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The Pension Reform in Norway

A Measure of Adequacy in Retirement Benefits from Fully Funded Occupational Schemes

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Abstract

The implementation of mandatory occupational pension schemes has created a second pillar in the Norwegian Pension System. The trend of moving from Defined Benefit schemes (DB) to Defined Contribution (DC) schemes has shifted the risk of adequacy to the employees. This increase in enrolment to the DC schemes, and the introduction of new Hybrid schemes, has exposed Norwegian employee's to market risk, thus increasing the risk of having inadequate pension benefits. In this master thesis we set out to analyse the performance of these fully funded pension schemes. Throughout our thesis we will walk the reader through the maze that is considered the Norwegian Pension System, and analyse these fully funded schemes using historical data from 1900 to 2013. Based on the approach used by Antolin (2009), we calculate replacement rates for a total of 75 hypothetical cohorts. Consistent with the past theoretical and empirical findings, our result shows that the all-equity allocation yields better median values of replacement rates than for bonds and balanced portfolios. There is a need for higher contribution levels than five per cent for all schemes and all investment strategies, except the Standard Model with all-equity allocation, to have an equal replacement rate as a public sector employee that receives a guaranteed retirement benefit equal to 66 per cent of final salary. As of 2013, more than 40 per cent had only the minimum contribution level of two per cent, suggesting that future retirees will end up having a lower replacement rate in the private sector in comparison to the public sector, and there is a need for evaluating the policies for minimum contributions. Further, our results imply that the life-cycle investment strategies available in the Norwegian market should be more aggressive.

Sammendrag

Introduksjonen av obligatorisk tjenestepensjon har laget en andre søyle av det norske pensjonssystemet. Siden flere har flyttet over fra ytelsespensjon til innskuddspensjon, har risiko knyttet til inntjening av pensjon blitt flyttet til arbeidstakere. Denne økte oppslutningen om innskuddspensjon, samt introduseringen av et nytt produkt; Hybridmodellen, har utsatt norske arbeidstagere for markedsrisiko, dermed økt risikoen for uforutsigbare pensjonsgodtgjørelser. I denne masteroppgaven skal vi analysere ytelsen av disse fonderte pensjonsordningene, og vi vil følge leseren gjennom det norske pensjonssystemet, for så å analysere de fonderte pensjonsordningene ved bruk av historiske data fra 1900 til 2013. Baser på metodene til Antolin (2009) beregner vi kompensasjonsgrader for totalt 75 hypotetiske kohorter. I samsvar med tidligere forskning og empiriske resultater viser våre resultater at investering i aksjer gir bedre kompensasjonsgrader enn obligasjonsinvesteringer og investering i kombinasjonsporteføljer. For alle pensjonsordninger og alle porteføljesammensetninger, må arbeidsgivere skyte inn mer kapital enn fem prosent av lønning hvert år for å oppnå en kompensasjonsgrad som tilsvarer 66 prosent slik som arbeidstakere i offentlig sektor har krav på. Dette er ikke medberegne Standardmodellen med aksjesammensetning. Fra statistikk gjort i 2013 mottar flere enn 40 prosent bare minimumsinnskuddet på to prosent, noe som antyder at fremtidige pensjonister i privat sektor vil motta lavere kompensasjonsgrad enn de i offentlig sektor. Det er dermed grunn til evaluering av minimumssatsene. Videre antyder våre resultater at nedrappingsmodellene tilgjengelig i det norske markedet burde inneholde større andel av aksjer.

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This master thesis ends our two-year master journey in MSc in Economics and Business Administration at Oslo and Akershus University College of Applied Sciences.

We would like to express our gratitude to our supervisor, associate Professor Knut Nygaard, for recommending the Norwegian Pension System as a theme for our thesis. Knowing little on the subject, we quickly discovered that the pension system of Norway is a complex issue and that the knowledge among Norwegians (ourselves included) was less than pleasing. Half a year, many hours of hard work later, and we here we are, at the end of the destination.

The help and support from friends and family are not forgotten. You have our deepest gratitude.

This master thesis is our independent work and should be regarded as such. Any opinions addressed in this thesis are our own.

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1. Introduction

As an answer to the growing population (Grech 2010), the increased life expectancy (OECD 2013), and the low participation rates among the elderly population (Pallares-Miralles, Romero and Whitehouse 2012), many countries throughout the word, Norway included, have reformed their pension system. The Norwegian pension reform applies strongly to the private sector as employers favors defined contribution schemes (DC) with their increasing exposure to market risk, whereas the public sector employees are members of defined benefits schemes (DB) and receive approximately 66 per cent guaranteed pension benefit of final salary. This guarantee is received regardless of benefits from the social security scheme,"folketrygden", but adjustments for higher life expectancy in the public sector is expected in the near future. (Ministry of Labour and Social Affairs 2011). The reform has moved from calculating pension benefits using 20 best year income to account for incomes of all years between the age of 13 and 75 into a notional individual pension account, along with the introduction of flexible retirement from the age of 62, and benefits paid out according to life expectancy of the cohort. Thus, retirees from the private sector are baring an increased amount of risk in pension benefits from risk factors such as; unemployment, longevity and market fluctuations, for pension benefits in excess of the guaranteed pension. (Plahte & Nordstoga, 2009).

The employer sponsors mandatory occupational pension schemes in the private sector, both cost and contributions, and employers can choose from three different schemes to enroll employees; Defined contribution (DC), defined benefit (DB) and the new Hybrid product introduced in 2014 (Plahte & Nordstoga, 2009). In 2013, around 91 per cent of employees in the private sector were enrolled in a DC schemes, with more than 60 per cent of contributions being less than 5 per cent, and 80 per cent of employees could make their own investment choices (FNO 2013).

This thesis will set out to explain the current pension system in Norway and compare components to that of the old system. Further focusing on fully funded[1] occupational schemes, from the perspective of the employees, where historical data from 1900 until today will be used to calculate annual pension benefits as a percentage of the final salary

[1] The DC- and Hybrid scheme.

(the replacement rate) for hypothetical retirees under different options and asset allocation strategies. After the financial crises of 2008, there has been news bulletin with recommendation to choose downward scaling asset allocation in equity investments toward retirement age. This is referred to as a "life cycle strategy", and is meant to reduce a sudden downfall in portfolio value as one approaches retirement, where a higher expected return from the equity market is traded with a more certain pension capital at retirement (Shiller, 2006). The analysis will present different allocation strategies including: i) 100 per cent investment in equity, ii) 100 per cent investment in bonds, iii) A balanced portfolio including equal amount of equity and bonds at all times, and iv) the age dependent life cycle strategy. This to find out what benefits a retiree under the schemes of today would have earned under historical market conditions with fluctuation in risk factors, such as; wage growth, inflation and return on the different allocation of capital.

As the observations of retirees within the different schemes are few, the implications on future retirees are hard to forecast, and the literature on the subject of Norway is scarce. Our glance then turns to the literature on other countries that have experienced reform, as well as research made on the adequacy and robustness of the available schemes[2].

Antolin (2009) used historical data to calculate hypothetical replacement rates (RR) for defined contribution schemes in the US and Japan, while Burtless (2003; 2009) and Cannon and Tonks (2013) did similar analyses for several countries. These papers focuses on the financial- and labour conditions that affect the defined contribution schemes, and what actions could be taken to provide a higher degree of certainty in retirement income, such as; higher contributions, start working earlier, and timing the market.

Antolin and Stéphanie (2011) found that the life cycle investment strategies decrease downside risk, protecting individuals from negative stock market shocks close to retirement. Booth and Yakoubovt (2013) were less convinced about the purpose of life cycle strategies, and Shiller (2006) found that the probability of lower pension benefits

[2] The Hybrid solutions in other countries differ in composition, and are therefore not directly comparable, while literature on the subject of DC schemes is diverse.

was high when a conservative life cycle strategy with low equity composition was used, in comparison to a more aggressive approach.

We will measure the adequacy in retirement benefit using RR of 66 per cent as a benchmark[3] for the DC scheme, along with the fresh Standard-, and Basic Model of the Hybrid product. Furthermore, we will conduct an analysis of the life cycle strategy and the regulation fund in the standard model. This to answer the following question:

Under what conditions can the fully funded schemes in the private sector achieve a target RR of 66 per cent, and how do different life cycle strategies perform in comparison to the fixed asset allocation strategies?

Using historical average wage, wage growth and inflation from Norway, along with equity- and bonds returns from the US market from 1900 to 2014, we will calculate RRs for 75 hypothetical cohorts in the fully funded schemes of the private sector, retiring from 1940 to 2014. Our methodology follows previous work of Antolin (2009), Burtless (2003; 2009) and Cannon and Tonks (2013), but using longer historical data of Norwegian wage, wage growth and inflation.

This thesis is structured into three main sections. In the first part, “Pension Systems in the World Today” a wide scope over the pension systems of the world are presented, as well as demographic- and labour indicators that lead to reform in pension systems. The second part; “The Norwegian Pension System”, explains the main components of the Norwegian pension system. In the third part; “Risk and Performance analysis of Occupational Pension schemes”, we will analyse the fully funded pension schemes under historical market conditions. In this part we show the methodology and the summary of the underlying risk factors used in the analysis, before presenting the results, and discuss the implications of the results. Lastly limitations and further research is presented, as well as a summary of the main findings in a conclusion.

[3] DB scheme in Public sector that yields RR of 66 per cent of final salary at retirement in net of the social security scheme of today; a percentage that the government is aiming at for future retirees (NOU 2004: 1).

For readers with good knowledge on the Norwegian Pension System, section 3 might be considered as repetition, and can be skipped. This section is meant as a stepping-stone for the analysis in section 4. Nonetheless, section 3.1.2 and 3.2.5 might be of interest, where a residual between the old- and new pension system is calculated, along with the altering of risk factors through an analysis of the fully funded schemes in Norway.

2. Pension Systems in the world today

A feasible pension system is supposed to decrease poverty by redistribute funds from the wealthier part of the population to the less wealthy, as well as provide an insurance (majorly for risks related to inflation and longevity) of not having their living standards majorly capped after they hit retirement age. This is often referred to as consumption smoothing; a term related to the linear consumption path for an individual, without exogenous shocks, whereas the insurance and redistribution of funds that make the consumption smooth are factors of a trade-off for efficiency in labour and the growth of a nation's economy. (Asher 2010).

To achieve these core objectives the World Bank has set up a guiding framework called the "Multi Pillared Approach", consisting of: a "zero pillar" where a basic pension entitlement is ensured without any contributions paid, a "first pillar" mandatory scheme with contributions related to earnings, a funded mandatory defined contribution plan with private administration ("second pillar"), while the "third pillar" is voluntary (often private savings), as well as the "fourth pillar" being non-financial (informal support). (Holzmann, Hinz and Dorfman 2008).

Funded pension systems are often referred to as *actuarially fair*. This means the net present value of contributions made towards retirement should cover the expected net present value of future retirement benefits. (Jousten 2007).

2.1. What is a pension system?

Pension systems can be contributory or non-contributory, mandatory or voluntary, individual or occupational, and private vs. public. The sources of contributions can derive from workers or governments, and they can be funded partially or fully, or designed as *pay-as-you-go* systems, where the pension liabilities of today are paid by the current work force (Holzmann, Hinz and Dorfman 2008). Countries often make hybrid solutions, mixing components of different schemes: Argentina with their mixed contributory system, Chile with their mandatory private pension system, and Sweden with a three-component system; social security with a nationwide NDC scheme, alongside funded schemes for occupational pensions and private savings. (Tapia 2008).

According to OECD (2013) there are seven important characteristics of a good pension reform, or –system:

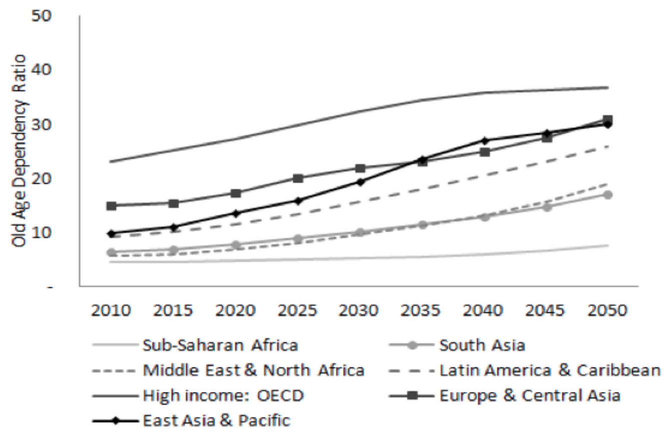
- Fighting poverty with redistribution of funds; **coverage**
- Ensuring a high *RR*; **adequacy**
- Maintain or provide **financial sustainability**
- Give **work incentives** to increase retirement age
- Ensuring low costs related to the scheme; **administrative efficiency**
- Assure sound policies that apply **diversification and security**
- Other policies that provide economic welfare on the macro economical level, such as crisis recovery and transitions necessary for reform; **other reforms**

The focus of this thesis is on adequacy of pension benefits after the Norwegian pension reform. The RR is used to measure adequacy since both the numerator and denominator are calculated at retirement time, thus provide comparable inter temporal values without the need of adjusting for inflation.

2.2. Todays' global situation and reasons for reform

The global demographic indicators such as fertility rate and mortality rate are important factors for an economically feasible pension scheme. Although the fertility rate is declining in the wealthier countries at the moment, the "Baby boom" generation that was born after World War 2 is now starting to adapt to a new way of life as pensioners. This, as well as longer life expectancy and changes in labour market indicators, that show low participation rates among the elderly population in high developed- and high coverage countries, suggests a high percentage of pensioners related to the working population. The most common measure here is the *old-age-dependency ratio*. This ratio divides the retirees with the workforce (in this case, 65+/(15-64)), giving an idea of the financial balance within the pension scheme. (Pallares-Miralles, Romero, & Whitehouse, 2012).

Figure 2-1 Old-Age Dependency Ratio (Ages 65+/15-64), by region and income group

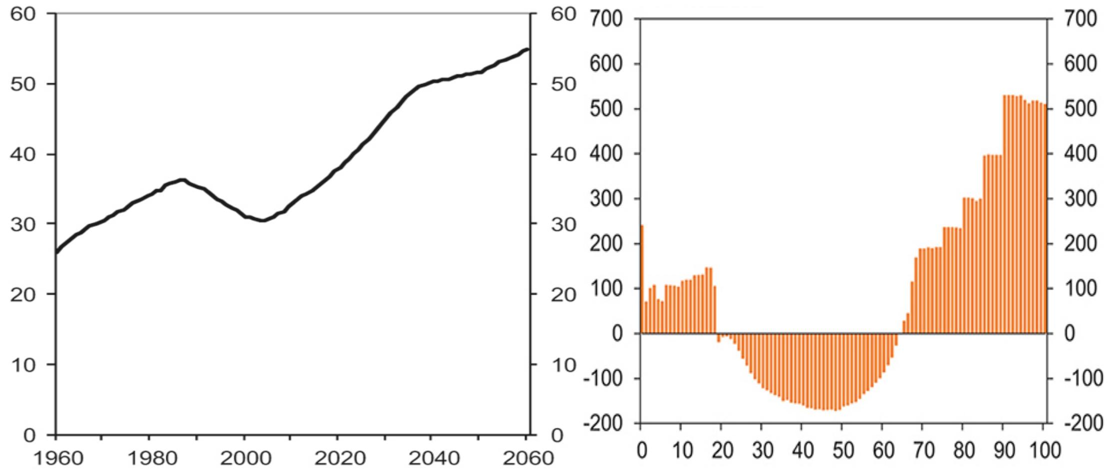


Source: (Pallares-Miralles, Romero, & Whitehouse, 2012).

From the graph above, we show that pensioners are increasing relative to workers all around the world. For high-income OECD countries (the upper line), the forecasts show that approximately three active workers are behind every retiree. The retirees are also expected to increase in number all the way up to 26.1 per cent of the overall population in developed countries by 2050 (Pallares-Miralles, Romero, & Whitehouse, 2012).

By looking at Norway alone, the effect of the aging population is even more evident. Here the working population is represented by the ages of 20-61. Since the pension reform of 2011 flexible retirement has made it possible to withdraw benefits from the age of 62, making the population of 62 and above a decent measure to represent the retired population. From being approximately three workers per pensioner today we see an expected old-age dependency ratio of just above 50 per cent in 2050, or just two workers behind every pensioner.

Figure 2-2 Old-Age Dependency Ratio in Norway (Age 62+/20-61) and *Net Transfers based on age in (1000 NOK)*



Source: *(Ministry of Labour and Social Affairs 2011)* Source: *(The Ministry of Finance 2014)*

The discovery of oil, and the constant income streams that followed, gave room on the national budget for further development of “safety nets”, without increasing the tax level. Given the projected conditions, a continued *pay-as-you-go* scheme would eat away the surpluses on the national budget and force countermeasures such as increased tax level. In fact, without reform the cost of old age- and disability pensions would have been expected to reach 18 per cent of GDP by 2050, a major increase from the liabilities of today (9 per cent of GDP). (Ministry of Labour and Social Affairs 2011).

2.3. Trend in the world

As an answer to the growing population many countries have implemented reforms throughout the world. Great uncertainty in adequacy for pensioners, and future costs imposed on governments, will make reforms and adjustments necessary for many countries’ pension scheme (Grech, 2010). Vittas (1994) argue that the implementation and design of feasible social security schemes is the most important factor of a well-run pension system. In its absence poor redistribution of benefits, manipulation in contributions, and other unfortunate effects, may arise.

The issues related to an informal pension scheme are more relevant for developing countries than for high-income OECD countries like Norway. Developed countries often have a formal scheme in place (OECD, 2013), but it is still the question of which scheme works best and maybe most importantly - under what conditions?

The *pay-as-you-go* scheme was the most dominant feature of funding in different social security schemes. In later years however, the trend has shifted towards funded schemes, or sometimes a mixture of the two. The reasoning behind the shift lies in the determinants of a sound *pay-as-you-go* scheme. Since the current workforce "pays the bill", pension benefits are reliant on factors such as population growth, the productivity of today's workforce, and the *old-age-dependency ratio*. In times when the economy performs badly and the unemployment is high, these factors make the government's financial balance suffer in a *pay-as-you-go* scheme, giving funded schemes more political attraction. This shift is seen in many countries in recent years. (Davis 2000).

The World Bank (1994) emphasize that growth in total earnings (wage growth and growth in population, an approximate measure of GDP) should be less than the return on investments at all times. Hemming (1998) comes to the same conclusion and states that if the opposite was true for a longer period of time (return on investment < growth in GDP) people would have an incentive to borrow, piling up debt, eventually forcing the real interest rate up to a level above the growth rate. According to Davis (2000), if the *dependency ratio* equals the *passivity ratio*[4] and the return on investments equals the wage growth, while other components remain constant, it is irrelevant what kind of funding it is. While a relatively higher *dependency ratio*, as well as a relatively higher return on investments, will favour a funded scheme.

The occupational schemes, the second pillar, have primarily been DB schemes in the past, but are now losing its market share to DC schemes. The DB scheme works as a security for each covered individual. Since the future benefit is given, the risk is shifted to the employer. A DC scheme is a form of saving and provides fixed cash inflows to an account that the future pensioner hold. This takes the uncertainty of cash outflows out of the equation for the employer, and shifts the risk to the employee. As DB schemes are fading out, DC schemes and mixtures of the two (hybrid schemes), increase their dominance around the world. (Broadbent, Palumbo and Woodman 2006).

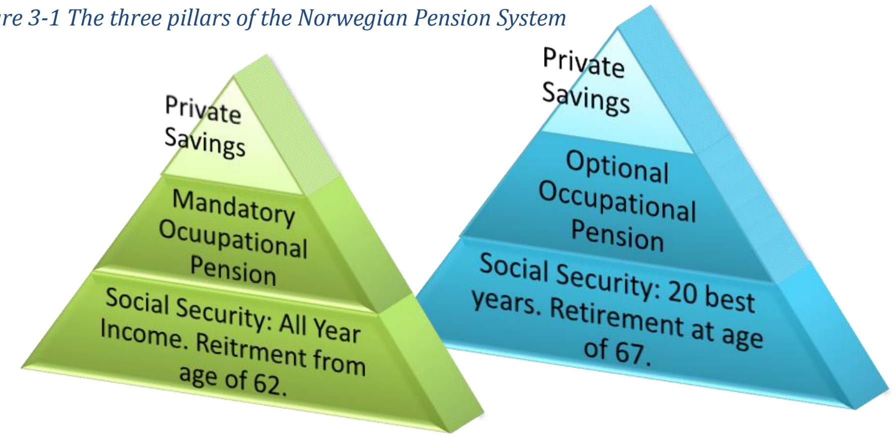
[4] Retirement years divided by years of employment.

In Norway, the same thing is happening. DC schemes are increasing, while DB schemes are fading out (see figure 3-8), giving space to hybrid schemes with components of both.

3. The Norwegian Pension System

The Norwegian pension system was introduced in 1967. It is a mandatory insurance and pension scheme managed by the Norwegian Labour and Welfare Service (NAV). After the reform of 2011, the Norwegian pension system is structured with three pillars[5]; the first two pillars are mandatory social security- and occupational funded pension schemes, while the third is a voluntary private scheme. It is a flexible pension system where the retirees can decide to retire from the age of 62 to 75, and how much benefit to withdraw. (Plahte and Nordstoga 2009).

Figure 3-1 The three pillars of the Norwegian Pension System



Source: Own figure. (New system to the left and old system to the right)

In this section we will map the structure of the Norwegian pension system, along with a brief explanation of the different pillars, as well as present examples calculating the RR under the different schemes in question. Throughout this section we will follow a hypothetical, single, pensioner, born in 1967, who starts working at the age of 27, and retire at 67, after 40 years of consecutive employment within the relevant scheme (without any unemployment risk). All contributions are made at the end of the year and

[5] The guaranteed minimum pension is to be considered a "zero pillar" since contributions are not made to receive the benefit. Nonetheless, it will be reflected in figure 3-1 as the first pillar, together with NDC.

accumulated with returns the following year (the contributions made the first year of employment, t, are accumulated with returns in year t+1, and so on). The wage level in the 40-year period is set to be different amounts, based on the average base amount [6](85 245 NOK in 2013, hereby referred to as "G"). The nominal wage growth and the growth in G are set at 4.20 per cent based on a ten-year average of pensionable income and G. Return on investments are 6.55 per cent deriving from historical values on bond- and equity returns.

Lastly, we assume the pension benefit payment profile to be paid as a lifelong payment[7]. For our calculation a unisex "annuity divisor", which divides the accumulated pension capital at retirement, is collected from NAV. This divisor is calculated for each cohort, and used for benefit calculation for the first pillar. In a report, Fredriksen and Stølen (2011) suggested that the average person is expected to outlive the life expectancy estimates incorporated in the annuity divisor calculated by NAV by two to three years. Of this reason, the divisor used in our calculations is above the one calculated by NAV with 10 per cent (as two to three years transfers into approximately 10 per cent), giving a divisor of 18.07 at age 67 in our examples.

Since the divisor from NAV is calculated for all cohorts, not representing the higher life expectancy of the working population over the unemployed, a further increase of 15 per cent in the divisor is made to reflect the ones receiving occupational pension. The divisor is then 20.78 for the new Hybrid product, and 21 for the DC scheme (to compare the RR directly), as DC scheme has the default option to receive benefits in fixed amounts over the retirement period. The calculated divisor for the social security scheme is imbedded with estimated mortality inheritance and under regulation of 0.75 per cent, while the adjustment removes this effect from the divisor because the members within the Hybrid scheme will receive actual mortality inheritance from members who die. (NOU 2012:13)[8]. The actual inheritance in the Hybrid scheme versus inheritance going to the heirs in the DC scheme, although an interesting subject of

[6] Introduced in 1967, the base amount is used to calculate pension benefits. The base amount is adjusted every year the 1. of May, in line with annual wage growth corresponding to the changes in earnings level.
[7] In addition to the NDC providing lifelong benefits, it is assumed that the new Hybrid product also will have lifelong benefits as their default option.
[8] Page 97-98.

debate, are not discussed in any further detail in this thesis. The only adjustment made is that a Mortality Cross Subsidy factor of 4.5per cent[9] is added to the accumulated pension capital at retirement in the Hybrid product.

The RR, calculated from annual benefit and final year salary, fail to measure the absolute value of the annual pension benefit. Biggs and Springstead (2008) provide an overview of different alternatives for calculating the RR; based on final earnings, present value payments, wage-indexed average earnings and real average earnings.

Bajtelsmit, Rappaport and Foster (2013) argue that the RR cannot describe the circumstantial differentiation between individuals. Furthermore, the calculated relationship ends at retirement since it just measures the relationship between working income and retirement income at retirement. As the RR assumes earlier income to be consumed, the RRs may not be appropriate benchmark for high-income individuals, or those with greater than average savings rate.

In an official Norwegian Report (NOU 2004: 1), the Finance Department used a RR of 66 % as target rate for Norwegian retirees, based on the average wage level. This, as single retirees were expected to get 60 per cent and married were expected a 73 per cent RR, averaging out to approximately 66 per cent. This target rate was based on the old pension system, but is used in this thesis since public sector employees have not been effect by the change in pension system and have guaranteed pension benefits of 66 per cent of final year salary. Throughout our analysis we therefore measure adequacy using the RR calculated at retirement. This rate can easily be compared across individuals, competitors and cohorts[10].

All these assumptions provide the basis for what we will refer to as the "Constant Model" in section 3, and an overview over the main assumptions are provided in the Appendix (see table 20).

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[9] According to AON presentation, the benefits are between three and six per cent higher when mortality inheritance is given back to the members.
http://www.vff.no/Internett/Fakta_om_fond/filestore/Frakollektivttilindividueltinvesteringsvalg_Ellingsen.pdf

[10] In this thesis we assume that the reformed pension system is fully applicable, thus we do not look at transition rules.

Main findings in this section:

- The minimum pension, so called guaranteed pension, in NDC provides high RRs for low-income workers, while the individual with income above the scope of guarantee pension receive lower RR.
- There is a significant residual between the payout from the old- and reformed pension system.
- Under current market conditions, almost 50 per cent of employers contribute only the minimum level of two per cent in the DC scheme, giving an insufficient retirement benefit, increasing the importance of private savings for future retirees in the private sector.
- Benefits from schemes in the private sector have become more volatile between- and within cohorts after the reform, while the public sector still has more predictable benefits.

3.1. The New Social Security Scheme

Under the social security scheme of today, individuals who have been living in Norway (registered under the National Insurance Scheme) for at least three years are entitled to a minimum guarantee pension, while entitlements beyond this are based on an individual's income contribution into a Notional Defined Contribution scheme. (Plahte & Nordstoga, 2009).

NDC is a fictional account showing an individual's accumulated pension right at retirement age. The annual contribution to the NDC-account is 18.1 per cent of pensionable income up to 7.1G, for ages between 13 and 75. During the contribution time, accumulated pension contributions are indexed in line with average wage growth in Norway. At the time of retirement the annual pension benefit is calculated by dividing the accumulated pension right using an annuity divisor. This annual benefit increases in line with wage growth less 0.75 per cent, which is reflected in the divisor. (Plahte and Nordstoga 2009).

Contributions into the NDC scheme are accumulated in the following way:

Equation 1[11]

$$P_{NDC,t} = \sum_{i=1}^{t} Y_{t-i+1} \prod_{j=1}^{i} (1 + w_{t-j+2})$$

Where wage growth at time $w_{t+1} = 0$ and $t = 1,\ldots,R$

R = Age at retirement less the age when the member start contributing *(40 for one who starts working at the age of 27 and retires at the age of 67).*
$P_{NDC,t}$ = Accumulated pension right at retirement.
Y_t = Total contributions each year (Pensionable income in year t multiplied by the accrual coefficient of 18.1 per cent).
w_t = Annual wage growth at time t.

Since contributions are assumed given at the end of the year, the first period (t=1) will provide only that value (Y_1), since $w_{t+1} = 0$, the second part $(1+w_{1-1+2}) = 1$.

If t = 1, then:

$$P_{NDC,1} = Y_{1-1+1}(1+w_{1-1+2}) = Y_1$$

The second period (t=2) will cancel out $(1+w_{2-1+2})$ both times it appears. The first year of total contributions will then be accumulated with the wage growth of the next period, adding the contribution at the end of that year.

If t = 2, then:

$$P_{NDC,2} = Y_{2-1+1}(1+w_{2-1+2})+Y_{2-2+1}(1+w_{2-1+2})(1+w_{2-2+2}) = Y_2+Y_1(1+w_2)$$

For the third period (t=3) the $(1+w_{3-1+2})$ will equal one, accumulating the total contributions of the two first years to period 3, as well as adding the total contributions of year 3.

[11] We thank Associate Professor Jukka Lempa for providing insights.

If t = 3, then:

$$P_{NDC,3} = Y_{3-1+1}(1+w_{3-1+2})+Y_{3-2+1}(1+w_{3-1+2})(1+w_{3-2+2})+ Y_{3-3+1}(1+w_{3-1+2})(1+w_{3-2+2}) (1+w_{3-3+2}) = Y_3+Y_2(1+w_3)+Y_1(1+w_3)(1+w_2)$$

This will go on until the final contributions are made at t = R, giving the total accumulated pension capital at retirement. This because it is assumed that the person retirees at the beginning the following year as there is no accumulation of the last year's total contribution.

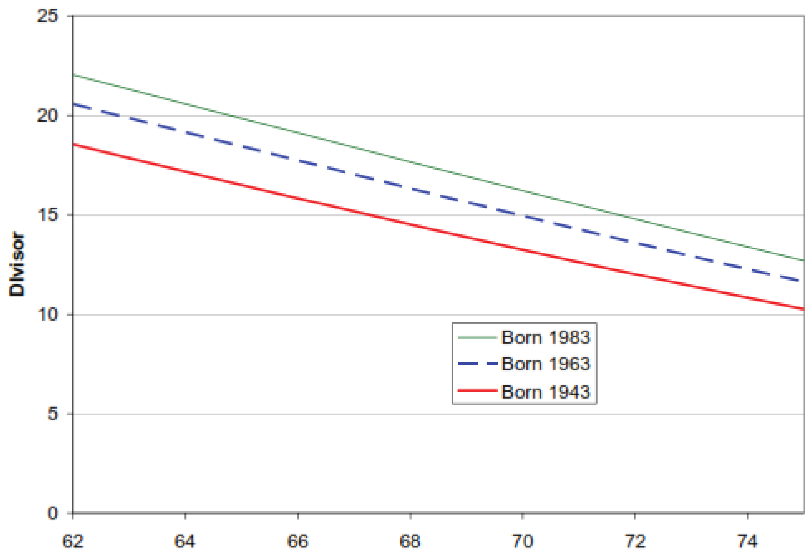
The Divisor:

Annual pension benefits for an individual in a cohort are calculated by dividing accumulated pension contribution in the NDC scheme with the respective cohort's annuity divisor. Divisors for retirement between 62 and 75 are available June 1th when the cohort reaches the age of 61, with no further adjustments made after this point in time. The divisor's main objective is to reflect each cohort's life expectancy (Veland 2013, Ot.prp. nr. 37(2008-2009) 2010).

The divisor is calculated based on historical mortality rates, a ten-year retrospective average to avoid random variations in mortality from the previous cohorts. An average mortality inheritance based on 40 years of lost pension entitlements from deaths within the scheme is credited for each cohort. Divisors are then adjusted for average wage growth, making sure pension benefits reflect the current wage level at all times, before cutting off 0.75 per cent as a regulatory limitation imposed by the government. When calculating the divisor interest rates are assumed to be equal to the wage growth. (Fredriksen and Stølen 2011a; Ot.prp. nr. 37(2008-2009) 2010).

As a retiree you can choose to withdraw benefits from the age of 62. Calculated annuity divisors for different retirement are designed to be *actuarially neutral*. Which means that the sum of benefits received during the retirement period are independent to when the withdrawal of pension entitlements starts (Queisser and Whitehouse 2006). This is only true when the life expectancy of the individual is approximately the same as the average in its cohort. It is also known that income highly correlates with life expectancy, giving the wealthier part of the population an advantage over the poorer (Legros 2003). In other words, pension benefits from NDC alone are redistributed inadequately, thus the need of a guaranteed minimum pension.

Figure 3-2 Divisors by retirement ages for different cohorts



Source: (Fredriksen and Stølen 2011b, 9)

We show in figure 3-2 that the longer one waits to withdraw their pension benefit the lower the divisor, reflecting shorter remaining life expectancy. When a person chooses to retire earlier, the pension benefit is lower since the accumulated pension right is adjusted for longer life expectancy.

Guarantee Pension:

To ensure decent living standards after retirement for persons with non- or low-income level during the accrual period, the government has ensured a minimum level of pension income from the age of 67. Everyone who have lived in Norway for at least 40 years are entitled to full guarantee pension, while benefits are reduced accordingly for a lower periods. Guarantee pension will be reduced by 80 per cent of accumulated pension right in NDC scheme. Full guarantee pension is given to immigrants regardless of how long they have lived in Norway. To retire before the age of 67, the accumulated pension right from the NDC scheme must at least equal the minimum pension. (NAV n.d., §20-19 & § 20-20).

The guaranteed pension level is fixed at the same level as the highest minimum pension from the old pension system, being 2G in 2013, where the benefits payment are indexed in line with average wage growth less 0.75 per cent. Different level of guarantee pension is paid for married-, unmarried- and disabled retirees. Married retirees are paid lower guarantee pension level (155 372 NOK in 2013), than single retirees (170 490 NOK in 2013).

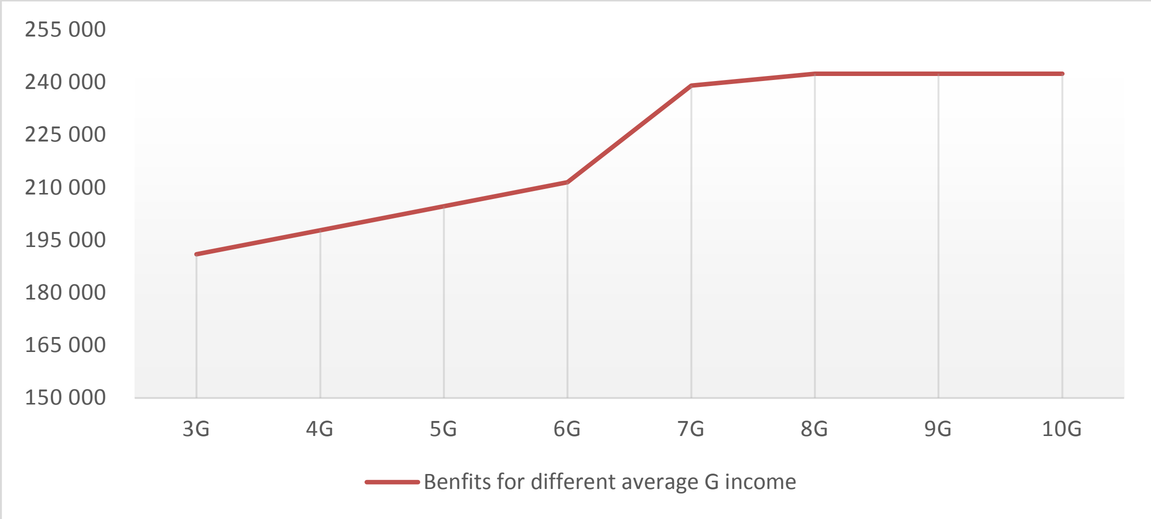
Table 1 Benefit from NDC for different average income over 40 years, retiring at the age of 67.

Income	Accumulated pension right	Accumulated Guarantee pension	Benefit from NDC	Benefit from Guarantee pension	Total benefit	RR (%)
3G	1 851 521	1 600 049*	102 447	88 533	190 979	74.7
6G	3 703 043	118 832	204 894	6 575	211 469	41.4
9G	4 381 934		242 457	-	242 457	31.6

Notes: * 1 600 049 NOK = 3 081 266- (1 851 521*0.8). Payout from Guarantee pension is reduced by 80 cents to every 1 NOK of the accumulated pension right. Total guarantee balance at age 0f 67 is calculated by multiplying 2G with respective divisor for retirement age of 67: 3 081 266 NOK = 2 * 85 245 * 18.07.
Source: (Own calculations, using the constant model assumption)

Table 1 show that the RR is higher for lower income but lower for higher income. This, since accumulation is capped at 7.1 G and the guarantee pension effect gives a higher RR for individual with lower income. From figure 3-3 below we show that until average income of 6G the benefit increases gradually, while there is a gentle increase in benefit from average income of 6G to 7.1G. This gentle increase in benefit is caused by the gradual reduction in payment from guarantee pension (80 per cent of NDC) until 6G. Benefits are flat for income above 7.1 G, as contribution in the accumulation period is capped at 7.1 G.

Figure 3-3: Pension benefits from guarantee and NDC pension for different average income over 40 years.



Notes: Calculation is done for different 40-year average wages measured in G, and a divisor of 18.07.
Source: (Own calculations, using the constant model assumption)

To compare RR from the 20 best years of income (old scheme) to all year income (NDC), we will calculate RR from the old pension scheme in the next section.

3.1.1. The Old Social Security Scheme

Benefits from the old social security scheme consisted of three different components: Residence-based minimum pension, earning-based supplementary pension (SP), and old age-, disability- and survivors' pension. Normal retirement age was 67. Basic pension, 1G, was paid to everyone regardless of earlier income[12], while full benefit was paid to individuals with membership of 40 or more years in the National Pension Insurance. For missing membership, the benefit was capped accordingly. (Plahte and Nordstoga 2009).

Minimum pension was received from the age of 67 for individuals who had lived in Norway more than three years, and had low- or no income during their working life. Minimum pension was a combination of basic pension plus a lower-income supplement (LS). The LS was set to 1G, while higher or lower per cent of the benefit was paid

[12] Single retirees were offered 1G in addition to supplementary pension benefits, while couples got 85 per cent of the base amount. Different rules applied regarding income of partner.

according to household earnings and dependency under retirement period. (Plahte and Nordstoga 2009).

Individuals with lower income would have received basic pension plus the LS component if the SP were lower than the LS, 1G. SP was calculated using pension points (p), where individuals received points for income between 1G and 6G, and one third of pensionable income between 6G and 12G. Maximum points one could earn each year was seven. Benefits were calculated using an average of the 20 best pension points, multiplied by a factor 0.42[13]. (Plahte and Nordstoga 2009). Maximum supplementary pension each year was then 2.94G (7*0.42*G).

Equation 2

$$P_{old} = b + Max(SP, LS)$$

P_{old} = Annual pension benefits.
b = Basic pension (1G if single).
SP = Supplementary Pension (0.42*G*p[14]).
LS = Lower-income Supplement (1G if single).

Table 2 Annual pension benefits from the old social security scheme for 3-, 6- and 9G.

Average Income	Average Pension Point	Basic Pension	Supplementary Pension	Pension Benefit	RR (%)
3G	2	85 245	Max (1G, 71 605)	170 490	66.7
6G	5	85 245	Max (1G, 179 014)	264 260	51.7
9G	7	85 245	Max (1G, 250 620)	335 865	43.8

Note: For individuals retiring at the age of 67 with different average income over 40 years, measured in G
Source: (Own calculations, using the constant model assumption)

Similar to NDC, the RR was higher for low-income workers and lower for high-income workers. Since guaranteed LS pension was reduced for each NOK earned in the supplementary pension (SP), while the reduction is 80 per cent in NDC, the low-income

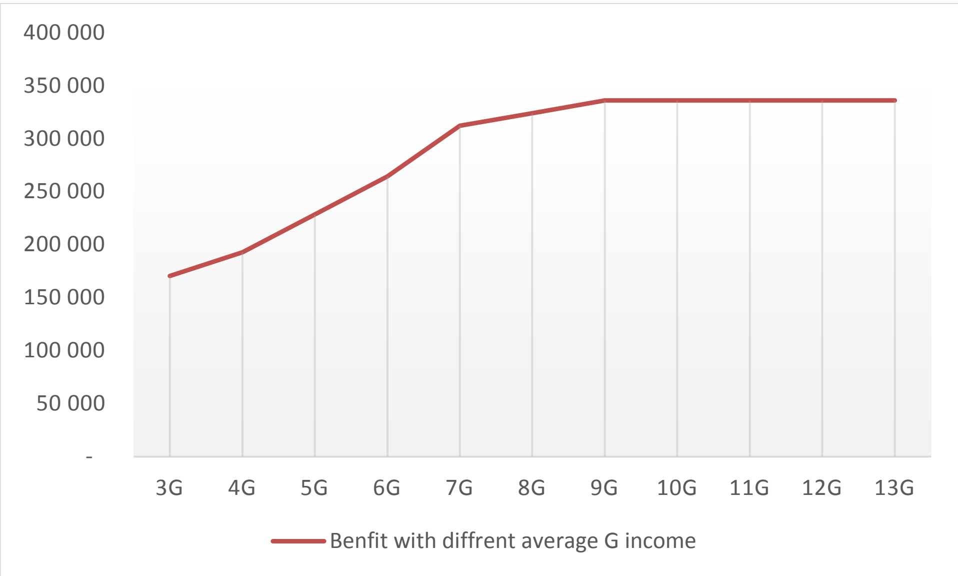
[13] This factor was changed in 1992 from 45 – to 42 per cent, as well as maximum pension points changed from 8 to 7 points. In our example we assume the factor to be 0.42, and the maximum pension points to be 7, when calculating the benefit.

[14] Pension points $=\frac{Income-1G}{1G}$, up to 6G of income. For income over 6G further pension points = $\frac{6G+0.33*(Income-6G)}{1G}$, where a maximum of 12 G is accounted for.

workers received lower RR in the old pension system compared to NDC. Since NDC pension caps income at 7.1 G, individuals with higher income received higher RR under old system. (Plahte & Nordstoga, 2009).

From figure 3.4 we show that the there is a steeper increase in pension benefits from 4G to 6G average incomes reflecting the effect of LS pension and entitlements from the supplementary pension. Effects of receiving one-third of income above 6G, and the maximum pension points of seven, gave flat benefits for individuals with average income above 9G over the 20-year period. The maximum pension benefit one could receive was 3.94 G. While in NDC the maximum pension one could receive was 2.84 G, meaning that individuals with higher income received higher benefits in the old scheme compared to the new. After further analysis in the next section we find that there is a significant residual for individuals with higher average income.

Figure 3-4 Annual pension benefits from the old social security scheme for a given average 40-year income.

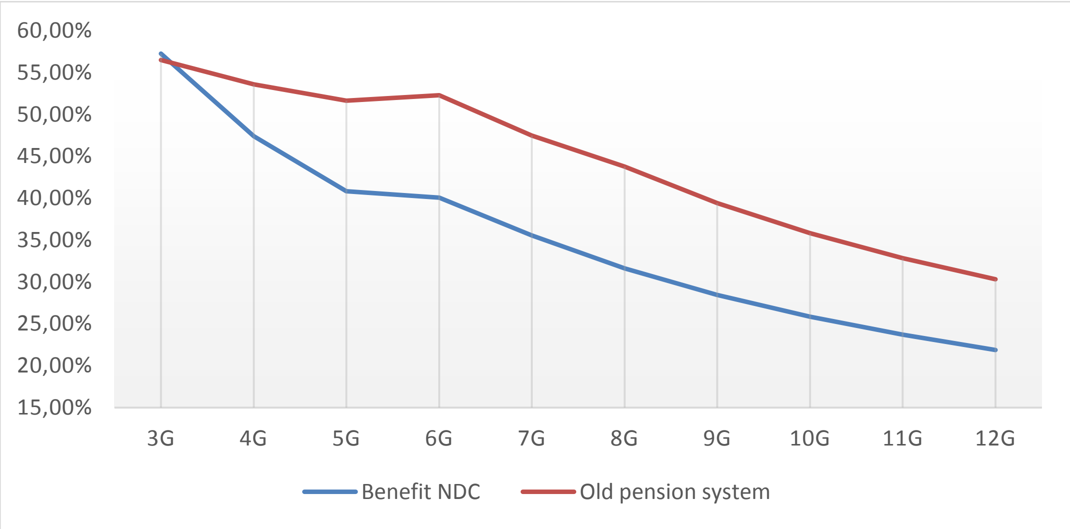


Source: Own calculations, using the constant model assumption

3.1.2. Benefits from New Scheme versus Old Scheme

This new actuarial system with flexible retirement age and amount to withdraw, as well as the possibility of having other income on the side, has made annual pension benefits more volatile than before, also between individuals, as retirees are now baring more risk for the benefit amount in excess of the guaranteed pension. Individuals are now greatly exposed to variation in pension benefits in context of being unemployed[15]. Adding the adjustment for life expectancy has shifted the longevity risk to individuals[16]. (Plahte & Nordstoga, 2009).

Figure 3-5 RR at retirement for different average wages under the new- and the old social security scheme.



Source: (Own calculations, using the constant model assumption)

The RRs in figure 3-5 indicates that annual benefits are constantly lower from the NDC scheme compared to the old pension scheme. Since both schemes include a minimum guaranteed pension there is little difference before individual reaches an average wage level of 5G. For persons with an average 40-year income between 5 - 9G the difference in RR is highest, representing a loss in annual benefit of between 23 818 and 93 408 NOK (a loss of more than 1G). As average wage in Norway was 489 200 NOK in 2013 (SSB[17]), almost 6G, this loss in pension income affects a larger part of the population. Because the income is capped at 7.1G in NDC the residual is largest between 7.1 and 9G, where the maximum pension is achieved in both schemes. Higher income than 9G would give a constant residual of 93 408 NOK. The RR will nonetheless decrease because there will be a higher figure in the denominator as a result of an increased wage level.

[15] Like other European countries, Norway has a social security ("safety net") for unemployed individuals, which pays unemployment wage until they get a job. But the amount itself is not big compared to the average wage level.

[16] Pension benefits are calculated based on life expectancy. The government (or the taxpayers) bares the risk of individuals living longer than expected, but introduction of this variable does make pension benefits dependent on expected life for the calculated cohort.

[17] www.ssb.no/lonnansatt/

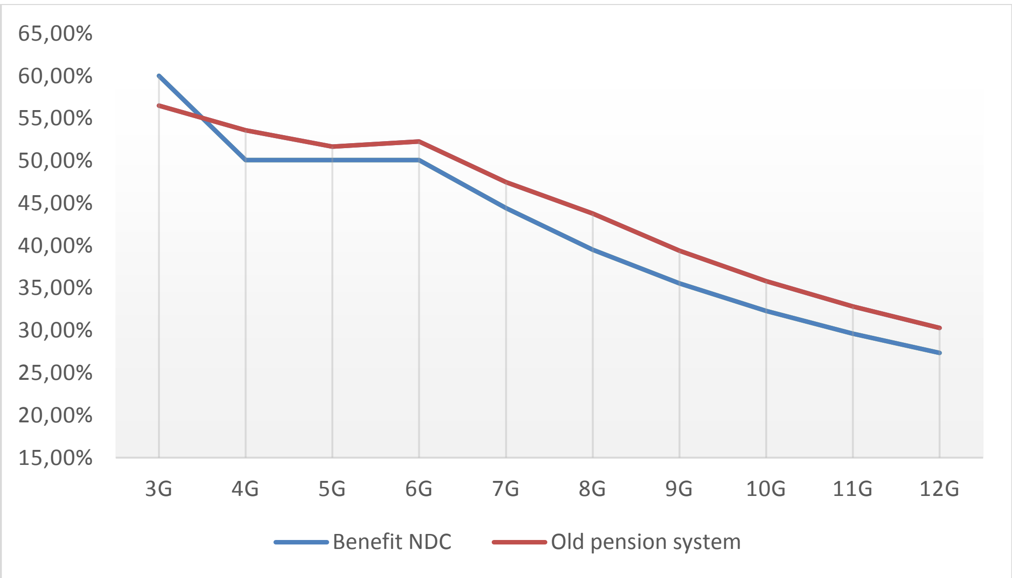
Table 3 Difference in RR (%) from the new- and old social security scheme, with average income measured in G.

Income	NDC	Old Scheme	Residual
3G	74.7	66.67	8.0
6G	41.3	51.67	-10.3
9G	31.6	43.78	-12.2

Source: (Own calculations, using the constant model assumption)

For persons with low average income the residual is positive (table 3), thus the payout from NDC is higher than from the old system. In section 3.1 we saw that the LS were given if not the supplementary pension was higher, max (LS, SP). In NDC scheme the guaranteed pension is overlapping (80 per cent rule), with the earning-based component providing a higher pension benefit for low-income workers. For medium- or high-income workers the decreases in benefits are highly relevant.

Figure 3-6 Benefits from the NDC versus the old social security scheme with 50-year income



Source: (Own calculations, using the constant model assumption)

On the other side, since all contributions between the age of 13 and 75 are accounted for in the NDC, individuals can get higher RR by contributing more years. If the individual in the constant model contributes for 50 years instead of 40, working from the age of 17 to 67, the RR from the NDC increases, but the residual is never covered (figure 3-6) since contributions are capped at 7.1 G.

3.2. Occupational Pension

After the Mandatory Occupational Pensions Act of 2006, all Norwegian employers in the private sector are obligated to have an occupational pension scheme for their employees above the age of 20. Employees working less than 20 per cent of full position, sole proprietorships and those without an employment contract do not fall under this act. Employers in the private sector are required to have DC-, DB- or hybrid pension schemes for their employees, where pension funds, life insurance companies, banks and mutual funds can provide this scheme (hereby referred to as underwriters). (Finans Norge 2011, Norwegian Public Service Pension Fund 2011). The Hybrid product was applicable from January 2014, giving employers more flexibility in the design and funding within the occupational pension plan they provide to the employee. (Ministry of Finance 2013).

3.2.1. Defined Benefit (DB)

The DB scheme is a pension scheme where employees are guaranteed a certain percentage of final salary before retirement as annual pension benefits. A percentage of the employee's salary is deducted (normally two per cent), usually two per cent, while individuals will receive a pre-agreed pension income regardless of economic condition and other macro-economic variables affecting the premium cost. Retirees, who have been members of a DB pension scheme for 30 years or more, will receive maximum annual pension benefits. Benefits are capped accordingly for those who do not satisfy this requirement. (Plahte and Nordstoga 2009; Norwegian Public Service Pension Fund 2011).

Under this scheme there is certain differentiation in annual benefits for employees in the private- and public sector. In the private sector, benefits from DB schemes are not harmonized with benefits from the NSI scheme. In contrast, public sector DB is paid out as a proportion of final salary, approximately 66 per cent, making DB benefits equal 66 per cent less the benefits from NIS. (Veland 2013).

As the calculated level of benefits from the DB scheme is a certain percentage of the final salary, workers have a strong incentive to keep the wage level high when they are close to retirement. When individuals change their working place, or terminate their contract, they would receive a pension capital certificate for the contribution firm has made. However, since there is no further contribution into the scheme the benefits tend to be lower than the targeted RR (Plahte and Nordstoga 2009). A person earning 6G with more than 30 years in the scheme will then get 337 570 NOK in annual pension benefits[18].

3.2.2. Defined Contribution (DC)

Under the DC scheme, annual contributions are accumulated in an individual account, adjusted by the return on the accumulated portfolio until retirement, before it is transformed into a stream of fixed payouts. In the DC scheme the employer covers contributions and administration costs. Employer's expenditure is tax deductive, while for employee's it is a tax-deferred pension entitlement, thus taxed when withdrawn. (Veland 2013).

The constitutional minimum contribution is two per cent of employees' salary from 1G to 12G, where the employer can contribute a maximum of seven per cent of employees' salary from 0G to 12G. On top of the seven per cent, a contribution of maximum 18.1 per cent is allowed for salary between 7.1G and 12G[19].

Employees' benefits depend on contributions and investment return, where employers can choose from three of the following models for investment of pension capital for the scheme they sponsor (Finans Norge 2011):

- Management (collective investment) of all contributions is done by the underwriter according to the investment rules of the institute.
- The company can appoint an internal management team, which is responsible for making investment decisions for all members (employees).

[18] 511 470 NOK*66 % = 337 570 NOK

[19] Under implications of the new occupational pension product in 2014 the floor (1G) of employee contribution was made optional in both the hybrid– and the DC scheme, along with the increase in contribution rates, as well as the breaking point for supplementary contribution (from 6 to 7,1G).

- Each employee gets their individual account and right to manage the investment and risk within predefined limits.

Employees have to carry the risk of investments fluctuating in value unless the employer has agreed a guaranteed return with the insurer. When the employees change their working place they will receive a pension capital certificate for the accumulated contribution from the previous employer's DC scheme, condition that they have worked twelve month or more. The employer covers the costs of issuing these certificates, while individuals are liable for costs regarding investment and management of this capital in their pension capital certificate. Normally, insurance providers deduct costs on the individual's account directly by reducing accumulated pension capital. (Plahte and Nordstoga 2009; NOU 2010: 6).

An individual can choose to withdraw benefits from the DC scheme while working, fully or partly, from the age of 62. Benefits from this scheme consist of a net amount, as it is not incorporated with benefits from the NIS. The withdrawal must be at least 20 per cent of G (at retirement age), and the benefits must be paid out over the course of at least ten years, and lasting until the age of 77. (NOU 2010: 6). In other words, individuals who start to withdraw benefits from the age of 62 will receive lower benefit each year since the withdrawal period must be 15 years in this case. There is no requirement of actuarial adjusted payment[20].

As mentioned above, the payout from this scheme is generally done as a saving agreement, but employers can agree upfront on an insurance-based payment (lifelong). Under insurance-based DC scheme, a higher contribution must be paid for women, since they have a longer life expectancy than men do. At the time of retirement, regardless of pre-agreed format of payment method, employees can decide whether to get benefits as a saving agreement or pension insurance. Concerning administration cost a lump-sum benefit can be paid to individuals with low accumulated pension. Annual benefits during payout is regulated normally from surpluses. When an individual within the scheme suffers an early death, the accumulated benefits transfers to the heirs. DC schemes are not required to have disability pension insurance but should contain a protection that

[20] There is no annuity divisor used to calculate annual payments in a DC scheme.

ensures the employees' continued earning of pension entitlements in the event of disability, meaning that the contribution to DC scheme is continued even though the employee has been unemployed because of disability. (Plahte and Nordstoga 2009; NOU 2010: 6).

In contrast to the DB scheme, benefits in the DC scheme are based on market performance, and therefore unknown until retirement. The total benefits depend on total years of contribution, contribution amount, return on investment, and the pre-agreed withdrawal period.

The contribution is accumulated in the following way[21]:

Equation 3

$$P_{DC,t} = \sum_{i=1}^{t} Y_{t-i+1} \prod_{j=1}^{i} (1 + r_{t-j+2})$$

Where return at time $r_{t+1} = 0$ and $t = 1,\ldots,R$

R = Age at retirement less the age when the member start contributing *(40 for one who starts working at the age of 27 and retires at the age of 67)*.
$P_{DC,R}$= Accumulated pension right at retirement time, R
Y_t = Total contributions each year (Pensionable income in year t multiplied by the corresponding contribution rate)
r_t = Annual return on investment in year t.

To give a simple example we use average values for wage, W, maximum contribution rate, c[22], geometric factor, g[23], and the real return, r_{real}[24]. Annual benefits under the

[21] Since contributions are assumed given at the end of the year, the first period (t=1) will provide only that value (Y_1), since $r_{t+1} = 0$, the second part $(1+r_{1-1+2}) = 1$. This is exactly the same calculation as when the benefit from NDC was calculated (see equation 1), except that now the return on investment is accumulating the total contributions instead of the wage growth (w_t is replaced by r_t).
[22] Seven per cent for wage equivalent to 6G
[23] $g = \frac{(1+r_{real})^R - 1}{r_{real}}$
[24] $r_{real} = \frac{(1+r)}{(1+w)} - 1$

constant model, earning 6G over 40 years will then be 108 875 NOK[25] from the DC scheme alone, a number equivalent to 21.29 per cent of income (6G).

3.2.3. Contractual Early Retirement Pension (AFP)

AFP is an earlier retirement pension scheme that originally was created as substitute retirement scheme for workers in heavy industries who were unable to continue working until the regular retirement age. To be entitled to benefits individuals in the private sector must work in enterprises connected with this scheme, while all public sector employers have this scheme as a standard pension product for their employees. After the reform AFP differ significantly in public and private sector. During the retirement period, benefits from both private and public sector are indexed with average increase in wage, reduced by 0.75 per cent. (Plahte and Nordstoga 2009).

In 2008, AFP in the private sector was changed into a lifelong supplement to the benefits received from the National Insurance Scheme. Benefits can be withdrawn from the age of 62 to 70 and can be combined with other pension schemes while working desirable hours. If individuals choose to withdraw AFP, they must draw portion of benefits from the NDC scheme also, from 20 to 80 per cent. Annual contributions are 0.314 per cent of all pensionable income earned (up to 7.1 G) until 61 years of age[26]. Benefits are also adjusted for life expectancy, thus the longer one waits to withdraw the funds, the higher the benefit. (Veland 2013; NAV 2011 a).

In the public sector, AFP is still an optional earlier retirement scheme between ages of 62 and 67. It is optional for employees to draw these benefits, but those who retire before the age of 67 are the only ones that can collect payment from this scheme. Benefits are equal to the amount individuals would have received from the National

[25] $P_R = \frac{Wcg}{D_{DC}}, P_{40} = \frac{6G \times 7\% \times 63.86}{21} = \underline{\underline{108.875 NOK}}$

[26] NOK 19 200 is paid as a fixed supplementary if AFP is drawn before the age of 67, this to reflect the same level as in the payout from the old AFP system. There by higher level is increased each year until age of 67.

Insurance scheme from the age of 67, plus an annual supplement of NOK 20 400[27]. (Veland 2013, NAV 2011 a).

We will not take AFP into account further in our analysis since everyone is not covered by it, and although it is a supplement to occupational pension schemes, it is not exposed to market risks compared to the fully funded schemes. Being an early retirement scheme in the public sector also makes it less relevant when the retirement age is set at 67 years.

3.2.4. The Hybrid Product

A new occupational pension product was introduced in January 2014: An insurance-based Hybrid scheme, along with the reform in the Occupational Pension Act. This product features a mixture of DB and DC, and is claimed to be a substitute to DB schemes in private sector. Minimum contribution is the same as for the DC scheme; two per cent of wages from 1-12G, with the option to start contribution from the first NOK salary. Maximum contribution is seven per cent for employee's salary up to 12G[28]. Higher supplementary contributions of 18.1 per cent are allowed for salary between 7.1 and 12G. This scheme comes with two different models, basic and standard, and different options under each model for the employer to choose from, affecting the risk ratio between employers, underwriter and employees. (Innst. 35 L (2013-2014) 2013).

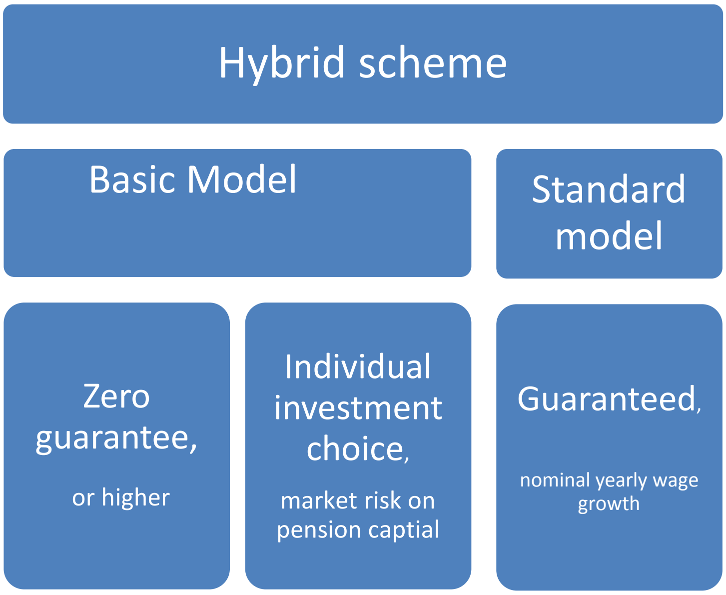
Hybrids schemes features a zero return guarantee rule, meaning that the nominal value of pension capital may not fall from one year to the next, whereas the underwriter can bill the employer for expenses of providing zero return guarantees. The employer can choose to offer higher guarantees than zero[29]. Pension capital is accumulated annually, while the contributions are regulated by return on investment or guaranteed upper regulation each year, plus actual mortality inheritance. Along with contributions during working years, employers pay the administration- and management cost under the accumulation and payout period. Similar to DC, when employees changes or terminates

[27] Different level of benefits is paid for individuals working in different working place, state or county/municipality, and from the age of 65 it is paid as 66 per cent of final salary.
[28] It was suggested to have a higher contribution rate for the basic model (8% until 7,1G, and totally 26.1 % between 7.1 and 12G), but this was never legislated. (NOU 2012: 13).
[29] Higher guaranteed level cannot be agreed for more than a period of five years, and not higher than the FSA upper limit, 3 per cent.

their work before retiring they are provided with an earned pension capital certification and an insurance of continued contribution into the scheme in event of disability before retirement. The employer covers the costs connected to the pension capital certification. (Innst. 35 L (2013-2014) 2013).

Since the scheme is insurance-based, and generally a lifelong payment, employers are required to contribute with higher contribution rate for female employees than for male, as females historically live longer than men do. It is estimated that female employees will cost employers an excess of 90 NOK per month with the lowest contribution rate and lowest wage level, and an excess of 2 000 NOK per month with highest contribution rate and highest wage level. (Innst. 35 L (2013-2014) 2013).

Figure 3-7 Components of the Hybrid product.



Source: Own Figure

The Basic Model: Regulation of contributed and accumulated pension capital is done in line with return on investment. Generally, there is a zero return guarantee for pension capital in case of negative return from investment. Employers can agree to create their own investment portfolio, accounting for all the employees' pension capital. Return from this investment portfolio is used to regulate the pension capital and the employers are required to provide zero return guarantees, thus need to cover any negative return from

investment. Furthermore, employers can provide employees with the right to create and invest in their own individual investment portfolio. Under this option the zero guarantees is not applicable. The employers cover general costs from the scheme, but if employees are allowed to create their own portfolio then the special cost (e.g. brokerage commissions etc.) can be tipped upon the employees'. (Innst. 35 L (2013-2014) 2013).
The general model with zero return guarantees will be[30]:

Equation 4

$$P_{B0,t} = \sum_{i=1}^{t} Y_{t-i+1} \prod_{j=1}^{i} (1 + \max(0, r_{t-j+2})) + M$$

Where return at time r_{t+1} = 0 and t = 1,…,R

R = Age at retirement less the age when the member start contributing *(40 for one who starts working at the age of 27 and retires at the age of 67).*
$P_{B0,R}$= Accumulated pension right at retirement time, R
Y_t = Total contributions each year (Pensionable income in year t multiplied by the corresponding contribution rate)
r_t = Annual return on investment in year t.
M = Mortality Cross Subsidy

The mortality cross subsidy, M, is accumulated until retirement giving the retiree an unknown supplement to his or her pension based on the inherited pension entitlements within the scheme. Mortality cross subsidy will be calculated like an add-on to the total pension benefit at retirement (4.5 per cent in our example).

The zero guarantee rules is not applied when employees are provided the right to create their own investment portfolio, thus employees' pension capital are exposed to the risk of negative return from their investment[29].

Equation 5

$$P_{B,t} = \sum_{i=1}^{t} Y_{t-i+1} \prod_{j=1}^{i} (1 + r_{t-j+2}) + M$$

[30] Since contributions are assumed given at the end of the year, the first period (t=1) will provide only that value (Y_1), since r_{t+1} = 0, the second part ($1+r_{1-1+2}$) = 1. This is exactly the same calculation as when the benefit from NDC was calculated (see equation 1), except that now the return on investment is accumulating the total contributions instead of the wage growth (w_t is replaced by r_t).

Where return at time r_{t+1} = 0 and t = 1,…,R

R = Age at retirement less the age when the member start contributing *(40 for one who starts working at the age of 27 and retires at the age of 67).*

$P_{B,R}$= Accumulated pension right at retirement time, R (Basic without zero guarantee).
Y_t = Total contributions each year (Pensionable income in year t multiplied by the corresponding contribution rate).
r_t = Annual return on investment in year t.
M = Mortality Cross Subsidy.

The mortality cross subsidy, M, is accumulated until retirement giving the retiree an unknown supplement to his or her pension based on the inherited pension entitlements within the scheme.

Under our constant model, the annual pension benefits can be calculated much like in the DC scheme[31], just adding mortality cross subsidy factor, m, and changing the divisor to a lifelong annuity[32]. Benefits will then amount to 114 957 NOK[33], or 22.48 per cent of final salary. This RR counts both with and without investment choice since the calculation is done under assumption of constant positive return. In other words, the zero guarantees only have value when the assets in question fluctuate, not average, like in our example.

The Standard model: Under his model, the employer guarantees an annual upward guarantee of pension capital either in line with general wage growth in Norway or growth rate within the firm or sector. Annual return on the investment on accumulated pension capital will be used to provide returns equivalent to the wage growth, and the return in excess of the wage growth is accumulated into a regulating fund. The regulating fund is to be used when the return from investment is insufficient to cover the wage growth. If the regulating fund runs out the employer has liabilities for any further insufficient amount, and when a member of the scheme retires he or she will

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[31] The benefits of zero return guarantees are absent when average values are used.

[32] $P_R = \frac{Wcg(1+m)}{D_{hybrid}}$

[33] $P_{40} = \frac{6G \times 7\% \times 63.86(1+4.50\%)}{20.78} = \underline{\underline{114.957 NOK}}$

receive a proportional amount of the fund. (Innst. 35 L (2013-2014) 2013). An assumption we make is that the fund is reinvested in the same allocation of assets as the one providing the excess over the wage growth guarantee.

The equations below are used to calculate the accumulated pension capital from the Standard Model based on the regulating fund plus the pension capital from the wage growth guarantee alone. The accumulated pension capital for the Standard Model at retirement, $P_{S,R}$ (Equation 6) will then equal the sum of the guaranteed pension capital at retirement, $PC_{S,R}$ (equation 7), the regulating fund, $F_{S,R}$ (Equation 8), and the mortality cross subsidy, M, assumed to be 4.5 per cent of the accumulated benefits at retirement, M = 4.5%($PC_{S,R}$ + max (0,$F_{S,R}$)).

Equation 6

$$P_{S,t} = PC_{S,t} + \max(0, F_{S,t}) + \mathrm{M}$$

Equation 7[34]

$$PC_{S,t} = \sum_{i=1}^{t} Y_{t-i+1} \prod_{j=1}^{i} (1 + w_{t-j+2})$$

Where return at time $w_{t+1} = 0$ and $t = 1,\ldots,R$

R = Age at retirement less the age when the member start contributing *(40 for one who starts working at the age of 27 and retires at the age of 67).*
$P_{S,R}$ = Total accumulated pension capital under the Standard Model at retirement time, R.
$PC_{S,R}$ = Guaranteed accumulated pension capital at retirement time, R.
Y_t = Total contributions each year (Pensionable income in year t multiplied by the corresponding contribution rate).
w_t = Annual wage growth at time t.
M = Mortality Cross Subsidy.

The mortality cross subsidy, M, is accumulated until retirement giving the retiree an unknown supplement to his or her pension based on the inherited pension entitlements within the scheme.

[34] Since contributions are assumed given at the end of the year, the first period (t=1) will provide only that value (Y_1), since $w_{t+1} = 0$, the second part $(1+w_{1-1+2}) = 1$. This is exactly the same calculation as when the benefit from NDC was calculated (see equation 1).

The equation below (equation 8) only represents a cross section of the data, a simplification made to better show the relation between the guaranteed accumulated pension capital and the regulating fund.

Equation 8

$$F_{S,t} = max\left(0, \left(PC_{S,t-1}\left(1 + (r_t - w_t)\right) + F_{S,t-1}(1 + r_t)\right)\right)$$

The regulating fund might run out in periods with lower return on investments than nominal wage growth, therefore the pension capital of the previous period, t-1, accumulated with (r_t-w_t), along with the accumulation of last periods regulating fund[35] might be the only proportion of the fund one would receive.

Since it is a new product, there is little evidence on how big the regulating fund actually will tend to be[36]. In our constant model, where investment return and wage growth are assumed to be constant, received pension benefit will be equal that of the Basic model; 114 957 NOK, or 22.48 per cent of final salary.

Individuals in the Hybrid scheme can start to withdraw benefits from the age of 62, fully or partly, ranging from 20 to 80 per cent of full annual benefit. Benefits are calculated from the accumulated pension capital adjusted for life expectancy. Generally, benefits are given as a lifelong annuity, but can also be withdrawn over a pre-defined period, reaching from 10 years, or at least until the age of 80. Those with low pension capital can have shorter withdrawal period, where the benefits are paid over required years for benefits to be 30 per cent of G. Annual regulating of benefits in the payout phase is done in line with annual return on investment, but employers can choose guarantees to index the annual benefit in similar way as in the NDC, using a new payout regulating fund, similar to the one used in the accumulation phase. Any guarantee commitment for the accrual- or withdrawal period will lapse if employer goes bankrupt and the regulating fund is empty. (Innst. 35 L (2013-2014) 2013).

[35] The regulation fund is assumed reinvested in the same asset allocation.
[36] The regulating fund is explained in further detail in chapter 4, where historical values on returns on investment and wage growth are used to show how the regulating fund would differ under altered conditions.

3.2.5. Benefits from Occupational Pension Scheme

The occupational Pension Scheme, the second pillar of the National Pension System, is a collective, but firm-based, scheme where firms can choose between three different tax favoured pension schemes, and one optional; AFP. As mention in the above section, under each scheme, employers (or employees) can choose from different options; contribution rate, risk allocation, investment assets, guarantees etc., which makes employee's benefits variable between individuals depending on the characteristics of the scheme they are members in. Along with the character of the scheme, the size of the benefit depends on many factors, such as number of working years, income level throughout the life-cycle, return on investment, longevity, interest rate etc. The table below shows risk allocation within the different type of schemes.

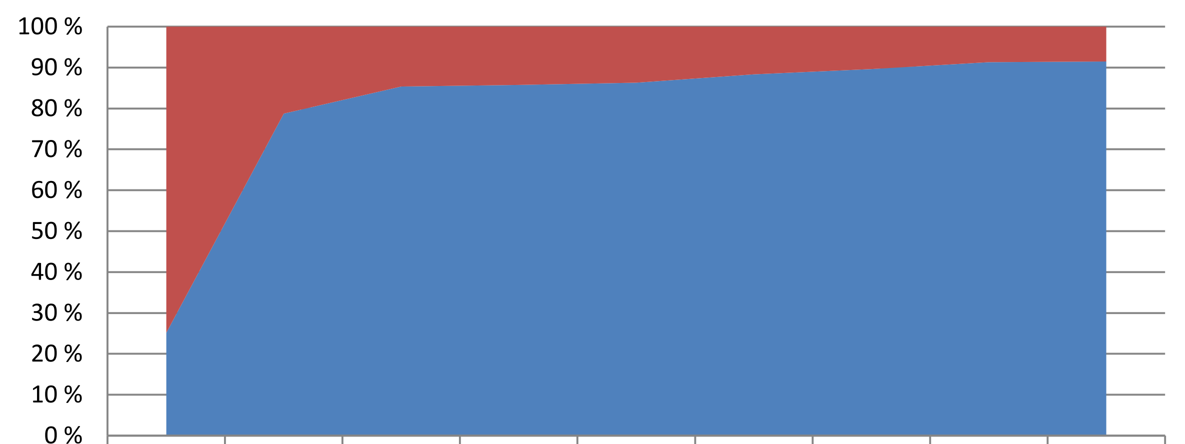
Table 4 Overview of risk distribution in the Norwegian Occupation Pension Schemes

Scheme	DB	DC	Hybrid Basic model	Hybrid Standard model
Contribution [a)]	Employer	Employer	Employer	Employer
Inflation	Employer	Employee	Employee	Employee
Longevity	Employer	Employee	Employee	Employee
RR	Employer	Employee	Employee	Employee
Employer bankruptcy	Employee	Fully funded	Fully funded	Fully funded
Investment allocation and asset return	Employer	Employee	Employee [b)]	Employer
Management and administration cost	Employer	Employer	Employer	Employer
Wage growth	Employer	Employee	Employee	Employer [c)]
Market timing	Employer	Employee	Employee	Employee
Job Mobility	Employee	-	-	-

Notes: Table contains risk allocation in different schemes during the accumulation phase.
a) Employer has risk for providing contributions, at least the mandatory minimum level, but employees have the risk of having insufficient or underfunded pension capital at retirement.
b) Risk allocation will differ according to options chosen by the employer. Under the basic model, employers can let employees invest in their own portfolio or create own collective portfolios for employees' capital to be invested into. While if the default strategy is chosen there is a zero investment return guarantee, thus the insurance provider covers the risk of fluctuations in return on investments.
c) Employers have risk for return on investment being less than the wage growth, thus have a cost for upward regulation to the guaranteed level when the regulating fund is empty. Source: (Own table)

Historically, occupational pension schemes in the private sector were a voluntary welfare benefit, mostly consisting of DB schemes since it was the only tax-deductible pension scheme. The DC scheme was made tax favorable in 2001, while DB and DC became mandatory in the private sector in 2006 (Plahte and Nordstoga 2009). From 3-8 we show that enrolment in DC schemes has increased after the mandatory act of 2006. Employers who previously had been providing DB schemes are also switching to DC schemes.

Figure 3-8 DB schemes relative to DC schemes for total enrolled employees in private sector from 2005 to 2013



	2005	2006	2007	2008	2009	2010	2011	2012	2013
DB	75%	21%	15%	14%	14%	12%	10%	9%	9%
DC	25%	79%	85%	86%	86%	88%	90%	91%	91%

Source: (based on statistics collected from Finance Norway (FNO))

There has been an increase in enrolment to DC schemes since 2006 accounting 82 per cent of occupational schemes in 2013. Seen from the employer's view, costs of DC schemes are more predictable and less volatile than DB schemes. According to a survey of Norwegian employers, the most common reason to favour DC schemes over DB was cost related (Veland, Hippe og Andersen 2006; Veland 2008). Further findings in the survey suggest that the unpredictable nature of costs in a DB scheme, and the increase in pension expenses, have motivated employers to choose DC schemes. In DB schemes, annual pension premium varies considerably depending on real return on investment, employer's pension commitments and the interest rate used for calculation (Engelstad 2010, 534-552).

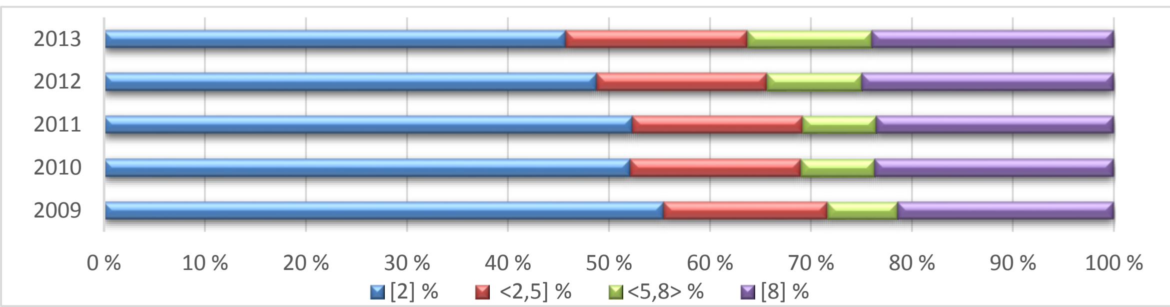
DC schemes are fully funded and received pension capital certificate can be moved from one insurance provider to the other. This reduces the risk of getting lower benefits while shifting working place. Blake (2003) did research on DB schemes in the UK and found that an employee that shifted between jobs six times lost 25 to 30 per cent of their total benefit. The move from DB- to DC schemes has increased mobility for employees. It is less costly to shift between jobs in a DC scheme (Bodie, Marcus and Merton 1985).

The hybrid scheme is meant to be a substitute to DB schemes in the private sector from 2014, though it is too early to say how popular this new product will be. In the context of predictability and volatile costs, the standard model might not be the most popular choice for employers, compared to the DC- and basic model, as the cost of the guarantee for the employer under the standard model depends on the relationship between the return on investment and the guaranteed return equal to the wage growth. For the employees this model transfers the risk of investment return and portfolio allocation to the employer, relieving the employee of some risk.

Contribution level:

Along with return on assets, the annual contribution rate has greater effect on the received benefits from these schemes at retirement. Figure 3-9 shows the market statistics of contribution level in DC schemes in Norway. Between the years of 2009 and 2013 more than 60 per cent of contributions were less than 5 per cent, while more than 45 per cent of contributions to employees were just two per cent in 2013, the minimum level of contributions. Of this reason it would be interesting to see what effect minimum contribution would impose on the RR.

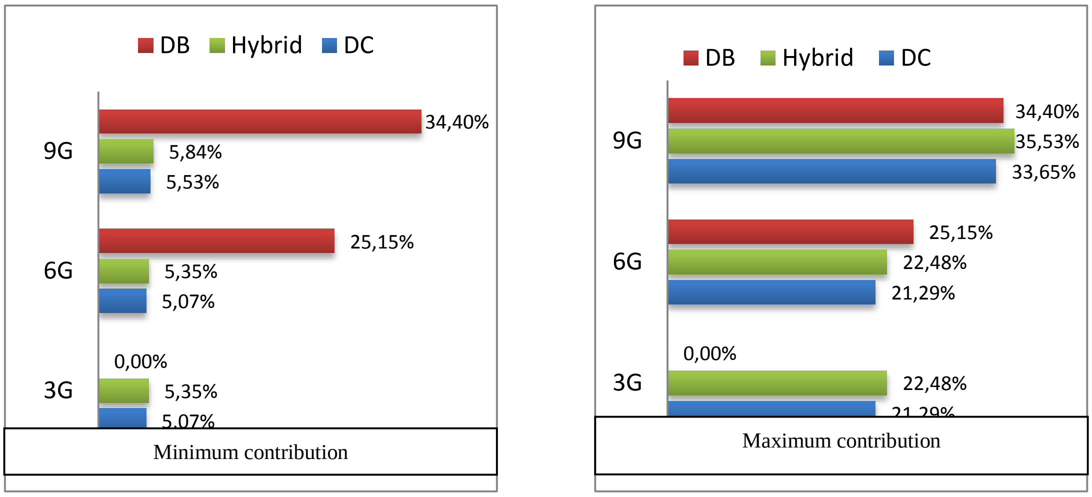
Figure 3-9 Contribution level offered by employers to members of a DC scheme in Norway between 2009 and 2013



Source: Source: (based on statistics collected from Finance Norway (FNO))

To illustrate the effect we will calculate RR under maximum contribution and minimum contribution, as there are differences between benefits received by individuals in private – and public sector. The Basic- and Standard model provide the same benefits in our example, and are therefore referred to as Hybrid in the figure below.

Figure 3-10 RR for occupational pensions with minimum- (for income above 1G) and maximum contribution level.



Notes: As the benefits from the NDC (minimum pension) give 76.79 per cent RR for an average wage of 3G, the net value of the DB scheme equals zero. Under maximum contribution for earning of 9G, the contribution is seven per cent for wages between 0 and 7.1 G, and 25.1 per cent for 1.9 G.
Source: (Own calculations, based on assumptions of the constant model)

Figure 3-10 shows that the RR is correspondent to the rate of contribution, where the RR is high for higher contribution and low for lower contribution. Under our constant model, the hybrid scheme does yield the highest RR of the fully funded schemes, reaching the DB benchmark with maximum contributions and an average wage of 9G. With minimum contribution the RR for all the fully funded schemes does not cover the residual between NDC and old pension schemes, although the minimum pension from the NDC provides high RR for an average wage of 3G. As of 2013, minimum contributions are given to about 45 per cent of employees in DC schemes (figure 3-9). A significant amount of the members will therefore end up having a retirement benefit under the new pension system that is insufficient to cover the residual from the old social security scheme alone (table 3). Along with contributions, the rate of return on investment will accumulate until the retirement; together determining the final pension capital at retirement.

Rate of return on investment:

Annual contribution is regulated using rate of return on investment, if not guaranteed, exposing accumulation of pension capital to market risk, along with macroeconomic risk of inflation and wage growth. The rate of return must at least answer for the increase in inflation for retirees to have adequate purchasing power at retirement. Table 5 contains RR for different average income when rate of return under the constant model is changed by one per cent[37]. RR for average wage of 6G and 9G under different schemes is presented in table below. Table is excluded for DB, since it is guaranteed RR of 66 per cent, and the risk lies on the employer.

Table 5 The effect on the RRs from a one per cent change in return on investment with maximum contributions. Values are in per cent.

	6G		**9G**	
Return	**DC**	**Hybrid**	**DC**	**Hybrid**
5.55	17.33	18.30	26.79	28.28
6.55	21.29	22.48	32.91	34.74
7.55	26.39	27.87	40.80	43.08

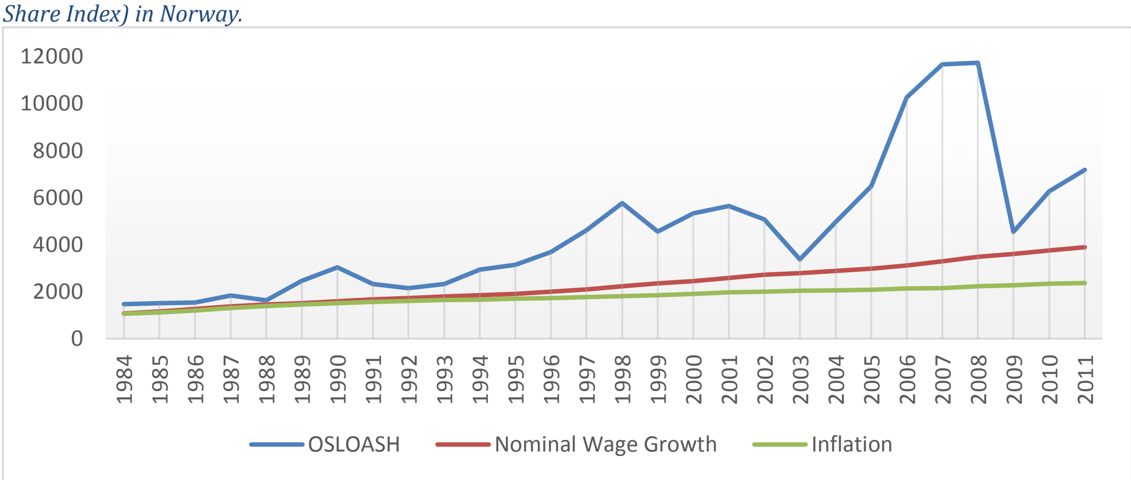
Source: (Own calculations, based on assumptions of the constant model)

The effect on the RR is quite substantial; a one-percentage decrease in returns lower the RR four to six percentage points, depending on the wage[38], and the marginal increase in returns provides a RR between five and eight percentage points higher. We have assumed a constant or average return for in our example, but in the real world, the return from financial assets could be highly volatile from one period to the other. With risk connected to return on investment in DC and Basic scheme the timing of retirement is an ever more important issue[39]. Figure 3-11 below shows the change in value of 1000 NOK starting from 1984 to 2011. In a period of less than ten years approximately 4000 NOK become 12000 NOK, before returning to just above 4000 NOK in 2009. This illustrates the volatility in the market along with upside and downside risk.

[37] 6.55 % ± 1 %
[38] Since a wage of 9G is above the “breaking point” of 7.1G, 1.9G is multiplied by a higher contribution rate (25.1 per cent). An average wage of 3G is not shown in this table since it provides the same RR as 6G.
[39] It could also be argued that the market timing is of importance in the standard model, since the regulating fund can be majorly capped under periods of recession, as we will show in the next chapter.

Individuals can receive higher RR by postponing their retirement, as well as start working earlier. Although increasing the RR in both cases, postponing retirement provides the highest positive effect. The logic behind this statement is simply that starting one year earlier gives an additional year of accumulated pension, but postponing retirement also decreases the retirement years, hence the passivity ratio decreases the most in the latter since both the numerator and the denominator are affected (Antolin, 2009). As pension capital value changes according to return from asset (table 5) individual retiring in different years would have received different RR. When individual's annual wage, wage growth, contribution rate and contribution years are assumed constant, an individual retiring at 2007 would have received substantially higher RR from fully funded schemes than one retiring at 2009. An example of this is shown in table 18 in section 4.

Figure 3-11: 1000 NOK indexed with inflation, wage growth and equity returns from Oslo Stock Exchange (OSEAX – All Share Index) in Norway.



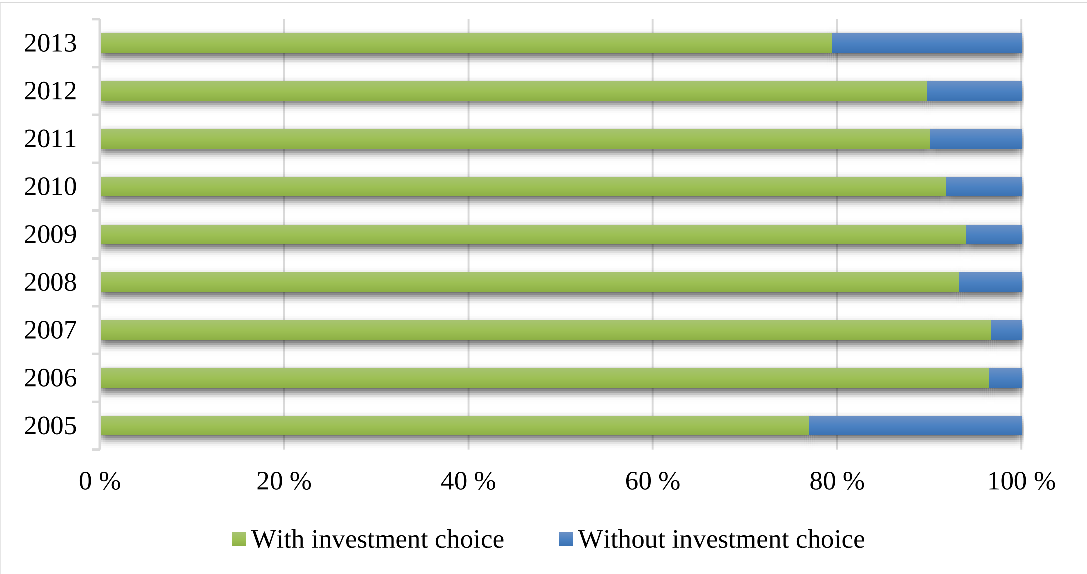
(Source: Reuters)

The wage index has been above the inflation index most of the time, while indexed returns on investment has the highest index value. The volatility of equity returns implies both upside- and downside risk, thus return on investment has great effect on the final value of the pension capital, and rational investment decisions are needed. Under the Basic model, underwriters offer a zero return guarantee if employees have no investment right, although inflation risk still counts for the employees, as the nominal value will lose its purchasing power. Figure 3-11 only represents the return on one index, Oslo Stock Exchange - All-Share Index, but there are other assets such as bonds and interest baring financial instrument.

Investment choices

As mentioned before, under fully funded schemes, employers can either let the underwriter make the investment decision according to their firm's rules and regulations, or give the employees the right to make investment- and risk decision for their pension capital. Figure 3-12 shows the percentage of DC schemes, with and without investment choices, from 2005 to 2013. In 2013, around 80 per cent of employees with DC schemes could make their own investment choices, while the percentage was even higher between the years 2006 to 2012. It will therefore be interesting to show if individuals with investment choices can collect higher benefits than the ones that are restrained from investing, but are offered guarantees on returns instead. This will be further addressed in section 4, where a balanced portfolio with zero guarantees is compared to DC- and Basic schemes with fixed asset allocation in equity, bonds or a balanced portfolio. In addition the wage growth guarantee of the Standard Model will be shown in comparison with the other fully funded schemes.

Figure 3-12. The percentage of DC schemes with and without investment choice from 2005 to 2013



Source: (based on statistics collected from Finance Norway (FNO))

Underwriter profile their investment portfolios under three different risk; low, medium and high. Risk profiling is done in regards to portfolio asset allocation between bonds and equity, where higher allocation on equity is profiled to be a riskier product (we measure risk in standard deviation). According to different media bulletins and websites of underwriters the most popular investment profile is medium risk portfolios (equity allocation between 50 to 70 per cent), which in some cases are default investment if members doesn't change the risk profile. Members can choose to change to a lower or higher risk portfolio, according to their preference. In line with general industry agreement formed by FNO, the underwriters report monthly data on their products to Norwegian pension site (norskpensjon.no)[40]. Data are presented in table the below:

Table 6 Descriptive statistics of annualized returns for different asset allocations offered by the leading underwriters in Norway.

		Low Risk	**Medium Risk**	**High Risk**
		[0,50>Equity	[50,70]Equity	<70,100]Equity
3 year*	**Lower Decile**			
	Returns	2.94	7.23	7.27
	Volatility	0.19	4.81	7.70
	Sharpe	1.30	0.76	0.56
	Median			
	Returns	6.59	8.75	9.82
	Volatility	2.40	6.31	10.26
	Sharpe	2.20	1.06	0.70
5 year**	**Lower Decile**			
	Returns	2.85	11.32	13.74
	Volatility	0.20	5.33	9.15
	Sharp	1.89	1.40	1.17
	Median			
	Returns	7.70	13.42	17.87
	Volatility	2.67	7.10	11.42
	Sharpe	2.41	1.63	1.31

Notes: The data is divided into three risk groups and annualized, before averaged across all products within each risk class. Portfolios with equity allocation below 50 per cent are classified as low risk, while between 50- and 70 per cent is medium risk, and above 70 per cent is high risk. Figures are presented in per cent. The volatility is measured in standard deviation of returns. Sharpe ratio under the FNO agreement is calculated in excess of the risk free rate, where the risk free rate is represented by a three monthly Treasury bill index collected from Oslo Stock Exchange (ST1X). The lower decile represents the 10th percentile of the returns, volatility and Sharpe within the different risk categories, while the median represents the 50th percentile.
*Annualized monthly return from 28.02.2011 to 28.02.2014.
**Annualized monthly return from 28.02.2009 to 28.02.2014.
Source: (Norskpension.no, data collected 03.03.2014)

From table 6 we show that the portfolio with highest equity allocation, high-risk profile, has higher annualized return in both 3-year and 5-year period. It is also the most volatile portfolio. Medium risk portfolios had the second best annualized returns, being more

[40] The obligation to send annual information on individual's pension capital account is to be considered as a "fourth pillar", a non-financial pillar (informal support), from the works of Holzmann, Hinz and Dorfman (2008), as mentioned in chapter 2.

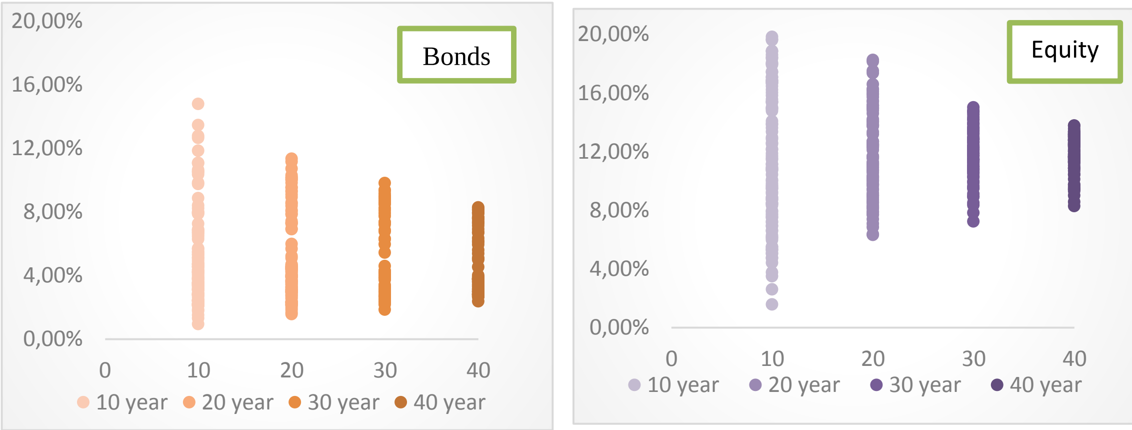
risky than the portfolios with higher allocation of bonds. Low risk profile products with more portfolio allocation in bonds and interest bearing securities had lower annualized returns, but were also less volatile. In the context of risk-return, presented by the Sharpe ratio, the low-risk portfolios provided the highest values for given the risk individual take, when risk measured in standard deviation.

The return from pension capital investment must be seen in perspective with wage growth or inflation to show the return in context of purchasing power. The annual average growth in wage the last 5 years was 3.6 per cent. The annualized 3- and 5 year median returns for all risk classes is higher than the wage growth, implying that the return from pension capital is higher than the growth in contribution from an increased wage level. Thus, the individual investing in this portfolio would have received a pension benefit giving higher purchasing power. Bond portfolios had the highest Sharpe ratio[41], meaning invested returns from bonds have better reward to the risk individuals take. Further, the lower decile value of 3 year annualized bond returns has been 2.94, in the case of sudden increase in inflation (3 per cent or more) the returns from this profile will be negative in real terms.

Underwriter and media bulletin have emphasized uses of age depended risk profile investment, where allocation of equity in portfolio is high at younger age and gradually decreasing allocation in bonds towards retirement, referred to as a "life-cycle strategy". This is assumed to be a better solution to reduce the downside risk to portfolios capital for short-term negative change in market condition prior to retirement.

[41] The Sharpe Ratio is used to measure asset performance adjusted for risk, where risk is measured in standard deviation. (Sharpe 1966).

Figure 3-13 Rolling average of 10 year US Treasury bond and S&P 500 from 1900 to 2013 for different time horizons.



Source: (own calculation, derived from the database of R. Shiller (see section 4.2))

From figure, 3-13 above the different historical rolling average of bond and equity shows that the equity returns are in overall more volatile than bonds. The rolling average returns of equity are more scattered on a 10- and 20-year horizon, compared to a 40-year horizon. The 40-year rolling average of equity are more compact, returns from about 8.3- to 13.8 per cent, making long term investment less volatile compared to short-term, an argument in favor of holding equity when retirement is far away. With returns being more scattered for equity holdings with a short time horizon (10-year rolling average), the safest portfolio allocation close to retirement is in bonds. The life-cycle strategy, with heavy allocation of bonds in the portfolio prior to retirement, reduces fluctuations in value. Although more volatile, individuals would expect higher returns with equity allocation, since equity generally have outperformed bonds in 10-year rolling average.

Siegel (1992) decomposed equity and bonds in an analysis of S&P 500 and long-term bond from 1802 to 1990. His findings suggest that the highest 30-year average equity return occurred in 1931-61, where the bonds had provided very low real returns. The nominal return on equity between periods of 1925 to 1990 had increased in almost identical amount to the inflation in the US, giving an unaffected real return. This suggests that the equity investment can be used to hedge against inflation over the long run. Further findings implicates that of all the holding periods of 20 or more years since 1871 stocks have underperformed short-term assets only once, while outperforming long-term bonds 95 per cent of the time.

The findings above indicates that a life-cycle strategy might not be the optimal investment choice for retirement benefits, since equity outperformed bonds most of the time. Basu and Drew (2009) suggested that the life-cycle does help to reduce the effects of market downturns, but compared to other strategies it fails to account for significant upside potential. As the size of the portfolio increases, the fluctuation in returns corresponds to a higher loss or gain than when the size is smaller. This is referred to as portfolio size effect, and will be further emphasized in section 4[42].

3.3. Private Pension Scheme

The third pillar of the Norwegian pension system is the voluntary private scheme, usually called private savings. Along with investing in mutual funds and tax favored saving schemes, individuals can make a higher contribution, along with employee's contribution in occupational pension scheme. However, the total contribution (combination of contribution from employees and employers) cannot be higher than the maximum level set by law in the occupational pension schemes. (Plahte and Nordstoga 2009).

The tax favored pension savings scheme; Individual Pension Saving (IPS) was introduced in 2008, where individuals over the age of 18 could save a maximum of 15 000 NOK annually and receive tax deduction for saved amount (up to 4 200 NOK). Benefits are taxed when withdrawn, thus it is a tax deferred saving. The IPS account cannot be withdrawn before retirement. The benefits can either be withdrawn as lifelong benefits or saving payment from age of 62, and are to be paid until the age of 77. (Plahte and Nordstoga 2009).

According to Annual statistics provided by FNO (2013), a total of 904 000 people saved in IPS, IPA[43] and annuity saving, which accounts for below 20 per cent of the population.

[42] Collected data in table 6, from Norwegian pension site (norskpensjon.no), has limitation towards analyzing in context of risk, return, cost, capital inflow and outflow. After many request, to both Norwegian pension site (norskpension.no) and underwriters directly, we failed to collect any historical data for pension products that is provided in market today. Thus, we ended up creating our own hypothetical pension portfolios and RR for individuals retiring under different schemes.

[43] Individual Pension Account (IPA) was removed in 2006, along with introduction of mandatory occupational pension, where the maximum taxed favored pension saving was NOK 40 000.

Although there are other means of saving; like paying back mortgage, bank account etc., that is not reflected in the statistics. As many employees have two per cent contribution in DC schemes (figure 3-9), there is a greater need of private savings.

4. Risk and performance analysis of occupational pension scheme

In this section, we will evaluate DC- and hybrid schemes performance using historical market conditions. To address the question of risk and performance of each scheme, a long time horizon is necessary. As fully funded schemes are relatively new in the Norwegian market, and most of the pension products were created around the implementation of mandatory occupational pension in 2006, the observations are few, and restrict our analysis on risk and return on different fully funded schemes. By looking at the composition of the available products offered by the scheme providers (norskpensjon,no), the benchmark for performance analysis are mostly a combination of international assets, which indicates that a significant amount of capital are invested on the global market. Of this reason, we will be using equity and bonds returns from the American market, where data are available for longer time horizons.

Using historical return data from 1927-2005, Burtless (2007) analyzed asset allocation on retirement savings cross-border within seven different countries. Findings suggest that individuals would have received better return by investing more in the foreign market, where retirees would have been able to obtained higher average pension with 100 per cent foreign allocation, rather than in domestic allocation. By using efficient frontier theory for asset allocation, Burtless found that retirement saving could get better average pension with lower downside risk.

The analysis is constructed to give a clue of what a hypothetical retiree would have received from the schemes offered in Norway today, given historical market conditions from 1900 until today. A similar analysis was done by Antolin (2009) for USA and Japan, where he address the question of required contribution rate for a given future RR. His findings suggested that the contribution rate should be between 5 and 15 per cent, depending on the target RR being 25 to 70 per cent[44], respectively.

Cannon and Tonks (2013) calculated hypothetical fund ratios (total pension capital at retirement divided by final salary), using historical data in the 20th century, and found that an all-equity strategy provided the best results. The average median value for all countries with all-equity allocation was calculated to be 10.7. Further findings suggest that in countries like Germany and Spain the life-cycle and 50:50 asset allocations between bonds and equity dominated equities at lower decile.

In the next section assumptions and methodology of the analysis is presented, while 4.2 show how data is collected and describe the underlying risk factors of the different schemes. 4.3 Show the simulated results under different conditions, with emphasize on the main findings. 4.4 will conclude the analysis, as well as show the implications the results give. Finally, 4.5 discuss the assumptions made in this analysis; limitations from it, and how different assumptions could have been made in light of present and future research on the subject of fully funded pension schemes.

4.1. Methodology

The analysis assumes that each employee follows the same scheme during their working life, with no work mobility, and without risk of being unemployed, thus Pension Capital Certifications, and the management fees that is connected, is not present in this analysis. We further assume that contributions are done at end of the year[45], thus the return on investment is added to the next year of accumulated pension capital. At the end of the working career, when the hypothetical persons turn 66, they receive their last contribution[46]. The accumulated capital at this point will equal the total accumulated pension capital at retirement; hence it is assumed that the pensioner will retire at the beginning of the year they turn 67.

[44] This article only looks at the second pillar, thus a RR of 70 per cent is from the DC scheme alone.
[45] This is a simplification since contributions are most commonly made partially throughout the year.
[46] In line with Cannon and Tonks (2013) we do not assume utility maximization. This since the Norwegian pension system is still ongoing changes and the contribution level is determined by the employer.

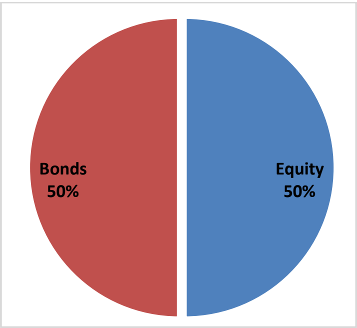
Hægeland and Kirbøen (2002) meant that the wage setting in Norway is more centralized, while other western countries are decentralizing, thus there is relatively small and stable wage difference between individuals in Norway. Furthermore, they pointed out that the wage growth is generally U shaped, that individual's wage rises quickly at the start of their career and then level off afterwards. Hyggen and Veland (2008) found that there is a difference in wage level and wage growth between and within private- and public sector for higher educated employees. Hægeland (2003) found that, using data between 1970 and 1997, one extra year of education in Norway yielded a five to six per cent increase in salary. His finding suggested that return on wage growth for one extra year of education in private sector was one per cent higher than public sector.

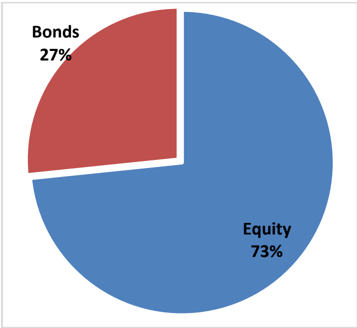
For our base case, hypothetical RRs are calculated for retirees with 40 years of contributions, where they start working at the age of 27, and retiree at the age of 67. The contribution rate is set equal to five per cent of the average wage, which increases by annual nominal wage growth in Norway, giving each hypothetical cohort a salary equal to the average wage level at all times[47]. The first person will then enter the labour market in 1900 at the age of 27, working 40 years, and retiring in start 1940 at the age of 67. While the last one retires in 2014, giving 75 hypothetical RRs for each scheme, total 825 ratios for base case. The results with these assumptions as input are intended to reflect the average population and work as a benchmark to reflect the change in results when simulations are made.

Contributed pension capital will be invested into three different investment portfolios, assuming constant asset allocation: i) 100 per cent bonds (low risk), ii) 50 per cent bond and 50 per cent equity (medium risk), iii) 100 per cent equity (high risk), to reflect the options offered by the Norwegian scheme providers[48]. Medium risk portfolio is assumed to be fixed as 50:50 allocations in bond and equity and is rebalanced each year, her by called balanced portfolio. This balanced portfolio represents a diversified profile, since it contains low and high volatile assets.

[47] The wage level of an individual during the course of a lifetime is therefore not reflected in our hypothetical cohorts.
[48] Norskpensjon.no

Figure 4-1 Volatility distribution of a portfolio consisting of 50:50 bonds and equity.



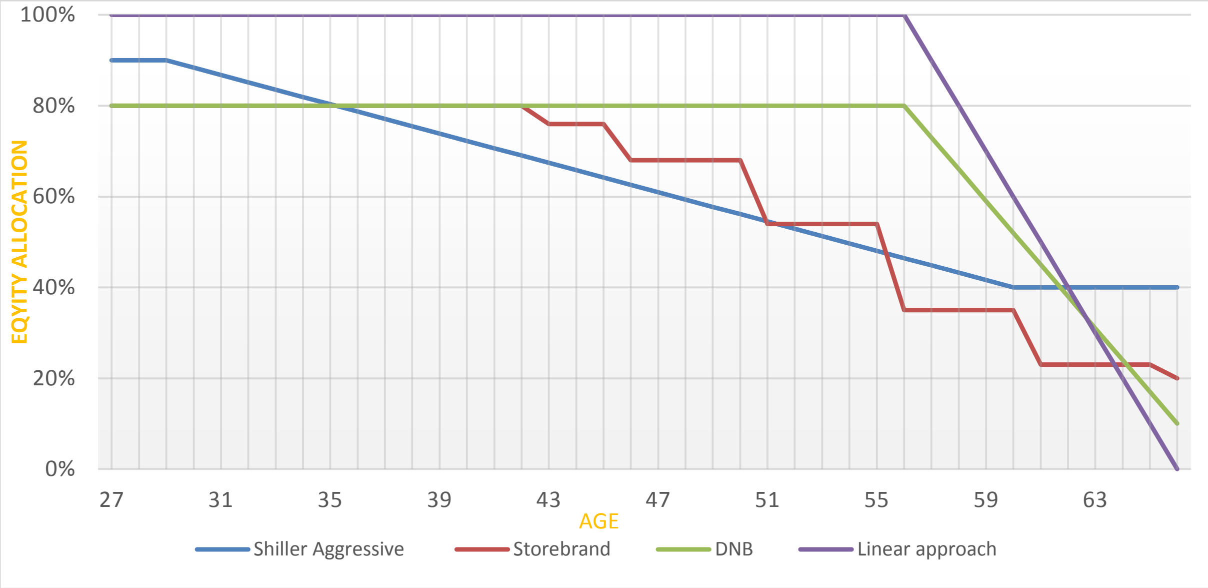


Note: Figure to the left show percentage invested in bonds and equity, while the figure to the right show the volatility distribution given the asset allocation.
Source: (Own calculations, based on data collected from the database of R. Shiller)

Underwriters recommend life-cycle investment strategy, where allocation to equity asset is reduced in portfolio towards retirement. This is done to reduce risk of a considerable haircut to the accumulated benefits from negative shocks in the equity market. In other words, a higher expected return from the equity market is traded with a more certain pension capital at retirement. The life-cycle investment model used in this analysis under the base case is downscaling of asset risk model proposed by Storebrand[49], where equity investment goes from 80 per cent to 20 per cent before retirement. We will use Storebrand's life-cycle investment strategy into our base case, and further in our analysis we will analyse the life-cycle model of DNB -, and Shillers aggressive strategy (Shiller, 2006). DNB and Storebrand accounted for more than 53 per cent of the DC market in 2012, while the strategy of Shiller is used as comparison. All three life-cycle strategies start off having lower equity allocation than 100 per cent. Gomes et al.(2008) suggested that the younger work force prefer equities while shifting towards less volatile assets prior to retirement. An aggressive age dependent strategy (hereby called linear), allocating 100 per cent of portfolio asset in equity for most of the contribution period and reducing it linearly with ten per cent from the age of 57, ending up having 100 percent allocation in bonds, is made to further test what composition of assets perform the best.

[49] http://www.storebrand.no/site/stb.nsf/Get/get37c8ee146c27dae327b9c60532f0687b/$FILE/Anbefalt_Pensjon_Brosjyre.pdf

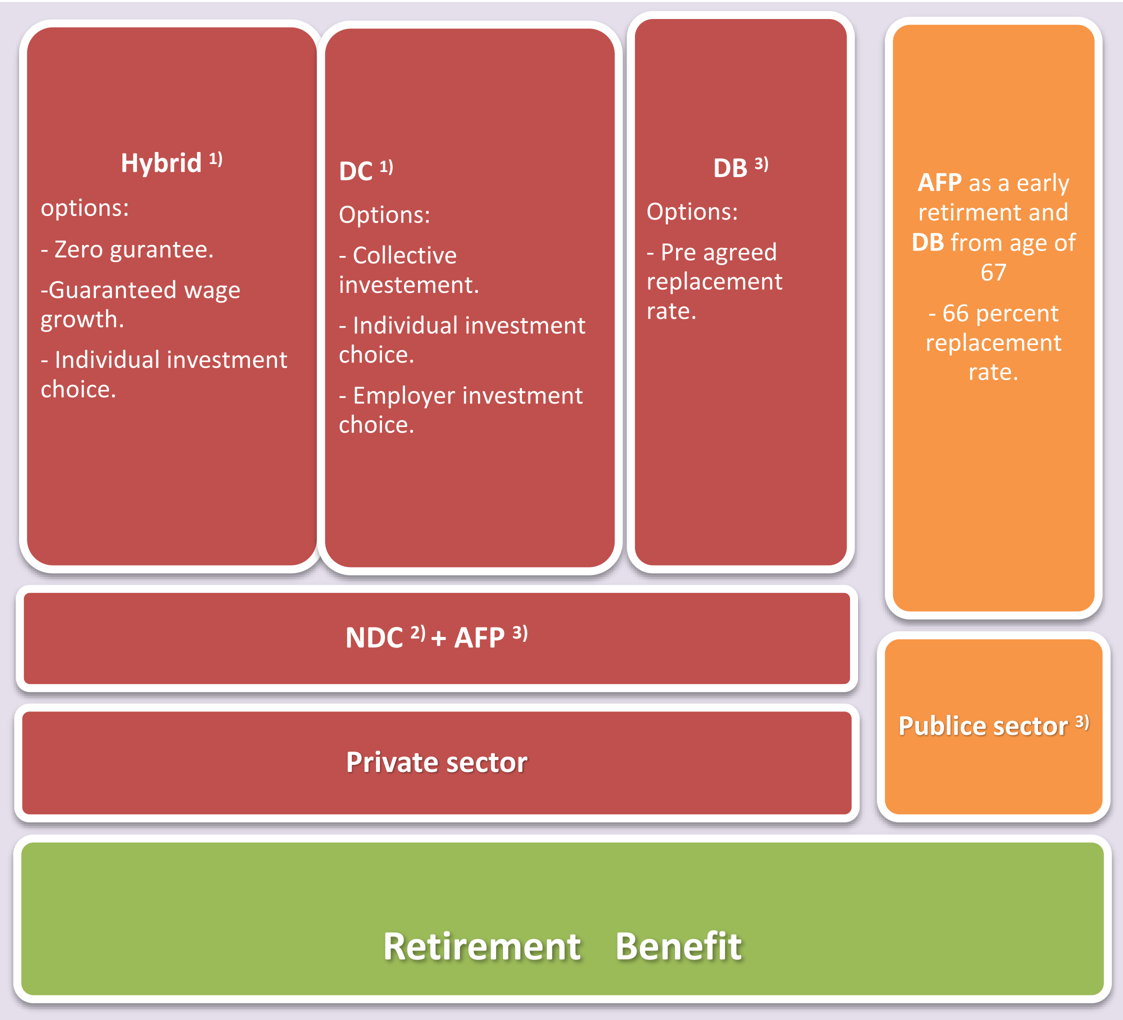
Figure 4-2: Different Life-cycle strategies with age dependent equity allocation.



Note: The linear strategy is constructed by the authors of this thesis.
Source: (Data collected from R.Shiller, Storebrand and DNB)

The linear life-cycle model is expected to provide better results than more conservative life-cycle strategies in the context of "portfolio size effect", as equity carry higher expected returns than bonds and the accumulated pension capital is expected to be larger with higher equity allocation. In this analysis the life-cycle strategy of Storebrand will be a part of the base case, while the other strategies will be introduced along the subject of market timing and the length of the contributing time horizon.

Figure 4-3 Overview over the Occupational Pension Schemes offered in Norway



Notes: 1) We will only analyses these schemes and the options since they have market risk, for the DC scheme individual investment choice is only taken into account. 2) We calculate the hypothetical RR when analyzing the target rate. 3) AFP in public and private sector is not analysed. DB schemes, both private and public sector are also excluded, although the DB scheme benchmark of 66 per cent is used throughout the analysis.
Source: (Own figure)

The figure 4-3 provides an overview over the pension system's main components, as it is today. In section three above, we provided information on different components of the Norwegian pension pillars; where the focus was to explain the risk and variability in RR among the same cohorts and give the reader an overview of changes and effects by using the constant model. In line with assumption made in the sections above, we will only analyses RR for fully funded schemes, the DC- and the Hybrid scheme, while AFP and DB adequacy will not be analysed. For further research on AFP and DB, schemes see Hippe and Vøien (2014).

Table 7 Scheme investment assumption and equations overview.

Scheme	Options	Invested	Used equations
DC [b)]	Individual investment right.	All three portfolios	3
Basic Model [b)]	Zero Guarantee	Balanced portfolio [d)]	4
	Individual investment right	All three portfolios	5
Standard Model [b)]	Guaranteed average wage growth in Norway	All portfolios	6 to 8
NDC	Divisor set at 18.07[a)]	-	1

Notes:

a) We assume the pension benefit payment profile to be paid as a lifelong payment. For our calculation a unisex "annuity divisor", which divides the accumulated pension capital at retirement is collected from NAV. This devisor is calculated for each cohort, and used for benefit calculation for the first pillar. In a report, Fredriksen and Stølen (2011a) suggested that the average person are expected to outlive the life expectancy estimates incorporated in the annuity divisor calculated by NAV by two to three years. Of this reason, the divisor used in our calculations is above the one calculated by NAV with 10 per cent (as two to three years transferred into approximately 10 per cent), giving a devisor of **18.07** at age 67 in our examples.

b) Since the divisor from NAV is calculated for all cohorts, not representing the higher life expectancy of the working population over the unemployed, a further increase of 15 per cent in the divisor is made to reflect the ones receiving occupational pension (bank committee 2013). The devisor is then **20,78 ≈ 21** for the new Hybrid product, and 21 for the DC scheme (to compare the RR directly), as DC scheme has the default option to receive benefits in fixed amounts over the retirement period. The calculated divisor for the social security scheme is imbedded with estimated mortality inheritance and under regulation of 0.75 per cent, while the adjustment removes this effect from the divisor because the members within the Hybrid scheme will receive the actual mortality inheritance. The actual inheritance in the Hybrid scheme versus inheritance going to the heirs in the DC scheme, although an interesting subject of debate, are not discussed in any further detail in this thesis. The only adjustment made is that a Mortality Cross Subsidy factor of 4.5 per cent is added to the accumulated pension capital at retirement in the Hybrid product.

c) Default product, zero guarantee, is assumed in analysis to be invested in a balanced portfolio. In real life the asset allocation of a zero return guarantee would be expected to include only a low portion of equity. Nonetheless, we assume that the zero guarantee is invested in a balanced portfolio in our analysis to better state the benefits one could best receive. If invested in equity the portfolio would be more volatile, causing the cost of the guarantee to rise. Furthermore, bonds have lower premium than equity and investment in a 100 per cent bond portfolio will not yield any significant result in RRs.

Table 7 provides further overview of assumptions used in our analysis. Throughout our analysis we will use median[50] rather than mean to measure average values. This is done

[50]In line with Cannon and Tonks (2013), that uses median fund ratios in their analysis.

to decrease the effect of outliers. For measurement of downside risk, the lower decile (10^{th} percentile) or the 5^{th} percentile is presented, while the 95th percentile is presented as a "maximum" value. The 0 percentile and the 100^{th} percentile (min and max) are not used in the analysis, and outliers are rather explained directly.

4.2. Data

The historical data include: Equity and bond returns collected from the database of R. Shiller[51]. This includes the S&P500 Price Index where reinvested dividends, Div_t, are added to find the total annual return including dividends:

Equation 9

$$R_{E,t} = \frac{Price_t + DIV_t - Price_{t-1}}{Price_{t-1}}$$

$R_{E,t}$ = Annual returns on equity

$Price_t$ = Index value at time t

DIV_t = Accrued dividends at time t

Yields on nominal US Treasury bonds with constant maturity of ten years are converted into annual returns using the formula below:

Equation 10

$$R_{B,t} = Y_{t-1} \times \frac{1-(1+Y_t)^{-10}}{Y_t} + \frac{1}{(1+Y_t)^{10}} - 1 + Y_{t-1}$$

$R_{B,t}$ = Annual bond returns

Y_t = Bond yield at time t

It is assumed that the constant maturity 10-year bond starts off with a coupon rate equal the interest rate and a face value equal to the par value. A year later, the bond's maturity

[51] Stock data from Irrational Exuberance [Princeton University Press 2000, Broadway Books 2001, 2nd ed., 2005] and Bond yields from Chapter 26 of the book "Market Volatility" (1989, revised and updated).

and coupon do not change, but the interest rate does. This formula originates from the works on bond- and equity returns of Aswath Damodaran; a highly respected author and professor of finance. We would like to thank Mr. Damodaran for providing insights on bond returns through our email correspondence.

Since returns on bonds and equity are collected from the US market, the investments of this analysis can be characterized as foreign investments. On that note the return would fluctuate more because of a changing exchange rate, giving a higher standard deviation[52] for the returns on investments made abroad (Burtless 2007). We therefore assume the return on investments to be hedged against exchange rate risk. This would cause the management costs to increase drastically in real life (Burtless 2007), but that is the theme of another study. For further knowledge on the theme of international investments see (Glen and Jorion 1993; Abken and Shrikhande 1997; Campbell et al. 2006).

Wage growth in Norway is collected from Statistics Norway[53] and inflation in Norway from (Smarte Penger 2014).

The table 8 presents summary statistics of the variables. The nominal median return for equity for the whole period amounted to 12.8 per cent, while bonds only collected 3.5 per cent of median returns, comparable to 9.2 per cent for the balanced portfolio. The values for standard deviation and lower decile in the balanced portfolio lays in between bonds and equity, while the equity portfolio is, not surprisingly, the most volatile with a standard deviation of 19 per cent, as well as receiving the lowest lower decile values. Differences in bonds and equity median returns for the whole period (3.5 per cent and 12.8 per cent) result in a high historic equity premium that is a well-known characteristic for the financial markets of the 20th century, and the US in particular, with the highest premium between 1940 and 1985 (about 12- and 11 per cent for the two sub-periods). The persistence of the equity premium results from the poor performance of bonds during this period. The US represents a mature market of a developed country.

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[52] Risk is measured in standard deviation in this thesis.

[53] For 1900 to 1930 https://www.ssb.no/a/publikasjoner/pdf/notat_200938/notat_200938.pdf.
For 1930-2002 https://www.ssb.no/a/histstat/aarbok/ht-0901-lonn.html, and the rest is collected directly from Statistics Norway.

Developing countries with more risk connected to their fixed income instruments usually receive lower equity premiums because of their higher bond returns. From figure 6-1 in the appendix we show that both the Norwegian and the US market has experienced higher returns on long-term bonds and equity than the rest of the world on average, suggesting the equity premium to be comparable between the two when long term bonds are used.

Table 8 Summary statistics of different variables, in different time intervals from 1900 to 2013.

	Using Historical Data							
	Panel A: Annual nominal returns			Panel B: Inflation and wage growth		Panel C: Correlation of real annual return		
	E	**50**	**B**	**I**	**w**	**E - B**	**E -w**	**B - w**
Lower Decile*								
Overall	-13.8	-5.6	-1.2	-2.6	-1.2	0.32	0.01	0.07
1900-1939	-21.8	-9.6	1.2	-6.9	-7.6	0.52	-0.06	-0.01
1940-1966	-8.7	-2.5	-1.9	0.0	4.5	0.20	0.23	0.68
1967-1985	-15.8	-7.1	-2.6	3.9	6.4	0.34	0.02	-0.14
1986-2013	-14.1	-3.5	-7.5	0.8	2.9	-0.05	-0.14	0.17
Median**								
Overall	12.8	9.2	3.5	2.9	5.3			
1900-1939	9.9	7.8	3.7	0.0	3.0			
1940-1966	14.2	9.2	1.9	3.0	6.5			
1967-1985	13.9	10.1	2.7	7.8	9.1			
1986-2013	13.7	9.4	7.8	2.3	4.4			
Volatility***								
Overall	19.0	10.3	6.9	6.5	6.9			
1900-1939	23.3	11.8	2.2	9.5	10.8			
1940-1966	15.7	7.5	3.3	4.6	2.6			
1967-1985	16.0	11.2	10.9	2.8	2.8			
1986-2013	17.5	9.7	9.2	1.9	1.5			

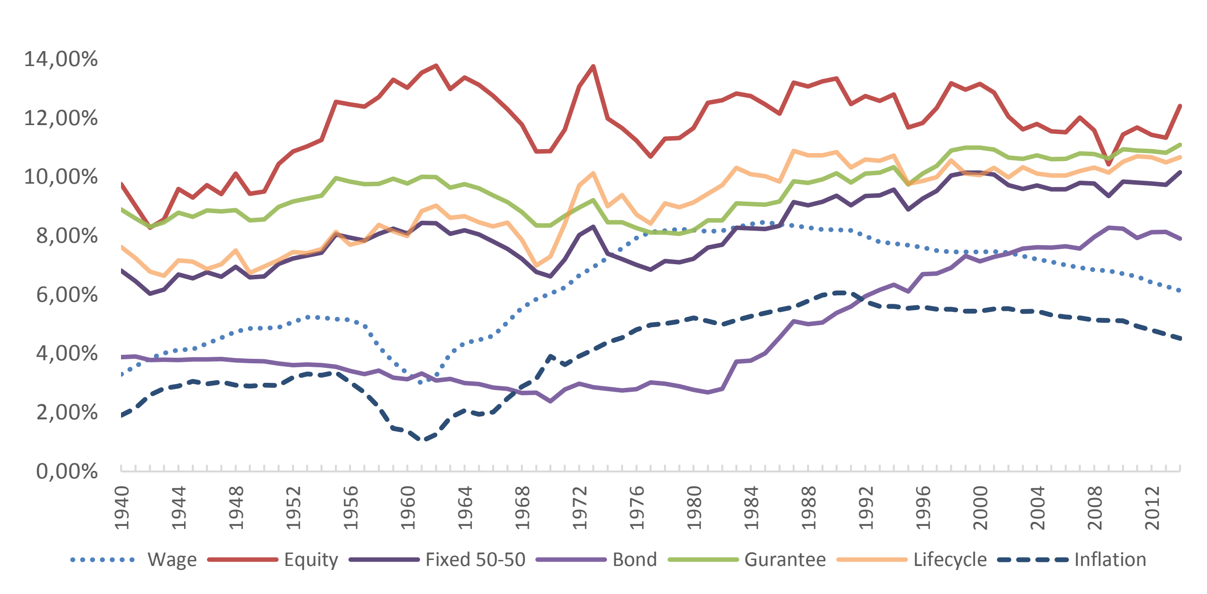
Note: The table reports summary statistics of the historical data from 1900 to 2013 that serve as a basis for the analysis. Panel A reports nominal equity (E)-, bond (B)-, and balanced portfolio (50) returns, Panel B reports nominal values of wage growth (w) and inflation (I) in Norway, Panel C reports correlation between equity returns, bond returns and wage growth, in real terms. All panels are divided into different sub-periods. Since the sub-periods differ in length the values are not directly comparable.
* The lower decile represents the 10th percentile of the returns.
** The median represents the 50th percentile of returns.
***The volatility is measured in standard deviation of returns.
Source: (Equity- and bond returns (the database of R. Shiller), wage growth (SSB) and inflation (Smarte Penger)).

Between 1900 and 1939 the wage growth and inflation in Norway was extremely volatile, with lower decile values of -7.6- and -6.9 per cent, respectively, as well as low- and volatile equity returns and stable bond returns. This will only be reflected in our first hypothetical retirees that retire in the 40s. The second sub-period (1940-1966) is the best period for holding equity, with a high- and relatively stable return, as well as bond returns being stable at a low rate. The wage growth was also high, thus this period would have boosted the accumulated capital for retirees with fully funded schemes. In the 70s Norway experienced high inflation after the discovery of oil[54] in the late 60s, giving a median value of 7.8 per cent for annual inflation between 1967 and 1985, and 9.1 per cent wage growth. From 86 until today, in the good economic climate of Norway, the inflation has stabilized at a low rate, causing predictable and steady wage growth. Our portfolio of bonds collects very high median returns (7.8 per cent), but they are highly volatile in this period, almost as volatile as the balanced portfolio, and with a lower decile value of -7.5 per cent, compared to -3.5 per cent for balanced portfolio. Also the equity returns were quite volatile from the dot-com bubble in 2000, the financial crisis in 2008, and the market upswing that followed. In this period the correlation between bonds- and equity returns were slightly negative, almost no correlation, suggesting that the two assets handle crises differently. When discussing the differences in RRs of retiring before and after a crisis in section 4.3.4, the financial crisis of 2008 is analyzed. This because the depression years are not at the end of the accumulation phase for any of the 75 hypothetical cohorts, thus the portfolio size effect would provide clearer implications when the crisis is at the end of the accumulation phase.

As shown in table 8, the equity- and bond returns overall have provided a weak positive correlation (some might say moderate) with a coefficient of 0.32. Between 1900 and 1939 the correlation was stronger with a coefficient of 0.52. While the correlation was high, the equity premium observed its lowest median values and the highest standard deviation values for the balanced portfolio, compared to other sub-periods. This implies that there was little value in diversifying exposure to equity by hedging the portfolio with bonds in this period. In other periods bonds, equity and wage growth have been weakly correlated, except from 1940 to 1966, when the correlation coefficient between bonds and wage growth was 0.68, suggesting a strong relation between the two.

[54]The"Dutch decease". A common characteristic of countries that suddenly experience a raise in foreign currency from exports is an increase in the domestic price level.

Figure 4-4 40-year rolling average of different asset allocation returns.



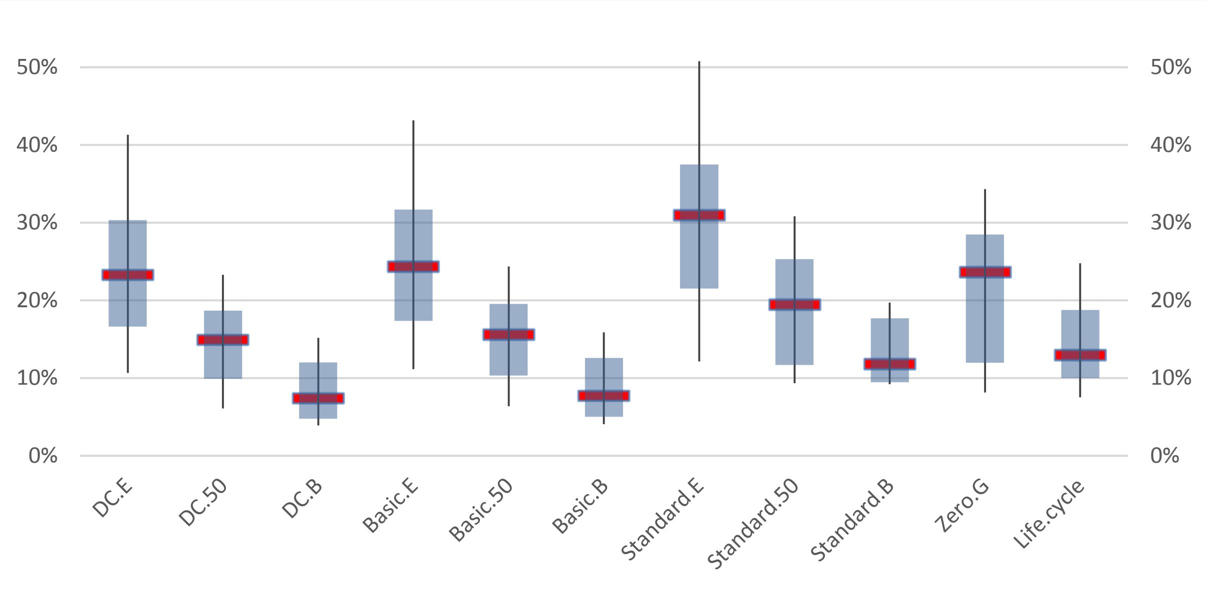
Source: (Own calculations, based on data as explained in section 4.2)

Not surprisingly the equity investment dominate all other allocation strategies in 40-year holding periods, while zero guarantee dose outperform all equity allocation approximately 1941 and 2007. Life-cycle is able to yield a better result than bonds. Average return from zero guarantee and life-cycle strategy of Storebrand seems to be more stable than equity. Bond allocation is the worst investment strategy, where the return yields lower returns than the wage growth between about 1968 and 1992. In 40-year holding periods, all other assets yields higher returns than inflation, but those individual holding bonds in around 1968 to 1992 would have average return negative in real terms.

4.3. Results

4.3.1. Base case analysis

Figure 4-54 RRs for hypothetical retirees under occupational pension schemes with different asset allocation



Notes: This Box and Whiskers plot presents summary of calculated RRs for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. Calculations are done under assumptions of 40-year earnings and with five per cent contribution rate. This model is referred to as the "base case". The whiskers represent the highest 95th percentile and lowest 5th percentile, the lowest point on the box is the 1st quartile, and the highest is the 3rd quartile. The median is the horizontal line in the middle of the box. E, B and 50 represents equity, bonds and a balanced portfolio within 3 different schemes: Defined Contribution (DC), the Basic Model (Basic) and the Standard Model (Standard). Life.cycle represents Storebrand's life-cycle investment strategy and Zero Guarantees (Zero.G) under the hybrid scheme is invested in a balanced portfolio.

The median RR for the standard model with 100 per cent equity investment is the highest with a value of approximately 31 per cent. Reasons for this originate from the guaranteed return equivalent to the nominal wage growth, as well as our assumption that the regulating fund is invested in the same portfolio (100 per cent equity, in this case). It even outperforms the zero guarantees (balanced portfolio), and the 100 per cent equity portfolio of both DC and Basic. Only looking at the median RR, the life-cycle strategy is not a good alternative since it provides median rates below the schemes with balanced portfolios and level with the 5th percentile of the Standard Model including equity allocation.

In the case of downside risk, represented by the 5th percentile in this case, the standard equity portfolio shows higher RR than its counterparts, with the other schemes with equity allocation right behind. An interesting point to note about the downside risk is the decrease in RR as the investments are less risky. In fact, all the conservative strategies, including the zero guarantee balanced portfolio and the life-cycle strategy, offer lower 5th percentile RR, something that stands in contradiction to their purpose of decreasing downside risk.

Although the schemes with 100 per cent equity portfolios provides higher median and 5th percentile rates than the more conservative investment strategies, the range in values are higher, reflected by the range between the 5th- and the 95th percentile of the Standard Model with 100 per cent equity allocation ranging from about twelve per cent to just above 50 per cent RR. The zero guarantees have a range almost as large, beating the schemes including balanced portfolio allocation with median rates in the same area as the DC- and Basic schemes with all equity portfolios. As mentioned above, the life-cycle strategy provides lower median values than all the schemes with balanced portfolios. Although providing slightly better rates for downside risk, it misses out on returns that the riskier products provide. The overall effect of this life-cycle strategy, under the conditions of the base case, therefore leads to the necessity of further investigation The life-cycle strategy will therefore presented in time intervals across the historical dataset and compared to the other schemes, as well as investigated against other life-cycle strategies in later sections providing a more in-debt analysis of the strategies used. In addition to the poor performance of the life-cycle strategy of Storebrand and the favouring of equity allocation over bonds, another question could be asked: How many of the hypothetical cohorts reach the benchmark of 66 per cent under the base case assumptions?

From the table 9 below, we show that few retirees reach the targeted rate of 28.2 per cent (66 per cent less the benefit of 37.8 per cent from the NDC). In fact, of the conservative portfolios including only bonds, none of the hypothetical cohorts receives benefits above the target rate, including the life-cycle strategy and the Basic- and DC schemes with a balanced portfolio. Although a contribution rate of five per cent might be looked upon as a low estimate, figure 3-9 showed that more than 60 per cent of employers gave contributions equal to- or less than- five per cent, thus the poor performance of the conservative strategies should be considered. The Standard Model provides the highest and most persistent RRs. With a balanced portfolio, just about one cohort out of ten receives benefits above the target rate, while the Standard Model with equity allocation have RRs beyond the target rate for more than half of the hypothetical cohorts (53.3 per cent between the target rate and 50 per cent, and with 4 of the 75 cohorts receiving benefits above 50 per cent). Approximately one out of three reach the target rate in the Basic- and DC schemes with equity allocation, while as many as about 60 per cent does not even receive ten per cent RR when the allocation is in bonds.

Table 9 Frequency distribution of hypothetical RR, in per cent

Using Historical Data											
	Panel A: DC			Panel B: Basic				Panel C: Standard			Panel D: Life.cycle
	E	50	B	E	50	B	Zero.G	E	50	B	Storebrand
[0,10>	1.3	25.3	64.0	0.0	24.0	61.3	16.0	0.0	16.0	38.7	25.3
[10,TR*>	66.7	74.7	36.0	65.3	76.0	38.7	57.3	41.3	74.7	61.3	74.7
[TR,50>	32.0	0.0	0.0	34.7	0.0	0.0	26.7	53.3	9.3	0.0	0.0
[50,∞>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0

Notes: This table reports frequency distribution for calculated hypothetical RRs for cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. RRs are calculated under assumptions of 40-year earnings with five per cent contribution rate. Panel A reports RR for a DC scheme invested in different portfolios, Panel B reports RR for Basic model invested in different portfolios, Panel C reports for the Standard model and Panel D reports for the life-cycle strategy of Storebrand. Investment portfolios are equity (E), bond (B) and balanced (50), while Zero.G represents zero return guarantee (in the Basic model) that is invested in a balanced portfolio.

*Under the assumptions of the base case, the target rate (TR) to reach 66 per cent annual retirement benefits including benefits from the NDC (37.8 per cent), amounts to 28.2 per cent.

As shown in the Box and Whiskers plot in figure 4-5 and table 9 above, the DC- and Basic schemes, with different allocation of assets (the zero guarantee Basic Model excluded), are almost identical. The only difference is that the mortality inheritance is given back to the other scheme members in the Basic Model, while it is given to the heirs of the DC scheme members, thus the 4.5 per cent mortality cross subsidy add-on in the Basic Model is the only difference between the schemes. Of these reasons the Basic model with asset allocation in bonds, equity and a balanced portfolio is removed in the following sections, before reappearing in the section 4.3.6 when contribution rates necessary to achieve the target rate of 66 per cent of final salary (including benefits from NDC) are presented.

Table 10 Base case RR divided into different sub-periods.

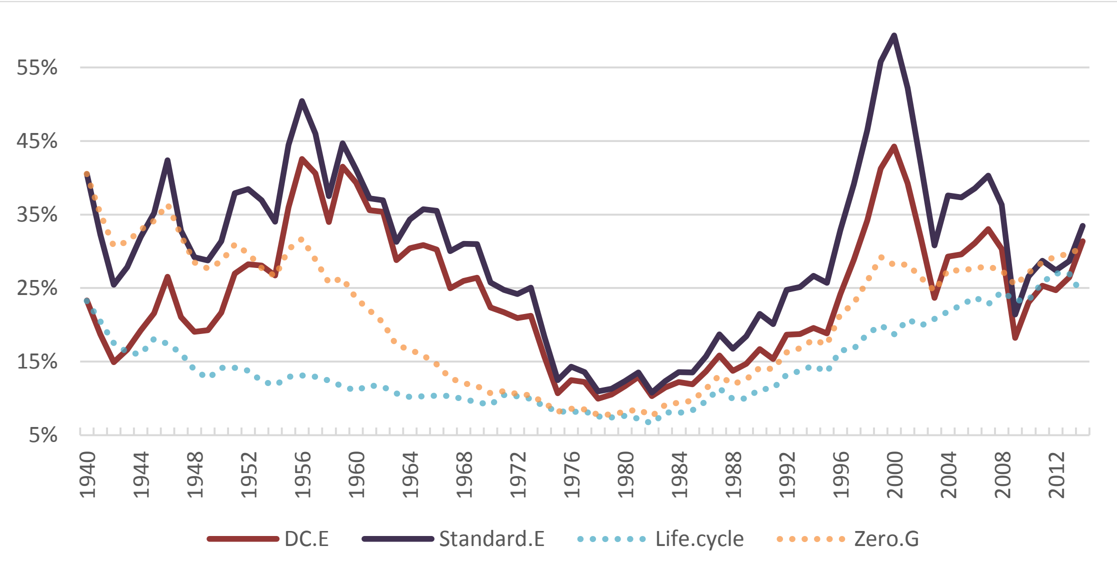
	Using Historical Data											
	Panel A: All Years			Panel B: 1940 to 1966			Panel C: 1967 to 1985			Panel D: 1986 - Onward		
	E	50	B	E	50	B	E	50	B	E	50	B
Lower Decile*												
DC	12.1	6.6	4.0	18.3	12.2	4.8	10.3	5.9	3.8	14.7	10.0	6.9
Standard	13.5	9.7	9.3	28.6	12.8	9.3	10.9	9.2	9.2	18.5	14.7	13.3
Zero.G		8.6			16.5			7.7			12.5	
Life-cycle	8.1			10.4			7.3			10.0		
Median**												
DC	23.3	14.9	7.4	28.0	15.4	6.6	12.5	7.4	4.2	24.7	20.1	13.2
Standard	31.0	19.5	11.8	35.7	20.7	9.7	13.6	9.8	9.4	28.7	24.6	17.8
Zero.G		23.7			28.7			9.4			26.0	
Life-cycle	12.9			13.0			8.2			19.9		
Volatility***												
DC	9.0	5.4	4.0	8.1	2.2	2.7	6.0	1.5	0.4	8.4	5.1	3.1
Standard	11.3	7.2	4.2	6.0	6.1	4.1	7.5	0.8	0.8	11.5	5.3	2.0
Zero.G		9.1			6.5			1.6			6.5	
Life-cycle	5.6			3.3			1.2			5.6		

Notes: This table reports summary statistics for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of the base case of 40-year earnings period with five per cent annual contribution rate. Panel A reports summary statistics for all years, while Panel B, Panel C and Panel D reports RRs for different sub-periods. Investment portfolios are equity (E), bond (B), balanced (50). Life.cycle represents Storebrand's life-cycle investment strategy and Zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.
** The lower decile represents the 10th percentile of the RRs.*
*** The median represents the 50th percentile of RRs.*
****The volatility is measured in standard deviation of RRs.*

From 1940 to 1966 the equity returns were high and bond returns were low. This is reflected in the in the RRs of Panel B in the table above being high for equity allocation and low for bond allocation. The following sub-period presented in Panel C was a characterised with high inflation and wage growth in Norway. Hypothetical cohorts that retire in this period receives lower purchasing power since the pension capital is accumulated by a low rate of return relative to the high inflation and wage growth, decreasing the RRs. In recent times the bond returns have boosted, something that is reflected in the schemes with bond allocation in Panel D. Comparing the summary statistics of the underlying data in table 8 with table 10 above, the same observations are made. In other words, the underlying data is reflected in the RRs in the same periods, which states the importance of portfolio size towards retirement.

As mentioned in section 3 and table 7 in section 4.1, the Basic Model provides a zero guarantee as the default option when the employer chooses the investment strategy, thus it is reasonable to assume that the employer would wish to hold a diversified portfolio with low risk to decrease fluctuations in returns and reduce costs connected to the guarantee. In real life the asset allocation of a zero return guarantee would be expected to include only a low portion of equity. Nonetheless, we assume that the zero guarantee is invested in a balanced portfolio in our analysis to better state the benefits one could best receive. If the employees were given the investment choice, the Basic scheme would look similar to the DC scheme, and is therefore removed and assumed "similar" to the DC scheme under different asset allocations further in our analysis. Since the DC- and Basic scheme with investment choice can be invested in all the different allocation strategies, these different alternatives will be compared to the zero guarantee in the Basic Model. This to provide answer to the following question: Would the zero guarantee from the Basic Model provide better RR for the hypothetical cohorts than what the employees with investment choice could earn with different asset allocations?

Figure 4-6 Different schemes with equity allocation, compared to life-cycle and zero guarantees.



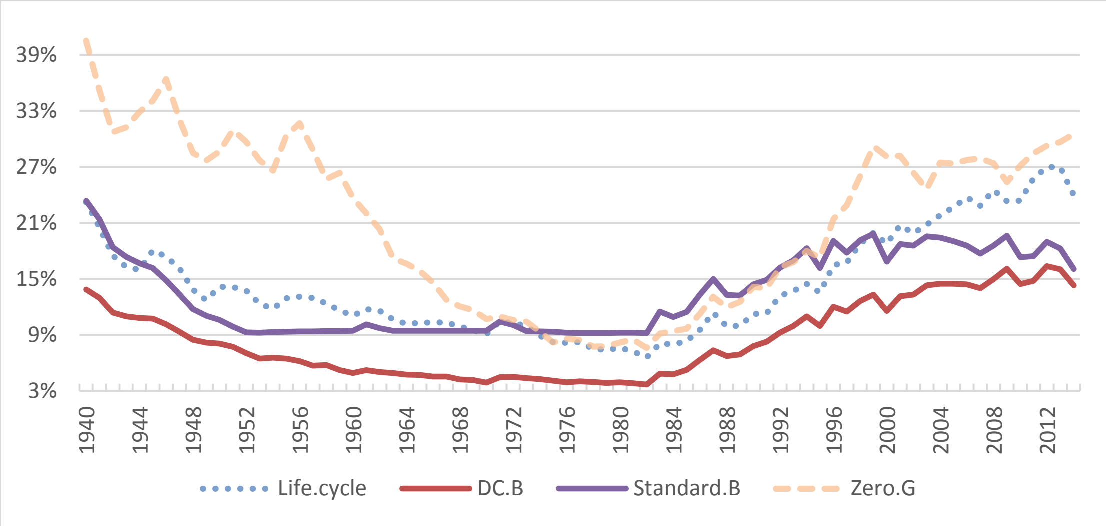
Notes: This figure presents hypothetical RRs for different schemes invested in equity, calculated under assumptions of 40-year earnings period with five per cent annual contribution rate, using historical data. DC.E is the DC scheme invested in equity and Standard.E is the Standard model invested in equity. Life.cycle represents Storebrand's life-cycle investment strategy and Zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.

The figure above shows the same tendency as previously in this section, with the Standard Model as the definite winner inn all periods. The effect of the wage growth guarantee represents why the Standard Model is so robust, although sharing the same trend as the DC scheme with equity allocation, with slightly higher values. The hypothetical cohorts that retiree in the 70s and 80s provide the lowest RRs for the Standard Model with equity allocation. This is also the case for DC- and Basic schemes with equity allocation. Under this period the regulating fund gave low RRs (see section 4.3.5), while the guaranteed accumulated pension capital provided the majority of the benefits in the Standard Model. This guaranteed benefit is consistent with the wage growth, thus the percentage of final salary is roughly a steady measure (around the area of ten per cent). If wage growth is assumed the reasonable deflator on the subject of pension benefits, the guaranteed accumulated pension capital will hold roughly the same purchasing power across cohorts, although the absolute value will differ. To measure the exact differences between the Standard Model and the DC- and Basic schemes is hard because the components are very different. This because the standard model reacts differently to fluctuations in wage growth and returns on investment as the regulating fund that is reinvested in equity, and the guaranteed component that follows the wage level, differ in size and exposure to the risk factors, with the portfolio size effect also playing a part.

The life-cycle strategy is only level with the schemes with equity allocation for the first- and the last hypothetical cohorts. As the first four decades of the 20th century provided low equity returns, with the biggest crisis that have occurred within the limits of the dataset happening at the last quarter of the accumulation phase for the first hypothetical cohorts retiring in the 40s, the schemes with equity allocation suffered the most. The same conclusion could derive for the cohorts that retire after the 2008 financial crisis. This suggests that the life-cycle strategies handle economic downswings better (see section 4.3.4).

Under the zero guarantee from the Basic Model the RRs are lower than the RRs in the DC scheme with equity allocation in the majority of the dataset, suggesting investment choice has high value for the employee when the funds are invested solely in equity.

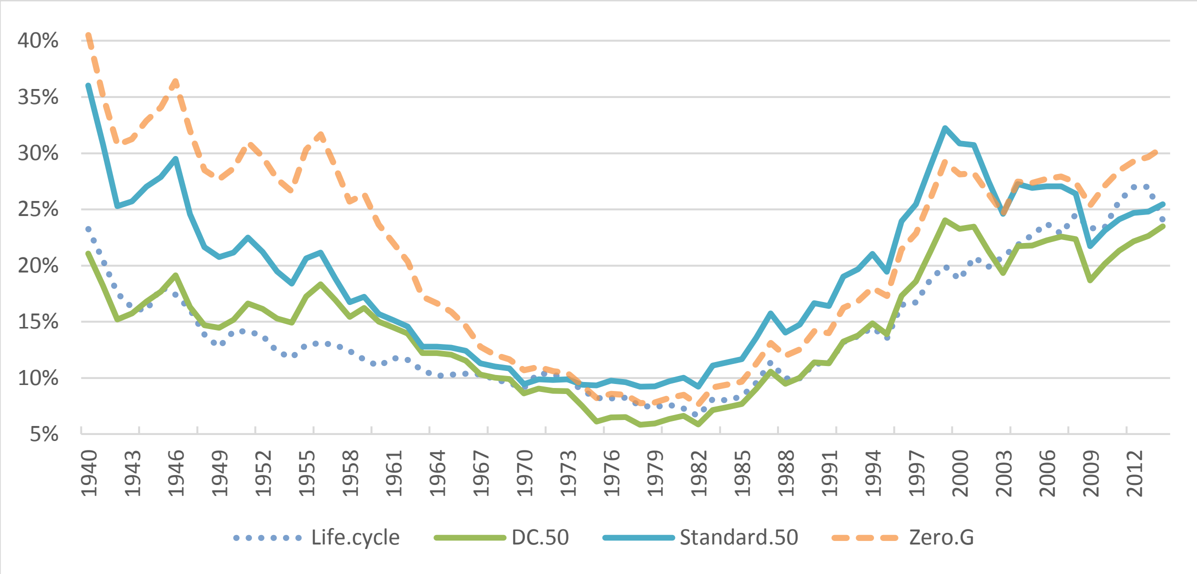
Figure 4-7 Different schemes with bond allocation, compared to life-cycle and zero guarantees.



Notes: This figure presents calculated hypothetical RRs for different schemes invested in bond portfolio, under assumptions of 40-year earnings periods with five per cent contribution rate, using historical data. DC.B is the DC scheme invested in bonds and Standard.B is the Standard model invested in bonds. Life.cycle represents Storebrand's life-cycle investment strategy and Zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.

The figure above shows the schemes when allocation is solely in bonds. Here, if the employee chooses to invest in bonds the benefits received from the schemes would differ dramatically from the balanced zero guarantee portfolio (more than 20 per cent lower RRs in some periods). This further emphasizes the poor performance of bonds over the century, and insinuates that employees should stay clear of bonds based on the historical dataset. Because bonds had a particular low return from the 40s to the 80s with median returns of 1.9- and 2.7 per cent for the two sub-periods (compared to wage growth of 6.5- and 9.1 per cent), the guaranteed accumulated pension capital in the Standard Model increased in size compared to the accumulated pension capital from the DC- and Basic schemes, while the members of these schemes practically lost purchasing power since both inflation and wage growth provided higher returns than bonds in this period.

Figure 4-8 Different schemes with balanced portfolio, compared to life-cycle and zero guarantees.



Notes: This figure presents calculated hypothetical RRs for different schemes invested in balanced portfolio, under assumptions of 40-year earnings period with five per cent annual contribution rate. DC.50 is the DC scheme invested in a balanced portfolio and Standard.B is the Standard model invested in a balanced portfolio. Life.cycle represents Storebrand's life-cycle investment strategy and Zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.

The figure above further addresses that the life-cycle strategy handles crises at the end of the accumulation phase better than the fixed portfolios (all equity, all bonds and balanced portfolio). Another thing to bear in mind is that as the bond composition increases towards retirement in the life-cycle strategy, and the size of the accumulated capital will be more exposed to variations in bond returns towards retirement. The high median returns since 1985 (7.8 per cent, see table 8 in section 4.2) could therefore be another reason why the life-cycle strategy handled the 2008 financial crisis as good as it did.

In this figure we also show the effect of the zero guarantee more clearly because all the schemes, except the life-cycle, are directly comparable when it comes to asset allocation. The Standard Model with its wage growth guarantee goes beyond the zero guarantee Basic Model in the 70s along with the boosting inflation and wage growth, making it the best schemes for about 30 years of the dataset. A point to note here is that although the balanced portfolio has experienced slightly higher median returns than the wage growth (10.1- and 9.1 per cent for the sub-period between 1967 and 1985, respectively, see table 8 in section 4.2), the standard deviation is observed to be 11.2 per cent for the balanced portfolio, suggesting lower diversifying effect while the correlation between bond and equity increases (see section 4.2).

Highly volatile returns and high and steady wage growth provide the best values for the Standard Model compared to the other schemes, when low allocation of risky assets is used (bond or balanced portfolio). This leads to the following question: Watching the three graphs above, why does the RR of the Standard Model with equity allocation in the 70s and 80s decrease compared to the other schemes with equity composition, while the exact opposite is true when the schemes with less risky asset allocation are compared? In section 4.3.5 the regulating fund will analysed further under the scope, comparing the total value of the fund with the value of the Standard Model including both regulating fund and guaranteed accumulated pension capital.

According to Antolin (2009) there are four main factors that determine adequacy in pension benefits in defined contribution schemes: i) The length of the contribution and retirement period (the passivity ratio), ii) Contribution rates and wage level, iii) Management costs, iv) Different asset allocation strategies.

In our analysis management costs are placed on the employer and retirement period is assumed constant. In the next sections we will test the robustness of the different schemes by altering the total contributions and comparing different investment strategies.

4.3.2. Analysis of changes in the contribution variables

Table 11 Frequency distribution of hypothetical RR with two per cent contribution, in per cent

	Using Historical Data							
	Equity		Balanced portfolio (50)			Bonds		Life.cycle
	DC.E	Standard.E	DC.50	Standard.50	Zero.G	DC.B	Standard.B	Life.cycle
[0,10>	56.0	29.3	100.0	74.7	52.0	100.0	100.0	96.0
[10,TR*>	44.0	70.7	0.0	25.3	48.0	0.0	0.0	4.0
[TR,50>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
[50,∞>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes: This table reports calculated frequency distribution for RRs for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of the 40-year earnings period with two per cent annual contribution rate. Investment portfolios are equity (E), bond (B), balanced (50). Life.cycle represents Storebrand's life-cycle investment strategy and zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.
*Under the assumptions of the base case, the target rate (TR) to reach 66 per cent annual retirement benefits including benefits from the NDC (37.8 per cent), amounts to 28.2 per cent.

From table 11 we show that with two per cent contributions none of the schemes provides the necessary benefits to reach the target rate of 28.2 per cent. Of the DC scheme with a balanced- or bond portfolio, as well as the standard model with bond allocation, all the 75 hypothetical cohorts receives RRs less than ten per cent. The same is almost true for the life-cycle strategy with 96 per cent of the RRs falling in the same interval. This is particularly interesting since figure 3-9 states that many employers contribute only at this minimum level (more than 40 per cent), and therefore the pessimistic results presented above could just as well represent a significant sample of the working population.

From panel B, table 12 below, we show that the RR falls drastically when minimum contributions are given. The highest median value is 12.4 for the equity allocated Standard Model, which is still way behind the target rate of 28.2 per cent. With downside risk, measured by the lower decile, on RR levels between 1.6- and 5.4 per cent. If contributions were given at seven per cent, Panel C shows that the median RRs for all the schemes are in the range 10.3- to 43.2 per cent. Although still low RRs from the more conservative options, the median RRs are more pleasing for the riskier alternatives. This further emphasizes the importance of contributions on RRs.

Table 12 RRs for different contribution rates and contribution years.

	Using Historical Data														
	Panel A: Base Case			Panel B: 2 %			Panel C: 7 %			Panel D: 35 year			Panel E: 45 year		
	E	50	B	E	50	B	E	50	B	E	50	B	E	50	B
Lower Decile*															
DC	12.1	6.6	4.0	4.8	2.6	1.6	16.9	9.2	5.6	9.2	5.8	3.9	15.1	7.3	4.2
Standard	13.5	9.7	9.3	5.4	3.9	3.7	18.9	13.5	13.0	10.7	8.5	8.2	16.6	10.8	10.3
Zero.G		8.6			3.4			12.0			7.4			10.0	
Life-cycle	8.1			3.3			11.4			7.2			8.3		
Median**															
DC	23.3	14.9	7.4	9.3	6.0	3.0	32.6	20.9	10.3	19.2	12.3	7.0	28.8	17.3	7.2
Standard	31.0	19.5	11.8	12.4	7.8	4.7	43.4	27.2	16.5	23.1	14.3	10.2	37.4	22.7	12.9
Zero.G		23.7			9.5			33.1			15.9			28.6	
Life-cycle	12.9			5.2			18.1			11.8			13.0		
Volatility***															
DC	9.0	5.4	4.0	3.6	2.2	1.6	12.6	7.6	5.6	7.0	4.7	3.6	12.0	6.2	4.4
Standard	11.3	7.2	4.2	4.5	2.9	1.7	15.8	10.1	5.9	8.5	5.8	3.4	15.9	8.2	4.8
Zero.G		9.1			3.6			12.7			7.5			10.1	
Life-cycle	5.6			2.2			7.8			5.1			5.7		

Notes: This table reports summary statistics for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. Panel A reports RRs under base case with 40 year earnings period and five per cent contribution rate, Panel B reports RRs under the assumption of 40 year earnings period with a contribution rate of two per cent, Panel C reports RRs under the assumption of 40 year earnings period with contribution rate of seven per cent. Panel D reports RRs under the assumption of 35-year earnings period with a contribution rate of five per cent, where each hypothetical cohort enters the private labour market at age 32 (first hypothetical cohort at 1905, second at 1906 and so on) and retiring at the age of 67. Panel E reports RRs under the assumption of 45 year earnings period with a contribution rate of five per cent, where hypothetical cohort enters the private labour market at age 22 (first hypothetical cohort at 1902, second at 1902 and so on) and retiring at age of 67. This, since the last five hypothetical cohorts from the base case does not reach retirement age. Investment portfolios are equity (E), bond (B) and balanced (50), while Zero.G representing zero returns guarantee (under Basic model) is invested in balanced portfolio.
* The lower decile represents the 10th percentile of the RRs.
** The median represents the 50th percentile of RRs.
***The volatility is measured in standard deviation of RRs.

If the years of contributing towards the scheme changes from the 40 years (assumed in the base case) to 35 years as shown in Panel D in table 12, the median values decrease, but are higher than the corresponding median values when the contribution rate decreased to minimum level. This states a point about the effect of contribution rates on RR being stronger than the years of contributing towards the scheme (although a decrease to two per cent in contributing rates are not directly comparable to the years of employment decreasing by five). The same can be said about an increase in contribution rates and years, as the median returns for seven per cent contribution rate is higher than the corresponding median returns for the 45 years.

Table 13 Frequency distribution of hypothetical RR with seven per cent contribution, in per cent

	Using Historical Data							
	Equity		Balanced portfolio (50)			Bonds		Life.cycle
	DC.E	Standard.E	DC.50	Standard.50	Zero.G	DC.B	Standard.B	Life.cycle
[0,10>	0.0	0.0	12.0	0,0	0.0	49.3	0.0	1.3
[10,TR*>	38.7	21.3	66.7	53.3	44.0	50.7	97.3	78.7
[TR,50>	50.7	45.3	21.3	45.3	53.3	0.0	2.7	20.0
[50,∞>	10.7	33.3	0.0	1.3	2.7	0.0	0.0	0.0

Notes: This table reports calculated frequency distribution for RRs for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of the 40-year earnings period with two per cent annual contribution rate. Investment portfolios are equity (E), bond (B), balanced (50). Life.cycle represents Storebrand's life-cycle investment strategy and zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.
*Under the assumptions of the base case, the target rate (TR) to reach 66 per cent annual retirement benefits including benefits from the NDC (37.8 per cent), amounts to 28.2 per cent.

With seven per cent contributions (table 13) the equity allocation strategies within the different schemes reach their target rate the majority of the time. The hypothetical cohorts with balanced portfolios reach the target rate 21.3- and 46.6 percentage of the time, giving them an advantage over the life-cycle strategy (20.0 per cent). None of the RRs are above the targeted level for the DC scheme with bond allocation, with approximately 50 per cent receiving less than ten per cent RR, while the Standard Model with bond allocation have only two hypothetical cohorts reaching the target rate. The Standard Model is very dependent on the regulating fund, since the wage growth guarantee alone does not provide sufficient benefits.

In table 22 in the appendix we have calculated returns based on different wage levels measured in G[55] to see if a change in wage level can better provide the necessary pension benefits with the maximum contribution level accounting the "breaking point". Frequency distribution of RRs with 9G average income and contribution rates of seven per cent between 0- and 7.1G, as well as 25.1 per cent contributions between 7.1- and 9G, are shown below in table 14. This is done to provide more insights on how RRs might differ with the total contributions that the member is given. Moreover, since the NDC benefits are capped at 7.1G the RRs from the social security scheme will decrease for average income of 9G.

[55] The G-value from 2013 is deflated back with wage growth each year to create a G value for all the historical years, before multiplied up by 3.5 and 9 to reflect a low-income worker and a high-income worker.

Table 14 Frequency distribution with 9G average wage and highest contributions, in per cent

Using Historical Data and 9 G wage								
	Equity		Balanced portfolio (50)			Bonds		Life.cycle
	DC.E	Standard.E	DC.50	Standard.50	Zero.G	DC.B	Standard.B	Life.cycle
[0,10>	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0
[10,TR*>	25.3	16.0	61.3	42.7	38.7	81.3	72.0	69.3
[TR,50>	26.7	9.3	37.3	26.7	9.3	0.0	26.7	22.7
[50,∞>	48.0	74.7	1.3	30.7	52.0	0.0	1.3	8.0

Notes: This table reports summary statistic for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of 40-year earnings period with annual wage is set at 9 times the base amount (G).Annual contribution rate are maximum rate where 7 per cent contribution are done for wage under 7.1 G and 25.1 per cent 1.9 G (9 G-7.1 G) wage. Annual base amount are discounted back from the G value of 2013 using wage growth as a discount factor. Investment portfolios are equity (E), bond (B) and balanced (50). Life.cycle represents Storebrand's life-cycle investment strategy and zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.
*With 9G average wage, the target rate (TR) to reach 66 per cent annual retirement benefits including benefits from the NDC (30.0 per cent, because NDC is capped at 7.1G), amounts to 36.0 per cent.

For hypothetical cohorts with 9G average income, the distribution of RRs shows more optimistic results. Of the schemes with equity allocation both the DC- and Standard scheme reach the target rate the majority of the time, with balanced allocation strategies providing 38.6- and 57.4 per cent above the targeted level. The zero guarantee only performs slightly better than the Standard Model with a balanced portfolio, and still none of the hypothetical cohorts that are members of a DC scheme with bond allocation reach the target rate in net of NDC benefits.

The life-cycle only satisfies the target rate condition of 36.0 per cent 30.7 per cent of the time. Because of the poor results of the life-cycle strategy of Storebrand we would like to introduce different life-cycle strategies to compare to the other schemes.

4.3.3. Analysis of the life-cycle strategy

The life-cycle strategy of Storebrand is presented, along with Shiller's aggressive strategy, DNB's strategy and the "ultra aggressive" linear life-cycle strategy that we composed on our own (see figure 4-2 in section 4.1).

Table 15 Life-cycle strategies under different sub-periods, 40-year contributions

	Using Historical Data										
	Panel A: Life-cycle				Panel B: DC			Panel C: Standard			Panel: D Zero.G
	Storebrand	DNB	Linear	Shiller	E	50	B	E	50	B	
Lower Decile*											
All Years	8.1	8.7	11.0	7.6	12.1	6.6	4.0	13.5	9.7	9.3	8.6
[1940,1966]	10.4	14.0	13.7	11.5	18.3	12.2	4.8	28.6	12.8	9.3	16.5
<1966,1985]	7.3	7.4	8.8	7.0	10.3	5.9	3.8	10.9	9.2	9.2	7.7
[1986 >	10.0	10.9	12.0	10.6	14.7	10.0	6.9	18.5	14.7	13.3	12.5
Median**											
All Years	12.9	15.6	17.1	14.7	23.3	14.9	7.4	31.0	19.5	11.8	23.7
[1940,1966]	13.0	16.1	17.1	15.1	28.0	15.4	6.6	35.7	20.7	9.7	28.7
<1966,1985]	8.2	9.5	12.7	8.2	12.5	7.4	4.2	13.6	9.8	9.4	9.4
[1986 >	19.9	22.4	23.4	21.0	24.7	20.1	13.2	28.7	24.6	17.8	26.0
Volatility***											
All Years	5.6	5.9	6.6	5.4	9.0	5.4	4.0	11.3	7.2	4.2	9.1
[1940,1966]	3.3	1.9	2.7	2.5	8.1	2.2	2.7	6.0	6.1	4.1	6.5
<1966,1985]	1.2	2.6	4.1	1.2	6.0	1.5	0.4	7.5	0.8	0.8	1.6
[1986 >	5.6	6.5	7.8	5.2	8.4	5.1	3.1	11.5	5.3	2.0	6.5

Notes: This table reports summary statistics for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 divided into different sub-periods under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of **40-year** earnings period with annual five per cent contribution rate. Panel A reports summary statistics for different lifecycle strategies, Panel B reports RRs for DC schemes with different asset allocation, Panel C reports RRs for standard model with different asset allocation and Panel D reports RRs for Zero guarantees (under Basic Model) which is invested in a balanced portfolio. Investment portfolios are equity (E), bond (B), balanced (50).
* The lower decile represents the 10th percentile of the RRs.
** The median represents the 50th percentile of RRs.
***The volatility is measured in standard deviation of RRs.

There are two components of the life-cycle strategy that holds great importance; the level of aggressiveness, and at which time on the investment horizon the aggressive- or the more conservative approach is used (the portfolio size effect), Among the life-cycle strategies presented in in Panel A of the table above there are two that starts downscaling earlier on the horizon (the strategy of Storebrand and Shiller), and two that holds high risk closer to retirement (DNB and Linear). Shiller's strategy is the one with highest equity composition at retirement with 40 per cent. The other strategies are therefore expected to handle negative shocks in the stock market close to retirement age better. In terms of downside risk (the lower decile), the values in the table suggest that downscaling of risk should happen closer to retirement age. The same conclusion holds for median values. The linear strategy with equity holdings of 100 per cent until the final ten years provide the best median values of the life-cycle strategies, suggesting, in addition to late downscaling of risk, that underwriters should offer life-cycle strategies that carries high risk until a few years before retirement, before downscaling heavily to decrease risk the last working years.

From the table below the Standard Model with equity- or balanced portfolios yields higher median RRs than the life-cycle strategies. As the balanced portfolio of the DC scheme provided higher median RRs in previous sections, the RRs of the implemented life-cycle strategies of DNB and the Linear strategy are higher, as well as better values in the Linear strategy in terms of downside risk for the whole period.

Table 16 Life-cycle strategies under different sub-periods, 20-year contributions

Using Historical Data											
	Panel A: Life-cycle				Panel B: DC			Panel C: Standard			Panel D: Zero.G
	Storebrand	DNB	Linear	Shiller	E	50	B	E	50	B	
Lower Decile*											
All Years	3.3	3.5	3.7	3.4	4.0	3.5	2.9	5.5	4.9	4.8	4.2
[1940,1966]	3.7	3.9	3.9	4.1	5.1	4.4	2.8	6.2	5.1	4.8	5.4
<1966,1985]	3.1	3.1	3.0	3.1	2.9	3.0	2.8	4.8	4.8	4.7	3.8
[1986 >	5.4	5.6	5.7	5.8	5.4	5.6	4.9	6.8	6.3	5.8	6.7
Median**											
All Years	4.7	5.3	5.6	5.1	7.2	5.5	3.7	8.4	5.9	5.2	6.1
[1940,1966]	4.2	5.0	4.8	5.0	7.6	5.4	3.2	9.1	5.8	4.9	5.8
<1966,1985]	3.7	3.9	3.9	3.9	4.3	4.0	3.0	5.8	5.0	4.8	4.6
[1986 >	7.3	7.8	8.2	7.4	8.6	7.5	6.3	9.0	7.9	6.9	8.5
Volatility***											
All Years	1.9	2.0	2.1	1.9	3.2	2.0	1.6	3.1	1.9	1.1	2.4
[1940,1966]	1.4	1.3	1.4	1.1	2.2	1.0	1.1	2.2	1.0	0.6	2.4
<1966,1985]	0.5	0.8	1.0	0.6	1.6	0.6	0.3	1.0	0.4	0.4	0.5
[1986 >	1.2	1.5	1.7	1.5	3.6	1.8	0.8	3.5	1.8	0.8	1.8

Notes: This table reports summary statistics for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 divided into different sub-periods under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of **20-year** earnings period with annual five per cent contribution rate. Panel A reports summary statistics for different lifecycle strategies, Panel B reports RRs for DC schemes with different asset allocation, Panel C reports RRs for standard model with different asset allocation and Panel D reports RRs for Zero guarantees (under Basic Model) which is invested in a balanced portfolio. Investment portfolios are equity (E), bond (B), balanced (50).
* The lower decile represents the 10th percentile of the RRs.
** The median represents the 50th percentile of RRs.
***The volatility is measured in standard deviation of RRs.

Although the riskier allocation strategies are more struck by the shorter investment horizon the order remains the same. The lower decile values are still lower for bond allocation than the balanced- and the equity portfolios, and the same remains for the median RRs, while the life-cycle strategies and the balanced portfolios receives similar values in terms of downside risk, median and volatility.

But the question still remains: What happens to the RRs of the hypothetical cohorts in a "worst case" scenario, where a sudden negative shock in the stock market impose threats to the accumulated pension capital?

In the next section the RRs of hypothetical cohorts within each scheme that retiree just before the financial crisis of 2008 are compared to the RRs of the ones retiring just after, this to test how the different schemes and investment strategies respond.

4.3.4. Market timing

Table 17 Market timing with different life-cycles strategies.

	Using Historical Data						
	Dc	Standard	Zero	Storebrand	linear	Shiller	DNB
Equity							
2007	33,02	40,31					
2009	18,23	21,40					
Difference	-14,79	-18,91					
50-50							
2007	22,58	27,06	27,92	22,83	31,92	23,35	27,66
2009	18,69	21,72	25,37	23,31	35,71	21,20	29,40
Difference	-3,89	-5,34	-2,55	0,48	3,79	-2,14	1,74
Bonds							
2007	14,02	17,70					
2009	16,12	19,65					
Difference	2,10	1,95					

Notes: This table reports calculated RRs for hypothetical cohorts retiring in 2007 and 2009 under different occupational pension schemes and life-cycle strategies, using historical data. These RRs are calculated under assumptions of 40-year earnings period with annual five per cent contribution rate. Investment portfolios are Equity, Bonds (B), balanced (50-50) and zero.G for zero guaranteed invested in a balanced portfolio.

When the bubble burst in 2008 the equity returns fell with 35.6 per cent (see table 22 in appendix). Naturally, schemes with equity allocation suffer the most, almost halving the accumulated pension capital for the hypothetical cohort retiring in 2009 versus the one retiring in 2007. This could have major implications on the future welfare level for the given cohort. The balanced portfolios, along with the life-cycle strategies, are shown in the middle of the table. The schemes with balanced portfolios receive lower RR, but not significantly compared to the ones with equity allocation.

The life-cycle strategies, so close to retirement, have switched all, or most, of their equity holdings with bonds. Shillers aggressive strategy has the worst outcome of the life-cycle strategies. This is because the Shiller strategy has 40 per cent of the assets in equity, and is therefore hit by the crisis[56], almost as much as the balanced portfolios. The other strategies actually increase their accumulated capital, with the Linear strategy providing the best results. On that note a high risk strategy when the time horizon is long, while gradually decreasing its holdings in risky assets towards retirement, is the best option to keep the returns that the equity gives, as well as take advantage of the certainty that bonds gives when the accumulated capital is at its largest.

The Standard Model invested in equity was the scheme that had the highest difference across the two hypothetical cohorts. Since the Standard Model is a new product it is hard to tell how the pension capital that increases with wage growth will be invested, and how the regulating fund itself will be invested. Of this reason the next section will present the different alternatives for the pension fund and the pension capital to be invested, and the implications on the RRs for the hypothetical cohorts.

4.3.5. Analysis of the regulating fund of the Standard Model[57]

From the table 18 below, when the fund is invested in bonds the RRs are lowest. The median RR for the Standard Model goes from 9.4 per cent in the worst period when both the pension capital and the fund is invested in bonds, to 35.7 per cent for the pest period when both investments are made in equity. Of this there is more than one interesting point. Firstly, the high median RR has been steadily high when tested under several different conditions. Secondly, the lowest median and lower decile values value of

[56] Under financial crises, the interest rate will fall giving an increase in yield. Thus, the bond strategy in securing the downside risk for portfolio return seems to work.

[57] We thank Associate Professor Helge Nordahl for suggesting to undertake an analysis of the regulating fund of the Standard Model.

roughly 9 is achieved in a time where the regulating fund has run out (see Panel F below), implying that the wage growth guarantee provide a “floor” of benefits that would be in the area of 9 per cent of final salary.

In the sub-period between 1940 and 1966, when the equity premium was highest, the lower decile RRs, both invested and reinvested in equity was 28.6 per cent. This means that roughly 24 out of 27 hypothetical cohorts received RRs above the targeted level (28.2 per cent in net of NDC for the base case) in this sub-period. The pension capital was high during this period because of the guaranteed wage growth accumulating the pension capital, as well as the regulating fund receiving reinvested benefits from the high equity returns. As the pension capital is accumulated with a higher factor, the size of the contributions made to the regulating fund increases, and therefore the returns made on the fund will be larger. This is an example of the portfolio size effect.

Not surprising, the bond investment shows lower RR. In period from 1940 to 1985, the lower decile of bond investment, for all investment strategy, had lower RR and the regulation fund was empty. Thus, there is higher risk retiree only received the guaranteed rate of return, wage growth, when bond allocation strategy is used.

The overall conclusion of the table below is that it matters both how the guaranteed pension capital is invested, and how the regulating fund is reinvested. If the guaranteed pension capital is invested in equity, the median RRs can differ between 20.7- and 31.0 per cent for the whole period, this whole difference derives from regulating fund (11.5- to 21.5 per cent, see Panel D). In real life the guaranteed capital and the regulating fund will probably be invested in assets with low risk, foregoing major benefits from equity allocation for employees under the scheme.

Table 18 How the Regulating fund in the Standard Model differs with different investment strategies.

	Using Historical Data																	
	RR Standard Model									RR Regulating Fund								
	Panel A: Equity			Panel B: 50 - 50			Panel C: Bonds			Panel D: Equity			Panel E: 50 - 50			Panel F: Bonds		
	E	**50**	**B**	**E**	**50**	**B**	**E**	**50**	**B**	**E**	**50**	**B**	**E**	**50**	**B**	**E**	**50**	**B**
Lower Decile*																		
All Years	13.5	11.9	11.1	9.7	9.3	9.3	9.3	9.3	9.3	4.3	2.6	1.8	0.5	0.4	0.4	0	0	0
[1940.1966]	28.6	23.7	17.9	14.8	12.5	11.2	9.4	9.4	9.3	19.4	14.3	8.4	5.6	3.5	2.0	0	0	0
<1966.1985]	10.9	9.7	9.3	9.0	9.0	9.0	9.2	9.2	9.2	1.7	0.3	0	0	0	0	0	0	0
[1986 >	18.5	17.6	16.7	15.5	14.9	14.4	14.4	13.8	13.3	9.2	8.3	7.4	6.0	5.5	4.9	5.1	4.5	4.1
Median**																		
All Years	31.0	26.5	20.7	23.6	20.1	15.4	15.9	14.0	11.8	21.5	17.1	11.5	13.7	10.8	6.5	6.7	4.7	2.6
[1940.1966]	35.7	29.4	21.0	26.8	22.6	15.1	14.7	10.9	9.7	26.3	19.9	11.7	17.6	13.5	5.7	5.5	1.7	0.3
<1966.1985]	13.6	13.3	12.3	10.8	9.6	9.7	9.4	9.4	9.4	4.4	4.1	3.0	1.8	0.4	0.4	0	0	0
[1986 >	28.7	29.4	26.5	25.6	25.1	22.2	22.3	21.0	17.8	19.0	19.6	16.9	15.6	15.4	12.4	12.6	11.4	8.4
Volatility***																		
All Years	11.3	8.7	6.7	9.4	7.8	6.1	7.0	5.7	4.2	11.2	8.7	6.7	9.3	7.7	5.9	6.9	5.7	4.2
[1940.1966]	6.0	4.7	5.1	6.7	6.9	6.0	5.8	5.7	4.1	5.9	4.8	5.2	6.8	7.1	6.1	6.0	5.8	4.2
<1966.1985]	7.5	3.8	2.0	1.5	0.9	0.8	0.8	0.8	0.8	7.4	3.7	1.9	1.4	0.8	0.7	0.9	0.8	0.8
[1986 >	11.5	7.5	4.8	8.2	5.5	3.6	5.5	3.3	2.0	11.5	7.4	4.7	8.1	5.3	3.4	5.4	3.2	1.9

Notes: This table reports summary statistics for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 in the standard model, using historical data. These RRs are calculated under assumptions of 40-year earnings with five per cent contribution rate. Panel A reports summary statistics for the standard model with pension capital invested in equity and regulating fund reinvested in different portfolios, Panel B reports pension capital invested in a balanced portfolio and regulating fund reinvested in different portfolios, Panel C reports pension capital invested in bonds and regulating fund reinvested in different portfolios, Panel D reports summary statistics for standard model regulation fund invested into different investment portfolio, while pension capital invested in equity. Panel E reports summary statistics for standard model regulation fund invested into different portfolios, while pension capital invested in balanced portfolio. Panel F reports summary statistics for standard model regulating fund invested into different investment portfolios, while pension capital invested in bonds.

Investment portfolios are equity (E), bond (B), balanced (50)..

** The lower decile represents the 10th percentile of the RRs.*

*** The median represents the 50th percentile of RRs.*

****The volatility is measured in standard deviation of RRs.*

4.3.6. Contribution Rate

Table 19 Contribution level necessary to achieve a median target rate of 66 per cent.

	Using Historical Data					
	DC	Basic	Standard	Zero	Storebrand	Linear
Contribution rate**						
Equity	5.9	5.7	4.6			
Balanced	9.6	9.3	7.4*	6.0		
Bonds	19.5	18.7	12.4*			
Life-cycle					11.0	8.2

Notes: This table reports summary statistics for necessary annual contribution rate for hypothetical employees with 40-year earnings periods to achieve median RR of 66 per cent (the target rate included NDC). Calculation is done for hypothetical cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data.
*The regulating fund is reinvested in the same assets as the guaranteed pension capital. As shown in section 4.3.5 above, this is not an optimal investment for the regulating fund.
** Since the wage level is below 7.1G at all times in the base case this contribution is to be considered as "flat".

The table above presents the required contribution rate to achieve the target rate of 66 per cent, including NDC. Which implies that the median of these different investment strategies is approximately 66 per cent. The Standard Model with asset allocation in equity needs the lowest contribution rate to reach the median target rate with 4.6 per cent. For the DC- and Basic scheme with equity allocation the mortality cross subsidy is the only difference, where the Basic reach the target rate with 5.7 per cent, while DC needs 5.9 per cent contributions. The schemes with conservative asset allocations, such as bonds, need a much larger contribution rate, between 12.4- and 19.5 for the DC- and Hybrid schemes, while the contribution rate equals 7.4- to 9.6 per cent for the balanced portfolios of DC- and Hybrid schemes.

For employees provided with investment choice in DC- or Basic schemes, the equity allocation is the best alternative, just as good as if the employer provided zero guarantees on a balanced portfolio in the Basic scheme. For the relatively conservative life-cycle strategy of Storebrand to have a median RR of 66 per cent, the contribution rate must equal 11 per cent, a higher contribution rate than the balanced portfolios. If the aggressive linear life-cycle strategy were the default portfolio strategy, the contribution rates necessary would be 8.2 per cent, giving an advantage over the balanced portfolios without guarantees.

If figure 3-9 in section 3.2.5 reflects a realistic estimate of contribution rates given in the future, less than 40 per cent of employers will have contribution rates of more than five per cent for their employees. In that case, more than 60 per cent of the employees in all the schemes (except Standard Model with equity allocation) will receive inadequate pension benefits at retirement based on historical data. If not a large proportion of the assets were allocated in risky investments with higher expected returns, the expected RRs would be insufficient to smooth consumption when reaching the retirement age.

4.3.7. Limitations and further research

There are two main issues related to our analysis. Firstly, we have calculated replacement ratios for hypothetical cohorts retiring between years of 1940 to 2014. Our calculated replacement ratios are done using overlapping data on historical investment returns, wages, wage growth and inflation, thus the ratios are not independent. To address this problem further research can be done using stochastic models with Norwegian parameters. Secondly, our data on returns includes the post war period in which the stock market has boosted, and outperformed bonds. In fact, the whole 20th century has provided high returns on the stock markets of the developed world. This influenced our results, and our findings could exaggerate the benefits of equity allocation, although the future is uncertain and the implications derived from the analysis could reflect future market conditions in a pleasing manner.

Our methodology includes different assumptions, but nonetheless our findings can provide interpretation and illustration of market risk and other components of fully funded pension system in Norway. To expand our analysis, further research should be conducted, or available research explored, on the following themes: i) Exchange rate fluctuation; creating portfolios of international and domestic assets with exposure to currency risk, ii) Wage and wage growth; reflecting an individual's life-cycle (U-Shaped wage growth), iii) Calculating annual mortality cross subsidiary using K2013 of FNO, iv) Use historical or stochastic interest rates and life expectancy to calculate annuity rates for different cohorts.

5. Conclusion

This thesis has analysed the relative performance of different investment strategies in fully funded pension plans in Norway given historical market conditions. In particular, it has evaluated the adequacy of retirement income after the reform. Where adequacy is measured as pension benefits at retirement in per cent of final salary; the replacement rate (RR). Using historical data, we have calculated RRs for different hypothetical cohorts throughout the 20th century under fully funded pension schemes in the private sector.

Throughout this period the stock market has achieved great returns, while bonds have performed poorly. This high equity premium over bonds makes fully funded schemes favor a higher composition on equity over bonds in our analysis, thus riskier investment asset allocation is preferred. This is reflected in the high median RRs when the pension capital is invested in equity. In fact, all the conservative strategies, including the zero guarantee balanced portfolio and the life-cycle strategy of Storebrand, offer lower 5th percentile RRs, something that stands in contradiction to their purpose of decreasing downside risk. The risk adverse individual should invest in balanced portfolios, rather than bonds, which also will yield better results than a passive life-cycle strategy.

The life-cycle strategy handles crises towards the end of the accumulation period better than the fixed allocation strategies, but the results vary along with the composition of the different life-cycle strategies. Testing the strategy of Storebrand against the Defined Contribution-, and Hybrid schemes with different fixed asset allocations provided poor results in regards to median RRs. The schemes with balanced portfolios performed better than the life-cycle strategy, implying that in securing certainty in retirement income by increasing its bond composition, the life-cycle strategy has sacrificed a higher expected return from riskier investments. The strategy must be more aggressive as the life-cycle strategies of DNB, Storebrand and Shiller yielded lower RRs than the constructed “ultra” aggressive strategy; the Linear strategy. This strategy of investing 100 per cent in equity and sharply decrease the equity holdings to zero towards the end of working career, made the hypothetical cohorts able to benefit from the high expected returns from equity, as well as provide certainty in retirement income. If the decrease in equity holdings would happen at an earlier stage in the life-cycle, the portfolio size effect would not be benefited from.

The Standard Model has the most persistent RRs, and carries a floor of benefits deriving from the wage growth guarantee. Nonetheless, the RRs of the Standard Model are very reliant on the regulating fund, and how it is invested. Investing in bonds instead of equity could cause a considerable haircut to the retirement benefits. Under the zero guarantee from the Basic Model the RRs are lower than the RRs in the DC scheme with equity allocation in the majority of the dataset, suggesting investment choice has high value for the employee when the funds are invested solely in equity. As mortality inheritance is given back to the members in the Basic scheme, members with equal contribution rate would receive slightly higher benefits from the Basic scheme, with investment choice, than from the DC scheme.

The results from the analysis imply that the difference between the public and private sector is quite remarkable. With contribution rates of two per cent, none of the schemes reach the target rate of 28.2 per cent (in net of the social security scheme), not even with the most aggressive investment strategies. Given the fact that more than 40 per cent of employees receive two per cent contribution in the DC scheme, as of 2013[58], there is necessity for private savings or higher minimum contributions. Increasing the contributions makes the more aggressive allocation strategies reach the target rate the majority of the time, but investing in bonds will never force the RRs above the target rate (except from the Standard Model with bond allocation).

The Standard Model with asset allocation in equity needs the lowest contribution rate to reach the median target rate of 66 per cent, with 4.6 per cent. The schemes with conservative asset allocations, such as bonds, need a much larger contribution rate, between 12.4- and 19.5 for the DC- and Hybrid schemes, while the life-cycle strategy of

[58] See figure 3-9 in section 3.2.5.

Storebrand (11.0) needs a higher contribution rate than the balanced portfolios of the DC- and Basic schemes (9.3 and 9.6), and the constructed Linear strategy (8.2). Since all the contributions needed are above five per cent, more than 60 per cent of the employees in all the schemes (except Standard Model with equity allocation) will receive inadequate pension benefits at retirement based on historical data[59].

[59] See figure 3-9 in section 3.2.5.

6. References

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7. Appendix

Table 20 Assumptions for the calculations in section 3

Assumptions for Section 3	
Sex	Gender Neutral
Marital Status	Not Married
Born	1967
Start Working	27
Age of Retirement	67
Retirement Year	2034
Base Amount	85 245
Growth in Base Amount	4,2% a)
Wage Growth	4,2% a)
Gross Return	6,55% b)
Contribution	End of the year
Return on Asset	End of the year
Divisor in NDC	18,07 c)
Divisor in Hybrid Scheme	20,78 c)
Divisor in DC Scheme	21
Hybrid Scheme:	
Mortality Cross Subsidy	4,5 %[60]
Regulating fund	(Returns - Wage Growth)

Maximum Contributions in Occupational Schemes	
Wage Level	All Schemes
0G - 7.1G	7 %
7.1G - 12G	25,1 %
Minimum Contributions in Occupational Schemes	
Wage Level	All Schemes
1G - 12G	2 %

[60] http://www.vff.no/Internett/Fakta_om_fond/filestore/Frakollektivttilindividueltinvesteringsvalg_Ellingsen.pdf

a) Growth in Base Amount and wage growth.

Growth in G			***Growth in pensionable income (w)***		
Year	Average G	Growth	Year	Pensionable income	w
2003	55 964		2002	245200	
2004	58 139	3,89 %	2003	253500	3,38 %
2005	60 059	3,30 %	2004	261600	3,20 %
2006	62 161	3,50 %	2005	273300	4,47 %
2007	65 505	5,38 %	2006	285200	4,35 %
2008	69 108	5,50 %	2007	304200	6,66 %
2009	72 006	4,19 %	2008	324300	6,61 %
2010	74 721	3,77 %	2009	333700	2,90 %
2011	78 024	4,42 %	2010	342500	2,64 %
2012	81 153	4,01 %	2011	356700	4,15 %
2013	84 204	3,76 %	2012	371500	4,15 %
	Average Growth	*4,17 %*		*Average Growth*	*4,25 %*
		≈4.20%			**≈4.20%**

Source: (NAV[61], SSB)

b) Gross Return

Annual Returns on Investment	
Global stock market	8,40 %
Global market for government bonds	4,70 %
50/50 portfolio	**6,55 %**

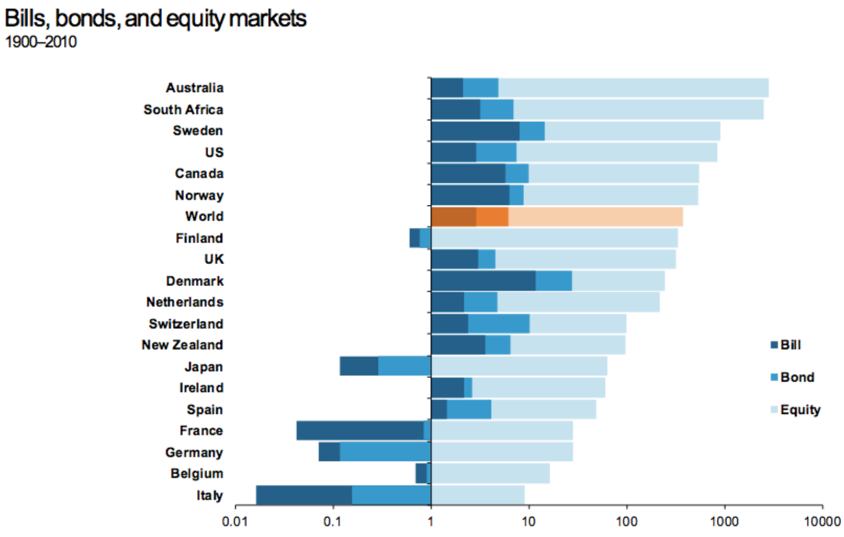
Source: (Finance Department[62])

[61] https://www.nav.no/Om+NAV/Satsar+og+utbetalingsdatoar/Grunnbeløpet+(G)
[62] http://www.regjeringen.no/nb/dep/fin/dok/regpubl/stmeld/2012-2013/meld-st-12-20122013/2/6/3.html?id=714079

c) Divisor for NDC and Hybrid scheme

Divisor born 1967				
Retirement Year	Age	Divisor[63]	NDC (Adjusted 10 %)[64]	Adjusted (15%)[65]
2029	62	20,48	22,53	25,91
2030	63	19,67	21,64	24,88
2031	64	18,86	20,75	23,86
2032	65	18,05	19,86	22,83
2033	66	17,24	18,96	21,81
2034	**67**	**16,43**	**18,07**	**20,78**
2035	68	15,63	17,19	19,77
2036	69	14,83	16,31	18,76
2037	70	14,03	15,43	17,75
2038	71	13,24	14,56	16,75
2039	72	12,45	13,70	15,75
2040	73	11,67	12,84	14,76
2041	74	10,90	11,99	13,79
2042	75	10,14	11,15	12,83

Figure 6-1[66]



[63] https://www.nav.no/Pensjon/Pensjon/Forholdstall+og+delingstall.353457.cms
[64] (Stølen and Fredriksen 2011a)
[65] Finance Department: http://www.regjeringen.no/nb/dep/fin/dok/nouer/2012/nou-2012-13.html?showdetailedtableofcontents=true&id=696306, chapter 5.3.5 page 97-98.
[66] http://www.texpers.org/documents/conferences/presentations/2012/tuesday/Dimensional-A%20Century%20of%20Global%20Returns%20201202.pdf

Table 21 Ten highest and lowest value of historical data.

Historical Data															
Panel A: Nominal wage growth Value				**Panel B: Equity Values**				**Panel C: Bonds Values**				**Panel D: Inflation Values**			
Year	**Lowest**	Year	**Highest**	Year	**Lowest**	Year	**Highest**	Year	**Lowest**	Year	**Highest**	Year	**Lowest**	Year	**Highest**
1922	-18,6	1917	41,9	1931	-44,93	1935	56,37	1999	-9,12	1982	39,47	1922	-18,23	1918	33,65
1927	-10,3	1918	31,7	2008	-35,60	1933	55,01	1994	-8,01	1985	25,32	1926	-15,42	1917	22,31
1926	-9,6	1919	23,1	1937	-32,80	1928	47,35	2009	-7,43	1986	23,96	1927	-11,78	1916	18,23
1923	-7,9	1920	19,6	1907	-24,16	1954	46,27	2013	-6,25	1995	23,72	1923	-6,90	1941	17,59
1928	-4,8	1916	17,6	1930	-22,62	1958	39,71	1969	-5,81	1970	19,07	1921	-6,71	1951	15,03
1931	-4,05	1975	16,06	1974	-20,67	1975	39,07	1958	-4,45	2000	18,15	1928	-6,45	1940	14,46
1921	-3,6	1976	12,77	2002	-19,91	1945	38,84	1987	-3,27	2011	16,17	1904	-4,88	1915	14,31
1932	-2,94	1974	12,63	1917	-18,70	1908	38,69	1967	-2,57	1991	15,52	1931	-4,88	1920	13,91
1933	-2,59	1951	12,37	1903	-17,38	1927	37,16	1941	-2,52	1989	14,94	1902	-4,65	1981	12,60
1902	-1,3	1952	12,01	1973	-15,80	1995	35,26	1956	-1,77	2008	14,41	1929	-4,55	1975	11,03

Note: Values in percentage.

Table 22 RRs for 3.5G with two per cent contribution and 9G with high contribution

Using Historical Data									
	Panel A: All year			Panel B: 3.5 G low			Panel C: 9 G high		
	E	50	B	E	50	B	E	50	B
Lower Decile*									
DC	12,1	6,6	4,0	4,8	2,8	1,7	26,1	15,0	9,1
Standard	13,5	9,7	9,3	5,4	4,0	3,8	29,2	21,5	20,6
Zero.G		8,6			3,7			19,8	
Life-cycle	8,1			3,3			17,9		
Median**									
DC	23,3	14,9	7,4	9,2	6,0	3,0	49,7	32,6	16,2
Standard	31,0	19,5	11,8	12,5	7,5	5,0	67,7	40,8	26,9
Zero.G		23,7			9,6			51,8	
Life-cycle	12,9			5,1			27,9		
Volatility***									
DC	9,0	5,4	4,0	3,6	2,1	1,5	19,6	11,3	8,4
Standard	11,3	7,2	4,2	4,5	2,8	1,6	24,1	15,1	8,6
Zero.G		9,1			3,6			19,7	
Life-cycle	5,6			2,1			11,4		

Notes: This table reports summary statistic for calculated hypothetical RRs for cohorts retiring between 1940 and 2014 under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of 40-year earnings periods. Panel A reports RRs with annual contribution rate of five per cent where annual earnings equals to average annual wage. Panel B reports RRs with annual contribution rate of two per cent where wage equals to 3.5 times the base amount (G). Panel C reports RRs where wage equals to 9 times the base amount (G) with maximum contribution rate. Annual contribution rate are maximum rate where 7 per cent contribution are done for wage under 7.1 G and 25.1 per cent 1.9 G (9 G-7.1 G) wage. Annual base amount are discounted G value of 2013 using wage growth as discount factor. Investment portfolios are equity (E), bond (B), balanced (50). Life.cycle represents Storebrand's life-cycle investment strategy and zero.G is zero return guarantees (under Basic Model) invested in balanced portfolio.
* The lower decile represents the 10th percentile of the RRs.
** The median represents the 50th percentile of RRs.
***The volatility is measured in standard deviation of RRs.

Table 23 Life-cycle strategies under different sub-periods, 30-year contributions

	Using Historical Data										
	Life-cycle				DC.50			Standard			Zero.G
	Storebrand	DNB	Linear	Shiller	E	50	B	E	50	B	
Lower Decile*											
All Year	5.4	5.8	6.2	5.2	7.0	5.0	3.6	9.0	7.4	7.1	6.3
[1940,1966]	6.1	7.2	7.3	7.2	12.3	7.8	3.7	14.3	8.6	7.2	8.9
<1966,1985]	4.7	4.7	4.8	4.7	5.7	4.5	3.5	7.1	7.0	7.0	5.7
[1986 >	7.2	7.8	8.0	7.7	9.7	7.9	6.1	12.4	11.0	10.0	9.5
Median**											
All Year	7.9	9.6	11.6	8.3	14.1	9.0	6.0	17.5	10.5	8.7	12.0
[1940,1966]	7.2	9.6	11.1	8.0	15.9	9.0	4.3	20.0	9.6	7.2	12.3
<1966,1985]	5.6	6.2	7.3	5.6	7.1	5.6	3.7	9.8	7.5	7.2	6.8
[1986 >	14.2	14.5	15.3	13.5	14.5	13.0	10.3	18.1	14.4	12.0	16.4
Volatility***											
All Year	4.0	4.3	4.8	3.9	5.8	3.9	3.0	6.6	4.4	2.6	6.0
[1940,1966]	3.3	2.5	2.6	2.8	2.7	2.4	2.4	3.5	4.0	2.4	6.4
<1966,1985]	0.9	1.8	2.8	1.0	4.1	1.1	0.4	3.9	0.6	0.6	0.8
[1986 >	3.3	4.2	5.2	3.3	6.9	3.5	1.9	7.6	3.3	1.3	3.9

Notes: This table reports summary statistics for calculated RRs for hypothetical cohorts retiring between 1940 and 2014 divided into different sub-periods under different occupational pension schemes, using historical data. These RRs are calculated under assumptions of **30-year** earnings period with annual five per cent contribution rate. Panel A reports summary statistics for different lifecycle strategies, Panel B reports RRs for DC schemes with different asset allocation, Panel C reports RRs for standard model with different asset allocation and Panel D reports RRs for Zero guarantees (under Basic Model) which is invested in a balanced portfolio. Investment portfolios are equity (E), bond (B), balanced (50).

** The lower decile represents the 10th percentile of the RRs.*

*** The median represents the 50th percentile of RRs.*

****The volatility is measured in standard deviation of RRs.*