Impact of the three months average DNB term structure on Dutch pension funds

Consequences for the coverage ratio and interest rate risk management

A Master's project for finishing the Master track Financial Engineering and management from the overarching study Industrial Engineering and Management

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Abstract

Pension plans are a popular topic of discussion in the Netherlands, mainly because of the demographic changes (e.g. aging population), a persistent economic crisis and the currently low market interest rates. Various measures are taken in order to either counter or soften the associated pension complications that result from the former. One of them is the implementation of an averaging feature in the interest rate curve, performed at the end of 2011. From that point forward, the present pension liability needs to be derived using a three months average interest rate term structure. The prescribed methodology is what this impact study focuses on. It is a research that aims to analyse the consequences for the coverage ratio and the interest rate risk management of pension funds, the former of which is done through backtesting. Constructing the interest curves, as well as generating future pension cash flows, are all part of this. Furthermore, with it, a consistency in regulations is guaranteed. Both processes are performed by conducting the methodologies prescribed by the Financieel ToetsingsKader (FTK).

In order to derive fitting conclusions, both the justifications used and motivations behind the implementation of, as well as potential (negative) impacts due to the switch to an average interest rate, are outlined in detail. For various scenarios, a comparison is made between an instance where averaging is not applied, as well as one where the latter is utilized. Because applying the Ultimate Forward Rate affects the difference between the ex- or inclusion of an averaging feature, analyses are performed that account for the UFR as well. Through use of the so-called "Graph constructor", a developed VBA tool, it is possible to study numerous scenarios via a step-wise process and by doing so, the impact of the average interest curve can be quantified.

At the time, applying the averaging feature led to higher coverage ratios and in turn, prevented or lowered the potential need of having to perform right cuts by the Dutch pension funds. Due to its nature of structurally altering the method of valuation (instead of it being a one-time-only thing, like it was supposed to be), current trends may be bent. The more stable height of the pension obligation does not result in a less fluctuating coverage ratio. The latter results from the fact that the replicating portfolio, the investment part that should mimic and follow a fluctuating pension liability (created by interest rate development), is still valued using the market interest rate term structure. Furthermore, applying the three months average DNB interest rate term structure in order to value the total pension provision will needlessly complicate the interest rate risk management. The hedging performance is affected. Also, averaging impacts the predictive and transparent character of coverage ratio developments. Through taking into account the UFR as well, differences between not applying the averaging feature, or applying it, are lessened.

There is a need to search for an alternative and better stabilizer. At the very least, as will be shown further in this research, the latter should be applied to both sides of the balance sheet. Also, the pension sector will benefit from a derivation of the coverage ratio which, as a leading variable, does not influence the way it is controlled. Applying an averaging feature to the coverage ratio itself may offer a solution. At any rate, it is crucial that all choices made should take into account that an overestimation of the financial status at this moment in time can cause for a more asymmetric distribution of capital over generations within pension funds.

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Furthermore, I owe a word of gratitude towards my fellow students Tobias Kocks and Xiao Tong Liu. Without them, my thesis would not have become the report that now lies before you. Both of them have closely followed the developments of this research and critically viewed some sections of the project. Without a doubt, with their help, the overall research itself has ascended to heights not previously possible.

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Wouter W. Slot

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Chapter 1

Introduction

In essence, pension is a straightforward product. Contributions form a commitment to future pension benefits. A pension fund collects all premiums, ensures risk sharing between its members and strives for investment returns that must lead to the actual realisation of promised benefits. This process is accompanied with uncertainties, which could be psychologically troublesome, but it is not a reason to treat pensions as something complicated. However, anyone who has followed the intense debate on the content and design of the new financial regulatory framework for pension funds, cannot but conclude that pensions involve extremely complex subject matters. Intense discussions have led, amongst others, to changes in the way in which the pension liabilities must be valued. This means no longer a fully market based valuation. The adjusted calculation method is subject to strong criticism. There are serious doubts whether the interventions in the discount factor have resulted in more stable coverage ratios and improved transparency of pension risks. In this research the impact of the current methodology will be quantified. This makes it possible to judge the extent to which the proposed objectives are indeed realized.

This opening chapter focuses on the framework[1] surrounding the research. First off, in Section 1.1 a short introduction is given about the organization, PricewaterhouseCoopers N.V. and the department PAIS in particular. Section 1.2 then covers the problem context in which some background information is given. Afterwards, Section 1.3 is devoted to the investigation of the existing state of affairs. This eventually leads to an obvious problem statement and an identified main research question. These formulations are explicitly stated in Section 1.4, the problem definition. Next, Section 1.5 is dedicated to a detailed description of the research goals accompanying this study. Of course, their links with the main research question are established as well. Thereafter, Section 1.6 sets out the research design. Deriving the relevant research questions, that will be answered throughout the report, and the way in which the data gathering process is structured, are central points. The chapter is concluded with a rough thesis outline in Section 1.7. The latter provides a draft of what can be expected in the remainder of the thesis.

[1] As reference material the *methodological checklist [MC] (Heerkens, 2004)* and *managerial problem solving method [MPSM](Heerkens 2009)* will be consulted throughout the report. These literatures are normally used by business and management students of the University of Twente to provide the conducted research with the needed methodology and structure. Despite the directives do not completely fit with this type of research, it kind of gives the report some guidance.

1.1. Brief company description and its background

PwC, also known as PricewaterhouseCoopers, is a well-known worldwide consultancy firm. Most are familiar with their accountancy business practices, but PwC has more to offer. Besides assurance, they are involved in many Advisory, Tax and Human Resource related issues. The thesis will be written within the PAIS, Pensions Actuarial and Insurance Services, division. This department consists mainly of econometricians and actuaries. PwC has thirteen offices in the Netherlands, with PAIS operating from the locations Utrecht, Rotterdam and their headquarters Amsterdam.

The main activities carried out by this department are located in the work field of pension accounting (within the IAS 19 framework), designing pension schemes and actuarial models, financial risk management, supporting mergers and acquisitions, accompanying pension transitions and advising insurers in, amongst others, the implementation of the Solvency II regulation. In short, PAIS consults public and private companies, pension funds and insurers. Furthermore, this is not only done from an actuarial point of view, but also from a strategic, legal and fiscal perspective. Combining strengths of different work areas, is one of their proposed main added values. Working together is an important virtue which enables PwC to advice in very diverse issues and to conduct a variety of assignments.

This thesis touches upon some relevant issues the pension sector is facing nowadays. The pension world is exposed to ongoing regulatory changes and heavily affected by fluctuating market conditions. The associated impact on the society is huge. These tumultuous times and their related and continuously arising social questions are, due to the diverse interests of all parties involved, difficult to solve and in addition, challenging for companies like PwC. Experience, expertise and up-to-date knowledge and understanding of the recent developments are of crucial importance to act as a reliable advisory body.

1.2. The pension landscape

Zooming out to a global viewpoint and without going into detail, the Dutch pension sector is basically confronted with a number of main problems.

First, due to the better living standards and the fact that the average number of children per adult is decreasing, the society is facing a so called ageing population. This means a disturbance of the relationship between the employed and the retired proportion of the community. Put differently, in terms of premiums and income taxes, less people pay for more. An ageing population primarily affects the AOW benefits and thus has an impact on the apportionment system. Therefore, it is a more public and governmental related issue. However, it must be stated that the longevity risk, the potential risk attached to the increasing life expectancy, not only causes a disturbance in the proportion of active to retired pension participants, but also increases the average length of time in which retirement benefits must be paid.

Second, the economic situation has extremely deteriorated over the past years. The recession has caused lower returns on the equity investments. Furthermore, facilitated by actions undertaken by the Federal Reserve and the ECB, the interest rates gradually declined. Given the fact that future cash flows are in effect discounted with lower rates, bond values increase. To summarize, the economic downfall has caused equity to go down and bond values to go up. However, altogether, because of the pension fund's large equity exposures (and the extent to which they diverge from one another), the asset base and capital cushion decreased sharply. Consequently, these changes in asset values lowered the coverage ratio of most pension funds, which is defined as assets divided by liabilities.

Third, the lower interest rates logically affect the pension liabilities as well. As is the case with assets, a lower rate results in higher present values. Therefore, the credit side of pension fund's balance sheet is also affected. The increased pension liabilities caused the coverage ratio to decline too. Besides, interest rate shifts have an impact on the interest rate risk position as well, e.g. changing durations. In the next chapter this latter notion will be explained in more detail.

These problems within the pension sector have led to drastic actions taken by pension funds and employers. One could think of increasing pension premiums, moving away from unconditional indexation, the provision of additional money to cover the emerged deficits and even, as a last resort, shortening pension benefits. Therefore, "hard" pension promises to employees cannot be realized in all cases. This has resulted in a trend to transfer the risks associated with pensions to insurers. However, they are not eager to take over these portfolios with a high level of guarantees, at least not for prices pension funds are willing to pay. Also, more and more pension designs are changing nowadays. Employers increasingly switch to (Collective) Defined Contribution ((C)DC), instead of Defined Benefit pension schemes. This has the effect that an increasing proportion of the risks are moved towards the individual employees. The pension promises are becoming "soft" (e.g. conditional indexation) ones with a more uncertain character.

All of the above described upcoming or already introduced measures, with their affiliated huge societal impact, were the reason for public authorities and governments to also interfere[2]. Over the last few years the pension sector has undergone many changes. This resulted in an intense public debate. For politicians, it is hard to solve problems which would arise in the future, but definitely need to be solved nowadays. Action must be undertaken to also ensure pension benefits in the long run, which implies taking away generation effects and preventing "rich counting" (presenting yourself financially healthier than you really are) by pension funds. There are many different opinions about the way the regulatory changes were made and the kind of measures that were undertaken. Only future will tell the precise impact and the extent to which the bill is passed on to future generations. In this research the political friction is not part of the discussion. Hence, changes are treated as a given. Nevertheless, it is good to keep the regulatory point of view in mind. The thesis could serve as input for the process to amend the current framework.

[2] There is even an upcoming intervention to increase the pensionable age at a faster rate than already agreed. See http://www.rijksoverheid.nl/onderwerpen/algemene-ouderdomswet-aow/wijzigingen-in-de-aow.

1.3. Problem identification

Next to the widely known governmental measure to increase the state pensionable age stepwise to age 66 in 2018 and age 67 in 2021, other actions were taken to conquer the problems within the pension sector. One of these actions concerns the adjustment of the term structure of interest rates (TSIR) for discounting future pension cash flows. Since year-end 2011, this curve is based on a three months average. Initially, given the exceptional market conditions as motivation, it was intended as a one-time deviation. However, this averaging methodology is still applicable and can thus be considered as permanent amendment. Besides, in September 2012 it was decided that, as a result of the "Septemberpakketpensioenen", an Ultimate Forward Rate (UFR) must be used for the discounting process of future cash flows occurring after the so called "last liquid point"(LLP) of twenty years (see De Nederlandse Bank, 2012*b*).

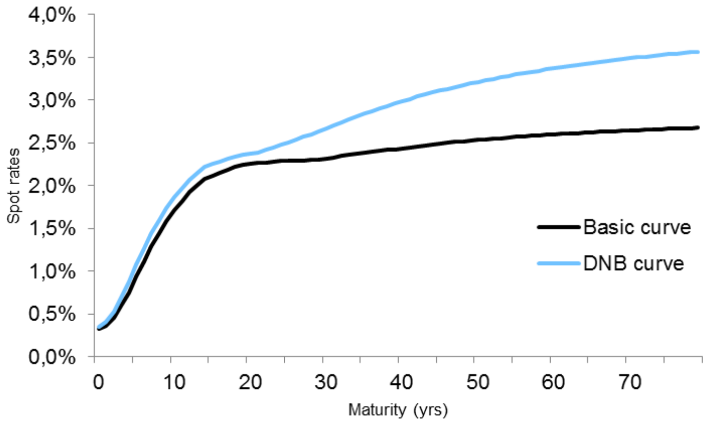

Figure 1.1: *Market curve vs. DNB curve at 31-12-2012*

Logically, both the switch to an equally weighted (all days within the averaging period receive the same weight) market interest curve and working towards a fixed forward interest rate in the long term do have an impact on the valuation of the pension liabilities. In past years, as is visualized in Figure 1.1 for 31-12-2012, using the UFR methodology results in significantly higher discount rates in the distant future. As a consequence, this lowers the present value of the liabilities and, as the UFR does not apply to asset valuation, results in a higher coverage ratio. It should be emphasized, however, that this relation could work in the opposite direction in case market forward rates are above the UFR of 4,2%.

In recent times, many studies have been conducted on the impacts and the structure of and the motivation behind the UFR. Up to today, the opinions about the conversion to a fixed forward rate are still in conflict. There is an intense and ongoing debate about its implications and correctness. At the moment, for instance there is a proposal (see Advies Commissie UFR, 2013) to adjust the UFR methodology to one that is more dependent on the economic situation, instead of a permanent fixed rate. Therefore, the rate would take a more principal based structure, rather than the rules based approach now.

The three months averaging methodology, however, has received much less attention. This part of the prescribed method for discounting future obligations has been considered to be of less importance due to its, at least at the moment, lower significance on the eventual outcomes. The gradual and proper predictability of interest rate developments made the possible (adverse) impact less substantial over the last periods. Extreme situations created by heavily volatile actual interest rates, have not occurred since its introduction ultimo 2011. Furthermore, at crucial measuring times, the averaging feature has had a "positive" stimulus on the coverage ratio (as leading variable). These points are probably the reasons why the influences of averaging are not thoroughly investigated until now. However, recently, it has been noticed that the application of an equally weighted market interest curve could lead to remarkable (and from the perspective of the funding ratio, undesirable) situations as well. For example, there are circumstances in which a so called "bathtub" effect appears. This implies a different direction of change between the two interest rate patterns. In Figure 1.2 such a "time window" effect is visualized. Consequently, the averaging feature of DNB curve becomes more and more involved in the debate concerning the determination of a properly established term structure[3].

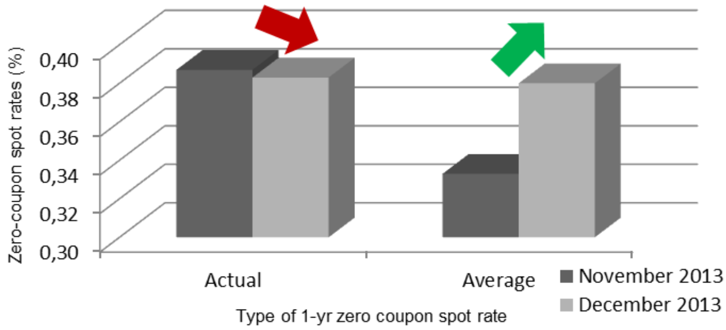

Figure 1.2: *Visualization "time window" effect*

Due to the arising awareness and recognition of the possible averaging effects, it has been decided to focus this research on the impact of using a three months average interest rate term structure for discounting pension liabilities. The following two effects are central and will be quantified:

- The impact of the averaging methodology on the coverage ratio of Dutch pension funds.
- The impact of the averaging methodology on the interest rate risk management performance of Dutch pension funds. Thus, the extent to which the proposed hedging level deviates from its actual position.

Taking a three months average, as well as using the UFR, must lead to a more stable development of the valuation pattern of the pension liabilities. This is also known as a so called "muted/mitigated effect" (Dutch: dempend effect). Via this way, the capital requirements and associated triggers to undertake managerial action are expected to be no longer heavily affected by the daily fluctuations and vagaries of the market. However, this methodology is not applied to the valuation of the financial instruments on the asset side of

[3] It is also part of the discussion examined in working paper *"Principes voor de rentetermijnstructuur, dé juiste curve bestaat niet"* published by the AG&AI (2013).

the balance sheet. This is because the value of liquid investments can readily and directly be deduced from the market and for illiquid ones, the actual interest rate curve is applied.

In other words, compared to the liabilities, the valuation process of the investment portfolio is based on other accounting foundations. The presence of two different prescribed valuation methods, one of which makes use of averaging in combination with UFR and is applicable to the liability side, and the other which makes use of the actual term structure and is applicable to the asset side of the balance sheet, could lead to mismatches. Basically, new information is interpreted differently.

As a consequence, in calculations where input from both sides of the balance sheet is needed, for instance when calculating coverage ratios, values are compared, which had a different kind of “treatment”. Such comparisons could lead to dangerous outcomes where the danger resides in possibly under- or overestimating the fund’s solvability. Therefore, this may lead to misleading information and interpretations for decision making. Due to the fact that these results, e.g. the solvability outcomes, are considered as important guides for policy making. For example think of the decision whether or not to compensate for inflation (indexation).

Furthermore, economic reality does not correspond to the theoretical and artificial situation implied by the application of an average interest rate term structure and the introduction of an UFR. The strategic policy in the field of interest rate risk management may be based on both frameworks. Hedging the “economic” world, may result in an interest rate hedge performance which does not work accordingly. At least not as proposed beforehand. Put differently, the actual extent to which the pension fund is exposed to interest rate risk could deviate from the degree its management initially had in mind.

1.4. Problem definition

The previously described problem identification clarifies the two central themes of this research. The adopted focus and related emphasis result in the following formulated problem statement:

The three months averaging methodology used for valuating liabilities leads to a mismatch between the actual and artificial coverage ratio of Dutch pension funds. Besides, the interest rate risk performance could be affected as well. A targeted interest rate risk management strategy based on the economical world (without averaging) deviates from the realized hedging level which is determined by the theoretical world (with average feature). These differences could possibly lead to sub-optimal decision making.

The magnitude of this problem must be quantified. Knowing the impact will eventually give the input to make a value judgment about the usage of prescribed methodology.

A problem statement is always accompanied and inextricably linked with a main research question. The analysis of the current situation has led to the following formulation:

What are the implications for Dutch pension funds when using the three months average DNB term structure for discounting their liabilities?

Eventually, after quantifying the possible mismatches and related implications, a link must be made towards the consequences on management level. Therefore, it is important to interpret the results from a decision making point of view.

1.5. Research goals

Obviously, the pension funds (and in fact its participants as well) are considered the problem owners. In the end, they are the ones affected by the obligation to discount their future liabilities by using the prescribed interest rate structure. In that sense, the ultimate goal is clear: quantifying the possible consequences the three months averaging methodology entails, both with respect to its impact on the coverage ratio as well as the implications in the field of their interest rate risk management.

The entire research should make pension fund's management and policy makers aware of the possible drawbacks and undesirable effects of using only "raw" outcomes as the basis of decision making. Hence, consciousness plays an important role as well. Proactively taking into account, that the method used and especially the results generated, are not as straightforward as expected, is one of the key objectives. It must help to avoid unpleasant surprises and lead to more robust and reliable decision making.

In addition to the problem owner, other stakeholders are involved. PwC has provided this assignment in order to obtain knowledge about the described phenomena. Via this research and the analyses made they aim to be valuable for the pension sector. When advising pension funds, the report should be helpful in giving a clear understanding and explanation of any (unexpected) deviations from a fund's targeted coverage or hedge position. Consequently, it must help PwC in their task to contribute to proactively manage pension fund's risks.

Furthermore, DNB states on its internet site and their documentation to be willing to periodically reconsider the applied methodology. Eventually drawn conclusions might contribute to such evaluation processes. From that standpoint, the outcomes could be of valuable input for suggestions made by the pension federation[4] or even directly in the realization of the "new FTK" directives.

1.6. The research design

The main research question is divided into several sub questions. Answering these sub question must eventually lead to successfully tackling the mentioned problem. Besides, it kind of gives the report a basic roadmap. A chronological sequence of sub questions serves as the leitmotif in this research. There are two categories of questions. First, the so called knowledge questions, which can be considered as required input in order to perform the

[4] The pension federation is a well respected advisory body in the Nederlands.
http://www.pensioenfederatie.nl/Document/Pers/Reactie_Pensioenfederatie_op_consultatie_FTK.

actual analysis. The latter is done in the second category in which each question treats a different perspective of the possible implications.

With the research goals in mind, the following sub questions are defined:

Knowledge question:

RQ1: *How is the interest rate term structure, prescribed by the DNB, technically constructed?*

RQ2: *How are future cash flows of the pension funds established?*

Actual analysis:

RQ3: *What are the driving forces behind the introduction of the averaging feature and are the associated objectives achieved?*

RQ4: *What is the effect of the three months average methodology on the coverage ratio of Dutch pension funds?*

RQ5: *What is the effect of the three months average methodology on the pension fund's (interest rate) risk management position?*

Knowing how the DNB curve is built up technically, makes it possible to also construct curves without the application of the averaging methodology and/or the UFR. As a result, differences between using interest rate term structures with and without taking an average can be quantified.

After constructing these curves, they must be applied to future cash flows in order to calculate the associated present values. However, pension liabilities in the form of disaggregated future cash flows are not readily available. Since this information is quite confidential, pension funds do not publish and are not willing to hand over these kind of data. As a consequence, the cash flows must be reproduced. This is done by consulting the pension scheme(s) and participant's files of a particular "benchmark" pension fund.

The data gathering process is of crucial importance for both knowledge sub questions. The input data needed for constructing the interest rate term structures must be retrieved and for producing the cash flows it is necessary to be able to know all kinds of characteristics of the pension participants.

After having answered the first two research questions, and thus being armed with the interest rate term structures and a pension fund's future cash flows, the actual analysis can begin. The next step is to examine the advantages as well as the possible disadvantage of the applied DNB averaging methodology. By analysing and quantifying both the pros and cons, the more general question to which extent the chosen methodology must really be considered a "problem" can be answered.

The impact analyses of the possible implications of the prescribed methodology are done by back testing, which is equivalent to the examining of historical data. However, based on this investigation, estimations are made of prospective market conditions and scenarios which could lead to "problematic" situations. Consequently, analyzing not purely from a current or historical perspective, but also an investigation with a view to the future.

Having answered the research questions eventually leads to quantitatively expressed analysis results. With some criteria in mind, these “raw numbers” must be interpreted. Thus, this part is concerned with the possible consequences on management level. An advice will be given on how the decision makers, viewed from a problem owner’s perspective, must respond to the generated outcomes.

1.7. Thesis outline

From the previous sections, the global plan of approach can indirectly be derived. The problem identification, which eventually leads to the problem definition, together with the drawn up research goals and associated research design, are translated into the following described rough thesis structure.

The intended audience and readers of this report will have a reasonable level of knowledge concerning the examined and analyzed material. Nevertheless, it is necessary to first study and explain some non-primary, but essential disciplines. Knowledge needs to be acquainted in three main categories:

- Market consistent valuation.
- The regulatory framework.
- Interest rate hedging.

These themes can be considered as required building blocks in order to perform the analyses that follow. The upcoming chapter is devoted to these so called “preliminaries”. Thereafter, Chapter 3 is dedicated to the construction of the different interest rate term structures. Subsequently, Chapter 4 discusses the process which ultimately leads to the projection of future cash flows linked to the liabilities of a “benchmark” pension fund.

Up to this point, the research is devoted to the elaboration of the knowledge sub questions. In essence, the preliminary themes can be regarded as valuable and necessary input for the actual impact analysis. Chapter 5 starts with the motives and reasoning behind the introduction of the averaging (and in short UFR) feature. The second part is dominated by the possible implications for the fund’s coverage ratio. In other words, answering research question number three and four, respectively. Afterwards, Chapter 6 concerns the adverse effects of the averaging methodology, related to the fund’s interest rate risk hedging performance, and thus research question five.

In Chapter 7, the thesis is concluded with a summary of the main conclusions and recommendations. The focus herein will be on the management level.

Chapter 2

Preliminaries

As described in the rough thesis outline (Section 1.7), this preliminary chapter focuses on outlining some literary prerequisites and various regulations that form the base of the different methods used throughout this research. Taking the goal of this chapter into account, the themes will be discussed briefly.

First, a section is dedicated to market consistent valuation, also known as fair value accounting. Afterwards, a number of regulatory bodies are discussed, as it is important to realize where the theory that is utilized originates from and to which parties it applies to. Also, this enables an analysis using an alternative (i.e. with a different framework) method whenever a similar case is treated. Finally, in Section 2.3, some literature surrounding interest rate hedging is given.

2.1 Market consistent valuation

The value of a financial product stems (in general and liquid circumstances) from its respective supply and demand. The market value can be defined as the monetary amount for which a good is traded between two independent parties. However, the market for trading pension- or insurance obligations is underdeveloped (as is the case for many other asset or liability categories). Because of this, a value derived through supply and demand is missing and with it, alternative valuation methods need to be found. In recent years, the so-called "fair value" approximation plays an important role herein. The way in which balance sheet positions of financial institutions are determined strongly depends (at least for the most part) on this "market consistent valuation". Furthermore, the latter financial accounting and reporting approach forms the base for the valuation of pension obligations as well.

In FAS (Financial Accounting Standards) 157, fair value is defined as follows: "The price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date". It reflects the idea; "exit value" (see Sutton, 2004) and its goal is to estimate as best as possible the prices for which the firm's possessions and its current hold would change hands in orderly transactions based on current information and conditions (see Ryan, 2008).

Fair value is applied based on a set hierarchy of measurement inputs; "the three levels approach". A distinction is made between the following:

Level 1: Inputs are unadjusted quoted market prices in active items for identical items (Quoted-Market-Prices).
Level 2: Inputs are either directly or indirectly observable market data (Mark-to-Market).
Level 3: Inputs are unobservable, firm supplied estimates (Mark-to-Model).

Basically, the regulation requires firms to measure fair values using level 1 inputs whenever they are available. If this is not the case, normally, level 2 inputs are preferred over level 3 inputs. However, during the recent credit crunch, the preferences have somewhat shifted. It turns out that fair value accounting and in turn, its associated potential illiquidity in financial markets, loses much of its desired characteristics in times of crisis. Due to a lack of available prices and the declining price transparency, level 2 inputs can be of such low quality that market participants would rather use level 3 inputs instead. Whenever this happens, model risk and expert judgment will play crucial roles in valuation. However, the latter may alter tremendously and potentially differ from the actual market value (see Foroughi, 2010).

The more and more prominent role of fair value approximation as a standard for valuation and in turn, the developments of applying this principle, have had their share of effects on deriving a market consistent valuation of pension- and life insurance obligations.

The valuation method of Dutch pension funds, up until 2006, was straightforward; all cash flows were valued at a constant interest rate of 4%. Afterwards, the transition was made to the concept of a market consistent valuation. The latter was done by using swap quotes when determining the appropriate interest rate term structure. This switch can be seen as the conversion from a simplified Mark-to-Model approach to the Mark-to-Market level within the fair value hierarchy. Extreme market conditions and circumstances resulting from the credit crunch have led to an alteration in the prescribed methodology in 2011 and 2012. By applying an averaging feature in the interest rate and through the use of the UFR, there is no longer a level 2 approach. In fact, the question remains as to whether or not using these two “artificial” components in the interest rate term structure even qualify as fair value accounting at all.

Taking everything into consideration, the market consistent valuation of pension- and insurance liabilities all comes down to making the best estimate for future cash flows (discussed in detail in Chapter 4), with respect to choosing an appropriate “risk free” interest rate term structure. Taking into account its potential impact, the latter is of crucial importance for present value derivations. However, a lack of clarity, as well as inconsistency between the different frameworks, continues to persist. This will be discussed next.

2.2 The regulatory framework

Even though the European Commission (EC), the European Central Bank (ECB) and DNB all consider consistency within the guidelines for pension funds and insurers to be of top priority, a high degree of inconsistency still exists for the fair value approach between these financial institutions. The latter is the result of the various term structures or interest rates that are prescribed. In this section, these differences will be discussed in more detail. First, a number of important regulatory bodies/frameworks are analyzed. The emphasis is put on the way in which pension obligations need to be valued.

2.2.1 Insurance sector

The Solvency II framework is a new, harmonized EU-wide insurance regulatory regime and has been published by the EC and approved by the European parliament and the European Commission in 2009. It has the following key objectives:

- Improved customer protection.
- Modernized supervision.
- Deepened EU market integration.
- Increased international competitiveness of EU insurers.

Performing and applying the framework is done by a new regulator known as the European Insurance and Occupational Pensions Authority[5] (EIOPA). After being delayed several times, the official starting date has been "set" to January 1, 2016. The interest rate term structure which Solvency II prescribes utilizes the EUR-swap curve. Due to the illiquidity at the long end of the curve however, a correction is made there. The latter is done via the Smith Wilson UFR methodology[6]. Also, there is the possibility for a raise of the short-term maturities, a phenomenon known as counter cyclical premium.

This approach may differ from the one used under the International Accounting Standards Board (IASB). Within this framework, an institution is free to choose its own interest rate curve. In turn, a term structure can be applied that suits a specific portfolio the best. However, this will result in further inconsistency and consequently, it will affect the comparability between various financial institutions. With the Market Consistent Embedded Value (MCEV), which assigns a value (i.e. the embedded value) to an insurance company, the insurer itself is yet again at liberty to determine a self-proclaimed appropriate "risk free" interest rate (see Hennen, 2013).

2.2.2 Pension sector

The Dutch pension funds are categorized under IORP-directive in European association. The abbreviation IORP stands for "Institutions for Occupational Retirement Provisions". At the moment, from a regulatory perspective, they are somewhat lagging behind with respect to the benefits added by the Solvency accords within the insurance sector. However, they aim to set up a similar framework for pension funds. Taking these prospects into account, it seems as though the strength of Europe within the pension sector will only continue to rise.

The "Financieel ToetsingsKader" (FTK) is the part of the Pension law in which the regulatory financial requirements for pension funds are recorded. As it became clear that this FTK was not suitable in times of economic crisis, the Dutch government (ministry of Social Affairs and Employment) asked two committees to look at the pension system and to

[5] See also https://eiopa.europa.eu.

[6] This subject will be revisited in later sections to come. However, seeing as this research focuses on the pension sector (for which this methodology does not directly apply to), the aforementioned will be described briefly.

come up with possible improvements of the assessment framework. After the reports of Frijns (2010) and Goudswaard (2010), a new FTK was constructed. It still needs to be implemented, but it is expected to be fully operational in January 2015. The primary goal of this amended framework is to protect the sustainability of the pension system and to keep the intergenerational balance. Despite the renewed framework not yet being completely viable, its interest rate term structures have to be utilized already nonetheless. Exactly what the methodology looks like will be detailed in the upcoming sub-section.

2.2.3 Concrete: differences in prescribed TSIR

Now, what exactly does the aforementioned mean to Dutch financial institutions? In essence, from the perspective of the regulator DNB, Dutch Insurance companies have to follow the regulations in the Solvency framework and pension funds have their own regulatory framework: the FTK. Below is a description that details the associated interest rate term structures. In the upcoming chapter, the construction process is outlined. With it, a better understanding is achieved regarding all of the terminology that is used.

Prescribed term structure for Dutch insurers:

- Up to the Last Liquid Point (LLP), spot rates are computed using EUR-swap quotes (LLP is set at 20 years).
- Working towards the value of the UFR is done between the LLP and the convergence point. The former is accomplished through utilization of the Smith and Wilson methodology, (2001) mentioned earlier (convergence point is set at 60 years).
- For this period of time, forward rates are determined using the forward rate preceding the LLP and the value of the UFR (UFR is set at 4,2%).
- The Smith Wilson method provides the extrapolation procedure. The weight w_t per maturity t that is assigned to the UFR (and logically $(1 - w_t)$) for the forward rate preceding the LLP ($f_{(LLP-1),\ LLP}$)) is determined using this methodology.

Prescribed term structure for Dutch pension funds:

- The spot rates are computed using EUR-swap quotes.
- Before applying the UFR (also set at 4,2%), the three months average is taken from this Basic curve. The latter is done on a daily base.
- From the LLP onward (again at the 20 year mark), up to the convergence point (once more 60 years), working towards the UFR is performed gradually.
- However, the forward rates that lie in between do not rely solely on the same two “ends”. Instead, the suggestion made by Rebel (2012) has been taken into account and with it, market information after the LLP is partially integrated as well. In turn, the forward rate is now determined using the market forward rate and the UFR.
- Weights are determined using the Smith Wilson methodology but contrary to insurers, these remain unchanged, i.e. fixed weights are utilized.

In short: there is definitely a difference between the interest rate term structure that insurance companies have to utilize, compared to the curve that needs to be accounted for by pension funds. Furthermore, insurers have the option to utilize the alternative ECB AAA curve (rather than the swap curve). However, the latter requires explicit permission.

2.3 Interest rate hedging

Interest rate risk reflects the risk that an investment's (or liability's) value will change due to a change in the level of interest rates. Hedging reflects the full or partial coverage of a financial risk, in this case related to the interest rate risk. Those who want to hedge their investments against this have many products to choose from, all suited for different scenarios or occasions. Examples include forwards, futures, swaps or all sorts of different options such as swaptions, caps floors et cetera.

Also, there are financial institutions that utilize a so-called duration matching or portfolio immunization[7]. Before this methodology is further explained, first, it is necessary to outline the concept of duration.

> **Duration***: a measure of how long, on average, the holder of a financial instrument has to wait before receiving cash payments. Whenever a portfolio is considered, e.g. multiple bonds, its duration amounts to nothing more than the weighted average of the durations of the individual portfolio instruments*[8]*. In formula form, duration can be written as:*

$$D = \frac{\sum_{i=1}^{n} t_i * c_i * d_i}{\sum_{i=1}^{n} c_i * d_i} \qquad [2.1]$$

Herein, duration is a weighted average of the times when payments are made, with the weight applied to time t_i being equal to the proportion of the portfolio's total present value provided by the cash flow at time t_i. In doing so, the duration is also an approximation to the ratio of the proportional change in its price to the absolute change in its yield.

Applying the portfolio immunization strategy basically means that one tries to achieve the same average duration for the assets and the liabilities alike. Consequently, liabilities can be regarded as some form of short position in bonds. The resulting net duration of zero ensures that small parallel shifts in interest rates will have little effect on the value of the portfolio of assets and liabilities. Hence, the duration relationship only applies to small changes in yields. This is a weakness of the approach and the duration matching strategy is therefore only a first step. Financial institutions have developed other tools to help them manage their interest rate exposure. Taking into account convexity as well can be considered an improvement, the former being a measure of the curvature in the relationship between the prices and the yield.

[7] See page 143-144 Hull Options Futures and Other Derivatives.

[8] See page 89-90 Hull Options Futures and Other Derivatives.

Chapter 3

Constructing the interest curves

In order to quantify the impact of the three months averaging methodology, it is necessary to compare the implementation of a number of interest rate term structures. Since these curves are crucial in calculating present values, they could be considered the most important research input. This chapter is concerned with its construction process, which is equivalent to find an answer to the first research question:

RQ1: *How is the interest rate term structure, prescribed by the DNB, technically constructed?*

As became clear in the previous chapter, the discounting methodology prescribed by DNB must be applied by Dutch pension funds[9]. Consequently, their technical procedures used to determine the interest rate term structure should be followed. DNB published two documents, named "vaststelling van de methodiek voor de rentetermijnstrucutuur" (explanation of the method to construct the prescribed TSIR) and "UFR Methodiek voor de berekening van de rentetermijnstructuur" (description of how the UFR must be applied), which provide the basis for the entire process.

A so called Basic curve forms the foundation for constructing the prescribed DNB curve. From the Basic curves, a three months average needs to be taken and subsequently, for maturities between the LLP (20years) and 60years, the UFR is gradually implemented to finally arrive at the curve which should be used by Dutch pension funds to value their liabilities.

The DNB curve is published only at the end of each month and does not contain the projected individual "building blocks"[10]. Given that they are essential in this study, constructing the curves ourselves has become a necessary step in the thesis. This makes a thorough study of the construction process, and thus answering the first research question, indispensable.

Furthermore, this process allows us to both compare on a more frequent basis (working days instead of only each month) as well as over a longer time horizon. The latter enables the possibility to analyse the impacts of the applied methodology if it had been introduced much

[9] Based on Article 2, paragraph 2 of the degree FTK.

[10] Curves for both the insurance and pension sector are published on the DNB site: (T1.3 Jaar/maand (XLS)) http://www.statistics.dnb.nl/?lang=nl&todo=Rentes.

earlier. Via this way, for instance, the volatile market conditions, which occurred around the years 2007-2009, can be taken into account, too.

Curves of interest

TSIR	*Average*	*UFR*	*Colour*
Basic curve	NO	NO	
Average Basic curve	YES	NO	
Basic curve + UFR	NO	YES	
DNB curve	YES	YES	

Table 3.1: *The curves and their associated features.*

Table 3.1 shows the different curves that are essential in this research. Also, it notes whether or not the term structure utilizes an average and/or the application of the UFR. Furthermore, the chosen colours are consistently used throughout the entire report, allowing one to know instantly which TSIR is discussed. Finally, it is worth mentioning that the Basic curve is considered to be the market term structure.

The next section is dedicated to the more general concepts and notions within the field of interest rates. Amongst others, spot rates, forward rates, discount rates and swap rates and the differences between them are briefly discussed. Next, Section 3.2 up to and including 3.5 are devoted to the construction of the four different curves. The latter section is concluded with some noticeable points observed throughout the whole process. Finally, Section 3.6 is dedicated to a short conclusion about the constructed interest rate term structure.

3.1 Term structure theory

Basically, an interest rate is defined as the cost of borrowing money or, in other words, as the compensation for the service and risk of lending money[11]. A TSIR is the relationship between interest rates and their maturities. The structure is frequently displayed as a so called "curve". This is a graphical representation in which the interest rate is plotted against maturity. It is important to note that the definitions "term structure" and "curve" are used interchangeably.

Before proceeding, some definitions regarding the family of interest rates are described. These are of importance for the remainder of the research. The terminology applied in the international edition of *Investment Science* (Luenberger, David G., 2009) or the eighth edition of *Options, Futures, and Other Derivatives* (Hull, John C., 2012) are used.

> **Spot rate:** *the spot rate s_t is the rate of interest, expressed in yearly terms, charged for money held from t=0 until time t. Both the interest and the original principal are paid at time t. Spot rates are considered the basic interest rates defining the term structure.*

[11] This terminology is also used by Heakal in "Forces Behind Interest Rates".

Zero- coupon bond (or in short: zero): *A security generating a single cash flow, with no intermediate coupon payments. The spot zero-coupon is symbolized by z_t (= s_t). In the rest of the thesis the z_t notation will be used.*

Discount rate: *the discount rate d_t is the factor by which a cash flow at time t must be multiplied to obtain an equivalent present value. Considering yearly compounding:*

$$d_t = \frac{1}{(1+z_t)^t} \qquad [3.1]$$

Forward rate (or forward): *The forward rate between times i and j with $i < j$ is denoted by $f_{i,j}$. It is the interest rate charged for borrowing money at time i which is to be repaid (with interest) at time j. A forward could be implied from the relationship with a given spot rate curve. This is specified as follows:*

$$(1+z_j)^j = (1+z_i)^i(1+f_{i,j})^{j-i} \qquad [3.2]$$

so,

$$f_{i,j} = \left[\frac{(1+z_j)^j}{(1+z_i)^i}\right]^{\frac{1}{j-i}} - 1 \qquad [3.3]$$

Swap: *an agreement between two parties (counterparties) to exchange the cash flows of two interest rate instruments. For example, party A may swap its fixed-income stream with party B's adjustable-rate stream.*

Swap rate: *The rate of the fixed portion of a swap (the entering agreement for party A) as determined by its particular market. The swap rate is denoted by r_t.*

The spot rate curve reflects the term structure of interest rates described by the zero- coupon yield curve on a yearly basis. It is one of the key macroeconomic parameters and enables the pricing of arbitrary cash flows, fixed income instruments and derivatives.

The term structure theory is based on the observation that, in general, the interest rate charged for money depends on the length of time that the money is held. Different theories have been proposed to explain the shape of the zero spot curve. The liquidity preference theory[12] is the most appealing one. It is based on the assumption that investors prefer to invest funds for short periods. Borrowers, on the other hand, usually give preference to borrow at fixed rates for long periods of time. The theory is consistent with the empirical result that yield curves tend to be upward sloping more often than they are downward sloping and also corresponds to the basic explanation of "a longer maturity entails a greater risk".

[12] Different theories to explain the shape of a zero spot curve are described in Hull, Options, Futures and other Derivatives. p93 – p96.

The most obvious way to determine spot rates is to obtain prices of zero- coupon bonds of all the different maturities available in the market. Unfortunately, the set of available zero-coupon bonds is typically rather sparse. Therefore, it is necessary to find a way to construct this spot rate curve. A number of procedures can be followed, but the most popular approach is known as the Bootstrap method (see Hull, 2010) [13]. This involves working from short maturities to successively longer maturities matching prices. Most often regular, coupon bearing, treasury bills and bonds are used as the primary price information source for constructing the riskless spot curve. However, DNB consciously chooses to make use of intraday European swap rates (bid prices)[14]. Three reasonable arguments are put forward as practical objections for using government bonds. These are[15]:

- The limited supply of maturities thus liquidity, in excess of 30 years.
- Periodic shortages effects.
- The fact that the hedging activities by pension funds are mainly done in the swap market.

The n-year swap rate is the yield on an n-year bond that sells at par. The London Composite Rate (ticker CMPL), which is considered to be a kind of market average, is chosen as a fixed rate which is swapped against the 6-month EURIBOR. The rates are published by Bloomberg on a daily basis. The conditions of the mentioned swap are arranged in such a way that no payments need to be made by any of the two parties at the beginning of the contract. In other words, the swap represents an equal exchange and thus, the initial swap value is zero.

3.2 Basic curve (market curve)

The process of constructing the Basic interest rate term structures is visualized by using a flowchart, which is displayed in Figure 3.1 on page 25. It covers the necessary steps in order to obtain all the curves for the period under consideration. Below, the individual increments will be explained in more detail.

Retrieving the required swap rates must be regarded as the starting point. Therefore, a local "Bloomberg Terminal" is conducted. This is a kind of computer system which provides access to real-time financial data such as stock market prices and financial news. As can be seen in the flowchart only the swap rates with maturities 1 to 10, 12, 15, 20, 25, 30, 40 and 50 years, are used as input data for the construction process. Even though the most intermediary swaps are available, due to reasons of illiquidity[16], these rates are not consulted. The selected procedure ensures that the swap curve is composed out of all reasonably liquid maturities and satisfies the no-arbitrage principle.

Focusing on a good fit in the long end of the curve, i.e. to retain a more smooth instead of a so called "saw-tooth pattern", results in the choice to determine the intermediate spot rates

[13] The Bootstrap method is explained at pages, p457 – p458.

[14] This method is also discussed in Hull, Options, Futures and other Derivatives. p159 – p160.

[15] Information provided by Broeders, D. During the lecture called "Pension finance and the regulations of pension funds", University of Twente, June 20, 2013.

[16] Illustrated by analysing the LIBOR Swap spreads in Determinants of Treasury (Malhotra, 2005).

by interpolating and extrapolating constant forward rates. Logically, this is done between the, at least considered, liquid maturities in the swap market.

First, the symbols, which are consistently applied, are set out next.

N	=	total number of days for which a curve must be constructed.
i	=	a particular day, so $i = 1,2,\ldots,N$.
t	=	time to maturity in years, varying from $t = 1,2,\ldots,80$. It is decided to construct and consequently perform the analysis for cash flows up to 80 years.
m	=	a process within the construction of a particular spot rate curve. A process is defined as an interval in which the forward rate must be assumed constant. There are seven such processes that need to be completed within the construction of a particular curve, so $m = A, B, \ldots, G$.
k	=	the number of spots that have to be determined within a certain process. This is not the same for all processes. Table 3.2 on the next page shows the number of spot rates that should be determined within a certain process.

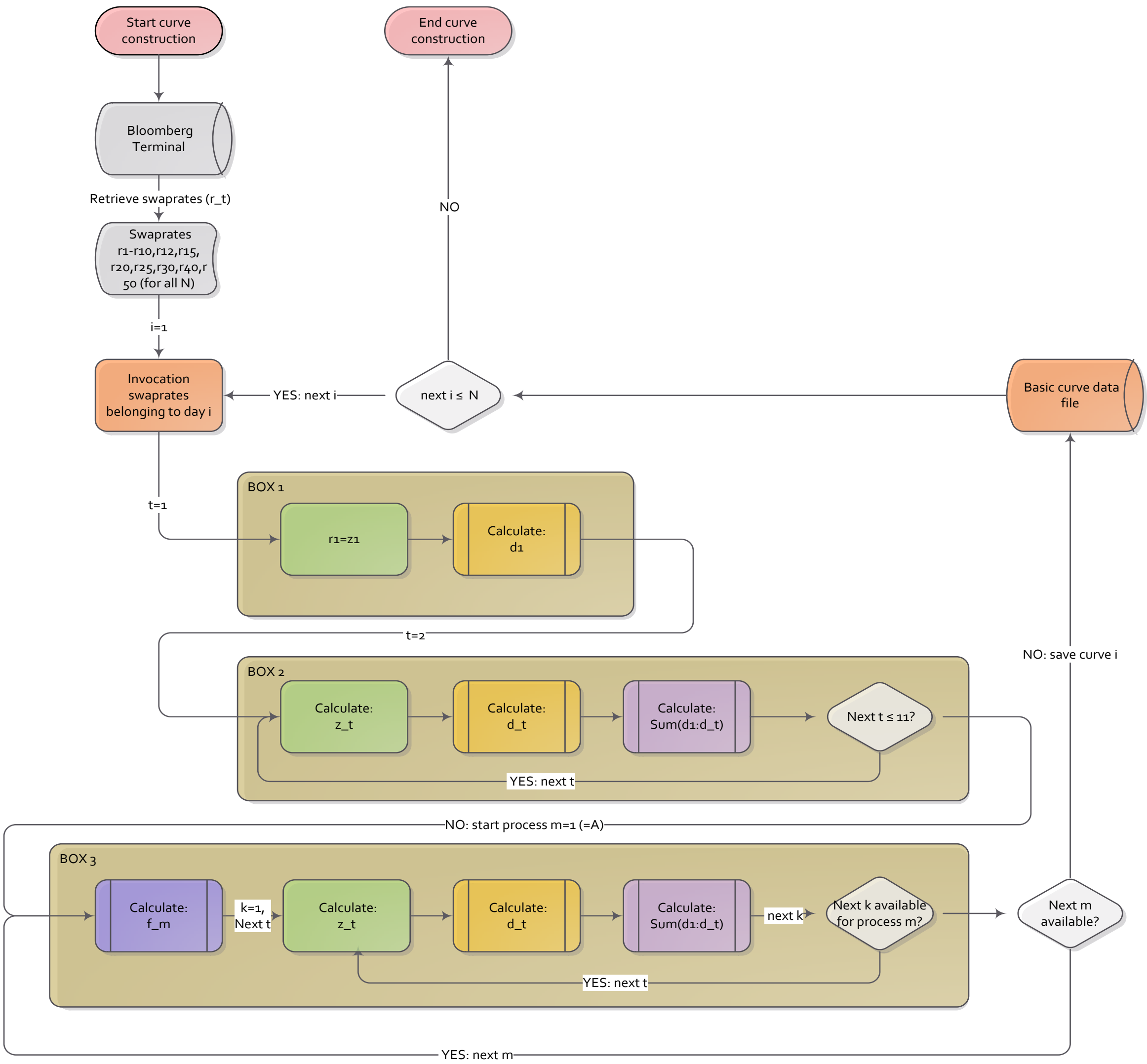

Figure 3.1: *The (Basic) curve construction process*

After clarity regarding the definitions and symbols used and the fact that the necessary input swap rates have been retrieved out of the Bloomberg Terminal, the actual construction process can begin. The bootstrap method works step-by-step and from maturity to maturity until $t = 80$ is reached.

Process (m)	#k	Constant assumed forwards	symbol	Associated spots
A	2	$f_{10,11} = f_{11,12}$	f_A	z_{11}, z_{12}
B	3	$f_{12,13} = f_{13,14} = f_{14,15}$	f_B	z_{13}, z_{14}, z_{15}
C	5	$f_{15,16} = f_{16,17} = f_{17,18} = f_{18,19} = f_{19,20}$	f_C	$z_{16}, z_{17}, z_{18}, z_{19}, z_{20}$
D	5	$f_{20,21} = f_{21,22} = f_{22,23} = f_{23,24} = f_{24,25}$	f_D	$z_{21}, z_{22}, z_{23}, z_{24}, z_{25}$
E	5	$f_{25,26} = f_{26,27} = f_{27,28} = f_{28,29} = f_{29,30}$	f_E	$z_{26}, z_{27}, z_{28}, z_{29}, z_{30}$
F	10	$f_{30,31} = f_{31,32} = f_{32,33} = f_{33,34} = f_{34,35} = f_{35,36} = f_{36,37} = f_{37,38} = f_{38,39} = f_{39,40}$	f_F	$z_{31}, z_{32}, z_{33}, z_{34}, z_{35}, z_{36}, z_{37}, z_{38}, z_{39}, z_{40}$
G	40*	$f_{40,41} = \cdots = f_{79,80}$	f_G	$z_{41}, \dots, z_{80}$

Table 3.2: *The assumed constant forward rate split into 7 processes*

<u>Starting at $t = 1$: (box 1)</u>

Since, the chosen swap rate is considered an equal exchange the first spot rate is determined by:

$$r_1 = z_1 \tag{3.4}$$

The discount rate d_1 must be calculated by [3.1] because it is a necessary input parameter to determine z_2 in the next step.

<u>For $t = 2, 3, \dots, 10$: (box 2)</u>

The determination of the swap rates for these maturities are quite straight forward. Making use of the no-arbitrage principle the following equation must hold:

$$\frac{r_t}{1 + z_1} + \frac{r_t}{(1 + z_2)^2} + \cdots + \frac{r_t}{(1 + z_{t-1})^{t-1}} + \frac{1 + r_t}{(1 + z_t)^t} = 1 \tag{3.5}$$

Via this relation z_t can be derived.

An example: the calculation of z_5 . Recall that, all spot rates up to z_4 are already known by now.

$$\frac{r_5}{1 + z_1} + \frac{r_5}{(1 + z_2)^2} + \frac{r_5}{(1 + z_3)^3} + \frac{r_5}{(1 + z_4)^4} + \frac{1 + r_5}{(1 + z_5)^5} = 1$$

$$r_5\left(\sum_{j=1}^{4}\frac{1}{\left[1+z_j\right]^j}\right)+\frac{1+r_5}{(1+z_5)^5}=1$$

$$r_5\left(\sum_{j=1}^{4}d_j\right)+\frac{1+r_5}{(1+z_5)^5}=1$$

The term within the brackets (summation of discount factors) is represented as a sub-process in the flow chart and is highlighted in purple.

$$(1+z_5)^5=\frac{1+r_5}{1-r_5\left(\sum_{j=1}^{4}d_j\right)}$$

Now, the z_5 can easily be determined by:

$$z_5=\left(\frac{1+r_5}{1-r_5\left[\sum_{j=1}^{4}d_j\right]}\right)^{\frac{1}{5}}-1$$

As a result the general formula for the derivation of the spot rate is as follows:

$$z_t=\left(\frac{1+r_t}{1-r_t\left[\sum_{j=1}^{t-1}d_j\right]}\right)^{\frac{1}{t}}-1 \qquad [3.6]$$

For $t = 11, 12, \ldots, 80$: (box 3)

The construction process after $t = 10$ is somewhat different than shown before. This is due to the fact that from then on not all market swap rates (r_t) are used anymore. Therefore, an additional calculation step is needed and the intermediate forward rates are assumed constant. As already mentioned, seven constant forward rates must be determined in order to derive spot rates to t = 80. This is done by making use of the relation shown in [3.7]. The defined process is displayed in box 3 of the flowchart and will logically be passed through seven times.

$$(1+z_{x+y})^{(x+y)}=(1+z_x)^x(1+f)^y \qquad [3.7]$$

It starts with m=A. As can be seen in Table 3.2, this process is applied to eventually determine the spot rates $z_{11}$and z_{12}. Relations [3.5] and [3.7] are relevant herein. Substituting the right values considering this particular process, results in the following equations:

$$\frac{r_{12}}{1+z_1}+\frac{r_{12}}{(1+z_2)^2}+\cdots+\frac{r_{12}}{(1+z_{11})^{11}}+\frac{1+r_{12}}{(1+z_{12})^{12}}=1$$

$$(1+z_{12})^{12}=(1+z_{10})^{10}(1+f_A)^2$$

Combining these two relations, or put differently, plugging the latter into the former gives:

$$\frac{r_{12}}{1+z_1}+\cdots+\frac{r_{12}}{(1+z_{10})^{10}}+\frac{r_{12}}{(1+z_{10})^{10}(1+f_A)}+\frac{1+r_{12}}{(1+z_{10})^{10}(1+f_A)^2}=1$$

$$r_{12}\left[\sum_{j=1}^{10}\frac{1}{\left(1+z_j\right)^j}\right]+r_{12}\frac{1}{(1+z_{10})^{10}}\left[\sum_{j=1}^{2}\frac{1}{(1+f_A)^j}\right]+\frac{1}{(1+z_1)^{10}(1+f_A)^2}=1$$

$$r_{12}\left(\sum_{j=1}^{10}d_j\right)+r_{12}d_{10}\left[\sum_{j=1}^{2}\frac{1}{(1+f_A)^j}\right]+d_{10}\frac{1}{(1+f_A)^2}=1.$$

Since, r_{12}, z_1, $z_2, \dots, z_{10}$, and thus $d_1, d_2, \dots, d_{10}$ as well, are already retrieved or calculated at this stage of the process, the only unknown parameter in this last expression is the forward rate f_A.

Defining the constants a and ω as

$$a=r_{12}d_{10} \qquad and \qquad \omega=r_{12}\left(\sum_{j=1}^{10}d_j\right)$$

and also let

$$x=\frac{1}{(1+f_A)}$$

Which leads to:

$$\omega+a(x+x^2)+d_{10}x^2=1$$

$$ax+ax^2+d_{10}x^2+\omega=1$$

$$(a+d_{10})x^2+ax+(\omega-1)=0.$$

This is simply a second power equation with the variable x as the only unknown. By applying the ABC- formula, x, and thus f_A, can be determined. Since a negative value for x, and consequently f_A, is not compatible, the equation always leads to a unique solution.

By using [3.2], the spot rates $z_{11}$and z_{12} can be calculated. The expressions are as follows:

$$(1+z_{11})^{11}=(1+z_{10})^{10}(1+f_A)$$

so,

$$z_{11}=[(1+z_{10})^{10}\ (1+f_A)]^{\frac{1}{11}}-1$$

and thereafter

$$(1+z_{12})^{12}=(1+z_{11})^{11}(1+f_A)$$

$$z_{12} = [(1 + z_{11})^{11}\ (1 + f_A)]^{\frac{1}{12}} - 1.$$

With this last step, process m=A has come to an end and subsequently triggers the commence of process m=B. Basically, all defined processes require analog calculation steps. The only difference is the number of (intermediate) forward rates that must be held constant. This directly affects the degree of the polynomial equation.

Process B, which considers three constant forward rates ($f_{12,13} = f_{13,14} = f_{14,15} = f_B$), is accompanied by a third degree equation. In this case the constants a and ω are defined as:

$$a = r_{15} d_{12} \qquad and \qquad \omega = r_{15}\left(\sum_{j=1}^{12} d_j\right)$$

and also let

$$x = \frac{1}{(1 + f_B)}$$

lead to the equation:

$$\omega + a(x + x^2 + x^3) + d_{12}x^3 = 1$$

$$ax + ax^2 + ax^3 + d_{12}x^3 + \omega = 1$$

$$(a + d_{12})x^3 + ax^2 + ax + (\omega - 1) = 0.$$

By means of using the analogous formula for solving polynomials of degree three, it is possible to calculate x and f_B algebraically (see Von Oertzen, 2006). The latter is also known as the “Formula of Cardano”. Determining z_{13}, z_{14} and z_{15} is again done in accordance with the relation between forwards and spot rates.

When arriving at process number m=C, a fifth degree equation needs to be solved. For such an equation, however, there is not a general algebraic solution method available[17]. As a consequence, finding the constant forward rates f_C, f_D, f_E, f_F *and* f_G and thus the spot rates with maturities after 15 years, a numerical procedure is required. Since it can be concluded that it is impossible to construct the entire curve completely algebraically, due to uniformity, all processes (including A and B), are derived using this technique.

The “Solver” function in Microsoft Excel is such a tool to solve these kinds of approximation methods. Since, testing the impact over the period 2005 - 2013 encompasses almost 2.500 (business day = curves) * 5 = 12.500 times the invocation of the “Solver” function, performing the calculations manually would be too cumbersome. This makes programming the curve construction process a necessity.

[17] Also explained by Baker (2013) in: “An Introduction to Galois Theory”. p2.

The use of the Solver function has made it possible to calculate all seven constant forward rates, which form the basis for the eventual spot rate curve(s). The resulting rates for a particular day are visualized In Figure 3.2.

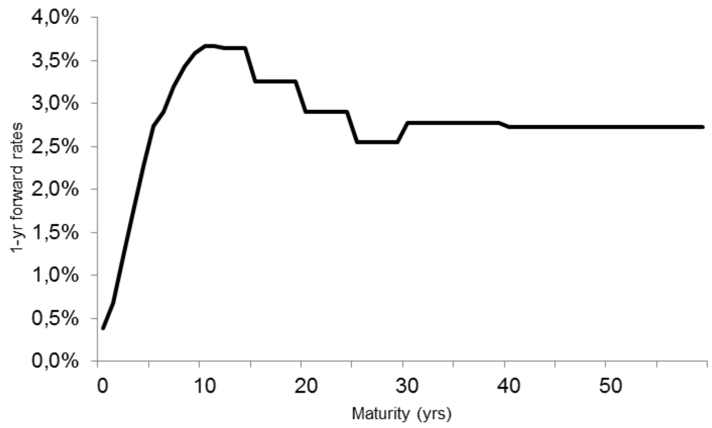

Figure 3.2: *The calculated basic curve forwards at 31-12-2013*

2.3.1 Programming the Basic curves

Due to the enormous number of data points, it is really important to write a code in such a way that the file size remains editable and the Macro run time is held as short as possible. Therefore, structured programming[18] is essential. The general outline and the procedure used, is described below. The code is (along with all other VBA activities) displayed in a separate attachment that comes with this report. The actual Excel files can be requested at any time.

The reasons mentioned resulted in the decision to use Microsoft VBA for the strict necessary operations only. This mainly refers to the invocation of the "Solver" function. In short, three sheets are of importance.

- The data input sheet. This contains the swap rates belonging to all days for which the curve needs to be constructed. The data has been extracted from the Bloomberg Terminal.
- The calculation sheet in which all the computations are performed (so not in Macro itself). This is done on a daily basis and thus makes it a kind of throughput sheet.
- The output sheet. When all calculations are completed for a particular day, the spot rates are pasted in this new field. Eventually, these rates are of interest and are necessary for discounting the pension liabilities.

The Macro works through a for-loop. Logically, the number of times the loop must be executed equals the number of working days for which a curve needs to be constructed. First, the swap rates of day i are plugged into the calculations sheet. Next, all calculations are performed and subsequently the constructed interest rate term structures are written in the

[18] A book written by Hugo and Evert Schouppe, (2011) has contributed to this.

output sheet. At the same time, this latter operation triggers the curve construction process associated with day *i+1*.

3.3 Three months Average Basic curve

The constructed Basic curve forms the foundation of the other three interest rate term structures. The processing step necessary to achieve the three months Average Basic curve appears to be quite easy at first glance. Basically, taking an average is relatively straight forward. However, there are some snags in this operation.

The fact that DNB publishes the TSIR ultimo each month's end boasts the expectation that the averaging takes place based on three data points. This is not the case. In reality, the process concerns the application of an equally weighted arithmetic daily average. The applied procedure entails the conclusion that DNB has the daily data already available. However, DNB provides the pension funds with month's end interest rate curves only. As a result, monitoring the actual coverage and interest rate hedging performance becomes less convenient. Hence, gradually responding to trends or changes in the market will be more complicated. The roadmap, which must be completed by each N-days, is visualized in Figure 3.3.

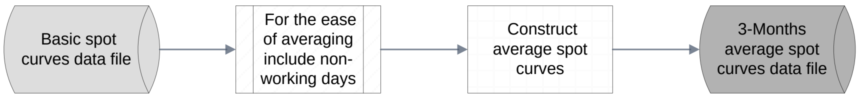

Figure 3.3: *Construction process of the Average Basic curve*

Obtaining the appropriate averaging period is crucial. The ending points are easily determined because they are equal to the days for which the interest rate curves must be constructed. Finding the proper starting points, however, is less obvious. In short, the following three issues should be dealt with:

- Since no swap rates are available, the Basic curve cannot be constructed for non-working days (at weekends and on public holidays exchanges are closed).
- In order to consistently analyze on a daily basis, the averaging term deviates, in one way or the other, from the period DNB applies (the case in four time points, see Appendix A).
- The number of days, over which the averaging needs to be determined, fluctuates.

In some cases, non-working days are considered the starting points of an averaging period. Since these could not be found in the Basic curve date file, it is decided to add an intermediate processing step in which the non-working days are inserted (as blanks) into the Basic curve data file. This operation is displayed in the second shape of Figure 3.3 and eliminates the problem of not finding the starting points. It is worth mentioning that empty cells are excluded in calculating averages.

Determining and subsequently using the appropriate averaging period was harder than initially expected. Due to the fluctuating number of days which must be averaged, finding the exact location from both the starting as well as the ending point was difficult to specify in Excel. The way this has been programmed, is described in Appendix A as well.

3.4 Basic curve plus application of the UFR

The constructed Basic curves are composed of spot rates. As the name already suggests, the UFR is a forward rate. Therefore, first of all it is necessary to translate the Basic curve to a forward curve. This is done by using relation [3.3]. The whole process is visualized in Figure 3.4.

Figure 3.4: *Construction process of the Basic curve + UFR*

In order to apply the Ultimate Forward Rate methodology, three characteristics are essential and determine the precise approach. This has been mentioned briefly in Chapter 2, where a deviation in one or more of these aspects between various regulatory frameworks is discussed.

- The level of the UFR.
- The starting maturity of the UFR methodology.
- The interpolation technique.

Currently, DNB prescribes an UFR of 4,2%. This level is established based on long term estimates (see Dimson et all., 2000) of the real interest rate (2,2%) and the inflation rate (2%). The so called "first smoothing point" is set at 20 years. The interpolation is based on the Smith-Wilson method[19]. It determines the weights (w_t) for the conversion towards the UFR. As already has been described in Chapter 2, this technique falls within the Solvency II framework. DNB uses a constant convergence speed, which results in a fixed weighting scheme. A table containing these weights is included in Appendix B.

The application of the UFR methodology results in modified forward rates. In formula form, these are determined by [3.8].

$$f_{t-1,t}{}^{*} = \begin{cases} f_{t-1,t} & for\ 1 \leq t \leq 20 \\ (1-w_t) * f_{t-1,t} + w_t * UFR & for\ 21 \leq t \leq 60 \\ UFR & for\ 61 \leq t \end{cases} \qquad [3.8]$$

Compared to the Basic curve, up to $t = 20$, nothing changes. Thereafter, the UFR is gradually implemented. After $t = 60$, the original forward rates are not included in the calculation anymore. In Figure 3.5 the effect of the UFR on the forwards is shown. Compared to the forward rates belonging to the Basic curve, the pattern is no longer composed of completely flat pieces.

19 As already been referenced, see Smith and Wilson, (2001).

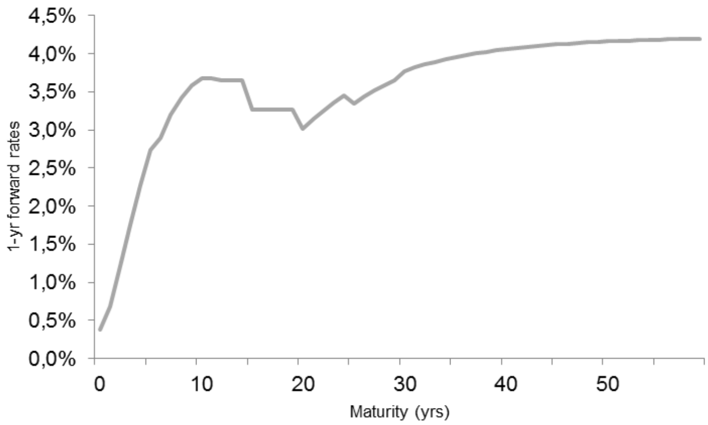

Figure 3.5: *The calculated Basic curve + UFR forwards at 31-12-2013*

In the last step, the spot rates must be determined by consulting relations [3.9] and [3.10].

$$(1 + z_t)^t = \prod_{j=1}^{t} (1 + f_{j-1,j}{}^*) \qquad [3.9]$$

$$z_t = \left(\prod_{j=1}^{t} [1 + f_{j-1,j}{}^*] \right)^{\frac{1}{t}} - 1. \qquad [3.10]$$

Repeating this process for every day (N), results in all needed Basic curve + UFR interest rate term structures.

3.5 DNB curve

DNB uses a curve based on a three months average and subsequently applies the UFR. Consequently, it can be seen as a combination of the two previous sections. The output of Section 3.3 forms the input of the process described in Section 3.4. The colours of the processing shapes used in Figure 3.4 correspond to those of Figure 3.6, indicating the identical calculation steps.

Figure 3.6: *Construction process of the DNB curve*

As already mentioned, compared to Section 3.4 only a different input is used. In this situation, the processes are applied on the Average Basic curves. The output generated can be regarded as the TSIR that the Dutch pension funds are obligated to use for evaluating their pension liabilities.

After completing the whole construction process, it is possible to compare the replicated interest rate term structures with the ones published on the DNB site. Two things are noteworthy here:

1) Beyond the four data points in which a different averaging period have been applied, one might expect identical curves. However, this is not always the case. For example, the constructed curves for the months September and October 2013 give exact matches (until maturity 60!). In contrast, the outcomes in August and July 2013 deviate slightly from the actual DNB curve. At the moment, the analyzed differences are still inexplicable. The extent to which the differences will have a material impact on the pension liabilities is another discussion. At first sight an observed maximum deviation of 1.1 basis points appears to be insignificant.

2) The previous point applies for maturities up to 60 years. Until recently, DNB did not publish the spot rates thereafter. Given the fact that pension liabilities go far beyond this maturity, the pension funds must still determine a part of the curve themselves. Due to different interpretations or calculation errors, this definitely might result in a non-consistent implementation between the funds. As a result, DNB adjusted its publishing policy. Nowadays, the interest rate term structures are retroactively given up to a maturity of 100 years. However, the way DNB is calculating the spot rates after 60 years seems not to be in line with the explanation given in their documentation. Obviously, in [3.8] it can be seen that the entire weight should be borne by the UFR. The curves provided by DNB do not reflect this. The resulting discrepancy is illustrated in more detail in Appendix C. Their faulty procedure is highlighted by the large jump in the spot rates between the maturities 60 and 61. It leads to a maximum observed deviation of 11.2 basis points.

3.6 Curve construction conclusions

Four interest rate structures have been constructed in the preceding sections. Answering the first research question was a necessary step in order to fulfil this process. Knowledge of the “building blocks” from which the curves are composed, the assumptions used, the way the averaging and UFR methodology must be applied and the manner in which the calculation steps should be carried out, is required to determine the described curves.

The interest rate curves will be used during the actual impact analysis later on in this research. It is now possible to make two comparisons between an interest rate structure with and without the application of the averaging methodology. The first one (Basic curve vs. Average Basic curve) does not include the UFR. This is in contrast with the second comparison (Basic curve + UFR vs. DNB curve), which does in fact take into account the efforts of working towards a fixed forward rate in the distant future. This distinction is made because the effect of the two “artificial” adjustments cannot be viewed entirely separate from one another. In Chapter 5, these points will be discussed in more detail. The fact that all curves are constructed in the first place is the primary focus at this stage.

In Figure 3.7, the four different interest rate term structures are visualized for a specific business day. It shows that the application of the UFR only affects the part after twenty years. At this specific date, taking the average leads to lower, whereas the UFR methodology results in higher rates (after LLP) compared to the Basic curve. Obviously, these effects may be different when another day is viewed.

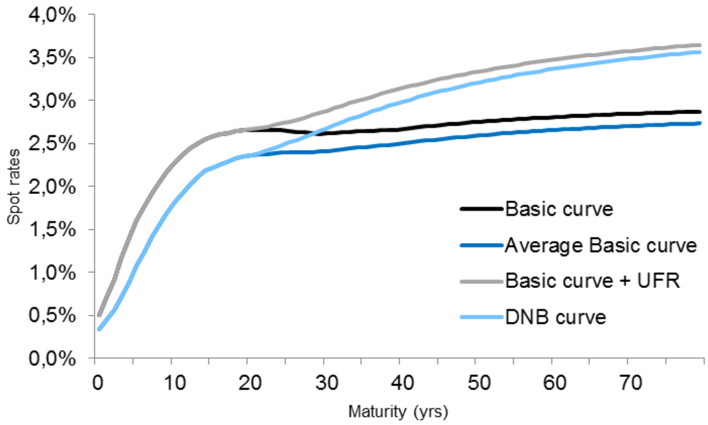

Figure 3.7: *All four different curves at 24-06-2013*

Chapter 4

Future pension cash flows

A pension fund's future cash flows reflect the liabilities to fulfil its contractual agreements related to the pension promises made to their participants. It is part of the so called secondary employment conditions. Therefore, the future cash flows depend heavily on the pension arrangements defined in the pension scheme. The type of plan (DB or (C)DC) as well as its specific characteristics (like indexation condition or the premium to be paid) varies by employer or industry-wide pension funds.

At the end of 2008, only 1% of the active participants within the pension funds had a final salary scheme (DB), 87% an average salary scheme (also DB) and 5% a DC scheme[20]. The remainder represents a mixture of different types of schemes. Over the past years, more and more the transition has been deployed towards the provision of a DC instead of a DB scheme. However, a DB (average pay) pension is still by far the most commonly used plan in the Netherlands.

Future cash flows of a typical "Benchmark" pension fund are required in order to apply, and thus analyse, the different interest rate term structures. A participant's file of a particular Dutch pension fund will form the basis of reproducing the future cash flows. The chosen fund can be considered a representative benchmark. This comes from the fact that the fund, when taking into account the whole Dutch pension industry, has an average character[21]. Logically, the average must be seen in terms of duration and the proportion of active versus inactive members. The research question that is central to this chapter is as follows:

RQ2: *How are future cash flows of the pension funds established?*

There have been other studies that utilize expected cash flows of pension funds, yet these do not specify exactly how they are derived or where they originate from. Do they even relate to Dutch pension funds and are they constructed via the regulations as provided by the FTK? Reproducing cash flows using a different framework, with different assumptions and

[20] These key aspects and an overview of the global Dutch pension system can be found at http://www.pensioenfederatie.nl/Document/Publicaties/English%20publications/Nederlandse_pensioensysteem_Engelstalige_versie.pdf.

[21] Characteristics of an average pension fund in the Netherlands can be found in studies performed by AON, see www.pensioenthermometer.nl.

methods of calculation, will result in inconsistency. To prevent this from happening, the cash flow reproducing process is also part of the research.

Before proceeding, it is important to note that it is not a goal to reproduce the cash flows as accurately as possible. Instead the main objective is to achieve relevant and realistic cash flows which a general fund could be facing. This means that for the ease of calculation, some additional assumptions are made. These are:

- Rounding to integer pensionable ages.
- The modification of each participant's birth date towards January 1st of the corresponding or the following year.
- Half of the pension benefits are paid at the beginning of the year and the other half at the very end of the year. This implies a deterministic instead of a stochastic death process. Thus, a possible participant's death during a particular year is only partially taken into account.

The pension scheme offered by the considered pension fund has the following specifications:

Type of pension scheme:	Defined benefit
Accrual rate:	2,15% of the pensionable base
Retirement pension:	Average salary scheme
Spouse pension:	70% of the old-age pension
Franchise:	€ 13.227
Marital status:	Married

Basically, the fund's cash flows are the summation of the cash flows of all its individual participants. The process will be explained on the basis of an exemplary person. The upcoming section details the method that needs to be applied in order to derive future cash flows, as outlined by the FTK framework. To emphasize that the former is indeed important, the difference with the calculations under IFRS (IAS 19) is discussed. In Section 4.2 the process to achieve the cash flows belonging to the retirement pension plan is explained. This will be done for the spouse pension in the section thereafter. The chapter is concluded with a brief review regarding other forms of pension and the final outcomes that result from performing the derivations for each participant. The generated cash flows will form the base for the actual analysis that will start from Chapter 5 and onward.

4.1 FTK pension accrual

To eventually project the cash flows corresponding to the exemplary person, it is first necessary to know some of its labour and personal characteristics. These details are set out below. 01-01-2014 must be considered as the calculation date.

Person:	X	
Gender:	Male	
Date of birth:	01-01-1964	(age is 50)
Salary:	€ 50.000	
Already accumulated pension:	€ 15.000	
Pensionable age:	67	

As already mentioned, in order to remain consistent, the calculations of the pension provisions will be computed using cash flows generated by applying the methodology specified in the FTK[22]. The latter deviates considerably from the one prescribed by IAS 19(r)[23]. Whereas FTK only utilizes accumulated entitlements, the so-called vested benefit obligation (VBO), a valuation under IFRS also has to account for future demographic and financial assumptions. This actually comes down to the inclusion of turnover rates, possible salary increases, inflation and indexation in the calculation of the pension provisions. With it, a proportionate share of the eventual entitlement has to be assigned to each year of service.

Thus, under FTK, the expected career path is not taken into consideration. In essence, potential future events are completely ignored. In fact, such a methodology equals one where everyone is viewed as inactive from the measurement date onward; it is as if they are no longer building up their pension all together.

The difference between procedures is further illustrated with Figure 4.1:

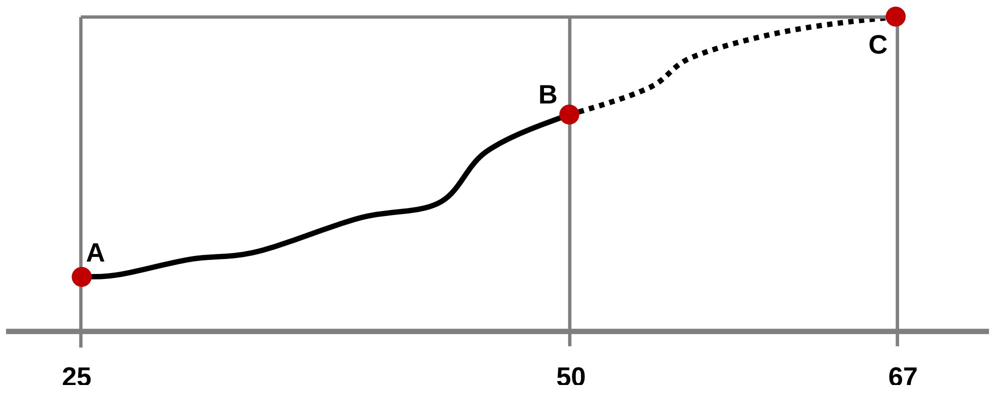

Figure 4.1: *Historical (solid line) and most likely future career path (dashed line) belonging to Person X, visualized in terms of future pension accrual*

By using FTK regulations, only the entitlements that have been accumulated up to (in this case) age 50 are taken into account. Under IFRS however, the so-called "Projected Unit Credit Method" should be applied. Using different assumptions, the most likely career path for each participant is projected. Considering Person X, this is represented by the dashed line in the figure above. Hence, for the pension computation (and thus the cash flow derivation), the entire trajectory from point A to point C is accounted for. Utilizing the calculated total entitlements, a time-proportionate share is then determined. In this particular example, the latter would result in a proportion of 25/42 of Person X's total expected pension entitlements (=25/42 of the expected total accrued pension rights) at the pension date.

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[22] For detailed information the consultation document of the Financial Assessment framework could be consulted.

[23] This calculation process is documented under IFRS in International Accounting Standard 19 – Employee Benefits.

As stated, due to consistency reasons, the more simple FTK methodology is assumed. With it (in Person X's case) only the € 15.000 worth of accumulated pension benefits is taken into account and therefore forms the basis for the eventual expected cash flow projections.

4.2 Cash flows belonging to retirement pension benefits

The application of mortality rates is a crucial aspect in determining the expected future cash flows. After all, the disbursement of pension benefits depends on whether or not the beneficiary is alive. For this, it is necessary to make use of a mortality table in which these mortality rates are listed. In the Netherlands the CBS (Centraal Bureau voor de Statistiek)[24] and the AG (Actuarieel Genootschap)[25] publish such a table. Since the institutions use other underlying models for determining the mortality rates, the tables differ slightly from each other. It is beyond the scope of this research to analyse the differences in more detail. DNB does not have a preference and accepts both methodologies. As a consequence, pension funds are free in selecting which one they will apply. The data source used in this study consults the table provided by the CBS.

Since a couple of years, the mortality rates do no longer solely depend on the age of an individual. Due to an increase in life expectancy the mortality rates are decreasing. Put differently, the chance someone survives, for instance, the period between age 50 and age 51 was substantially lower a number of years ago. As a result, this longevity, needs to be taken into account as well. Therefore, nowadays, a mortality table takes the form of a (two-dimensional) matrix and consequently must be used diagonally instead of the original vertical way. Furthermore, a distinction is made between a male and female. This comes from the fact that in general, women live longer than men. Hence, both have their own mortality rates and thus a different mortality table.

The life expectancy of the working population is significantly higher than that of the entire population[26]. Therefore, often a so called mortality experience is applied to the "raw" mortality rates published by the CBS. In essence, this step is an adjustment to the mortality table in order to obtain appropriate rates for a specific pension fund. The customized rates match the most likely mortality probabilities belonging to a particular participant's file.

How the described process exactly works will be explained by means of an example. Returning to person X. The mortality rates in Table 4.1 belong to the next few years of a man with age 50. The relevant fund specific mortality experience is visualized in Table 4.2.

CBS MEN	2014	2015	2016	2017
50	0,002630	0,002585	0,002535	0,002490
51	0,002900	0,002850	0,002795	0,002745
52	0,003210	0,003155	0,003095	0,003040
53	0,003590	0,003525	0,003460	0,003395

Table 4.1: *Mortality rates example*

24 This table can be found in the statline database of the CBS, http://statline.cbs.nl/statweb.

25 The AG mortality rates (or rather survival probabilities) can be downloaded from: http://www.ag-ai.nl/view.php?action=view&Pagina_Id=480.

26 See also the working paper of Meijer and Dongelmans, (2010), Towers Watson.

Mortality (adjusting factor)

	Main insured		Co-insured	
Age	**Man**	**Woman**	**Man**	**Woman**
50	47,8%	51,2%	47,8%	51,2%
51	47,8%	51,3%	47,8%	51,3%
52	47,9%	51,8%	47,9%	51,8%
53	48,1%	52,7%	48,1%	52,7%

Table 4.2: *Mortality experience example*

The following notations are commonly used in the life insurance sciences[27]:

$_np_x$ = *probability a man with age x survives at least next n years.*
$_nq_x$ = *probability a man with age x dies within next years.*
$_np_y$ = *probability a woman with age y survives at least next n years.*
$_nq_y$ = *probability a woman with age y dies within next n years.*

When considering a one year period, displaying the number n is usually omitted. Given the data in Table 4.1 and Table 4.2, the following fund specific mortality rates for a man with age 50 can be derived:

q_{50} = 0,00263 * 0,478 = 0,001257
q_{51} = 0,00285 * 0,478 = 0,001362
q_{52} = 0,003095 * 0,479 = 0,001483
q_{53} = 0,003395 * 0,481 = 0,001633

Because this section is about the retirement pension, only Person X's survival rates are relevant. The logical relations between survival and mortality are as follows:

$$_np_x = 1 - {}_nq_x \qquad [4.1]$$

$$_np_x = p_x * p_{x+1} * \dots * p_{x+n-1} \qquad [4.2]$$

$$_nq_x = q_x + p_x * q_{x+1} + {}_2p_x * q_{x+2} + \dots + {}_{n-1}p_x * q_{x+n-1} \qquad [4.3]$$

Now, for instance:

$$_4p_{50} = (1 - q_{50}) * (1 - q_{51}) * (1 - q_{52}) * (1 - q_{53}) = 0,99428$$

The process of calculating these survival rates must be done for each year until Person X would reach an age of, say, 105. To reproduce the cash flows associated to the retirement pension of person X, the following survival probabilities need to be determined.

1) All future one-year survival probabilities.

   Calculate: p_x *for* $50 \le x < 105$

[27] In this study the notation used by Gerber in life Insurance Mathematics (1997) is used.

2) The survival probabilities to reach all future retirement years (by using 1)

Calculate: $_{n}p_{50}$ for $17 \leq n \leq 65$

Thereafter the cash flows belonging to future year n can be calculated by:

$$CF(n) = {}_{n-1}p_x * \frac{1}{2}C + {}_{n}p_x * \frac{1}{2}C \qquad [4.4]$$

C = the total pension accrual, as already stated in the previous section, of € 15.000

Some results and example undiscounted cash flows, are illustrated in Table 4.3.

Year n	**Age**	**$_{n}p_{x}$**		**Cash flows**
15	65	$_{15}p_{50}$	0,96235	€ -
16	66	$_{16}p_{50}$	0,95758	€ 14.399,52
17	67	$_{17}p_{50}$	0,95236	€ 14.324,56
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
43	93	$_{43}p_{50}$	0,28592	€ 5.392,90
44	94	$_{44}p_{50}$	0,23808	€ 4.656,20
45	95	$_{45}p_{50}$	0,19250	€ 3.929,95
.	.	.	.	.

Table 4.3: *Cash flows belonging to person X's old age pension*

Then, the computed expected cash flows that belong to the retirement pension of Person X look as follows:

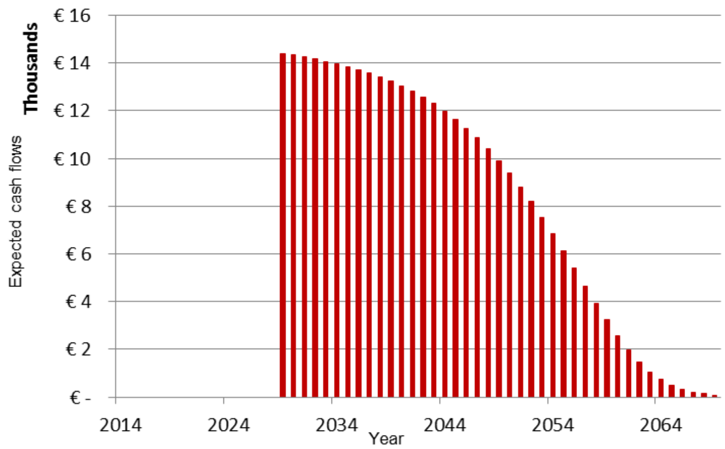

Figure 4.2: *Expected future cash flows belonging to Person X's retirement pension benefits*

4.3 Cash flows belonging to spouse pension benefits

In addition to the reasonably straight forward retirement pension, many employers provide other forms of pension as well. The most important one is the spouse pension. In case the main insured passes away, part of the pension entitlements are taken over by its relatives. Thus, since the pay-out depends on the life status of multiple people, this spouse pension is more complex. Furthermore, the timing of the event which triggers the starting point is no longer fixed.

As already given, the spouse pension is determined by the chosen benchmark pension fund as 70% of the old-age pension. No orphan's pension is included. Therefore, the C is in this case equal to:

C = 70% * € 15.000 = € 10.500.

It should be noted that in the actual file, for most instances, the accumulated spouse pension does not perfectly match 70% of the compiled retirement pension. This results from various changes that have been implemented in the past. Furthermore, it is possible for certain participants to have accumulated a partial amount when they were operating within another pension plan. Therefore, entitlements that have been compiled already can be generated from a different pension regulation.

The spouse pension is only disbursed in case the main insured is deceased and the partner is still alive. Since detailed information about an employee's partner is usually not administered, the common actuarial assumption is made that females are three years younger than their spouse.

Because this form of pension considers both genders (actuarial assumption that only man-woman couples exist). Therefore, the female (indicated by y) mortality table must be consulted as well. Its functioning is identical to that of a man (indicated by x), only the mortality rates are different.

To reproduce the cash flows associated to the spouse pension of Person X, the following probabilities need to be determined.

Main insured (participant):

1) All future one-year survival probabilities of Person X:

   Calculate: p_x *for* $50 \leq x < 105$

2) The survival probabilities of Person X to reach all different future years (by using 1):

   Calculate: ${}_np_{50}$ *for* $1 \leq n \leq 65$

3) All future one-year mortality rates of Person X:

   Calculate: $q_x \, (= 1 - p_x)$ *for* $50 \leq x < 105$

Co-insured (spouse):

4) All future one-year survival probabilities of Person X's partner:

Calculate: p_y for $47 \leq y < 105$

5) The survival probabilities of Person X's partner to reach all different future years (using 4):

Calculate: ${}_np_{47}$ for $1 \leq n \leq 58$

In order to determine the expected benefits associated to the spouse pension, two events must be combined:

- Person X is deceased.
- His partner is still alive.

The process is explained on the basis of year $n = 4$:

The probability that Person X's partner is still alive is simply: ${}_4p_{47}$ (female)

The probability that Person X dies within 4 years must be split into:

Person X dies in year			1:	$= q_{50}$	(male)
,,	,,	,,	2:	$= p_{50} * q_{51}$	(male)
,,	,,	,,	3:	$= {}_2p_{50} * q_{52}$	(male)
,,	,,	,,	4:	$= {}_3p_{50} * q_{53}$	(male)

As a result, the probability that the spouse pension must be disbursed in year 4:

$$P(CF(4)) = {}_4p_{47} * (q_{50} + p_{50} * q_{51} + {}_2p_{50} * q_{52} + {}_3p_{50} * q_{53})$$

Once again, it is important to note that the first part of the formula is determined by utilizing the female mortality table and the second part (between brackets) must be derived by applying the male mortality rates.

The method described above, but then written in a more general way, is as follows:

$$P(CF(n)) = \begin{cases} p_y * q_x & for\ n = 1 \\ {}_np_y * (q_x + \sum_{j=1}^{n-1} {}_jp_x * q_{x+j}) & for\ n > 1 \end{cases} \quad [4.5]$$

With the calculation of the latter step, all probabilities are known in order to obtain the future cash flows belonging to the spouse pension. As has been done in case of the retirement pension, half of the pension benefit is paid out at the beginning of the year and the other half at the end of the year:

$$CF(n) = P(CF(n-1)) * \frac{1}{2}C + P(CF(n)) * \frac{1}{2}C \quad [4.6]$$

In Table 4.5 on the next page, some of the calculated cash flows belonging to person X's spouse pension are visualized:

Year n	${}_n p_y$		$q_x + \sum_{j=1}^{n-1} {}_j p_x * q_{x+j}$		Cash flows:
1	p_{47}	0,99914	q_{50}	0,00126	€ 6,59
2	${}_2 p_{47}$	0,99823	$q_{50} + p_{50} * q_{51}$	0,00263	€ 20,31
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
44	${}_{44} p_{47}$	0,51526	$q_{50} + \sum_{j=1}^{43} {}_j p_{50} * q_{50+j}$	0,71408	€ 3.888,38
45	${}_{45} p_{47}$	0,46689	$q_{50} + \sum_{j=1}^{44} {}_j p_{50} * q_{50+j}$	0,76192	€ 3.799,28
46	${}_{46} p_{47}$	0,41602	$q_{50} + \sum_{j=1}^{45} {}_j p_{50} * q_{50+j}$	0,80750	€ 3.631,23
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
52	${}_{52} p_{47}$	0,12255	$q_{50} + \sum_{j=1}^{51} {}_j p_{50} * q_{50+j}$	0,97315	€ 1.441,94
53	${}_{53} p_{47}$	0,08976	$q_{50} + \sum_{j=1}^{52} {}_j p_{50} * q_{50+j}$	0,98241	€ 1.089,07
.	.	.	.	.	.

Table 4.5: *Cash flows belonging to person X's spouse pension*

Again, the expected cash flows that belong to this spouse pension example are illustrated by a graph. As can be seen in Figure 4.3, due to the nature of this pension form and its possibility of a sudden start, the overall shape deviates from the one that showcases the cash flows associated with the retirement pension.

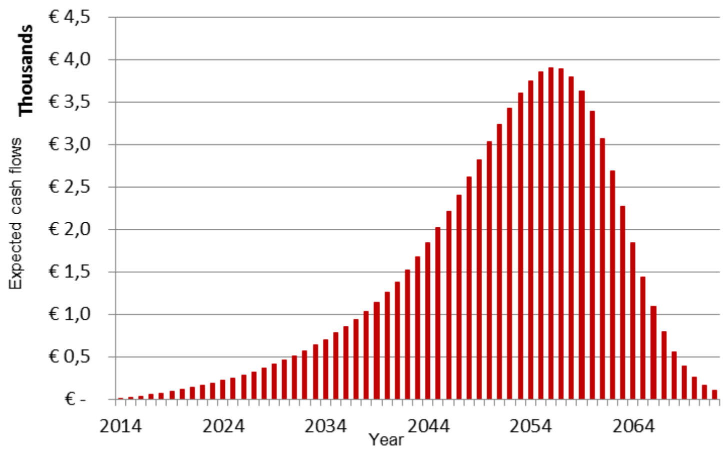

Figure 4.3: *Expected future cash flows belonging to Person X's spouse pension*

4.4 Total cash flows

Adding up the cash flows of both forms of pension results in an overview of all cash flows belonging to the pension of the exemplary "person X". Discounting all these cash flows with the TSIR prescribed by DNB would give the present value of the pension fund's liability related to the pension agreements with person X. This is also known as the technical provision.

The example that is used as leitmotif in this chapter concerns an individual. In order to obtain the total pension exposure of the considered benchmark pension fund, this process must be repeated for all active as well as inactive participants. Obviously, all individual members have their own characteristics and, in some cases, even their own pension arrangements.

There are participants that engage in other forms of pension, e.g. a temporary retirement pension and a temporary spouse pension. These are meant as transitioning pensions for people that stop working before the retirement age of 67, which is the moment when AOW (state old age pension) is received. Another form is the disability pension (i.e. for people that are not able to perform labor anymore). For this example, the FTK takes a "status quo" approach as well. Hence, no recovery chances or similar aspects are taken into account.

For the above "other forms of pension", the structure of the calculation process equals that of the already discussed (simplified) procedures. Consequently, the examples given in this chapter are a good representation for the stipulation of the cash flows associated with all other participants, each with their specific pension arrangements[28].

Furthermore, for a small group which is rather dated and already inactive, unconditional indexation agreements have been made. This indexation obligation has its effect on the valuation. The interest rate curve needs to be corrected by applying an inflation rate. However, this topic lies outside the scope of this research. Still, it is comforting knowing that it has not been neglected altogether.

When all participants from the participant's file have been treated, the expected future pension cash flows for the benchmark pension fund can be computed. The result is presented in Figure 4.4 and the actual monetary amounts can be found in Appendix D.

[28] Discussing all possible forms throughout the main text would be overdoing it. However, the overall structure remains the same. Furthermore, the outlined retirement pension and the spouse pension make up for the majority of a fund's pension liabilities.

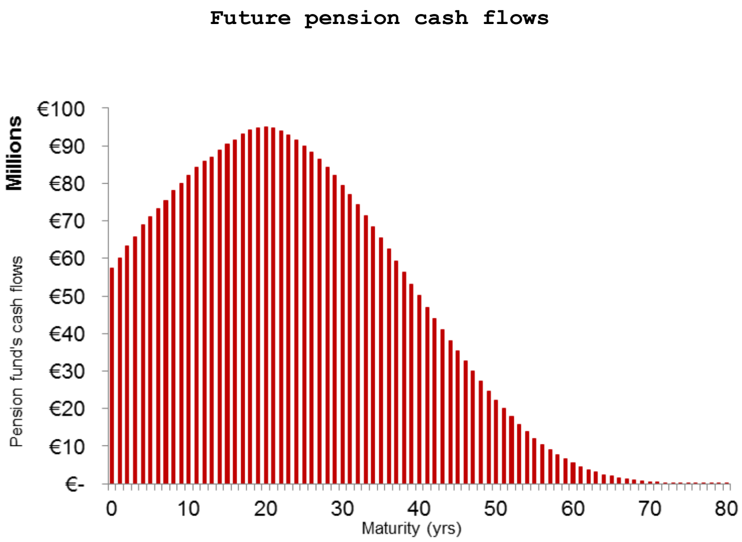

Figure 4.4: *Total cash flows belonging to the benchmark pension fund*

Chapter 5

Impact on the coverage ratio

To a certain extent, the previous chapters cover all the knowledge and data required to perform the actual analyses. The preliminary chapter discussed the original thoughts regarding market consistent valuation as well as the concept of duration to measure the interest rate exposure. Chapter 3 was marked by the construction of the prescribed interest rate term structures. Furthermore, obtaining relevant and truthful cash flows were the central theme in the preceding chapter.

In this chapter these prior items come together. The generated curves will be analysed. Applying the interest rate term structures to the projected cash flows, makes it possible to quantify their impact on the present value of the total pension provision. Subsequently, when also considering the asset side of the balance sheet, a research on the consequences for a pension's fund coverage can be conducted.

Throughout the entire analysis and at every measuring point, the same exact cash flows (Chapter 4) are utilized. This is not entirely a faithful depiction of reality. Normally, the participant's file changes, its composition is renewed, members pass away etcetera. However, for the purpose of this research, the assumption that the aforementioned cash flows remain constant will suffice. The essence lies at making different comparisons based on an average benchmark pension fund. With it, a slightly altering cash flow pattern will not be of added value. Furthermore, through utilization of this approach, resulting and analyzed deviations cannot be attributed to a sudden change of the file.

Comparisons will be made between discounting the pension cash flows without applying the averaging feature on one hand and taking the latter into account on the other. Since the application of the UFR affects the averaging impact, these two adjustments to the basic curve cannot be seen completely separately. This is precisely the reason why a comparison is made that includes the UFR as well. In essence, the following is analyzed and quantified:

1) Basic curve versus Average Basic curve (both without the application of the UFR).
2) Basic curve + UFR versus DNB curve (both with the application of the UFR).

Referring back to Table 3.1, it is helpful to repeat that throughout this entire report, the same colour palette is applied. The black line is associated with the use of the Basic curve, dark blue represents the Average Basic interest rate term structure, grey depicts the Basic curve + UFR and finally, the bright blue line corresponds with the application of the DNB curve (selected in a way such that the greyscale colours do not use averaging, in contrast to the blue ones, where the average feature is in fact applied).

Furthermore, the analysis is subdivided into four themes, which are all treated in a separate section of this chapter.

Theme 1: Impact on the level of the pension liabilities.
Theme 2: The mitigating effects.
Theme 3: Implication for a pension fund's coverage.
Theme 4: Transparency: the predictive character of the coverage ratio.

As can be derived from the mentioned themes, research question three and four are central in this part of the research. This comes down to investigating and testing the initial motives and incentives behind the introduction of the averaging methodology, as well as its associated consequences for the coverage ratio. Finally, in Section 5.5, the chapter will be concluded with the main findings originated from the performed analyses.

5.1 Theme 1: Impact on the level of the pension liabilities

A number of incentives underpin the modification towards working with an average curve instead of an actual one. Understanding the background and the motivation behind it are necessary to eventually give an opinion and draw some overall conclusions. Therefore, the analysis starts with the reasons why this averaging methodology is implemented. In fact, the third research question will be answered in this section.

RQ3: What are the driving forces behind the introduction of the averaging feature and are the associated objectives achieved?

The motivation related to the modification towards using an average curve is briefly explained in a news item published by DNB on 6 January 2012[29]. The adjustment is attributed, and even described as a necessary intervention, to the so called "exceptional market conditions" at that time. Thus, the link with the earlier (Chapter 2) treated criticism about market consistent valuation (fair value) is easily made.

In this press release serious doubts are stated about the price formation of the interbank swap quotes. Due to a lack of liquidity in the longer end of the swap market, the quotes are accompanied with uncertainty. Therefore, the correctness of applying the direct market information was questioned. Given the significance of the coverage ratio at the end of the year, and since it is decisive for a fund's disbursement policy throughout the upcoming year, The Dutch Central Bank decided to make this change. As a result, the issues of the day were more or less neglected or rather taken into account more gradually. It can be seen as kind of smoothing the pension liability at that moment.

[29] This news item can be found at: http://www.dnb.nl/nieuws/nieuwsoverzicht-en-archief/nieuws-2012.

The ultimate objective of introducing the averaging methodology is to reduce the pension uncertainty in the Netherlands. Without the implementation of the prescribed correction, 180 pension funds would be obligated to reduce the participant's pension rights ('korten') in 2012. However, with the amendment to an average interest rate term structure, only 125 funds were forced to do this. Since all curves are constructed for the period between the beginning of 2005 and 2014, the above statement could be checked. The latter has been done in Figure 5.1

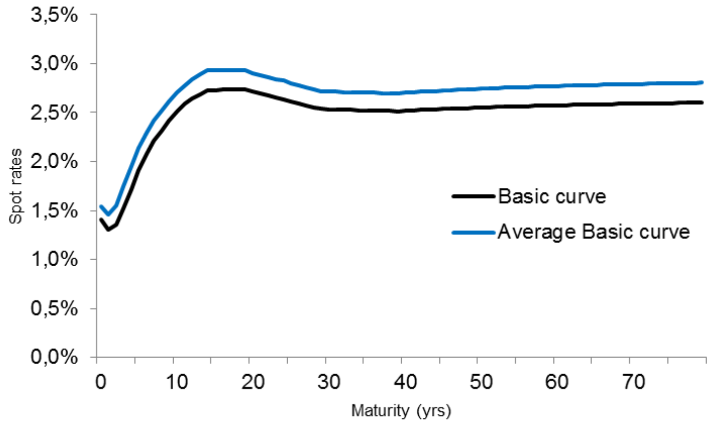

Figure 5.1: *Interest rate curves at 31-12-2011*

As can be seen in the illustrated graph, working with an average interest rate curve results in structural higher spot rates at this particular date. Suppose that the pension fund, for which the cash flows are constructed in Chapter 4, would have a coverage ratio of 102,5% at 31-December 2011. The following table shows the impact of using the Average Basic curve to discount the pension liabilities.

Impact of switching towards an
average interest rate curve (31-12-2011)

	Basic curve	Average Basic curve
Total asset portfolio	€ 2.195.000.000	€ 2.195.000.000
Total pension liability:	€ 2.140.627.242	€ 2.066.740.252
Coverage ratio:	102,5%	106,2%

Table 5.1: *Resulting figures of switching towards an average TSIR*

As a consequence of using the Average Basic term structure, the coverage ratio increases to more than 106%. Via this way, the crucial level of 105% is bridged in a certain sense.

The letter of DNB explicitly states that the adjustment is a one-time correction. However, the averaging methodology has been applied in subsequent months as well. In the beginning of 2012, DNB clarified to provisionally continue with the application of the Average Basic curve. Up to today, this policy is still used. Additionally, since September 2012, the Ultimate Forward Rate has been introduced. From then on, taking an average and the application of the UFR are jointly applied as adjustments to the actual Basic curve.

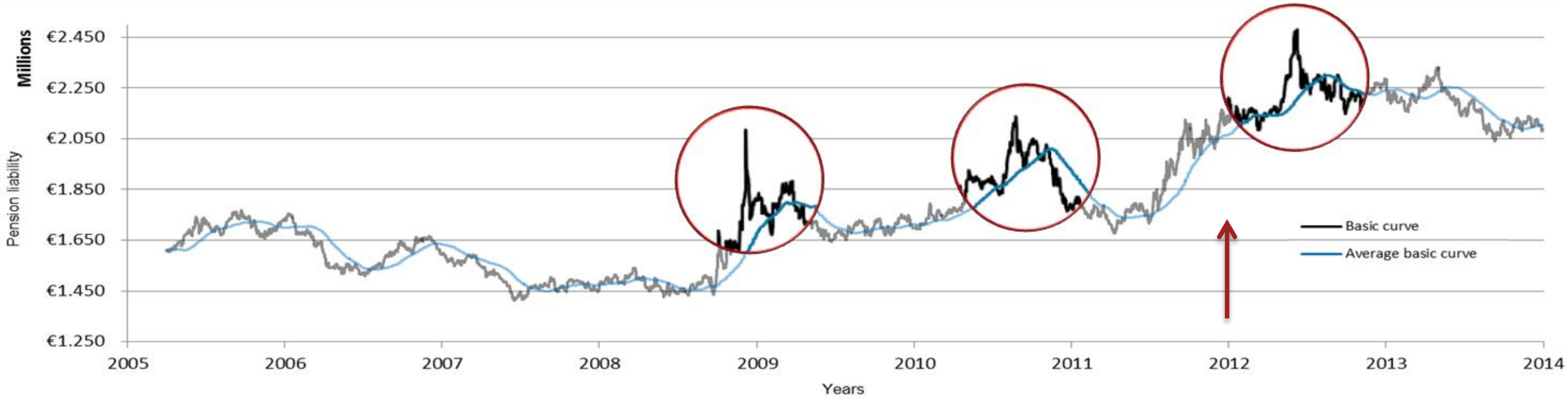

Figure 5.2: *Total pension liability value movement. Black line: pension liability valuated by the Basic curve. Dark blue line: pension liability valuated by the Average Basic curve.*

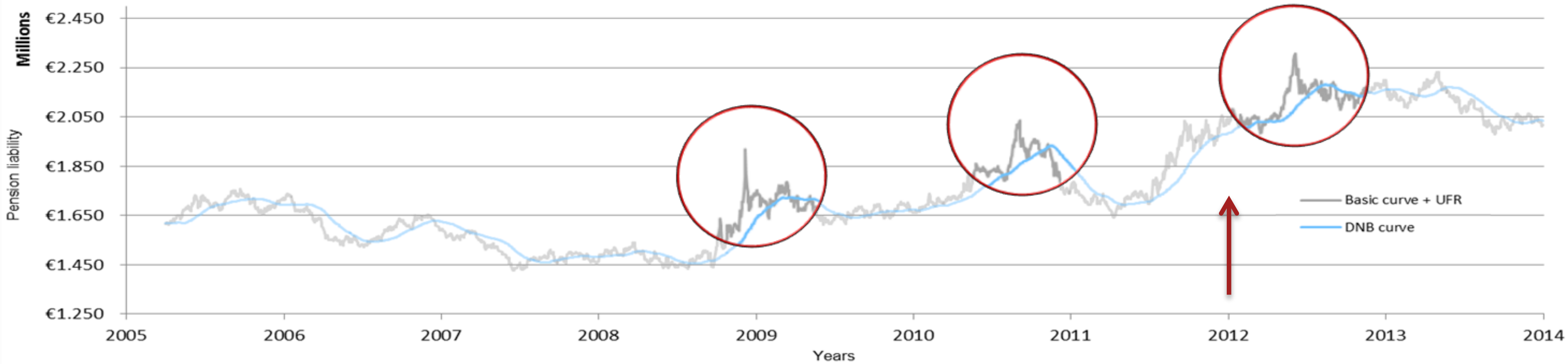

Figure 5.3: *Total pension liability value movement. Grey line: pension liability valuated by the Basic curve + UFR. Bright blue line: pension liability valuated by the DNB curve.*

In the figures on the previous page, the evolution of the total pension provision of the “benchmark” pension fund are visualized. The graphs demonstrate the averaging effect on the value of the total pension provision. In Figure 5.2, compared to the “saw-tooth pattern” of the Basic curve, the value movement is much more stable when the Average Basic curve is used. The pattern flows more smoothly and is less spiky. Three parts are highlighted through a red circle. The deviation between the two valuation techniques is the largest at these points in time. The arrow indicates the moment in which the averaging method has been introduced.

In Figure 5.3, with inclusion of the UFR, the same time points are highlighted. It is notable that the deviations are less severe when the Ultimate Forward Rate is also taken into account. This automatically makes the difference between not averaging and averaging slightly smaller. The visualizations suggest that the UFR in a sense has some kind of stabilizing effect. This seems reasonable since the UFR implies the gradual transition towards a constant, and thus stable, forward rate. The fluctuating market interest rates obtain less weight when the longer maturities are considered. Furthermore, the value of the total pension liability with the application of the UFR is lower the entire period. Since the impact of the UFR will not be investigated, the latter is not so relevant for this research.

The findings of the foregoing eyeballing process are tested by some basic characteristics. Hence, two boxplots are designed, which are visualized in Figure 5.4.

Characteristics of the pension provision under the different curves (x 1.000.000)

	Basic curve	Average Basic curve
Minimum	€ 1.412	€ 1.449
1st quartile	€ 1.593	€ 1.593
Median	€ 1.735	€ 1.722
3th quartile	€ 2.061	€ 2.025
Maximum	€ 2.478	€ 2.301
Average:	€ 1.804	€ 1.796
St. Deviation:	€ 263,26	€ 258,82

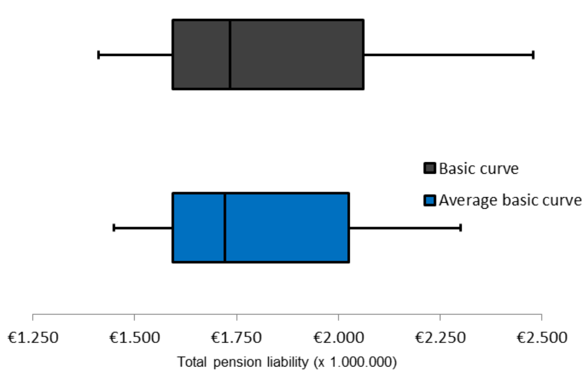

Figure 5.4: *Basic characteristics and boxplot (1)*

The boxplot related to the Average Basic curve is a bit more compact. The disparity is mainly found in the last quartile, which is where the graph is much vaster in case of the Basic curve.

In that sense, the boxplot confirms the earlier suggestions based on the findings highlighted in the red circles.

The differences between the averages and standard deviations are not worth mentioning. Since both curves use the same input data, this seems quite logical. The Average Basic curve simply incorporates the market information more gradually and thus at a slower rate. Because the analyzing period (nine years) is much longer than the period over which the average is taken (three months), these outcomes are in line with expectations. However, basically, only the historical volatility closely around a specific data point is relevant. Not analyzing the whole timeline, but for instance only a couple of months, would definitely lead to another result. In the table below the calculation of these statistics are set out for the last one and three months of 2013.

Standard deviation of the total pension provision under the different curves (x 1.000)

	Basic curve	Average Basic curve
Last month	€ 14.060	€ 3.782
Last three months	€ 20.234	€ 9.360

Table 5.2: *Difference in volatilities in two shorter time periods (1)*

The actual Basic curve has a standard deviation of approximately four and two times that of the Average Basic curve, respectively. The interest rate evolution in the considered periods was reasonably calm. Therefore, it must be said that the analysed volatility differences could be greater in some other time frames.

Characteristics of the pension provision under the different curves (x 1.000.000)

	Basic curve + UFR	DNB curve
Minimum	€ 1.426	€ 1.455
1st quartile	€ 1.589	€ 1.589
Median	€ 1.701	€ 1.695
3th quartile	€ 1.974	€ 1.936
Maximum	€ 2.316	€ 2.193
Average:	€ 1.764	€ 1.757
St. Deviation:	€ 228,32	€ 223,70

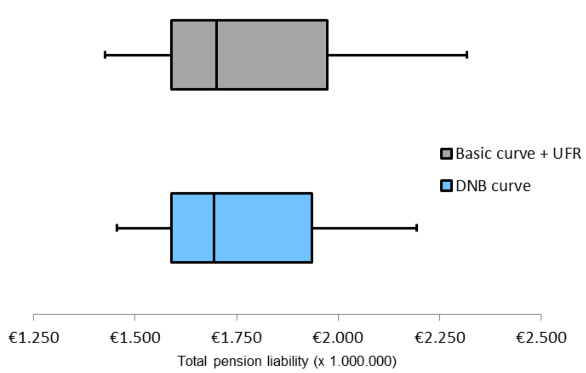

Figure 5.5: *Basic characteristics and boxplot (2)*

An analysis of the same standard characteristics regarding the comparison between the Basic curve + UFR and DNB curve is depicted in Figure 5.5. Basically, the contrast between not applying the averaging methodology and applying the latter is shown, but with inclusion of the UFR in both interest rate term structures. The boxplot confirms the already observed stabilizing workings of the UFR. The difference between not averaging and averaging is lessened. Both boxplots depicted above, the Basic curve + UFR and the DNB curve respectively, are more compact when compared to their counterparts from Figure 5.4 (the Basic curve and the Average Basic curve). The same can be derived when considering the volatilities of the entire time period; these are smaller when viewing the curves of the second comparison.

Again, the volatility of the last month and the last three months (in this example of 2013) are compared. In similar fashion, it can be seen that there is in fact a difference between not applying and applying the averaging methodology. Most noticeably, with both curves, the volatility is lower when taking into account the UFR, as opposed to not include the latter at all (refer back to figures shown in Table 5.2).

Standard deviation of the total pension provision under the different curves (x 1.000)

	Basic curve + UFR	DNB curve
Last month	€ 11.422	€ 2.688
Last three months	€ 16.217	€ 7.211

Table 5.3: *Difference in volatilities in two shorter time periods (2)*

All of the foregoing was about the value of the pension liability as such, not about the difference at particular dates. The application of two different curves lead to a different value of the provision each day. To clarify: it is about the (absolute) difference in height regarding the total pension provision by not utilizing or utilizing an averaging methodology on the interest curve. Two new boxplots are drawn in order to obtain some knowledge about the magnitude of the resulting discrepancy.

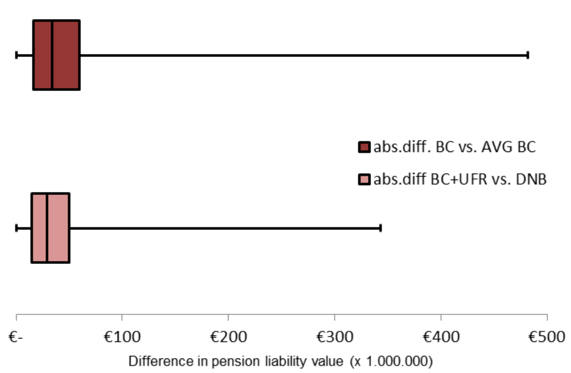

Figure 5.6: *Absolute difference in total pension liability*

As can be seen above, the value of the pension provision might deviate considerably. Also, this analysis is another argument to show that the averaging effect is significantly less when taking into account the UFR. The fourth quartile area is very large compared to the other parts of the boxplots. However, it does not say much about the number of outliers. To determine these quantities, the guidelines of J. Tukey[30] are used. Herein, weak outliers lay outside 1.5 times and extreme outliers outside 3 times the interquartile value. Total number of data points is 2282.

Number of weak and extreme outliers according to J. Tukey

	Weak outliers		Extreme outliers	
Abs.diff. BC vs. AVG BC	120	5,26%	115	5,04%
Abs.diff. BC + UFR vs. DNB	32	1,40%	24	1,05%

Table 5.4: *Outliers of the absolute difference*

From Figure 5.6, the absolute differences are significantly smaller when making a comparison with the UFR included. When viewing the numbers/percentages of outliers, this difference is not very large (especially when looking at the weak category). The latter is the result of the categories themselves being dependent on the interquartile distances, which, in turn, are smaller as well. It is important to note that all of the characteristics, meaning the minimum, the first quartile, the median, the third quartile and finally, the maximum, are lower at the second comparison. Consequently, this shows that the differences between not applying and applying the averaging methodology are, when taken as a whole, smaller in cases where the Ultimate Forward Rate is taken into account.

In conclusion, working with an average interest curve to value the pension liabilities results in a more stable and smoother level of the total pension provision. Interest shocks are more gradually incorporated in the liability value. The derivation of a more stable development of the total liability is thus reasonably accomplished. The latter is reflected by the short-term volatility, which is several times lower. Furthermore, the true importance of another driving force, the “exceptional market conditions” at the time of introduction, was noticeably exaggerated. Instead, a better description would be the recognition of a trend, one that has not occurred before yet. In any case, they certainly are not “one time only specific conditions”. Along with the two aforementioned motives, a third (and perhaps the most important) incentive is mentioned: the illiquidities that are tied to the longer maturities in the swap market. Doubts with respect to a correct price development were the primary cause to make the transition to apply an averaging methodology. However, a conspicuous detail is that the same reasoning is used for the introduction of the UFR, nine months later. The application of the Ultimate Forward Rate significantly lessens the differences between not averaging and averaging.

5.2 Theme 2: The mitigating effects

The previous section concluded with the knowledge that utilizing an average interest curve indeed results in a more stable pension liability. Stabilizing is one thing, but this does not

[30] There are many different interpretations about the definition “outliers”. In this research the guidelines considered by Tukey are applied.

necessarily mean that a mitigated pension provision is achieved as well. The latter will be analyzed by performing comparisons between the absolute month-to-month differences. Mitigating effects are present if these differences are significantly less when applying the averaging feature (thus: $|\Delta_{average}| < |\Delta_{actual}|$).

The theme itself is divided into two parts: the mitigation of interest rates (5.2.1.) and the mitigation of the pension liability (5.2.2.). Of course, these individual parts are related.

5.2.1 Mitigation of average interest rates

The mitigation of raw interest rates is analyzed by utilizing the maturities 1, 3, 5, 10, 15, 20, 25, 30, 40 and 60. The absolute month-to-month differences with respect to the interest when not utilizing average features are compared to their respective counterparts that do apply an averaging methodology. In Figure 5.7 the differences between the Basic curve and the Average Basis curve are visualized. This illustration concerns the 3-years interest rates.

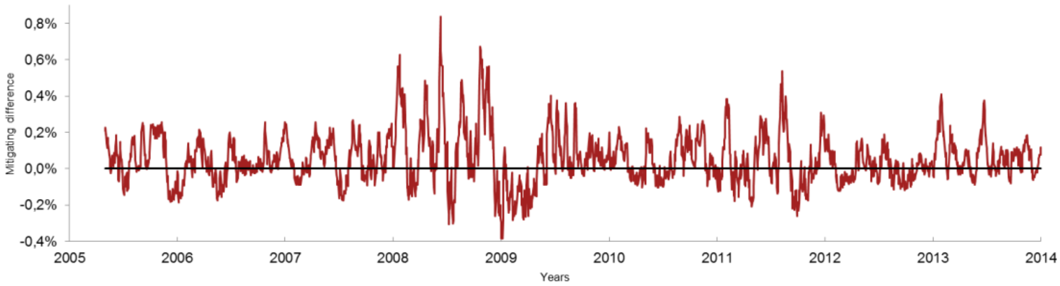

Figure 5.7: *Mitigating effects of the averaging feature*

Basically, the graph is constructed by deducing the absolute month-to-month differences of the 3-years average interest rates from the absolute month-to-month differences of the 3-years current interest figures ($|\Delta_{actual}| - |\Delta_{average}|$). Now, this means that in case the graph lies above the black line (=0%), the averaging feature is indeed mitigating. In other words, in these scenarios the differences between interest rates, at a month-to-month base, are smaller (i.e. the new value lies closer to the old one) with the inclusion of the averaging methodology. Furthermore, the graph shows the actual size of the differences themselves.

Extent to which the averaging feature has a mitigating effect on the level of interest

		Mitigation		No mitigation	
Maturities: 1, 3, 5, 10, 15, 20	Count	8816	65,01%	4744	34,99%
	Avg. magnitude		12 bp		7 bp
Maturities: 25, 30, 40, 50	Count	6370	70,46%	2670	29,54%
	Avg. magnitude		13 bp		7 bp
Total: (both categories)	Count	15186	67,19%	7414	32,81%
	Avg. magnitude		13 bp		7 bp
	Maximum		146 bp		51 bp

Table 5.5: *Mitigating characteristics (1)*

The table depicted on the previous page represents both the number, as well as the average scope of the potential mitigation effect. Basically, when no mitigating effect is present, this actually means that the month-to-month differences between the actual interest rates is less compared to that of the averaging interest rates.

As can be seen in Table 5.5, in about two-thirds of all cases, working with an averaging feature results in smaller month-to-month interest rate differences. Consequently, it cannot fully be concluded that averaging the interest rates leads to mitigation. What is noteworthy however, is the fact that the average scope of the differences is bigger when application of the averaging methodology indeed results in a mitigating effect (expressed in basis points, bp). This can also be seen in the maximum difference, which is nearly three times as large compared to the scenarios in which no mitigation effects are available (now, from the perspective of the Basic curve, the new value lies closer to the old one (=the opposite of mitigation)). In Appendix E, a tolerance test is performed for this part. With it, small differences will be left out of the comparison. This slightly affects the results.

In this theme, again, the effect of utilizing the UFR on the averaging feature is analyzed. Because the Ultimate Forward Rate is only applied after the last liquid point of 20 years and onwards, there will be no use in showing another graph that depicts the differences in mitigation of interest rates with maturity 3-years when making the comparison between Basic curve + UFR and the DNB Curve. Such a portrayal would only result in the same findings as shown in Figure 5.7. The characteristics presented next are related to the second comparison.

Extent to which the averaging feature has a mitigating effect on the level of interest

		Mitigation		No mitigation	
Maturities:	Count	8816	65,01%	4744	34,99%
1, 3, 5, 10, 15, 20	Avg. magnitude		12 bp		7 bp
Maturities:	Count	6269	69,35%	2771	30,65%
25, 30, 40, 50	Avg. magnitude		9 bp		5 bp
Total:	Count	15085	66,75%	7515	33,25%
(both categories)	Avg. magnitude		11 bp		6 bp
	Maximum		104 bp		42 bp

Table 5.6: *Mitigating characteristics (2)*

It follows that the values for the first maturities equal those shown in the previous table. For the second category, which includes the application of the UFR, two things are noticeable. First, compared to not using the Ultimate Forward Rate, the quantities remain more or less the same. Put differently, the number of times that the averaging feature results in smaller month-to-month differences in interest rates, still lies around two-thirds of all instances. However, second, the scope of the average differences drastically lessened. Consequently, the stabilizing workings of the UFR are demonstrated here as well.

5.2.2 Mitigation of total pension liability through the averaging feature

A potential smaller difference in month-to-month interest rates has rippling effects on the (mitigating) height of the pension obligation. In this subsection, the aforementioned connection is made, the analysis of which represents the weighted inclusion of all maturities (the height/values of the cash flows being the determining factor). Logically, the mitigating effects of the interest rates surrounding the duration of the obligations play an important role herein.

First off, the possible mitigation is again shown below. Now, it is focused on the height of the pension obligation. Once more, a mitigating effect means that the difference on a month-to-month basis is smaller when an averaging feature is utilized.

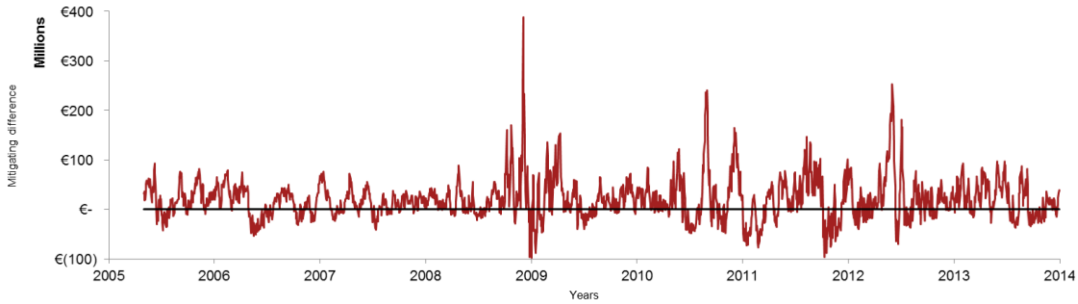

Figure 5.8: *Mitigating effects of the averaging feature on total pension liability (1)*

As can be seen in the graph, the difference in total pension liability mitigation might be very large. This can also be derived from the following table, which again shows the most crucial standard characteristics.

Extent to which the averaging feature has a mitigating effect on the total pension liability

	Mitigation		No mitigation	
Count	1559	68,98%	701	31,02%
Avg. magnitude		39 million		20 million
Maximum		388 million		97 million

Table 5.7: *Mitigating characteristics (1)*

Similar like before, in about two-thirds of all analyzed data points, a mitigating effect is achieved through the application of an averaging feature. This is in line with expectations. However, this time around, a comparison has been made based on monetary amounts and because of that, it results in a more realistic feel of the true impact of averaging the interest curve. Most notably, the maximum deviation catches attention; a difference of nearly 400 million on a total pension liability, the latter of which lies around two billion. That is a considerable amount, to say the least. The distinction lies in mitigation, meaning that the actual mutation regarding pension liability may be even bigger. For this part, a tolerance test is performed as well (refer to Appendix E).

For completeness, shown below is the analysis that takes into account the UFR. Compared to Figure 5.8, the dissimilarities are solely related to differences that occur in the interest rate curves after 20 years.

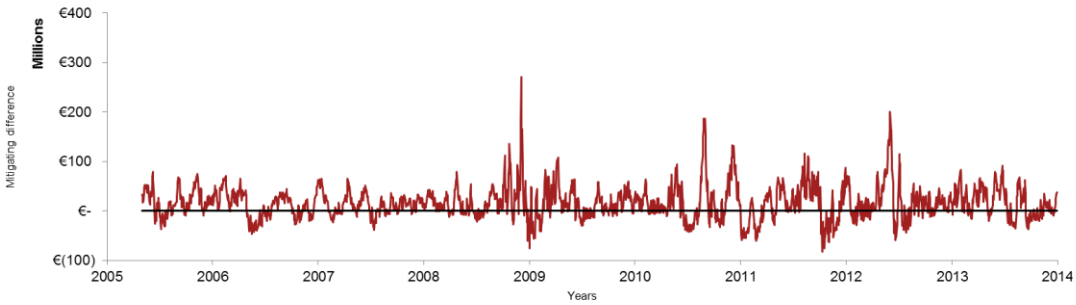

Figure 5.9: *Mitigating effects of the averaging feature on total pension liability (2)*

Because the Ultimate Forward Rate is applied, the differences are more closely grouped together. The graph itself is more compact and the deviations are less extreme. These results can be found in Table 5.8 as well.

Extent to which the averaging feature has a mitigating effect on the total pension liability

	Mitigation		No mitigation	
Count	1554	68,76%	706	31,24%
Avg. magnitude		32 million		17 million
Maximum		271 million		83 million

Table 5.8: *Mitigating characteristics (2)*

Again (and logically), the amounts differ next to none. In contrast, it does once more demonstrate the stabilizing workings of the UFR; the mitigation differences have become even smaller now that the Ultimate Forward Rate is integrated within the interest rate curve.

In conclusion, averaging the interest curve does not guarantee a mitigation of the interest rate and in turn, it does not automatically result in a mitigation of the related height of the pension obligation. In other words, the averaging feature does not necessarily lead to smaller month-to-month differences. In reality, this only happens about two-thirds of the time. However, the deviations between not averaging and averaging are several times smaller whenever the current interest curve is mitigating compared to when the average curve results in a larger month-to-month differences. The latter is represented by the average magnitude/ size of the possible deviation.

Another thing that is noteworthy relates to the scope of potential mitigation deviations. During this analysis, it is again illustrated that the effects and impact resulting from the averaging feature can be diminished when the UFR is taken into account as well.

5.3 Theme 3: Impact on coverage ratio

Although the findings and conclusions of the previous sections regarding stabilizing and potentially mitigating the value of pension liabilities are informative, it should be noted that these analyses are based on a comparison between applying one of the curves (without averaging) with the application of the other interest rate term structure (with averaging). However, for the coverage ratio, which is the prime element (leading variable for policy making) of a pension fund, these two curves cannot be viewed entirely separate from one another. For this reason, simply comparing the two will not be very useful. Instead, it is all about the combined effects of the curves put together.

To offset the variability in the pension liability, an replicating asset mix exists. For the most part, the latter is constructed of highly rated fixed income securities (examples include treasury- and corporate bonds). This so-called replicating portfolio should be able to counter fluctuations in interest rates; in essence, its purpose is to ensure (partly) the hedging of the value of the pension obligations.

The market consistent valuation of the instruments within this replicating part is based on the current market interest rates (without averaging and without UFR). Consequently, the averaging feature, as well as the UFR, are only applied at the liability side of the balance sheet. Because of these different valuation methods, the replicating value does not move in perfect sync with the pension liabilities.

Besides the fact that the set-out goal is accomplished (for the most part), one could argue whether or not this was correct in the first place. Ideally, the goal should be to mimic the same exact movements in the total value of the pension obligation, offset by the countering replicating portfolio. Whenever the fluctuation is copied at the asset side, the coverage ratio is more or less stable (80/80 = 100% and 120/120 = 100%). An averaging feature, with its forthcoming stabilization and potential mitigation that only applies to the liabilities, are therefore not affecting the asset side of the balance sheet. In turn, this may lead to mismatches. Quantifying the possible adverse implications of this phenomenon are analyzed in this theme. With it, the primary focus lies on the fourth research question:

RQ4: What is the effect of the three months average methodology on the coverage ratio of Dutch pension funds?

An Excel tool has been developed for the analysis itself, which is described in detail in the following subsection.

5.3.1 The graph constructor

Utilization of the constructed tool enables the execution of a wide variety of analyses. With it, different scenarios can be generated and results can be derived that fit a specific profile. Also, one has the option to evaluate a past period in detail. To illustrate: it is possible to just view the period around the year 2008 or even the period to which this regulation is actually applied. The latter enables one to thoroughly research the impact of the averaging methodology.

To start using the analysis/ graph construction, some initial choices have to be made and a number of characteristics have to be specified. The user might indicate the preferences by means of a Userform. The following is a list of all of the required input, outlined in a step-wise process:

Time period: specify a Start date and an End date.
Initially, the whole period is considered but it is possible to highlight a particular time span as well. By doing so, a period in which the market was subject to specific conditions can be analyzed.

***Comparison type*:** choose "BC versus AVG BC" or "BC+UFR versus DNB".
Specify whether to analyze the averaging feature without or in conjunction with the application of the UFR. The choice made will be used to value the total pension provision. The replicating portfolio will always be valued by using the Basic curve (=considered the market interest term structure).

Replication percentage: specify the replication percentage.
This determines which targeted part of the pension liability should be replicated.

Replication method: choose "Exact cash flow replication" or "Duration/ liquid replication".
Exact cash flow replication automatically implies a continuous rebalancing frequency. When the Duration/liquid replication method is selected, the rebalancing frequencies "Monthly" or "Quarterly" can be chosen.

Rebalance frequency: choose "Continuously", "Monthly" or "Quarterly".
After selecting the replication method, the associated options become available. In case of the "Duration/ liquid replication", this results in monthly or quarterly rebalancing.

Equity portfolio: specify the specific components of the equity portfolio.
Three index trackers can be chosen: AEX, S&P500 and the NASDAQ. The equity portfolio proportions invested in these different classes must be entered.

Initial coverage: enter the coverage at the Start Date.
The analysis needs a starting coverage. This makes it possible to analyze the averaging impact out of an underfunding position (coverage shortfall) or an initially covered situation.

All specific input data and command buttons must meet various kind of restrictions in order to run the graph construction process. In case of incorrect and/or incomplete input, a distinct message is shown, detailing exactly what went wrong. Describing all of the requirements and restrictions would be overdoing it. However, they are shown in detail in Appendix F. Here, the tool itself is further explained as well. Finally, the actual programming code can be found in the separate VBA coding attachment.

The form automatically pops-up with a number of fields already set to standard values. These input can be altered in order to create the scenario that the user wishes to analyze.

The Userform itself has the following format:

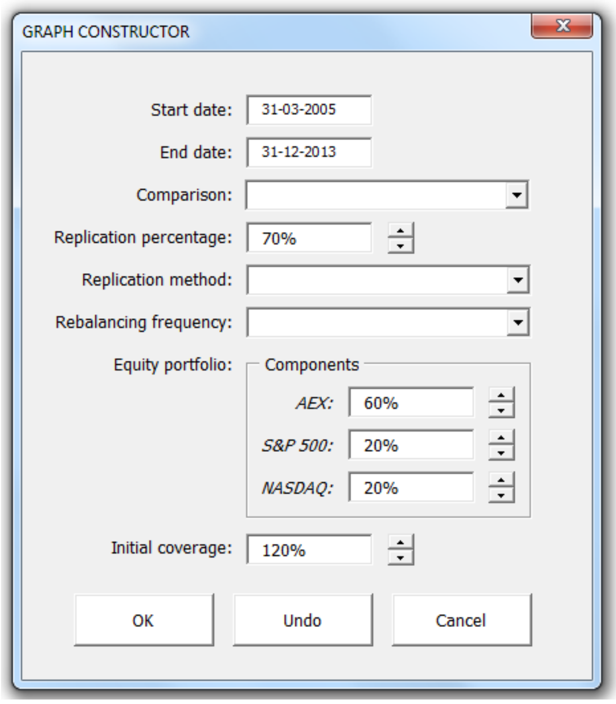

Figure 5.10: *Userform related to the graph constructor*

The graph constructor generates three graphs and some relevant standard statistics (i.e. the output). All of these results are derived based on the criteria specified at the input of the Userform. The graphs depict the following:

1. The movement in coverage ratio under the two specific valuation methods: one without, and one with the averaging feature.

2. The movement of the total pension liability under both valuation methods, as well as that of the asset portfolio's total value (replicating and equity).

3. The movement of value of the replicating portfolio and that of X% of the liability value under both valuation methods. With it, an analysis can be made, detailing exactly to which extent the replicating portfolio actually/truly covers X% of the pension liability.

The standard characteristics concern the coverage differences, the volatility of the coverage ratios and the deviations between the replicating portfolio value and the replication percentage multiplied by the value of the total pension liability. To clarify, the latter is a quantification of the results that are visually represented in graph number three.

The volatility statistic is computed and then displayed across two periods of time. The long term volatility applies to the entire period, or in case of the standard values, starting at 2005 and ending at 2014. In contrast, short term volatility only covers about the last three months of the period under consideration.

Covering all possible scenarios will exceed the scope of this research. The Excel Tool is within reach at all times. With it, it enables the simulation of a specific asset mix, combined with other characteristics of a pension fund. In turn, one is able to realistically analyze the averaging effects within these user-created funds.

For this research, two (primary) scenarios will be included throughout the main text. Starting with Subsection 5.3.2., a full replication portfolio will be discussed. A replicating percentage of 100%, combined with an initial coverage ratio of 100%, will ensure that the comparison between not averaging and averaging will be as clean (unbiased) as possible. Afterwards, in Subsection 5.3.3., the analysis is supplemented with a more realistic scenario which is comprised of 60% replication, this time with an initial coverage of 120% (which is a quite reasonable level early 2005)[31]. Studies performed by DNB have shown that an average Dutch pension fund covers about half of its interest rate risks[32]. The article which is referenced mentions an actual coverage; the 60% is a targeted rate. More often than not, the performance falls somewhat short of what the pension fund itself has in mind. The latter has been realistically integrated within the second scenario. Finally, it is important to note that the cash flows related to the pension obligation are assumed to be constant during the entire time period. Let us start the analysis in order to quantify the problem that has been described.

5.3.2 Full replication

In this full replication scenario, the deviations in coverage ratio are fully attributed to the interest rate differences between the two curves. This is because the replication percentage, as well as the initial coverage, are set at 100%. Furthermore, the entire backtesting period is considered and the presence of an exact cash flow replication (and consequently, also a continuous rebalancing frequency).

This scenario itself is implausible in any economic environment, seeing as no pension fund is able to replicate 100% of its cash flows. Again, the purpose is to make an unbiased comparison for the goal that is strived to be accomplished with this research. The fluctuations related to the coverage ratios, for this scenario, are not generated by good or bad capitalized returns from the equity components; these are not present, and therefore cannot have strengthening or weakening effects.

Of course, an analysis via the duration/liquid replication method is possible as well. However, the latter is not performed, seeing as the discussed scenario is kept pure theoretically. As a result, the targeted input interest rate hedge percentage immediately equals the actual realized percentage (in case the Basic curve is considered). In contrast, in Section 5.3.3., where the prime focus lies on a more realistic portfolio, the other option of working with the replication method is utilized, thus stripping the ability of continuously rebalancing.

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[31] Statistics Netherlands; De Nederlandsche Bank: average funding levels over time.

[32] These research results were published in the DNB bulletin, see http://www.dnb.nl/nieuws/nieuwsoverzicht-en-archief/dnbulletin-2013/dnb295970.jsp.

Despite the fact that the entire backtesting period is analyzed, the graphs shown in this theme only depict the two most recent years. This decision was made in order to better emphasize the full impact. Without zooming in on a specific time span, the effects cannot be depicted clearly in a report of this physical size. As a consequence, the detailed representation shown is not the most "extreme" or "exciting" period but instead, it is the most up-to-date one for now. As will become apparent soon, the implications for this period, which are coupled with relatively steady market conditions, are in fact significant (or better yet; even for this period, they are still significant).

As a starting point, again, a comparison is made between the Basic curve and the Average Basic curve. For this specific scenario, the graph constructor only generates two figures. This is because the input criteria necessary for the full replication scenario result in graphs two and three to be exactly the same. Shown next is the output derived by the tool (see Figure 5.11 and 5.12 on page 64). Afterwards, the results, along with the standard characteristics taken from Table 5.9, are analyzed in detail.

Statistic description:	**Value:**	
Maximum difference in coverage ratio at a particular day		30,20%
Average coverage difference		2,50%
	BC	*AVG BC*
Long term coverage volatility	0,00%	3,40%
Short term coverage volatility	0,00%	1,26%
Average difference with replicating portfolio	0,00%	2,46%

Table 5.9: *Standard statistics belonging to the full replication scenario (1)*

Logically, this pure theoretical scenario, in which a 100% exact cash flow replication is combined with an initial coverage ratio of 100%, results in a constant coverage ratio whenever the pension liabilities are also valuated with the Basic interest rate term structure. The Average Basic curve fluctuates around this 100%. As can be seen however, this is not always the case (i.e. the differences do not always center around the aforementioned value). In fact, the deviations are considerable in some instances, with the largest one measured being over 30% (see Table 5.9). Consequently, applying an averaging feature can have a serious impact, as should have become apparent.

The second graph illustrates the developments of the values related to both the asset mix and the liabilities. Not shown is the value movement of the same pension fund, valuated by using the actual Basic curve. This pattern is an exact replica of the one that is followed by the asset movements. The stabilizing workings of the Average Basic curve at the height of the total pension provision are clearly observable.

For this scenario, the volatility values of the Basic curve equal zero, which follows from the fact that a perfect mimic of the movements of a fully replicating portfolio results in a constant coverage ratio of 100%.

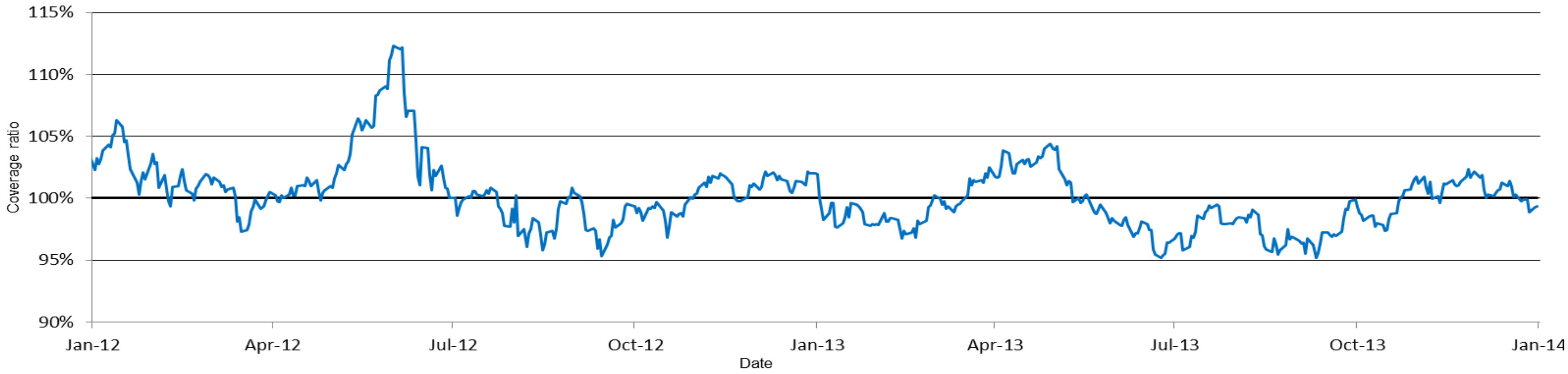

Figure 5.11: *Full replication scenario (1). Coverage ratios. Black line: pension liabilities valuated by the Basic curve. Dark blue line: pension liabilities valuated by the Average Basic curve. The colour palette can be found in Table 3.1.*

Figure 5.12: *Full replication scenario (1). Value movements. Green line: value total asset mix. Dark blue line: value of the total pension liability valuated by the Average Basic curve. The colour palette can be found in Table 3.1.*

Whenever the Ultimate Forward Rate is included in the comparison, the impact of the averaging feature diminishes with respect to the coverage ratio. This phenomenon is illustrated by the following results, which show both a lower maximum- and average difference in coverage.

Statistic description:	Value:	
Maximum difference in coverage ratio at a particular day		23,76%
Average coverage difference		2,20%
	BC+UFR	*DNB*
Long term coverage volatility	1,97%	4,01%
Short term coverage volatility	0,30%	1,22%
Average difference with replicating portfolio	2,19%	3,36%

Table 5.10: *Standard statistics belonging to the full replication scenario (2)*

By applying the UFR, both methods now have a difference in valuation between the asset side, thus the replicating portfolio, and the liability side of the balance sheet. Without the use of averaging, i.e. whenever the Basic curve + UFR is utilized in order to discount the future pension cash flows, the coverage ratio does not consistently equal 100% either.

The stabilizing workings (and to lesser extent, the mitigation) of the height of the pension obligation resulting from applying the averaging feature, does not lead to a stabilized or mitigated coverage ratio as well. In fact, the coverage ratio is much less subject to fluctuations whenever the Basic curve (or Basic curve + UFR) is used on its own to value the pension liability. This is the direct result of the numerator, in case of applying the average interest rate term structure, not being a perfect replication of the denominator. The former is further emphasized by the volatility statistics. Whenever the coverage ratio is considered, the value of the volatility itself is much lower when not utilizing an averaging feature (visible in both Table 5.9 and Table 5.10). This result is the exact opposite of the volatility findings when the focus solely lies on the height of the pension obligation alone.

In the second graph (Figure 5.14, on page 66), it can be seen that the pattern of the pension liability, which is valued by using the Basic curve + UFR, is almost the same as the value movements of the total asset portfolio. The only thing worth mentioning within the time frame that is considered is the fact that, when viewing the entire period as a whole, the UFR leads to a lower pension obligation with respect to its mirrored replicating portfolio. Consequently, it results in structurally higher (artificial) coverage ratios (for nearly the entire span between 2005-2014).

What is noteworthy as well is the fact that the average difference with the replicating portfolio (see: last row in the tables with standard statistics), which is the difference between the value of the X% replicating portfolio and X% of the values of the total pension liabilities under the two valuation methods, is also larger when the averaging feature is used. This results in a larger deviation between the targeted and the actual replication whenever the average interest rate term structure is taken into account. This theme is discussed in detail in Chapter 6.

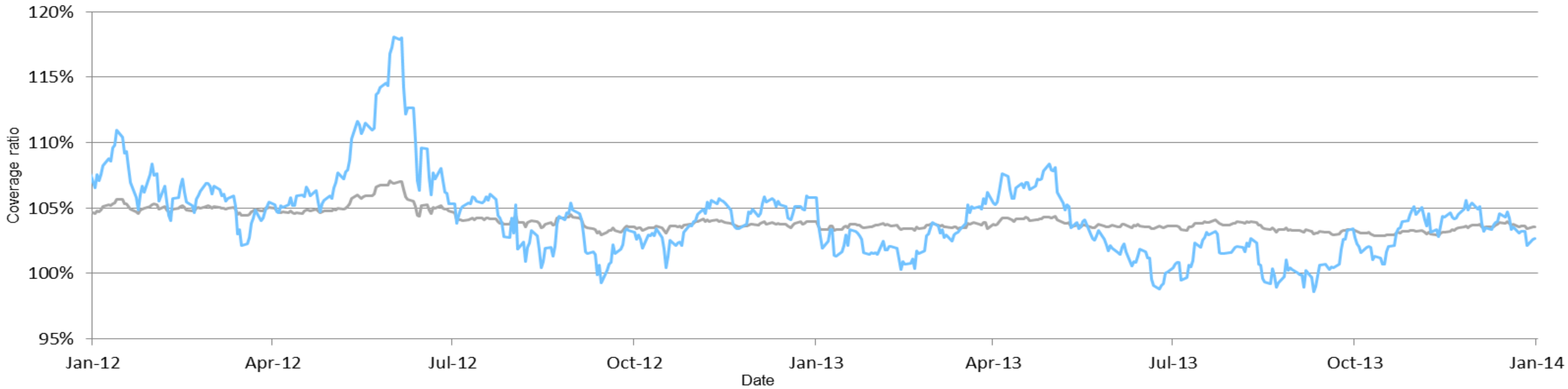

Figure 5.13: *Full replication scenario (2). Coverage ratios. Grey line: pension liabilities valuated by the Basic curve + UFR. Bright blue line: pension liabilities valuated by the DNB curve. The colour palette can be found in Table 3.1.*

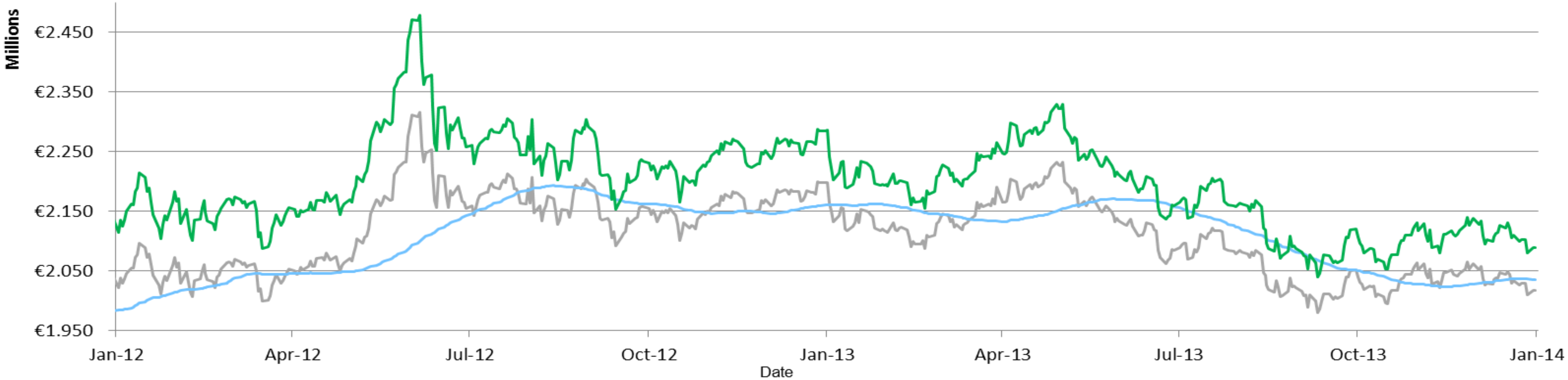

Figure 5.14: *Full replication scenario (2). Value movements. Green line: value total asset mix. Grey line: value of the total pension liability valuated by the Basic curve + UFR. Bright blue line: value of the total pension liability valuated by the DNB curve. The colour palette can be found in Table 3.1.*

5.3.3 *Realistic replication*

For the second scenario, 60% of the cash flows will be replicated. Consequently, the differences in coverage ratio cannot be solely attributed to interest rate developments. Potentially analyzed deviations may be the result of capitalized returns on the given equity positions. For the research itself, the latter may be viewed as some form of "white noise" (although normally, there is a certain degree of correlation between equity and interest rates). Furthermore, the initial coverage is set at 120% and an alternate rebalancing method is chosen for this scenario as well. Often, a perfect replication of the liabilities is impossible. This is due to the fact that there is hardly any market available to hedge cash flows after a period of, say, 30 years. Consequently, in this case, the duration/liquid replication method is selected. The rebalancing frequency is set at a quarterly basis. By not choosing an exact cash flow replication, a deviation is created between the inputted targeted interest rate risk coverage, and the actual one. This impacts the analysis of the difference between not averaging and averaging as well.

Again, the analysis starts by making a comparison between the Basic curve and the Average Basic curve. As can be seen in Figure 5.15., even in this more realistic scenario, the averaging feature still does not ensure a more stable coverage ratio. Also, the more stable height of the pension liability does not result in more stability of the latter either. This is reflected and confirmed by the short term coverage volatility, which is again smaller when the actual interest rate term structure is used. Furthermore, in Figure 5.15 it can be seen that the coverage ratios themselves follow a very diverse pattern. In fact, it would not be wrong to conclude that only for relatively long periods of time where interest rates are stable, do the different valuation methods show a similar trend in coverage. Noticeably, the direction of change within certain time frames is completely different as well.

Due to the fact that full (100%) replication is no longer accounted for within this scenario, the graph constructor shows the third graph as well (Figure 5.17). Herein, the effect of using the duration/ liquid replication method is illustrated. The green line reflects the replicating portfolio and the other two lines illustrate (X=)60% of the total pension liabilities under both inputted curve comparisons. In an ideal situation, the replicating portfolio has, under all market circumstances, exactly the same value as 60% of the total pension provision. In that sense, the deviations with this green line show the precise differences between the targeted and the actual replication performance. Consequently, from the third graph, it can be concluded (and seen) that not applying the averaging feature results in a better replicating performance. This is further strengthened by the fact that the average difference with the replicating portfolio (see Table 5.11) in case of the actual Basic curve (1,30%) is smaller than that of a comparison made with the Average Basic curve (1,72%).

Furthermore, it can be seen that the long term volatility, when compared to the full replicating scenario, has increased considerably. Apparently, a realistic scenario is more vulnerable to heavy market conditions. Of course, this realization should not come as a shock and in practice, it means that in times of crisis, the coverage ratios of pension funds are subject to a lesser degree of assurance. The analysis has shown that, even under these circumstances, valuating the pension liability through the application of an average interest

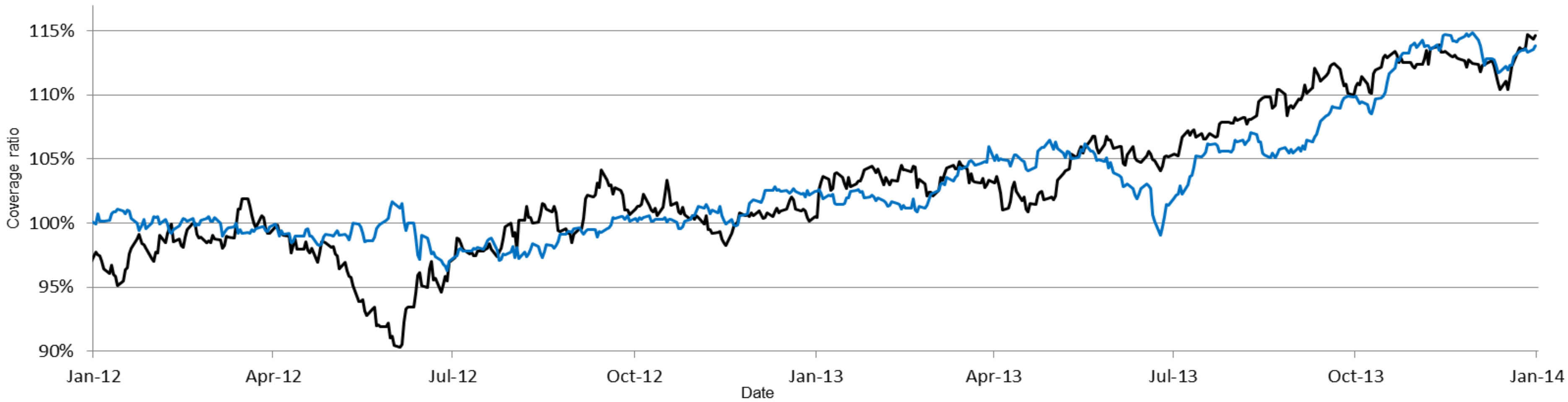

Figure 5.15: *Realistic replication scenario (1). Coverage ratios. Black line: pension liabilities valuated by the Basic curve. Dark blue line: pension liabilities valuated by the Average Basic curve. The colour palette can be found in Table 3.1.*

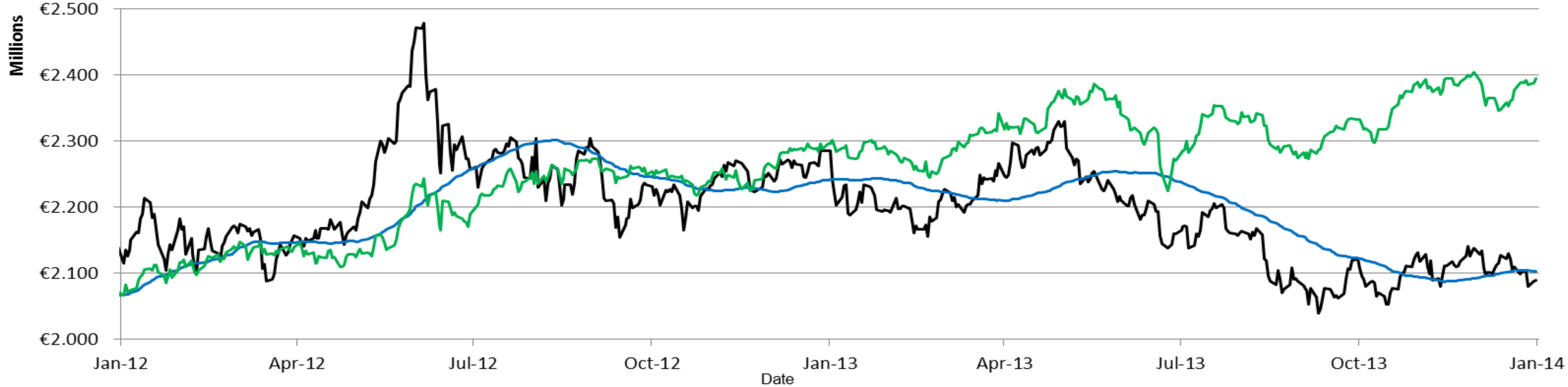

Figure 5.16: *Realistic replication scenario (1). Value movements. Green line: value total asset mix. Black line: value of the total pension liability valuated by the Basic curve. Dark blue line: value of the total pension liability valuated by the Average Basic curve. The colour palette can be found in Table 3.1.*

Figure 5.17: *Realistic replication scenario (1). Replicating performance. Green line: actual replication value. Black line: 60% of total pension liability valuated by the Basic curve. Dark blue line: 60% of total pension liability valuated by the Average Basic curve. The colour palette can be found in Table 3.1.*

Statistic description:	**Value:**	
Maximum difference in coverage ratio at a particular day		24,78%
Average coverage difference		2,78%
	BC	*AVG BC*
Long term coverage volatility	17,53%	16,62%
Short term coverage volatility	1,04%	1,76%
Average difference with replicating portfolio	1,30%	1,72%

Table 5.11: *Standard statistics belonging to the realistic replication scenario (1)*

rate term structure does not result in a stabilizing and/or mitigating effect on the height of the coverage ratios.

Basically, the same conclusions can be drawn when the UFR is included (see next page). However, the difference between not averaging and averaging is again smaller. In contrast, the average deviations with the replicating portfolio are larger. The latter is quite reasonable since the UFR is not applicable to the asset side of the balance sheet. Given this fact, it automatically leads to a mismatch between the targeted and the actual replicating performance.

Moreover, it can be seen that the UFR immediately diminishes the instances where the coverage is largely below what it should be. This is illustrated by comparing Figures 5.19 and 5.16. By applying the Ultimate Forward Rate, the value of the assets is well above both total liability values during the majority of the time span that is considered. Without the UFR, the results are very different.

Finally, some concluding remarks. The analysis performed in this theme showcases that the averaging feature and consequently, the more steady height of the pension obligation, does not guarantee a more stable coverage ratio. In fact, the opposite is true; the pension liability follows the value of the replicating portfolio more by not utilizing the average interest rate term structure. First, this results in a better replicating performance and second, the total asset mix further moves and fluctuates in the same direction as the value of the total pension liability. Consequently, a less volatile coverage ratio is created. With the help of the "graph constructor" that has been developed, a variety of different backtesting scenarios can be both generated and afterwards, fully analyzed. From this, it has been concluded that "the higher the replication percentage, the higher the (negative) averaging impact on the coverage ratio", as demonstrated throughout this theme by viewing the differences between the full- and the realistic replication scenario. In that sense, a fund that replicates the most is also affected the most (which can result either positively or negatively, but still being affected the most).

Furthermore, it is possible for the coverage ratio to move in the opposite direction when utilizing the averaging feature. In conclusion; things are not becoming any more transparent, especially when more (and deviating) asset classes are taken into consideration for the scenario analyses (e.g. real estate portfolios). The aforementioned aspect, i.e. the transparency, is precisely what will be discussed next.

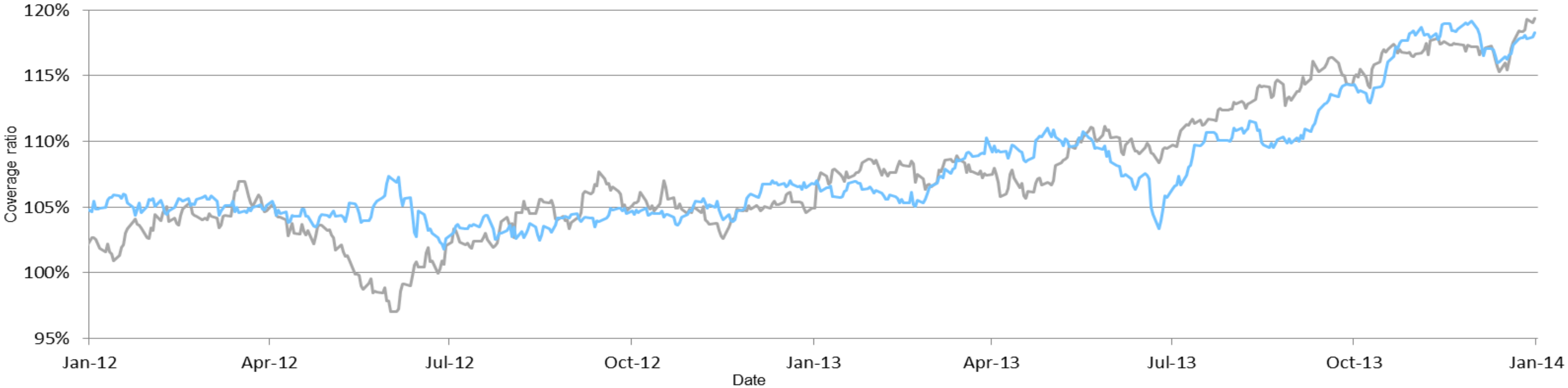

Figure 5.18: *Realistic replication scenario (2). Coverage ratios. Grey line: pension liabilities valuated by the Basic curve + UFR. Bright blue line: pension liabilities valuated by the DNB curve. The colour palette can be found in Table 3.1.*

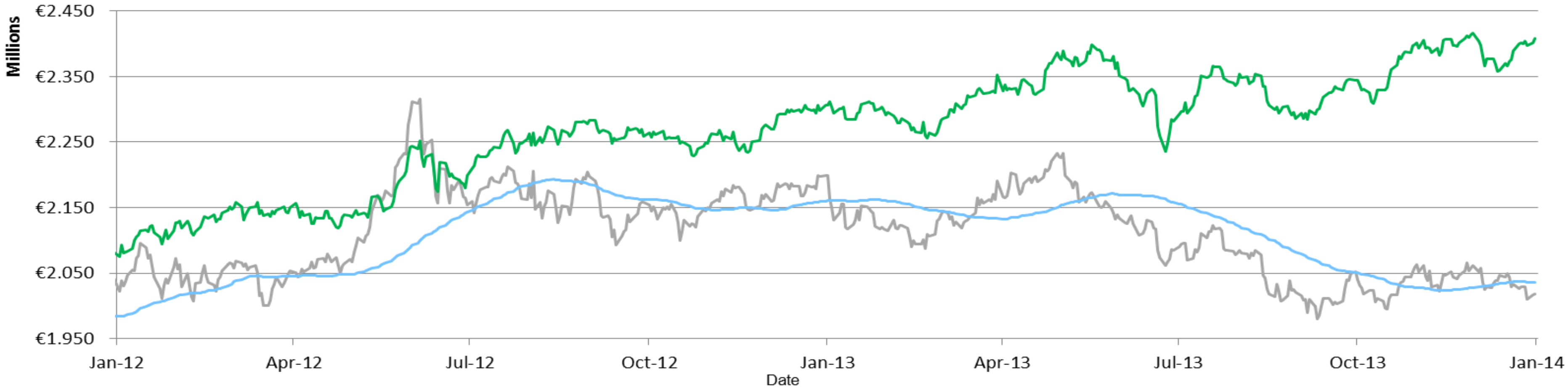

Figure 5.19: *Realistic replication scenario (2). Value movements. Green line: value total asset mix. Grey line: value of the total pension liability valuated by the Basic curve + UFR. Bright blue line: value of the total pension liability valuated by the DNB curve. The colour palette can be found in Table 3.1.*

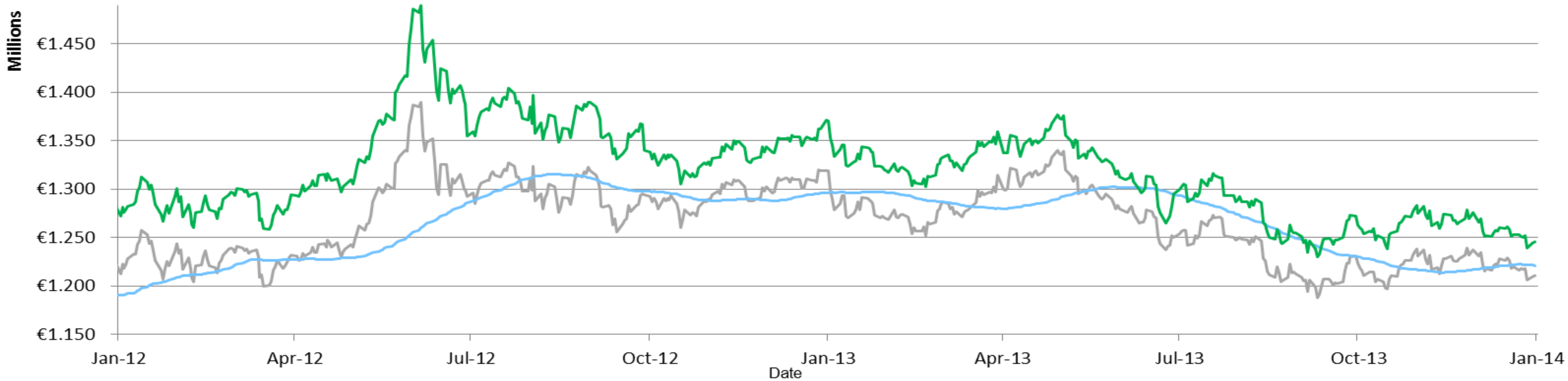

Figure 5.21: *Realistic replication scenario (2). Replicating performance. Green line: actual replication value. Grey line: 60% of total pension liability valuated by the Basic curve + UFR. Bright blue line: 60% of total pension liability valuated by the DNB curve. The colour palette can be found in Table 3.1.*

Statistic description:	**Value:**	
Maximum difference in coverage ratio at a particular day		19,57%
Average coverage difference		2,46%
	BC+UFR	*DNB*
Long term coverage volatility	15,93%	15,04%
Short term coverage volatility	1,08%	1,74%
Average difference with replicating portfolio	2,44%	2,79%

Table 5.12: *Standard statistics belonging to the realistic replication scenario (2)*

5.4 Theme 4: Transparency and the predictive character

In recent memory, the debate surrounding the averaging methodology has taken off. Besides the already-discussed stabilizing and mitigating effects, another point of interest remains: transparency. “The difference in valuation methods affects the predictive character of the coverage ratio” is a much-repeated statement. This criticism has been mentioned regularly in news articles of the past few months; Appendix G shows a selection of these items. For the theme itself, it is both analyzed and tested to which extent the averaging feature indeed affects the predictive character of the coverage ratio.

The analysis is performed by means of comparing the old coverage with the associated expected and new coverage ratios. The old and new funding levels are simply the actual values at the start and end of the month, respectively. Logically, both make use of the averaging feature, seeing as this methodology needs to be applied at this very moment. The expected coverage is based on the realized equity returns and the actual interest rate developments, applied at the old funding level (and its associated asset and liability components). For this research, the results linked with the comparison “Basic curve versus the Average Basic curve”, taken from the realistic replication scenario, are used.

A distinction can be made between the following categories:

1)	Old	<	New	<	Expected
2)	Old	<	Expected	<	New
3)	New	<	Old	<	Expected
4)	New	<	Expected	<	Old
5)	Expected	<	Old	<	New
6)	Expected	<	New	<	Old

These categories are further divided amongst three groups:

A) Categories 1 and 6: the new coverage lies between boundaries (mitigating effect).
B) Categories 2 and 4: the new coverage lies outside boundaries.
C) Categories 3 and 5: The total direction has changed (completely counterintuitive).

For group A, the true new coverage lies between the old and the expected ratio. In turn, this may be viewed as some form of mitigation; no (giant) leap is made towards a new (i.e. the expected) coverage ratio but instead, a coverage is achieved that lies somewhere between the original- and the forecasted (daily delusions) ratio. Group B on the other hand, characterizes the exact opposite of Group A. Finally, Group C even alters the entire direction of movement. The latter is the case whenever one expects a smaller (larger) coverage ratio, but the true coverage turns out to be larger (smaller).

The dataset that is analyzed classifies 2260 backtesting points, taking into account the defined categories and groups. Results are shown in Figures 5.22 and 5.23.

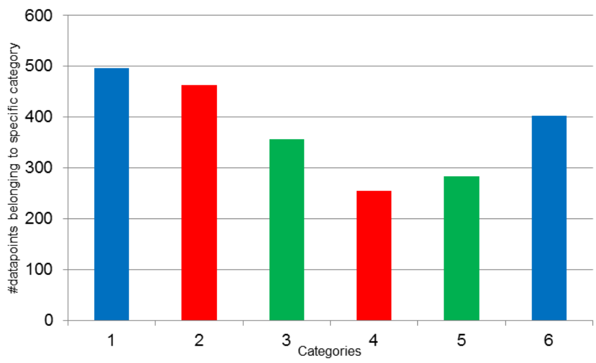

Figure 5.22: *Data points divided into the specific categories*

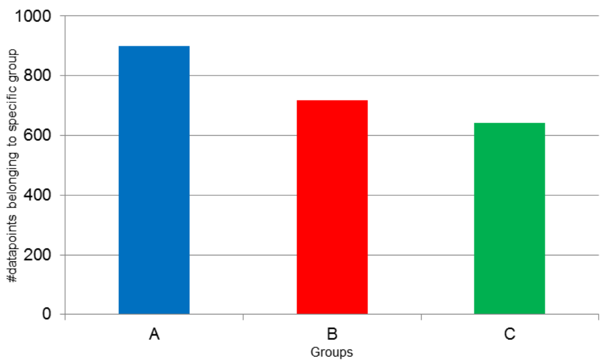

Figure 5.22: *Data points divided into the specific categories*

The first figure utilizes the colors that are associated with their respective overarching group (shown in the second illustration). The amounts and the average difference between the expected and the true new coverage belonging to the specific categories and groups are given in Table 5.13.

Group	Category	#data points within category/ group	Average absolute difference between expected and new coverage
	1	497	1,91%
A	6	403	2,28%
		900	2,07%
	2	464	1,66%
B	4	255	1,55%
		719	1,62%
	3	357	3,45%
C	5	284	3,11%
		641	3,30%

Table 5.13: *distribution amongst the different categories and groups*

From the analysis above, it can be concluded that, by applying the averaging feature, the movements of the coverage ratio become unpredictable or at least, they can no longer be forecasted based on current interest rate developments and realized equity returns alone. With it, confusion might arise. The development of the most crucial leading variable, i.e. the coverage ratio, has become less transparent. Thus, in order to faithfully derive an expectation, the inclusion of advancements regarding the average interest rate is required as well. Being able to construct forecasts that are actually helpful turns out to be dependent on charting the developments of the current interest rate, with respect to the average interest rates. In essence, it can be concluded that utilizing the average interest rate term structure does in fact impact the predictive character/the transparency of the coverage progress. The latter is especially felt by smaller pension funds for which, with their limited capacity and facilities, the aforementioned can have devastating/problematic effects. For this part, a tolerance test is performed as well, refer to Appendix E.

5.5 Conclusions on coverage impact

In this final section of the chapter, a summary is given, detailing the most important findings of the four research themes that have been covered earlier. From themes one and two, it can be concluded that the averaging feature does create a more stable development of the height of the pension obligation. In turn, the latter becomes more shock-resistant and is less subject to daily delusions. These results are confirmed by the short term volatility which, when compared to not using average interest rates, is smaller.

However, the above conclusions have been derived by solely focusing on the liability side (i.e. the total pension provision). Whenever the asset side is included in the comparison as well (e.g. when analyzing coverage ratios), the findings have proven to be of less worth. This is due to the fact that now, it is no longer about comparing two different curves but instead, the analysis centers around discovering the impact and effects of both of them combined. By applying an averaging feature for the valuation of the total pension liability, the numerator and denominator no longer move in sync. The difference in valuation methods results in the replicating portfolio no longer being able to absorb the shocks and fluctuations of the pension obligation. Consequently, the coverage ratio becomes more volatile whenever the average interest rate term structure is utilized. Thus, a more stable height of the coverage ratio leads to a more unstable coverage itself.

An added phenomenon is related to the predictive character, which is now affected. Current interest rate developments and the realized equity returns are no longer of use on their own when trying to forecast the future movements of the coverage ratio.

The fact that applying an averaging feature for the interest rate curve may lead to large deviations when compared to the situation where no average interest rate term structure is used, is perhaps best and easiest illustrated by viewing the average interest rate difference (between the actual and the averaged interest rates) at a duration of 18. The latter amounts to nearly 15 basis points. Although the latter may not look like much initially, it does result in a significant deviation in the height of the pension obligation.

Finally, the various themes have shown that the impact of the averaging feature is lessened whenever the UFR is taken into account for the comparison as well. Basically, the Ultimate Forward Rate has a stabilizing effect, thus eliminating the “jagged edges” of the implications created by the average interest rate term structure.

Chapter 6

Impact on interest rate risk management

Pension funds are subject to long-term obligations, and pension payouts are made well into the future. The associated expected cash flows are of considerable size (refer to Appendix D). Consequently, the interest rate that is used for discounting might have a tremendous effect on the height of the pension liability. With it, uncertainty arises and in turn, it creates a risk. A drop in interest rates results in a higher present value and as a result, a lower coverage ratio. One way to counter this is to engage in interest rate swaps (they receive the fixed lag and pay the floating one) and invest in bonds to protect themselves against some of the interest rate risk. In the previous chapter, this part of the investments is termed replicating portfolio. Depending on the replication percentage, these fluctuations are partially absorbed. With it, albeit to a certain degree, one is protected (i.e. hedged) against future interest rate developments.

However, by applying an averaging feature (and UFR), the liability side of the balance is discounted via a different term structure compared with the one that is used for the asset side. A deviating valuation results in fluctuations no longer being properly absorbed by the replicating portfolio. In fact, it may even have opposite effects.

The above has been briefly discussed in Chapter 5. The impact on the interest rate risk management was primarily illustrated by the third graph, generated by the Excel Tool ("graph constructor"). The figure showcased that an X% replication portfolio does not perfectly mimic X% of the pension liabilities. In this chapter, the latter is studied in more detail. By conducting a similar analysis, the mismatch between the targeted and the actual realized interest rate risk hedge performance is quantified. Consequently, the fifth and final research question will be answered.

RQ 5: *What is the effect of the three months average methodology on the pension fund's interest rate risk management performance?*

The chapter is sub-divided into two themes:

Theme 1: Duration differences and hedging performance.
Theme 2: Interest rate sensitivity by maturity.

In the upcoming section, the first theme is treated, while the focus lies on theme 2 in Section 6.2. Afterwards, the chapter is concluded in Section 6.3 with a brief summary of the main findings.

6.1 Theme 1: Duration differences and hedging performance

In Chapter 2, the concept surrounding duration is explained. In order to derive the latter, the interest rate acts as a crucial input variable. Seeing as this figure deviates when comparing the replicating part and the pension liability itself, the duration differs as well. Thus, the two valuation methods each have a varying interest rate sensitivity.

Figure 6.1 on the next page shows the duration movements associated with the pension obligation cash flows, calculated by applying the four distinct interest rate curves. The graph is accompanied by Table 6.1, which shows the average durations. These have been derived for various periods of time, whereas the whole period is again the entire backtesting time span (between 2005 and 2014).

The four different term structures

Time period	BC	AVG BC	BC + UFR	DNB
Whole period	18,107	18,071	17,651	17,629
Last two years	19,535	19,555	18,710	18,722
Last year	19,332	19,382	18,592	18,640
Last three months	19,117	19,117	18,407	18,426
Last month	19,206	19,097	18,420	18,406

Table 6.1: *Average durations*

In essence, it is not about the values themselves but instead, the focus lies on the comparison between not averaging and averaging. Despite the fact that the period that is shown, 2012 and 2013, depicts relatively stable interest rate developments (i.e. there have been no extreme scenarios), the difference resulting from not applying or applying an averaging feature is still clearly visible.

Furthermore, it can be derived that the difference in duration between using the Basic curve + UFR or the DNB curve is smaller than amongst applying the Basic curve or the Average Basic curve. This is also highlighted by the red line, which represents the variation between the two. However, for this analysis and the overall goal of the chapter, these comparisons are of less worth. The focus within this theme lies on the mismatch in which interest rate developments are absorbed at the asset and the liability side of the balance sheet. In essence, this all comes down to a two-fold comparison with the duration based on market valuation, which is always applicable to the asset side. Concrete:

1) Basic curve (=considered the market curve) versus Average Basic curve.
2) Basic curve (=considered the market curve) versus DNB Curve.

In Table 6.2, the absolute differences in average duration are shown for these two comparisons. With it, it can be concluded that applying an Ultimate Forward Rate (which is the case for the DNB curve) does not result in less duration mismatch. On the contrary;

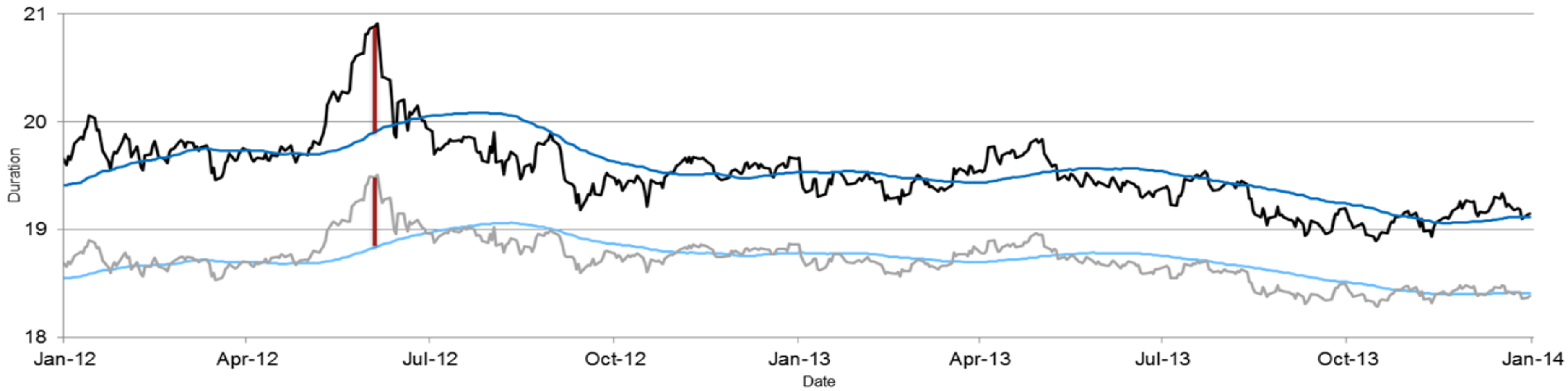

Figure 6.1: *The duration movements belonging to the liability cash flows, discounted with the different interest rate term structures. The colour palette can be found in Table 3.1.*

Absolute differences with durations, based on the market interest rates

Time period	*AVG BC*	*DNB*
Whole period	0,233	0,549
Last two years	0,174	0,813
Last year	0,135	0,692
Last three months	0,115	0,691
Last month	0,111	0,801

Table 6.2: *Average differences in duration between assets and liabilities*

using the UFR has only increased the absolute difference in duration between the replicating portfolio and the pension liability. The fact that this larger mismatch did not lead to a more volatile coverage ratio in the previous chapter is the result of the actual difference being exactly the same as the absolute difference (for nearly the entire period). The UFR with its, at least up until now, resulting higher interest rate, leads to structurally lower pension obligations and consequently, durations. As a result, the variation in duration is always positive, when applying the UFR.

The averaging feature however, might work both ways. This methodology resulted in a higher, as well as a lower provision in past periods. In practice, this means that sometimes, the duration's value is bigger while at other times, it is smaller when compared to that of the replicating portfolio. Consequently, whenever non-absolute deviations are considered, the average differences are much smaller. As can be seen in Table 6.3, it centers closely around zero, which contrasts the absolute variation illustrated by Table 6.2.

Raw differences with durations, based on the market interest rates

Time period	AVG BC	DNB
Whole period	0,036	0,478
Last two years	-0,020	0,813
Last year	-0,050	0,692
Last three months	0,000	0,691
Last month	0,110	0,801

Table 6.3: *Raw average duration mismatches*

A different discounting factor results in a different duration. Consequently, a perfect hedge of the targeted strategic replication percentage that is based on covering X% of the total pension liability is no longer feasible. Taking the realistic scenario discussed in the previous chapter as the primary example, the actual replication percentage is shown in Figure 6.2. In essence, the graph represents the percentage of the pension liability that is truly covered. The table below details the maximum and the average absolute deviations from the targeted replication (60%) that are tied to various periods of time.

Absolute deviations from the targeted 60% hedging percentage

Time period	Maximum	Average
Whole period	32,38%	3,53%
Last two years	18,10%	4,25%
Last year	8,35%	2,88%
Last three months	5,58%	3,48%
Last month	5,13%	3,65%

Table 6.4: *Deviations from targeted replication*

As can be seen from the table, the differences can amount to considerable figures, with the center of attention being the maximum deviation of 32.38%. For this particular instance, almost 80% (60*1.3238=79.43) of the pension liability was covered by the replicating

Figure 6.2: *Actual replication percentage belonging to the targeted rate of 60% between 2010 and 2013*

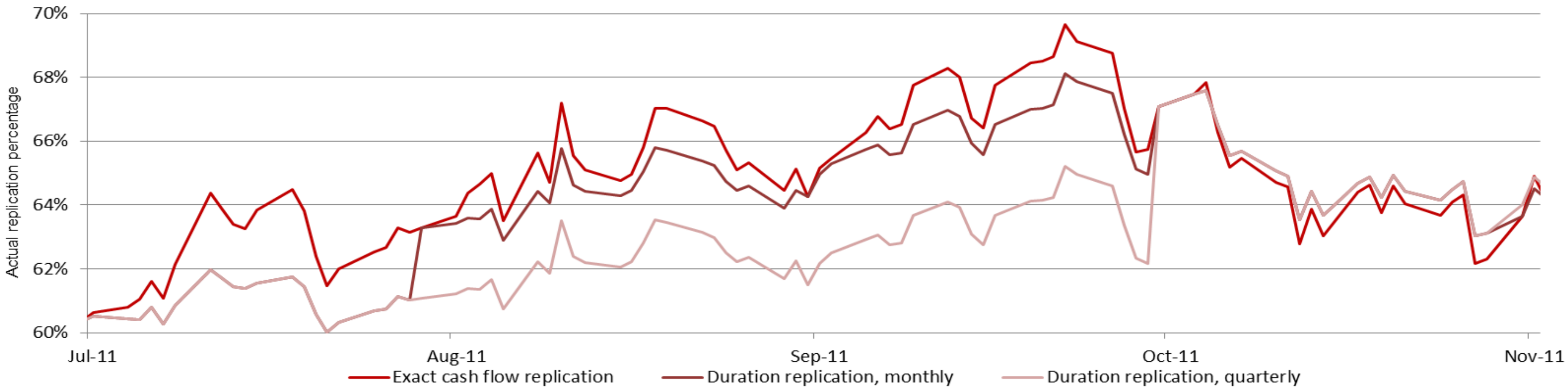

Figure 6.3: *Detailed overview of the implications of the different replication methods*

portfolio. Of course, the variations can go the other way as well, leading to an actual replication percentage that lies (well) below the targeted level of 60%. Table 6.4 depicts the deviations as a percentage of the targeted rate. This is done in order to ensure that the information is still relevant when another replication percentage is chosen.

As expected, the selected replication method also affects the coverage ratio, illustrated by Figure 6.3. A randomly chosen period shows the distinct differences between on one hand using an exact replication of the liability cash flows, versus applying the duration/liquid method on the other. Furthermore, within the latter replication method, a distinction is made between monthly- and quarterly rebalancing. The graph shows that, with duration replication, only parallel shifts are taken into consideration. With it, we have a perfect link with the next theme.

6.2 Theme 2: Interest rate sensitivity by maturity

The previous section only focused on the parallel movements of the interest rate curve. Since the latter does not say anything about the sensitivity in the shape of the curve and the relative shifts between the various segments, it may result in a misrepresentation of reality. Solely analyzing duration differences does not create a faithful or trustworthy depiction of the phenomenon. Instead, this section makes use of the so-called basis point value (BPV) method. Throughout literature[33], this has been a common way to portray the interest sensitivity per maturity segment[34]. The formula is as follows:

$$BPV_i = \frac{PV_i^- - PV_i^+}{2 * PV_i * 0{,}0001} \quad [6.1]$$

Herein, the BPV is the benchmark for measuring the interest sensitivity belonging to maturity i. The method can be considered to be some form of central approximation around the true figures. PV_i^- is the re-calculated present value of the pension liability, but determined through a constructed term structure in which 1 basis point is deducted from the actual swap rate with maturity i. The same is done for PV_i^+, but with 1 basis point added to this swap rate. For the actual computation, this theme again uses the cash flows determined in Chapter 4.

The BPV method is performed for the Basic curve and the Average Basic curve on a randomly selected day. Results are shown in Figure 6.5 on the next page. The short-term interest rate sensitivity can be neglected and has not been included in the graphs. From the depicted positive values of the duration by maturity, it can be concluded that a rising interest rate results in a drop in market value of the assets.

The Basic curve and the Average Basic curve show a similar upward trend regarding the sensitivity by maturity. In a way, this is a logical result, seeing as the averaging feature is applied to a variety of Basic curves which all have an analogous sensitivity. If a curve were to be analyzed that also includes the UFR, the outcomes would change completely. This is because the Ultimate Forward Rate creates a very strong concentration, with the 20-year

[33] Method is used by Kocken et al., (2012) as well.

[34] See also Van Bragt et al., (2012).

(the LLP) mark being the center. Afterwards however, due to the gradual implementation of the fixed forward rate, it shows a significant sensitivity decline (the Smith Wilson UFR, applied throughout the insurance world, even being more extreme with multiple sudden shifts/spikes). The latter will not be discussed in detail, as the focus of this research lies on examining the averaging feature.

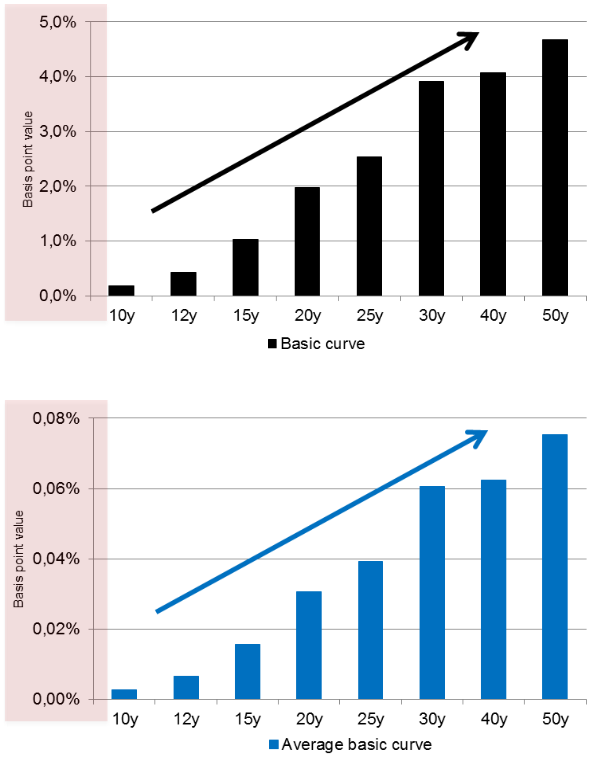

Figure 6.5: *Interest rate sensitivity per maturity at 28-06-2013*

Even though applying the averaging feature does not influence the sensitivity patterns of the various maturities, the differences between interest rate sensitivities between both curves are considerable. This follows from looking at the deviation in axis scale in Figure 6.5 (even highlighted in purple). It both confirms and further strengthens the finding made earlier; the effects of and the reactions to a shock differ tremendously for the underlying swap interest. Whenever an average interest rate is applied, a sudden fluctuation will have little to no effect. In turn, there, the basis point values are much smaller and it creates a more stable height of the pension obligation. The difference in valuation methods is well-illustrated through the use of these BPVs.

Example: the basis point value at the 40-year mark amounts to 4% for the Basic curve, while it is only 0,06% for the Average Basic curve. Consequently, whenever the 40-year swap interest rate drops by 1%, it results in an increase of 4% and 0,06% in the present value of the pension obligation, respectively. With a total liability of 2 billion, the increase is only 1.2 million whenever an averaging feature is applied. Utilization of the current interest rate however, will lead to a rise of the pension obligation by 80 million.

Above, the pension liability is used twice as the base for consecutive calculations. However, it is important to note that the strong fluctuations in case of the Basic curve (since it is considered the market curve) also apply to the replicating portfolio. Thus, whenever an average interest rate is used for the pension provisions, the asset side of the balance sheet will react much more violently to shocks, compared to its liability counterpart. Ideally, one would want the replicating portfolio to process the interest rate developments in a similar fashion.

Finally, it is of note that the BPV variations are at their biggest for the longer maturities. This means that the averaging effects are stronger for younger pension funds. A higher duration has a larger sensitivity difference between the valuation methods and in turn, it leads to a stronger impact.

6.3 Concluding comment on the interest rate risk performance

The interest sensitivity differs when an average rate is applied. The duration can be both larger, as well as smaller than expected when the current interest rate is taken into account and the variation in sensitivity is larger for longer maturities. All of this combined makes it very hard to truly accomplish the targeted replication percentage. A deviating valuation method for the replicating portfolio and the derivation of the pension obligation further complicates a successful application of the (economic) hedging policy. It is possible for the coverage ratio to drop below 100%, whilst one is still fully (or partly) hedged against market rate developments. With it, it may give rise to an overhedged scenario, thus leaving the coverage ratio below the desired height whenever the interest rates change. Consequently, it may even be possible that situations are created that impact the entire hedging strategy as a whole. This could become an incentive to adjust the hedging approach.

In summary, the above confirms the findings that have been depicted by the graphs in the preceding chapter. An Average Basic curve is better suited against shocks in the underlying swap curve. In turn, it leads to a more stable pension obligation, whilst simultaneously creating bigger mismatches with the replicating portfolio. These differences can be considerable.

Chapter 7

Conclusions & Recommendations

The impact of the three months average DNB interest rate term structure is illustrated, with the focus on the consequences for the coverage ratio and interest rate risk management. Through constructed curves, comparisons are made between not applying and applying an averaging feature in the term structure. Also, scenarios in which the Ultimate Forward Rate has been accounted for are included in the analyses. The "Graph Constructor" that has been developed acts as the primary tool which is used in order to evaluate various scenarios. In doing so, the impact is outlined (through three kinds of graphs) and quantified (by means of some standard statistics) for a specific portfolio and its associated investment- and hedging strategies.

All results found in the research are summarized in this concluding chapter. In the upcoming section, these findings are briefly discussed. In it, a reflection is made back to the main research question, which was as follows:

"What are the implications for Dutch pension funds when using the three months average DNB term structure for discounting their liabilities."

Section 7.2 covers the recommendations and finally, the chapter is concluded with Section 7.3, detailing some limitations and the possibilities for further research.

7.1 The main research findings

Replacing the market (basic) interest rate for an average one in order to valuate future pension liabilities, has resulted in higher coverage ratios when it was first introduced at the end of 2011. For 55 Dutch pension funds, this eliminated the need for right cuts altogether. The change was implemented as a result of a debate surrounding unique, heavily fluctuating market conditions and doubts regarding a proper price development (due to illiquidity reasons) at the long end of the swap curve. Initially, the plan was for a one-time adjustment. However, up to this day, the averaging feature is still being applied.

Using an average interest rate curve to value the pension obligation ensures a more stable height of the total pension provision[35]. With it, the latter is no longer subject to daily delusions. Furthermore, in (considering this research) two-thirds of all instances, this method results in a mitigating effect, meaning that the month-to-month differences are smaller, compared to instances where the current interest rates are utilized. However, the averaging feature leads to a change in valuation method for the liability side of the balance sheet, whereas the asset part remains unaltered. Because of the deviation that is now created, various problems arise.

This is because the asset mix is partly constructed of investing in fixed-income financial instruments. The portfolio is devised in such a way as to being able to (partially) replicate the liability cash flows. With it, its goal is to absorb potential shocks in the interest rate. In practice, this means that the replicating portfolio should be able to mimic the movements of the fluctuating height of the pension obligation. However, a variation in interest rate makes a perfect alignment impossible.

A much smaller interest sensitivity[36] may lead to a more stable progression of the pension liability, but a replicating portfolio that reacts differently to interest rate developments does not result in a more firm coverage ratio. In fact, the opposite has been revealed throughout this research. A more stable height of the pension obligation leads to a more volatile coverage ratio[37] in most of the time periods. However, it should be noted that deviations are the largest for funds that target a higher replication percentage. Following this reasoning, the less progressive investment strategies are affected the most by the averaging feature (which could be either good or bad). Funds who replicate the most are in turn also affected, in the sense of a comparison with not averaging, the most.

The analyzed scenarios have shown that an opposite movement of the current- and the average interest rate development results in the biggest implications. A rising (declining) current rate, combined with a declining (rising) average interest rate, amplify each other in terms of determining the alteration of the coverage ratio. On top of that, whenever the movements of interest rate developments are the same (i.e. both increasing or decreasing), the coverage ratio may change counter-intuitively. Due to the difference in valuation method, it has become necessary to analyze the interest rate developments with respect to each other. In essence, this means that the truly realized equity returns and the interest rate developments no longer have a trustworthy[38], predictive character for the movements of the coverage ratio. Things have not become more transparent, which complicates the monitoring of alterations.

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[35] Referring to Table 5.2, the volatility of the total height of the pension obligation for the last month of 2013 was nearly four times smaller through the application of the Average Basic curve, compared to using the actual Basic curve.

[36] See Figure 6.5. For instance, the BPV of the 30y-point on this particular day. Basic curve: almost 4%. Average Basic curve: only 0,06%.

[37] Take for example the scenario from Table 5.11, associated with the comparison between the Basic curve and the Average Basic curve in the realistic replication scenario that has been discussed. The short term coverage volatility without an average interest rate term structure lies at 1,04%, but with averaging it rises to 1,76%.

[38] Even in nearly 30% of the analyzed data points (see Table 5.12, 641/2260 = 28,36%), the coverage ratio completely changes direction due to the application of the average interest rate term structure.

Seeing as the Ultimate Forward Rate and the averaging feature cannot be completely separated from one another, scenarios have been analyzed that include the UFR as well. It is important to emphasize that the focus does not lie on a comparison whether or not to apply the Ultimate Forward Rate altogether. Instead, it is about studying the effects of applying averaging in cases where the UFR is taken into account as well. The research has shown that working towards a fixed forward rate for the long end of the curve lessens the difference between not averaging and averaging[39]. The stabilizing workings of the UFR definitely result in less averaging effects with respect to the coverage ratio.

An inexplicable jump in the interest rate curve is pretty much the only situation where switching to an average can be sympathized. Structurally implementing the latter methodology has not accomplished the goal it set out to achieve. Because of this, it is not about correcting sudden and incomprehensive market developments but in contrast it could lead to bending initiated trends that have occurred. Furthermore, whenever some sort of jump has indeed come forward, one has to wonder whether or not alternative stabilizers (e.g. one superior to the average interest rate term structure) can be applied to (better) achieve the same goal. In the next section, more details will be given on the latter.

Strangely enough, in essence, the same reasoning is used to introduce the Ultimate Forward Rate nine months after the implementation of the three months average methodology. Whenever applying the averaging feature does not lead to satisfactory results, one would expect this change in the term structure to-be-utilized to act as a replacement, rather than a complement. On top of that, averaging the shorter maturities as well raises questions. In practice, illiquidity within the swap curve can only become tangible after a period of 30 years[40]. Therefore, applying an averaging feature after this point would be better in line with the objective.

Everything considered, it can be concluded that the impact on the coverage ratio by applying a three months average interest rate term structure is, in certain instances, well beyond the actual goal that was set out to achieve when the methodology was introduced in the first place (not talking about the extent to which it is accomplished). It was presented as a non-stringent resolution, but it turned out to have drastic effects on both the coverage ratio and the interest rate risk hedging performance nonetheless. An average interest curve to value the pension liabilities can be deemed a fake stabilizing measure (Dutch: schijnstabilisering). Even under reasonably calm market conditions, the consequences are, in terms of the difference in coverage ratio for both valuation methods, considerable[41].

[39] This is showcased by the values for maximum coverage and average coverage difference: Full replication scenario: Basic curve vs. Average Basic curve: (see Table 5.9) 30,20% and 2,50%, Basic curve + UFR vs. DNB curve: (see Table 5.10) 23,76% and 2,20%. Realistic replication: Basic curve vs. Average Basic curve: (see Table 5.11) 24,78% and 2,78%, Basic curve + UFR vs. DNB curve: (see Table 5.12) 19,57% and 2,46%.

[40] See van der Vorst (2013), which states the following: the illiquidity presumption of the swap market after 20 years is disputable, since the size of the trading volume of 15-20 years swaps is not that different from the 20-30 years swaps.

[41] Input Graph constructor: time period 2013, Basic curve vs. Average Basic curve, an exact replication percentage of 50%, continuous rebalancing, using the initial equity components and an initial coverage of 120%. Even these characteristics, within a period of reasonably stable interest development, the average coverage difference between not averaging and averaging amounts to: 2,38%.

Finally, taking into account the potential impact of averaging and because this methodology does not apply to the insurance sector, it is possible that a similar contract is valued differently compared to when it is still present on the balance sheet of a pension fund.

7.2 Recommendations

As of 2006, pension funds have to value their liabilities using a fair value approach. At the time, it was an intentional switch to the concept of market consistent valuation. However, due to the introduction of the three months average methodology and the utilization of the (artificial) UFR, it is unclear to which extent the aforementioned still applies. Furthermore, determining the discount factor to-use has become a much more complex thing to do. It is worth considering reverting back to some form of simplicity but foremost, to some form where (short-term) averaging of the interest rate is no longer applied.

To some extent, it is important to disconnect the concept of the coverage ratio acting as a leading variable on one hand, and as a measuring variable on the other. However, at the moment, the latter is very hard to accomplish, especially considering the averaging feature (as well as the UFR). Whenever the coverage ratio approaches the critical values of decision making (e.g. the levels of 105% and 120%), it is possible that interest rate risk management is processed differently. No longer will it be purely driven by the economic market conditions.

A potential averaging of the coverage ratio could offer a solution. In Appendix H, an exemplary graph is given, in which this effect is shown. It would result in a desired stabilizer. With it, the delusions of the day discussed earlier can be avoided. Also, a possible conflict due to the coverage ratio acting simultaneously as a leading-, as well as a measuring variable, can be prevented. The latter is the result of investments and obligations once more being valued using the same methods and techniques. In turn, the hedging performance benefits and overall, it leads to a more predictive and transparent movement of the coverage ratio.

Besides, it would be wise to just think about exactly how sensitive a yield curve is allowed to be for choices that have to be made outside of the term structure model and the actual financial market conditions. Whenever interest rate developments do not meet these expectations, problems may arise for pension funds. Valuing the liabilities with an (artificially) increased yield curve could prevent serious rights cuts. However, putting off benefit cuts today means passing on the problem of underfunding to next generations.

Finally, throughout this research, DNB has already somewhat altered its publication policy. As of now, instead of only stating the interest rates up to the 60 year mark, the maturities afterwards up to year 105 are given as well. However, it would be desirable if the interest curve was published on a daily basis, rather than just once per month. With it, the insecurity for the period in between will be eliminated and in turn, the non-transparent character will improve. Seeing as the averaging feature is based on daily interest rates, these data need to be known at DNB. In essence, it all comes down to making these curves readily available.

7.3 Limitations and further research

The underlying model ("Graph constructor") that has been developed and used for analysis can be further upgraded. Examples include being able to work with multiple asset categories (e.g. real estate). With it, a more realistic asset mix can be constructed and in turn, the practical effects of averaging can be quantified even better. The investment categories that are currently included in the analysis limit themselves to index trackers and (supposed risk free) bonds. Next, the "exact replication" and the pure "liquid/duration replication" methods can be considered to be two of the extreme possibilities out there. Utilizing duration buckets or solely a perfect mimic of the liquid maturities and using a duration replication for the remaining cash flows could reflect reality better. Furthermore, every analysis and every period of time within this study uses the same cash flows. In reality, the cash flow pattern alters throughout time, resulting from, for instance, mutations in the participant's file or newly formed pension accrual. These have not been accounted for. Also, a number of simplified assumptions are made for the computation of these cash flows. However, they can still be considered a benchmark for an average Dutch pension fund and using this approach ensures a consistent application of the regulations prescribed under the FTK. The latter framework is consulted for both constructing the interest rate term structures, as well as the derivation of pension cash flows .

Additionally, this *ex-post* research can be complemented with an *ex-ante* analysis. The latter could chart the behavior of averaging for future interest rate developments. Due to many drawbacks, as well as the vast complexity that accompanies the more reliable interest rate models, this has fallen outside the scope of the research. Seeing as discussing the less-extreme backtesting periods has already yielded problematic impacts for the averaging feature, the potential additions may even be unnecessary.

In the previous section, a suggestion has been given to switch to averaging for the coverage ratio as a whole, rather than solely applying it on the interest rate curve at the liability side. However, further studies are necessary in order to know the full extent to which the conflict between leading- and measuring variable is solved by doing so. Perhaps there is still a possibility for directing the current coverage ratio in order to create a desired movement for the average funding level (leading variable). For instance, participating in more risky investments during a specific month, with the purpose of increasing the leading variable above a certain threshold. Of course, this all depends on the averaging characteristics. For the latter, examples include the overall time span for which an averaging feature is utilized, as well as the weights that are given to each measuring point. Furthermore, averaging the coverage ratio could potentially affect the risk aversion of pension funds. These are all subjects that require extensive research.

Finally, there are some things that do not directly tie in with the main theme of this research, but have come up throughout its completion nonetheless. These are as follows:

- The forward rates between the liquid maturities that are assumed to be constant in order to construct the Basic curve. Does this reflect reality? What are potential alternatives and how big is their impact?

- A choice can be made between two different mortality tables, one provided by the CBS, the other by the AG. In what way do these two differ from one another? How are the exact values calculated? In essence, it is about analyzing the underlying models used.

- The expectation surrounding the implementation of stochastic mortality tables. The life expectancy is rapidly rising. With it comes insecurity. Because of that, in the near future, a transition may be made to a stochastic mortality table. If this indeed were to happen, what are the consequences? How will it impact the coverage ratio?

- The convergence speed. Where does it originate from? Is it determined correctly and why do pension funds deviate from the method that applies to insurers? At first glance, it seems as though there are no objective criteria for determining the appropriate convergence speed.

- The default value of the convergence parameter, alpha, (to determine the weights applied to the UFR in the Smith- Wilson method) is based on a study with South-African data (see Thomas and Maré, 2007). A qualitative assessment regarding the performance of the Smith- Wilson model for different values of alpha using European data is needed. Whenever lower values of alpha give sensible results for European data, the default value of alpha has to be lowered (slower convergence towards the UFR) in order to prevent artificial high coverage ratios.

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Appendices

Appendix A: Using the appropriate averaging period

A difference in the considered time frame:

The analysis is not only performed at each month end (publishing policy of DNB). The comparisons are made on a daily basis. In order to apply the same averaging algorithm, just to be consistent, the used averaging period deviates in four data points from the period which is most likely used by the DNB.

To be specific, the following starting points, belonging to the stated ending points, are different.

Ending point	**Starting point**	
	Method used	*DNB method*
30-11	31-08	01-09
30-06	31-03	01-04
30-04	31-01	01-02
28-02	29-11	01-12

Finding the appropriate starting point of the averaging period:

Method used:

1) = date(year(end date) ; month(end date) – 3 ; day(end date) + 1) ‘unless this date does not exist. In that case:

2) = date(year(end date) ; month(end date) -2 ; day(01)).

Any possible change in years (and months) is automatically modified by Excel.

As an example, following the prescribed procedure results in:

Ending point	**Method used**	**Starting point**
29-12-2013	(1)	30-09-2013
30-12-2013	(1)	31-09-2012
31-12-2013	(2)	01-10-2013
01-01-2014	(1)	02-10-2013

Applying method (1) for 31-12-2013 would result in another starting point of the averaging process. This is because Excel acts as follows:

31/12 - 3 months = 31/9. This date does not exist. Therefore, the adjustment towards 01/10 is implemented automatically. Subsequently, the operation + 1 day provides a starting date of 02/10. This is the reasoning behind the procedure to work with two calculations methods. Which of the two must be applied depends on the situation. The distinction is made by an If-statement.

Functions used to program the right averaging period within the large dataset:

After determining the appropriate starting and ending dates between, this range must be specified in such a way Excel applies the averaging period correctly. Eventually, the following functions within the average comment have led to the proper outcomes:

> ***Indirect function***: returns the reference specified by a string. The string consists of the specific sheet in which the actual averaging process takes place, the ending point and the starting point.
>
> ***Address function****:* creates a cell reference as text, given specified row and column numbers. This is required since the location of the ending and starting point must be indicated by their row and column number.
>
> ***Match function****:* returns the relative position of an item in an array that matches a specified value in a specified order. The row numbers are actually constant because they are determined by a given maturity. The column numbers, however, will depend on the particular ending and starting points. Looking for an entered (exact) date, utilizing the match function will return the associated column location.

Appendix B: The UFR weighting scheme

Maturity (t)	**Weight** (w_t)
21	0,086
22	0,186
23	0,274
24	0,351
25	0,420
26	0,481
27	0,536
28	0,584
29	0,628
30	0,666
31	0,701
32	0,732
33	0,760
34	0,785
35	0,808
36	0,828
37	0,846
38	0,863
39	0,878
40	0,891
41	0,903
42	0,914
43	0,923
44	0,932
45	0,940
46	0,947
47	0,954
48	0,960
49	0,965
50	0,970
51	0,974
52	0,978
53	0,982
54	0,985
55	0,988
56	0,990
57	0,993
58	0,995
59	0,997
60	0,998

Appendix C: Differences between DNB and the constructed curves

September 2013

Maturity	DNB curve	Constructed curve	Abs. diff.
1	0,408	0,408	0,000
2	0,578	0,578	0,000
3	0,781	0,781	0,000
4	1,026	1,026	0,000
5	1,266	1,266	0,000
6	1,489	1,489	0,000
7	1,673	1,673	0,000
8	1,844	1,844	0,000
9	2,000	2,000	0,000
10	2,142	2,142	0,000
11	2,265	2,265	0,000
12	2,368	2,368	0,000
13	2,456	2,456	0,000
14	2,531	2,531	0,000
15	2,596	2,596	0,000
16	2,624	2,624	0,000
17	2,649	2,649	0,000
18	2,672	2,672	0,000
19	2,691	2,691	0,000
20	2,709	2,709	0,000
21	2,715	2,715	0,000
22	2,727	2,727	0,000
23	2,743	2,743	0,000
24	2,763	2,763	0,000
25	2,785	2,785	0,000
26	2,807	2,807	0,000
27	2,830	2,830	0,000
28	2,854	2,854	0,000
29	2,879	2,879	0,000
30	2,905	2,905	0,000
31	2,933	2,933	0,000
32	2,961	2,961	0,000
33	2,988	2,988	0,000
34	3,015	3,015	0,000
35	3,041	3,041	0,000
36	3,067	3,067	0,000
37	3,092	3,092	0,000
38	3,116	3,116	0,000
39	3,139	3,139	0,000
40	3,162	3,162	0,000
41	3,184	3,184	0,000
42	3,206	3,206	0,000
43	3,227	3,227	0,000
44	3,247	3,247	0,000
45	3,267	3,267	0,000
46	3,286	3,286	0,000
47	3,304	3,304	0,000
48	3,322	3,322	0,000
49	3,339	3,339	0,000
50	3,355	3,355	0,000
51	3,371	3,371	0,000
52	3,386	3,386	0,000
53	3,401	3,401	0,000
54	3,416	3,416	0,000
55	3,430	3,430	0,000
56	3,443	3,443	0,000
57	3,456	3,456	0,000
58	3,469	3,469	0,000
59	3,481	3,481	0,000
60	3,493	3,493	0,000
61	3,539	3,505	0,034
62	3,550	3,516	0,034
63	3,560	3,527	0,033
64	3,570	3,537	0,033
65	3,579	3,547	0,032
66	3,588	3,557	0,031
67	3,597	3,567	0,030
68	3,606	3,576	0,030
69	3,614	3,585	0,029
70	3,623	3,594	0,029
71	3,631	3,602	0,029
72	3,639	3,611	0,028
73	3,646	3,619	0,027
74	3,654	3,626	0,028
75	3,661	3,634	0,027
76	3,668	3,642	0,026
77	3,675	3,649	0,026
78	3,681	3,656	0,025
79	3,688	3,663	0,025
80	3,694	3,669	0,025

August 2013

Maturity	DNB curve	Constructed curve	Abs. diff.
1	0,403	0,402	0,001
2	0,563	0,561	0,002
3	0,744	0,742	0,002
4	0,967	0,964	0,003
5	1,191	1,187	0,004
6	1,401	1,397	0,004
7	1,576	1,572	0,004
8	1,742	1,738	0,004
9	1,895	1,891	0,004
10	2,035	2,031	0,004
11	2,158	2,154	0,004
12	2,260	2,257	0,003
13	2,348	2,345	0,003
14	2,424	2,420	0,004
15	2,489	2,486	0,003
16	2,520	2,517	0,003
17	2,546	2,544	0,002
18	2,570	2,567	0,003
19	2,592	2,589	0,003
20	2,611	2,608	0,003
21	2,618	2,616	0,002
22	2,632	2,630	0,002
23	2,651	2,649	0,002
24	2,673	2,671	0,002
25	2,698	2,696	0,002
26	2,722	2,720	0,002
27	2,747	2,745	0,002
28	2,774	2,772	0,002
29	2,801	2,799	0,002
30	2,828	2,827	0,001
31	2,859	2,857	0,002
32	2,889	2,887	0,002
33	2,918	2,917	0,001
34	2,947	2,945	0,002
35	2,975	2,973	0,002
36	3,002	3,000	0,002
37	3,028	3,027	0,001
38	3,054	3,052	0,002
39	3,079	3,077	0,002
40	3,103	3,101	0,002
41	3,126	3,125	0,001
42	3,150	3,148	0,002
43	3,172	3,171	0,001
44	3,193	3,192	0,001
45	3,214	3,213	0,001
46	3,234	3,233	0,001
47	3,253	3,252	0,001
48	3,272	3,271	0,001
49	3,290	3,289	0,001
50	3,307	3,306	0,001
51	3,324	3,323	0,001
52	3,341	3,340	0,001
53	3,356	3,355	0,001
54	3,372	3,371	0,001
55	3,386	3,385	0,001
56	3,401	3,400	0,001
57	3,414	3,414	0,000
58	3,428	3,427	0,001
59	3,441	3,440	0,001
60	3,453	3,453	0,000
61	3,577	3,465	0,112
62	3,587	3,477	0,110
63	3,596	3,488	0,108
64	3,605	3,499	0,106
65	3,614	3,510	0,104
66	3,623	3,520	0,103
67	3,632	3,530	0,102
68	3,640	3,540	0,100
69	3,648	3,550	0,098
70	3,656	3,559	0,097
71	3,663	3,568	0,095
72	3,670	3,577	0,093
73	3,678	3,585	0,093
74	3,685	3,594	0,091
75	3,691	3,602	0,089
76	3,698	3,609	0,089
77	3,705	3,617	0,088
78	3,711	3,625	0,086
79	3,717	3,632	0,085
80	3,723	3,639	0,084

Legend
Exact match
Indicating the jump in DNB curve
Small deviation
Large deviation after t=60

Appendix D: Benchmark pension fund’s total cash flows

Maturity (yrs)	Cash flows		Maturity (yrs)	Cash flows	
1	€	57.408.785	**41**	€	50.121.854
2	€	60.147.884	**42**	€	47.066.111
3	€	63.421.011	**43**	€	44.051.076
4	€	65.812.661	**44**	€	41.086.162
5	€	683921.350	**45**	€	38.181.108
6	€	71.090.404	**46**	€	35.345.253
7	€	73.392.770	**47**	€	32.587.158
8	€	75.302.289	**48**	€	29.901.972
9	€	78.018.083	**49**	€	27.290.535
10	€	80.061.391	**50**	€	24.766.347
11	€	82.242.669	**51**	€	22.339.677
12	€	84.212.148	**52**	€	20.026.122
13	€	85.965.298	**53**	€	17.836.620
14	€	87.083.423	**54**	€	15.780.878
15	€	88.760.512	**55**	€	13.866.720
16	€	90.487.915	**56**	€	12.099.826
17	€	91.598.171	**57**	€	10.483.385
18	€	93.128.221	**58**	€	9.017.177
19	€	94.148.177	**59**	€	7.698.136
20	€	94.633.675	**60**	€	6.520.781
21	€	94.949.449	**61**	€	5.477.428
22	€	94.703.760	**62**	€	4.559.383
23	€	94.009.356	**63**	€	3.757.593
24	€	92.945.286	**64**	€	3.063.079
25	€	91.597.021	**65**	€	2.467.092
26	€	89.936.795	**66**	€	1.961.267
27	€	88.309.777	**67**	€	1.537.321
28	€	86.471.335	**68**	€	1.187.007
29	€	84.341.134	**69**	€	902.108
30	€	82.025.843	**70**	€	674.368
31	€	79.546.829	**71**	€	495.621
32	€	76.919.041	**72**	€	357.987
33	€	74.236.121	**73**	€	254.073
34	€	71.460.697	**74**	€	177.157
35	€	68.527.699	**75**	€	121.362
36	€	65.524.133	**76**	€	81.688
37	€	62.486.300	**77**	€	54.026
38	€	59.405.028	**78**	€	35.119
39	€	56.304.896	**79**	€	22.443
40	€	53.206.469	**80**	€	14.101

Appendix E: Tolerance test

In this appendix, for three different analyses, being the mitigating effect on the level of interest rates, the mitigating effect on the total pension liability and the transparency theme, a tolerance test is performed. In doing so, (very) small differences are left unaccounted and will not be included in the end results. The data points with no noteworthy characteristics are filtered from the analysis. What this does, is illustrated below. This tolerance test is only applied to the comparison between the Basic curve and the Average Basic curve.

Extent to which the averaging feature has a mitigating effect on the level of interest, tolerance boundary included

		Mitigation		No mitigation	
Maturities:	Count	8278	66,26%	4216	33,74%
1, 3, 5, 10, 15, 20	Avg. magnitude		13 bp		8 bp
Maturities:	Count	6040	71,92%	2358	28,08%
25, 30, 40, 50	Avg. magnitude		14 bp		8 bp
Total:	Count	14318	68,53%	6574	31,47%
(both categories)	Avg. magnitude		13 bp		8 bp
	Maximum		146 bp		51 bp

Depicted above are the results of the interest mitigating test, now with the integration of a maximum deviation of 1 bp. The latter translates to every month-to-month differences smaller than 1 bp now being within the tolerance boundaries and therefore, they will not be included in further analyses. 1708 data points are affected, which is slightly more than 7,5% of the original total that was used in Table 5.5. Initially, roughly half of these points (868) were considered to be a scenario in which the mitigation effect appeared. Seeing as at first, there were more data points that did show mitigation, now, in terms of percentage, more data points without mitigation fall within the tolerance boundaries. This was somewhat to be expected, as the average magnitudes for no mitigation are much smaller. In the renewed situation, the average magnitudes have increased slightly. This follows logically from the fact that the smaller differences have now been filtered out. The maximums remain the same; they are unaffected by the boundaries.

Whenever the tolerance test is introduced for the analysis surrounding the mitigating effect of the (related) height of the pension obligation as well, the results are as follows:

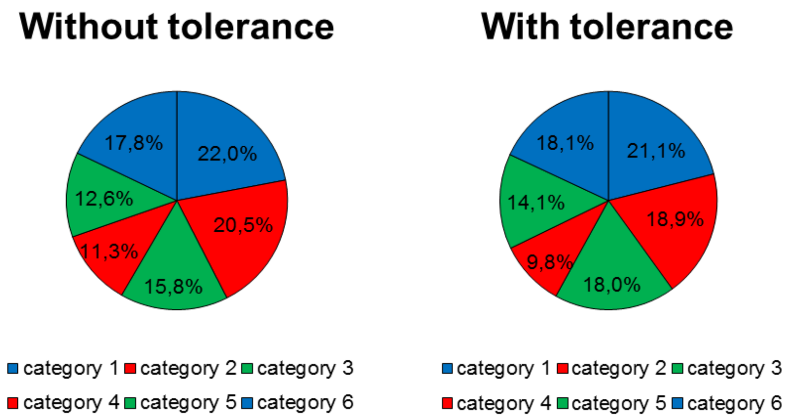
Extent to which the averaging feature has a mitigating effect on the total pension liability, tolerance boundary included

	Mitigation		No mitigation	
Count	1487	70,84%	612	29,16%
Avg. magnitude		41 million		23 million
Maximum		388 million		97 million

Basically, a similar view/image is depicted. However, it should be noted that out of all points that lie within the boundary, even more originate from the no mitigation category (89 versus

72). This further strengthens the findings that, in general, the deviation in case of no mitigation is much smaller. Put differently; whenever there is mitigation, the extent of mitigation is simultaneously strong.

Finally, a tolerance test is performed regarding the transparency theme as well. A difference between the actual new coverage and the expected coverage that is less than half a percentage point, is excluded in further analyses. This applies to 296 data points, which translates to (296/2260) 13,1%. The pie diagram below showcases the differences (with or without tolerance) for the distribution of the data points in the formulated categories (see Section 5.4).



The allotment in categories, percentage wise, does not change all that much. However, it can be seen that Group C, the two green pieces, has grown. This can be attributed to the fact that the number of data points that lie within these categories has barely been reduced (i.e. nearly none of them fall within the tolerance area). The total number of data points has declined, thus the respective percentages rise.

Despite applying the tolerance test, the conclusion remains that no visible improvement has appeared regarding the transparency of coverage ratio development. Yet again, solely viewing the actual equity returns and the current interest rate developments are not enough to conduct a faithful forecast for the height of the coverage ratio.

Appendix F: The Userform; input and command characteristics

Through utilization of the developed graph constructor, the averaging impact of various scenarios can be analyzed. A particular scenario can be studied via a step-wise process by inputting the associated characteristics at the Userform. However, a number of restrictions have to be taken into account, which are outlined below. When applicable, an initial value is specified as well.

Input:
Programmed restrictions and initial values

Input:	Tool:	Description:
Start date	Textbox	Initial date: 31-03-2005 Input must be a date (format "dd/mm/yyyy") Start date must lay between 31-3-2005 and 31-12-2013 Start date must lay before End date Time period to analyze must be at least half a year
End date	Textbox	Initial date: 31-12-2013 Input must be a date (format "dd/mm/yyyy") End date must lay between 31-3-2005 and 31-12-2013 Start date must lay before End date Time period to analyze must be at least half a year
Comparison	Combobox	Input must be: "BC versus AVG BC" or "BC+UFR versus DNB"
Replication percentage	Spinbox	Initial value: 70% Input must be a number Minimum percentage: 0% Maximum percentage: 100% Should at least be equal to the initial percentage (when starting below, spinning up also affects the initial coverage percentage)
Replication method	Combobox	Input must be: "Exact cash flow replication" or "Duration/ liquid replication" The "Exact cash flow replication" method implies a continuous rebalancing frequency After selecting the "Duration/ Liquid replication", two possible rebalancing frequencies can be chosen, "Monthly" or "Quarterly"
Rebalancing frequency	Combobox	Before the rebalancing frequency can be specified, a replication method must be selected Input must be: "Continuously", "Monthly" or "Quarterly"
Equity portfolio	Frame	-
AEX	Spinbox	Initial value: 60% Input must be a number Minimum percentage: 0% Maximum percentage: 100%
S&P500	Spinbox	Initial value: 20% Input must be a number Minimum percentage: 0% Maximum percentage: 100%
NASDAQ	Spinbox	Initial value: 20%

		Input must be a number Minimum percentage: 0% Maximum percentage: 100%
Initial coverage	Spinbox	Initial value: 120% Input must be a number Minimum percentage: 0% Maximum percentage: 100% Initial coverage must be higher than the replication percentage

Whenever input is specified that lies outside the range of possibilities, a specific error message is displayed. Also, the respective toolbox will reset to its initial value. Finally, it is not required to utilize the Spinbox or the Combobox; when desired, manual input is an option as well.

Commands:
Programmed restrictions and initial values

Command:	**Tool:**	**Description:**
Cancel	Command button	-
Undo	Command button	Start date: 31-03-2005 End date: 31-12-2013 Comparison: clear contents Replication percentage: 70% Replication method: clear contents Rebalancing frequency: clear contents AEX: 60% S&P500: 20% NASDAQ: 20% Initial coverage: 120%
OK	Command button	All boxes must be filled Sum of the three equity components must equal 100%

Pressing the cancel button will let the program return to the previously generated output. With it, it equals closing the Userform by using the Close ("X") button.

Undo equals resetting all values of the Userform back to their initial values.

By pressing the OK button, the "Graph constructing" process is initialized. The latter can only be done when the Userform is both complete and input entries are correct. Whenever these conditions are met, the calculations belonging to the specified scenario are performed. Output is generated and displayed through the three graphs, along with some standard characteristics associated with the analysis that is derived.

The layout of the graph depends on the input criteria. Examples include the colour palette that is utilized, as well as the titles and legends. Also, nearly all axis options result from the specified input and the generated outcomes of the scenario that is analysed, the former being the minimum, maximum, major unit and number format. With it, figures are displayed in a way that is as detailed and user-friendly as possible. In essence, everything is programmed beforehand.

Furthermore, there are instances where displaying the third graph will have no added value and whenever this applies, the latter is discarded all together. At times, output may differ due to utilization of a secondary y-axis as well.

Finally, it should be noted that in some scenarios, the initial coverage value that is input may conflict with the replication percentage that is chosen. Whenever these specified figures lie close to one another (note: the replication cannot exceed the initial coverage), it is possible that one or both input restriction(s) is/are violated. Whenever this is the case, a matched replication percentage is preferred, although the initial coverage will differ slightly from the inputted value.

Appendix G: Criticism in News articles, a snapshot

Dekkingsgraad PFZW daalt in tweede kwartaal

Dow Jones
donderdag 18 juli 2013, 06:39

Tweet 0 | Share | Like 0

AMSTERDAM (Dow Jones)--De dekkingsgraad van Pensioenfonds Zorg en Welzijn (PFZW) is in het tweede kwartaal van 2013 gedaald, vooral vanwege een daling van de rekenrente en het negatieve rendement op beleggingen.

De dekkingsgraad daalde in het tweede kwartaal naar 101% van 105% aan het einde van het eerste kwartaal. De oorzaak is een daling van de voor pensioenfondsen voorgeschreven driemaandsgemiddelde UFR rente, aldus PFZW. Hierdoor nam de waarde van de verplichtingen toe.

De marktrente is in deze periode echter opgelopen, wat resulteerde in een negatief resultaat op het afdekken van het renterisico.

'Moeilijk uit te leggen' pensioenverlaging dreigen bij rentestijging

Pensioenfondsen die rond 104 % dekkingsgraad zitten, lopen ri[sico] een economisch gezien onterechte verlaging van hun uitkering[en] Oorzaak is de methode waarmee zij hun dekkingsgraad moete[n] berekenen van de Nederlandsche Bank.

Daarvoor waarschuwen deskundigen tegenover FD Pensioen Pro.

Het risico bestaat uit een plotselinge, forse rentestijging in de laatste weken van het jaar. Dat is bijzonder, want pensioenfondsen zijn normaal gesproken juist erg blij met een rentestijging. Het betekent dat de contante waarde van hun pensioenverplichtingen daalt, zodat de dekkingsgraad omhoog gaat.

Eind dit jaar ligt het echter anders. Een rentestijging van een half procent in de laatste weken van 2013 jaar kan de pensioenfondsen wel 2 tot 5 %punt dekkingsgraad kosten op 31 december. Dat kan grote gevolgen hebben voor de vele fondsen die nu rond de minimumdekkingsgraad van 104 % zitten.

3maands-middeling

Oorzaak is dat fondsen een 3maands-gemiddelde rente gebruiken bij het berekenen van hun verplichtingen, zegt risicomanager Jens van Egmond van Cardano. ,,Het positieve effect van een rentestijging werkt dus vertraagd door aan de verplichtingenkant van de balans. Maar aan de bezittingenkant hebben de fondsen renteafdekking. Die daalt wel meteen in waarde."

[Onnodige] korting pensioenen dreigt

[...]ember 2013, 00:00

Tweet 4 | Share | Like 1

Maarten van Wijk
Amsterdam

Een rentestijging in de laatste weken van het jaar kan ertoe leiden dat pensioenfondsen in 2014 hun pensioenuitkeringen moeten verlagen, terwijl dat economisch gezien niet nodig is. Dit is het gevolg van de manier waarop zij hun dekkingsgraad moeten berekenen op last van de Nederlandsche Bank. Daarvoor waarschuwen deskundigen tegenover FD Pensioen Pro.

Het risico bestaat dat de rente plotseling flink stijgt in december. In beginsel is dat goed voor de fondsen: een hogere rente betekent lagere verplichtingen. Maar het leidt toch tot een lagere dekkingsgraad per 31 december, waarschuwt risicomanager Jens van Egmond van Cardan[o] komt doordat pensioenfondsen hun verpl[ichtingen] berekenen met een driemaandsgemiddelde rente. Het positieve eff[ect] [van een] rentestijging werkt dus vertraagd door. Maar fondsen hebben [...] renteafdekking. Die wordt op dagkoersen berekend en daalt [...] [wa]arde.

Vraag het inspirerende boek aan >

PENSIOEN DENKERS & DOENERS

ROBECO The Investment Engineers

Meer over dit onderwerp
Krant-20131122-0-017-062.pdf

Trefwoorden:
Dekkingsgraad, Korting, pensioenfondsen, rente

[Ono]nterechte verlaging

In dit scenario van rentestijging zou een fonds dus in 2013 zijn dekkingsgraad zien dalen, op basis daarvan de pensioenen moeten korten, om vervolgens in 2014 te constateren dat de dekkingsgraad alsnog opveert, naarmate de gestegen dagrente doorwerkt in het gemiddelde.

'Een fonds dat op basis van de dagkoersen de buffers op orde heeft, zou de pensioenen moeten verlagen,' zegt van Egmond. 'Een vreemde, moeilijk uit te leggen situatie.'

Indekken

Volgens Cardano komen renteschommelingen van een half procent in een op de tien maanden voor. 'Tegen dit risico kan een fonds zich vrijwel niet indekken,' zegt consultant Geert-Jan Troost van Towers Watson. 'Het enige is de renteafdekking helemaal afbouwen. Dat is natuurlijk ook erg risicovol.'

Fondsen met veel renteafdekking, zoals de meeste ondernemingsfondsen, hebben meer last van het effect dan fondsen met weinig afdekking, zoals het ABP.

'De middeling was prima door het jaar heen, om de dekkingsgraad minder te doen schommelen,' zegt Troost. 'Maar dit systeem geeft een probleem als je er een dagstand uithaalt en er een verlaging op baseert.'

Actuele rente

Daar komt bovenop dat pensioenfondsen de renterisico's niet afdekken op basis van de driemaands rente, maar op basis van de actuele rente. Doordat de rente opliep, daalde de waarde van deze renteafdekking in juni al flink. De lasten van de hogere rente werden dus wel al doorberekend, maar het profijt bleef nog even uit.

SCHAFFHAUSEN

Trefwoorden:
beleggingswezen, Dekkingsgraad, pensioenfondsen, Rendement

[...] dekkingsgraden word[en] namelijk sinds vorig ja[ar] berekend op basis van e[en] driemaands gemiddelde rente. De hoge rente van juni werd daardoor gedempt door de lage rente in april. Dat is de pijnlijke keerzijde van de geste die de Nederlandsche Bank (DNB) in 2012 heeft gedaan naar de pensioenfondsen.

DNB introduceerde de driemaandsmiddeling om de pensioenfondsen uit de brand te helpen. De rente ging destijds juist omlaag. Door die rente te middelen over drie maanden kwamen de dekkingsgraden toen een stuk hoger uit. Hierdoor daalde het aantal fondsen dat in problemen zat in één klap van 180 naar 125.

Nu de rente weer stijgt, is deze middeling een last voor de pensioenfondsen geworden. Het profijt van de hogere rente werkt vertraagd door in de dekkingsgraad, terwijl de verliezen op de obligaties en de renteafdekking door de hogere rente wel al direct meetellen. Zonder de driemaandsmiddeling had de dekkingsgraad van metaalfonds PME bijvoorbeeld op 100% gestaan eind juni, in plaats van de huidige 96,6%.

Frank Driessen van AON schat nog er nog zo 30 tot 35 pensi[oenfondsen] [...] moeten korten, waaronder de twee grote pensioenfondsen PME en PM[T] [...] lijken de dans niet te kunnen ontspringen', aldus Driessen. Het grootste pensioenfonds ABP heeft het volgens AON net wel gehaald.

Driemaandsmiddeling

Pensioenfondsen zagen de waarden van aandelen stijgen in december, maar dat was niet voldoende om het verlies op obligaties door de hogere rente te compenseren. Pensioenfondsen investeren meer in obligaties. Daarnaast stegen de verplichtingen, omdat die op basis van de rente over de afgelopen drie maanden wordt berekend, en die daalde. Als het Rijk deze driemaandsmiddeling afschaft hoeven minder fondsen te korten, stelt Driessen van AON.

De gemiddelde dekkingsgraad van de Nederlandse pensioenfondsen is in mei gedaald tot 104%.

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De gemiddelde dekking was in mei met 104% 3 procentpunt minder dan in april. Hiermee voldoen Nederlandse pensioenfondsen gemiddeld niet meer aan de minimaal vereiste dekkingsgraad van 105%.

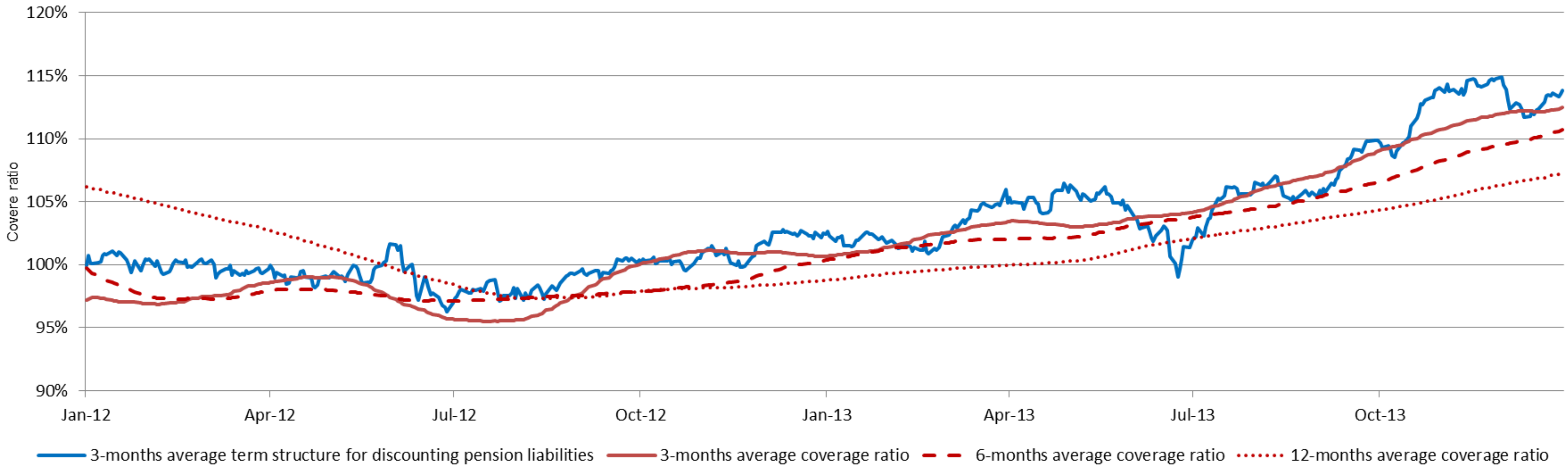
Dat meldt adviesbureau Aon Hewitt, dat dagelijks de dekkingsgraden bijhoudt. De dekkingsgraad is de verhouding van de bezittingen van een pensioenfonds ten opzichte van de pensioenverplichtingen.

Rentestijging

Ondanks de rentestijging in mei, daalde het driemaands gemiddelde doordat de hogere rente uit februari niet meer meetelt in de middeling. De dekkingsgraden worden op basis van de driemaands gemiddelde marktrente en met de zogeheten Ultimate Forward Rate als rekenrente berekend.

Het rendement op aandelen is gedaald in december en de rente is gestegen. Dit laatste lijkt gunstig voor pensioenfondsen, want hoe hoger de rente hoe lager de verplichtingen. Dit effect werkt echter vertraagd door in de dekkingsgraad, omdat die wordt gebaseerd op de gemiddelde rente over drie maanden. Een rentestijging is echter wel direct voelbaar aan de vermogenskant, omdat het rendement op obligaties en derivaten daalt. Daardoor kan een hogere rente in eerste instantie juist de dekkingsgraad drukken.

Appendix H: Averaging the term structure vs. Averaging the coverage ratio



Same input data (Graph Constructor) as under the realistic portfolio (see Section5.3). Dark blue line is the coverage ratio based on the application of the Average Basic curve for discounting the pension liabilities (is also visualized in Figure 5.15). The red lines represent averaging the coverage ratios, in which the original (not averaged) coverage ratios are based on the Basic curve for discounting the pension liabilities. Averaging the coverage ratio instead of the term structure results in less volatile patterns. A longer averaging period entails a larger period of time to move along with an actual initiated trend.