LISBON
SCHOOL OF
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UNIVERSIDADE DE LISBOA

MASTER

ACTUARIAL SCIENCE

MASTER'S FINAL WORK

INTERNSHIP REPORT

SOLVENCY BASIS – FEATURES AND PURPOSES OF A SOLVENCY VALUATION OF A PENSION SCHEME

PATRÍCIA RAQUEL LOPES OLIVEIRA

OCTOBER-2019

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SUPERVISION

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Abstract

Pension schemes are designed to replace employment income upon retirement. There are several types of pension schemes, in particular, the defined benefit pension schemes; simplistically, in this type of pension scheme the benefits promised to the member upon retirement are defined in advance, not being dependent on the fund's investment performance. In the United Kingdom, there are robust laws trying to assure that the funds of the defined benefit pension schemes can to provide all the promised benefits to their members. One of those laws requires that an actuarial valuation takes place, at least, every three years. The main goal of these actuarial valuations is to access if the scheme has enough assets to cover its accrued liabilities. As part of those mandatory actuarial valuations, it is required to provide a solvency estimate: this is one of the purposes of the solvency valuations.

Broadly speaking, a solvency valuation involves estimating the price of securing the benefits promised to the members with an insurance company, adding to this the expected costs of winding up the scheme and comparing the result to the scheme's assets. The solvency ratio is then the ratio between the value of the scheme's assets and the price estimated.

A solvency valuation can be done for several reasons: to comply with the law that requires a solvency estimate in the triennial actuarial valuations, to estimate the price of a buy-in or a buyout or to calculate the debt of an employer to the scheme.

One of the most important features of a solvency valuation is the solvency basis: the assumptions chosen to use when calculating the expected price of securing the benefits with an insurance company. These assumptions aim to replicate the assumptions chosen by insurances to price their annuities, which are not public.

In this report, the purposes of a solvency valuation are analysed as well as the choice of assumptions required. Real life examples of solvency valuations for the different purposes and the assumptions used for each are also provided.

Key Words: Pension Funds, Solvency Valuation, Solvency Basis, Statutory Solvency Estimate, Buy-in, Buyout, Section 75 debt

Resumo

Os planos de pensões estão pensados para prover uma pensão durante a reforma dos seus membros, que substituirá o rendimento anteriormente garantido pelo salário. Há vários tipos de planos de pensões, nomeadamente os planos de benefício definido: simplificando, neste tipo de planos os benefícios estão previamente definidos, não estando sujeitos a alterações consoante a performance do fundo de pensões. No Reino Unido há leis sólidas que tentam garantir que os fundos de pensões correspondentes aos planos de pensões de benefício definido terão condições para pagar todos os benefícios prometidos aos seus membros. Uma dessas leis requer que sejam feitas avaliações atuariais com uma periocidade mínima de 3 anos. O principal objetivo destas avaliações é verificar se o fundo tem os ativos suficientes para cobrir todo o passivo. É obrigatório incluir nestas avaliações atuariais uma estimativa da solvência do plano, sendo esta uma das finalidades das avaliações de solvência.

Em termos gerais, uma avaliação de solvência consiste em estimar quanto custaria comprar a uma seguradora as rendas que cobririam todos os benefícios prometidos aos membros. A este valor será adicionada uma estimativa das despesas de fechar o plano. Finalmente, compara-se a soma obtida com o ativo do fundo. A estimativa de solvência corresponde, portanto, ao rácio entre valor do ativo e o valor estimado.

Uma avaliação de solvência pode ser feita com diversos objetivos: para cumprir a lei que exige uma estimativa de solvência em cada avaliação atuarial, para estimar o preço de um *buy-in* ou de um *buyout* ou ainda para calcular a dívida de um empregador ao plano.

As bases de solvência, que se referem às hipóteses assumidas quando se calcula o custo das rendas atrás mencionadas, são muito importantes neste tipo de avaliações. Estas hipóteses são calculadas com o objetivo de representarem as hipóteses assumidas pelas seguradoras, que não são públicas, aquando do cálculo dos preços das rendas.

Neste relatório, são analisadas as finalidades das avaliações de solvência, bem como o processo de escolha das hipóteses correspondentes às bases de solvência. Para uma melhor compreensão das questões tratadas, apresentam-se exemplos reais destas avaliações com diferentes finalidades, assim como das bases económicas e demográficas usadas.

Palavras-chave: Fundos de Pensões, Avaliação de Solvência, Bases de Solvência, Estimativa Estatutária de Solvência, Buy-in, Buyout, Section 75 Debt

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Acronyms

AoS	Analysis of Surplus
AVCs	Additional Voluntary Contributions
bSP	Basic State Pension
CARE	Career Average Revalued Earning Scheme
CETV	Cash Equivalent Transfer Value
CMI	Continuous Mortality Investigation Bureau
CPI	Consumer Prices Index
DB	Defined Benefit
DC	Defined Contributions
DR	Discount Rate
GMP	Guaranteed Minimum Pension
GRB	Graduate Retirement Benefit
LSC	Lisbon Service Centre
LVD	Last Valuation Date
MFR	Minimum Funding requirement
NI	National Insurance
NICs	National Insurance Contributions
nSP	New State Pension
OECD	Organization for Economic Co-operation and Development
PPF	Pension Protection Fund
PPI	Pensions Policy Institute
RA	Retirement Age
RPI	Retail Price Index
S2P	State Second Pension
SERPS	State Earnings-Related Pension Scheme
SFO	Statutory Funding Objective
SFP	Statement of Funding Principles
SPA	State Pension Age
UK	United Kingdom
WTW	Willis Towers Watson

1. Introduction

This report is the result of a five month curricular internship at Willis Towers Watson (WTW) under the master's degree in Actuarial Science. Willis Towers Watson is a global advisory, broking and solutions company, operating in more than 140 countries, including Portugal, where the internship took place, at the Lisbon Service Centre (LSC). In the LSC a variety of work is performed comprising actuarial valuations work (including live valuations and conversions), individual member calculations, Guaranteed Minimum Pension (GMP) reconciliation, data digitization and pension-construction exercises.

During the internship the focus was on UK pension plans, more specifically in pension funds valuations (live valuations). The valuation process consists of five stages, described below:

- Preparation Workstage - in this phase the scope of the work was agreed and planned aiming to ensure the valuation would occur smoothly and in the adequate timescales;
- Data Workstage - data provided was analysed and corrected when inconsistencies were found, to guarantee the data was appropriate for valuation purposes;
- LVDATE Basis Workstage - the data analysed on the Data Workstage was used to perform liability calculations and A/E (actual/expected) analysis such as post-retirement mortality analysis or salary increase experience, valuing the benefits using the same assumptions as per last valuation date (LVD) – all the results derived were then used to produce the draft Analysis of Surplus (AoS), which attempts to explain the differences between the surplus/deficit at LVD and the ones obtained in the LVDATE Basis Workstage;
- New Basis Workstage - consisted on the valuation of benefits using new assumptions. This stage includes, among others, the solvency and Pension Protection Fund (PPF) valuations. To guarantee the quality of the work provided, reasonableness checks on the liability results were always performed. The results obtained were then sent to the UK, where, based on those results, an actuarial report was written.
- Closedown stage – comprised an evaluation of the work done and pointing what could be improved in the next valuation.

These tasks demand a deep understanding of the UK legislation for pension schemes and of the plan rules of each project.

Pension schemes in the UK are subject to strong legislation that tries to protect the pension schemes' members. Under that legislation, the scheme's trustee/manager is required to submit

an actuarial valuation periodically, at least every three years, in order to assess the scheme's funding level. This actuarial valuation must include the actuary's certification of the calculation of the Technical Provisions (that are described later in this report) and the actuary's estimate of the solvency of the scheme (The Occupational Pension Schemes (Scheme Funding) Regulations 2005, 7(4)). The latter, simplifying, usually consists of an estimation of the proportion of accrued benefits that could have been secured by buying insurance policies with the assets held by the scheme at the valuation date. Given that insurers do not reveal their pricing basis, this estimation is calculated based on a solvency basis derived using market knowledge, indicative pricing information, analysis of live quotations, and knowledge of the legislation and supervision requirements for insurance companies. The solvency basis, and solvency valuations in general, are the main topics included in this report which is divided into five chapters. Chapter 2 is an introduction to UK Pension Funds, where the basic definitions needed to have a clear understanding of the following chapters are presented to the reader, including the definition of pension funds, types of pension funds, funding requirements, an introduction to the economic and demographic assumptions and the definition of buy-ins and buyouts. The third chapter's focus is the different purposes of a Solvency Valuation, particularly the statutory estimate of solvency and the Solvency calculations for Section 75 purposes. Starting with a brief historical background, this chapter includes a vision of the solvency valuation as a regulatory requirement. Subsequently, chapter 4's emphasis is the solvency basis and its derivation (both economic and demographic assumptions).

Chapter 5 comprises a study of real solvency valuations, performed during the internship. It aims to apply all the theoretical concepts described in the preceding chapters.

Finally some conclusions are presented.

2. Introduction to UK Pension Funds

A pension plan is designed to replace employment income upon retirement. Each plan has its own rules that define the benefits a member is entitled to, which often include disability and death benefits (if the member dies, the pension benefits are inherited by a surviving spouse and/or children).

Pension funds are one of the long term investing financial institutions in the UK, specialized in the administration of personal and corporate pension plans. The purpose of pension funds is to accumulate assets in order to finance the promised benefits to retired beneficiaries. These funds are financed by employers' and employees' contributions. The money collected by the pension fund is used to generate additional income by investing in financial securities which will provide rents, dividends and interest on the assets. The portfolio held is supposed to maintain a good balance between immediate liquidity needs and longer term investment returns.

Summing up, and according to the Organization for Economic Co-operation and Development (OECD), a pension plan comprises the promise of benefits to the members, while a pension fund comprises the portfolio of assets held to finance the promised benefits (Fleming and Thornton, 2011). It's worth noticing that in the United Kingdom the plan and the fund together are referred to as the pension scheme. Pension schemes are said to be "funded" if contributions from current workers and/or their employer are used to accumulate assets that will be partially or totally used to pay benefits in the future; otherwise, if the current contributions are used to pay benefits to current retirees, the scheme is said to be "unfunded" or on a "pay as you go" contributory basis.

Pension Schemes in the UK are usually categorized into three types: State Pension Schemes, Personal Pension Schemes and Occupational Pension Schemes. This categorization is not unique, the Pensions Policy Institute (PPI) classifies the pension scheme into three tiers. Tier 1 is provided by the state, aiming to provide a minimum level of retirement income. Almost everyone contributes or has access to this pension. Tier 2 is state responsibility as well and the goal is to provide a pension income tightly related to employee's earning levels. Both tier 1 and 2 operate on a 'pay as you go' contributory basis through the National Insurance (NI) system. Finally, tier 3 consists of voluntary and private pension arrangements. The main goal of private pensions is to redistribute income across an individual's lifetime (Pensions Policy Institute, 2018).

In this chapter we will describe the main differences between these types of pension schemes and focus on the Defined Benefit Occupational Pension Schemes (included in tier 3) since those are the ones for which a solvency valuation is required.

2.1. First and second tiers - State Pension Schemes

State pension schemes are organized by the British government. The statutory state pension system consisted, until April 2016, of a basic state pension (bSP) and an earnings-related additional pension known as the state second pension (S2P) (HM Treasury 2014). Both were substituted by the new State Pension (nSP) – further details on this pension below. As mentioned in the beginning of this chapter, a pension fund is financed by contributions: in the state pensions' case, those contributions are earnings-related National Insurance Contributions (NICs).

An important concept to understand state pensions is the State Pension Age (SPA). SPA is the minimum age from which state retirement pensions are normally payable (Pensions Management Institute, 2018). The SPA was initially 60 for males and 65 for females but it has been increasing over the years to account for the increase in life expectancy. As a first step, women's SPA raised to equalise with men' at age 65 by November 2018 (Pensions Act 2011). After the equalisation, SPA is increasing for both genders aiming for 66 years in October 2020 (Pensions Policy Institute, 2014).

2.1.1. New State Pension

The bSP is included in tier 1, according to the PPI, as is the nSP, introduced in April 2016. The nSP applies only to people reaching SPA on or after 6th April 2016; it's considered to be a contributory pension given that the final amount an individual will receive from nSP depends on the number of National Insurance Contributions made, or credited, before reaching SPA. The nSP is replacing the bSP and the additional State Pension and is designed to redistribute wealth across the population ensuring a minimum standard of living. The level of the benefit guaranteed by the nSP doesn't depend on the size of the contributions but on the number of the contributions made - in this way, individuals will receive the same benefit as long as they have contributed for the same number of years. The full nSP, fixed at £168.60 a week for the current year, is provided to a pensioner with 35 years or more of complete NICs contributions. A minimum of 10 qualifying years are necessary to get any new state pension. When reaching

SPA, individuals can choose to defer the commencement of their nSP, receiving an increase in the level of State Pension Payments (Age UK 2019).

2.1.2. Basic State Pension

People who reached SPA before 6th April 2016 are entitled to receive the bSP instead of the nSP. The entitlement to the full amount of a basic State Pension, currently fixed at £129.20 per week, implies at least 30 qualifying years of service for people retiring between 6th April 2010 and 5th April 2016; there is no minimum number of qualifying years required for pensioners who retired before 2010. Pensioners with less than 30 qualifying years get a pension proportional to the full amount according to their contributing service - 1/30 of the full State Pension amount for each qualifying year.

Legislation requires an annual increase on the bSP that has to be, at least, in line with average earnings. Since 2011 the government has chosen to increase the state pension by the "triple lock" - the highest of average earnings, CPI or 2.5% (HM Treasury 2014).

2.1.3. Additional State Pension

The additional State Pension (S2P) is included in the second tier provision, according to PPI. People can no longer contribute to the second tier since, as previously mentioned, the nSP is substituting both the bSP and the S2P. Up to 2016, the second tier evolved into different types of pensions, starting with the Graduate Retirement Benefit (GRB) which was in force from 1961 and was abolished in 1975. State Earnings-Related Pension Scheme (SERPS) was introduced by the Social Security Pensions Act 1975 and came into force in April 1978 (Bozio, Crawford and Tetlow 2010). In 2002 the S2P substituted SERPS. The aim of S2P was to provide income to those for whom a private pension was not an option, to the ones not undertaking paid work due to caring responsibilities and in general for people with low incomes.

The S2P increases in line with the Consumer Prices Index (CPI). The maximum amount of additional State Pension increased from £172.28 (2018) to £176.41 (2019) per week.

2.2. Third tier – Private Pensions

Occupational Pension Schemes, together with Personal Pension Schemes, are part of the third tier, under PPI's classification. This third tier consists of private pensions where the goal is, as stated before, to redistribute income across an individual's life time.

2.2.1. Occupational Pension Schemes

Also known as workplace pensions or company pensions, occupational pension schemes are set up by employers to provide their employees with retirement benefits. Employers, who are the sponsors of the pension schemes, offer occupational pensions as a way of recruiting and retaining good staff. These pensions, voluntary in the UK since 1986 (until then they were compulsory), are financed by employer contributions, and often, by employee contributions as well.

Some of these schemes offer the employees the option to make Additional Voluntary Contributions (AVCs) that can be used to buy extra years of service, or be invested. Either way it results on an increase of the pension.

Occupational Pension Schemes can be structured as Defined Benefit (DB), Defined Contributions (DC) or hybrid.

Defined Benefit Schemes

In a DB scheme there's a promise to pay a specific level of benefits when an individual retires. This means the benefit formula is defined being, for the majority of DB schemes in the UK, dependent on years of service, final salary and accrual rate. The accrual rate is the proportion of the final salary that accrues as additional pension for each additional year of service (Sutcliffe, 2016). The pension amount for final salary pension schemes is then computed through the following formula, where $\alpha\%$ is the accrual rate:

$$Annual\ Pension = \alpha\% \times years\ of\ service\ \times Final\ Salary \tag{1.1}$$

Alternatively the annual pension formula can be based on the career average salary over the entire career of the employee – in that case the scheme is said to be a Career Average Revalued Earning Scheme (CARE). The pension for this type of pension scheme is calculated as follows:

$$Annual\ Pension = \alpha\% \times \sum_{i=a}^{RA} W_i \quad (1.2)$$

Where $\alpha\%$ is the accrual rate, a is the member's age when he or she joined the scheme (entry age) and W_i is the salary at age i revalued up to Retirement Age (RA) to offset inflation.

Note that, besides the factors mentioned earlier, pension formulas might be dependent on other options available to members such as early retirement.

As benefits are defined in advance, and not linked to the fund's performance, the liabilities of the scheme may exceed its assets (for instance if the fund's investments returns are not as high as expected or the members live longer than expected). When this happens, the scheme is said to be in deficit.

In a DB scheme the employer is typically responsible for deficits in the scheme funding which leads to varied contributions that aim to ensure the level of promised benefits is reached. Contributions are invested in a pooled manner, meaning that all contributions are paid into a common fund, which is invested to provide all retirement benefits (in unfunded schemes, contributions are used to pay the benefits to current pensioners). The investment performance of the scheme assets has no impact on the benefits the members receive as it is the scheme provider's duty to make good the deficit, so all the risk is placed on the employer. In different circumstances, when the scheme is in surplus, that surplus is generally considered to be owned by the employer.

Defined Contribution Schemes

In a DC scheme, also known as Money Purchase Scheme, the contributions are known in advance whilst the benefits will correspond to the pension that can be bought with the value of contributions made plus interest accrued on investments. Contributions, coming from the employer and often from employee as well, are usually expressed as a percentage of the salary or total earnings. The rate of contributions is sometimes a flat rate but it might also be dependent on various factors such as age, length of service or seniority.

At retirement, the pension depends on the contributions made, length of saving, investment performance, charges and the choice of retirement product. Unlike DB plans, in a DC plan, all the risks are borne by employees.

Personal pension schemes, which will be described later in this report, are mostly defined contribution schemes.

Hybrid Pension Schemes

A hybrid pension scheme combines defined benefit and defined contributions features. Particularly, risk is shared between both employers and employees. Some schemes, instead of CARE or final salary benefits, offer a final salary lump sum: instead of receiving a pension, members receive a lump sum upon retirement. In this case, risk is shared between the employer, who bears the risk until retirement, and the employee, who bears longevity and investment risk after retirement.

There are many other options among hybrid pension schemes, for instance: DC schemes that guarantee a minimum benefit equal to a final salary scheme; a DB scheme that caps the salary used to calculate the benefits, incorporating a DC add-on for members who have a higher final salary.

2.2.2. Personal Pension Schemes

Personal pension schemes are individual contracts organized by financial institutions such as banks or insurance companies. In this type of pension scheme there's a direct contract between the member and a pension provider. This type of pension scheme is an option to all people, whether they are employers, employees or not working. In the employee's case, employers might contribute to their personal pension as well. Contributions made are invested and usually the member has the opportunity to choose which fund to invest in, knowing that different funds are associated with different risk profiles.

2.3. Valuation Process of a DB pension scheme

The Pensions Act 2004 introduced a variety of mandatory procedures that are still in place today. One of the biggest changes presented in this document was the establishment of the scheme specific funding requirement, under which trustees are required to undertake a full actuarial valuation at least every three years.

Valuations may be undertaken with different objectives, therefore there are many ways to measure the funding status of schemes. There are four main approaches to measure the funding

position of a scheme: Statutory Funding Objective (SFO), Accounting Valuation, Pension Protection Fund Valuation and Solvency Valuation.

2.3.1. Funding Valuation

Besides the legal requirement, there are two main purposes to carry out a Funding valuation:

- Assess the financial position of the scheme relative to its SFO, defined as having sufficient and appropriate assets to cover the scheme's liabilities (Pensions Act 2004 Explanatory Notes);
- Determine the appropriate level of future contributions.

Whenever the scheme doesn't meet the SFO, the trustee needs to prepare a Recovery Plan where the strategies to remove the deficit are specified, particularly the length and amount of the payments. These terms are, in most cases, negotiated with the sponsor/employer.

The Pensions Act 2004 gives the trustees the responsibility of determining which methods and assumptions to be used when calculating the scheme's technical provisions. A scheme's "technical provisions" means the amount required, using an actuarial calculation, to make provision for the scheme's liabilities (Pensions Act 2004).

Legislation requires the use of prudent assumptions that should allow an appropriate margin for adverse deviation and the valuation of the scheme's assets according to market values. Besides, the actuarial assumptions proposed to the trustee by the scheme actuary are supposed to take into account the financial conditions of the scheme at the valuation date, its investment strategy, the employer covenant and the population demographics and scheme experience.

2.3.2. Accounting Valuation

An Accounting Valuation, is carried out annually as at the end of the reporting period and is calculated with the purpose of being published in the employer's annual reports and accounts. The process to set assumptions is defined in the relevant accounting standards. In this type of valuation, liabilities are typically measured using the current yield on high quality corporate bonds irrespective of the scheme's investments.

2.3.3. Pension Protection Fund's Section 179

The Pension Protection Fund (PPF) is a statutory fund run by the Board of the Pension Protection Fund, a statutory corporation established under the provisions of the Pensions Act 2004. It started its activity on 6 April 2005 applying to schemes that started winding up after that date. The PPF pays a compensation to members of DB and hybrid occupational pension schemes when the employer becomes insolvent and the pension scheme doesn't hold enough assets to cover the PPF levels of compensation. PPF is financed by the assets of the schemes that enter PPF, investment returns and levies paid annually by eligible schemes.

The PPF pays different levels of compensation according to the member status in the scheme. People that have reached the scheme normal retirement age before the scheme enters the PPF or are entitled to an ill-health or survivors' pension, receive 100% of their benefits. The other members will be entitled to receive 90% of their benefits subject to a compensation cap. Most schemes are not expected to need the support of the Pension Protection Fund.

The PPF Valuation, an estimation of the funding needed to secure PPF compensation levels, is legally mandatory according to Section 179 of the Pensions Act 2004. The main purpose of this valuation is to calculate the levy paid by schemes eligible for PPF protection, but it is also used as an indicator of the level of benefits that would be secured by the PPF in the event a winding up of the scheme with an insolvent sponsor. Therefore, active members are assumed to leave at the valuation date and are valued as deferreds.

The assumptions used are standard for all schemes and intend to give an estimation of the cost of securing the value of PPF compensation level benefits with an insurance company at the valuation date;

Pensions Act 2004 sets out another type of PPF valuation, under section 143. If a qualifying insolvent event occurs to an eligible scheme for PPF, a valuation under section 143 is required. The purpose of this valuation is to assess if the scheme has enough funds, on the date immediately before the qualifying insolvency event, to pay the PPF levels of compensation; if this is the case, the trustee should secure, with an insurance company, the highest value of members' benefits that the scheme's assets are enough to secure (that are equal or better than the benefits the PPF would pay). In case this valuation result points to the insufficiency of assets to pay PPF levels of compensation, the valuation report will be sent to the Board, including all the relevant details, to be approved to enter PPF.

2.3.4. Solvency Valuation

The Pensions Act 2004 requires that the actuarial report includes an estimate of the solvency of the scheme at the valuation date. To calculate the solvency estimate, the actuary assumes the "discontinuance" of the scheme, i.e. the actuary calculates the solvency estimate as if the scheme would wind-up at the valuation date, and thus all the active members will be valued as deferreds.

The solvency measure refers to a comparison of the assets with the estimate of the cost of securing scheme liabilities with an insurer – the price of a full buy out (a description of buyout is provided in section 2.5 of this report).

The solvency valuation will be carefully studied in the following chapters, along with a comparison between the funding levels acquired with each of the different approaches presented.

2.4. Assumptions

An Actuarial Valuation involves a variety of future events that are unknown at the valuation date. It depends, as an example, on the total amount of pensions that will be paid each year, which is impossible to know in advance given that it depends on how many pensioners will be alive in that specific year, as well as on the pension amount of each of those pensioners (where increases are often linked to inflation and thus are difficult to predict); therefore an actuarial valuation requires the use of assumptions. Assumptions can be prudent or best estimate. A prudent assumption would be one where it is perceived to be more likely that the actual outcome will be more favourable than that assumed, rather than less favourable (Fleming and Thornton 2011); an assumption is said to be a Best Estimate if the probabilities of getting a more favourable or a less favourable outcome than the one assumed are equal.

The assumptions to be used depend on many factors including the membership of the scheme and the purpose of the valuation being carried out.

The required assumptions to undertake an actuarial valuation fall into two types: Demographic and Economic assumptions.

In the following sections, a general overview of some of the most relevant economic and demographic assumptions is presented. An extensive study on demographic and economic

assumptions and their derivation for the specific case of a solvency valuation is presented in Chapter 4 of this report.

2.4.1. Demographic Assumptions

The demographic assumptions are expected to project the timing and probability of benefits being paid. Demographic assumptions include, among others, the following: mortality rates, withdrawal rates, retirement on ill-health, proportion married and commutation.

Mortality Rates

A mortality rate represents the probability of death within one year. Mortality assumptions usually include two components: the base tables and allowance for future improvements in life expectancy.

Base tables aim to represent the current mortality and are produced, in most cases, by the Continuous Mortality Investigation Bureau (CMI). The latest tables produced by CMI are based on mortality experience of members of occupational pension schemes from 2009 to 2016 (IFOA 2019).

Assumptions used in the valuation should reflect the profile of the membership, nonetheless most schemes start by looking at the available standard mortality tables. After selecting the table that is believed to be more suitable to the particularities of the scheme, an adjustment may be applied. Some of the common adjustments include using the table data for a different age from the actual age of the member or applying a percentage loading (assume that the mortality rate to be applied is a percentage of the mortality rate presented in the standard table). Ideally an analysis of actual mortality should be performed and determine scheme specific mortality base tables, however generally schemes are not sufficiently large to make the experience reliable. The option is to decide the most appropriate adjustment to be applied to a standard table by analysing some features of the membership. Two common analyses are based on the size of members' pensions or on the post code of members' primary residence. The first analysis is carried out since it has been observed that members with large pensions, which suggests higher socio-economic class, live longer than average; the second analysis is due to the observation that members living in wealthy areas live longer than the average (Ndayong 2017).

As stated before, there's another component to mortality assumptions, besides mortality tables, which is the allowance for future improvements in life expectancy. CMI publishes projections of future improvements in life expectancy as well and updates them every year.

Withdrawal Rates

Withdrawal Rates attempt to reflect the estimated rates of termination at each age, meaning that this assumption is supposed to reflect the rate of employees that are expected to change from active to deferred status at each age.

Actual withdrawal experience depends on economic circumstances, such as the availability of other work, and the prevailing culture regarding job mobility (Booth et al. 1999). If the withdrawal happens when the member has less than two years of service, member's contributions may be reimbursed on withdrawal along with interest for most of the schemes; otherwise, the member is entitled to a deferred pension that will be calculated according to the normal pension formula, using the date of leaving and the salary at withdrawal date. Therefore, higher withdrawal rates generally lead to lower liabilities since the deferred pension receives revaluation in deferment, which tends to be lower than salary increases.

Retirement on Ill-Health

Each scheme has its own rules about ill-health retirement. Usually a member is considered eligible for an ill-health pension if he/she is unable to carry out his/her normal job due to sickness. If the scheme rules allow, a pension can be put into payment from any age. From the moment the member retires on ill-health grounds the mortality rates applied are usually derived from normal mortality rates, using an adjustment. One of the adjustments often used is assuming that ill-heath pensioners experience the same mortality rates as a healthy pensioner who is some years older.

Commutation

Commutation is an option, available in most pension schemes, that allows members to exchange part of their pensions for an immediate tax-free lump sum at retirement. Usually the lump sum paid is based on a best estimate set of assumptions, therefore assuming members choose to commute their pensions can reduce schemes' liabilities on a prudent funding basis. When choosing the commutation assumptions the actuary must consider previous commutation experience and how the proportion of pension commuted may evolve in the future.

Proportion Married

Most schemes provide a pension to the member's spouse following the member's death. To allow for this possibility, an assumption for the proportion of members that are married is taken into account. Normally this proportion is assumed to be around 80% to 90% at Normal Retirement Age. The most common spouse's pension on death of the member is equivalent to

50% of the member's pension, usually based on the member's pension prior to commutation, thus this benefit amount can represent a substantial amount of the liabilities.

2.4.2. Economic Assumptions

Economic assumptions are derived in order to project future economic factors. They include assumptions for investment return, inflation, general salary and pension increases, and discount rates (Pensions Management Institute 2018)**.**

Discount Rate

Discount Rate is one of the most material assumptions, and special attention should be given to its derivation. The discount rate is the rate at which the amount of benefit payable at a future date is discounted to give a current value (Fleming and Thornton 2011).

As specified before, the choice of assumptions should be influenced by the type of valuation they are chosen for. The discount rate, in particular, might be significantly different in valuations with different purposes:

- For accounting purposes it is taken to be the yield on 'AA' corporate bonds of appropriate duration;
- For solvency valuation the discount rate is close to the gilt yield (as described in Chapter 4 of this report);
- For funding valuations the derivation of discount rates might not be that straightforward, as explained below.

Funding valuations results will influence the contributions required from the sponsor of the scheme and the amount of those contributions is often largely affected by the discount rate assumption applied, since a higher discount rate assumption leads to an assumed higher level of future investment returns and consequently to a reduction in the contribution rate. Therefore the assumption of the discount rate needs to account for the investment strategy of the scheme; this strategy is likely to change over time, mostly in schemes that are now closed to future accrual or new entrants. Those schemes often opt to have different discount rates for pensioners and non-pensioners, typically assuming a low-risk strategy for pensioners and a higher risk, return-seeking strategy for active and deferred members. As time passes by, the number of non-pensioner members decreases and, along with it, the materiality of the discount

rate applied to non-pensioners, leading to the use of a single discount rate (considering only the pensioner discount rate).

Inflation

Providing a pension aims to ensure that people keep a decent income after retirement. In order to guarantee that the pensioners' buying power does not decrease with time, there are statutory requirements for the pension to increase in line with inflation. The statutory minimum requirements for DB pension schemes' pension increases, and revaluation in deferment, linked to inflation, are as follows:

- Pension increases minimums:
    - No minimum pension increase for benefits accrued before 06 April 1997;
    - In line with Consumer Prices Index (CPI) capped at 5% for benefits accrued from service between April 1997 and April 2005;
    - In line with CPI capped at 2.5% for benefits accrued from April 2005 on.
- Revaluation in deferment minimums:
    - Capped at 5% for benefits in respect of service before 6 April 2009;
    - Capped at 2.5% for benefits accrued on or after 6 April 2009.

Salary increases are often linked to inflation as well. Hence the benefits to be paid are usually highly dependent on inflation rates, making it of extreme importance to derive an assumption that will take this factor into account when projecting future benefits. Some pension benefits increase in line with Retail Prices Index (RPI) whereas others increase in line with CPI.

Salary Increases

If the scheme is open to accrual of benefits or has been closed to accrual but maintains a link to final salary for the members still employed by the company, an assumption for salary increases is required.

Salary increases are within the control of the company so the input of the sponsoring employer can be required to set a more accurate assumption. It is important to bear in mind that the salary increase assumption should be adjusted to the current membership of the scheme. For instance, if the scheme is closed to new entrants, members accruing benefits are expected to be older than the average age of the company's employees and consequently the probability of receiving promotional increases might be lower (Deloitte 2017).

2.5. Bulk Annuity Transactions

Assumptions are required for all types of pension schemes' valuations. However, there are some other definitions that are important in order to understand how solvency valuation, in particular, is performed. That's the case of the bulk annuities transactions, which are the main topic of this section.

A pension scheme is subject to a number of risks that might threaten its ability to meet all its liabilities. Among those risks there are longevity risk, inflation, investment risk and second life risk: all of these risks can be transferred to a third party by a bulk annuity transaction leading to a de-risking of the pension scheme. A bulk annuity consists of an arrangement between the scheme and an insurance company in which the scheme purchases an insurance policy that covers all the pension payments – this way the insurance company takes on all the risks previously mentioned. There are two types of bulk annuities: buy-in and buyout.

A buy-in comprises the purchase of a bulk annuity that is held as an asset of the scheme. The insurer doesn't take the legal responsibility of paying the members' pensions directly, it makes the payments to the scheme and the scheme continues providing the benefits to the members. Nevertheless, the scheme still holds counter-party risk, as if the insurance company does not pay the benefits, it will be the scheme's responsibility to do it.

In summary, a buy-in allows the trustees to obtain a matching asset that produces an income equal to the benefits they have to pay to the members. Sometimes buy-ins are purchased with the purpose of converting the buy-in into a buyout with the same insurer, as part of winding up the plan in the future (Mercer, 2013). A buy-in is often purchased only for a subset of the members, usually pensioners. This happens for several reasons (Sutcliffe, 2016):

- Longevity for pensioners is shorter, meaning that it can be better predicted than the longevity of deferred or active members;
- The options available are fewer for pensioners: there's no possibility of early/ill-health retirement, commutation or other options available for non-pensioners.
- As pensioners have shorter longevity, it is easier for an insurance company to find matching assets to their duration.

All of the reasons mentioned above lead to less risk and consequently better prices from insurance companies, making it more affordable for a pension scheme to buy annuities for pensioners than for actives or deferred members.

A buyout allows the transference of all the risk to the insurer: the scheme buys insurance policies in the members' names and they become the policyholders of the insurance, ceasing their membership in the scheme. In this case the scheme members are the ones holding the counter-party risk.

There are two types of buyout – full and partial. A full buyout implies the winding up of the scheme, all its assets are transferred to the insurance company in exchange for the annuities. If there is a difference between the price of the bulk annuity and the value of the assets held by the scheme, the sponsoring employer will have to make an additional contribution to fill that gap. On the other hand, a partial buyout allows for the continuance of the scheme and only the liabilities referent to the pensions of a specified subset of scheme members are transferred to the insurance company; the pensions of the remaining members continue to be the responsibility of the scheme.

The major advantage of de-risking by buying bulk annuities relates to the perfect match between assets and liabilities that is provided by this approach; these are the only investment products flexible enough to match the exact benefit payments irrespective of the members' options, date of retirement or death, or changes in the market conditions.

Buying bulk annuities has disadvantages as well, the most straightforward being the strong financial covenant of an insurer and its intention to make a profit, therefore including profit margins and margins of prudence in the price of the bulk annuities. These two factors make these products expensive, sometimes being significantly more than the market value of the scheme's assets, making this approach unaffordable for some schemes.

A more extensive study of buyout scenarios will be carried out in the next chapters.

3. Solvency Valuation – Purposes

An estimate of solvency can be completed for various purposes including statutory requirements, solvency estimate for Section 75 debt and assessing the possibility of winding up the scheme in short/medium term. In this chapter the first two purposes mentioned are described. A special attention will be given to the statutory estimates of solvency under Regulation 7(4) of The Occupational Pension Schemes Regulations 2005.

3.1. Statutory Solvency Estimate

The funding of a pension scheme is simultaneously trying to achieve two objectives which are not always aligned (Cowling et al. 2017). One of the goals is to fund benefits as they fall due and the other one is to provide security for member's benefits. In order to protect pension schemes' members, UK is subject to a funding policy that has evolved over the years.

In this section, an historical background of the legislation that led to the introduction of a mandatory Solvency Valuation included in all the triennial valuations will be firstly provided, considering the period from the previous funding regime (the Minimum Funding Requirement) to the current funding regime (Scheme Specific Funding) (Cowling et al. 2017). Secondly the main features of the statutory estimate of Solvency are described.

3.1.1. Historical Background

In the early 1990's thousands of people were affected by what is known today as the Maxwell scandal: Robert Maxwell, owner of the Mirror Group, had plundered millions of pounds from his company's pension funds causing enormous losses to many pensioners (Washington Post, 1991). Public concerns following the Maxwell scandal led to the Pensions Act 1995, under which the Minimum Funding Requirement (MFR) was established, coming into effect on 6 April 1997.

The MFR was designed to ensure that, even if the sponsoring company went insolvent, pensions in payment would continue being paid and non-pensioner members would receive a cash equivalent transfer value (CETV) that, after being invested, would give the members an even chance to receive a pension equivalent to the one that would have been provided by the scheme itself, if the company continued sponsoring it.

Pensions Act 1995 sections from 56 to 61 were dedicated to the MFR, establishing mainly that trustees had to obtain a valuation from an actuary on the MFR, generally on a triennial basis. Following that valuation, trustees should prepare a schedule of contributions where the duration was dependent on the valuation results. If the scheme was funded at least at 90%, the contributions should be payable over a period of five years, either to maintain the scheme funded at 100% or to reach 100% funding in those five years. The other schemes were required to reach the 90% level in 12 months, if no major under-provision issues were identified, otherwise, the scheme would be required to reach the 100% level within six years. Some scheme characteristics were not taken into account in the MFR, namely the expected long-term investment strategy of the pension scheme and the employer covenant strength (according to The Pensions Regulator (TPR), the covenant is the employer's legal obligation and financial ability to support their defined benefit (DB) schemes now and in the future).

A few years later, some concerns about MFR were raised. Many industry bodies, for instance, were concerned about the fact that the public perception of MFR was not consistent with the actual security this method provided or about MFR distorting investment decisions.

In March 2001 the current funding regime – Scheme Specific Funding - was introduced. However, the MFR was only formally abolished and the scheme specific funding regime became law, in 2004: both changes under the Pensions Act 2004.

The scheme specific funding regime was introduced to provide more flexibility to scheme funding, allowing for the scheme specific circumstances to be taken into account, and requires that every scheme meets the Statutory Funding Objective: to have sufficient and appropriate assets to cover their technical provisions (TPR, 2019). The strategy to meet the SFO must be included in a document, the so-called Statement of Funding Principles (SFP).

In a DB scheme, any deficit becomes a debt of the scheme's employer. On 11th June 2003 the Government changed the debt on the employer regulations to be based on full solvency liabilities rather than MFR liabilities, as long as the employer was solvent at the time of the wind up. Otherwise, if the company was insolvent, the Debt was calculated under the MFR basis until the Pensions Act 2004 came into force, and under the scheme specific funding basis after its implementation.

In addition to the scheme specific funding requirements, the Pensions Act 2004 introduced other modifications to the UK pensions' regulation. Among those changes it's worth highlighting the institutions of The Pensions Regulator and the Pension Protect Fund (PPF).

TPR is the UK regulator of workplace pension schemes. Its objectives are mainly to protect members' benefits and ensure that the schemes are run properly – avoiding, this way, that schemes enter PPF.

3.1.2. Statutory Solvency Estimate - Overview

This subsection is based on official documents, namely Pensions Act 1995 (along with the revised versions of this document), Pensions Act 2004 and The Occupational Pension Schemes (Scheme Funding) Regulations 2005.

The statutory estimate of solvency is required by Regulation 7(4) of The Occupational Pension Schemes (Scheme Funding) Regulations 2005, transcribed below.

7(4) An actuarial valuation must include—

(a) the actuary's certification of the calculation of the technical provisions, in the relevant form set out in Schedule 1, and

(b) the actuary's estimate of the solvency of the scheme.

In The Occupational Pension Schemes (Scheme Funding) Regulations 2005

The actuary's **estimate of the solvency** of the scheme refers, in most cases, to an estimate of the proportion of liabilities that can be discharged by purchasing annuities, which cover the scheme's accrued liabilities, in terms consistent with those available in the market, from one or more insurance companies, with the assets held by the scheme at the valuation date. The assets to be taken into account for this purpose exclude employer-related investments, debts due to the trustees or managers of the scheme (the ones outlined on section 75 of 1995 Act, described on section 3.2 of this report) in the event of a relevant insolvency, amounts due in accordance with a schedule of contributions that shall be treated as debt due from the employer to the trustees or managers and any rights under an insurance policy that the actuary considers appropriate to exclude. The estimate of the solvency needs to account for the expenses likely to incur when proceeding to a winding up of the scheme.

The approach suggested in the last paragraph is not practicable to all schemes. When the actuary considers a scheme has some characteristics that inhibit this approach (e.g. if the scheme is too large), the actuary must calculate an estimate of the solvency of the scheme in the way he/she

considers more appropriate, given the specificities of the scheme. When this is the case, the valuation report must include an explanation of the assumptions and methods used in the calculation.

It is important to highlight that an estimate of the cost of buying annuities along with the estimate of the expenses of winding up a scheme are imprecise and subject to changes across time, therefore a statutory solvency estimate is subject to a number of uncertainties and limitations. Some of those are described in the next section.

3.1.3. Statutory solvency estimate – Limitations

The price of a buyout is influenced by numerous factors that may cause substantial fluctuations in those prices over time or even between different insurers at the same date. Changes in market conditions can lead to substantial variations in the terms available at different dates (WTW, 2018). The variability in prices is greatly influenced by the assets available to the insurer and their suitability to match the liabilities being taken on. On the other hand, the existence of means to discharge risk, such as reinsurance, will influence the buyout price as well. The insurer's appetite for writing new business is another factor that leads to differences in prices – for instance, an insurance that has many life insurance policies may accept lower values for the bulk annuities in order to diversify the risk it is exposed to. Mortality risk results from differences between observed and expected mortality rates in an insured population. By contrast, longevity risk is related to the phenomenon of increasing average human lifespans, and tends to affect government pension systems, defined-benefit pension schemes, and life insurers writing annuities (Scordis, Pompella 2017). By issuing life insurance (subject to mortality risk) and taking on a bulk annuity transaction (subject to longevity risk), the insurance company ensures that, if actual mortality is not consistent with the expected mortality, there will be a loss on one side, but a gain on the other, helping to minimize profit losses.

Besides general market factors, buyout prices are dependent on the scheme characteristics. Schemes that allow for options or carry any additional uncertainty will face higher prices, as will schemes with poor quality data or a complex benefit structure.

For large schemes, prices may vary accordingly to whether annuities are bought all from the same insurer or from more than one insurance company.

Summarizing, the estimate of solvency provided in valuation reports is only valid for the effective date of the valuation and could be very different at any other date.

3.2. Solvency calculations for Section 75 purposes

Section 75 of 1995 Act deals with deficiencies in assets. According to it, in a defined benefit or hybrid scheme, whenever the value of the assets of the scheme is not enough to cover the liabilities, the difference between assets and liabilities is to be treated as a debt due to the trustees or managers of the scheme.

Pensions Act 2004 includes a section about failure to make payments (section 228). This section applies to the cases where a specified amount is expected to be paid by or in behalf of the employer or an active member, in accordance to a schedule of contributions, and this amount is not paid on or before the due date. The amount due shall be treated as a debt due from the employer to the trustees or managers of the scheme.

Section 75 debt is calculated on a 'buyout' basis and becomes payable in several scenarios: the employer becomes insolvent, the scheme winds up, the employer has no more active members in the scheme or, in a multi-employer scheme (a pension scheme that is sponsored by different employers who share the costs and the benefits of the scheme, being responsible - in varying proportions - for ensuring the scheme is adequately funded), a participating employer withdraws while the scheme is ongoing.

As for the statutory estimate of solvency, the liabilities for section 75 debt purposes are calculated as an estimate of the price of securing all the scheme's members benefits with an insurance company, including an allowance for the expenses that would arise in an hypothetical wind up.

The actual debt is then calculated as the shortfall between assets and the liabilities calculated for this purpose. In multi-employer schemes, the debt of the departing employer corresponds to the portion of the benefits that were accrued by his/her employees plus a pro-rata share of the scheme's benefits that are not attributed to any participating employer.

This debt may imply very large payments, even when the scheme is fully funded on an ongoing basis, due to the prudent assumptions that need to be used in order to replicate the assumptions used by insurance companies when pricing annuities, and is subject to all the limitations mentioned for the statutory estimate of Solvency.

The calculated debt may not be fully paid - there are some alternatives that should be considered by the trustee, such as: the Deferred Debt Arrangement (DDA), the period of grace notice, the scheme apportionment arrangement, the withdrawal arrangement, the approved withdrawal arrangement or the regulated apportionment arrangement.

The DDA allows the employer to defer the payment of section 75 debt by remaining liable for their share of the liabilities of the scheme and continuing to pay the deficit contributions to the scheme. For this to be an option it's required that the trustee believes that the employer's covenant is unlikely to weaken in the next year and the scheme is not likely to start a PPF assessment within that time.

The "period of grace" notice can be used when an employer no longer employs active members but expects to have active members in the near future. The section 75 debt won't be triggered for a period between 12 and 36 months.

Besides all the approaches mentioned above, if the trustee understands that the departing employer's liabilities are minimal or that there is no weakening of covenant caused by the employer departure, the employer is not liable to pay the section 75 debt.

4. Solvency Basis

Independently of the purpose for which the estimate of solvency is being calculated, the results will be greatly influenced by the economic and demographic assumptions chosen by the trustee under the actuary's advice. As mentioned previously, the assumptions used intend to replicate the assumptions an insurance company would select when calculating the price of securing the scheme's benefits. This chapter consists of a brief description of the derivation of both economic and demographic assumptions used for the solvency estimates performed by Willis Towers Watson. It's important to note that, even though this chapter is based on an internal guidance of the company, for confidentiality reasons, this description cannot be too extensive and will consist basically of public information or any knowledge that doesn't compromise the internal models of the company.

As insurers do not reveal their pricing basis, the assumption basis for solvency estimates are derived by the company performing the solvency estimate. Willis Towers Watson receives data from several insurance companies that is then included in a model used to determine the single discount rate needed to reproduce the pricing provided, expressed as a margin over WTW nominal and real gilt yield curves. The process follows using this data, market knowledge, indicative pricing information, analysis of live quotations, particularly pricing analysis on recent bulk annuity transactions, legislation and the supervision requirements to which insurance companies are subject, to derive a central guidance that is then adjusted to each client according to its specificities.

4.1. Demographic Assumptions

From the demographic assumptions specified in Chapter 2, some are not needed for the solvency valuations. Namely the withdrawal rates won't be needed, given that all the active members will be valued as deferreds for solvency purposes; moreover the valuation is done without allowing for commutation, so commutation assumptions are not needed as well.

Hence there are three main demographic assumptions to be taken into account for a solvency valuation: mortality rates (including the base table and future mortality improvements), proportion married and age difference. These assumptions are described below.

Mortality Rates

For the vast majority of the cases the mortality table to use for the solvency estimation is the best estimate of the base table that would be used for funding purposes.

It is worth to notice that the tables used for funding purposes usually take into account the features of the membership, allowing, for example, for the results of postcode studies (the mortality rates used take into account the areas the members live in, as there are different mortality rates being observed in different areas). However, insurers and reinsurers won't give full credibility to the experience data in small schemes.

Most of the recent Solvency valuation estimates are calculated using the CMI 2016 Core Projections Model (with the default smoothing parameter of 7.5) with a 1.5% pa long term improvement rate. This is adapted to the population of each scheme, mostly if the scheme has a very homogeneous population that leads to the use of different long term improvement rates – This is, for instance, the case of schemes which members are all (or almost all) white collar; a higher long term improvement rate is used as these members are expected to have lower mortality rates.

Proportion Married

The proportion married assumption is dependent on the scheme specificities, the most common approach is to choose an assumption that varies between 80-90% at retirement age for males and 70-80% for females.

Age Difference

As pension schemes usually provide a pension to the spouse of a member following the member's death, it is important to know the age of the spouses of the scheme members in order to accurately make an allowance for the liabilities that may arise in respect of them, if the member dies before the spouse. When this data is not known, an assumption is considered. This assumption is the age difference: it is assumed that the spouse is some years younger/older than the member of the scheme. This assumption is generally different for male and female members (usually male members are assumed to have younger spouses whilst the opposite is assumed for female members).

For solvency purposes, where the actual age difference is known, no assumption is needed, actual data is used as this is what an insurance company would do. Otherwise the scheme's best estimate assumption should be used.

4.2. Economic Assumptions

As mentioned for the demographic assumptions, some of the assumptions specified in Chapter 2 are not needed for the solvency valuation. Same happens for economic assumptions – the salary increase assumption won't be considered in this chapter as it applies only to active members. This means there are two main economic assumptions for solvency estimate valuations: the discount rate and the inflation, to which the pension increases are usually associated.

Discount Rate

The discount rate is calculated by applying a margin to the nominal gilt yield curve. It is the assumption that allows for the fact that liabilities should be higher when there's greater risk or higher uncertainty over the amount to pay. As a result, the margins to apply to the nominal guilt yield curve are dependent on various features of the scheme, some of which are listed below.

1. **The size of the scheme –** When a solvency estimate is being calculated for very large or very small schemes, the margin to apply may be smaller. In both cases there's a reduction in the competition between insurers: either because not all the insurance companies can afford to bid for a large transaction (in this case the hypotheses of securing the benefits with more than one insurer may be considered) or due to the implied amount of time and resources that are required from the insurers, which may reduce their appetite for small schemes transactions when larger schemes are available in the market.
2. **The age profile of the membership –** when the vast majority of the members of the scheme are very young or very old a lower discount rate may be applied.
    a. Young members are associated to the uncertainty over the longevity risk. Furthermore, they represent a longer duration liability, which is linked to an increase in the reinvestment risk – this means that a young population has both higher longevity and reinvestment risk, leading to the application of a lower discount rate.
    b. Insurance companies seek to make a profit in all the transactions. For an older group of pensioners, in order to get the desired profit margin and return on capital, insurers apply a lower discount rate than for a younger group.

3. **Fixed and non-fixed pension increases -** Non-fixed pension increases are more difficult to match with assets, mostly if they have caps and floors. This difficulty can be reflected by using lower discount rates.

4. **Complexity of the benefits –** Schemes with complex benefits require higher costs for the administration of the scheme after the buyout. Moreover, if there are no restrictions in the benefits, such as young spouse reductions or benefits being payable only to a spouse who was married to the member when he/she retired, higher liabilities are expected. Insurers will choose lower discount rates in this case to compensate the expected expenses/increase in liabilities.

5. **State of the scheme's membership data –** Good quality data allows insurers to calculate more accurate liabilities, reducing the uncertainty and consequently leading to higher discount rates.

6. **Scheme's assets –** When the scheme's assets are compatible with the assets usually held by insurance companies the discount rate may be higher. Otherwise, the expenses associated with the disinvestment of existing scheme assets might be included in the price of the buyout.

7. **Mortality risk concentration –** for smaller schemes it is difficult to be sure about the appropriate mortality assumptions to use. To account for this uncertainty, a lower discount rate may be applied. For larger schemes, postcode analysis and others that may impact the mortality assumptions may be taken into account as well.

Besides the schemes' features, the Scheme Actuary takes into account the competitive price tension, when choosing the discount rate to apply.

Inflation

Pricing of benefits when increases are linked to inflation is typically based on full gilt-implied RPI inflation curve adjusted to take into account caps and/or floors to which pension increases are subject (usually insurers price less favourably these benefits given they are more difficult to match exactly). A different adjustment is applied when benefits are linked to CPI as this is usually lower than RPI.

4.3. Expenses on wind-up

Winding up a pension scheme has some associated costs that are included in the solvency estimate.

As mentioned in 4.2, an allowance for some of those expenses, including the insurer's costs of setting up the buyout contract and administration costs, are already included in the discount rate derived to calculate the solvency liabilities.

Other expenses that need to be taken into account separately include adviser costs in managing the scheme through the wind-up process, legal costs of winding up, trustee indemnity insurance, mailing costs and a possible covenant assessment of the chosen insurer.

For the statutory solvency estimate, the expenses estimate used for the purpose of the PPF's Section 179 valuation is considered a good approximation, for liabilities until £100 million, as the expenses incurred are similar. For liabilities over £100 million PPF guidance suggest an allowance of 1% of the liabilities, whilst for the solvency estimate 0.5% is used. These means that an estimate of the expenses may be:

- 3% of liabilities (excluding benefit installation / payment expenses) up to £50 million;
- 2% of liabilities (excluding benefit installation / payment expenses) between £50 million and £100 million;
- 0.5% of liabilities (excluding benefit installation / payment expenses) in excess of £100 million.

5. Case Study

In Chapter 3, several reasons to perform a solvency valuation have been given. In this chapter, we will illustrate three of them (statutory, for buy-in/buyout and section 75) by studying real pension schemes.

The schemes under study are actual WTW clients. Due to the data privacy policy currently in place at WTW, all details that could identify the schemes used for this study are not disclosed, therefore the name of the schemes won't be revealed and amounts have been amended to guarantee they are not recognisable. To ensure the confidentiality of the schemes, some details are either not disclosed or vaguely mentioned, which may cause some explanations to be less clear.

We will study two different pension schemes, which will be referred to as "Scheme X" and "Scheme Y" for this report's purpose. The goal is to illustrate the various purposes of a solvency valuation, its basis (and how it can vary with time) and the comparison between the solvency valuation and other funding measures. In the first scheme presented, the solvency valuation is used to assess the possibility of a buy-in. In the second scheme, a solvency valuation was performed for the purpose of calculating the Section 75 debt. The solvency estimate for statutory purposes will be studied for both schemes, as the comparison between funding levels, however this study will be much more detailed for the first scheme (Scheme X) as the reasoning to reach conclusions would be very similar for both schemes.

5.1. The Scheme under study – Scheme X

5.1.1. Solvency Valuation for statutory purposes

WTW Approach

An estimate of the solvency position at date of each formal valuation is required under the Regulation 7(4) of The Occupational Pension Schemes Regulations 2005. This is calculated in the New Basis Workstage of the WTW valuation process aiming to determine if the plan would be in deficit or surplus in case of a winding up at valuation date, by comparing the actual plan's assets against its liabilities in a winding up scenario.

In practice this is done by modelling the discontinuance of the scheme. As a consequence, all the active members are valued as deferreds while all the other statuses are valued in the same status as they would be for another funding measure, using the specific assumptions derived for

the solvency valuation. As mentioned in Chapter 4, those assumptions are derived based on an internal model that takes into account information from several insurance companies (this information is collected by asking quotations for fictional individuals, with different characteristics, that allow WTW team to estimate fairly accurately the assumptions that were used to calculate those quotations).

Additionally, expenses are added to the liability in line with the wind up expenses described in Chapter 4.

To study the statutory solvency estimate, we start by comparing it with other funding measures.

Solvency vs other funding measures

Scheme X is a pension scheme which membership includes dependants, retirees and deferreds. As the scheme does not have active members, the solvency estimate is calculated in the same way as all the other funding measures. The differences between the results of each funding measure are only due to the different assumptions used. The solvency basis is usually much more prudent than the remaining ones to allow for the prudence that insurance companies use in their estimates.

In the following table there's a comparison between the economic assumptions for three of the approaches to measure the funding position of a scheme mentioned in Chapter 2. Economic assumptions for PPF valuation are not included in the table below as those are pre-defined for all schemes, varying only according the scheme's valuation date (aiming to avoid the identification of this specific scheme's valuation date, PPF assumptions are not disclosed in this report).

	Central Basis	Accounting	Solvency
DR – Pensioners	1.92	2.55	1.90
DR – Non-Pensioners	1.27	2.55	1.25
Increases in deferment	2.6	2.35	2.6
RPI_0_5	3.3	3.05	3.3
CPI_0_3	2.1	1.95	2.1
RPI_3_5	3.8	3.8	3.8

Table 1 Scheme X – Economic Assumptions for different funding measures

Source: Data provided by WTW

For the avoidance of doubt, RPI and CPI are two different measures of inflation (Retail Price Index and Consumer Price Index, respectively). The notation used identifies to which inflation measure the increases are linked along with its cap (minimum value) and floor (maximum value) – as an example, consider the RPI_3_5: it refers to the inflation linked increase with an annual cap and floor of 3% and 5% respectively.

It is clear in this table that the Solvency Estimate is the most prudent of the funding requirements: discount rates (DR) are lower when compared to the other funding requirements' ones, whilst all the pension increase assumptions are higher, as well as in deferment pension increases. We would expect a big difference between the liabilities for Solvency Valuation and the ones related to the ongoing valuation (central basis), however, for this valuation, the Trustees and Company agreed to set the technical provisions assumptions in line with the cost of securing benefits with an insurance company, which caused the assumptions for Central Basis (that has the technical provisions assumptions) and Solvency to be very similar.

PPF assumptions can be compared to the ones in the table as follows: the discount rate used is lower than the ones used for all the other funding requirements, increases in deferment are generally higher and increases in payment for post 97 benefits are smaller. It is worth noting that PPF considers the statutory increases in payment for pre 97 benefits, which are 0%. Besides, as mentioned in Chapter 2, the PPF pension is subject to a cap, which will decrease the liabilities.

The demographic assumptions will have a major impact on the funding level as well. The following table includes the demographic assumptions for the different funding measures considered.

		Central Basis	**Solvency Basis**	**Accounting Basis**
Base Table	Male	S2NMA-L	S2NMA-L	S2NMA-L
	Female	S2PFA-L	S2PFA-L	S2PFA-L
Multiplier	Male	1	1	1
	Female	1	1	1
Improvements	Male	CMI_2016_M_(1_75%)	CMI_2016_M_(1_75%)	CMI_2017_M_(1_50%)
	Female	CMI_2016_F_(1_75%)	CMI_2016_F_(1_75%)	CMI_2017_F_(1_50%)
Proportion Married	Male	90%	90%	90%
	Female	90%	90%	90%
Age Difference	Male	3	3	3
	Female	-3	-3	-3

Commutation Percentage	Male	0%	0%	10%
	Female	0%	0%	10%

Table 2 Scheme X - Demographic Assumptions for different funding measures

Source: Data provided by WTW

As shown in table 2, the demographic assumptions used for the Central Basis were exactly the same as the ones for Solvency – as it was expected due to the decision of having the technical provisions in line the cost of securing benefit with an insurance company.

Accounting Basis and Solvency Basis in this valuation have very similar demographic assumptions: proportion married, age difference and mortality tables are equal for both, however the Accounting Basis uses a slightly different set of mortality improvements. The mortality improvements considered for the Accounting Basis are slightly less conservative than the ones used for central and solvency basis (this has an impact of around 2% in the total liabilities).

For PPF, the demographic bases used assume a proportion married at retirement of 85% for males and 75% for females.

Solvency Basis, Central Basis and PPF assumed no commutation, whilst the accounting valuation assumed 10% commutation, with the commutation factor at the average payment age equal to 25.1. Allowing for expected commutation gives rise to a considerable reduction in the deferred liabilities, since the cost to the scheme of providing a lump sum is significantly lower than the value of the pension that would be given up in exchange for a lump sum ("commuted pension"). This is because the basis used to convert the commuted pension to a lump sum does not include any allowance for prudence, whereas the solvency, central and PPF bases include significant margins for prudence.

The funding levels on the different approaches are as follows.

	Central Basis	**Accounting**	**PPF**	**Solvency**
Funding Level	106%	129%	155%	104%

Table 3 Scheme X – Comparison between funding levels on different basis

Source: Data provided by WTW

As the Central Basis was set in order to calculate the cost of securing benefits with an insurer, the difference in the funding level between this and the Solvency is very small and due mostly to a difference in the estimated expenses: the central basis considers only the expected expenses related to GMP equalisation, GMP reconciliation or other unknown liabilities, whereas the Solvency expenses include the expected cost of winding up the scheme as well.

The funding level for the accounting valuation is much higher than the Solvency one. This is due to differences in the economic and demographic assumptions as well as in the expenses considered. As mentioned before, the economic assumptions used for solvency are more prudent than the ones applied for accounting, and the difference in the mortality assumptions represent around 2% of the difference in the liabilities. Also, solvency valuations never include allowances for commutation, but for accounting purposes commutation was allowed - this represents an increase of almost 5% in the deferred members' liability (and around 1.6% in the overall liability). The remaining difference is explained by the expenses, as the solvency valuation includes the expected expenses on wind up.

Comparing the PPF with the Solvency valuation, we can conclude that there's a considerable difference in the funding levels: although the economic assumptions for PPF are slightly more conservative than the ones that were used for the solvency valuation, the liabilities arising from the solvency valuation are much higher both due to more conservative demographic assumptions applied for solvency valuation, smaller compensation increases for PPF (being the biggest difference for benefits accrued before 06 April 1997, that are not subject to any increase under PPF basis, but increase in line with inflation in a solvency basis) and to the fact that there's no cap affecting the pension that is valued for solvency purposes, contrary to what happens for the PPF compensation.

In general, the Solvency Basis is the most prudent, followed by the PPF Basis and the accounting basis. The Central Basis will depend on what's agreed with the Trustee and the Company. At the valuation considered, for the scheme under study, the basis used were very similar to the solvency ones and consequently, prudent. However, this is not usually the case. As an example, we can consider the assumptions used for the same scheme in the previous valuation.

	Central Basis	Solvency
DR – Pensioners	2.25	2.10
DR – Non-Pensioners	2.25	1.70
CPI	2.55	3.25
RPI_0_5	2.95	3.00
CPI_0_3	2.05	2.25
RPI_3_5	3.00	3.00

Table 4 Scheme X – Last Valuation economic assumptions

Source: Data provided by WTW

It is clear from the table above that the assumptions used for Solvency purposes were more prudent than the ones used for the central basis.

The demographic basis used were the same for both ongoing and Solvency Valuations and there was no allowance for commutation in neither.

The difference in the economic assumptions, along with different expected expenses (always higher for solvency as there's an allowance for the expenses incurred on the winding up of the scheme), led to different funding levels: 86% on a Solvency Basis and 93% on an ongoing basis.

The difference between ongoing and solvency basis can be even more significant. Usually there's an allowance for commutation on an ongoing basis that decreases considerably the liabilities for deferred and active members and a higher difference between economic assumptions, particularly on the discount rate, that usually causes considerably lower liabilities on an ongoing basis. Scheme Y is one good example of how the funding levels for Solvency and Ongoing valuations may differ, as we will see on section 5.2 of this report.

Solvency Ratios – comparison between valuations

Scheme's X solvency ratio has been increasing over the last three valuations. The evolution of this ratio is illustrated in the next graph where the difference between two consecutive valuations is exactly three years. The second graph shows the evolution of both assets and liabilities in the three valuations considered (where valuation 3 is the main valuation being analysed in this report until now, and valuation 1 and 2 are previous valuations of the same scheme).

Figure 1 Scheme X - Solvency Ratios across valuations

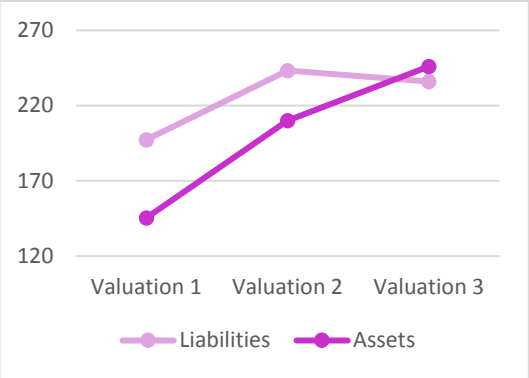

Figure 2 Scheme X - Assets and Liabilities (£m) across different valuations

Source: Data provided by WTW

In 6 years the Solvency ratio increased 30 percentage points. We can see in graph two that from the first to the second valuation, the liabilities increased, as did the solvency ratio. This is mostly due to a good investment performance, which was better than assumed, and high deficit reduction payments made by the employer over the intervaluation period. These two factors were the same that lead to an increase of around 18% in the assets during the intervaluation period from valuation 2 to valuation 3. This, along with a small decrease in liabilities (around 3%), allowed the scheme to have a much higher solvency ratio, being overfunded on a Solvency Basis in the most recent valuation considered.

As mentioned in Chapter 4, a solvency estimate cannot be relied upon to indicate the position on a future wind-up as it is dependent both on market conditions and on the supply and demand for annuities. However, the fact that the scheme is overfunded on a solvency basis is a good indicator that buy-ins, buyouts our even winding up the scheme are strong possibilities, if the trustee wishes to go on a de-risking strategy. In the case of Scheme X, the possibility of a full buy-in was assessed, as described in the next section of this report.

5.1.2. Solvency Valuation as a proxy to a buy in/buy out

As the solvency basis is derived in order to estimate the price of securing the scheme's members benefits with an insurance company, it can be used to derive the expected price of a buy-in or a buyout and be the basis for the negotiation of annuities prices with an insurer, always bearing in mind that this should be done as close to the expected date of the actual transaction as possible, to take the adequate market conditions into consideration.

For this part of the study, we will consider Scheme X and a possible full Plan buy-in, to happen a few months after Valuation 3 (the valuation considered in precedent sections). The date of valuation of this possible buy-in will be addressed as Valuation 4.

In the following table the assumptions used for the statutory estimate of solvency on Valuation 3 and to calculate the expected price of the buy-in (Valuation 4) are described.

	Statutory Solvency estimate (Valuation 3)	**Solvency for buy-in estimate (Valuation 4)**
DR – Pensioners	1.90	1.55
DR – Non-Pensioners	1.25	1.20
CPI	2.60	2.55
RPI_0_5	3.30	3.45
CPI_0_3	2.10	2.70
RPI_3_5	3.80	4.00

Table 5 Scheme X - Economic assumptions for Solvency Valuations 3 and 4

Source: Data provided by WTW

The economic assumptions used for the buy-in estimate were more prudent than the ones used for the statutory solvency estimate, so we expect an increase on the liabilities calculated. This reveals a more prudent approach and it's a consequence of the differences in the economic environment and market conditions between those two dates, which is reflected in the gilt yield curves and, consequently in the assumptions used.

The discount rate included in a Solvency Basis is based on the nominal gilt yield curve as at the effective date of the valuation. In the following graphs, there's the evolution of the nominal and real gilt yield curve of a UK 15 - Year Bond, as well as the implied inflation (difference between nominal and real yields) in the same period. For further information on gilt yields, please refer to the appendix.

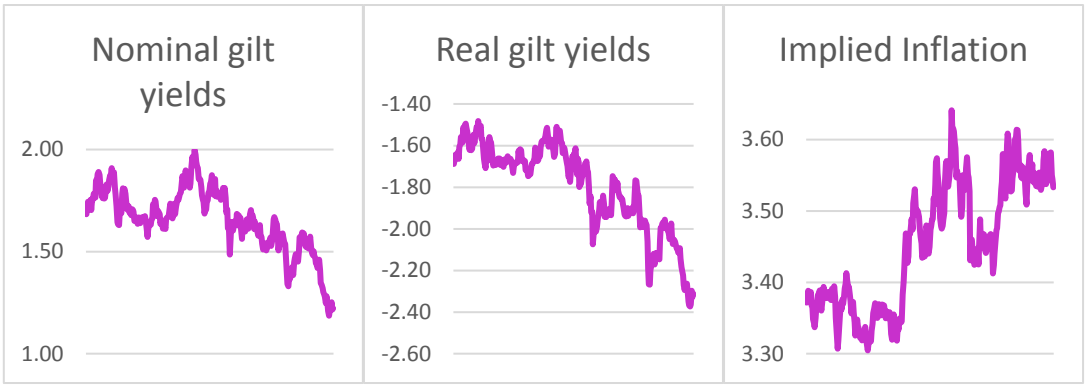

Figure 3 Scheme X - UK 15 Year Bond - Nominal gilt yields between valuations 3 and 4

Source: Bank of England

Figure 4 Scheme X - UK 15 Year Bond - Real gilt yields between valuations 3 and 4

Source: Bank of England

Figure 5 Scheme X - UK 15 Year Bond - Implied Inflation between valuations 3 and 4

Source: Bank of England

Valuation 3 and 4 happened around the beginning and the end of the time considered in the graphs above, respectively. There was a clear decrease in the nominal gilt yields between those two dates, what explains the decrease in the discount rate, considering that the discount rate used in the solvency basis is directly linked to the nominal gilt yield curve.

Furthermore, there's a visible increase in the implied inflation, which would explain the increase in the inflation linked assumptions.

On the other hand, the demographic assumptions were the same for both estimates, so no material difference is expected related to these assumptions.

There were some differences in the membership of the scheme between the two valuations that justify part of the changes in the liabilities:

- Some members left the deferred status. Those members represent 13% of the liability of the deferred members in Valuation 3.
- Some members left retiree and dependant statuses, but those members represent less than 1% of the liability of the respective status, so we do not expect a big impact due to this change.
- New dependant members represent 5% of the new liability of this status.
- There were pension increases in the intervaluation period – these were generally higher than what was assumed in Valuation 3.

Summing up, the assets of the scheme increased around 1.7% between Valuation 3 and Valuation 4, whilst the liabilities increased around 2.3%. This leads to a funding level of 103.4%.

An insurance company was contacted to provide a quotation for a full Plan buy-in, and the initial liability calculated by the insurance company (and consequently the premium being asked to secure all the benefits of the members of the scheme) was around 2% higher than what WTW estimated – this is expected for an initial quotation as it is still subject to changes and is expected to decrease during the negotiations.

The funding level of the scheme on the basis used by the insurance company is 101.7%, so a buy-in is still possible under these circumstances. If the trustee prefers a full buyout, additional expenses on winding-up should be applied to this – these expenses are expected to be around 1.5% of the liability estimated (following the expenses formula presented on Chapter 4). Adding these expenses to the liability suggested by the insurer, the scheme is still overfunded, which means that a buyout is likely to happen.

In this example we can see how accurate the Solvency Valuation is to estimate the price of a buy in/buyout, as long as it is calculated on the moment the transaction is expected to happen: the quotation from the insurance company is exactly within the expected range of values (a bit higher than what was estimated due to being a first quotation), however it is clear that the estimate calculated on Valuation 3 is not as accurate for Valuation 4 (the difference between the figures calculated on valuation 3 and the insurance company's quotation at Valuation 4 date is over 3%).

5.2. The Scheme under study – Scheme Y

Contrary to Scheme X, Scheme Y membership includes four membership statuses: actives, deferreds, retirees and dependants.

As the solvency for statutory purposes and the comparison between the solvency valuation and other funding measures were already deeply analysed for scheme X, in this section, there will be only a broad comparison with the central basis, to show the impact of having active members. Another purpose is to highlight the difference between funding levels on a scheme which trustee doesn't set the technical provisions to be in line with the price of securing the benefits with an insurance company.

This scheme will then be analysed on a section 75 debt perspective, to make clearer what's the purpose of this type of solvency valuations.

It is worth noting that for simplicity, we are only analysing the assumptions that are common to the ones used for Scheme X. Additionally there are some scenarios that are set to be able to illustrate the different situations that may arise on a Section 75 debt, but are not real for the scheme considered.

5.2.1. Solvency Valuation for statutory purposes

In the table below there's a description of some of the economic assumptions used for the ongoing valuation and for the solvency basis.

	Central Basis	Solvency Basis
DR – Pensioners	2.5	1.93
DR – Non-Pensioners	2.5	1.37
CPI	2.15	2.57
RPI_0_5	2.95	3.34
CPI_0_3	1.85	2.68
RPI_3_5	3.75	3.87

Table 6 Scheme Y – Valuation 1 Economic assumptions on different basis

Source: Data provided by WTW

The assumptions used for solvency are much more prudent than the ones used for the ongoing valuation, as expected.

Regarding the demographic assumptions, there was an increase of 5 percentage points in the proportion married assumed for solvency. Additionally the mortality improvements applied are more conservative for the solvency valuation and, for the central basis, there was an allowance for commutation.

No expenses were considered for the ongoing valuation, whereas the usual expected expenses on the wind up of the scheme were considered for solvency purposes.

These differences led to a relatively high difference between the funding levels of these two valuations – being 69.2% the funding level on a solvency basis and 95.9% on an ongoing (central) basis.

All statuses had an increase in the liability when passing from the ongoing to the solvency basis, however, this difference is much more significant for some statuses than for others, as shown in the following table.

Status	Difference in liability
Actives	47.2%
Deferreds	58.3%
Retirees	16.0%
Dependants	12.2%

Table 7 Scheme Y - Comparison of the liability by status for ongoing and solvency valuations

Source: Data provided by WTW

The difference is smaller for pensioners – as mentioned before, as the uncertainty is lower for pensioners, insurance companies have prices more similar to the ones on an ongoing basis.

Regarding non-pensioners, the difference is higher and there's a considerable difference between the percentage shown for actives and deferreds - this may lead to the question "why is the difference for deferreds much higher than the one for actives?". The answer to this question is mainly linked to the fact that actives are valued as deferred members for solvency purposes (so uncertainty would be the same for both statuses), but the way liabilities are calculated for actives and deferred members will lead to a decrease in the difference for actives:

- if a member is valued as an active, his/her pension is calculated as follows (where salesc represents the assumption for salary increases):

$$Pensionable\ Salary \times Salesc^{NRA-AGE} \times Years\ of\ Service \times Accrual$$

- if an active member is valued as deferred, his/her pension is calculated as follows (where Rev represents the revaluation assumption – linked to inflation):

$$Pensionable\ Salary \times Years\ of\ Service \times Accrual \times Rev^{NRA-AGE}$$

- salary increases are almost always assumed to be higher than inflation;
- this leads to a decrease in the liabilities when actives are valued as deferreds.

Hence, the active members' liabilities for solvency and ongoing valuations increases for the solvency valuation due to more conservative assumptions and no allowance for commutation

(as it does for deferred members), but is attenuated by the decrease in liabilities caused by the assumption of the discontinuance of the scheme.

5.2.2. Solvency Valuation for Section 75

Scheme Y is a multi-employer scheme. If an employer wants to withdraw from these type of scheme, or if one employer ceases having active members, a section 75 debt is triggered. For scheme Y, the calculations for this purpose were based on the assumptions described below.

	Statutory Solvency (Valuation 1)	Section 75 debt (Valuation 2)
DR – Pensioners	1.93	2.01
DR – Non-Pensioners	1.37	1.60
CPI	2.57	2.68
RPI_0_5	3.34	3.46
CPI_0_3	2.68	2.79
RPI_3_5	3.87	3.99

Table 8 Scheme Y - Economic assumptions for Solvency - Valuations 1 and 2

Source: Data provided by WTW

To do a similar analysis to what was done for scheme X, in the graphs below there's the nominal and real gilt yields curve (for a UK 15 years gilt) for the period between the statutory solvency valuation and the section 75 debt valuation, and the implied inflation for the same period.

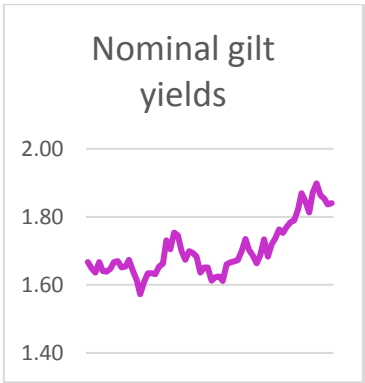

Figure 6 Scheme Y - UK 15 Year Bond - Nominal gilt yields between valuations 1 and 2

Source: Bank of England

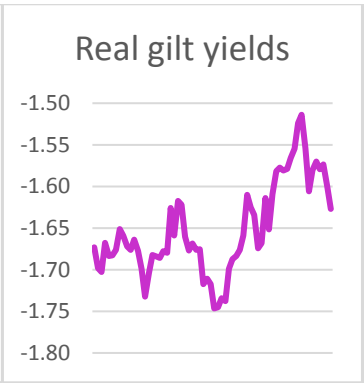

Figure 7 Scheme Y - UK 15 Year Bond - Real gilt yields between valuations 1 and 2

Source: Bank of England

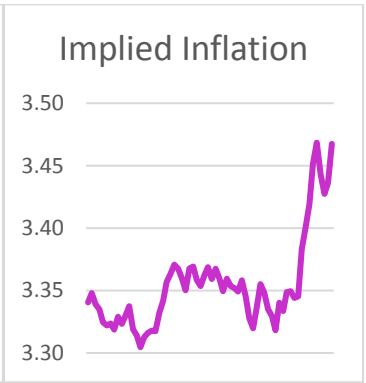

Figure 8 Scheme Y - UK 15 Year Bond - Implied Inflation between valuations 1 and 2

Source: Bank of England

Both the nominal rates and the implied inflation increased in the intervaluation period, justifying the increase in the discount rate and inflation linked assumptions used for the section 75 debt purposes.

The liabilities on a Solvency basis were calculated by employer, for the calculation of the section 75 debt, so that it is clear for each employer the amounts they are liable for. In order to leave the scheme, an employer needs to pay enough contributions to settle his/her debt.

The scheme has a shortfall between assets and liabilities, on a solvency basis, of around £150m. It has 5 employers and each one is liable for the following percentage of this debt:

EMPLOYER	**1**	**2**	**3**	**4**	**5**
% LIABILITY	12%	3%	81%	1.9%	2.1%

Table 9 Scheme Y - Share of liability by employer

In order to illustrate what would happen if one employer wanted to leave the scheme, let's consider that employer 2 wants to withdraw. To be able to do that, the sponsor company has to pay the equivalent of 3% of the debt calculated (would be entitled to pay around £4,500k). This aims to ensure that the employer leaving the scheme won't have any negative impact on the scheme funding, neither in the short or in the long run.

Assume now, that 5 refers to an employer that left the scheme before the rules for section 75 were in place. Then there's no employer directly liable for those liabilities, which are called "orphan liabilities". In this case, for employer 2 to leave the scheme he/she needs to pay the 3% of the debt, plus a share of the 2.1% that correspond to orphan liabilities. Hence, to the 3% of the debt we need to add 3% of 2.1% which corresponds to 0.063% - concluding that employer 2 is liable for 3.063% of the total debt (almost £4,600k).

6. Conclusion

The internship at Willis Towers Watson was a great opportunity to learn more about pension schemes and to develop knowledge on the particularities of the UK pension schemes. Special attention was given to the regulatory framework that includes the statutory solvency valuation, having performed several solvency valuations during those 5 months. Valuations for Section 75 debt calculation or for buy-in/buyout purposes were less common, but still enough to understand the main propositions behind them. This, complemented with research, lead to the results presented in this report.

Throughout this report, we tried to show that the solvency basis is usually the most prudent basis, being the economic assumptions on this basis strongly connected with the economic conditions in the UK. Good economic conditions will lead investors to risk, investing in more risky assets, causing the gilt yields to rise, to attract more investors. Otherwise, if the economic conditions are not so good, investors prefer the safety of gilts, and the increase in the search for gilts will cause the yields to decrease. Both discount rates and inflation are derived having the gilt yield curve as a base, so changes in the gilt yield curve will lead to changes in the economic assumptions to use.

It is clear from the results presented in this report that a small change in the assumptions may have a great impact on liabilities and on the funding level – this shows how the choice of assumptions adequate to a specific valuation date is important for the accuracy of the solvency estimate. A solvency estimate may be very close to the price an insurer would ask, at the valuation date, to secure the scheme's benefits, but in some months, the quotation provided by an insurance company could be quite different due to the changes in the market conditions.

Regarding the three purposes for solvency valuations that were considered in this work, it is clear that they have many things in common. The derivation of the basis is done under the same guidelines and the valuation proceeds in the same way for the three purposes.

We have seen that the statutory solvency valuation is a great indicator of the possibility of de-risking by doing a bulk annuity transaction, and although there are not many schemes funded on a solvency basis, the number of these transactions have been increasing over the last years, particularly for pensioners. This trend is expected to continue.

It is then reasonable to anticipate that the solvency basis and consequent valuation assume an increasing importance in the next few years, mostly for the de-risking of defined benefit pension schemes.

This increasing importance may lead to further studies on this topic. One of those studies could be about the margins of prudence applied for the inflation risks when calculating the price of buy-ins and how/if the schemes can find a work around this: as insurers will always require high margins of prudence for every risk, it may be on the schemes' interest to keep the inflation risk and secure the remaining ones. This can be done by securing the member's pension with 0% increases instead of the inflation linked increases that are actually due to the member. This way, the insurance company would pay the members' pension and the scheme would be liable to pay the inflation-linked increases on top of the pension paid by the insurance company. It would be interesting to assess if this is more profitable to pension schemes than the typical buy-in.

Both the internship and the writing of this report allowed me to learn and discover new topics of interest, growing both academically and professionally.

Appendix - Gilts

Gilts are nominal bonds issued by the UK Government to fund its borrowing. There are different types of gilts and we will describe two in this report: conventional gilts, which are the most common ones, and index-linked gilts.

A conventional gilt is denoted by its coupon rate, which usually reflects the market interest rate at the time of the first issue of the gilt, and maturity. The coupon specifies the percentage of the nominal that the holder will receive each year – this amount is then divided by two and paid every six months. The maturity reflects how long the British Government will take to pay back the nominal value of the gilt. Maturities vary and can go up to 55 years (UK Debt Management Office, 2019).

Index-linked gilts differ from conventional gilts as the coupon payments and the principal are adjusted in line with RPI, to take into account the accrued inflation since the gilt was issued.

The graphs presented in Chapter 5 of this report include nominal/real gilt yields and the implied inflation that correspond to:

- Nominal gilt yields – refers to the spot interest rate applicable today on a 15 year risk free nominal loan, based on conventional gilts.
- Real gilt yields - refers to the spot interest rate applicable today on a 15 year risk free loan, based on index linked gilts.
- Implied inflation rates – The nominal rates considered include the real interest rate plus a compensation for the decrease in the purchasing power of this investment by inflation (Bank of England, 2019). The implied inflation rates are calculated using the nominal and real gilt yields, accordingly to the Fisher relationship, described below.

$$Real\ interest\ rate = Nominal\ interest\ rate - Expected\ inflation\ rate$$

Investing in gilts is considered risk free, as until now the British Government has never failed to pay coupons or the nominal amount as they fall due – this also means that the returns are very low. However, the low risk attracts insurers, which is why gilts are so important in the construction of a solvency basis.

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