MESTRADO

CIÊNCIAS ATUARIAIS

TRABALHO FINAL DE MESTRADO

RELATÓRIO DE ESTÁGIO

SETTING ASSUMPTIONS – DIFFERENT WAYS TO MEASURE THE FUNDING POSITION OF A UK PENSION SCHEME

MARIA INÊS PEREIRA ROSA

OUTUBRO DE 2017

MESTRADO

CIÊNCIAS ATUARIAIS

TRABALHO FINAL DE MESTRADO

RELATÓRIO DE ESTÁGIO

SETTING ASSUMPTIONS – DIFFERENT WAYS TO MEASURE THE FUNDING POSITION OF A UK PENSION SCHEME

MARIA INÊS PEREIRA ROSA

ORIENTAÇÃO:

DANIELA DINIS PATEIRO

ONOFRE ALVES SIMÕES

OUTUBRO DE 2017

Abstract

A pension fund is defined as an investment product in which the members of the scheme pay contributions in order to receive an income at retirement. This is a very simplistic definition when compared to the United Kingdom's Pension funds, which are complex and very specific financial products.

This report is a result of an internship at the Willis Towers Watson Lisbon office, in the area of retirement, where the main scope of the work was in UK pension schemes' Actuarial Valuations.

Those Actuarial Valuations will result in a statutory and mandatory formal report to the government, showing the funding position of the scheme, which needs to be regulated at least every three years. The responsible actuary will present in this report results computed according to different scenarios, which are defined using different economic and demographic assumptions, therefore allowing to estimate the value of future liabilities.

The main goal of this project is to study the different ways of measuring the funding position of a pension scheme, regarding the setting of assumptions. This will result in a practical demonstration of the impact of the defined assumptions on the results obtained. In order to do that, two pension schemes will be used, from companies that have been the focus of the internship.

For academic purposes, this internship report contributes to a better understanding on measuring the funding position of pension schemes, and also on the application of knowledge obtained in the master's, for example on survival models, life annuities, financial markets and other subjects/topics.

Key words: Pension Funds, Actuarial Assumptions, Defined Benefits Plan, Retirement Benefits, Funding Methods, Mortality Tables.

Resumo

Um fundo de pensões é um produto de investimentos, onde cada membro desse fundo paga contribuições para na idade de reforma receber uma pensão. Este á uma definição de fundos de pensões é extremamente simples, ao comparar com fundos de pensões provenientes do Reino Unido, onde eles são bastante complexos e específicos.

Este relatório resulta de um estágio realizado no escritório de Lisboa da Willis Towers Watson, na área de Fundos de Pensões, onde a maioria do trabalho desempenhado foi em relação a avaliações atuariais de fundos de pensões do Reino Unido.

Estas avaliações atuariais resultam num relatório formal e obrigatório, pelo menos de três em três anos, apresentado ao governo que regula esta área. O atuário responsável irá apresentar neste relatório resultados obtidos quanto ao valor de obrigações que o esquema terá no futuro, referente a diferentes possíveis cenários. Estes cenários são definidos conforme os pressupostos económicos e demográficos que são usados durantes os cálculos.

O objetivo principal deste projeto é analisar as diferentes formas de avaliar a posição de financiamento de um fundo de pensões, tendo em conta a escolha dos pressupostos. Como resultado desse estudo teremos uma análise prática do impacto dos pressupostos escolhidos nos resultados obtidos. Neste estudo foram usados dois esquemas, com os quais trabalhei durante o meu estágio curricular.

Academicamente, este relatório de estágio contribuiu bastante para o meu conhecimento quanto á avaliação do nível de financiamento de um fundo de pensões, bem como para a aplicação prática de conhecimento adquirido durante o meu mestrado, em áreas como modelos de sobrevivência, cálculo de pensões, mercados financeiros, entre outros.

Palavras-chave: Fundos de Pensão, Pressupostos Atuariais, Planos de benefícios definidos, Benefícios de reforma, Tabelas de Mortalidade

Acknowledgments

Contents

List of figures

List of tables

Acronyms

ASB	Actuarial Standard Board
BAS	Board of Actuarial Standards
BSP	Basis State Pension
CARE	Career Average Revalued Earning Scheme
CETV	Cash Equivalent Transfer Values
CMI	Continuous Mortality Investigation
CPI	Consumer Price Index
DB	Defined Benefits Schemes
DC	Defined Contribution Schemes
FRC	Financial Reporting Council
GMP	Guarantee Minimum Pension
GPPS	Group Personal Pensions Scheme
HCPI	Harmonised Consumer Price Index
ICE	Initial Cash Equivalent
IFoA	Institute and Faculty of Actuaries
IFRS	International Financial Reporting Standards
N/A	Not Applicable
NIC	National Insurance Contributions
NRA	Normal Retirement Age
OFNS	Office for National Statistics
PPF	Pension Protection Fund
PPS	Personal Pensions Scheme
PR	Pension Regulator
PREC	Professional Regulation Executive Committee
RPI	Retail Price Index
SAPS	Self- Administrated Pension Scheme
SERPS	State Earning Related Pension Scheme
SOA	Society of Actuaries
SPA	State Pension Age
SPS	Stakeholder Pensions
TAS	Technical Actuarial Standards
TPs	Technical Provisions
UK	United Kingdom

1. Introduction

This report is a summary of a five-month curricular internship at Willis Towers Watson (WTW), developed as a final project in the Master degree in Actuarial Science. More precisely, the internship took place in the WTW Lisbon Service Centre (LSC), where the main line of business is the valuation of UK schemes. Although the LSC is expanding its scope to other countries and different actuarial services, during these five months the work consisted of UK pension funds valuations.

Comparing with Portugal and most European countries, the United Kingdom is very unique in relation to retirement benefits, not only because of the different existing types of funds, but also due to the particularities and restricted rules imposed by the Pension Regulator, "the UK regulator of workplace pension schemes" (Pensions Regulator website (f)). In order to satisfy all the requirements imposed by the government, each company will need to send to the regulator an actuarial report showing the financial position of their particular scheme, annually or in three-year intervals. In these reports, the responsible actuary ensures that the company has enough funds to fulfil its obligations on the payments to members who retire from the company and also to their dependants, in case of a member's death. The reports will present analytically the funding requirement of the scheme, which will be the ratio between the computed liabilities and the existing assets. If the scheme does not verify all the government rules, the actuary must suggest a recovery plan to the fund.

During the internship, internal software, templates and actuarial Excel tools have been used to first set up schemes, secondly compute the value of their obligations, and finally, in order to guarantee excellence in every stage of the process, some checks are processed against the results obtained in the previous valuation. For reference, the work developed follows a process, which is divided in two main phases. First we proceed with the treatment of the data, where an extensive study on the membership, pension values, increases, and salaries is done. Following it, come the benefits and funding level calculations, for each funding requirement asked by the company or scheme's trustees. This can be a very challenging task due to the dependence on each scheme rules and assumptions, and the range of particularities a UK scheme can have. After getting the results, the work goes on to our consultant colleagues in the UK, who will advise the company or the trustees about the investment strategy and management of the pension fund for the next years.

In these five months a special attention was given to the actuarial assumptions used to produce a pension valuation, both economic and demographic. Those assumptions are estimates of variables derived by actuaries in order to specify important information of the plan in the calculations. For a normal valuation it will be required to set assumptions which represent the current market conditions, particular properties of the scheme, as pension increases, salary increases, age of retirement, mortality statistics for that particular membership and other specificities.

1

The main purpose of this internship is to highlight the relevance of adequately defining actuarial assumptions related to pension funds. The detailed analysis of the impact of the chosen assumptions on the liabilities results, and the dependence on the market conditions and financial position of the scheme on those settings, will also be included.

This report is divided in two main parts, the first part corresponds to Chapters 2, 3 and 4, which will present all the relevant concepts about UK Pension Funds. This legal and theoretical knowledge about the specific schemes from the United Kingdom were acquired during the training period of the internship. The aim was to explain the relevant concepts for the understanding of the rest of the report, and to transmit the most important rules and particularities related to this actuarial work, in this country. Due to the limitations of space and time, the information in the first part is a bit condensed and little interconnected, which can lead to a slight more difficult reading.

In Chapter 2, a brief introduction of the UK Pension Funds, with focus on state pensions processed with defined benefits, is given. If the reader is interested in the history of the UK pension schemes, Appendix A gives a brief explanation about the progress of pension schemes in the country. Following this, Chapter 3 presents a detailed analysis of both the economic and demographic assumptions, with the aim of clarifying the reader about the utility of these assumptions in a pension valuation, and a general knowledge about the methods that are used to build them.

For each pension valuation, the actuary will ask for results obtained from different scenarios, which will be defined as Funding Requirements, in Chapter 4.

Finally in Chapter 5 a practical analysis will be done. This analysis is the application of the theoretical concepts referred in part one, and reflects the practical work done during the internship. Along with the numeric results there will be an analysis on two particular schemes, which have been studied during the internship. This report finishes with some conclusions and final thoughts.

2. Introduction to UK pension funds

2.1 State Pensions

For the past 60 years, the UK government provides a state pension to the people entitled to it. This pension intends to ensure that everyone is supported in the old age by a basic amount of money. These schemes do not depend on how much citizens have earned during working life, but on the NICc they have done while working (Crawford and Tetlow, 2010).

The UK State pension is divided into three main elements: Basic State Pension, Additional Pensions and Pension Guarantee (Blake, 2003).

The Basic State Pension (BSP), also known as Retirement Pension, is a weekly endowment paid to a person over the State Pension Age (SPA), who made the minimum number of contributions to the NI defined by the Government. The SPA was 65 years old for men and 60 years old for women until April 2010. After that, the female SPA has been increasing one month every year (by date of birth) to be equated to the men's. Since then, the SPA for both men and women has been increasing, and it may reach 68 years in 2020. Furthermore, people get this "contribution-based" benefit full amount if they make the necessary number of contributions. Otherwise they will get penalties in the weekly amount, by a pre-defined formula. Last but not least, if a citizen wants to increase his or her pension, he or she can defer the receipt of the benefit.

The Additional Pension intends to pay an extra amount over the BSP. It started with the Graduated Pension, between April 1961 and April 1975. During those years the UK government was giving a small amount of 1£ a week, to those who were qualified for that, according to the payment of a number of fixed amount of NICs. This extra benefit on retirement was followed by the State Earnings Related Pension Scheme (SERPS) from April 1975 until April 2002. In this case, a fixed percentage (25%) of their earnings above a "lower earnings limit" was paid to those entitled to it. That qualification was based on a "band range" between the lower earnings level and the upper earnings level, in each tax year. In order to pay lower values to the National Insurance, the employers also had the possibility of contracting-out the SERPS, by paying a minimum guaranteed pension (this is only possible for people under an occupational pension scheme).

With the supplementary objective of giving an additional retirement income to the workers, the Guaranteed Minimum Pension (GMP) 2 was created. The GMP is a complex supplement pension system managed as an occupational pension, which will provide a promised income to the worker. This guaranteed level of scheme pension is funded with additional contributions to the NI and paid according to the same principles as the state pensions, but have the main difference of being optional. This specific pension is famous for being complex because it has an intrinsic relation with inflation. As a consequence of that, we need to consider two different amounts of GMP, one related to service before 06/04/1988 and one related to service after or on 06/04/1988, the date when

---

[2] According to the Pensions Terminology, the GMP is the minimum pension provided for employees who were contracted out between April 1978 and April 1997. The value of this pension is related to the salaries which the member would receive if he/she was not contracted out.

specific rules changed. Following that, the existence of the GMP adds additional complexity to the scheme's benefits, as the way these amounts increase are different from the way the remaining scheme's benefits are calculated. This pension is provided by schemes that are contracted out. A pension scheme is contracted out when it provides benefits in place of State Second Pension and holds a contracting out certificate or appropriate scheme certificate granted by the National Insurance Contributions Office.

With the objective to provide higher pension amounts to people with low earnings, the UK government decided to change from SERPS to the Second State Pension, which is nowadays in use.

The Second State Pension was introduced by the Child Support, Pensions and Social Security Act 2000, but it only was enforced in April 2002. It is very similar to the SERPS, regarding the benefits people receive, and the requirements that allow their entitlement. Moreover, it started with an earnings-related pension policy but now it is a flat-rate pension. The main goal of the extra state pension is to help people for whom a private pension is not an option, and also to assist those with moderate earnings to build up a better second pension.

2.2   *Occupational Pensions*

A pension is a fixed amount of money paid at regular intervals of time, under some conditions, to a person or to a person's surviving dependents, with consideration of past services. That amount comes from an investment fund to which that person or their employer has contributed during their working life.

In simple terms, a pension scheme is just a way to save money for later life with more favourable tax treatments, compared with other kinds of savings.

As this work is focused on the UK Occupational Pension Schemes, in particular on Defined Benefit Pension Schemes, this report will mainly focus on those specific types of schemes. The main concept around the Occupational Pension Schemes is the fact that they are not public – they are set by an employer or a trade union, and paid to the member of the scheme, employee of the company.

This type of private pension funds was created under the Pension Scheme Act 1993, (and later amended by the Pension Scheme Acts 1995 and 2008), and their greatest characteristic is the fact that they are fully managed by employers or organizations on behalf of employees.

These savings plans can be defined as:

1. Contributory, if both the employer and the employee make contributions to the fund.
2. Non-contributory, if exclusively the employer contributes.

Moreover, they can be Funded, if contributions are invested over time and accumulated, or Non-funded, if the revenue from current contributions is directly used to pay for current retirement benefits. Finally, they can be Insured, if the sole investment is an insurance policy, or Self-Administered, in case beneficiaries manage the fund investments.

Occupational pension schemes are sub-divided in two categories, according to how benefits are computed: Defined Benefit Schemes (DB) and Defined Contributions Schemes (DC).

A DB pension scheme promises a guaranteed benefit to the employee. It is guaranteed since the formula used to compute it is known ahead of time and is available to everyone. This category of pension schemes can be also divided in Final Salary Scheme or Career Average Revalued Earning Scheme (CARE Scheme) (Pires, 2017). The first, as the name says, pays to the employee a percentage of the final pensionable salary at retirement. The second, the CARE Scheme, is calculated in a similar way, but instead of calculating the total pension amount using the final pensionable salary at retirement, it will use average earnings over the entire career – the pension accrued each year is calculated and revalued up to retirement age. Summing up, the main difference between them is the one between the formulas below, where (1) refers to the Final Salary Rule and (2) to the CARE rule.

$$(1) \qquad Pension = \alpha\% * years\ of\ service * final\ pensionable\ salary$$

$$(2) \qquad Pension = \alpha\% * Salary_{year\ 1} * Rev_{y1\ to\ ret\ age} + \alpha\% * Salary_{year\ 2} * Rev_{y2\ to\ ret\ age} + \cdots + \alpha\% * Salary_{year\ n} * Rev_{yn\ to\ ret\ age}$$

Therefore, as the pension value is known in advance, the changes on the amount depend only on the years of service, member's salary history, and on the accrual rate. These Defined Benefit Schemes are typically administered by specialized trustees or, in case of government workers, by the government itself. The trustees hold the legal power of managing the pension schemes, mainly the assets of the scheme, and the obligation to ensure that the scheme has enough means in accordance with the terms of the trust. Often the trustees can be members of the scheme, employees of the sponsoring employer, or both.

In the DB schemes early retirement benefits are admitted, with a penalty in the monthly pension, and also post-retirement benefits, which are higher than the usual. The company administers portfolio management and investment risk of the fund, so consequently the employer assumes all the associated risk (PR (a), 2004).

On the opposite side, in the Defined Contributions Schemes the employer, or both the employer and the employee, make regular payments to the fund, and this fund is used to buy a pension when the employee retires. This is also called Money Purchase Scheme, where the amount of pension depends on the bulk of money invested, on how long it stays invested, on the interest rates and also on the projected mortality rates. This means that there is guarantee on the amount of money that the pensioner is going to receive at the retirement age. Nowadays many companies are replacing DB plans for DC plans, due to both reduced expenses and the long-term obligations associated with the DB schemes.

Another important characteristic related to the scheme benefits applicable in the United Kingdom is the vested rights. As the definition says: "A right belonging completely and unconditionally to a

person as a property interest which cannot be impaired or taken away without the consent of the owner" (OECD Working Party on Private Pensions, 2005). Depending on the type of scheme offered by the company, if those rules allow for vesting, this means that the employee accrues the total right to receive the amount of benefits that he/she has earned in his/her pension scheme.

Last but not least, although some companies define a vesting schedule in order to determine when the employee acquired full ownership of the assets, in other cases, the vesting is immediate. With immediate vesting pensions, the member of the scheme is entitled to receive the benefits instantly after the contribution is made. In this case, the members are able to receive pension benefits whether they stay in the company for five years or five days.

2.3   Personal Pensions

Personal or individual pensions are tax-privileged ways of investing money, normally used to finance retirement or death pensions.

Those accounts are funded in a voluntary and private way, which means that each person can easily decide when to contribute, the amount of the contributions and the type of contribution (which for example can be an individual savings plan, insurance, and others).

The level of the pension each member will receive depends just on the money he/she has invested and how the fund's investment has yielded. Personal pensions are mainly DC based, and are divided in three main types: Stakeholder Pensions (SPS), Personal Pensions Scheme (PPS) and Group Personal Pensions Scheme (GPPS), which will not be described in detail, since this report will focus only on Occupational Pensions.

2.4   Valuation Process of a UK pension fund

A pension valuation is a process carried out by an actuary on a regular basis, in order to test future funding or current solvency. More precisely, this mathematical analysis of the financial condition of a pension fund intends to measure the value of assets in order to cover Technical Provisions (prudent measure of liabilities), and then conclude about the funding position of the scheme (Jackson and Hamilton, 1968).

In detail, an actuarial valuation has the objectives shown on figure 1.

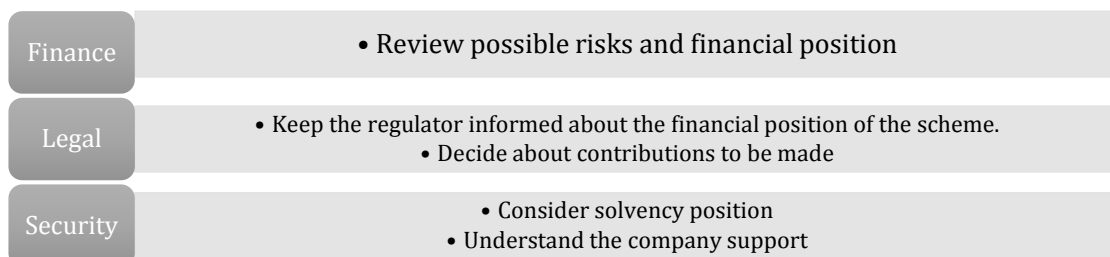| Finance	• Review possible risks and financial position
Legal	• Keep the regulator informed about the financial position of the scheme. • Decide about contributions to be made
Security	• Consider solvency position • Understand the company support

Figure 1: Main objectives of an actuarial pension valuation from WTW internal documents

In the case of a scheme that does not meet the funding objectives, the trustees will need to provide a recovery plan. In this special report, the scheme's trustees need to decide a specific time frame

for when this recovery is proposed to be done, and also need to agree on the level of contributions that are needed. As each scheme is different, the rules for the recovery plans are not predefined and thus each board of trustees needs to agree on the plan for that particular company, always with the objective of returning to full funding (Cordwell, 2008).

The Scheme Valuation also has to foresee the amount of benefits and income from contributions and investments which the company is going to face (Vivian, 2014). This mandatory action needs to be done at least once every three years. Between valuation dates, the company just needs to update the funding position, observe, and act over possible changes. In the end, the funding statement is reported to the members of the fund.

The following paragraphs will present in detail the valuation process in Willis Towers Watson.

The Valuation process of a UK Pension fund has three main stages:

1. Planning, when the Trustees decide which data is going to be required, determine deadlines for each phase of the process, and update the financial strategy (established by the company).

2. Selecting the assumptions and methods that are going to be used, depending on each scheme, and the funding position in the last valuation.

3. The practical process, when the actuary uses its own software, in order to compute the amount of benefits and contributions. It consists of four steps.

3.1   Analysing pension data

To perform any sort of calculations, data is fundamental (EIOPA, 2015). Data is provided by the pension scheme's data administrators and includes several items that are essential to perform the actuarial valuation, such as dates of birth, service dates, salary figures, pension amounts and other relevant information.

At this step, an actuarial analyst will check if there are any data items needed for the calculations that are missing and will then proceed to verify that the data is robust enough for valuation purposes.

As an example, the analyst will check the reasonableness of movements of membership and whether pension amounts provided have received the appropriate increase since the last valuation. After finishing this analysis, and if there are some queries left, it should be sent back to the client.

3.2   Performing a run on last valuation's assumptions

In this stage, the scheme's liabilities are calculated using the new data but still with the assumptions chosen at last valuation. This stage will help to understand if and why the funding position has changed, and also to discuss if the forecasts and assumptions used in the last valuation meet reality.

3.3   Performing a run on the new assumptions

After these initial steps, the analyst will value benefits using the new set of assumptions. Therefore, these are the results that reflect the current market conditions, in relation to financial assumptions and the latest experience, now in relation to demographic assumptions.

Those are the preliminary results, which are sent to the client with the respective comparisons between the different types of valuations, and also the comparison with the last valuation.

3.4   Reporting Workstage

At this step, a presentation of the results is prepared for the meeting with the trustees, including both the preliminary and the final sets. Independently of the trustee approach, the company needs to agree with the final results from a list of different valuations computed with several sets of assumptions and send the final report to the Pensions Regulator (PREC, 2012).

3. Assumptions Analysis

An actuarial assumption represents an uncertain variable that is going to be required for the liability calculations of a pension valuation. This stage of a pension scheme valuation is really crucial because if the assumptions are chosen appropriately, then the scheme will be subject to a low level of volatility from one valuation date to another. An appropriate set of assumptions for a particular

pension scheme will portrait the scheme's financial position in a more realistic way, which is fundamental from a managerial and investments point of view.

The process of setting assumptions to a specific scheme is the actuary's responsibility, and in order to define them he/she is required to apply his/her technical actuarial knowledge and a fair professional judgement. The actuary not only needs to develop the correct assumptions to use in the valuation, but must also provide a clear explanation of the reasons for the choice.

In some cases, the set of actuarial assumptions to use can be defined by the government as a law. For example, when doing a Pension Protection Fund (PPF) Valuation, the assumptions to use should be the ones defined previously by the corresponding Board.

The Pension Regulator provides, in the Pension Act, some guidance about this work for each specific type of valuation.

The final stage of an actuarial valuation of UK pension plans is the final decision about the assumptions to be applied. This is made by the trustee of the scheme, and preferably this decision is made together with a representative of the company and the responsible actuary.

Independently of the approach used to set the assumptions, the scheme actuary should always consider three points (American Academy of Actuaries, 2004):

- Nature of the pension scheme;
- All the available and relevant data, and general information;
- Possible reasons to believe that trends will change in the future.

In addition, there is a general principle that actuaries should always follow in order to define actuarial assumptions, the Principle of Prudence. According to this general guideline, the assumptions choice should be conservative and it should not overestimate nor underestimate the value of contributions and expenses. This principle is going to be further explained ahead.

Concerning the approaches to define an appropriate and correct actuarial valuation, this report will focus on the two basic models in use: Financial Economics Perspective and Best Estimate Perspective.

The first approach is mainly used to determine economic assumptions, and its main characteristic is its relation to the current market conditions. This means that actuaries make decisions according to the market basis approach. In simple terms, this is a method where the value of an asset is determined by the real price of similar items. After getting those values it is possible to consider some adjustments, which will make them more appropriate to the corresponding scheme. For example, a possible adjustment to make can be related to the risk. In order to better represent the level of risk in question, actuaries can change the discount rate (Rosenberg, 2014). It is easy to explain this with a practical example of a Solvency Valuation. In this case, the fund should not be exposed to any risk, so a risk-free discount rate is used.

The second and most common approach to define which actuarial assumptions to use in a pension valuation is called Best Estimate. This method is defined in the IAS 37 paragraph 36 as the "The

amount recognised as a provision shall be the best estimate of the expenditure to settle the present obligation at the end of the reporting period" (IFRS – IAS 37, 2009).

In other words, the best estimate approach should represent the most likely scenario of a pension scheme. The assumptions defined with this method must be comprehensive, explicit, reasonable, supportable, internally consistent, and finally they should represent the future expected trends. Furthermore, the actuary should ensure correlation between all the assumptions in use, based on the same approaches. This method is crucial in order to compute the minimum funding requirements for a PPF Valuation or the minimum amount of contributions for other types of valuations. This best estimate approach is consistent with current market prices (in order to define some market assumptions), unless there is reliable evidence that justifies a change in the trend (Blum and Otto, 1998). Related with market assumptions, the most important one will be the discount rate, which should reflect the risk specific and also the current market value of money. Regarding the non-market assumptions, it should be mostly based on the specific data of each scheme. Only in the case of not having enough data, or a not perfectly correct one, actuaries are able to use published information. In this case they need to clearly explain the decision, prove similarities between schemes, and properly analyse the assumption previously used to get those values.

3.1   Principle of Prudence

"The economic and actuarial assumptions must be chosen prudently, taking account, if applicable, of an appropriate margin for adverse deviation", see in *The Occupational Pension Schemes Regulations 2005 Regulation 5(4) (a) – (c).*

When selecting economic and demographic assumptions for a pension fund valuation, there are no defined rules and approaches, there is only guidance and advice. The only principle which actuaries must follow, while setting those assumptions, is related with prudence.

According to the market conditions, the actuary should be conservative when measuring the amount of assets, and should also not underestimate the amount of liabilities (Smits, 2006).

This principle asks for records that reflect the realistic environment, with the objective of achieving a good match between the value of liabilities and appropriate investments.

Moreover, this key accounting principle predicts changes that sometimes may occur, when reflecting an expected variation on the level of risk. In this case, the actuary is free to be more or less prudent, depending on the change.

The actuary should comply with the actual legislation, with the principle of prudence, with all the existent professional guidance, and also it is recommended to use recognised and certified actuarial methods when computing final and intermediaries' calculations.

As it is expected, this principle creates different opinions between the two involved parties. The trustees are interested in the biggest level of prudence and funding (i.e. higher liabilities and by

consequence, contributions). On the other hand, the companies interest is always addressed to reduce the level of prudence and funding (i.e. lower liabilities and, by consequence, contributions). Furthermore, while reporting the chosen assumptions, the actuary should consider that as long as the level of prudence goes down, he/she should increase the level of support, the justifications about the results and produce an extra and more complex analysis.

Of course, the prudence concept is just a general guideline, the actuary should use his/her professional judgement and always consider the purpose of the respective valuation in his/her decisions.

3.2   Demographic Assumptions

Demographic assumptions are all the premises related to the demographic characteristics of a person and also all the non-economic attributes which may be needed, for example the proportion of married members, the difference in the age of the member and the spouse, and others. This information is going to influence mostly the timing of the benefit payment and also the probability of this being made.

While producing a pension valuation, a number of different assumptions will be required related to mortality, retirement, termination of employment, disability, marriage, divorce, transfer out of the scheme, household composition, and others. Some of them are optional, but most are mandatory, such as the mortality assumptions, which are those with the largest impact on the result. For this reason this report will mainly focus on it. Most of the demographic assumptions are related with mortality rates, a measure of deaths over a given population in a defined interval of time (ASB (a), 1999).

3.2.1 Mortality Tables

A mortality table is a result of a huge compilation of data by actuaries and statisticians. These tables supply the rate of death at any given age, according to the number of deaths that occur for a very large number of individuals of that age, at a particular interval of time. These indispensable tables are normally separated by gender, socio-economic status, smoking status, types of occupation, and other factors that can affect the probability of death OFNS, 2016).

Mortality rates records are mainly used in a Defined Benefit scheme when computing the contribution rates, the value of liabilities, the transfer values, the member's benefit on retirement, in some calculations related to the Pension Protection Fund, and also when an insurance company takes some or all of the scheme's liabilities.

The use of mortality rates is completely necessary in a pension fund valuation, not only for the numerous points where it is needed, but also because of their impact on the scheme's daily reality. There are a big number of possible consequences related to wrong choice of mortality assumptions. For example, in the case of underestimation of future mortality, which means that the actuary

assumed that people live more than they actually do, this can lead to too high contribution rates and consequently to extra costs for the sponsors, and probably to closure of the scheme to new entrants. On the opposite, in the situation of overestimate future mortality, which means that people die later than assumed by the actuary, the scheme may face a problem of having no assets to cover the corresponding liabilities, given by the low contribution rates, and consequently leading to the pensioners not receiving the amount they were expecting. Also in the case of buyout liabilities to an insurance company, it will be sold for a lower value than the actual, thus the company will make a smaller profit.

It is possible to set a simple and clear approach of how to decide about mortality assumptions in three main points (PR (c), 2008).

1. Decide which appropriate base tables and margins of prudence to use;
2. Define how to apply future improvement rates;
3. Clearly justify the methodology used and the final proposed mortality rates;

Given the impact of these assumptions in the valuations and in order to turn this approach regulated and controlled by a special board, the IfoA created the Continuous Mortality Investigation (CMI). Additionally, in Appendix C, a comparison between the UK and Portugal relating to the mortality study developed in both countries is presented.

3.2.2 Continuous Mortality Investigation

The Continuous Mortality Investigation is a private company, overseen by an Executive Committee and owned by the Institute and Faculty of Actuaries. This committee is entirely funded by the subscriptions, which are paid annually by companies and associations for the published papers.

It is an impartial, independent and authoritative company with the main objective of providing mortality and sickness rate tables for the UK life insurers and pension funds.

The CMI purpose can be expressed in five specific points:

- Divide the insured lives, annuitants and pensioners in classes, and for each one provide a vast research related with mortality and morbidity experience;
- Analyse those statistics and publish them in appropriate reports;
- Prepare mortality and morbidity tables divided in categories for subscribers' use;
- Estimate future long-term trends in mortality and morbidity rates.

Much of the CMI's work is documented in some Working Papers. These documents are divided in different lines of business: annuities, assurance, income protection, mortality projections, self-administrated pension scheme mortality, and others.

For the purpose of the specific pension valuation studied during the internship, the Self-Administrated Pension Scheme (SAPS) Mortality working documents had to be used (CMI (b), 2014). The SAPS investigation began in 2002 and it is administrated by the CMI. These studies are based

on data from dependants and pensioners of occupational schemes with at least 500 members (CMI (a), 2011).

As it was said before, in a pension fund valuation, for the demographic assumptions, the actuary has to define the mortality table to use, and which improvements are going to be applied for that particular group of members. In order to support this necessity, the CMI has been also publishing some working papers related to that. These mortality improvements are adjusted to the mortality rates, which will make them more appropriate to each scheme. On the other hand, they can also represent big changes that have occurred, resulting from natural catastrophes.

The Continuous Mortality Investigation provided a CMI Projection Model, which is a software in a Microsoft Excel format. This document is available for all the subscribers, and is prepared to give appropriate results for all types of membership and pension funds. The actuary who is going to use it just needs to introduce some inputs related to the nature of the scheme. The necessary information to obtain the results is the initial improvements, which is the last year for which the rates of mortality are known, the long-term projection assumptions, date of calculation, the base mortality table scaling factor, the defined retirement age and, finally, the interest rate (CMI (d), 2017). In Working Paper 99, it is possible to learn about how the actuary should apply the CMI Mortality Projection Model.

Also, as described in the Working Paper 98 (CMI (d), 2017), the main objective of the CMI Mortality Projection Model is to provide some projection on future mortality rates and also on future improvements. In a general way, historical data are used to project those rates by applying the method of interpolating, using current rates.

This process starts with a vast calibration to the dataset, which should contain information about deaths and exposure data from age 20 to age 100. After that, in order to obtain the total improvements, the age-period and the cohort components, a model of central mortality rates is applied. In detail, the model is called the Age Period Cohort Improvement Model, and assumes a Poisson Model for deaths and the method of maximum likelihood. For further details see (CMI (c), 2017). In the following stage, the model projects the age period and the components of mortality improvements to the future, using a convergence function. Next the model basically sums the information of the cohort components and the age period, and gives the overall mortality improvements. As a final stage, the life expectancies and annuity tables are calculated with basis on the obtained projected mortality improvements and on the specified base table.

The final product of this model is a table with a naming convention in the following format, *CMI_YYYY_G[L%]*. Where the year should represent the model version, the "G" should be the gender and "L" should be the long-term rate (CMI I, 2017).

Just to give a more mathematical sense about mortality rates (4) and mortality improvements (3), find below the analytic definitions of that rates represented.

$$(3) \qquad Mortality\ Improvement = r_{x,t} = 1 - \frac{q_{x,t}}{q_{x,t-1}}$$

$$(4) \quad Mortality\ Rate = q_x = min(q_x^{base} * scaling\ factor, 1)$$

In the above formulas, the q_x (probability of death between age *x* and age *x+1*) is the mortality rate used to calculate life expectancies and annuities, and the q_x^{base} is the mortality table from the base table.

This model is updated annually since 2009 and so it reflects the latest experience. With a general analysis of the results obtained in the last years, it can be seen that the initial improvements are lower for females at the youngest ages, but higher for males at pensioner ages. Additionally, it is clear that due to socio-economic conditions and cold winters, the mortality has increased since the peak of the highest mortality improvements, which was in 2004 for males, and 2006 for females. (Ridscale, 2016).

The procedure described is applied for the Self Administrated Pension Schemes, but for the general population the annual mortality improvements can be calculated in an easier way. This difference on the complexity of the methodologies is due to the fact that in the general population schemes there are less changes in the dataset year over year, and also because the improvements are higher in the SAPS for both males and females, for all ages. (SOA, 2011)

The previous description about the model to calculate mortality improvement refers to the use of the mortality base table. The CMI board also provides these tables, and currently the actuaries use the ones called "S2" series of mortality tables. These new tables are based on recent data retrieved from occupational schemes between 2004 and 2011 and were published in the CMI Working Papers 71 (CMI (b), 2014). The main difference between the newest SAPS tables 'S2' and the first 'S1' is the extent to lower ages which is a consequence of the increase in the life expectancy.

The set of "S2" mortality tables is divided according to the status of the member, such as ill-heath pensioners, normal health pensioners, all pensioner and dependants. Also they are divided by gender, with the exception of dependant's members where only females are considered. Apart from the type of membership and gender, these mortality tables also differentiate according to the benefit amount. There are Light, Middle and Heavy tables, depending on the amount of benefits in comparison with a pre-defined value (CMI (f), 2017).

The graduation methodology to set these tables is done on an amount basis, which means that the weight given to each record will be higher for the ones with a higher amount of benefits. In order to compute the expected number of deaths at each age, a model based on central exposed to risk is used. The underlying assumption is that deaths follow a Poisson distribution. According to this approach, the expected number of deaths at age *x (qx)* is computed through the expression (5).

$$(5)\ q_x = 1 - e^{-\int_0^1 \mu_{x+t}\ dt}$$

In order to fit the instantaneous rate of mortality (μ_{x+t}) the Gompertz–Makeham approach is applied, and the integral is computed using a method of approximation.

The final results of these calculations are the values of q_x and μ_x, which are provided in a set of tables in a Microsoft Excel format.

As previously mentioned, each scheme has its own purposes and membership, so it is possible that for some schemes these tables are no longer appropriate. Given this, the actuary or the person using the base table, is responsible to ensure that they are correctly using the base mortality tables for that specific scheme.

3.3 Economic Assumptions

In order to test the financial position of a pension fund, a number of different scenarios needs to be set. Each of these scenarios will have their own economic assumptions, and so they will represent types of economic situations that can possibly happen. This allows to study the impacts that different economic changes can have on the scheme's funding position. For this reason, and also given the huge impact that an economic assumption represents in a valuation, this topic is one of those that requires more commitment from the actuaries.

The economic assumptions used in a UK Pension Valuation are a set of premises that will most likely define the economic situation of the scheme in the following years. In almost all schemes it is necessary to set assumptions related with salary increases, pension increases, pension revaluations, inflation, discount rates and also, depending on the purpose of the valuation, there are some specific requirements that differ from scheme to scheme.

The main question is: "How to define economic assumptions?". There is no correct answer for that, given that it is very dependent on the scheme properties, the valuation purpose, the weight of the scheme in respect of amount of liabilities, etc. There are some assumptions prescribed by law, but most of them are defined between the actuary, the trustees and the board of the company. Sometimes it may be helpful to speak to the scheme's investment advisor to have a better understanding of how the scheme's assets are likely to change over time, since this is very important while setting economic assumptions.

It is the actuary's responsibility to provide the proposed assumptions to the trustees and to produce a clear and complete description about the choice. With all necessary information, the company's board has the entire responsibility to formally select the final chosen assumption for that valuation. Preferably, this should be done in a meeting with the actuaries, the trustees and the company's representatives, so they can discuss each point of view.

In order to define these assumptions, the actuary should follow the existent guidance from the Pension Regulator, which will, however, only include some general advice and some proposed approaches. As it was said before, these assumptions vary from scheme to scheme and depend on the valuation date and valuation purpose, so the actuary should adjust them for the scheme in case.

In the background, these assumptions are predictions of what can happen in the economy of the scheme, in the future. Therefore, they also represent an opportunity for the actuary to present some possible changes in the future, unusual events, economic catastrophes, and others.

Following in this chapter, some of the most common methods to calculate some of the rates will be presented. However, there are some considerations that actuaries should have in mind for every economic assumption.

The first is related with the involved costs, that is, the actuaries should reflect about the cost of setting new assumptions (ASB (b), 2013). For example, if they were dealing with a small plan, it is possible that it would be preferable to use assumptions already settled from a general research.

Secondly, sometimes it can be most favourable to apply a rounding technique in order to select assumptions. Certainly, it depends on the purpose and materiality of the plan, but in this case the actuary will spend less time and money.

Another important advice to consider is the difficulty of measuring items, such as adverse deviation or plan provisions. For this purpose, the actuary can opt to adjust some already existent economic assumptions instead of creating them from the beginning.

Moreover, when deriving assumptions to carry out valuations, it is very important to consider how these assumptions are expected to change in response to changes in market conditions over time.

According to the TAS – Technical Actuarial Standards, the created assumptions will be reasonable for the proposed objective if they comply with the following properties:

- The assumptions are appropriate for the purpose;
- The assumptions reflect the actuary's professionalism judgement;
- The assumptions take into account historic and current economic data until the date of valuation;
- The assumptions reflect the actuary's opinion about what will occur in the future;
- The assumptions do neither reflect pessimism nor optimism.

3.3.1 Retail Price Index & Consumer Price Index

Inflation is the rate of change of prices for goods and services, easily seen as the measure of change in the cost of buying a "basket" of products. While valuating a pension scheme, the inflation rates are used to set the statutory minimum increase for pensions, both for revaluation up to retirement and for pensions in payment.

Retail Price Index (RPI) is the original UK index that can be traced back to the World War I. Following that the Office for National Statistics created a new inflation index called Consumer Price Index (CPI). This new measure of inflation, for pension increase, started to be in use from June 2010 to certain state benefits, and after one month also for private sector occupational pensions (UK Government's Department for Work and Pensions, 2010).

There are small differences between them. Both are calculated from the same underlying data, however the statistician department changed the methodology in use and its coverage. Compared to the RPI, the CPI method of calculation underestimates the inflation in the UK and it is usually around one per cent lower.

The main reason for this change was due to the European influence. The UK Statistic Authority and the Office for National Statistics (ONS) believe that the old UK RPI measure is no more internationally acceptable, and on the other hand, the consumer price inflation is used in most of the European Countries measured by the HCPI (Harmonised Consumer Price Index). This new index is measured according to the same methodology in all European Area, so this can bring many advantages, as the fact that it is easier to share and compare data from country to country.

The changes have been made and nowadays most of the pension's increases are measured with the CPI, except those that were announced in the past (and set as RPI in the Scheme Rules), which remain based on the RPI. Furthermore, some schemes still use the old index, and as a consequence of the change, for some schemes it would be necessary to modify pension rules and statements. Both the RPI and the CPI are announced each year by the government according to the most actual price inflation. There are also monthly updates to the indexes.

3.3.2 Common Approaches to set Economic Assumptions

<u>Discount Rate Assumption</u>

Setting the correct discount rate is imperative if one wants to produce a correct pension plan valuation. The chosen index will be used whenever you need to calculate the present value of an expected future payment. Precisely, it will be useful when projecting values as contributions, pension costs, or the anticipated investment return for the pension fund. Last but not least, it will be implicit in the asset allocation and in the settlement of new strategies.

This specificity of the interest rate can be used by a pension plan in three different formats. It is possible to set it as a single rate, as a dual rate, specifying different values for post-retirement and pre-retirement or finally, it can be expressed by a yield curve (a line that plots the yield of fixed interest securities against the time to maturity of the corresponding financial products).

Next two common and simple forms of measuring the discount rate will be presented. The first process is mainly used for schemes with no significant hedging liability, or in the case of having a plan with significant return but still immature. This process is generally defined as a way to derive the real return using a dual or trial discount rate. For the pre-retirement discount rate, this approach is based on the expected return of assets over the next 10 or 15 years. The post-retirement discount rate is calculated in a more complex way, since it depends on the type of pensioners that are being considered for the valuation. In the case of people who are already considered pensioner members, the calculation is based on a matching between liabilities and assets over the past 10 or 15 years, with an allowance for an additional return on assets, if it is justifiable. If we are dealing with new

pensioner members the matching between assets and liabilities will be referent to the following 10 or 15 years, based on long-term bond yields.

The next methodology of measuring the discount rate is characterized by the use of Gilt and Swap Curves. Gilts are products, normally bonds, with low investment risk, and issued by the British government. The gilt curves are applied with the objective of guaranteeing that the scheme achieves self-sufficiency, so this approach is advisable for schemes with a significant gilt portfolio. In practice, the method represents the actual liabilities of the scheme as a portfolio of gilts with similar duration and inflation. Calculated with an annual effective compounding basis, the zero coupon gilt yield curve represents the interest rate term structure of the UK nominal government securities.

The methodology to produce this curve is based on real and daily data of price of conventional gilts. With this data an annual zero coupon nominal yield curve is fitted using a variable roughness penalty approach. Below a plot of a real zero coupon gilt curve, of a specific date, is given. This figure shows the relation between the spot rate and the yield to maturity, between 0 and 100 years.
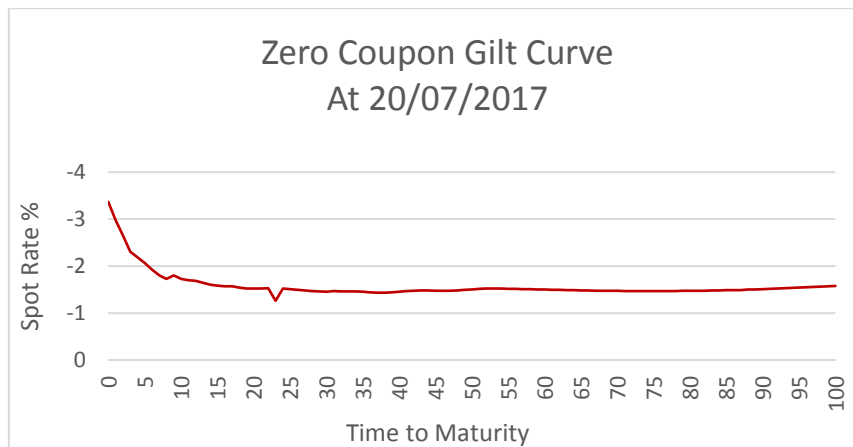
Source: ONS – Office of National Statistics
Figure 2: Plot of a zero coupon gilt curve at 20/07/2017

With a very similar approach, the actuaries also use the zero coupon swap rates. In order to compute those Zero-Coupon Swap Nominal Yield Curves the actuaries receive data directly from real market participants and investors on banks. The data in use is basically the medium prices at which the transaction of a zero-coupon nominal interest rate swap is done. After receiving the data, actuaries just need to extrapolate the rates of a maturity of one hundred years.
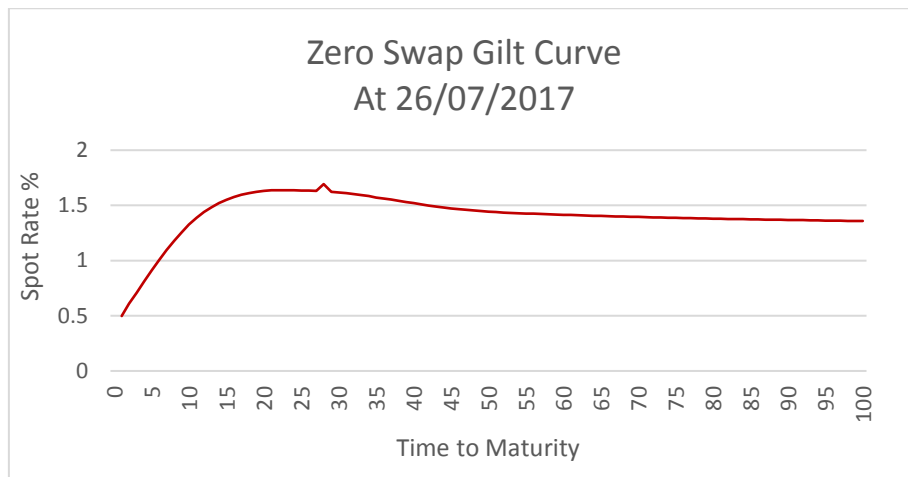
Source: ONS – Office of National Statistics
Figure 3: Plot of a zero swap gilt curve at 26/07/2017

Investment Return

This rate is a measure of the efficiency of an investment. It gives an analytical comparison between the cost of an investment and the respective amount of return. Generally, it is measured using the Consumer Price Index levels in short-term. For pension valuation purposes, in order to compute the value of liabilities which the scheme will face, a forecast of this value will be calculated for the next year, and an average for two to five years in the future (Owadally, 2003).

Pension Increase Assumption

The pension increase assumption is represented as a single rate, which depends on some characteristics of the member, like age, service and productivity, but also depends on some market conditions, such as inflation.

In order to define it, the actuary should consider a specific plan-sponsor with similar characteristics and use its historic and current data.

Inflation Assumption

The rate of inflation is the expected increase in the price of a standardized product, or a group of them, in a specified time range.

Hence, in order to select a single inflation rate, the actuary should only consider existent forecasts and, he/she should base calculations in the existent data, as CPI, price deflator and other financial rates related with open market.

Salary Increase Assumption

As the name says, the salary increase assumption refers to how much the salary of an active member will grow in the following years. Similarly to the pension increase assumption, this rate depends on some socio-economic characteristics and it can be different from member to member.

Normally it is valued using CPI, by adding a margin to the inflation assumption.

4. Valuation funding requirements

One of the main material sections of the actuarial report, in a Pension Funds Valuation, is the funding position of the scheme. According to the results obtained, the Board of Trustees will report to the Regulator whether the scheme is overfunded or underfunded, and if they conclude that the scheme has not enough assets to cover the liabilities (is underfunded), the trustee, with the actuary's help, should prepare a recovery plan for the following years (PR (d), 2009).

With this imposition, the trustees not only need to present the result about the funding position, but they also must prepare and revise a statement of funding principles. According to this, actuaries create several different ways to define the funding position. Depending on the scheme and on the objective of the trustees and the employers, the report must show not only the results coming from those different funding principles, but also the assumptions and considerations about them. The next section will explain some of the main common funding principles in UK pension funds valuations. Notice that some of them are mandatory by the Pension Regulator, others are only needed when the scheme is underfunded, and others can be requested by the companies (if these want to study a specific case).

4.1   *Technical Actuarial Standards*

In order to discuss UK pension schemes, and more precisely upon the selection of appropriate assumptions for each used funding method, it is necessary to introduce the Technical Actuarial Standards.

The Financial Reporting Council (FRC), through the UK Corporate Governance Code is responsible for promoting high quality governance in areas like Audit, Assurance, Accounting and Actuarial. They provide codes, standards and methodologies for these areas of financial activities, in order to ensure fairness, give confidence to the investor and also to force the market to be more regulated and transparent.

In order to do that, the FRC created a section called Board of Actuarial Standards (BAS), which produces the famous "original TAS", an important document that was in force since 1 October 2011. Recently, in December 2016, this document was revised, and from 1 July of the present year the "Revised TAS" was in effect.

These standards are divided into three main chapters: the Generic TAS, the Specific TAS and the Framework for FRC Technical Actuarial Standards.

The generic actuarial standards are written on the Technical Actuarial Standard 100: Principles for Actuarial Work (FRC (c), 2016). In this document actuaries and trustees can find indispensable principles and provisions in the following areas: judgment, data, assumptions, models, communications and documentation.

The specific TAS are focused on specific areas, where there is a high degree of risk to the public interest related to the work in question. Inside the Specific TAS there are the TAS 200: Insurance, TAS 300: Pensions and finally TAS 400: Funeral Plan Trusts.

Last but not least, the FRC provides a third document where the actuaries and trustees can find an explanation of the status of the TAS and also how they should be applied in the real world.

The FRC believes that "users for whom actuarial information is created should be able to place a high degree of reliance on that information's relevance, transparency of assumptions, completeness and comprehensibility including the communication of any uncertainty inherent in the information", as it is written in the TAS M – Modelling, page 3 (FRC (a), 2010). This council considers that actuarial information, which may be either the chosen assumptions or the used methods, can be very crucial for a valuation, in the sense that it can change completely the results. For that reason, and also to protect the employees, the FRC developed those documents, with all the standards and rules to be applied in actuarial valuation of a UK pension scheme.

As this report is focused on UK Occupation Pension Valuation, the most relevant subjects present in these documents are in the Generic TAS (the matter about the documentation and models) and also, the TAS 300: Pension, in particular, the guidance in the assumptions choice.

In this environment, models can be defined as technical simplifications of reality, which should fit the purpose they serve. They are used especially for projecting assets and liabilities of a scheme, from one valuation date to the next one, and also to calculate the level of funding of that pension scheme. In the Generic TAS it is possible to find information about the way models in use should be described in the report, and also which documents should be included in it. Also attention is called to the trustees and actuaries to guarantee that their reports contain the description of all models used in the preparation of the actuarial work.

These reports must also include the description of the limitations and satisfactions of the model, measured according to the compliance with regulatory requirements, calibration for qualitative assumptions and also regarding the importance of the "object being modelled" to the scheme (amount of pension related, for example). Usually the report has the comparisons of the outputs with the actual experience, tests of sensitivity and analysis of member's movements. Finally, they need to conclude about liabilities' values and the funding position with a corresponding description and advice.

As previously described, there is a TAS specific for pensions – TAS 300. Reminding the main objective of the Financial Reporting Council, which is to provide reliability of the employees, this consulting document provides the actuaries and trustees with all the important points that should be met (FRC (b), 2016). First, all the actuarial information used to support decisions made about financing and payable benefits should be relevant, comprehensible and sufficient. Secondly, it provides the necessary standards that will help the sponsors and governance to carry out their regulatory responsibilities. Thirdly, with the specification of all the calculations to or from pension schemes, it guarantees that these calculations are in accordance with the assumptions and measures.

In the TAS 300: Pensions there are some advices that the trustees should always keep in mind: all the changes related with the rules of a pension scheme should be made with the consent of the governing body; when trustees and sponsors are sharing work they should always be fully professional and ethical; practitioners need to follow the professional standards described in the Actuarial Code; it is important that trustees have the information always updated and with quality, so they can take all the important decisions based on truthful data.

Another very important chapter present in this document is related with Actuarial Assumptions. In global sense, applicable to both demographic and economic assumptions, there are some rules that trustees and actuaries need to follow. The Financial Council explains that an assumption will be appropriate in a given situation if it is based on sufficient information. Furthermore, it is very important when choosing the assumptions that the real state of the economic world, on the effective date of calculation in known. All the changes that are made in one assumption from one valuation to another should be reported, well explained, including not only the change but also what led to it, and a comparison between the old and the new decision.

Regarding the economic assumptions, especially the discount rate, it is really important that the explanations allow the users to understand how they are derived, all the involved implications of adopting them, and in which cash flows they are applied.

Trustees and actuaries, when setting demographic and economic assumptions should always take into account that "different assumptions are appropriate to different circumstances and for different purposes".

4.2   *Technical Provisions*

It is defined by the Pension Regulator that Technical Provisions (TP) measure the extent of liabilities to pay pension benefits, in relation to past service, as they fall due.

As it was said before, the majority of the UK pension funds are DB based, hence they are subject to a funding objective in each formal valuation. That funding objective is acquired when the pension scheme has sufficient and appropriate assets to cover its liabilities. Thus, in order to decide whether a scheme is funded or underfunded, the trustees need to calculate the value of the liabilities under a Technical Provisions basis.

Ideally, the Technical Provisions should be determined so that they will be sufficient on average, for paying the funded part of the pension when the interest and mortality rates are taken into account. In detail, this amount also called "pension liability" can be divided into two categories. The first category is in respect of future pension contingencies, where we consider premiums that have not been earned, referring to old-age pension, disability pensions, bonuses and equity-linked buffer. The second one counts pensions that have already occurred but have not been fully paid, and also the provisions for pooled claims. In conclusion, provisions are the sum of all these amounts and correspond to the sufficient amount to pay future pensions, considering the earned interest.

There are many different ways of computing the TP of a scheme, and each one has its own method. First of all, trustees need to know in detail everything about the nature of the scheme's liabilities, its investment strategy, the employer covenant, and the data on demographics. After having this information, the Board needs to choose an accrued benefit funding method (which will be described further on), and be very careful about the data chosen to value the benefits. Also very important are the assumptions in the calculation and, as it was mentioned above, for that decision the trustee should contact the responsible actuary.

The main rule for the assumptions choice is prudence, which means that when considering that premise we are avoiding risk and taking a margin to the anticipated experience assumption. Prudence should also be related with the capacity of the employer to support a range of likely adverse outcomes. This rule is mostly linked with the economic actuarial assumptions, where actuaries should take into account the evolution of expenses over time (including future ones), considering its nature and according to inflation.

Regarding demographic assumptions, trustees should start with an analysis of the plan membership, about long-term trends and recent changes. Then, they should consider relevant statistics applicable to similar schemes, and finally be aware of possible changes in the future, with respect to that particular scheme. Generally, assumptions should be evidence-based.

As a final review, trustees should check if the chosen assumptions are consistent with the current market data, the characteristics of the business and the whole undertaking.

4.3   Types of Valuation Funding Requirements

4.3.1 Neutral Basis

Another mandatory way to estimate the value of liabilities of a given scheme is according to the Neutral Basis. Imposed by the Pension TAS, neutral basis is set with the same method of computing Technical Provisions, but removing all the prudence margins. In this kind of calculations the trustees always choose measures, assumptions and judgments that are neutral and do not represent either optimistic or pessimistic opinions. Additionally, these decisions should not incorporate any adjustments that reflect the desired outcome.

The main objectives of this method is to help the trustees to understand the impact of their decisions about measures, assumptions, and others, as well as to test if the Technical Provisions and the neutral basis are effectively in the same line and in accordance with each other. This is also very useful to help trustees to identify how margins in the TP change over time, and the level of prudence of it.

Unfortunately the Neutral Basis also produces some concerns, especially to trustees. Understanding the real definition of what a neutral basis is can be slightly difficult for the employers and this can result in bad decisions about investments in bonds and equities, as well as forecasting the amount of contributions that the company should pay.

Regarding the methodology that the trustees must follow in order to compute the neutral basis, there are two possible ways. It can be either setting all the assumptions and measures from first principles, according to those rules expressed above, or using the Technical Provisions computations performed before and make some adjustments, stripping out margins of prudence.

4.3.2 Cash Equivalent Transfer Values Basis

The Cash Equivalent Transfer Values, also known as CETV, is a method to calculate the benefits for early leavers, and was imposed in October 2008 by the Pension Regulator. Transferring value from a final salary scheme or representing the value of the benefits given up, are both different ways of representing the CETV. In a more technical form, it can be defined as the expected cost of providing the members' benefits within the scheme (PR (b), 2008).

Furthermore, the CETV has different meanings for schemes with DC or DB benefits. For the first ones it can be said that it is the accumulation of the member's contributions with the corresponding investment returns. On the other hand, for the DB schemes it is the amount that, if invested appropriately, is expected to provide the relevant members' benefits as they fall due.

The transfer out of cash amount in a scheme is not very common in DB schemes, due to the risk associated with the money purchase arrangement. Even so, it can happen in events like divorce or when a member needs to take benefits earlier.

Another important property of the CETV basis is when a scheme is considered underfunded. If it is really necessary and the scheme is under a recovery plan for long years, the trustees are able to reduce the cash equivalent.

The Pension Regulator presents two possible methods of calculation of the CETV. The first one is based on the expected cost of supporting the member's benefits in the scheme. It starts with an amount called Initial Cash Equivalent (ICE), composed by the value of the member's accrued benefits and some discretionary benefits, and it suffers changes over time until it comes to the final CETV. As for all the methods to compute the value of liabilities, the actuary's opinion is crucial here, not only for the scheme's funding strategy but also for the assumptions decisions.

In order to define which assumptions to use, it is necessary to consider the investment strategy of the company, and all the decisions should be made in an evidence-based way. Obviously, it is not possible to predict the future, but decision makers should focus on facts about the past and make reasonable judgements about the future. There are some concepts that trustees should always be informed about, for example the past history of investment income, the published mortality tables, statistics about marriage, civil partnership, age of retirement, age of divorce and others. Also assumptions should be set at the same time as the Technical Provision is calculated, in order to ensure that they are consistent.

The second methodology to compute the CETV is more useful for schemes which are in surplus, because it is done by setting the CETV at a higher level than under the best estimate basis. It can be

done by setting one or more assumptions from the prudent best estimate, and the others following a less prudent line.

Trustees should consult the employers about these decisions related with transfer values, and they must give permission to them. In the valuation report, trustees must show all the reasonable details of the scheme's relevant transfer basis and include all the information about the options and discretionary benefits that were included in the CETV.

4.3.3 Section 179 / Pension Protection Fund Basis

Settled by the UK government and formally in service with the Pensions Act 2004, the PPF is a statutory fund with the main objective of improving the confidence of the members in the UK pension funds. Members with Defined Benefit funds, which are not covered with the Crown guarantee, are those who are eligible to the protected fund. In short, those who are qualified will receive a compensation amount, if the employer suffers an insolvency event or if the company holds insufficient assets to cover the PPF levels of compensation.

The compensation that PPF will pay to a member depends on the scenario considered. There are five possible ways of receiving a PPF payment, in case the company/employer became insolvent (PPF (a), 2009).

1. The first scenario is common for three types of pension members. They can be retired with more than the normal retirement, or retired due to ill health, or a dependant from a dead member. In any of these cases, the pensioner will receive the full amount that he/she has been receiving until that date.

2. The pensioner can also retire before the normal retirement age, in that case he/she will only receive 90% of the pension amount at the time, and it will be subject to an annual cap. This cap will be lower depending on how earlier the person retires.

3. If the pensioner is still in service, the PPF will pay until the Normal Retirement Age (NRA) the normal compensation and payments related to the years in service can also increase in line with inflation if they were from 5 April 1997.

4. In the event of death, the compensation will be paid to the legal partner, or to his/her children until 18 years old or until 23 years old, in case of being disabled or student on a full-time basis.

5. Finally, the PPF compensation can be paid to a legal ex-partner, but only if the court makes an order in that sense.

There are two possible ways to proceed with a PPF Valuation. One is in Section 179 Valuation, which is mandatory for all the schemes that are under the PPF, in the sense that it will help the trustee to determine the level of funding position in accordance with the Section 179 of the Act . Moreover, it will give access to the general level of scheme underfunding, it will be used to set a levy quantum (amount of money that will be charging for the PPF) and a scaling factor, and also to calculate the

PPF levy for that scheme (PPF (b), 2009). With the obtained results, the board of the PPF will have all the necessary information to see which schemes are eligible, and precede with the responsibility for that particular scheme. Another type of calculation related to the PPF is the Section 143, also from the Pension Act 2004, which is only needed when the scheme sponsor becomes insolvent and consequently needs to transfer the scheme into the PPF (Carolyn Wing, 2009).

The valuation of the liabilities in this special form must be done as the present value of the accrued benefits, and in order to do that, actuaries should use the specified assumptions which are defined in the most recent version of the "Guidance on assumptions to use when undertaking a valuation in accordance with Section 179 of the pension act 2004" (PPF (c), 2009). It is possible to find in the Annex the most recent document with the defined assumptions, but it is important to take into consideration that those are updated periodically.

The actuary responsible to give certification to the fund should follow the principle of prudence, in any approximation or possible decision.

When reporting the Pension Fund valuation to the Pension Regulator and to the PPF board, the trustee should include all the results in the normal report and also include the certificate of the PPF (available on the PPF board website). This special PPF report should be sent to the board within a year after the relevant year (the date when the assets and liabilities of that particular scheme are calculated). Lastly, for a particular scheme to be in accordance with Section 179, the valuation must be reported to the board by the last working day of the relevant financial year (6 April).

4.3.4 Solvency Basis

One of the main objectives of the UK pension funds valuation is to preserve the company's solvency, in other words, to ensure the ability of the company to meet the long-term financial obligations.

In practice, the Pension Regulator (PR) introduces a rule on the minimum solvency requirements for all defined benefit plans.

In order to perform this study, the PR defined that every scheme should present a report related with the company's solvency position, every three years and following some rules, which are presented in the Pension Act.

The also called hypothetical wind-up valuations are calculated as if the plan was to end up on the valuation date. In other words, when calculating the Solvency Valuation, actuaries and trustees, treat both the deferred[4] and active members as deferred. This is explained by the fact that in this scenario there are no more active members, but the deferred members don't start receiving their pensions. Then, the approach is to project the retirement benefit of each member to the retirement date and finally discount to the valuation date, by the specific interest rate. This is the reason why a solvency valuation is also called Discontinuance Valuation.

---

[4] Deferred members are no longer active members but not yet retired, with a benefit related to past service.

There are also some procedures that actuaries should follow in order to conclude about the solvency position of a given scheme, related to market assets. They should guarantee that, on the valuation date, the market assets match or exceed the liabilities determined on a market basis. This is crucial because this way they can ensure that if the fund ends, there will be enough assets to pay all the benefits promised on the valuation date.

The correct assumptions to use in this approach are those the insurance companies will use. Given that they are not public, actuaries must simulate them with a minimum possible risk associated. After the valuation, the Pension Regulator is informed about the solvency liability and the assets on the market basis, and with that they can decide if the scheme is under the minimum requirements. If a particular fund fails the requirements (less assets than the solvency liability), the trustees of that scheme need to produce a recovery plan, and have a period of five years to present to the regulator the scheme with a solvency level of 100%.

This valuation is very rigid and easy to apply, in order to guarantee that every user follows the same methodology.

4.3.5 Optional Funding Requirements

Additionally to the funding Requirements discussed before, in Appendix A a description of some other optional funding requirements, usually requested in UK pension valuations, is developed. Namely:

- Accounting Valuation
- Self-Sufficiency basis

The figure below gives a representation about the level of prudence for each specific funding requirement.
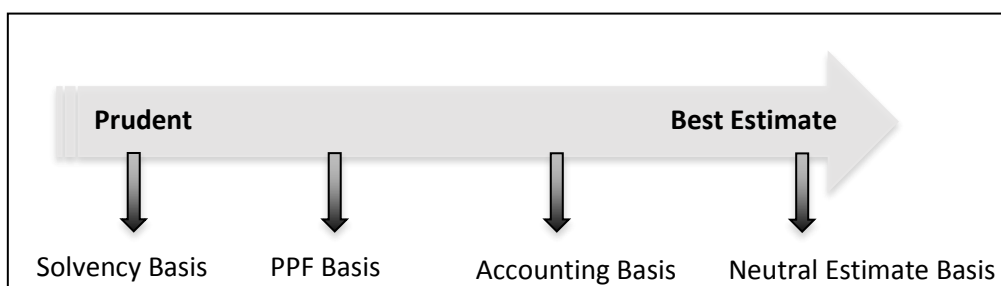

Figure 4: Chart with the position of each funding requirement on the level of prudence

5. Practical Study: Assumptions and Funding Level Analysis

5.1 *Purpose*

The purpose of this chapter is to analyse the impact of the assumptions choice on the funding level as a result of a formal pension valuation. In order to produce this study, two different pension schemes, which have been subject of study during the internship at WTW, were used. Additionally, to respect the legal policy of the company, these schemes were anonymised and some characteristics were not described in the report.

In detail, this analysis is composed by three main subchapters, differentiated by the purpose of the study:

- In the first chapter each scheme was analysed individually, with the aim of understanding the impact that the underlying assumptions of each valuation funding requirement has on the funding level of the scheme;

- In the second section a comparison between the results obtained on the funding level of the same pension scheme in different valuation dates is made. In this case, for each funding requirements, the assumptions (especially the economic assumptions) should be revised, thus this difference was taken into account and connected with the funding position of the scheme.

- Finally, in the third part of the study a comparison between the assumptions chosen by two different schemes on the same valuation date is made. This last research was conducted with the aim of linking the choice of assumptions with the financial position of the scheme, highlighting the fact that each valuation funding requirement is underpinned by the same principles, i.e. to measure how different a specific assumption could be for the same scenario but for different schemes.

5.2 *The two schemes*

Scheme A

The membership in Scheme A is composed by dependants (spouses and children), retirees and deferred members. This fund is closed to future accrual with no further salary linkage in the inter-valuation period. In practice, this means that all active members present in the scheme at last valuation are now considered deferred members. At the last valuation date, this scheme was under the statutory funding level, i.e. it did not have the appropriate assets to cover the liabilities calculated under the Technical Provisions assumptions. Consequently, according to the UK government laws, the scheme must be under a recovery plan. In this special plan, new rules and

objectives were defined by the actuary, with the aim of putting the scheme in a comfortable and safe funding level, in order to guarantee pensions to the pensioners.

For example, changes on the assumptions used in the valuation and an increase of the amount of contributions paid by the employers were agreed between the Trustees and the employer. After three years under the recovery plan, the scheme has already increased the funding level by 6.8%, and the objective for the next valuation is an additional increase of 8.5%.

In this valuation, the scheme actuary asked for the following funding requirements to be considered: Solvency basis, PPF basis, Neutral basis, five different types of Accounting basis, Central basis and two Sensitivity basis (one change in future mortality improvements and another in the mortality base table).

In the following table it is possible to find the economic assumption chosen for each funding requirement. For deferred members (whose pensions are not yet in payment) the scheme offers the possibility of exchanging part of the pension for an immediate lump sum, according to the pre-defined commutation factor and commutation percentage. The commutation factor represents the amount of lump sum payable per *x*£ of pension, i.e. if the member has a pension of £100 with 9 as commutation factor, he/she will receive a lump sum of 900£. The fraction of money which the person will need to give up from her/his retirement benefits, when taking this decision is measured by the commutation percentage (Revenue Irish Tax and Customs, 2017).

	Central	Fut. Imp	Base Table	PPF	Neutral	Accounting	Solvency
DR – Po (Pen)	4.10%	3.85%	4.05%	3.85%	3.85%	4.70%	3.50%
DR – Pr (Non-Pen)	5.90%	6.05%	6.05%	3.85%	7.60%	4.70%	3.10%
Dr – Po (Non-Pen)	4.70%	4.05%	4.05%	3.85%	4.05%	4.70%	3.10%
GMP reval.	4.75%	4.75%	4.75%	-	4.75%	4.75%	4.75%
RPI	3.50%	3.65%	3.65%	-	3.65%	3.40%	3.65%
CPI	2.80%	2.95%	2.95%	-	2.65%	2.30%	3.65%
Comm. factor	14.8(M)|16.3 (F)	14.8(M)|16.3 (F)	14.8(M)|16.3 (F)	N/A	14.8(M)|16.2 (F)	14.9(M)|16.3 (F)	N/A
Comm. %	23.2%	23.2%	23.2%	0%	27.8%	30.9%	0%

Source: Data provided by WTW, with its own calculations
Table I : Economic Assumptions of Scheme A

DR – Pr (Pen) – Pre-retirement discount Rate for Pensioners
DR – Po (Pen) – Post-retirement discount Rate for Pensioners
DR – Pr (Non-Pen) – Pre-retirement discount Rate for Non-Pensioners

DR – Po (Non-Pen) – Post-retirement discount Rate for Non-Pensioners
C – Commutation

Next, a table with the comparison between the demographic assumptions in use is presented. To facilitate the analysis and comparison between the different funding requirements, the present value of an increasing whole life continuous annuity was calculated considering a member with exactly 65 years of age, which means that he/she is a pensioner at valuation

date. Also, the calculation is only in respect of the member's benefit, i.e. the reversionary annuity payable to the spouse in case of member's death was ignored for the purpose of this comparison. It is also assumed that the pension increases every year in line with inflation (CPI assumption).

	Central	Fut. Imp	Base Table	PPF	Neutral	Solvency
Base Mortality (M)	S2PMA	S2PMA	S1PMA	PCMA00	S2PMA	S2PMA
Multiplier (M)	1.15	1.15	1.15	1	1.3	1.15
Improvements (M)	CMI_2013_M_(1_50%)	CMI_2013_M_(1_50%)	CMI_LIB_Medium_Cohort(2002-2011)	MEDIUM min 1.5%	CMI_2013_M_(1_25%)	CMI_2013_M_(1_50%)
Base Mortality (F)	-	-	CMI_2013_M_(1_25%)	-	-	-
Multiplier (F)	S2PFA	S2PFA	S1PFA	PCFA00	S2PFA	S2PFA
Improvements (F)	1.15	1.15	1.15	1	1.3	1.15
Proportion Married (M)	CMI_2013_F_(1_50%)	CMI_2013_F_(1_50%)	CMI_LIB_Medium_Cohort(2002-2011)	MEDIUM min 1%	CMI_2013_F_(1_25%)	CMI_2013_F_(1_50%)
Proportion Married (F)	-	-	CMI_2013_F_(1_25%)	-	-	-
Average PV continuous annuities	80%	80%	80%	75%	80%	80%
Base Mortality (M)	70%	70%	70%	65%	70%	70%
Multiplier (M)	18.49(M) 19.93(F)	19.35(M) 20.92(F)	18.67(M) 20.52(F)	18.73(M) 20.36(F)	17.82(M) 19.26(F)	21.91(M) 23.91(F)

Source: Data provided by WTW, with its own calculations
Table II: Demographic Assumptions of Scheme A (part A)

	Acc. 1	Acc. 2	Acc. 3	Acc. 4	Acc. 5
Base Mortality (M)	S1NMA	S1NMA	S1NMA	S2NMA_H	S1NMA
Multiplier (M)	1.3	1.3	1.3	1.1	1.3
Improvements (M)	CMI_2013_M_(1_00%)	CMI_2014_M_(1_00%)	CMI_2015_M_(1_00%)	WP90_CMI_2016_M_(1_25%)	WP90_CMI_2016_M_(1_25%)
Base Mortality (F)	S1NFA	S1NFA	S1NFA	S2NFA_H	S1NFA
Multiplier (F)	1.3	1.3	1.3	1.1	1.3
Improvements (F)	CMI_2013_F_(1_00%)	CMI_2014_F_(1_00%)	CMI_2015_F_(1_00%)	WP90_CMI_2016_F_(1_25%)	WP90_CMI_2016_F_(1_25%)
Proportion Married (M)	65%	65%	65%	65%	65%
Proportion Married (F)	65%	65%	65%	65%	65%

Average PV continuous annuities	15.66(M) 16.98(F)	15.61(M) 16.96(F)	15.47(M) 16.81(F)	14.31(M) 16.51(F)	14.98(M) 16.49(F)

Source: Data provided by WTW, with its own calculations
Table III: Demographic Assumptions of Scheme A (part B)

For a more comprehensive analysis, it is important to look at the funding level obtained for each scenario. As a reminder, the funding level of a pension scheme is calculated as the ratio between the amount of total assets, over the amount of total liabilities. The result of this ratio is the percentage of covered liabilities at the valuation date. For this reason, this is a good method to evaluate the funding situation of a pension scheme. The results of the funding level for Scheme A, at this valuation date are presented below in tables IV and V.

	Central	Fut. Imp	Base Table	PPF	Neutral	Solvency
Funding Level	88%	79%	80%	64%	96%	45%

Source: Data provided by WTW, with its own calculations
Table IV Funding Level of each funding requirement of Scheme A (part A)

	Acc. 1	Acc. 2	Acc. 3	Acc. 4	Acc. 5
Funding Level	91.2%	91.5%	91.1%	88.2%	91.2%

Source: Data provided by WTW, with its own calculations
Table V: Funding Level of each funding requirement of Scheme A (part B)

Scheme B

This scheme is already closed to new entrants but not to future accrual, which means that active members are still part of the membership and they keep paying contributions to the plan.

As usual, this scheme will need to meet the statutory funding objective according to the Pension Act 2004 (PR (g), 2004), which is to have sufficient and appropriate assets to cover the plan's Technical Provisions. Adding to this, Scheme B has a secondary funding objective where the main goal is to achieve the long-term buy-out target. This additional funding objective assumes a discontinuance scenario, where the scheme closes to future accrual, there are no more payments made by the company and the results of the liabilities are a proportion of benefits secured by insurance policies.

This fund has a very large number of members, in all possible status (active members, deferred members, dependants and retirees).

Following the results on the funding objective after this valuation date, this scheme will need to start a simple recovery plan. In this particular case, there were no changes in the rules and objectives, as according to the schedule of contributions defined in previous years, it is expected that the scheme will achieve the statutory funding objective in the next valuation.

It is expected that this sort of situations are closely monitored by the actuary, to make sure that the objectives are on track.

For this scheme, ten different funding requirements were requested, such as Central basis, a Sensitivity on five different Technical Provisions (on the Impact of members who live 1 year longer, on the Impact of members who live longer, on the Commutation sensitivity, on the Impact of 10% improvements in the commutation factors, and last on Retirement sensitivity), Solvency basis, CETV basis, Neutral basis and PPF basis. Following the same approach as in the previous scheme, Table VI shows the economic assumptions used in the valuation.

	Central Basis	Members w/ 1y +	Members live longer	Comm. Sensitivity	+10% comm. factors
DR – Po (Pen)	3.50%	3.75%	3.75%	3.75%	3.75%
DR – Pr (Non-Pen)	3.50%	3.75%	3.75%	3.75%	3.75%
Dr – Po (Non-Pen)	3.50%	3.75%	3.75%	3.75%	3.75%
SE	3.80%	3.95%	3.95%	3.95%	3.95%
GMP	4.75%	4.75%	4.75%	4.75%	4.75%
RPI	3.55%	3.45%	3.45%	3.45%	3.45%
CPI	2.45%	2.55%	2.55%	2.55%	2.55%
Comm. factor	15.7(M)|16.1(F)	15.6(M)|15.6(F)	15.6(M)|15.6(F)	15.6(M)|15.6(F)	17.2(M)|17.2(F)
Comm. %	26.9%	26.9%	26.9%	0%	25.1%

Source: Data provided by WTW, with its own calculations
Table VI: Economic Assumptions of Scheme B (part A)

	Solvency Basis	CETV Basis	Neutral Basis	Retirement Sensitivity	PPF Basis
DR – Po (Pen)	2.91%	4.70%	4.60%	3.75%	2.58%
DR – Pr (Non-Pen)	2.97%	4.70%	4.60%	3.75%	2.58%
Dr – Po (Non-Pen)	2.97%	4.70%	4.60%	3.75%	2.58%
SE	0%	0%	3.95%	3.95%	-
GMP	4.75%	4.75%	4.75%	4.75%	4.75%
RPI	3.55%	3.30%	3.45%	3.45%	-
CPI	2.65%	2.80%	2.55%	2.55%	-
Comm. factor	N/A	15.6(M)|15.6 (F)	15.6(M)|15.6 (F)	??	N/A
Comm. %	0%	0%	26.9%	26.9%	0%

Source: Data provided by WTW, with its own calculations
Table VII: Economic Assumptions of Scheme B (part B)

For the demographic assumptions, the following values were used:

	Central Basis	Members w/ 1y+	Members live longer	Comm. Sensitivity	+10% Factors
Base Mortality (M)	S1NMA	S1NMA	S1NMA	S1NMA	S1NMA
Multiplier (M)	1.0	1.0	1.0	1.0	1.0

Improvements (M)	CMI_2012_M_(1_50%)	CMI_2012_M_(1_50%)	CMI_LIB_Long_Cohort	CMI_2012_M_(1_50%)	CMI_2012_M_(1_50%)
Final Age rating	0	-1	-1	0	0
Base Mortality (F)	S1NFA	S1NFA	S1NFA	S1NFA	S1NFA
Multiplier (F)	1.0	1.0	1.0	1.0	1.0
Improvements (F)	CMI_2012_F_(1_50%)	CMI_2012_F_(1_50%)	CMI_LIB_Long_Cohort	CMI_2012_F_(1_50%)	CMI_2012_F_(1_50%)
Final Age rating	0	-1	-1	0	0
Proportion Married (M)	80%	80%	80%	80%	80%
Proportion Married (F)	80%	80%	70%	80%	80%
Average PV continuous annuities	20.10(M) 21.99(F)	20.37(M) 22.19(F)	20.26(M) 22.28(F)	19.75(M) 21.56(F)	19.75(M) 21.56(F)

Source: Data provided by WTW, with its own calculations
Table VIII: Demographic Assumptions of Scheme B (part A)

	Solvency Basis	CETV Basis	Neutral Basis	Retirement Sensitivity	PPF Basis
Base Mortality (M)	S1NMA	S1NMA	S1NMA	S1NMA	PCMA00
Multiplier (M)	1.0	1.14	1.14	1.0	1.0
Improvements (M)	CMI_2012_M_(1_50%)	CMI_LIB_Long_Cohort	CMI_2012_M_(1_50%)	CMI_2012_M_(1_50%)	CMI_LIB_Medium_Cohort
Final Age rating	-1	-1	-1	-1	-1
Base Mortality (F)	S1NFA	S1NFA	S1NFA	S1NFA	PCFA00
Multiplier (F)	1	1.14	1.14	1.0	1.0
Improvements (F)	CMI_2012_F_(1_50%)	CMI_LIB_Ling_Cohort	CMI_2012_F_(1_50%)	CMI_2012_F_(1_50%)	CMI_LIB_Medium_Cohort
Final Age rating	-1	-1	-1	-1	-1
Proportion Married (M)	60%	80%	80%	60%	85%
Proportion Married (F)	60%	80%	80%	60%	75%
Average PV continuous annuities	22.94(M) 25.25(F)	17.95(M) 19.70(F)	17.76(M) 19.26(F)	20.37(M) 22.19(F)	21.56(M) 23.58(F)

Source: Data provided by WTW, with its own calculations
Table IX: Demographic Assumptions of Scheme B (part B)

In the above demographic assumptions, the value of the final age rating, which was not specified in the previous scheme, given that it is 0 for all the funding requirements, is now defined. In this example, for some funding requirements, there was a final age rating of -1, which means that the probability of surviving for age *x* will be the same as for age *x-1*, when taking this factor. The obtained funding levels in this valuation are presented below.

	Central Basis	Members w/ 1y+	Members live longer	Comm. Sensitivity	+10% Comm. Factors
Funding Level	90.3%	92.4%	92.8%	90.7%	94%

Source: Data provided by WTW, with its own calculations
Table X: Funding Level of each funding requirement of Scheme B (part A)

	Solvency	CETV Basis	Neutral Basis	Retirement	PPF Basis

33

	Basis			Sensitivity	
Funding Level	76%	111%	99%	114%	96%

Source: Data provided by WTW, with its own calculations
Table XI: Funding Level of each funding requirement of Scheme B (part B)

5.3   Individual Scheme Analysis

The following analysis will be performed according to the funding level of each funding requirement scenario, following the expression on (6). Given that there are no changes in the asset amounts between the different valuations, the changes in the funding level will be only due to the liability value.

$$(6) \qquad Funding\ Level = \frac{Total\ assets}{Total\ liabilities}$$

This analysis has the aim to establish a relation between the assumptions that were selected by the actuary and the funding level, or liability result. To compare these amounts, the Central Valuation of each scheme will be used, once it uses to be the valuation which better represents the reality of the scheme.

In order to compare the total liability for each valuation, the present value of an annuity payable continuously will be used, since it reflects both the demographic and economic assumptions chosen.

According to the calculated present values, the valuation with the highest value is also the one with higher liability value as expressed in (7), which will result in a lower guarantee funding.

$$(7) \qquad \text{T}otal\ liability = Pension\ at\ valuation\ date * Annuity\ at\ average\ age$$

Starting with Scheme A, and as a preliminary analysis, we can immediately verify that the discount rate used in the Solvency basis is the most prudent of the whole set of assumptions – this corroborates the available guidance, which emphasises prudency in this particular funding requirement. Also, note that the discount rate for the Neutral basis is located between the Solvency and Technical Provisions assumptions, showing that the underlying principles of a Neutral funding requirement is also being followed.

Doing a global analysis on the results obtained in this scheme's formal valuation, a similar conclusion to the one reached by observing the chosen assumptions can be obtained – the funding level under the solvency funding requirements is much lower than that of the remaining calculations, as it is the most prudent choice available. As it was said before, in this special valuation the actuary tries to replicate the insurance assumptions, which are not public, but are definitely very prudent. Following that, the used assumptions represent a very low level of risk (lower discount rate values for the same mortality tables), therefore a higher value of required liabilities and so, a lower funding level is achieved.

In this particular situation, the Neutral assumption yields a larger funding level than the central basis – this is due to the demographic assumptions choices, which seem to be more prudent at the central basis level.

Still in the current scheme, the evaluation was required in five different Accounting scenarios, which only differs in the mortality assumptions. Furthermore, it is possible to notice that between Accounting 2 and 4 there is a small difference in the present value of the annuity, due to two years difference in the mortality improvements tables [5], and differences in the mortality table multiplier. This triggers to a 3.3% difference on the funding level, which can be very crucial on the company's accounting.

Now, looking on Scheme B, the Solvency Valuation applies the lowest discount rates, which makes it the most prudent scenario in this scheme, as expected.

On the other hand, it can be highlighted that the Retirement Sensitivity is one of the less prudent valuations, taking into consideration the high discount and pension increase rates in use.

Regarding the membership, still for the Retirement Sensitivity, an age rating of -1 is considered. This means that in the described mortality tables, instead of considering the average age *x*, the annuity was applied using an age of *x-1*, which has a lower mortality rate than *x*.

In line with the prudence levels referred before, the Retirement Sensitivity is the one with highest funding level, which results in a lower amount of liabilities. According to that, it is possible to say that less one year on the average age of the scheme's membership can result in a funding level difference of almost 24%, comparing with the Central basis. Additionally in Scheme B, for the most prudent scenario where there are no more contributions and where an insurance company buys the scheme, the lowest funding level is achieved. However, this is not worrisome given that it is an extreme scenario.

In order to test the impact on the commutation factor, a comparison between the results from the Central basis and the Commutation Sensitivity basis can be made. This is only possible given that both have exactly the same basis, with the only difference on the null commutation factor for the Sensitivity Valuation. This difference causes an impact of 0.4% on the total liability value.

---

[5] The improvement mortality tables are yearly updated with more and actual data. For example a CMI 2016 have all the data as the previous tables, but updated with the new mortality data from 2016.

5.4   Inter-valuation Period Analysis

In this section, there will be a focus on Scheme A. A comparison between similar funding requirements at two different valuation dates (referred as Val 1 and Val 2) is made, so that we can analyse changes in the assumptions as time passes.

	Central Basis	Future Impr.	Base Table	PPF Basis	Neutral Basis	Solvency Basis
	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2
DR – Po (Pen)	4.10%|3.25%	3.85%|2.45%	4.05%|2.45%	3.85%|1.58%	3.85%|3.05%	3.50%|1.80%
DR – Pr (Non-Pen)	5.9%|5.25%	6.05%|5.25%	6.05%|5.25%	3.85%|1.47%	7.60%|6.75%	3.10%|1.55%
Dr – Po (Non-Pen)	4.70%|2.45%	4.05%|3.25%	4.05%|3.25%	3.85%|1.47%	4.05%|3.80%	3.10%|1.55%
GMP	4.75%	4.75%	4.75%	-	4.75%	4.75%
RPI	3.50%|3.5%	3.65%|3.50%	3.65%|3.50%	-	3.65%|3.50%	3.65%|3.50%
CPI	2.80%|2.80%	2.95%|2.80%	2.95%|2.80%	-	2.65%|2.50%	3.65%|3.00%
Comm. factor	14.8(M)|16.3 (F)	14.8(M)|16.3 (F)	14.8(M)|16.3 (F)	N/A	14.8(M)|16.2 (F)	N/A
Comm. %	23.2%|23.3%	23.2%|23.2%	23.2%|23.2%	0%|0%	27.8%|27.8%	0%|0%

Source: Data provided by WTW, with its own calculations
Table XII: Economic Assumption for two following years of Scheme A

	Central Basis	Fut. Imp Basis	Base Table Basis	PPF Basis	Neutral Basis	Solvency Basis
	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2
Base Mortality (M)	S2PMA	S2PMA	S1PMA	PCMA00	S2PMA	S2PMA
Multiplier (M)	1.15	1.15	1.15 | 1.05	1	1.3	1.15
Improvements (M)	CMI_2013_M_(1_50%) | CMI_2016_M_(1_50%)	CMI_2013_M_(1_50%) | CMI_2016_M_(1_75%)	CMI_LIB_Medium_Cohort(2002-2011)| CMI_2016_M_(1_50%)	MEDIUM min 1.5%| CMI_2014_M_(1_50%)	CMI_2013_M_(1_25%) | CMI_2016_M_(1_25%)	CMI_2013_M_(1_50%) | CMI_2016_M_(1_50%)
Subsequent Improvements (M)	-	-	CMI_2013_M_(1_25%) | N/A	-	-	-
Base Mortality (F)	S2PFA	S2PFA	S1PFA	PCFA00	S2PFA	S2PFA
Multiplier (F)	1.15	1.15	1.15 | 1.05	1	1.3	1.15
Improvements (F)	CMI_2013_F_(1_50%)| CMI_2016_F(1_50%)	CMI_2013_F_(1_50%)| CMI_2016_F_(1_75%)	CMI_LIB_Medium_Cohort(2002-2011)| CMI_2016_F_(1_50%)	MEDIUM min 1%| CMI_2014_F_(1_25%)	CMI_2013_F_(1_25%)| CMI_2016_F_(1_25%)	CMI_2013_F_(1_50%)| CMI_2016_F_(1_50%)
Subsequent Improvements (F)	-	-	CMI_2013_F_(1_25%)	-	-	-
Proportion Married (M)	80%	80%	80%	75%	80%	80%
Proportion Married (F)	70%	70%	70%	65%	70%	70%
Average PV continuous annuities	18.49|20.12(M) 19.93|21.79(F)	19.35|22.28(M) 20.92|24.29(F)	18.67|22.80(M) 20.52|25.07(F)	18.73|24.76(M) 20.36|26.61(F)	17.82|18.96(M) 19.26|20.60(F)	21.91|24.61(M) 23.91|27.02(F)

Source: Data provided by WTW, with its own calculations
Table XIII: Demographic Assumption for two following valuations of Scheme A

	Central Basis	Fut. Imp	Base Table	PPF Basis	Neutral Basis	Solvency Basis
	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2	Val 1|Val 2
Funding Level	88%|87%	79%|86%	80%|84%	64%|55%	96%|112%	45%|45%

Source: Data provided by WTW, with its own calculations
Table **XIV**: Funding Level of each funding requirement of Scheme A for two following valuations

Between the inter-valuation period (three years, as usual in formal valuations), there are a number of changes in the scheme that affect the funding level. As an example:

- Changes in the assumptions, as these need to reflect the current market conditions, on one hand, and the demographic experience of the scheme on the other.

- Changes in the asset value, which needs to be updated following the scheme's investment activity.

- Changes in the population structure, e.g. the scheme no longer has active members, which will have an impact on the liability projections.

Due to those differences, the objective here is to analyse the changes in the assumptions used in each valuation date, relating them with the economic environment and also with the funding position of the scheme. Additionally, given that this scheme was under a recovery plan, it will be possible to verify whether the actions taken were sufficient to achieve the defined objectives (PR (e), 2014), from one valuation date to another.

The fact that low interest rates affect both asset and liability sides of a business (Pablo, Sebastian and Juan, 2011) is clearly visible in this analysis. For this particular case, the asset's value has increased by 34% since the previous valuation, which can also be related to the absence of risky investments, following the rules in the asset's investments of the recovery plan. Looking at the variations of the economic assumptions on both dates, the discount rates and pension increases have decreased for all the funding requirements. This fact is caused by the state of the economic environment, which at the time of Valuation 2 is less favourable.

In detail, the funding requirement with the highest growth between valuation dates was the Neutral Valuation, which started from an underfunding level in Valuation 1 and became overfunded in Valuation 2, as you can see in the following graph:
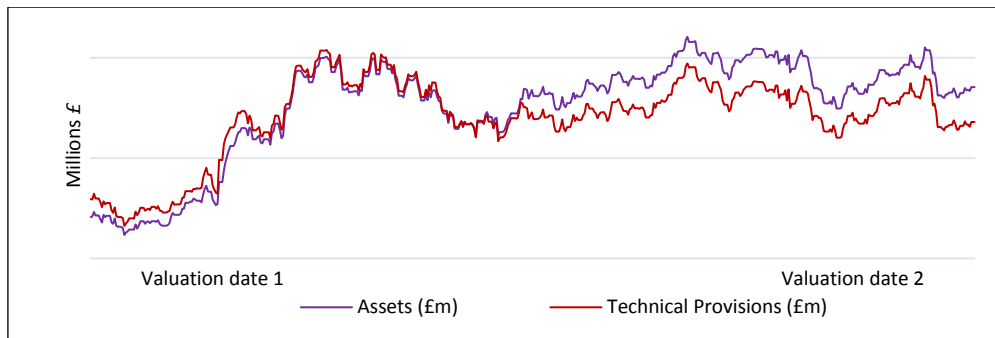
Figure 5: Relation between level of assets and liabilities of Scheme B

Finally, it can be seen that the actions taken after the recovery plan, despite of being very challenging for the contribution and for the scheme, were very relevant considering the difference of the funding level in the three years period.

In conclusion, Scheme A was in the latest valuation more prudent than in the previous one, which can be due to the restricted measures imposed by the recovery plan, and also by the economic environment.

5.5   Comparative Scheme Analysis

In this section, a comparison between the two schemes at the same valuation date, will be made. The objective is to show how different the choice of assumptions can be from scheme to scheme. In order to do it, common valuation requirements in both pension valuations will be compared. In addition, all components are different for the two schemes: the amount of assets, the amount of contributions, and membership. As a consequence, it is not possible to compare directly the numerical values of the assumptions.

There are four common valuations for the two schemes: PPF, Solvency, Neutral and Central bases. Looking at the results, the Neutral approach is the one with the highest levels of funding in both schemes, which was expected since it is the one computed with less prudence and with higher discount rates. On the opposite, in the Solvency runs, the funding level will be the lowest due to the nature of the actions that the scheme will need to take in a scenario of insolvency.

Finally, the results of the PPF Valuation are the easiest to compare for different schemes, as it uses the same statutory basis at the same valuation time. In this case, also for the PPF Valuation we get very different results, which is justifiable not only by the difference in the amount of assets but also by the amount of liabilities in Scheme A. The combination of assets and liabilities results in the low levels of funding of this scheme, which is a consequence of its financial position.

As mentioned before, Scheme A was under a formal recovery plan on this valuation date, so the rules imposed by the pension regulator for this particular valuation were very prudent and in favour of pensioners and dependants. Following that, the assumptions used for Scheme A are, in general, much more prudent and the highest difference is on the discount rate used, which is significantly lower for Scheme B.

6.   **Conclusions**

The internship associated to this report had the goal of study the legislation and the method of valuating pension funds from the United Kingdom, with main focus on occupational pension schemes characterized as defined benefits plans. As suggested by the company, the

study focused on the economic and demographic assumptions used, when measuring the liability values of a specific fund.

During the past five months an opportunity was given to learn more about the guidance and rules behind the choice of economic and demographic assumptions in the UK, which are used to calculate the benefits of UK pension schemes. Even though these choices made by actuaries in the UK and not by the Lisbon office, it was a time to understand how the figures emerge for each individual scheme. In order to apply in practice the knowledge acquired during the internship, an analysis of the impact of the chosen assumptions on the liability results, and consequently on the funding level was developed.

This analysis led to several conclusions. From these it is essential to highlight the importance of the chosen discount rate, which is the variable with more impact on the results and one of the most instable. Moreover, the main strategy imposed by the UK government is the theory of prudence. For both the economic and demographic assumptions, when defined the final assumptions, actuaries always choose the ones with the highest level of prudence. This leads to low levels of discount rates, and also to low mortality probabilities.

Giving a quick look on the pension valuations done in a near past, it is interesting to conclude that the new pension rules are more restricted, induce a stronger control on the status of the scheme, which will lead to a high security level on the future of the employees and also on the financial positions of the UK companies.

In the end, I look at this internship as a success, in terms of both academic and professional goals. Adding to all the technical qualities that this experience gave me, it also helped me to achieve good team work qualities and communications skills.

References

Actuarial Standards Board (a) (1999) – Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations, *Actuarial Standard of Practice No.35,* (December), Doc. No. 093, 1-19.

Actuarial Standards Board (b) (2013) – Selection of Economic Assumptions for Measuring Pension Obligations, *Actuarial Standard of Practice No.27*, (September), Doc. No.172, 1-31.

American Academy of Actuaries (2004) – Fundamentals of Current Pension Funding and Accounting for Private Sector Pension Plans, (July), 1-12.

Antolin, Pablo, Sebastian Schich and Juan Yermo (2011) – The Economic Impact of Protracted Low Interest Rates on Pension Funds and Insurance Companies, *OECD Jounal: Financial Market Trends*, Vol. 2011 – Issue 1, 1-3.

Blake, David (2003), - The UK pension system: Key issues, *Pensions: An International Journal*, Vol. 8, No. 4, 330-375.

Blum, Kathleen A. and David J. Otto (1998) – Best estimate loss reserving: An Actuarial Perspective, *CAS Forum Fall*, Vol. 1, No. 55, 1-19.

Brozio, Antoine, Rowena Crawford and Gemma Tetlow (2010) – The history of state pensions in the UK: 1948 to 2010, *IFS Briefing Note BN105* - London: Institute for Fiscal Studies, 12-29.

Continuous Mortality Investigation (a) (2011) – An initial investigation into rates of mortality improvement for pensioners of self-administered pension schemes, *Working Paper No. 53* - Institute and Faculty of Actuaries, London, 3-27.

Continuous Mortality Investigation (b) (2014) – Graduations of the CMI SAPS 2004-2011 mortality experience based on data collected by 30 June 2012: Final "S2" Series of Mortality Tables, *Working Paper 71* - Institute and Faculty of Actuaries, London, 1-18.

Continuous Mortality Investigation (c) (2017) – CMI Mortality Projections Model: CMI_2016, *Working Paper 97* - Institute and Faculty of Actuaries, London, 8-19.

Continuous Mortality Investigation (d) (2017) – CMI Mortality Projections Model: Methods, *Working Paper 98* - Institute and Faculty of Actuaries, London, 1-18.

Continuous Mortality Investigation (e) (2017) – CMI Mortality Projections Model: Software user guide, *Working Paper 99* - Institute and Faculty of Actuaries, London, 1-20.

Continuous Mortality Investigation (f) (2017) – Mortality experience of pensioners for the period 2008 to 2015, *Working Paper 95* - Institute and Faculty of Actuaries, London, 1-36.

Cordwell, Ian (2008) – Scheme Specific Funding in Practice*, The Pensions Regulator PMI Conference London,* 11 (March), 1-15.

European Insurance and Occupational Pensions Authority (2015) – *Guidelines on the valuation of Technical Provisions*, 1-14.

Financial Reporting Council (a) (2010) – Technical Actuarial Standard M: Modelling, *Board for Actuarial Standards,* (April), 1-17.

Financial Reporting Council (b) (2016) – Technical Actuarial Standard 300: Pensions, (December), 1-8.

Financial Reporting Council (c) (2016) – Technical Actuarial Standard 100: Principles for Technical Actuarial Work, (December), 1-6.

International Financial Reporting Standards (2009) – International Accounting standard 37: Provisions, Contingent Liabilities and Contingent Assets, 5-7.

Jackson, Paul H. and James A. Hamilton (1968) – The valuation of pension fund assets, *Transactions of Society of Actuaries,* Vol. 20, No. 58, 386-436*.*

OECD Working Party on Private Pensions (2005) – Private Pensions: OECD Classification and Glossary.

Office for National Statistics (2016) – Mortality, 2014-based national population projections reference volume – Learning from the Web, https://www.ons.gov.uk/peoplepopulationandcommunity/.

Owadally, Iqbal (2003), – Pension funding and the actuarial assumptions concerning investment returns, *ASTIN Bulletin: The Journal of the IAA,* Vol. 33, No. 2, 289-312.

Pension Protected Fund (a) (2009) - PPF Compensations – Learning from the Web, http://www.pensionprotectionfund.org.uk/Pages/Compensation.aspx.

Pension Protection Fund (b) - Charting a Course for the future: Our expected direction of travel for the Levy – Learning from the Web, https://www.actuaries.org.uk/documents/ppf-levy.

Pension Protection Fund (c) (2009) - Section 143 valuations – Learning from the Web, *http://www.pensionprotectionfund.org.uk/DocumentLibrary/Documents/s143*.

Pires, Fátima (2017) – Pension funds – Lectures notes, available in *https://www.iseg.ulisboa.pt/aquila/disciplinas/fpen-ca/.*

Professional Regulation Executive Committee (2012) – Conflicts of Interest: A Guide for Actuaries, *Professional Regulation Executive Committee*, (June), 1-24.

Revenue Irish Tax and Customs (2017) – Lump Sum Benefits and Commutation*, Tax and Duty Manual Chapter 7*, (September), 1-3.

Ridscale, Brian (2016) – UK Mortality and Longevity – Learning from the Web*, www.actuaries.org.uk/news-and-insights/news/uk-mortality-and-longevity-update-may-2016.*

Rosenberg, Kerrin (2014) – Are Interest Rates an 'Unrewarded' Risk?, *Institute and Faculty of Actuaries,* (May), 2-28*.*

Shaw, Mark (2016) – Pensions: Self-sufficient pensions, – *Learning from the Web,* http://www.theactuary.com/archive/old-articles/part-4/pensions-3A-self-sufficient-pensions/.

Smits, Gijs Van Ijisel (2006) – Guidelines on implementation of the prudent personal principle or institutions for occupational retirement provision in respect of actuarial practice, *Groupe Consultatif Actuariel Europeen*, (September), Vol. 1, 3-7.

Society of Actuaries (2011) – Mortality Improvements: Analysis of the past and projection of the future, *The Actuary Magazine August/September,* Vol. 8, No.4, 21-6.

Thane, Pat (2005) - Old age in English history: Past experiences and present issues, *Oxford University Press*, Vol. 2, 236-239.

The Pension Regulator (g) (2004) – Pensions Act 2004 Chapter 35, (December) Pt.1, 4-32.

The Pensions Regulator (a) (2004) – Regulatory Code of Practice no. 4: Early leavers – reasonable periods, 1-12.

The Pensions Regulator (b) (2008) – Guidance on calculation of cash equivalent transfer values, (November), 1-12.

The Pensions Regulator (c) (2008) – Mortality Assumptions – Learning from the Web, http://www.thepensionsregulator.gov.uk/guidance/guidance-mortality-assumptions.aspx.

The Pensions Regulator (d) (2009) – Scheme Specific Funding and the employer covenant, (June), 1-6.

The Pensions Regulator (e) (2014) – Code of practice no. 3: Funding defined benefits, (July), 1-51.

The Pensions Regulator (f) – Learning from the Web, http://www.thepensionsregulator.gov.uk/about-us.aspx.

UK Government's Department for Work and Pensions (2010) – Statement on moving the CPI as a measure of price inflation – Learning from the Web, https://www.gov.uk/government/news/statement-on-moving-to-cpi-as-the-measure-of-price-inflation.

Vivian, Sue (2014) - NHS Pension Scheme – Valuation as at 31 March 2012: Advice on assumptions, *Government Actuary's Department,* (June), 1-75.

Willets, Richard (2009) – The CMI Mortality Projections Model - *The Actuarial Profession*, (October).

Appendix

Appendix A – History of UK pension funds

In the Appendix A will be presented a brief historical development of pensions funds in the United Kingdom, mainly focusing on the UK Occupational Pension System.

Everything started with a high level of poverty at older ages in which the country was involved. As a response to it, the first pension scheme was mainly designed to avert these kind of situations.

The UK Occupational Pension System was born in 1588, with a very simple scheme called Chatham Chest. This fund was created in order to provide a safe retirement for disabled people who had worked as seamen for the Royalty (Pat, 2005).

During the seventeenth and eighteenth centuries, the existing funds were only available to a limited number of government employers.

In the beginning of the 20th century important changes happened to UK government. The first big news were the non-contributory schemes, which are schemes where the pensioner makes no payments to the fund, and they are supported by the younger generations' taxes. Every woman or man, single or married, could be a pensioner if he/she was a UK resident for at least twenty years and also they had to be successful in a test of good character.

After 55 years since the first schemes, the first contributory benefits schemes appeared with the Widows, Orphans and Old Age Contributory Pension Act 1925.[6] With this evolution, a widow would be able to get a benefit in case of divorce, if they are still married at the time of her husband's death and if she was his only wife. Similarly, orphans were also entitled to receive an amount of money in case of death of their parents, up to the age of majority, or in some cases up to the end of their schooling. This scheme had lots of criticisms because it was not universal being only mandatory to manual and other low-wage workers.

In 1942, there was a major break with the past by the introduction of the universal coverage, based on social security models with the Social Security and Allied Services, also known as the Beveridge Report. Coming as a consequence of the war that was still going on, this proposal aimed to ensure that all the individuals would be able to receive a fixed income. This one was funded through contributions made during working life, calculated in order to avoid absolute poverty, and according to actuarial fair basis.

---

[6] An Act is an official document, provided by the UK government with laws and guidance's.

In 1948 the changes were very significant with the National Assistance Act. With this document, the British parliament introduced a system of social security similar to the one that we have nowadays in Portugal. The contributions were made weekly by the people with working age, and the benefits were not only the retirement benefits but also for sickness, unemployment, death, widow's or orphan's. Also they started providing a minimum income to those who were not paying National Insurance contributions (NIC). This plan seemed to be almost perfect but it had a lot of criticisms derived from the fact that a married woman and some self-employed workers were not entitled to receive the pension.

Appendix B - Optional Funding Requirements

In addition to the funding requirements common to all schemes, which were described in Chapter 3, there are some extra valuations that the trustees use to ask for. This depends on various facts, like the purpose of the valuation, the solvency position of the scheme, the risk profile of the administration etc.

One of the most frequent calculation classified as extra is the Accounting Valuation. Despite of not being mandatory by the Pension Regulator, almost all pension valuations present accounting results in their reports.

This funding requirement is valuated year-by-year, and normally it is requested by the company. With the main objective of calculating the monetary value of the company's assets, the results of this valuation supposedly will give the best estimate of the scheme accounts. Those results are sometimes used while setting economic and demographic assumptions, because they offer an important and concrete view over the scheme.

This valuation has specific economic assumptions, namely for the single discount rate, which is settled according to the values of "high quality corporate bonds". This means that the discount rate will reflect in a more adequate way the time value of money.

Another common extra valuation is the Self-Sufficiency Valuation. This additional funding requirement is mostly used when the scheme has a secondary funding objective. For example, when the scheme, apart from pretending a funding level of 100% also expects to reach a pre-defined increase during the inter-valuation period.

The Self-Sufficiency Valuation has the main goal of advising the company about an extreme scenario, where the funding target is defined by low risks. Without pre-defined rules and reserves, this calculation considers the less risk investment and assumes that the scheme is discontinued at the valuation date, which means that there will be no more contributions. In relation to the chosen assumptions the main goal is related to the discount rate, which in this case doesn't depend on the investment strategy, it only depends on the government bonds, since the statutory discount rate is used (Shaw, 2016).

The Self-Sufficiency Valuation in general does not provide a real valuation of the scheme. Still, it will allow the company to know about the acceptable level of risk, which must guarantee the company's self-sufficiency**.**

Appendix C - Comparison between the UK and Portugal

Comparing with UK, Portugal is much less developed in relation to Mortality tables, and improvements in mortality. In the UK, the board responsible for this subject produces regular studies and updates, with real data from life companies. Some schemes with very large membership have their own mortality tables, which are very specific to their own population and tend to reflect their mortality patterns in a more realistic way.

However, independently of the membership size, UK pension schemes have access to mortality tables specifically built for Self-Administered Pension Schemes, which reflects the actual mortality in a better way than using tables built for the whole UK population.

On the opposite, in Portugal there are a small list of mortality tables available. The *Instituto Nacional de Estatística* provides only a set of Portuguese Mortality tables, for males and females. But given the low level of diversity of those tables, and the fact that they are not very current, most of the insurance companies use French and Swiss mortality tables - this choice is due to the similarities in the culture and socio-economic conditions.