule here is that catch up indexation can only be given over actually missed indexation, since total given indexation cannot be higher than the equivalent of 3% indexation annually. Catch up indexation can only be given as long as it does not make the real funding ratio decrease below 105%. Hence, catch up indexation can be partial as well. Catch up indexation is given on the basis of a recalculated funding ratio after regular indexation, to make sure catch up indexation is only given using what is left after giving full indexation. What is important to note is that in an average pay DB indexation, once it is given, becomes part of the nominal accrued rights. Only future indexation is conditional.

If accrued rights are always fully indexed for wage growth, the replacement rate of final salary during retirement including social security from the first pillar is approximately 85%. So, the best case scenario of the pension fund provides participant with a retirement income that is 85% of final wage. What matters most to participants however, is the downside of their income probability distribution, since this indicates the level of income security they will obtain from the pension plan. This level of security is something to be obtained from the simulation analysis.

3.4.3 Contributions and lump sums

Contributions are assumed to be paid at the start of the simulation year. Additional lump sums paid by the employer are paid at the end of the year, when evaluation of the passed year's performance shows this is needed. Contributions in the simulation model are fully paid by the employer. In most pension schemes, employees pay part of the contributions themselves. This assumption is made for simplicity of the model. In theory, the legal incidence of contribution payments should not matter for the economic incidence. In the average pay DB, the contribution rate is flexible and adjusts not only to the costs of the newly accrued benefits that should be paid out of contributions. It adjusts to the funding ratio of the pension fund as well. In this way, the employer provides extra financial support to maintain a healthy financial position for the pension fund if needed. His costs can also be lowered when the pension fund is doing well and obtains sufficient funds from investments.

It was stated before that when an average pay DB faces financial distress, the sponsor company may either decide to provide additional financial support by making a lump sum payment or nominal rights should be cut. The assumption made in the simulation model is that the average pay DB scheme has a strong sponsor that is able to provide additional lump sum payments whenever needed. The credibility of this assumption has become more questionable recently, now many single employer average pay DB schemes are facing extremely low funding ratios and employers are unable or unwilling to provide additional funds. However, even in current times, some employers have still made generous contributions to their pension funds and even some of those who are under high pressure from DNB to cut nominal rights are still refusing to do so. In the simulated average pay DB, hard rights are actually hard guarantees. The table below displays the rules for the contribution rate, contribution rate adjustments and lump sum payments.

Funding Ratio	**Contribution rate**	**Lump Sums**
> 120% Real	Actuarial costs + Solvability buffer – Discount	Transfer to sponsor
>105% Real	Actuarial costs + Solvability buffer – Discount	-
100%-105% Real	Actuarial costs + Solvability buffer	-
< 100% Real	Actuarial costs + Solvability buffer + Raise	-
< 87.42% Nominal	Actuarial costs + Solvability buffer + Raise	Payment by sponsor

For setting the contribution rate in the model, rules laid down by the supervisory institution DNB can be applied. The base of the contribution rate is the amount needed to pay for newly accrued benefits, the so called actuarial costs. These were defined in the previous chapter. Furthermore, the contribution rate includes a solvability buffer. This buffer is set in the same way as the solvability buffer for the funding ratio. It makes sure the probability that paid contributions will be insufficient for newly accrued benefits within one year is 2.5%. Again, the only risk factor is investment risk and like for the funding ratio, the solvability buffer is thus 27.35%. This percentage is added to the actuarial cost level. If the contribution rate provides some payment for indexation, this should be included as well. However, it is assumed that in this pension contract no provision for indexation is given. Furthermore, operational costs should be included in the contribution rate (DNB, 2007). For the current model, this would require information with respect to whether operational costs are different in a CDC. Since the structure of both contracts is very similar, they are assumed to be equal and thus operational costs are left out of consideration. Hence, only the actuarial costs of new rights and a solvability buffer are included. Together, they form the cost covering level of the contribution rate for the pension fund. However, as stated before, the contribution rate may be increased or decreased depending on the funding ratio.

The opinion that pension funds should always strive to maintain the real value of given rights is a widely recognized one. Hence, as long as the real funding ratio is below 100%, a raise will be given on top of last year's contribution rate. As long as the real funding ratio is between 100% and 105%, the funding ratio is at least at the base level, the cost covering contribution rate. Whenever the real funding ratio exceeds 105%, a discount can be given on last year's contribution rate. Since large shocks to the contribution rate are generally prevented within pension funds as it has to be negotiated between stakeholders, a maximum annual contribution rate of 2% is chosen. The contribution rate adjustment rules are set as follows:

Contribution rate + (percent point) = (Nominal $FR^{100\% \text{ Real}}$ – Nominal FR^{current})*0.5 → Max 2%
Contribution rate – (percent point) = (Nominal FR^{current} – Nominal $FR^{105\% \text{ Real}}$)*0.5 → Max 2%

Hence, last year's contribution rate is raised by 0.5 percentage point for each percentage point the funding ratio is below the nominal funding ratio that corresponds to a 100% real funding ratio. Last year's contribution rate is decreased with 0.5 percentage point for each percentage point the funding ratio is above the nominal funding ratio that corresponds to a 105% real funding ratio. These outcomes are subject to the set maximum change of 2%. The only exception is when the real funding ratio falls below 105%. In this case, a minimum contribution rate applies and the contribution rate can jump back to cost covering level. This prevents the contribution rate from increasing too slowly when pension fund performance suddenly goes down. A maximum is also applied to the contribution rate, to prevent outrageous levels. The maximum is set at 20%. This level is reasonable since the pension contract only involves an old age pension, without any additional provisions like early retirement and a widow pension.

Lump sums need to be paid whenever the pension fund is facing severe distress. When exactly this is the case needs to be defined, however. FTK regulations are applied here as well. They determine the pension fund has to be able to return to a nominal funding ratio of 105%, using reasonable assumptions, within 3 years. The expected asset mix return, equal to 6.3%, is then used to set the funding ratio underneath which additional lump sum payments will be required:

Lump sum payment level: 105% - (1+expected return) ^ 3 = 87.42%

Whenever the funding ratio is below this level, the sponsor company will pay as much extra funds as needed to get the pension fund back to this minimum level. It may however also be the case that the pension fund is doing extremely well and the employer decides to draw funds from the pension fund. It is hard to determine what is a reasonable boundary funding ratio level for this, since there are no rules for this, except of course the funding ratio should satisfy solvability requirements. In the simulation model, the funding ratio for funds withdrawal is set at a real funding ratio of 120%, since this will leave the pension fund with sufficient funds to meet the discounted value of future accrued rights as well as future indexation. Whenever the real funding ratio exceeds 120%, the employer may draw funds from the pension fund up until the point where the real funding ratio is back to 120%. What is important to note is that this will only take place after full indexation and catch up indexation are given. Funds withdrawal is based on a recalculated funding ratio after indexation and catch up indexation.

3.4.4 CDC adjustments

As explained in the beginning of this chapter, two main elements will be adjusted to turn the pension contract into a CDC scheme. First, the contribution rate can no longer be adjusted to the funding ratio. Furthermore, the contribution rate has to be set for at least a 5-year period. Second, additional lump sum payments and funds withdrawal from the pension fund by the sponsor is no longer allowed. Rules for nominal right cuts will have to take their place. These explicit rules for nominal right cuts without the possibility of the sponsor preventing them make nominal rights conditional as well. CDC contract adjustments will be specified in this paragraph.

Contribution rate

The base for the contribution rate is again the cost covering level, which includes actuarial costs and a solvability buffer, like in the DB contract. DNB guidelines for CDC pension funds state a component should be added to the cost covering level to compensate for possible changes in the cost covering level of the contribution rate. Factors that may raise this level are increased longevity, a lower discount rate, changes in the population structure, a different asset mix risk and changes of the pension contract. However, all these factors have been fixed in the current model. Hence, no such extra component is required. Furthermore, the contribution rate could be increased to compensate for the higher risk for participants in a CDC, so that they obtain a higher buffer than only the required solvability buffer in the cost covering level. Such a premium will not be given in the simulation model, since it would interfere with the exact purpose of the analysis. This is to analyze the risk transfer that is involved for participants when the average pay DB contract is turned into a CDC contract. By bringing additional changes to the CDC contract that compensate for this risk transfer, results will be biased. Furthermore, as long as the risk transfer is not specified, there is no way to specify what risk premium would be appropriate. This kind of information is exactly what could be derived from the results of the simulation model. In a CDC contract, the contribution rate can be recalculated every 5 years to check if it is still sufficient. Since the cost covering rate is stable in the current model, this re-evaluation of the contribution would in effect not be needed. The CDC contribution rate in the model is given by:

CDC contribution rate = actuarial costs + solvability buffer → Only calculated every 5 years

Nominal right cuts

While in the average pay DB the employer will provide additional funds when the funding ratio is so low that short term recovery to a 105% nominal funding ratio can no longer be assumed, in the CDC this can not be the case. Also, funds withdrawal by the employer is not allowed in a CDC. Hence, in the CDC model rules for lump sum transfers are eliminated. They are replaced for rules that implement nominal right cuts in case of severe underfunding, as well as rules for compensating for previously cut rights. These rules are presented in the table below.

Funding ratio	**Nominal Rights**
> 127.35% Nominal	Symmetric right recovery
< 87.42% Nominal	Symmetric right cuts

Since the CDC fund has the same asset mix as the average-pay DB fund, the funding ratio at which action has to be taken, according to FTK rules, to prevent it from falling further is the same. In case of a CDC, this action is nominal right cuts. This cut will be implemented symmetrically over all participants. Hence, all participants will have an equal share of their benefits cut. Rights will be cut as much as needed to get the pension fund back to the nominal funding ratio of 87.42%. Whether right cuts should be implemented symmetrically is a very widely discussed topic with convincing arguments on both sides. The only CDC fund that has set guidelines for cutting nominal benefits is SNS Reaal. They have chosen for symmetric right cuts in case they should be needed. The motivation for this, as given by pension fund director Mariëtte Simons, is that while younger participants have more time to get compensated for cuts during better times, at the same time the effect of a right cut accumulates over time. If it takes a long period for the pension fund to recover and compensate for previously cut rights, this severely hurts the general accumulation of retirement income for the young.

Compensation for previously cut rights will start when the pension fund no longer has a solvability buffer shortage. This implies the pension fund is no longer in recovery according to FTK rules. This compensation is applied symmetrical for all participants as well. Previously cut rights will than be accrued back to individuals as much as possible without sending the pension fund back into a solvability buffer shortage. Compensation for previously cut rights is thus implemented before catch up indexation and even before full indexation for the current year. The motivation for this is exactly the fact that the longer it takes to compensate for cut rights, the more participants will miss out on indexation on these rights as well, and hence the nominal right cut actually keeps on growing when the pension fund is recovering. However, it would be irresponsible to start compensating before the pension fund is out of the solvability buffer shortage. This would make the risk of sending the pension fund right back into financial distress too large.

3.5 Output

The simulation of risk factors combined with the input population and specified pension contracts will produce a large source of data for further analysis. This output will be described in the following paragraph and can be divided into three main categories: Costs, assets and liabilities.

3.5.1 Costs

The simulation model will determine contribution rates and lump sums paid by the employer for each simulation year. The cost output provides information on for example average costs, cost volatility and probability of lump sums for the employer. While the analysis will focus on the participants' outcomes, the output for costs can still provide a better picture of the trade off of risks involved between participants and the employer.

3.5.2 Assets

The accumulation of assets is directly related to the simulation output of the investment risk. Assets are also influenced by liabilities and costs. Liabilities create the amount of actual benefits, which are paid out of assets. Contributions as well as lump sums are added to the assets. While the output for assets does not have a meaning for the pension fund on its own, it is a main determinant of the funding ratio.

3.5.3 Liabilities

The output most important to the following analysis is liabilities. Liabilities show what matters to participants, namely accrued benefits. From the total of liabilities, liabilities for specific (groups of' participants) can easily be derived to obtain more meaningful results in terms of retirement income. In particular retirement income volatility and the downside risk involved will be of importance.

The various types of output are closely linked to each other and provide a great source of information on the interactions between risks, rules and results. Through this, many insights in the functioning of pension funds can be obtained. This great source of information thus brings along the need to narrow down what results will be taken from the simulation analysis. This specification of the data analysis will be presented in the following chapter.

4. Data analysis description

The model described in the previous chapter provides a powerful tool for comparing the average pay DB scheme to a CDC scheme. This chapter will explain how the model is applied to the research questions to obtain useful data for providing answers, as well as describe the analysis applied.

4.1 Programming the simulation model

The model presented above was programmed into the statistical computing program "R". In order to obtain useful results from the simulation model, the simulation has to run over a long term time span. Pension funds hold liabilities that mature over decades of time and so their evaluation period when looking ahead should span decades as well. The simulation period is set at 40 years, which is the normal duration for a full career over which nominal rights are accrued.

For results to be valid, a reasonable quantity of scenario simulations for each specified pension contract needs to be set as well. If the amount of scenarios used for analysis is too low, results may be significantly different between scenario simulations. Obviously, no reliable results can be based on such outcomes. Test runs of the model showed output for 1,000 simulations was still too volatile. Output for 10,000 scenario simulations proved to be sufficiently stable. Hence, for each simulation specification 10,000 scenario simulations were obtained from the computing program.

4.2 Scenario simulations

The simulation model presented in the previous chapter can be adjusted in several ways to obtain the data needed for answering the research questions. Input can be changed, as well as elements in the pension contract itself, which is the core of the model. The various scenario simulations applied and how they help answering the research questions will be clarified in this paragraph.

Base simulation

The first two scenario simulations will serve as a reference for output from following simulations. They are simulations of the average pay DB and CDC model as described in the previous chapter. In these scenario simulations the start level of assets, which was not determined yet, is set such that the start real funding ratio of the model is 100%. The corresponding nominal funding ratio is approximately 149%. Both the nominal and real value of accrued benefits is thus covered. In this case, the pension fund is completely healthy and at its target position, since its position is in line with its ambition to maintain the real as well as the relative welfare of accrued benefits. The analysis of the output from these scenario simulations will provide some basic information related to the main research question:

What does a transition from an average-pay DB scheme to a CDC scheme mean for participants in terms of their risk position and outcomes?

Contract elements

When moving from average pay DB to CDC, the two changes in the pension contract are fixing the contribution rate and replacing lump sum transfers with nominal right cuts in case of severe financial distress. Sub-question 1 to the main research question proposed to separately analyze differences between the average pay DB and CDC contract:

Sub-question 1: What risk transfers are involved in specific elements of the CDC contract?

The next step is thus to perform two additional scenario simulations. In the first one, an average pay DB in which the contribution rate is fixed and lump sum transfers remain is simulated. In the second one, an average pay DB in which lump sums are abandoned and the contribution rate remains flexible is simulated. This provides additional insights in the separate as well as the combined effect of these two contract changes

Compensating strategies

As noted before, since a larger share of risk is carried by participants in a CDC, the pension fund may attempt to reduce the risk involved or to compensate for this. Evaluation of such strategies is related to sub-question 2:

Sub-question 2: What tools are most effective in compensating for the riskier position of participants?

Since the simulated risk in this analysis is solely investment risk, it is easy to choose this risk by changing the asset mix. Thus, a scenario simulation will be executed that applies a lower risk asset mix to the CDC fund. This asset mix will be composed as follows:

	Average Return (nominal)	**Average Return (real)**	**Standard Deviation**	**Mix Share**
Bonds	4.5%	2.5%	8.8%	80% (base: 50%)
Stocks	8.3%	6.3%	25%	15% (base: 40%)
Real Estate	7.3%	5.3%	15%	5% (base: 10%)
Asset Mix	*5.63% (base: 6.5%)*	*3.63% (base: 4.5%)*	*11.05% (base:13.95%)*	

A natural implication of this change in the asset mix is that the required solvability buffer will be lower.

Solvability buffer: $t(P<0.025)*\sigma_{mix}$= 21.58% (base: 27.35%)

This implies the fixed contribution rate will be lower, as the solvability buffer needed is lower. The funding ratio at which nominal right cuts will be needed is higher, since expected recovery will be slower. However, since the solvability buffer is lower, the funding ratio at which compensation for nominal right cuts start is lower as well

Nominal right cut level: 105% - (1+expected return) ^ 3 = 91.31%

Nominal right recovery level: 100% + Solvability buffer = 121.58%

A technique to compensate for the risk transfer to participants that is generally deemed appropriate and applied by pension funds moving to CDC is a lump sum transfer at the point of transition. The effect of this is a higher start funding ratio for CDC. The effect of this tool is evaluated by a scenario simulation of a CDC fund with a start nominal funding ratio of 180%. While this lump sum is rather arbitrary, it does provide a general idea of the effects of a lump sum transfer. With smaller or larger transfers, these effects will simply be more or less pronounced. The evaluation of both risk compensation strategies will be aimed at judging whether either one can provide sufficient reduction of risk for participants.

Sensitivity analysis

In order to test whether results from the analysis are not a product of the input itself, the assumed start funding ratio as well as the population are adjusted to check for any changes this may bring in the results. This applies to sub-question number 3:

Sub-question 3: What internal and external factors influence the size of the risk transfer?

The external factor that may change the input of the simulation model is the start funding ratio. Bad pension fund performance may motivate employers to move to CDC, as during bad periods costs of running a DB may be significantly higher. Low funding ratios also correspond to the situation pension funds are currently facing, which makes this separate analysis even more interesting. Thus two extra scenario simulations are applied for both a DB and a CDC with a low start funding ratio of 105%.

The internal factor changing the input of the simulation model is the population structure. For this, the uniform spread of participants over age groups assumed in the base simulation is adjusted. Instead, a grey population structure as well as a green population structure is set up and they are applied to scenario simulations for both the DB and CDC contract. The total number of active participants remains the same as in the base population structure. The population flow rates between population status groups remain the same as well. Inactive and retiree quantities are then adjusted so that the population remains stable during the simulation period. The population structures for both the grey and the green pension fund are displayed in the tables below:

Grey population:

Age group	Active	Inactive	Retired
25-34	2		
35-44	6	1	
45-54	17	4	
55-64	25	11.5	
65-74			37.5
75-84			18.75
Total	*50*	*16.5*	*56.25*

Green population:

Age group	Active	Inactive	Retired
25-34	22		
35-44	15	11	
45-54	8	18.5	
55-64	5	22.5	
65-74			27.5
75-84			13.75
Total	*50*	*42*	*41.25*

Additionally, the differences in the risk transfer for various age cohorts will be discussed. For this, no additional scenario simulations are required. Age cohort effects can be analyzed in the base simulations of Db and CDC.

4.3 Variable selection

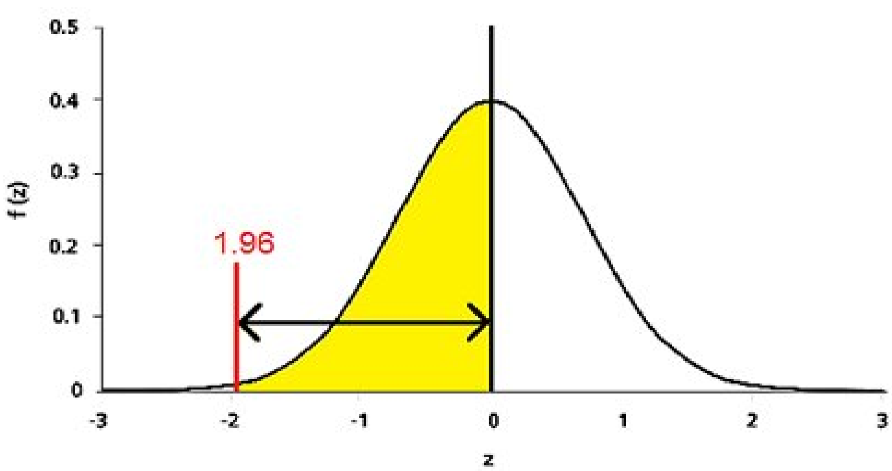
The described scenario simulations produce a great source of output data. Therefore, this paragraph will clarify what data will be selected from the pool and used for further analysis. Evaluating the situation of an individual who has spent a full career in this particular pension fund will provide the most complete picture of the risk transfer when moving from DB to CDC. The simulation period is 40 years, which is the length of a full career. A person who spent a full career under the average pay DB or CDC contract will be 64 (turning 65) at the end of the simulation and will be at the point of retirement. For the analysis the participants' perspective is taken and what matters to participants is their retirement income. Hence, the main output for further analysis will be based on the distribution of retirement income for a 65 year old participant at who spent a full career in the pension fund, exactly during the period of simulation. This output corresponds with the analysis by De Haan (2008), who analyzed wealth accumulation for retirement under DC over a 40-year full career period. Comparability with results from this research will extend the results of the current analysis to comparability of CDC with DC as well. Retirement income will be given as a percentage of final wage, since this replacement rate is meaningful to the participant in terms of both the real value of income as well as in terms of relative welfare level. For this purpose, social security benefits from the first pillar will be added to the pension funds' outcome as well.

Distribution graph

Output results will first be displayed by graphing the probability distribution of the replacement rate at age 65. Such a distribution will give a general picture of volatility, upside and downside risk. The skewness and standard deviation of the distribution will be given as well to describe the distribution numerically. The standard deviation indicates how widely outcomes are distributed around the mean, whereas the skewness provides information about the position of the mass of the distribution with respect to the mean.

Certainty benchmark

The certainty benchmark is the replacement rate of final wage at age 65 that will be obtained with 97.5% certainty for each scenario simulation. It can be derived by obtaining the 2.5% quantile from the replacement rate distribution. This method for measuring risk is derived from the value-at-risk method that is often used by financial analysts to present a single measure for indicating risk at a certain benchmark level (Linsmeier and Pearson, 1996). The graph below illustrates the concept using a standard normal distribution, where the arrows represent value at risk. However, any other distribution may be applied to derive value-at-risk.



In the current case of retirement income risk, all retirement income that may be obtained above the 97.5% certainty benchmark level is the "value-at-risk" for participants, since this income is obtained with less than 97.5% certainty.

A general target for average pay DB schemes in the Netherlands is to provide 70% of final wage with 97.5% certainty. For each scenario simulation, the obtained probability for receiving less than 70% of final wage will be obtained. Furthermore, probabilities for the best case scenario (obtaining fully indexed benefits), for obtaining less than 80%, 60% and 50% of final wage will be given. This provides an additional illustration of income certainty levels obtained, apart from the certainty benchmark presented above.

Certainty factor

The certainty factor was also applied in the analysis of DB versus DC by De Haan (2008). He used the general target for income certainty in a DB scheme (97.5% chance for 70% of final wage) and calculated how much contributions would have to be increased in a DC, by analyzing by what factor the DC outcome distribution would have to be shifted, to match the DB benchmark outcome at the 97.5% certainty level. A similar approach will be taken in the current analysis to compare pension contracts. By dividing the 2.5% quantiles of benefit level distributions from different scenario simulations, the distribution shift needed to place them both at the same 97.5% certainty level will be obtained. This certainty factor represents the cost increase needed to provide equal income security at the 97.5% certainty level in both schemes. Hence, to find out what cost increase is needed in the base simulation of CDC to obtain the same income with 97.5% certainty as in the base simulation of DB, the calculation is:

Certainty factor = 2.5% quantile income level base DB / 2.5% quantile income level base CDC

In this calculation, only income from the actually obtained pension fund should be considered, hence social security benefits are left out of consideration.

This certainty factor then has an interesting implication. The only costs involved in the CDC assumed so far is the amount of fixed contributions, based on the cost covering level. No lump sums or risk premiums on the contribution rate are incorporated. Since the certainty factor reflects the cost increase needed in the CDC, it exactly corresponds to the contribution rate increase needed to compensate for the risk transfer when moving from average pay DB to CDC, assuming the benchmark is to provide equal certainty at the 97.5% level.

Downside trade off: Lump sums versus nominal right cuts

The worst case scenarios cause additional lump sum payments in the average pay DB scheme, while in the CDC they cause nominal right cuts. This causes a very black-and-white difference between who bears the very bottom of downside risk in the average pay DB versus the CDC. It is in these scenarios that the greatest conflict of interests between employers and participants will arise. Employers will not like to pay great lump sums into a

DB fund, or simply not be able to, and perhaps try to cut some nominal rights as well. Participants are likely to protest heavily against nominal right cuts and may try to obtain sponsor support anyway in a CDC. Hence an important result will be how often such scenarios appear in different pension contracts. Thus, for each scenario simulation, data on the probability of lump sum payments and nominal right cuts is presented. Given the potential for crisis, the probability of such events has high importance.

The data output described in this paragraph was obtained for all the scenario simulations described in the previous paragraph. These results are presented in the next chapter.

5. Results

From the scenario simulations the results described in the previous chapter were derived. They will be presented as well as clarified in this chapter.

5.1 Base simulations

The base scenario simulations are structured as follows:

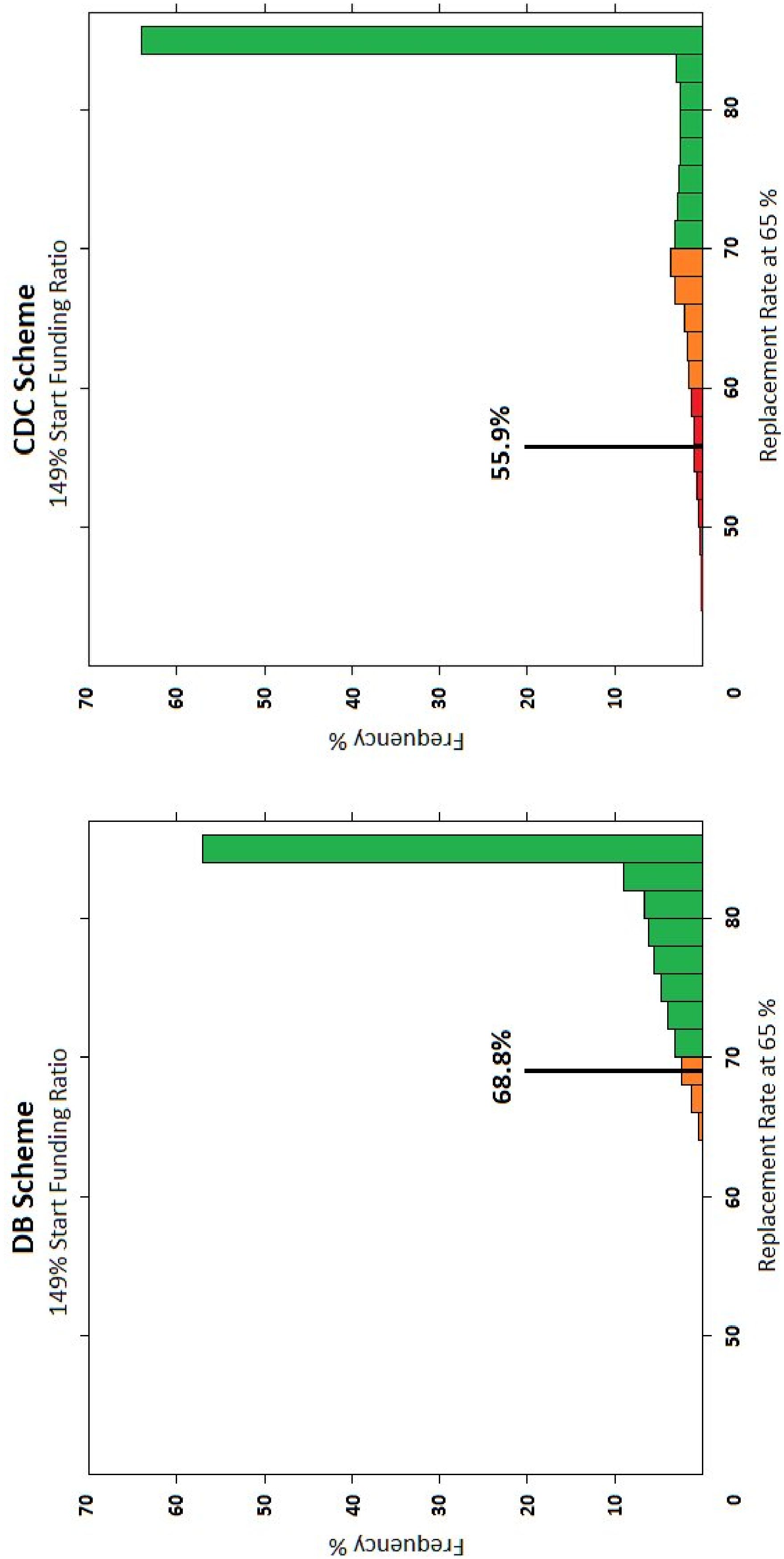
Base Simulations	**Scenario Simulation 1**	**Scenario Simulation 2**
Asset Mix	50% Bonds 40% Stocks 10% Real Estate	50% Bonds 40% Stocks 10% Real Estate
Start Funding Ratio	100% Real	100% Real
Population	Standard	Standard
Pension contract	DB (Average Pay)	CDC (Average Pay)
Indexation	Conditional	Conditional
Contribution	Flexible	Fixed
Lump Sums	Yes	No
Nominal right cuts	No	Yes

Distribution graph

In figure 1 the distribution graph for the replacement rate of final wage at age 65 after a full career in scenario simulation 1 and 2 are displayed.

Both graphs have large peaks on the right side. These peaks represent the optimal outcome for participants from participating in the pension scheme. The maximum participants can obtain is full benefit accrual with wage indexation. This results in a replacement rate of approximately 85%. Both in a DB and in a CDC, indexation above wage indexation is not possible. It is immediately clear that the peak is much higher for the CDC scheme. However, the spread of possible outcomes is much larger as well and more outcomes are at the downside of the distribution. The lowest possible outcome for the DB simulation is nominal rights without indexation, since lump sums provide guarantees for nominal rights. However, in the CDC the outcome can be lower through nominal right cuts. A small peak can be seen in the middle of the CDC distribution. The peak is caused by the fact that there is a gap between the funding ratio at which indexation is no longer applied (105% nominal) and the funding ratio at which nominal right cuts are applied (87.42% nominal). Hence, the peak consist of outcomes representing only nominal rights or nominal rights with little indexation.

Figure 1. Distribution of replacement rate of final wage at age 65 after a full career. Base Db and CDC



The table below shows the standard distribution and skewness of both scenario simulations as indicators for the distribution.

	DB (Base simulation)	CDC (Base simulation)
Standard deviation	5.19%	9.08%
Skewness	-1.32	-1.54

The base simulation DB gives a replacement rate of 68.8% with 97.5% certainty, which is very close to the general standard of 70% for a DB scheme. The CDC is far below this target by providing only a 55.9% replacement rate with 97.5% certainty. The distribution graph also presents the position of the certainty benchmarks. As explained before, all outcomes to the right of the certainty benchmark in the graph present the value-at-risk for participants. Certainty levels for various replacement rates are displayed below.

Replacement Rate	DB (Base simulation)	CDC (Base simulation)
Max	40.7%	59.4%
< 80%	27.3%	30.5%
< 70%	4%	16.9%
< 60%	0%	4.7%
< 50%	0%	0.58%

The row titled “max” represents the probability for obtaining the optimal outcome, represented by the peak in the distribution graph. It represents obtaining full indexation with wage inflation on all accrued benefits, which, as stated before, implies a replacement rate of about 85%. The probability for obtaining the best case scenario is much higher in the CDC simulation. However, income security levels at the presented target levels are actually lower, which presents a good reflection of the increased risk for participants. While the best case scenario is 18.7 percentage points more likely to occur, the target replacement rate of 70% is 12.9 percentage points less likely to occur. Even a target replacement rate of 80%, which is only slightly below the maximum level of 85% is already less likely to occur in the CDC than in the DB simulation.

Certainty factor

The certainty factor shows by what factor the income distribution from the CDC simulation should be shifted to provide the same income security as the DB simulation at the 97.5% certainty level. It should be noted that the value of the certainty factor highly depends on the chosen certainty level of 97.5%. This level is chosen since it is generally applied for certainty evaluation by pension funds and pension fund regulations like FTK. Furthermore, it makes the current results comparable to earlier work by De Haan (2008).

Certainty factor	
Base simulation	1.41

This certainty factor implies it is 41% more expensive to provide the same income security at the 97.5% certainty level in the simulated CDC than in the DB simulation. Hence, the fixed contribution rate should be increased by 41%.

To illustrate the sensitivity of this certainty factor to the exact evaluation point chosen, if the certainty factor would be calculated for matching income certainty in the DB and CDC simulations at the 98% certainty level, the certainty factor would be 1.46. If it would be calculated at the 97% certainty level, the certainty factor would be 1.38.

Lump sums and nominal right cuts

The table below shows the probability for additional lump sum payments and nominal right cuts in the simulated DB and CDC, respectively.

	DB (Base simulation)	**CDC (Base simulation)**
Lump Sums	1.84%	-
Nominal right cuts	-	2.95%

The probability for lump sum payments of 1.84% corresponds to once every 54.3 years. The probability for nominal right cuts of 2.95% corresponds to once every 33.9 years. These numbers show that the fixed contribution rate in a CDC causes nominal rights cuts in a CDC to be more likely than lump sum payments in a DB. When moving from the DB to the CDC scheme without a risk premium on top of the contribution rate, a 1.84% chance of lump sum payments by the employer is traded for a 2.95% chance of nominal right cuts.

While in the current DB simulation an employer who can afford any lump sum payment is considered, it may be interesting to take a look at the size of lump sums well. By adding up costs for contributions and lump sums and translating them into a total cost rate, the probabilities for the sum of contributions and lump sums in terms of percentage of salary can be obtained. This provides information on the probability that a sponsor with a limited capacity to pay additional costs will have to default on the nominal rights. The table below shows probabilities for total costs to exceed a certain percentage of total salary, including corresponding average frequencies.

Total costs (% of salaries)	**> 25%**	**> 30%**	**> 50%**	**> 100%**
Probability	1.52%	1.26%	0.54%	0.03%
Frequency (nr. of years)	65.8	79.6	217.4	3333.3

The lump sums represent all costs above 20%, since the contribution rate will be at its maximum when lump sum contributions have to be made. Total costs amounting at least 25% of total salary (5% of salary lump sum) occur with a probability of 1.52%, which translates to once every 65.8 years on average. Total costs above 30% of total salary (10% lump sum) occur with 1.26% probability, which translates to once every 65.8 years. Total costs amounting at least 50% of total salary (30% lump sum) occur with a probability of 0.54%, which translates to less than once in 200 years. Very extreme values for lump sums (total costs over 100% of total salaries) make up only a small share of the distribution and hence will not exert much influence on outcomes from the analysis.

As a comparison, the table below presents sizes and corresponding probabilities for nominal right cuts. It is important to note that the size is given as a percentage of total liabilities. These liabilities are much larger than the total annual salary sum.

Nominal right cuts (% of liabilities)	**> 3%**	**> 5%**	**> 8%**	**> 10%**
Probability	2.15%	1.72%	1.19%	0.94%
Frequency (nr. of years)	46.5	58.1	84	106.4

A nominal right cut of at least 3% occurs with a probability of 2.15%, corresponding to once every 46.5 years. It is striking that a nominal right cut of more than 5% of liabilities has a higher probability than a lump sum payment of 5% of total salary. However, cuts above 10% of liabilities are very uncommon and less likely than lump sum payments above 10% of total salaries.

5.2 Contract elements

The following two scenario simulations will represent a DB contract that is adjusted so that the contribution rate is fixed, as well as a DB contract in which lump sum payments are replaced by nominal right cuts. These scenario simulations are structured as follows:

Contract Elements	**Scenario Simulation 3**	**Scenario Simulation 4**
Asset Mix	50% Bonds 40% Stocks 10% Real Estate	50% Bonds 40% Stocks 10% Real Estate
Start Funding Ratio	100% Real	100% Real
Population	Standard	Standard
Pension contract	DB Fixed Contribution Rate	DB No Lump Sums
Indexation	Conditional	Conditional
Contribution	Fixed	Flexible
Lump Sums	Yes	No
Nominal right cuts	No	Yes

Distribution graph

In figure 2 the distribution graphs for the replacement rate of final wage at age 65 after a full career in scenario simulation 3 and 4 are displayed.

The distribution graphs show rather different effects on the distribution for fixing the contribution rate and replacing lump sum payments with nominal right cuts. When only the contribution rate is fixed, the guarantee on nominal rights remains. Hence, nominal rights are guaranteed. However, volatility in between the worst case scenario and best case scenario increases sharply. This is reflected by the higher standard deviation and lower skewness compared to the DB base simulation (see table below). When lump sums are replaced with nominal right cuts, all accrued rights become conditional like in a CDC. Hence, the distribution has a longer tail to the downside. However, flexibility of the contribution rate causes the tail of the distribution to be smaller than in the base CDC simulation. The peak for a DB without lump sums is even larger than for the CDC, since the contribution rate increases when the pension fund is underperforming, which helps to keep results on the upside of the distribution. This large peak causes skewness to be extremely high for the DB without lump sums. Standard deviations and skewness for both scenario simulations are displayed in the table below.

	DB Fixed Contribution Rate	**DB No Lump Sums**
Standard deviation	6.94%	5.68%
Skewness	-0.614	-2.3

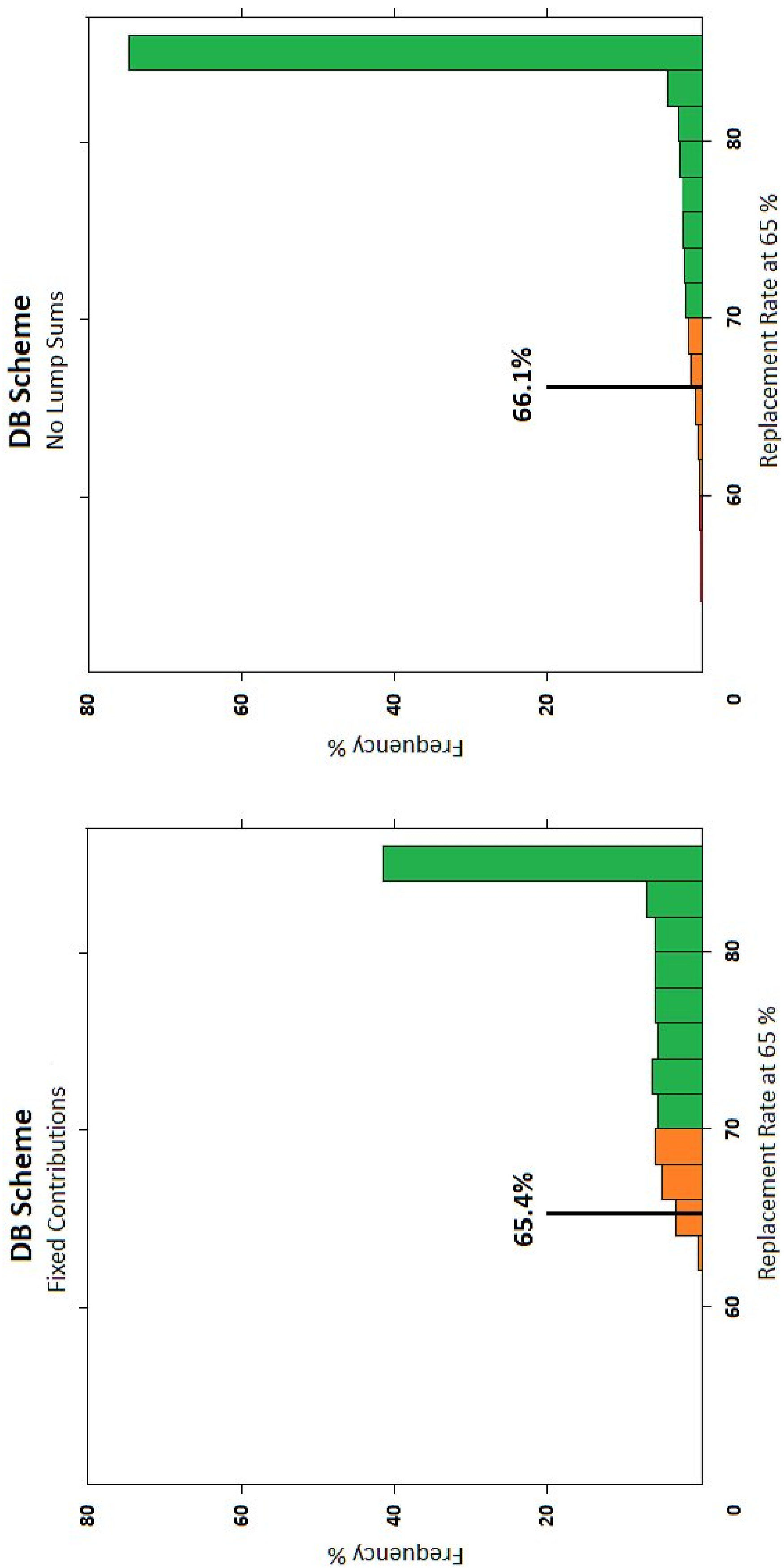
Certainty benchmark

The replacement rates of final wage that will be obtained with 97.5% certainty are displayed in the table below.

	DB Fixed Contribution Rate	**DB No Lump Sums**
Certainty benchmark	65.4%	66.1%

Even though nominal right guarantees are maintained when the contribution rate is fixed and not when lump sums are abandoned, the replacement rate that is obtained with 97.5% certainty is still higher in the DB simulation without lump sums than in the DB simulation with fixed contributions. This is a remarkable result and indicates that flexible contributions may be more important for improving income certainty than lump sum payments providing nominal guarantees. Both certainty benchmarks are also much closer to the DB outcome from the base simulations than to the CDC outcome.

Figure 2. Distribution of replacement rate of final wage at age 65 after a full career: DB fixed contribution rate and DB no lump sums



The table below presents certainty levels for various replacement rates.

Replacement Rate	**DB Fixed Contributions**	**DB No Lump Sums**
Max	29%	66.9%
< 80%	45.3%	17.9%
< 70%	15.1%	5.6%
< 60%	0%	0.64%
< 50%	0%	0%

While the DB simulation with fixed contributions has a guarantee for nominal rights, the probability of receiving less than 70% replacement rate is close to the level of the base CDC simulation. The chance for the best case scenario to occur is however much lower than in both the base DB and CDC scenario simulations. In the DB simulation without lump sums probabilities are close to the level of the DB base scenario simulation, except for the probability for the best case scenario, which is much higher. The probability for obtaining a replacement rate below 80% is also still below the base DB level. The probability of obtaining a replacement rate below 60% is only 0.64%, and over 10,000 simulations not a single one resulted in a replacement rate below 50%. Hence, the DB simulation without lump sums very clearly outperforms the base CDC simulation.

The relatively high performance of the DB without lump sum transfers raises the question whether this may be caused by very high costs. Like in the DB base scenario simulation, the contribution rate can be 20% maximum. The fixed contribution rate in the CDC simulation, which is the cost covering level in the DB simulations as well, is 12.358%. So there is still plenty of room for the average DB contribution rate to be much higher. However, the average contribution rate over all simulations of the DB without lump sums is only 11.16%, even below the cost covering level paid in the CDC simulation. Hence, a large gain in retirement income security for participants is caused by higher cost volatility for the employer, not higher costs in general.

Certainty factor

The certainty factors for both schemes are set by calculating how much the distribution of retirement income in both scenario simulations would have to be shifted to match income security at the 97.5% certainty level in the DB base scenario simulation. This reflects a shift from the base DB to the DB with a fixed contribution rate or the DB without lump sum transfers.

Certainty factor	
DB Fixed Contribution Rate	1.083
DB No Lump Sums	1.066

The certainty factor shows both schemes are relatively close to the DB base simulation level. As expected, the difference is smaller for the DB without lump sums. Hence, fixed contributions make up a larger share of the risk transfer when moving from DB to CDC than the elimination of lump sums. What is however particularly interesting to see is that the certainty factor in the base simulation, which is 1.41, is larger than the sum of the certainty factors for both elements that turn a DB contract into a CDC contract. Hence, the major part of the risk transfer is caused by the combination of fixing the contribution rate and eliminating lump sums, rather than by their separate effects. When the pension funds' performance is low, the combined facts that the contribution rate will not increase and lump sum transfers will not occur makes results fall much lower.

Lump sums and nominal right cuts

When facing an extremely low funding ratio, lump sum payments are required in a DB with a fixed contribution rate and nominal right cuts will be needed in a DB without lump sums. The chance of either one occurring is given in the table below.

	DB Fixed contributions	**DB No Lump Sums**
Lump Sums	3.74%	-
Nominal right cuts	-	1.39%

The probability that the sponsor will have to make extra lump sum payments in the DB simulation with fixed contributions is 3.74%, which corresponds to once every 26.74 years on average. This probability is significantly higher than in the DB base simulation, where the probability was 1.84%. This is of course related to the fact that the contribution rate is not adjusted upward to prevent the funding ratio from decreasing to a very low level at which lump sums are needed. The probability of lump sum payments is higher in the DB with a fixed contribution rate than the probability for nominal right cuts in the CDC, because lump sum transfers to the employer are possible as well. Thus, in a CDC higher buffers can be built up against bad times than in a DB with a fixed contribution rate.

A similar reasoning applies to why the probability for nominal right cuts is lower in the DB simulation without lump sums than the probability for lump sum payments in the DB base simulation. In the DB without lump sums, the fact that there are also no transfers to the employer allows for the pension fund to build up larger buffers. The flexibility of the contribution rate obviously explains why the probability for nominal right cuts in the DB simulation without lump sums is lower than in the base CDC simulation. The probability for nominal right cuts here is 1.39%, which corresponds to once every 71.9 years. Like for the DB base simulation, a table will be presented to show the likelihood of certain total cost rates for the DB with fixed contribution rates. In this case, any total cost percentage above 12.358% represents lump sums. However, to maintain comparability with previous results, the percentages shown in the table will remain constant. How the probabilities translate in average frequency is shown as well.

Total costs (% of salaries)	**> 25%**	**> 30%**	**> 50%**	**> 100%**
Probability	2.39%	1.96%	1.27%	0.03%
Frequency (nr. of years)	41.8	51	78.7	3333.3

The table shows high total cost rates are more common in the DB simulation with a fixed contribution rate than in the base DB simulation. The probabilities of costs exceeding 25, 30 and 50% of total salary are between 0.7 and 0.9 percentage point higher in the DB simulation with fixed contributions. The table below shows probabilities for certain sizes of nominal right cuts in the DB simulation without lump sums.

Nominal right cuts (% of liabilities)	**> 3%**	**> 5%**	**> 8%**	**> 10%**
Probability	0.98%	0.77%	0.49%	0.37%
Frequency (nr. of years)	102	129.9	204.1	270.3

Probabilities for any sizeable nominal right cuts are extremely small in the DB simulation without lump sums. Comparing these outcomes to probabilities derived for the base CDC simulation, it shows again that income security is much higher in the DB without lump sums than in the CDC.

5.3 Compensating strategies

The first paragraph of this chapter showed that the risk transfer to participants when moving to CDC is rather high. Therefore, it makes sense to look for opportunities to reduce this risk transfer. Two methods were proposed: a lump sum transfer at the point of the transition which causes the start funding ratio of the fund to increase and reducing the risk in the asset mix. The two new scenario simulations are summarized in the table below.

Compensating Strategies	**Scenario Simulation 5**	**Scenario Simulation 6**
Asset Mix	50% Bonds 40% Stocks 10% Real Estate	80% Bonds 15% Stocks 5% Real Estate
Start Funding Ratio	180% Nominal (+/- 120% Real)	100% Real
Population	Standard	Standard
Pension contract	CDC Lump Sum Transfer	CDC Low Risk Asset Mix
Indexation	Conditional	Conditional
Contribution	Fixed	Fixed
Lump Sums	No	No
Nominal right cuts	Yes	Yes

Distribution

Simulated distributions for the replacement rate of final wage at age 65 in scenario simulation 5 and 6 are graphed and displayed in figure 3.

The distribution for the CDC simulation with a higher start funding ratio is similar to the distribution with a 100% real start funding ratio. However, the peak is clearly higher and the mid-range of the distribution is flatter. However, the worst case scenario does not seem to have improved much. This is reflected by the lower standard deviation and higher skewness than in the CDC base scenario simulation (table below). In the CDC simulation with a low risk asset mix, the worst case scenario has not improved much either. Furthermore, in this particular scheme, the peak is actually lower and volatility in between has increased too. This is shown by the higher standard deviation and lower skewness in the table below.

	CDC Lump Sum Transfer	**CDC Low Risk Asset Mix**
Standard deviation	7.95%	9%
Skewness	-2.05	-0.89

Certainty benchmark

The table below shows for both CDC simulations the replacement rate of final wage that will be obtained with 97.5% certainty.

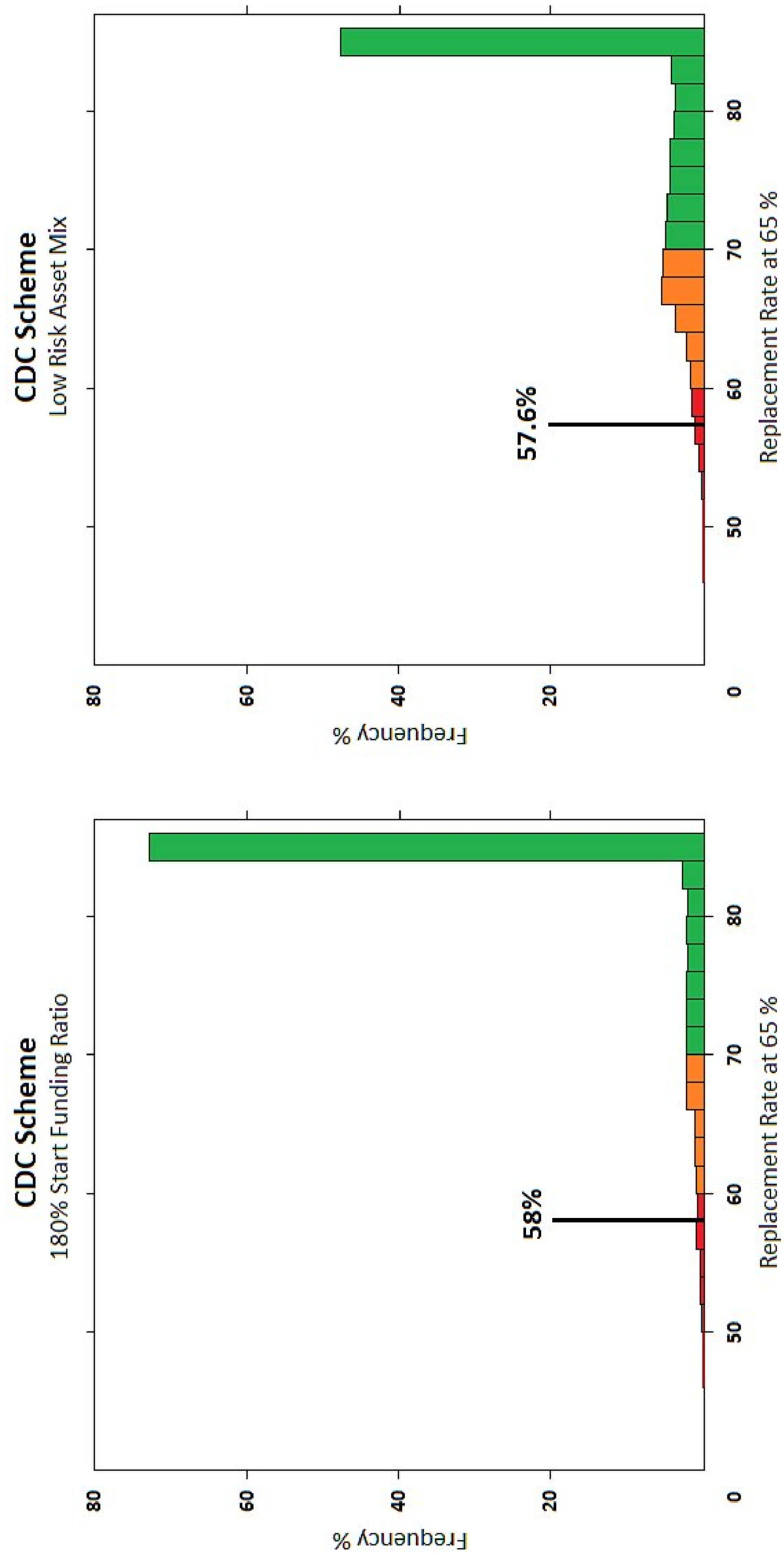
	CDC Lump Sum Transfer	**CDC Low Risk Asset Mix**
Certainty benchmark	58%	57.6%

The certainty benchmark replacement rates for both scenario simulations are still far below the base DB simulation level. This is an indication that both do not do an impressive job in improving income certainty. However, to obtain a more complete picture, the table below presents probabilities for various replacement rates at age 65.

Replacement Rate	**CDC Lump Sum Transfer**	**CDC Low Risk Asset Mix**
Max	68.3%	41.3%
< 80%	22.3%	44.4%
< 70%	11.4%	22.3%
< 60%	3.4%	4.2%
< 50%	0.34%	0.2%

The probability for a best case scenario is higher for the CDC simulation after a lump sum transfer than for the CDC base scenario simulation. However, this probability in the CDC simulation with a low risk asset mix is even lower than in the DB base scenario simulation. In

Figure 3. Distribution of replacement rate of final wage at age 65 after a full career. CDC lump sum transfer and CDC low risk asset mix



general, probabilities in the CDC after a lump sum transfer become more spread. While the probability for obtaining a replacement rate less than 80% improves 8.2 percent point with respect to the CDC base simulation, the relative improvement gradually decreases as lower benchmarks are chosen. The improvement is thus much more present on the upside of the distribution, while the lump sum has a hard time covering downside risk. The opposite is true for the CDC with a low risk asset mix. While the upside of the distribution shrinks and the probabilities for obtaining a replacement rate below 80% and 70% increase, the probability for obtaining a replacement rate below 60% is slightly lower than in the CDC base simulation, 0.5 percent point, and the probability for obtaining a replacement rate below 50% is even lower than for the CDC after a lump sum transfer.

Certainty factor

The table below shows the calculated certainty factors for moving from the DB base scenario simulation to the CDC after a lump sum transfer and the CDC with a low risk asset mix, respectively.

Certainty factor	
CDC Lump Sum Transfer	1.32
CDC Low Risk Asset Mix	1.34

The certainty factors for both compensation methods are much lower than for the CDC base scenario simulation. The lump sum transfer performs slightly better than the alternative asset mix. This does however depend on the exact specified transfer, which was in this case 31% of liabilities (100% real corresponds to 149% nominal funding ratio). Any transfer below or above this amount would have resulted in a different certainty factor.
The certainty factor for the low risk asset mix depends on the specific asset mix chosen as well and would be different if an alternative asset mix was specified. A general result that can be derived from the certainty factors however is that there is limited potential for both techniques to compensate for participants' increased risk. The lump sum transfer is very large and the specified asset mix invests a great share in bonds. It is thus unlikely that the certainty factor using these techniques can be decreased much more than what is presented here.

Lump sums and nominal right cuts

Since both simulations are of CDC schemes, lump sums are absent and only nominal right cuts apply. Probabilities for nominal right cuts are presented in the table below.

	CDC Lump Sum Transfer	**CDC Low Risk Asset Mix**
Lump Sums	-	-
Nominal right cuts	1.91%	2.45%

The lump sum transfer at the point of transition to a CDC decreases the probability of nominal right cuts from 2.95% (CDC base scenario simulation) to 1.91%. This translates to once every 52.4 years, which is actually a quite considerable improvement compared to once every 33.9 years in the CDC base scenario simulation. Considering the likely stakeholder conflict involved in cutting nominal rights, a decrease in this frequency is valuable. However, like the certainty factor, this exact number depends to a large extent on the exact size of the lump sum transfer. For the low risk asset mix, the frequency reduction is considerably lower, which adds more question marks to the topic whether lowering the risk in the asset mix is desirable. These results reflects how the low risk asset mix operates effectively only in the very low regions of the probability distribution. The tables below display frequencies for sizes of the nominal right cuts.

CDC Lump Sum Transfer				
Nominal right cuts (% of liabilities)	**> 3%**	**> 5%**	**> 8%**	**> 10%**
Probability	1.39%	1.11%	0.76%	0.57%
Frequency (nr. of years)	71.9	90.9	131.6	175.4

CDC Low Risk Asset Mix				
Nominal right cuts (% of liabilities)	**> 3%**	**> 5%**	**> 8%**	**> 10%**
Probability	1.58%	1.14%	0.64%	0.42%
Frequency (nr. of years)	63.3	87.7	156.25	238.1

The tables show that at high nominal right cut levels, the CDC simulation with a low risk asset mix outperforms the CDC simulation after a lump sum transfer by providing a lower probability. The tables support that indeed, the low risk asset mix provides protection particularly in the very bottom of the retirement income probability distribution.

5.4 Sensitivity analysis

While the core of the simulation structure, formed by the defined pension contracts, could be based on common practice and regulations, the input choice of the model relies on some assumptions that can be adjusted. To test to what extent results could depend on various forms of the input, alternative specifications will be analyzed in this paragraph. First, the start funding ratio used in the base simulation will be set at 105%. Second, population will be adjusted in two ways. A simulation of a grey population and a simulation of a green population will be presented for both DB and CDC. The structures of the simulations applied for sensitivity analysis are given in the tables below. Finally, the base simulation, as well as the simulation with a start funding ratio of 105% will be analyzed for differences in risk transfers between age cohorts.

Low start funding ratio	**Scenario Simulation 7**	**Scenario Simulation 8**
Asset Mix	50% Bonds 40% Stocks 10% Real Estate	80% Bonds 15% Stocks 5% Real Estate
Start Funding Ratio	105% Nominal	105% Nominal
Population	Standard	Standard
Pension contract	DB Low Start Funding Ratio	CDC Low Start Funding Ratio
Indexation	Conditional	Conditional
Contribution	Flexible	Fixed
Lump Sums	Yes	No
Nominal right cuts	No	Yes

Grey Population	**Scenario Simulation 9**	**Scenario Simulation 10**
Asset Mix	50% Bonds 40% Stocks 10% Real Estate	50% Bonds 40% Stocks 10% Real Estate
Start Funding Ratio	100% Real	100% Real
Population	Grey	Grey
Pension contract	DB Grey Population	CDC Grey Population
Indexation	Conditional	Conditional
Contribution	Flexible	Fixed
Lump Sums	Yes	No
Nominal right cuts	No	Yes

Green population	**Scenario Simulation 11**	**Scenario Simulation 12**
Asset Mix	50% Bonds 40% Stocks 10% Real Estate	50% Bonds 40% Stocks 10% Real Estate
Start Funding Ratio	149%	149%
Population	Green	Green
Pension contract	DB Green Population	CDC Green Population
Indexation	Conditional	Conditional
Contribution	Flexible	Fixed
Lump Sums	Yes	No
Nominal right cuts	No	Yes

Below, the most important results from the sensitivity analysis will be presented.

Low start funding ratio

The graphs representing the distribution of the replacement rate of final wage at age 65 for scenario simulation 7 and 8, the DB and the CDC with a start funding ratio of 105%, are presented in figure 4. The most striking result from the simulation of a DB and a CDC with a start funding ratio of 105% is that the results for the DB scheme are not too different from the base simulation, whereas outcomes for the CDC scheme are clearly worse. In the DB simulation, the replacement rate that is achieved with 97.5% certainty is still 68.5, a small decrease compared to 68.8% in the base scenario with a start funding ratio of 149%. A CDC that is in a bad position to begin with will suffer even more from the fact that the contribution rate cannot be increased and is also more likely to be hurt by the fact that lump sums do not apply. The peak of the distribution shrinks and more results end up in the mid range as well. The probability for a best case scenario decreases to 42.2% (versus 59.4% for the base CDC), while the probability for a replacement rate below 70% increases to 26.9% (versus 16.9% for the base CDC). The probability for nominal right cuts increases considerably to 6.4% (versus 2.95% in the base CDC). The probability for obtaining a replacement rate below 60% increases sharply as well, to 8%. This reflects that the downside risk grows sharply and income security is much worse in a CDC that has a start funding ratio of 105%. The certainty factor when moving from DB to CDC at a start funding ratio of 105% is 1.49.

Population structure

The resulting replacement rate distributions for scenario simulation 9 and 10, representing a grey population DB and CDC and for scenario simulation 11 and 12, representing a green population DB and CDC, are presented in figure 5 and 6, respectively. The most important result from changing the population structure of the pension fund is that while for the DB scheme a green population seems to be slightly more beneficial, a CDC is actually better off with a grey population. The logical explanation for this is that in a DB, the flexible contribution steering tool is more effective when the population is young. A CDC however, does not have this tool and thus is not affected by this. What is more important is that a grey pension fund has liabilities that have on average a much shorter time to maturity. Given that the pension fund has a good starting position, it has strong buffers that apply to a relatively short period of time. The cost covering level of contributions is also much higher in a grey fund, which gives a DB scheme less room to adjust the contribution rate upwards. For a CDC however, what matters is that even in the contribution rate the buffers that are built in are needed for a relatively short period of time.

The certainty factor for a grey population is lower than in the base simulation, whereas the certainty factor of a green population is higher. Exact numbers should be

Figure 4. Distribution of replacement rate of final wage at age 65 after a full career. DB and CDC start funding ratio 105%

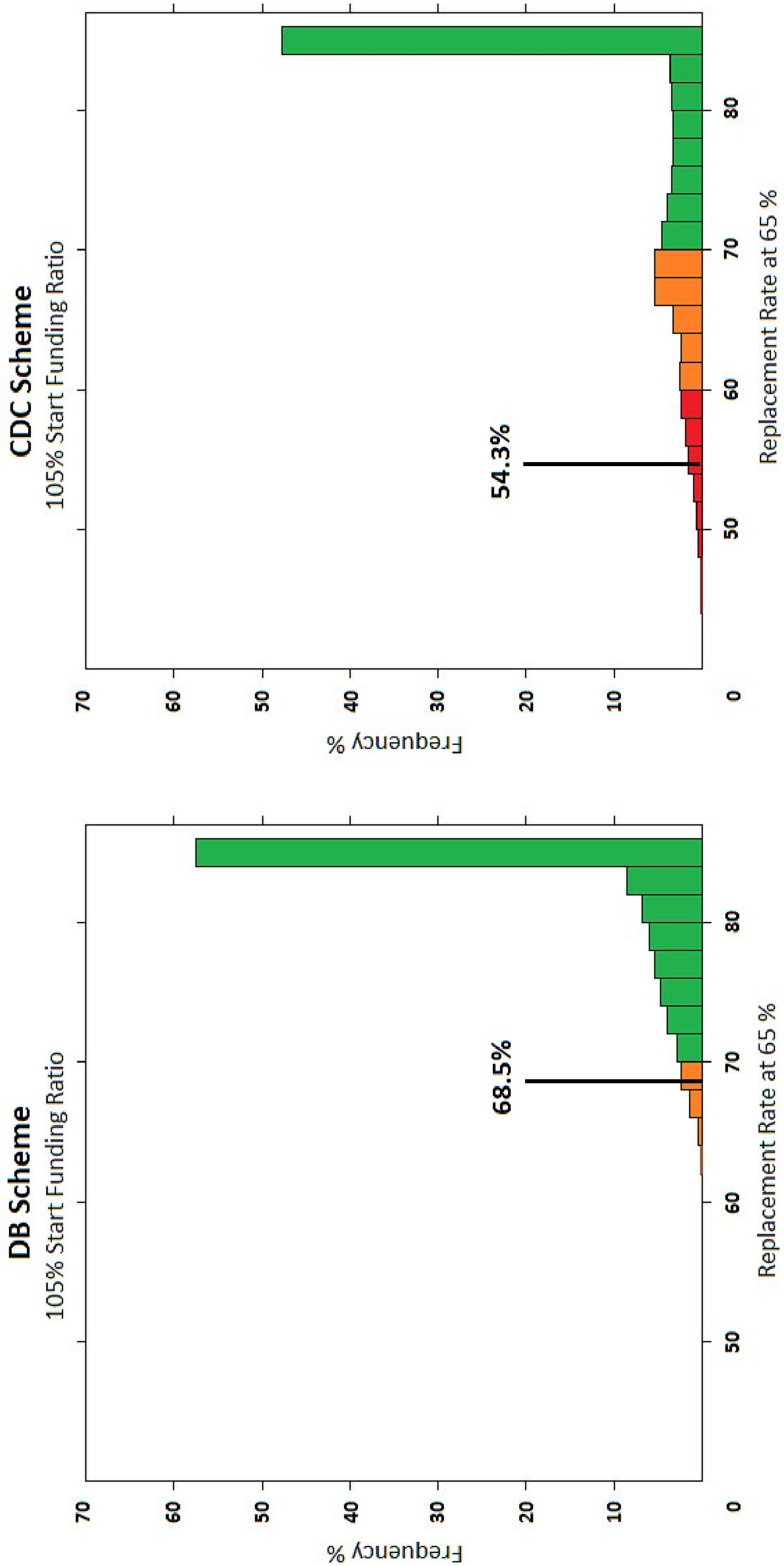


Figure 5. Distribution of replacement rate of final wage at age 65 after a full career. Grey population DB and CDC

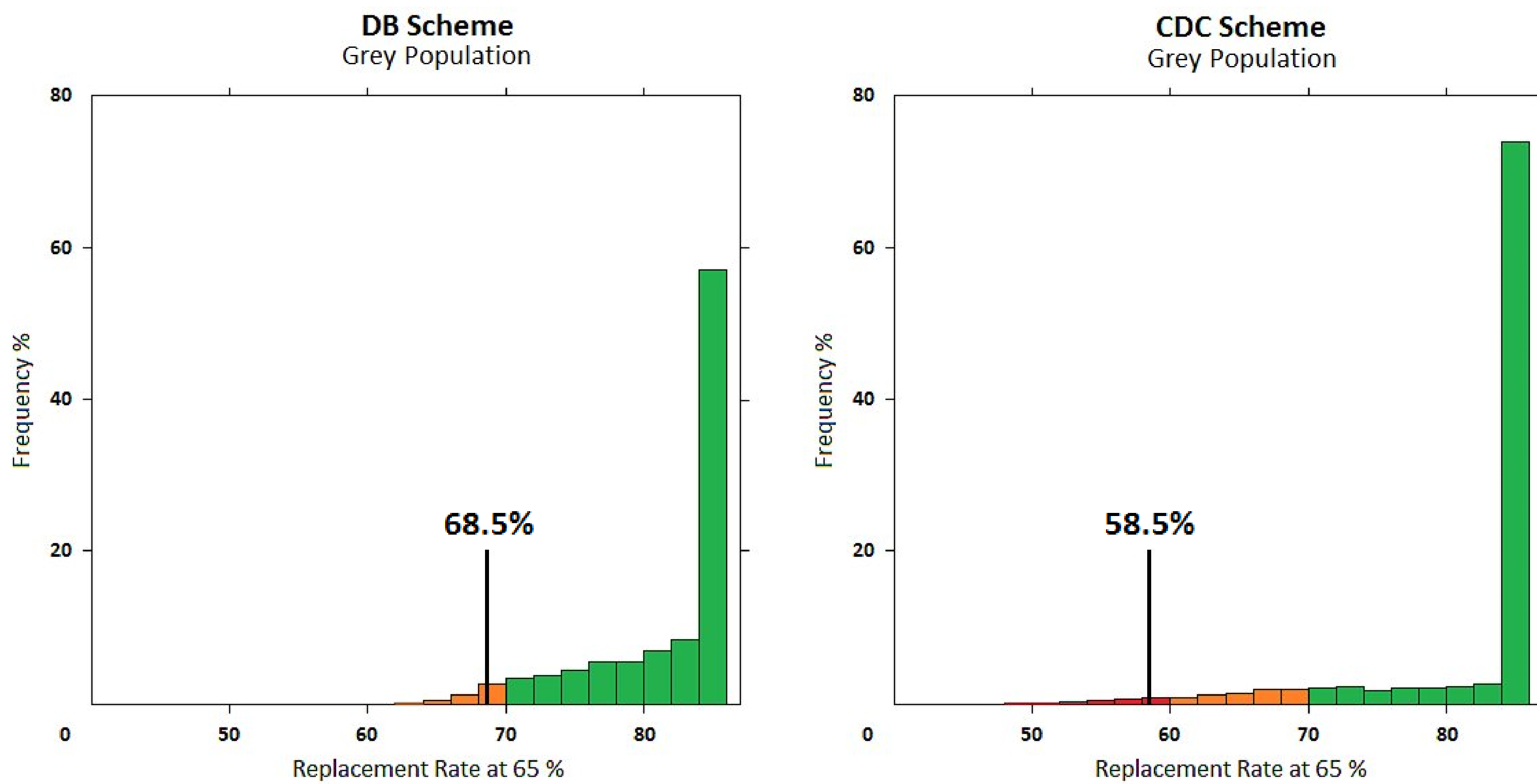
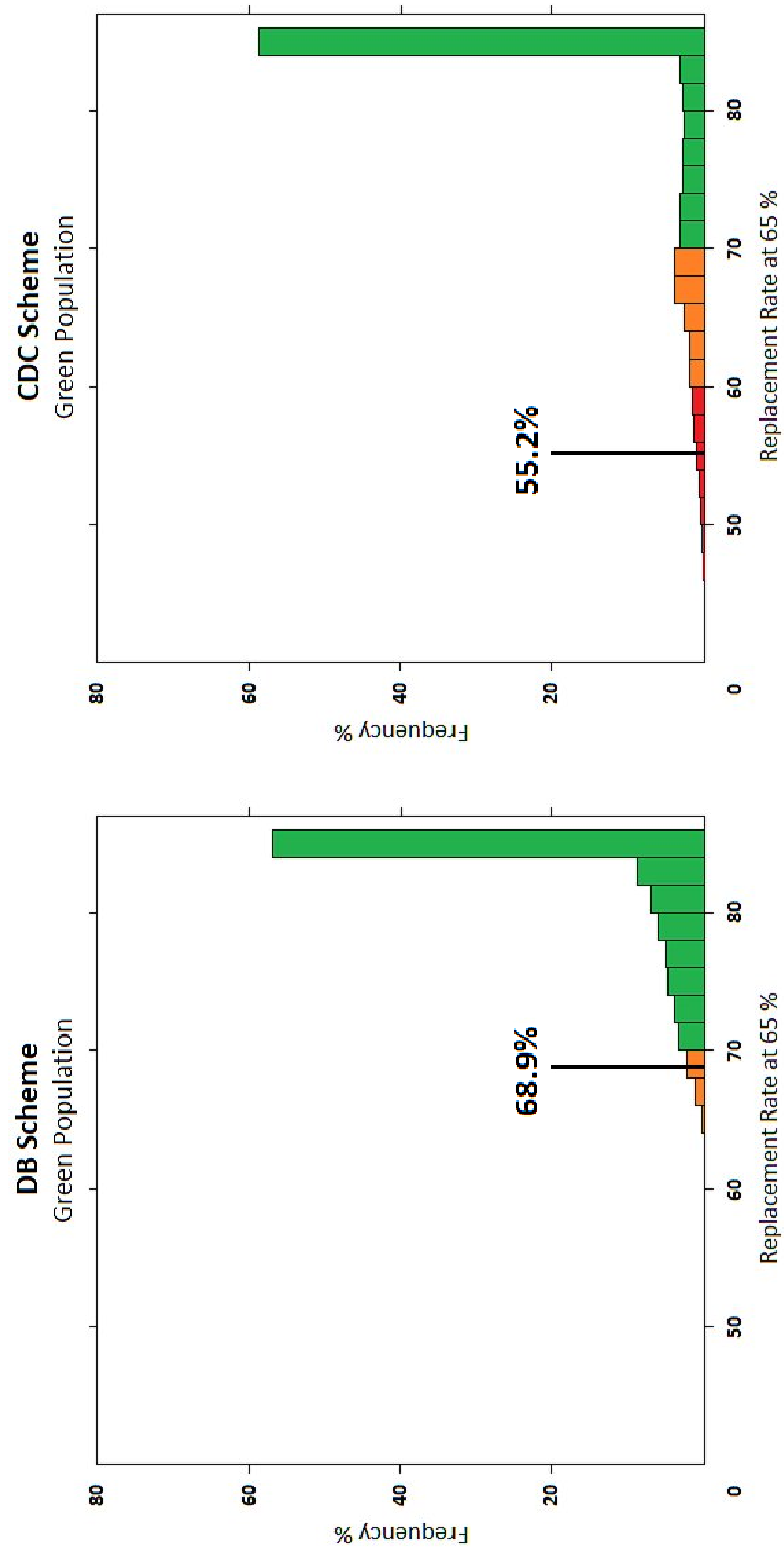


Figure 6. Distribution of replacement rate of final wage at age 65 after a full career. Green population DB and CDC



interpreted carefully, as they depend strongly on the exact specification of the population. The certainty factor for the green population increases only slightly, to 1.42. The certainty factor for a grey population falls quite considerably to 1.3. It should be taken into consideration that the number of active participants in the oldest age group relative to the number of participants in the youngest age group in the grey population (25/2) is higher than the number of active participants in the youngest age group relative to the number of participants in the oldest age group in the green fund (22/5). Hence, the grey population is "greyer" than the green population is "green". However, even when taking this into consideration, the effect on outcomes of having a greyer population than the base simulation is still stronger than the effect of having a greener population. A grey population may thus reduce the risk transfer, given that the pension fund has a strong starting position.

Age cohorts

The analysis of population structure effects suggested that buffers are more useful for grey populations, given that the liabilities have a shorter time to maturity. This raises the question whether risk transfers may be different for age cohorts in general. The base simulation considers a full career in the pension fund and thus a participant who is 25 at the start of the simulation. The assumption is that a participant who will spend a full career under the CDC contract is most representative for analyzing the complete risk transfer involved. In the base simulation indeed, the risk transfer increases for younger age cohorts. The certainty factor for achieving the same income level in a CDC with 97.5% certainty at age 65 as in a DB is 1.17 for participants who are 55 at the start of the simulation, 1.33 for 45 year olds and 1.4 for 35 year olds. While the trend is increasing, the difference between age cohorts becomes smaller. It is likely that the certainty factor will not increase much further above 1.41. The found pattern can be explained by two countervailing effects. The buffer present at the start of the simulation protects rights in the short run, which is mainly beneficial for older participants. On the other hand, young participants have more time to make up for nominal right cuts and missed indexation. Over time, the effect of buffers decreases, like the effect of lump sums, while the effect of participation duration increases. Therefore, the growth of the certainty factor over age cohorts decreases. Whether this clarification holds can be tested by applying certainty factors for age cohorts in the simulations of a DB and a CDC with start funding ratio 105% as well. Since the buffer here is much smaller, the effect for older cohorts should be smaller as well. While the funding ratio buffer is only 5%, the buffer before nominal right cuts need to be applied is 18%. It may thus still be effective for the oldest age cohort. And indeed, these expected results hold exactly. The certainty factor for 55 year olds is 1.48, while it increases to 1.5 for 45 year olds. It increases further to 1.52 for 35 year olds, while it falls back to 1.49 for 25 year olds, as the effect of participation duration takes over.

6. Practical implications

Important practical implications for participants in pension funds that are moving from DB to CDC, or are considering doing so, can be derived from the results. They will be presented in the current chapter. In addition to the model simulation, interviews were held with prominent people from three Dutch CDC pension funds. These will be used as a practical illustration of the model's results.

6.1 Implications of results

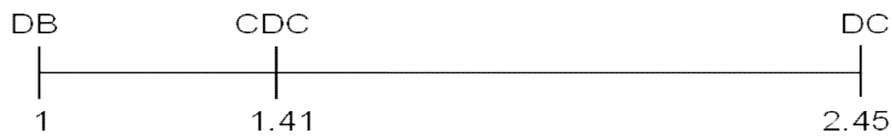
Practical results deriving from the previous chapter are presented in this paragraph, following the structure used in chapter 5 as well.

6.1.1 Base simulation

From the first base scenario, the general distribution of replacement rates obtained in the specified CDC was found. Compared to the DB, it is a much more spread distribution, with both a larger peak on the upside and a longer skew to the downside. This result could be expected when taking more risk. The probability of a high replacement rate improves and so does volatility of results. Retirement income security is likely to be the most important benefit gained from participating in a collective pension fund for participants. The focus should thus not be on the upside but on the downside of the distribution. The obvious question is then, what do participants lose in terms of income security in trade for the gain of a higher probability for the best case scenario? The certainty benchmark for CDC (55.9% replacement rate with 97.5% certainty) shows that participants indeed lose a great share of income certainty. The certainty factor shows what contribution rate premium participants in the model should require from their employer when moving to CDC, in case they want to maintain income security at the 97.5% certainty level. This increase of 41% is rather sizable.

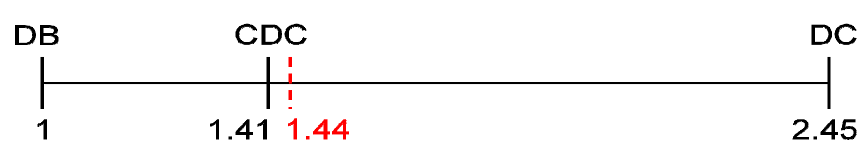
The obtained result for the certainty factor can also be put in line with previously obtained results by De Haan (2008). The current analysis calculated what increase of the fixed contribution rate in the simulated CDC would be needed to provide income certainty at the level of the simulated DB scheme. The evaluation point for this was the income level provided with 97.5% certainty in the DB simulation. This income level corresponded to a 68.8% replacement rate including social security benefits. De Haan (2008) assumed a DB scheme provides a replacement rate of 70% with 97.5% certainty, which is close to the results of the current analysis. The contribution rate for the DC scheme he simulated was based on a cost covering level, like the contribution rate for CDC in the current analysis. The derived certainty factor by De Haan (2008) corresponded to the required increase of the contributions needed to provide income certainty at the same level as the defined DB standard. In the current analysis as well, the certainty factor reflects the required cost increase needed for the CDC contribution rate to provide cost certainty at the DB level. De

Haan (2008) obtained a DB certainty factor of 2.45. The CDC certainty factor is 1.41. Putting both results together provides a broader scope for the results obtained in this thesis. The scale below presents the combination of both results.



The number 1 reflects the cost covering level of contributions and is presented as corresponding to a DB scheme on the scale. In reality, the DB contribution rate is not stable like in a CDC and DC, hence a representative fixed equivalent has to be chosen for the scale. The median contribution rate in the simulated DB is approximately the cost covering level. Furthermore, in reality as well as in the model, the cost covering level of the contribution rate is the base for setting the actual contribution rate in a DB scheme. Hence, it is a good candidate for a fixed equivalent of the flexible DB contribution rate. The scale above presents the relative position of CDC with respect to DC in terms of additional costs for providing DB-level income security. It puts the required cost premium for CDC in a different perspective, as it shows the gain from the fact that CDC is a collective fund, while DC is an individual pension scheme. While 41% is still a high cost premium, it is a high reduction from 145% in individual DC.

The main difference between the assumptions in the analysis by De Haan (2008) and the current analysis is that De Haan (2008) assumes a DB scheme in which, in principle, all risk is with the employer, with a default risk of 2.5%. This is comparable to typical British DB schemes and old Dutch final pay schemes. The structure of the DB scheme in the current model is that of an average pay DB scheme, which allows for some participant risk through conditional indexation and in trade aims higher in terms of the right accrual rate. The replacement rate provided with 97.5% certainty is obtained through simulation rather than by assumption. It would however be interesting to see how much the CDC certainty factor would be different if an analysis similar to De Haan's would be applied. Hence, a certainty factor for CDC is calculated to see what the increase of the contribution rate should be to provide a 70% replacement rate with 97.5% certainty. The certainty factor now increases to 1.44. The previously presented scale then changes as presented below.



As can be seen, the picture would not change much. The CDC contribution rate would have to increase by 44% instead of 41% and the gain from collectivity is still 101% (instead of 105%). Hence, the fact that the gain from collectivity is much larger than the loss from the withdrawal of the employer as a risk bearer strongly holds in both cases.

The scales above actually provides a rather modest representation of the gain from collectivity. The analysis by De Haan (2008) only reviewed individual asset accumulation exposed to investment risk. However, annuitization risk is also important in a DC scheme since the interest rate at the point of retirement, when an annuity is bought from savings, adds great volatility to possible income levels from the same amount of savings. It makes sense for the current analysis to leave this factor out, since interest rate was fixed for both the DB and CDC simulations as well. Hence, 2.45 as a certainty factor is likely to be an underestimation of the true additional income risk in a DC. The difference between DC and CDC as a collective fund will thus be larger as well in reality.

The analysis in the first paragraph also provides additional insight in the situations feared most by all stakeholders in a pension funds. When funding ratios are extremely low, the burden on whichever stakeholder bears the downside risk becomes much heavier. Participants, who in normal ranges of the funding ratio only bear the risk of missing indexation, will have to give up their nominal rights in the CDC. The employer who normally only bears the risk of contribution rate volatility will have to make additional lump sum payments in the DB. Conflicts are very likely to arise here, since DB contracts often do not specify exactly what will happen in such a situation and who will bear the burden. In the case of a CDC, it is specified that participants will be the ones who will incur nominal right cuts. However, it is likely that only in these moments participants will find out about the true nature of their pension contract and attempt to fight right cuts. Furthermore, it was stated before that employers may have motivations for running a CDC scheme other than not being willing to accept cost volatility per se. They may simply have moved to CDC to avoid the effects of new accounting regulations (IFRS), while still being concerned with a solid pension scheme for their participants.

Many experts in the field are worried about these so called “open endings” to collective pension schemes, the lack of a definition of what will happen when worse come to worse. For these reasons, the question how often such distress in the pension fund will arise is a rather crucial one. The analysis of the base scenario showed that these scenarios are less likely to occur in the long run in an average pay DB than in a CDC. The logical explanation for this is that contribution rate flexibility in a DB scheme will keep the pension fund away from the bottom. It is important to note that the better outcomes from DB cannot be attributed to higher costs. Expected long run costs are actually lower in the DB scheme.

6.1.2 Contract elements

The second paragraph of the previous chapter expanded on the effects of the separate elements that change in the pension contract when moving from DB to CDC, namely fixing the contribution rate and replacing lump sums for nominal benefit cuts. The value of a DB contract has often been dedicated to the fact that the employer will support nominal rights with additional lump sum transfers if needed. The analysis in the second paragraph however presents a different picture. The first simulation, where contribution rates are fixed, represents a pension scheme in which lump sums are still present while contribution rate flexibility is abolished. The second simulation represents a pension scheme in which lump sums are no longer provided but contribution rate flexibility is still present. At first glance, it already shows that a DB without lump sums is by far not equivalent to a CDC, nor is a DB without contribution rate flexibility equivalent to a DB with both a flexible contribution rate and lump sum transfers. Hence, the difference between DB and CDC cannot be attributed to lump sum payments only. In fact, the certainty factor for moving from the base DB to the DB without lump sums is lower than the certainty factor for moving to the DB with fixed contribution rates.

The analysis also showed that the average costs of a DB scheme simulation without lump sums, that provides income security far above the CDC level, are below the fixed contributions of the simulated CDC, which are at the cost covering level, and even further below the fixed contributions that would be needed if the CDC were to provide income security at the DB level. This shows the power of cost volatility in providing income certainty to participants. In practice, the same expected costs over a long time period can provide more certainty when volatility is allowed. Vice versa, the same income certainty over a long time period is obtained with lower expected costs when cost volatility is allowed. These findings bring a critical note to employers complaining DB schemes are too expensive, now the financial crisis is raising contribution rates of these schemes. During such crisis times it is easy to take a short term perspective and translate high cost volatility into high costs. The current analysis shows the two should not be confused. However, high costs during bad times for the pension funds will be even more pressing if these coincide with bad times for the sponsor company. Hence, the higher expected costs in the CDC may be well worth the trade for cost stability for the employer.

Another valuable finding from the analysis in the second paragraph is that exactly the combined effect of fixing contributions and eliminating lump sums causes the greatest risk transfer. The previously found implication that the expected costs for providing a certain level of income security depend on the volatility allowed for these costs applies here as well. Both fixing the contribution rate and eliminating lump sums separately decrease cost volatility. The certainty factor found for moving to a fixed contribution rate is larger than for moving to a scheme without lump sums. And indeed, the decrease of cost volatility found for eliminating lump sums is smaller than the decrease of cost volatility for fixing the contribution rate. To illustrate, the previously presented certainty factors and the standard deviation of the total annual costs over a 40-year period (one simulation period) for the base DB simulation, the DB with fixed contribution rates, the DB without lump sums and the base CDC simulation are displayed.

	Base DB	DB Fixed Contribution Rate	DB No Lump Sums	CDC
Certainty Factor	1	1.082	1.065	1.41
Standard Deviation Total Cost Rate	29.5%	26.4%	29.1%	0%

The table illustrates how come the combination of fixing the contribution rate and eliminating lump sums leads to a certainty factor that is higher than the sum of both. While both elements separately reduce cost volatility to some extent but not dramatically, combined they reduce cost volatility to 0. When fixing contribution rates only, lump sums can take over a share of the role played by the flexible contribution rate in a standard DB. When eliminating lump sums only, the accumulation of assets above the funding ratio where lump sum transfers to the employer would otherwise apply and the upward flexibility of the contribution rate take over some of the role of lump sums.

These findings provide useful information for participants who are confronted with an employer who wishes to move to CDC. When negotiating on the terms of the transition, participants should take into account what the strength of the employer as a sponsor of the scheme is. This depends on what the employer can handle in terms of cost volatility, regarding both contribution rates and additional lump sums. The cost volatility an employer can handle is directly related to the risk transfer involved. It is essential for participants to realize that any room for cost volatility can provide higher income security. The value of cost volatility also illustrates participants should not be satisfied with a CDC contribution rate that corresponds with the expected average contribution rate in a DB scheme. Volatility has a value of its own and should therefore be compensated for.

While the current analysis considers a single employer pension fund, the implications of the second paragraph extend to industry wide pension funds. Recently, low funding ratios in some of these funds have raised the question who will support the nominal rights accrued by participants during bad times, when lump sums transfers are needed. It is unlikely that large groups of, often small, employers will end up agreeing on lump sum transfers and hence, nominal benefit cuts would be needed. This has lead to speculations about the reliability and sustainability of DB schemes in which nominal rights cannot be supported. Particularly since some funds have indicated that maximum contribution rates payable by participating employers have been reached as well. However, these pension schemes correspond exactly to the simulated DB without lump sum. In this scenario simulation, a maximum contribution is set as well. And still, this scheme proves to be very different from a CDC schemes, delivering much higher income certainty.

The analysis also implies that in case an industry wide pension fund is considering moving to CDC, this may still imply a rather large risk transfer. As previous findings show, the risk transfer depends on the contribution rate volatility acceptable for participating employers. The maximum contribution rate set in the applied model of 20% is not an exceptionally generous one. Cost volatility in industry wide pension funds is likely to be lower than in single employer funds, since many employers have to agree on contribution rate changes. The maximum change in the simulated pension fund is set at 2%, which is quite modest for a single employer fund. It is actually more suitable for industry wide funds. Hence, the results from the simulated DB without lump sums are likely to apply to industry wide funds as well and the risk transfer when fixing the contribution rate in these funds will remain sizable.

6.1.3 Compensating strategies

The simulation of a lump sum transfer at the point of transition shows that the effectiveness of using such a transfer to protect participants from the downside of the risk distribution in a CDC is very limited. It is mainly effective in improving the upside, giving an even higher chance of a high retirement income. The distribution as a whole however is not shifted much by this lump sum and thus a large share of the downside risk remains. The purpose of compensating participants for the higher downside risk is thus not very effectively tackled by a lump sum transfer. It seems that to shift the distribution anywhere close to the DB certainty benchmark using lump sums, excessively large transfers would be needed. An important note to this finding is that the current analysis is aimed at participants who spend the full career under a CDC contract. One can imagine that a lump sum transfer may be particularly effective in the short run, especially when the pension fund experiences some years of low investment return shortly after the transition. During these years, the lump sum can be used to replace returns. However, the lump sum will be dried up at a certain point. After the lump sum has been fully used for compensation during bad times, the pension fund will operate like a fund without lump sum transfers again. It is thus likely that the effectiveness of the lump sum depends on the time a participant spends in the pension fund. Indeed, additional calculations show that the effect of the lump sum on the income level at age 65 for a participant who is 55 at the start of the simulation is strong. The certainty factor is exactly 1, which implies the participant is fully compensated during those 10 years. This also implies lump sums are likely to be more effective for the average participant in a pension fund with a relatively grey population. However, liabilities in this fund have a relatively short time to maturity and thus it will also be relatively expensive to raise the start funding ratio by the same percentage. Thus lump sums are most efficient for compensating older participants in a relatively young pension fund.

A solution to this problem may be to introduce requirements for the use of the lump sum transfer. For example, by raising solvability buffer requirements after the transition. Additionally, this buffer may be allowed to decrease gradually after the transition. In this way, it could be used more fairly by all participants involved in the transition.

While the effect of a lump sum transfer is limited but clearly beneficial, this is less clear for decreasing the risk in the asset mix. While the main concern is income security and indeed, certainty at the 97.5% level is higher than in the CDC base simulation, some critical notes should be added. First, as was stated before, a common goal for collective pension funds in the Netherlands is to provide a replacement rate of 70% of final wage (including social security benefits). The probability of achieving this target however is lower (5.4 percent point) for the CDC with a low risk asset mix than in a CDC with the standard asset mix. The low risk asset mix starts to perform better than the standard mix at lower benchmark levels close to a 60% replacement rate. And in trade for this, a lot has to be given away on the upside of the distribution and even in the mid-range. Hence, whether the low risk asset mix is a preferred choice over the standard asset mix for a CDC is very questionable. It should however be noted that indeed, the low risk asset mix caused the fixed contribution to decrease in the current model. In a pension fund where the contribution rate is based on expected returns from the asset mix, the contribution rate also experiences an upward effect from the lower expected returns. Probably, relative performance of the low risk asset mix compared to the standard mix would then be higher. However, the general result, that a low risk asset mix does more harm to the upside of the distribution than it does good to the downside will likely remain the same.

A general result from both simulations is that tools invented and applied so far to compensate for higher participant risk in a CDC affect the upside of the distribution mostly. Improving the downside of the distribution however, proves to be very hard and costly. For keeping the income provided by DB with 97.5% certainty, the fixed contribution rate will still have to be increased with a high risk premium. This may well make the lump sum transfer not worth its costs for the employer, although he would compensate older workers, who often form a strong lobby. The desirability of lowering the asset mix risk is questionable.

6.1.4 Sensitivity analysis

Some important side notes to the implications can be derived from the sensitivity analysis, in which the start funding ratio as well as the population input were adapted.

Low start funding ratio

The results for changing the start funding ratio can be compared to the effect of a lump sum transfer in the previous paragraph. Here, a higher start funding ratio did not cause a great difference to improve the downside of the distribution. However, the results from simulating a low start funding ratio in a CDC show that a lump sum transfer may matter much more when the CDC scheme would otherwise have a bad starting position. Hence, lump sums are more effective for DB schemes in a bad position that consider moving to CDC than for DB schemes in a good position. It should be noted that employers may be more motivated to move to CDC when the DB scheme is in a bad position than when the DB scheme is performing well. The current analysis shows that participants should be very careful when an employer wishes to move to CDC and the current DB scheme is suffering from low performance. They should mainly consider what the start position of the CDC scheme will be, in case the employer wishes to pay lump sums, and set the required risk premium on top of the contribution rate accordingly. Transitions to CDC at a low funding ratio are much more risky for participants than transitions during good times.

Population structure

For the population structure as well, it is useful to first recall the previous finding that lump sum transfers are more useful for older generations. The simulations of both the grey and the green population start with a 100% real funding ratio, which implies there is a significant buffer for nominal rights. Like the lump sum transfer helps participants more in short run and is thus more useful to older participants, the buffers in the funding ratio, as well as in the contribution rate, are more useful to older participants, and thus the CDC with a grey population beats the CDC with a green population in terms of income security. Therefore the risk transfer may be considerably lower for a pension fund operating with a grey population. This is, when the pension fund has a good starting position and thus strong buffers. Two critical notes need to be added to prevent the conclusion that a transfer to CDC is less significant for a grey fund. First of all, a lower premium on the cost covering contribution rate does not imply that CDC is cheaper for a grey fund. The cost covering contribution rate level of a grey fund is higher to begin with, since average time to maturity of accrued rights is shorter and thus the percentage of risk premium needed is also higher in terms of percentage points. Second, the condition that the CDC has strong buffers is a crucial one for the found lower certainty factor for a grey fund. Like buffers are more powerful in a grey fund, so are buffer shortages or even funding shortages. Therefore, the aforementioned importance of a strong starting position of a CDC is even more salient for a grey fund than for a green fund.

Age cohorts

The analysis on age cohorts, combined with different start contribution rates, shows that differences in the risk transfer for age cohorts depend on how much the funding ratio is above the level at which nominal right cuts need to be applied. In case of a low start funding ratio, nominal right cuts are close. Younger participants with a long term time frame are likely to be compensated for this during better times before they retire. Older participants however have a much shorter time frame. Therefore, buffers are more valuable to them as they provide mainly short term protection, as was already concluded before. However, in case nominal benefit cuts occur, their available time for recovery is much shorter. When buffers are large, young participants face the largest risk transfers. When buffers are present but small, participants in the middle age cohorts suffer the most from a transition to CDC. When buffers are absent, old participants will suffer the most. Thus, first of all, the relative risk transfer of older participants (compared to young participants) increases as the start funding ratio is lower. Second, the sensitivity of the risk transfer to the start funding ratio is higher for older participants than for younger participants. The certainty factor difference between a nominal start funding ratio of 149% (100% real) and 105% is only 0.08 for the youngest active age cohort (start age 25), while it is 0.19 for the oldest active age cohort (start age 55). These findings also support that the better performance of a grey fund in a CDC with a good starting position is mainly caused by the presence of strong buffers and the picture is likely to change if the start funding ratio would be lower. An important general finding that can now be formulated is that, when considering how to compensate participants for a transition to CDC financially, lump sums to serve as buffers matter for older participants, whereas higher contribution rates matter for the young. Lump sums keep up the funding ratio in the short run, higher contribution rates improve the income security over longer time periods.

6.2 CDC interviews

Three interviews were held with prominent individuals from Dutch CDC pension funds. These interviews were held with Mariëtte Simons, director at the SNS Reaal pension fund, Gijs Damen and Wim de Veij, director and chairman of the Total pension fund and Lex Bolwerk, recently retired director of the Akzo Nobel pension fund. Al three pension funds run CDC schemes. There are however some interesting differences. The Total pension fund has been a CDC fund since 1991, even before the term CDC existed, while SNS Reaal and Akzo Nobel have moved to CDC after 2000 and after the announcement of new IFRS and FTK regulations. Al three pension funds operate in very different sectors. SNS Reaal is a bank/insurer. Akzo Nobel is a large producer of chemical products. Total is an oil company. This paragraph will present summaries of the interviews and links these to the presented findings.

6.2.1 SNS Reaal

Interview

The SNS Reaal pension fund moved to CDC shortly after the merger of the SNS bank with Reaal. This caused the need to merge both pension funds as well. According to Simons, new IFRS and FTK regulations played an important role in the decision of the employer to propose a transition to CDC. The company was planning on entering the stock market. Therefore, it wanted to move away from the obligation to include the pension fund in the annual statements. The employer presented a generous offer including a lump sum transfer that was sizeable compared to the liabilities of the fund. At that point, the SNS Reaal pension fund was recovering from a solvability shortage and thus the lump sum was very welcome. Not accepting this offer would have implied that the pension fund would not be able to provide indexation for probably some years to come. After the transition, full indexation could be given for several years. Simons says that this trade off of not providing indexation versus being able to give full indexation made the offer very hard to refuse. Furthermore, in case the offer would have been refused, it is unlikely that the employer would have been willing to provide additional financial support to the DB scheme on top of the contribution rate to make indexation or even sustaining nominal rights possible.

The financial crisis in 2008/2009 also showed that SNS Reaal is very sensitive to the same financial risks as its pension fund. While the pension fund was facing a solvability buffer shortage after the stock market crashed and interest rates went down, the employer was facing severe financial distress and was forced to request state support. It is thus unlikely that the employer would be able to provide additional financial support during bad times through lump sums or increasing the contribution rate. If the pension fund would have refused the CDC deal, it would probably be facing funding ratios even far below the level of today's CDC fund and the employer would have been unable to provide additional financial support. Nominal right cuts may have been more likely in this scenario than they are now, while the pension fund is operating a CDC contract. Even if the employer would have been able to pay additional lump sums, Simons indicates it is essential in a CDC that the pension funds should never expect to receive such additional financial support. It should always operate assuming that the employer will not give more than the agreed fixed contribution rate.

In the general context of the CDC contract, Mariëtte Simons thinks a DB contract that is actually supported by a strong sponsor is always better for participants than a CDC contract. However, she thinks many employers that are currently running a DB are not able to support nominal rights. For these schemes, it would be fairer to move to CDC. In a CDC scheme, the employer is explicit about the fact that he cannot support a guarantee on the rights accrued by participants. It is explicitly stated in the CDC contract all accrued rights are conditional. Mariette Simons thinks that CDC is thus especially attractive for pension funds with a weak sponsoring employer. The strength of the employer depends on profit margins as well as on to what extent the employer is exposed to the same risks as the pension fund. This namely determines whether additional support can be provided during bad times. Simons thinks more employers will move to CDC in the future, as they recognize that they are not able to support DB schemes.

Theoretical analysis

When the SNS Reaal pension fund moved to CDC, they were offered a generous lump sum which provided funds for indexation for some years to come. However, the contribution rate increase was limited. Only 0.5 percent point was added to the cost covering level, which in this case corresponded to a risk premium of approximately 2.5%. The lump sum transfer has effectively protected the pension fund so far from strong beatings in the current financial crisis. However, the funding ratio has still decreased sharply and is currently rather low as well. Hence, the initial lump sum transfer will be all used up after this first heavy shock to the CDC fund. Indeed, it can be assumed that in the past few years the pension fund performance has drastically exceeded what would it have been in case the fund would have remained a DB. However, a pension fund should always consider a long term perspective. Now the lump sum is virtually all used up, the risk over the upcoming years will be much higher for participants than it was during the first years. As the analysis presented in this thesis showed, the lump sum has probably been most useful for older participants, who had relatively little time left in the pension fund at the point of transition. However, since the SNS Reaal pension fund has a very young population, the eventual effectiveness of the lump sum by the time they retire will be limited. As suggested before, the application of the lump sum perhaps should have been limited in the first few years, to spread the benefit over age cohorts.

The contribution rate increase negotiated at the point of transition is small. However, the argument presented by Simons that SNS Reaal as a bank/insurer is to a great extent exposed to the same risks as the pension fund is a very valid one. Therefore, the risk transfer when moving to CDC is likely to be relatively low for this pension fund indeed and thus limited compensation would be required. However, Simons is also concerned about other DB schemes that may not be able to provide lump sums and suggests that it may be fair for these schemes to move to CDC. The analysis in this model shows that, while this may be true if the sponsor of a DB scheme is very weak, these conclusions should not be made too quickly. The simulation of a DB without lump sums sets a reasonable maximum for the contribution rate and lump sums are proved to be of limited importance. Hence, DB schemes in which the employer cannot afford lump sums, even when a limited contribution rate is affordable, are still by far not equal to CDC. As the analysis showed, cost volatility provided by the sponsor is very valuable to a pension contract even when it is only limited.

An interesting fact about the SNS Reaal pension fund is that it has a very low risk asset mix. While no judgment about whether this is a good or a bad choice can and will be made here, the analysis has shown that this may to some limited degree decrease the risk transfer involved in moving to CDC as well.

6.2.2 Total

Interview

The Total pension fund is a special case, as it has been a CDC pension fund since 1991. The term CDC was not even known then, say Gijs Damen and Wim de Veij. However, it was decided in this time that the pension fund would move to a pension contract with a predefined contribution rate, while the pension fund remained collective. The term CDC was introduced for the first time in 2003. However, this did not change the pension contract itself. Only after the pension fund, like many others, faced difficulties after the financial crisis, the difference between the pension contract of the Total pension fund and other pension funds that were running a DB scheme became obvious. Before that time, social partners representing participants had never complained about the nature of the pension contract, since it did not matter as long as the pension fund was doing well. According to Damen and de Veij, social partners have not been paying much attention to what has been and is going on in the pension fund so far. Now, however, the pension fund is on the list of the supervisor, DNB, as one of the funds that are at high risk of being requested to cut nominal rights, since they are facing a very low funding ratio. Furthermore, the purpose for benefit accrual is 2% in the pension fund and the realized accrual rate has been below this 2% for a few years now, since the fixed contribution rate was no longer cost covering. The pension contract does therefore no longer state any accrual rate, this rate is simply based on what can be bought from the contribution rate paid by the employer. It thus seems that Total is the first example of a CDC in serious distress, where the downside risk that has been distributed to participants shows itself. Other pension funds that moved to CDC a few years ago have been protected by the initial lump sum transfers so far.

What is however particularly interesting in the case of the Total pension fund is that it has a rather strong sponsor company. Total, as an oil company, is doing well under the current high oil prices. Profits are still very high. Damen and de Veij believe that it would be hard to explain to participants why right cuts in the employer's pension fund are needed when the employer is making good money. They indicate that the attitude of employees in general is that this would be unfair, which can already be felt within the company and there should be a realistic concern within the board of the company that cutting pension benefits could harm the moral of employees. What strengthens this, is that Total as a company and employer likes to position itself next to Royal Dutch Shell. This company has recently made large lump sum contributions to its DB pension fund, while it was not even by far performing as badly as many other pension funds. It will therefore be interesting to see whether Total will stick to not providing lump sums and whether nominal benefit cuts will actually be applied in practice. Wim de Veij thinks that the latter is highly unlikely to occur.

In the context of the CDC contract in general, Damen and de Veij conclude that participants (or social partners as their representatives) should be very aware when the employer wishes to move to CDC. Implications of the risk transfer should be critically evaluated. They agree that this risk transfer will depend on the strength of the employer. When the employer is weak as a sponsor, a transition to CDC may be reasonable. However, in case of a strong sponsor, the pension fund should be hesitant to move to CDC or require decent compensation.

Theoretical analysis

The Total pension fund shows that indeed, when funding ratios are really low, the question who bears the bottom of the risk distribution becomes a topic of heavy discussion among stakeholders, even when the risk distribution should be clear like in a CDC.

A risk that is exposed here, which was not involved in the simulation model, is the risk that the fixed contribution rate will no longer be sufficient. In the model, the cost covering level is fixed and hence, the CDC contribution rate is always cost covering. In fact, participants in the Total pension fund have already missed out on nominal rights, compared to a DB scheme situation, since nominal right accrual was not at the target level of 2%.

However, the most interesting comparison of this CDC to the model is in the context of employer strength. No lump sum transfers were involved in the transition of the Total pension fund to fixed contributions. No risk premium was given on top of the cost covering contribution rate either. Meanwhile, the sponsor of the pension fund would very likely be able to pay much higher contributions and even provide lump sums. Hence, it seems like participants should have received a decent compensation for accepting a CDC contract. The reason why this has not happened seems to be mainly a lack of need for participants to require such compensation in the past. In the current situation however, social partners may finally stand up and the employer may be worried about consequences of the current situation as well. Officially the contribution rate cannot be increased due to bad performance and no lump sums can be paid if the pension fund is to remain a CDC. The future of the Total pension fund is thus an interesting case to follow.

6.2.3 Akzo Nobel

Interviews

While Lex Bolwerk is retired nowadays, he was the director of the Akzo Nobel pension fund when this fund moved to CDC and during the first years following the transition. According to Bolwerk, the motivation for this move was simply IFRS rules. IFRS would otherwise obligate Akzo Nobel to incorporate its pension fund performance in the annual statements. Since the size of the pension fund relative to the size of the company was quite large, this was unacceptable and thus moving to a DC-like pension contract was the only option for Akzo Nobel. Bolwerk was very involved in setting the deal and requiring compensation for the risk transfer. He decided that a good start position for the pension fund would be a start funding ratio of 130%. According to the fund’s indexation rules, full indexation was provided at a funding ratio of 115%, hence there was a good buffer for providing indexation during the first years. The contribution rate was also set at the cost covering level plus a buffer of 30%.

Bolwerk indicates that the Akzo Nobel pension fund had a few very good years after the transition, due to the generous lump sums that increased the start funding ratio. However, due to the financial crisis, these good years have already passed. Still, Bolwerk does not think participants in a CDC will end up with a lower retirement income in a CDC than in a DB. In fact, he says, most industry wide pension funds are also really CDC funds, although they call themselves DB funds. Industry wide pension funds have limited opportunities to increase the contribution rate and additional lump sum payments are completely out of the questions. Hence, Bolwerk thinks it would fair if they would admit that they are in fact also CDC funds. An advantage of a CDC fund compared to these funds, he adds, is that in a CDC contract participants receive a risk premium on top of the cost covering level. Due to this, contributions in a CDC are likely to be higher. Even more so, since the flexible contribution rate in a DB fund has a maximum affordable level as well. Bolwerk thinks lump sums are better than putting the money in increasing the contribution rate over the long run, since investment return on the lump sum will be much higher.

Since the Akzo Nobel pension fund faces a low funding ratio momentarily as well, the question arises when nominal right cuts should be applied. Lex Bolwerk indicates no fixed rules have been set stating when and how this would be done. In principle a CDC should cut rights whenever the funding ratio is below 100%. However, he does not expect the pension fund to start cutting rights immediately at that point. His own opinion is that cutting rights should only be a final way out in case of severe distress. Like Simons, Bolwerk thinks that a CDC fund should never consider the option that the employer may choose to make a lump sum contribution to save the fund from right cuts.

Bolwerk thinks CDC is an attractive pension contract for many companies, since it provides the employer with predictable costs for his pension fund. The costs for a DB are very hard to predict and manage for a company. Especially when the pension fund is rather large compared to the company itself, this can ruin the financial planning of the whole company. When DB contracts were introduced, says Bolwerk, life expectancy was still much lower, which made providing pensions much cheaper and DB seemed like the simplest solution. By now pension funds have grown so large that their risk has become hard, if not impossible to handle by employers, which shows during the current financial crisis. Therefore many employers wish to move to CDC now. However, Bolwerk indicates a good start position is essential for a CDC and many companies are currently unable to afford great lump sum transfers. On the other hand, if a company in the current situation is willing to offer large a lump sum for a transition to CDC, the current situation will make this very hard for participants to refuse.

Theoretical analysis

Bolwerk states that industry wide pension funds are in fact CDC funds, since their contribution rate flexibility is limited and lump sums are absent. However, as stated before, absence of lump sums does not make a DB fund equal to a CDC. Limited contribution rate flexibility was also incorporated in the model. Perhaps flexibility in an industry wide fund could be even lower than in the model. However, the analysis shows that any cost flexibility (other than the 5-year adjustment to changes in the cost covering level of the contribution rate), even when limited, makes a pension fund different from a CDC. Bolwerk is right when he says that pension funds with a sponsor (or multiple sponsors in an industry wide fund) that can only afford limited cost volatility may be equally well off with a risk premium on the cost covering level of the contribution rate. However, the analysis does show that this risk premium should still result in a fixed contribution rate that is higher than the expected costs in a DB in the long run, since even when cost volatility is only limited, employers are giving up a risk premium. The risk premium is however likely to be lower if affordable cost volatility is low. Hence, the step to CDC, as well as the difference with CDC, is smaller for pension funds whose sponsors can afford very low cost flexibility. Bolwerk clearly thinks that pension funds should not call themselves DB funds if they cannot support guarantees. However, the analysis shows this does not imply the fund is a CDC either.

Bolwerk makes a strong point for lump sum transfers, namely the fact that return on this lump sum will be much higher than when extra money is spread over time in the contribution rate. This should however be weighed against the finding that mainly older participants will benefit. Indeed, Bolwerk indicates the lump sum received at the point of transition is used up by now. This supports the previously presented suggestion that rules could be introduced for using the lump sum over a longer period of time, by increasing buffer standards. In this way, the advantage of higher returns over the initial lump sum can be kept and the benefit can still be spread over multiple generations.

It seems plausible that indeed, DB funds have grown tremendously, mostly due to the increase in life expectancy, over the past decades. Therefore, as Bolwerk indicates, employers can no longer afford the generous DB schemes they offered in the past. The move to average pay DB schemes was an important step for employers in moving away from excessive risks in their pension funds. Bolwerk thinks the next step is that many funds will move to CDC. This would involve not only moving away from any guarantees, it also implies moving away from any additional compensation for low pension fund performance. While it seems reasonable that many employers are indeed no longer capable of giving guarantees on accrued pension funds, it is quite another thing to think it is reasonable that these employers are also not able to bear any cost volatility at all anymore. The analysis shows that the two should clearly be separated and any acceptable cost volatility should be carefully valued for what it is worth.

7. Conclusions

7.1 Research conclusions

After the 2000 dotcom bubble, the introduction of new accounting rules (IFRS) that forced companies on the stock market to report their DB scheme on the annual statements and the implementation of new Dutch rules for the financial sector (FTK) that added interest rate volatility to the liabilities of pension funds, some companies changed their DB pension contracts into CDC contracts. However, none of them executed a thorough analysis of the obvious risk transfer from the employer to participants. Nor has any academic analysis so far been dedicated to evaluating the participants' point of view in the risk transfer. This thesis attempted to put forward such an analysis by applying Monte Carlo scenario simulation to both an average pay DB scheme, which is the most common contract form for pension funds nowadays in the Netherlands, and to a CDC scheme. Results from both simulations were then compared on the basis of the outcomes for participants, which are defined by the income level they obtain at the point of retirement after a full career in the pension fund.

The results show that the added risk for participants is directly translated into more spread of the results. This leads to a large decrease in retirement income security if the fixed contribution rate is simply set at the cost covering level. The risk transfer is translated into a certainty factor. This factor indicates the cost increase needed in a CDC to provide income security in a CDC like in a DB at the 97.5% security level, which is 41%. While it is a large number, previous research by De Haan (2008) calculated the certainty factor for individual DC schemes to be 2.45. Hence, there is also a significant gain from collectivity.

The pension contract elements that change when moving from DB to CDC are the fixing of the contribution rate for at least 5 years and the elimination of lump sums. Separate simulations for a DB scheme with a fixed contribution rate and a DB scheme without lump sum transfers were executed, to see what part of the risk transfer each of these changes makes up when moving from DB to CDC. The simulation results show that when either one is eliminated, the other one can take over part of the security it provided. Hence, the risk increase for participants when either contribution rates are fixed or lump sums are replaced with nominal right cuts is limited. However, when both are implemented, like in a CDC, the risk transfer is thus much larger than the effect of either one separately. This result is important in the context of both single employer pension funds that have recently discovered they cannot afford lump sum payments, as well as in the context of industry wide pension funds where lump sums are not reasonably an option. Some of these funds see CDC as a possible solution for the future, since they feel they have also reached the maximum contribution rate affordable. The analysis presented in this thesis, however, shows that there is still a great risk transfer involved in this move. DB schemes that have a limited capacity for contribution rate flexibility and cannot guarantee accrued benefits with lump sums and thus do not provide guaranteed rights are by far not equivalent to CDC schemes.

The analysis of DB schemes with fixed contribution rates and without lump sums showed another important conclusion that matters for both participants and employers. The size of the risk transfer when moving from an average pay DB scheme to another scheme, whether DB with fixed contributions, DB without lump sums or CDC, is related to the reduction of cost volatility involved. The fact that the combined effect of both fixing the contribution rate and eliminating lump sums is much larger than the effect of each one separately is then easily clarified. While each element separately causes a limited reduction of cost volatility, both combined reduce cost volatility to 0. The result that the risk transfer, and thus the required contribution rate premium to compensate, increases with the reduction of cost volatility seems intuitive, since risk for the employer expresses itself as cost volatility, whereas risk for participants translates into retirement income volatility. The important implication however is then, that employers too can benefit from cost volatility in the long run, as long as it is cost volatility they can reasonably bear. For accepting cost volatility, the employer obtains a risk premium, which translates into lower total expected costs in the long run. For the participants, some acceptation of cost volatility by the employer is valuable as it decreases their retirement income volatility.

When a pension fund is considering moving to CDC, these findings are crucial. How much cost volatility an employer can accept may be different per case. However, participants should consider how reasonable it is, when an employer wishes to move to CDC, that he is not willing to accept any cost volatility at all anymore. In case a pension fund moves to CDC in order to avoid IFRS regulations, which was a very important reason when some large funds moved to CDC a few years ago, it may be unavoidable to fix costs. If a move to CDC is in any way necessary, the consideration of how much cost volatility an employer could support financially is crucial in setting the appropriate compensation. A fixed contribution rate at the level of the expected contribution rate in a DB is not sufficient, compensation for cost volatility itself is needed as well. Hence, the expected total costs for the employer in a CDC scheme, when fair risk compensation is given to participants, is higher than the expected total costs in a DB scheme. How much the fair risk compensation is depends on the strength of the employer sponsoring the scheme. What cost volatility he can reasonably accept will depend mainly on profit margins as well as on to what extent he is exposed to the same risks and the same conjuncture as the pension funds.

Besides a risk premium on top of the contribution rate, the employer may attempt to compensate the risk transfer in other ways. The analyzed methods are lump sum transfers at the point of transition and a reduction of the risk involved in the pension funds' asset mix. The analysis shows the effectiveness of both is limited. Lump sums are effective only in the short run, until they are used up during bad times. They are therefore particularly useful for compensating older participants with a short term time frame in the pension fund. The analysis shows it is extremely difficult to provide compensation that covers the downside of the risk distribution in a CDC by lump sums. The short term effectiveness of the lump sum is not sufficient to cover for the long term over which participants are in the fund. The general benefit from lowering the risk in the asset mix is questionable. It only slightly improves income security while severely harming the upside of the outcome distribution in a CDC.

Sensitivity analysis by adjusting the input in the simulation model shows that the exact risk transfer is sensitive to the start funding ratio, the specific population structure and the age cohort considered. This is caused by two main factors. First of all, buffers at the start of a CDC scheme are mainly valuable to older participants. They provide nominal right security in the short run and very high buffers even provide indexation security in the short run. This is most valuable to older participants. A high funding ratio is therefore also more valuable to a grey fund. It should be noted however, that in absolute quantities, a much higher buffer is needed to provide the same funding ratio to a grey fund.

The second factor is that younger participants profit from being able to spread risk over a longer time frame. They have much more time to compensate for nominal right cuts and missed indexation during good times. These factors imply the risk transfer for old participants and grey funds is very sensitive to present buffers and the start funding ratio, respectively. For young participants and green funds, this sensitivity is much lower. At very low start funding ratios, the risk transfer is much higher for older participants, whereas at very high start funding ratios, the risk transfer is much lower for this group.

From the employer perspective, it should be noted that he should be aware when moving to CDC that he is giving up on a risk premium involved in accepting cost volatility. This he should compensate for when moving to CDC. What this compensation should be depends on his own strength as a sponsor for the fund, the population structure and the financial situation of the pension fund.

7.2 Implications for pension contract redesign

Recent difficulties with maintaining accrued rights in DB pension schemes have raised concerns about the sustainability of DB pension contracts. Many believe that a general move towards CDC schemes is unavoidable. The conclusions from this thesis can provide some valuable input for this discussion. The analysis showed that cost volatility may translate into lower expected total costs in the long run. This can be related to the argument that contribution holidays taken by many employers during the 90's are an important cause of currently high costs. Through these contribution holidays the employers accepted a high degree of cost volatility in the pension fund. They are facing the downside of this now. It is unreasonable to contribute currently high costs to the average pay DB schemes that are operated in many pension funds.

More importantly, this thesis showed that long term expected costs are negatively related to cost volatility, while participant retirement income security is positively related. If a certain degree of cost volatility is thus financially acceptable for the employer, it may lead to an improved outcome for the employer as well, as costs decrease in expectation. If not, at least the value of cost volatility (or cost stability) for the employer should be weighed against the value of increased retirement income security to participants. Any acceptable cost volatility for the employer will likely lead to a welfare gain from risk sharing. It should however be carefully considered how much cost volatility is acceptable for the employer, as well as what level of income security can reasonably be desired by participants. This depends on risk preferences as well as financial ability to bear risks for both participants as well as employers. When reformulating pension contracts, employers and participants should thus search for the optimal degree of risk sharing. The appropriate question when considering a move to CDC specifically is, is the employer truly unable to bear any risk? It is likely that an optimal risk sharing contract will involve at least some risk bearing and thus cost volatility from the side of the employer.

It has often been argued that many DB schemes are not truly “defined benefit” since they cannot reasonably be assumed to provide guarantees. At the same time they tend to make participants believe that accrued rights are real promises. Therefore, CDC schemes may be considered fairer as they do not make any promises and are explicit about the conditionality of rights. This does not imply however that it would be better for DB schemes that do not really provide “defined” benefits to move to CDC. The results of this thesis suggests it would be better for both participants and employers to step out of the DB and CDC boxes and start redefining pension contracts in terms of risk sharing. By defining who is to bear what risks, there is more freedom to find a pension contract that spreads risks in a way that is optimal for the specific pension fund. A pension contract based on defining the risk distribution also deals with the problem of open endings to pension contracts and makes clear to participants what exactly they can and cannot expect from the pension contract.

7.3 Limitations and suggestions for future research

The presented model is a highly stylized version of an actual pension fund. Therefore, presented exact numbers should be considered specific outcomes for the model and interpreted with care. However, general results and implications derived from them hold.

The model assumes all contributions to the pension fund are paid by the employer and hence, in the CDC model contributions are completely fixed. In reality, some share of contributions, which may differ per pension fund, is paid by employees themselves. This part of the contribution may remain flexible even in a CDC. Consequently, the slight flexibility of contributions may reduce the income insecurity involved. However, this does not change the general results with respect to the risk transfer, since flexible employee contributions merely represents risk redistribution from future (retirement) income to present (net of contributions) income.

Lump sum transfers in the simulated DB scheme are unlimited. In reality, especially considering lump sum transfers from the employer to the pension fund, this is unlikely to hold. First of all, the model could be adjusted to limit the lump sum transfer allowed. This also implies it should be possible to combine lump sums and nominal right cuts. By doing so, more detailed insights in the cost volatility versus income security trade off can be gained. Also, with this adjustment the dependency of the risk transfer on the strength of the sponsor company can be analyzed.

The population in the model was assumed to be stable in each scenario simulation is unlikely to be exactly stable. It may grow, shrink or age. The model does provide the possibility to simulate such population development. The CDC contribution rate would then also change every 5 years. As stated at the start of the analysis, the model provides a great range of opportunities for analysis and therefore, many interesting options were filtered out. It thus provides opportunities to analyze what the relation between the risk transfer and the development of the population is.

It was suggested that some optimal risk sharing point between the employer and participants could be specified for pension funds. Future research could focus on specifying on what the optimal degree of risk sharing depends. Such a framework could be applied for redesigning pension contracts in practice.

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