Actuarial Valuation of Pension Schemes- An Irish Perspective

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Abstract

The liabilities of a pension plan are monetary amounts to be paid at various times in the future.The current legal and regulatory framework for Irish occupational pension schemes can result in three different valuations for a scheme at any particular point in time. Using valuation models, this paper considers whether across the three different valuation bases, there is consistency in the sensitivity of the reported results to changes in the key actuarial assumptions and what are the most sensitive assumptions under each calculation basis. It questions whether this current valuation framework creates potential hazards for scheme trustees who are charged with governance of the scheme and are ultimately responsible for the key decision making processes within the scheme.

JEL Classification: M40.

Key Words: sensitivity, transparency, complexity

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1. INTRODUCTION

The pensions system in Ireland (in common with many other countries) has two main elements, a State run Social Welfare system and a system of private, voluntary, supplementary, pensions provided through a variety of arrangements and regulated by the State. A sizeable proportion of voluntary pension arrangements take the form of occupational pension schemes, that is, privately managed pension schemes offered by employers to some or all employees as part of an overall remuneration package. These schemes are funded by contributions by the employer and also in many cases the employees, the objective being that the contributions together with the return from the investment of the contributions will provide a targeted level of replacement income on retirement to complement the employee's social security pension. For employees, the vast majority of voluntary pension arrangements are either defined benefit (DB) or defined contribution (DC) schemes. A DB scheme is one where the pension on retirement is fixed in advance usually as a proportion of the member's salary in their last year of service or based on an average of their annual earnings over a number of years. The level of contribution by the employer /employee is set at a level which is actuarially calculated to produce the targeted pension on retirement. In the event of a shortfall, the employer commits to make up the deficit so that the promised level of pension is met. The risk for the employee in a DB scheme is that the employer is financially unable or unwilling to honour this guarantee. DC schemes do not have an employer guarantee (all investment risk is borne by the employee). In the absence of this guarantee pension payments become a function of returns.

The principal objective of any pension arrangement is that it meets its' targeted pension liabilities as they fall due. At any particular point in the life of a pension scheme, its' ability to meet its' targeted pension liabilities can, (and is required by regulation to) be assessed, although this can only be a best estimate given that the future is always uncertain.A valuation exercise for a defined benefit scheme requires assessment of both the scheme's assets and its liabilities. While there may be some subjectivity in the valuation of certain types of assets (where for example there is no ready market (more prevalent during recessionary times) or where it is considered appropriate to use a smoothed value), the main area of estimation arises in relation to the valuation of liabilities. This is further complicated in the Irish context, by the fact that the basis of valuation is different, depending on whether the valuation is for the regulator, the scheme trustees, or the sponsoring company's shareholders. The issue is complicated further still, at

least for stakeholders, by the fact that disclosures as to the sensitivity of a valuation result to key valuation assumptions are minimal, and in some instances, non-existent (see O'Brien, Woods and Billings (2010) for example in the case of IAS 19 disclosures by relevant FTSE 100 companies).

These issues are important because the flexibility in assumption setting and the lack of standardised sensitivity analysis disclosures in annual reports create potential hazards for scheme trustees who are charged with governance of the scheme and are ultimately responsible for the key decision making processes within the scheme. Most Irish pension schemes are legally structured as trusts [1] and the board of trustees of the scheme has ultimate responsibility for the management of the pension schemes' affairs.[2] While trustees may take advice from appropriate experts, case law[3]has held that "It is for advisors to advise and for trustees to decide". Consequently, the existence of three valuation frameworks, flexibility in assumption setting, inconsistency in importance of actuarial assumptions across the three frameworks and non-standardised sensitivity disclosures, potentially provide a challenge for trustees in fulfilling their trustee duties, notwithstanding the availability of expert advice from third parties. A new era for scheme trustees has arrived where trustees are required to oversee in some cases pension scheme closure and in others considerable pension scheme restructuring such as changes in pension entitlements and increased contributions. The current recession is the first time for many schemes to encounter deficits which threaten the viability of many schemes, with consequent implications for the role and liability of trustees. It follows that when pension schemes fail to deliver on pension promises, scheme trustees are accountable to scheme members for their actions. Trustees could have a case to answer if they are found to have presided over periods where actuarial assumptions adapted were ultimately found to be less than realistic.

With this in mind, the principal objective of this paper is to consider in the context of defined benefit pension schemes, whether the existing valuation framework in Ireland which requires a different calculation basis depending on whether the valuation is for the regulator, the scheme members or the sponsoring company's shareholders, incorporates a level of flexibility, complexity and disjointedness which poses challenges for trustees charged with governance of pension schemes. Secondly the paper considers whether across the three different valuation bases, there is consistency in the sensitivity of the reported results to changes in the key actuarial assumptions and what are the most sensitive assumptions

under each calculation basis.[4]While it is well established in the international literature that changes in key assumptions can and do have a significant impact on valuation results (see Lane, Clarke and Peacock (2008) for example), work in this area in the Irish context and the implications of such flexibility for scheme governance is minimal.[5]Finally the paper considers the consequent practical issues for trustees charged with the governance of pension schemes.

The paper proceeds as follows. In the next section, we describe the three valuation models which form the framework for the valuation of pension scheme liabilities in Ireland. Section 3 describes our methodology and approach. Sections 4 and 5 discuss our principal findings and section 6 concludes.

2. WHY ARE ACTUARIAL LIABILITIES CALCULATED?

The valuation of a defined benefit pension scheme's assets and liabilities is required in at least three different circumstances. It may be required for the purposes of determining whether the fund satisfies the minimum funding standard valuation set down by the regulatory authority. The fund trustees may also require a valuation to review contribution rates and for the purposes of their annual trust report to the members of the pension scheme. Finally in the case of a defined benefit scheme, a valuation may be required for the purposes of the financial statements of the sponsoring company, to recognize the "fair value" of the surplus or deficit in the pension scheme.

What is interesting is that there is no specific requirement for consistency in the valuation assumptions used in each of the three valuation processes. At any given valuation date therefore, a defined benefit scheme may have three different valuation results, required for three different purposes, each of which would be regarded as fully acceptable for its specific purpose and to its specific target audience. Indeed, as can be seen in subsequent paragraphs, the prescribed guidelines to be followed in each of the three valuation processes in themselves necessitate differing assumptions and calculation bases and different emphasis in the produced results. For the remainder of this paper we will refer to the alternate valuations required for the purposes of the regulator, the trustees and sponsoring company's financial statements as the MSF, Trustee and IAS 19 valuations, respectively. In what follows, we briefly describe the most salient features of each in turn.

THE MFS VALUATION

The objective of the MFS valuation is effectively to establish whether the scheme is holding sufficient assets to meet the benefits which have already accrued to members at the date of the valuation, i.e. if the scheme were to be wound up on the valuation date. Irish pension schemes are regulated by the Pensions Board, a statutory body set up by the Irish Government under the Pensions Act 1990. The MFS was introduced by the Pensions Board in 1991 (it was provided for in S. 44 of the Pensions Act 1990) in order to set out the minimum assets that a defined benefit scheme must hold and what steps must be taken if the assets of the scheme fall below this minimum. The funding standard is satisfied if, broadly, in the actuary's opinion, the scheme's assets on the date of the valuation are more than the sum of; (1) the transfer values at that date (see later) to which the members would be entitled to; and (2) the estimated expenses of winding up the scheme.

All pension schemes are required to register with the Pensions Board and subject to some exceptions[6]; all defined benefit schemes must submit an Actuarial Funding Certificate (AFC) to the Board every three years. This certificate states whether in the Actuary's opinion, the resources of the scheme would/would not be sufficient, if the scheme were wound up, to provide for the liabilities of the scheme under the Pensions Act, and the estimated expenses of administering the winding up of the scheme, i.e. whether the scheme satisfies the funding standard of the Act.

If an AFC indicates that, in the actuary's opinion, the scheme does not satisfy the funding standard, the scheme trustees must submit a funding proposal with the AFC to the Pensions Board. The funding proposal must set out the contribution plan to be undertaken which the scheme actuary can certify as being sufficient to allow the scheme satisfy the funding standard within the period of the proposal. The period of the proposal was restricted to three years up until 2003 but since 2003, given the growing number of DB schemes in deficit, the Pensions Board has allowed in certain circumstances a longer period of exemption.

The guidelines to be followed by a scheme actuary in valuing the assets and liabilities of a pension scheme for the purposes of determining whether it complies with the Funding Standard are included in Actuarial Statements of Practice (ASP PEN3 and ASP PEN 2) issued, by the Society of Actuaries in

Ireland and periodically updated.[7]The legal basis for the guidelines is Section 42(4) of the Pensions Act 1990 which refers to "applicable professional guidance issued by the Society of Actuaries in Ireland" For the purposes of the funding standard, assets must be valued at their realizable value at the effective date with allowance being made for the expenses of sale where appropriate. Liabilities can broadly be split between pensions currently payable to pensioners and deferred pension entitlements (for all active members. i.e. employees and former employees who have not yet reached retirement age and have future pension entitlements from the scheme). The cost of pensions in payment can be determined by reference to the cost of an equivalent annuity or annuities. The value of deferred pension entitlements is taken as the individual transfer values to which each member would be entitled if he or she had transferred out of the scheme at that date. The transfer is calculated by projecting the benefit payments to which the members will be entitled based on their employment to date, including an appropriate margin for mortality improvement and assuming a prescribed investment return rate as a discount factor, calculating the size of the fund required in today's terms to meet the projected benefit payments. The prescribed investment return is calculated assuming investment in equities (assumed to generate a return in excess of the fixed interest rate, i.e. an equity premium or a return over and above the fixed interest rate to compensate for the fact that equities are a riskier investment) until 10 years before normal retirement age and thereafter, a mix of equity and fixed interest investments with the proportion of fixed interest investments gradually increasing to 100 per cent by normal retirement age.

THE TRUSTEE VALUATION

Section 56 of the Pensions Act 1990 (supplemented by S.I. No 301 of 2006), requires the trustees of a defined benefit pension scheme to have audited financial statements produced annually for the scheme and to have the assets and liabilities of the scheme valued by the actuary of the scheme at such times as may be prescribed. When the legislation was first introduced, the requirement was for a valuation every 3 or 3 and 1/2 years, depending on the nature of the scheme and when it was established. With effect from 23 September 2005, the period between valuations became 3 years for all schemes. The main purpose of this valuation is to assess an appropriate funding/contribution rate from the employer/employees for the scheme.

Actuarial Standard of Practice PEN 1 (ASP PEN 1) Funding Defined Benefits- Actuarial Reports, (Society of Actuaries 2010[8]) sets out the blueprint for actuaries carrying out a valuation for the purposes of S.56 of the Pensions Act 1990. A valuation report issued in accordance with ASP PEN 1 must state the value of the schemes' assets (at market value), and a statement of the benefits payable under the scheme. This will include the value of accrued liabilities (in respect of past service) and liabilities in respect of future service. It should also state the funding level on which the valuation is based and recommend the level of contribution required, consistent with the funding objectives of the scheme until the next actuarial valuation. The level at which the employer and/or the employees must contribute to the scheme in order to meet their commitments under the scheme i.e. the funding level, will be based on a wide variety of assumptions. These include projected rates of return on contributions invested, numbers and ages of members entering and leaving the scheme, mortality rates of members, early retirement rates and salaries of members on retirement. These assumptions can be estimated based on previous experience (for example, mortality rates) and expectations for the future (for example future returns). ASP PEN 1 states that it is not intended to restrict the actuary's freedom of judgement in choosing the method of valuation and the underlying assumptions employed in deriving the level of contribution required but it is intended to ensure that the methods and assumptions used are properly explained and that variations between the assumptions chosen and actual experience are analysed in the report. The report must contain a summary of the demographic and economic assumptions made explicitly and implicitly, in valuing the liabilities, target benefits and scheme assets.

The level of subjectivity in a trustee valuation is far greater than in a MFS valuation given that the former valuation will encompass assumptions on future outcomes in a number of key areas. With effect from 2011, the law requires that the trustees' annual report to scheme members must also include a copy of the latest Actuarial Funding Certificate together with an up to date Actuarial Statement of the schemes' funding position at the last date of the period to which the annual report relates. A trustee annual report may therefore incorporate references to two different valuation processes. The challenge currently for trustees is to understand and reconcile these different valuation processes. Notwithstanding the existence of investment advisers to the scheme, trustees could find themselves exposed to a legal challenge for non-

performance of duties if they are not informed sufficiently as to the robustness of the valuation results and try to abdicate their responsibilities in this regard in favour of the actuary.

THE IAS 19 VALUATION

Accounting for defined benefit plans in the financial statements of the sponsoring company is a complex matter. The complexity arises because the employer must, in each accounting period, recognize as an expense in its income statement/profit and loss account the cost to the employer of the retirement benefits that will eventually be paid to employees as a result of the services that they have provided during the period. Because these benefits may be payable in many years' time and their cost will depend on a number of factors (e.g. mortality, return on investments etc.), which are difficult to determine in advance, the calculation of the expense which should be recognized in an accounting period is not straightforward. As the sponsoring company potentially carries the risk of any shortfall arising on a defined benefit scheme (i.e. if amounts contributed by both the employer and the employee, together with the net investment return on such contributions were insufficient to pay the scheme pensions and benefits as they fall due), such a shortfall if it were to exist, could constitute a medium to long term liability of the sponsoring company, over and above its annual funding commitment and need to be recognized as such in the sponsoring company's financial statements. The converse also applies in that any excess of assets in the pension scheme (i.e. surplus) which could reduce the sponsoring company's payments or commitments in the future would also be required to be recognized as an asset in its financial statements.

The International Accounting Standard No. 19 (IAS 19) (International Accounting Standards Board 2008) provides the internationally recognized guidance on accounting for and disclosure in Financial Statements of defined benefit pension benefits and obligations. The first stated objective of IAS 19 is to ensure that an employer's balance sheet reflects a net pension liability/asset in respect of employee benefits to be paid in the future. This is known as the "balance sheet" approach. The second stated objective of IAS 19 is to ensure that the employer's Income Statement recognizes an expense when the employer consumes an economic benefit arising from the services provided by the employee in exchange for employee benefits. Notwithstanding, these stated objectives, the IAS also incorporates provisions to facilitate a more "smoothed" result in the published financial statements (the "corridor" approach).

Accounting for defined benefit plans is complex because actuarial assumptions and valuation methods are required to measure the balance sheet obligation and the income statement expense. The plan liabilities (the defined benefit obligation) and the plan assets are measured at each balance sheet date. The plan assets are measured at fair value (not necessarily the same as either "net realizable value" or market value). The defined benefit obligation is measured on an actuarial basis and discounted to present value. The difference between the fair value of the plan assets and the present value of the defined benefit obligation is a surplus or deficit. A surplus is regarded as an asset to the extent that the employer gains an economic benefit from it.[9] A deficit is regarded as a liability to the extent that the employer has a legal or constructive obligation to make it good. It is the accrued net cost to date at the Balance Sheet date (over and above the employers' normal contribution rate) of the promise inherent in a DB scheme that the employer will make good any shortfall in the schemes funding. Subject to certain conditions, a surplus or deficit should be recognized as appropriate as an asset or liability on the employer's balance sheet.
IAS 19 requires the amount recognized in the employer company's balance sheet as a defined benefit liability (deficit) or asset (surplus) to be the net total of the following amounts: (1) The present value of the defined benefit obligation at the balance sheet date; plus (2) any actuarial gains less any actuarial losses not yet recognized as income or an expense because of the smoothing afforded by the corridor approach[10]; less (3) any past service cost not yet recognized[11]and (4) the fair value at the balance sheet date of plan assets out of which the defined benefit obligation is to be settled directly.

3. METHODOLOGY AND APPROACH

We construct 3 valuation models, one for each valuation basis (MFS, Trustee & IAS 19). For comparative purposes we construct a base case of a 40 year old female who joined the scheme at age 30 and plans to retire at age 65. We make assumptions on other core variables necessary for the purposes of determining the three alternate valuations for our base scenario (see Table 2 for base case data). The 3 valuation results are different, in fact very different (see Table 3). For example, the MFS valuation is €50,490 while the IAS 19 valuation is €125,764. Yet all three results could be regarded as reasonable and acceptable depending on the target audience and the objective of the valuation. The high level of assumption underlying each calculation is evident.

The paper considers whether across the three different valuation bases, there is consistency in the sensitivity of the reported results to changes in the key actuarial assumptions and what are the most sensitive assumptions under each calculation basis. A priori, there is no reason to expect that the sensitivities are the same, given the differences in the level of the pension find liabilities calculated under each approach. We display the sensitivity of the three approaches to changes in the underlying assumptions by recalculating the base calculations to reflect different ranges of the key inputs, namely the discount rate, salary growth, pension increases, retirement age and mortality with all other inputs held constant at their base values. We calculate the median z-score of each approach using a wider range of key inputs. The relative sensitivity of each constituent assumption in each of the valuation bases becomes apparent as well as the capacity for significant variation in reported results depending on the "final mix" of assumptions adopted.

4. THE SUBJECTIVITY OF THE VALUATION PROCESS

In summary, some of the key determinants in an actuarial valuation process can have differing meanings and different calculation bases, depending on the objective under which the valuation is carried out, as can be seen in Table 1. Under a typical Revenue approved defined benefit pension scheme[12], the annual pension entitlement of a scheme member at normal retirement age is calculated as follows: n/60 x pension-able salary (final salary or an average of a number of years' salary, e.g. last three years), where n is the number of years of pension-able employment completed by the scheme member and cannot exceed 40 years. The member may opt to take part of his pension entitlement as a lump sum on retirement and a correspondingly reduced annual pension thereafter. The calculations are relatively straightforward once the scheme member reaches retirement age. The difficulty arises in estimating accurately what the final pension entitlement (and hence the scheme's liability to each member) will be at any point before the member reaches normal retirement age.

A number of variables used in the calculation, require further elaboration. (1) The number of years of pension-able employment equals the number of years the member will be in the scheme if he remains working for the scheme employer until normal retirement age. Tax legislation sets the maximum pension entitlement for a tax approved pension scheme at 1/60 of final pension-able salary for every year

of completed service subject to a maximum of 40/60. (2) Pension-able salary - expected salary on retirement or some average, calculated based on expected annual earnings over a number of years, up to the date of retirement. Expected salary at date of retirement is current salary increased by the estimated annual rate of salary increase for each year remaining up to retirement. Generally the expected salary on retirement is reduced to reflect the fact that the pensioner will be entitled to a state pension also on reaching state retirement age. However for the purposes of the examples below, this will be ignored. (3) The annuity factor is calculated based on number of years an employee is expected to live post retirement and if an employee has a spouse, the number of years the employee's spouse is expected to outlive the employee thus becoming eligible for a spouses' pension. This factor is determined by mortality tables which are actuarially calculated and compiled based on historic mortality experience and also taking into account both the discount rate and expected pension increases but it may be adjusted to reflect assumptions on expected mortality experience into the future. (4) Finally, the discount rate is used to estimate the present day value of the future liability.

Table 3 shows the comparative calculations and liabilities under the three methods of valuation assuming base data outlined in Table 2.[13]The MFS valuation calculates the lump sum required to meet future pension entitlements of the scheme member (details in Table 2) based on completed years of pension-able service to date (10 years) and current pension-able salary.. Future pension entitlement is calculated by taking the expected annual pension entitlement in the year of retirement and multiplying it by an annuity factor (taken from actuarially produced annuity tables) to reflect the expected life span of the member post retirement, and the gap between any expected pension increases and any investment return on the lump sum post retirement. The lump sum calculated as required to meet the members' entitlement is then discounted back to the present by reference to pre and post retirement investment growth rates prescribed by the regulator.

The trustee valuation calculates the total expected future pension entitlement of the member based on continued service up to age 65 and expected salary at the date of retirement (current salary indexed for expected annual salary increases). This figure is also increased by an annuity factor and discounted back to the present by reference to an estimated investment growth. This total expected

liability is then split pro rata between completed years of pension-able service to date and future years of service to retirement.

Finally, the IAS 19 valuation is calculated as a pro rata % of the total expected pension entitlement calculated by reference to completed years of service to date (10/35 *35/60). The discount rate used for this calculation is the AA Corporate bond rate while the annuity rate is again based on mortality tables and the gap between the rate of pension increase and the discount rate.

Interestingly, the liability in respect of service to date is lowest under the MFS valuation, which is supportive of the Society of Actuaries (2008d) submission that the MFS calculation should be more conservative and a higher minimum funding requirement (to be achieved possibly over a longer time frame) should be introduced. The IAS 19 valuation produces the highest liability calculation, however as the Lane Clarke and Peacock (2009) research discussed earlier indicated, there is significant opportunity to manage this particular calculation within the range of what might be considered "acceptable" assumption setting.

In the case of a group scheme (more than one member), the individual liabilities for each of the scheme members whether active, deferred or pensioners are accumulated to arrive at the total service liability for inclusion in the valuation exercise. Given the deviations in the results of the three calculations above for one individual employee, there is potential for significant differences to arise in schemes with large numbers of employees. The examples in Table 3 do not reflect the complexities of early retirement options, disability clauses or a spouses' pension (if payable) all of which would impact on the calculations although not necessarily in equal measure across all three.

In setting assumptions, the actuary can therefore be faced with a serious conflict of interest between his obligations to scheme trustees and scheme members and his desire to avoid confrontation (e.g. on contribution rates) with the sponsoring company who may directly or indirectly be paying the actuary for his services and to whom the actuarial firm may be providing a range of related services.[14]The trustees can likewise find themselves in difficulty with scheme members if it can be demonstrated that they presided over sustained periods of inadequate funding levels and high risk investment strategies yet they remained aloof from the actuarial process which informs critical aspects of these decision making processes.

There is much discussion currently as to the rigidity of the MFS and in the light of the increasing number of schemes in deficit or failing to meet the Standard there is an increasing view that the Standard is too high and should be lowered. As discussed earlier - the opposite view however is also strongly held (in particular by the Society of Actuaries) i.e. that the Standard is too low and should be strengthened. This view of the Society of Actuaries is supported by the results of this paper which demonstrate that the MFS valuation always produces a lower result that the equivalent trustee valuation or IAS 19 valuation. It must also be accepted that the relative rigidity of the MFS calculations from the regulators perspective can provide a common benchmark and a meaningful basis for comparison across pension schemes. From an individual trustee's perspective, it can provide comfort that the scope for subjectivity by the actuary in terms of the key underlying assumptions is reduced. This assurance for the trustee cannot be underestimated given the diversity of results, which could conceivably arise from the three valuation approaches outlined above. However, the results of this study also highlight the importance of striving for realism in setting prescribed assumptions should the rigidity of the MFS be retained.

4. SENSITIVITY ANALYSIS

Having established that the three valuation models produce different results, we now look at how sensitive the models are to changes in each of the key inputs. The key inputs are considered to be the discount rate, the rate of salary growth, the assumed rate of pension increases, the retirement age, and mortality. Using our base case calculations (Table 3) as a base for comparison we allow each of the key assumptions to change by plus and minus twenty percent from its base value, while holding all other inputs constant at their base values.[15]We recalculate the pension fund liability to assess the effect of each percentage change in each key assumption whilst holding all other inputs constant. The results of doing so are presented in Appendices 4 through 6. Appendix 4 presents the pension fund liabilities calculated under IAS 19; Appendix 5 shows the equivalent MFS calculations and Appendix 6 shows the pension fund liabilities adopting the trustee valuation approach.

To measure the relative sensitivity of each valuation model to changes in the key inputs, we calculate the median z-score for each key input under each valuation model. The results are presented in Table 4. We present the median, as opposed to the average z-score, since by definition, the z-score has

mean zero with a standard deviation of one. Each individual z-score is calculated as the difference between each pension fund liability calculation less the average pension fund liability calculation, divided by the standard deviation.[16]We concentrate on using z-scores because other measures of dispersion/variation e.g. the standard deviation are sensitive to scale. The z-score is independent of scale, and thus allows us to make comparisons across the key inputs, even though each is measured/constructed using different scales. By definition, z-scores are unit-free, and measure the distance of each data item (here the pension fund liability) from its average value in standard deviations. Hence they are expressed in a common scale. Since the pension fund liabilities can be above or below their mean values given a range of input values, z-scores can then be either positive or negative. For example, a z-score of 0.5 (-0.5) suggests that the pension fund liability is half of one standard deviation above (below) the average pension fund liability. The median z-score is outlined for each key input and under each pension fund valuation method in Table 4. The individual z-scores, calculated over the range of each key input, are outlined in Appendix 3.

Table 4 (column 4) and Appendix 4 indicate the following in relation to the sensitivity of the IAS 19 model to changes in key inputs; The pension fund liability is, as expected, a decreasing function of the discount rate i.e. higher discount rates lead to lower pension fund liabilities. In contrast, pension fund liabilities increase with increases in expected salary and pension growth and with improvements in mortality. Pension fund liabilities increase with decreases in the expected age of retirement. For example, for an individual retiring at 71.5 years of age, and holding all other inputs constant at their base values, the pension fund liability is €102,803 compared to the base case of €125,764 where it is assumed that the individual retires much earlier at 65 years of age. In contrast, and as expected, pension fund liabilities increase with improving mortality. To illustrate consider an individual who lives to 103.95 years of age. His pension fund liability is calculated as €147,677 or 1.17 times (see Appendix 4, column labeled "Ratio L/Base") the base case (i.e. 147,677/125,764 = 1.17). For an individual who lives to 80.325 years of age, the pension fund liability is much lower at €78,836 or just 63% of that of the base case (i.e. (78,836/125,764)*100). In terms of relative sensitivity, the IAS 19 model is most sensitive to changes in the age of mortality (standard deviation is 36,235, and z-score is 0.17), followed closely by changes in the discount rate (standard deviation is 35,950, with a median z-score of (0.13)). The pension fund liability

under IAS 19 is less sensitive to changes in salary growth (standard deviation is 20,671, with a median z-score of (0.07)), and the retirement age (while the standard deviation is high (30,335), the median z-score is just (0.05)). Finally, under IAS 19, the pension fund liability is least sensitive to the assumed rate of pension increase, since the median z-score is just 0.03.

Table 4 (Column 3) and Appendix 5 presents the same analysisfor pension fund liabilities calculated using the trustee model. The trustee model is also most sensitive to the age of mortality (median z-score is (0.23)), followed by the discount rate (median z-score is (0.16)). It is less sensitive to changes in salary growth (median z-score is (0.07)), the rate of pension increases (median z-score is (0.04)), and is least sensitive to the assumed retirement age (median z-score is (0.03)).

Table 4 (column 2) and Appendix 6 present the equivalent results for pension fund liabilities calculated under the MFS model. In contrast to the IAS 19 and trustee models, the MFS is most sensitive to changes in the assumed retirement age. The median z-score for the retirement age under ongoing trustee (wind-up) valuation is (0.22), followed by the discount rate (median z-score is (0.15)), the age of mortality (median z-score is (0.11)), and finally, pension increases (median z-score is (0.03)).

Our findings thus far highlight how changes in the key inputs affect the pension fund liabilities differently across the different valuation models. In terms of relative sensitivity, in summary the changes in the discount rate has greatest relative impact on the trustee model followed by the MFS and the IAS 19 models respectively (compare (0.16) under trustee to (0.15) under MFS and (0.13) under IAS 19). The effect of changes in salary growth (and pension fund increases) on the pension fund liability is largely the same across the different valuation models. Only the MFS valuation is largely affected by the age of retirement (Compare (0.22) under MFS to (0.03) and (0.05) under trustee and IAS 19, respectively).All three models are sensitive to changes in mortality assumptions, but the greatest sensitivity arises under trustee valuation (Compare (0.23) to (0.11) under MFS and (0.17) under IAS 19).

In column 5 of Table 4, we assess across the different valuation methods, which key input has greatest impact across the three models. To do this, we sum the absolute values of the (median) z-scores for each input, across the three models. The key input with the largest sum of absolute median z-scores is the input which has the greatest relative impact across the three models. Column 5 of Table 4 suggests that across the three different valuation methods, the pension fund liability is most sensitive to the age of

mortality (sum of median absolute z-scores is 0.51, with an average of 0.17), followed by the discount rate (sum of median absolute z-scores is 0.43, with an average of 0.143). The pension fund liability is least sensitive to the assumed rate of salary (sum of median absolute z-scores is 0.14) and pension growth rate (sum of median absolute z-scores is 0.10).

In the remaining rows of Table 4 (rows 9 to 12), we assess the relative sensitivity of each of the models. To do so, we sum the absolute value of the median z-scores, not across the key inputs, but for each model, and compare the three results. The model most sensitive to changes in the key inputs will display the largest (absolute) aggregated (median) z-score. Our findings suggest that the MFS model is most sensitive (sum of absolute median z-scores is 0.51 (0.15 + 0.03 + 0.22 + 0.11) with an average z-score of 0.1275, compared to 0.46 (with an average z-score of 0.115) for the trustee model (0.16 + 0.04 + 0.03 + 0.23), and 0.38 under IAS 19 (0.13 + 0.03 + 0.05 + 0.17) (with an average z-score of 0.095).

In Table 5, we calculate the average percentage (%) change in the pension fund liability assuming a 1 unit change in each key input.[17]This exercise is performed for all three models. Coughlan et al. (2007) and Blake et al. (2008) show that the pension fund liability changes on average between 3-4% when they assume life-expectancy changes by one-year. Along similar lines, May et al. (2005) and Gohdes and Baach (2004) show that a 1% point change in the discount rate (i.e. for example between 4 and 5%) changes the value of the pension fund liability on average by 15%. Our findings suggest that the Irish valuation models are just as sensitive to changes in the assumed age of mortality (the average percentage change in the pension fund liability is 2.91%),but more sensitive to changes in the discount rate (the average percentage change in the pension fund liability is 35.21%).

5. PRACTICAL IMPLICATIONS FOR SCHEME GOVERNANCE

The deviation in valuation results across the three valuation model and the inconsistencies demonstrated by the sensitivity analysis in terms of how the individual models are impacted by changes in constituent key inputs is interesting for a variety of reasons. It highlights the challenge to ensure that every care is given to ensure that actuarial assumptions adopted on key inputs are based on sound principles. It could be argued that it provides opportunities to manage a reported valuation result. It certainly poses challenges for trustees charged with governance of pensions schemes in understanding the actuarial

process and the impact of what might seem small percentage changes in certain assumptions on the required funding rate or the reported scheme surplus/deficit. Tax incentivized pension schemes do not have a long history in Ireland (dating back only to the 1960's). It is only in the relatively recent past that pension scheme members and trustees have had to contend with scheme deficits and schemes failing to deliver on pension promises. To date there has not been any case of legal action being taken against scheme trustees for breach of pension promises due to inadequate funding because of over aggressive actuarial assumption setting. This may however be due to individual members being without the means to take such a case rather than they being of the view that they do not have a grievance. In any event recent pronouncements by the Pensions Board (Pensions Board (2009)) and the Society of Actuaries would seem to suggest that inadequate funding due to aggressive assumption setting is not only possible as our paper demonstrates but in fact a harsh reality notwithstanding the absence of litigation.

The accounts preparation and audit exercise coupled with the actuarial valuation processes are relied on by all scheme stakeholders, - trustees, members and employers alike to gain assurances in relation to the financial health of a pension scheme, or at least to be presented with up to date facts which will facilitate planning for remedial action. In the first instance, members will assume that trustees are adequately informed so that they the members can in turn be adequately informed. Assumptions underpinning the actuarial valuation exercise are critical to this monitoring process. Trustees must understand the assumptions underlying each of the three possible valuation results if they are to make informed decisions on required contribution rates, investment strategies, discretionary bonuses etc. This necessitates full transparency on the acceptable "range" for each assumption, where the adopted assumption fits within that range and what would be the impact of a more prudent/optimistic approach. It would also require for all but specialist trustees, standardised specific education on the alternate methods of valuations and the reasons for the significant differences that can arise between these valuations[18]. It is not appropriate that these decisions be entirely delegated to the actuarial profession. Trustees cannot defray their responsibilities by remaining largely aloof from the actuarial exercise and relying on their own assumption that the "expert" i.e. the actuary is always right

While the MFS valuation has been heavily criticized, particularly currently given the turmoil in the financial markets, one advantage it can boast is that it is the least subjective of all three valuation approaches and as such provides a common benchmark against which the financial health of pension schemes can be assessed. It reduces the potential conflicts of interest for the scheme actuary and agency issues arising from the relationships between the trustees, the sponsoring company and the actuary. While regulators are being forced to relax on the time period given to schemes to bring their funding back within the minimum limits, they should be slow to reduce the rigidity of the valuation itself. Indeed as this paper demonstrates that the MFS valuation produces consistently lower results than either the equivalent trustee or IAS 19 valuations it supports the view of the Society of Actuaries that the level at which the Minimum Funding Requirement is set should be reviewed upwards. From a regulatory perspective, it is important that actuarial assumptions used for the purposes of a minimum funding standard valuation are appropriate both in the context of the life of the scheme and the point in time at which the valuation is made.

6. CONCLUSIONS

The assessment of pension fund liabilities is a complex exercise exacerbated by the potential for different acceptable valuations for one scheme and (as evidenced by this paper) inconsistencies in the sensitivity across the different valuation frameworks to changes in underlying valuation assumptions. The high level of estimation required in setting certain key assumptions and differences in the relative sensitivity of reported results to changes in those assumptions has implications for scheme governance in that it requires trustees and other parties charged with scheme governance to understand the key assumptions driving the result rather than just accept the result as the only possible correct answer. It is of particular relevance to trustees who have ultimate responsibility for scheme governance. If trustees do not understand the potential impact of changes in certain key assumption on a valuation result, they cannot contribute fully to an informed debate of appropriate contribution rates and accordingly cannot discharge their trustee obligations entirely.

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Table 1

Comparison of the three valuation approaches to measuring pension fund performance

This table summarizes how pension scheme assets and liabilities are to be valued for regulatory purposes (MFS), for trustee reporting purposes and for inclusion in the financial statements of sponsoring companies (IAS 19).

	Valuation Approach		
	Minimum Funding Standard (ASP Pen 3)	Trustees Ongoing Valuation (ASP Pen 1)	Accounting Approach (IAS 19)
Valuation of Assets	Realizable Value	Market Value	Fair Value
Valuation of Liabilities	Annuity cost of pensions in payment plus transfer values of deferred pensions.	Final estimated liability discounted back to valuation date and apportioned between past and future service.	Final estimated liability, based on service to date, discounted back to balance sheet date.
Discount Rate	Prescribed rate of investment return pre and post retirement which assumes an equity premium in the period prior to retirement.	Assumed expected return on investments.	Yield on high quality corporate bonds
Mortality	Based on most recent mortality tables but with assumptions on future trends.	Based on most recent mortality tables but with assumptions on future trends.	Based on most recent mortality tables but with assumptions on future trends.
Annuity Factor	Based on mortality assumptions and the gap between the expected rate of pension increase and the discount rate.	Based on mortality assumptions and the gap between the expected rate of pension increase and the discount rate.	Based on mortality assumptions and the gap between the expected rate of pension increase and the discount rate.

Table 2

Base Case

For comparative purposes, we construct a base case incorporating the key assumptions set our below. The base case data facilitates comparison across the three valuation models and is used to highlight the sensitivity of the valuation models to changes in the key assumptions.

Base Case Characteristic	Value
Employee (Female) age	40 years of age
Joined Scheme	30 years of age
Status	Active
Retirement Age	65 years of age
Expected Lifetime	94.5 years of age (based on latest available mortality tables)
Current Salary	€45,000
Expected annual rate of salary increase	5%
Expected annual rate of pension increase	2.5% (assume this is also the rate prescribed by the Pensions Board for (MFS) valuation)
Expected inflation	2.5%assume this is also the rate prescribed by the Pensions Board for (MFS) valuation)
Discount rate – trustee valuation –based on estimated investment growth rate	7%
Discount rate – IAS 19 valuation –based on Corporate Bond rate (AA)	5.6%
Discount rate – MFS valuation –based on prescribed investment returns for pre and post retirement.	7.75%pre-retirement and 4.5% post retirement.

Table 3

Comparative results under three valuation bases

This table outlines how the pension fund liability is calculated for each valuation model - MFS, trustee and IAS 19 valuation, respectively, for the base case. The base case refers to a 40 year old female, who joined the scheme 10 years previously, and who plans to retire at 65 years of age. Based on current mortality tables this individual is expected to live until the age of 94.5 years of age. Her current salary stands at €45,000, which is assumed to continue to grow at a rate of 5% until retirement. The annual rate of pension increase is 2.5%. The corporate bond rate is 5.6% while the investment growth rate assumed by the trustees is 7%. The row "Valuation" contains the value of the pension fund liability calculated for each model. The base case details are presented in Table 2.

	Valuation Approach		
	Minimum Funding Standard Valuation	Trustees Ongoing Valuation	IAS 19 valuation
Calculation	10/60 * (45,000 * (1.025 ^ 25)) * 22.872 * 0.1547	35/60 * (45,000 * (1.05 ^ 25)) * 16.365 * 0.184 (Note 1)	10/35 * 35/60 * (45,000*1.05^25) * 0.256 * 19.336
Valuation (PSL)	€50,490	€268,030 (TSL) of which €76,580 (PSL) relates to past service and 191,450 relates to future service.	€125,764
	Individual Valuation Component Calculations		
Pensionable Salary	(45,000 * (1.025 ^ 25))	(45,000 * (1.05 ^ 25))	(45,000 * (1.05^25))
Discount Factor	0.1547 (Note 2)	0.184 based on investment growth rate – 7per cent	0.256 based on corporate bond rate - 5.6per cent
Annuity Factor	22.269 - based on mortality and the gap between rate of pension increase and prescribed post retirement discount rate	16.365 - based on mortality and the gap between rate of pension increase and discount rate.	19.336 - based on mortality and the gap between rate of pension increase and discount rate.
MVA	1.054	-	-

Notes:

Note 1: Maximum pension entitlement is 1/60 of final pensionable salary for every year of completed service subject to a maximum of 40/60. In this example, the employee joined the scheme at age 30 and therefore has a potential maximum number of years of completed service of 35.

Note 2: Discount factor (pre- retirement prescribed investment return) – 7.75 per cent.

Discount rate (post – retirement prescribed investment return) – 4.5 per cent

The discount rate of 0.155 is a composite rate based on the discount rates pre and post retirement and a market value adjustment (M.V.A.) to reflect the gradual transfer out of equities to fixed interest stocks in the 10 years prior to normal retirement age.

Table 4

Sensitivity of Pension Fund Liability to Changes in Key Inputs

This table displays the median z-score of the pension fund liability calculated under IAS 19, MFS, and trustee models, respectively, assuming a range of values for each key input between plus and minus 20% of their base value, with all other inputs held constant at their base values. The key inputs are the discount rate, salary growth, pension increases, retirement age, and mortality, and their base values are 5.6% (7% under ongoing trustee valuation, and 7.75% (pre-retirement discount rate) and 4.50% (post-retirement discount rate under minimum funding valuation), 5%, 2.5%. 65 and 94.5 years of age, respectively. The individual z-scores are calculated as $\left(z = \frac{X - \overline{X}}{s} \right)$, where X is the pension fund liability, X-Bar is the average pension fund liability, and s is the standard deviation of the pension fund liability. In the bottom rows of Table 4, we present the sum (average) of the absolute values of the (median) z-scores for each valuation method. In the remaining column of Table 4, present the sum (average) of the absolute values of the (median) z-scores for each key input.

	Pension Fund Liabilities Valuation Method			
Key Input	Minimum Funding Valuation	Trustees Ongoing Valuation	IAS 19 Valuation	Sum (average) of absolute z-scores by Input
	Median z-score			
Discount Rate	(0.15)	(0.16)	(0.13)	0.43 (0.143)
Salary Growth	-	(0.07)	(0.07)	0.14 (0.070)
Pension Increases	(0.03)	(0.04)	0.03	0.10 (0.033)
Retirement Age	(0.22)	(0.03)	(0.05)	0.30 (0.100)
Mortality	(0.11)	(0.23)	(0.17)	0.51 (0.170)
	Sum (average) of absolute z-scores by valuation method			
	0.51 (0.1275)	0.53 (0.106)	0.45 (0.090)	
	Sum (average) of absolute z-scores by valuation method (Excluding Salary Growth)			
	0.51 (0.1275)	0.46 (0.115)	0.38 (0.095)	

Table 5

Average % change in Pension Fund Liability assuming a 1 unit change in each input

In this table we calculate the average percentage (%) change in pension fund liability assuming a 1 unit change in each key input. Discount rate, salary growth and pension increases range from 1 to 12%. The retirement age ranges from 60 to 70 years of age, and mortality from 80 to 100 years of age. In the case of minimum fund valuation, the pre-retirement (post-retirement) discount rate ranges from 4.25% to 16.25% (1% to 12%).

	Pension Fund Liabilities Valuation Method			
	Minimum Funding Valuation	Trustees Ongoing Valuation	IAS 19 Valuation	Average
Discount Rate	34.75%	35.44%	35.44%	35.21%
Salary Growth	0.00%	23.50%	23.50%	15.67%
Pension Increases	15.48%	12.44%	14.80%	14.24%
Retirement Age	7.37%	3.60%	2.72%	4.56%
Mortality	3.35%	2.46%	2.93%	2.91%

Appendix 1

Calculation of Pension Fund Liabilities under Minimum Fund Standard, Ongoing Trustee, and IAS 19 Valuations

The exact formula used to calculate the pension fund liability under minimum funding standard valuation is presented as Equation (1), where AF and AR are the annuity factor and rate, respectively. All variables are defined in Appendix 2.

$$TSL = \left(\frac{m}{60}\right) * \left(CS * (1+IR)^{y}\right) * \left(\frac{1}{(1+r_{pre})^{y}}\right) * \left(\frac{\left(1-\left(\frac{1}{(1+AF)}\right)\right)^{P}}{AF}\right) * MVA \quad (1)$$

$$AF = \left(1-\left(\frac{1}{1+AR}\right)\right)^{\frac{P}{AR}}, AR = \left(\frac{(1+r_{post})}{1+PI}\right) - 1$$

The ongoing trustee valuation calculates the total expected future pension entitlement of the member according to Equations 2 and 3. The expected future pension entitlement calculation is based on continued service up to age 65 and based on an expected salary at the date of retirement (current salary indexed for expected annual salary increases). This figure is also increased by an annuity factor and discounted back to the present by reference to an estimated investment growth. This total expected liability is then split pro rata between completed years of pensionable service to date and future years of service to retirement.

$$TSL = \left(\frac{n}{60}\right) * \left(CS * (1+SG)^{y}\right) * \left(\frac{1}{(1+r)^{y}}\right) * \left(\frac{\left(1-\left(\frac{1}{(1+AF)}\right)\right)^{P}}{AF}\right) \quad (2)$$

$$PSL = TSL * \left(\frac{m}{n}\right) \quad (3)$$

$$AF = \left(1-\left(\frac{1}{1+AR}\right)\right)^{\frac{P}{AR}}, AR = \left(\frac{(1+r)}{(1+PI)}\right) - 1$$

Finally, the IAS 19 valuation (Column 4) is calculated as a pro rata % of the total expected pension entitlement calculated by reference to completed years of service to date (10/35 *35/60), according to Equation (4). The discount rate used for this calculation is the AA Corporate bond rate while the annuity rate is again based on mortality tables and the gap between the rate of pension increase and the discount rate.

$$TSL = \left(\frac{m}{n}\right) * \left(\frac{n}{60}\right) * \left(CS * (1+SG)^{y}\right) * \left(\frac{1}{(1+CBR)^{y}}\right) * \left(\frac{\left(1-\left(\frac{1}{(1+AF)}\right)\right)^{P}}{AF}\right) \quad (4)$$

$$AF = \left(1-\left(\frac{1}{1+AR}\right)\right)^{\frac{P}{AR}}, AR = \left(\frac{(1+r)}{(1+PI)}\right)-1$$

Appendix 2
Variable Descriptions

Variable	Description
TSL	Total Service Liability
PSL	Past Service Liability
m	m is # of years of pensionable service completed to date
CS	Current salary
IR	Expected rate of inflation
Y	# of years to retirement
r_{pre}	Pre-retirement discount rate
r_{post}	Post-retirement discount rate
P	Expected life-span post-retirement
AF	Annuity Factor
AR	Annuity Rate
MVA	Adjustment to allow for reduction in the pre-retirement discount rate to the post-retirement discount rate on a uniform basis over the 10 years immediately prior to normal retirement age. MVA factors are prescribed by the society of actuaries
r	Discount Rate
SG	Salary Growth
n	n is the # of pensionable years
CBR	AA Corporate bond rate

Appendix 3

Individual and Median z-Scores

This table displays the value of the z-score of each individual pension fund liability calculated under IAS 19, minimum funding standard valuation, and wind-up valuation, respectively, assuming that each input ranges between plus and minus 20% of their base value, while all other inputs are held constant at their base values. The key inputs are the discount rate, salary growth, pension increases, retirement age, and mortality. Their base values are 5.6% (7% under ongoing trustee valuation, and 7.75% (pre) and 4.50% (post) under minimum funding valuation), 5%, 2.50%, 65 and 94.5 years of age, respectively. The individual z-scores are calculated as follows $\left(z = \frac{X - \overline{X}}{s} \right)$, where X is the pension fund liability, X-Bar is the average pension fund liability, and s is the standard deviation of the pension fund liability.

Individual and Median z-Scores of the Pension Fund Liabilities calculated under IAS 19

Discount Rate		Salary Growth		Pension Increase		Mortality		Retirement Age	
Value	z-Score	Value	z-Score	Value	z-Score	Value	z-Score	Value	z-Score
4.48	1.65	4.00	(1.36)	2.000	1.42	75.600	(1.70)	52.00	(1.39)
4.76	1.13	4.25	(1.07)	2.125	1.09	80.325	(1.13)	55.25	(1.07)
5.04	0.66	4.50	(0.75)	2.250	0.74	85.050	(0.64)	58.50	(0.75)
5.32	0.24	4.75	(0.42)	2.375	0.39	89.775	(0.21)	61.75	(0.41)
5.60	(0.13)	5.00	(0.07)	2.500	0.03	94.500	0.17	65.00	(0.05)
5.88	(0.46)	5.25	0.30	2.625	(0.34)	99.225	0.49	68.25	0.32
6.16	(0.77)	5.50	0.70	2.750	(0.72)	103.950	0.77	71.50	0.70
6.44	(1.04)	5.75	1.12	2.875	(1.10)	108.675	1.01	74.75	1.11
6.72	(1.28)	6.00	1.56	3.000	(1.50)	113.400	1.23	78.00	1.54
Median	(0.13)		(0.07)		0.03		0.17		(0.05)

Individual and Median z-Scores of the Pension Fund Liabilities calculated under Ongoing Trustee Valuation

Discount Rate		Salary Growth		Pension Increase		Mortality		Retirement Age	
Value	z-Score	Value	z-Score	Value	z-Score	Value	z-Score	Value	z-Score
5.60	1.68	4.00	(1.36)	2.000	(2.15)	75.600	(1.80)	52.00	1.51
5.95	1.13	4.25	(1.07)	2.125	(1.64)	80.325	(1.13)	55.25	1.10
6.30	0.64	4.50	(0.75)	2.250	(1.12)	85.050	(0.58)	58.50	0.71
6.65	0.22	4.75	(0.42)	2.375	(0.58)	89.775	(0.13)	61.75	0.34
7.00	(0.16)	5.00	(0.07)	2.500	(0.04)	94.500	0.23	65.00	(0.03)
7.35	(0.48)	5.25	0.30	2.625	0.52	99.225	0.53	68.25	(0.39)
7.70	(0.77)	5.50	0.70	2.750	1.09	103.950	0.77	71.50	(0.74)
8.05	(1.02)	5.75	1.12	2.875	1.67	108.675	0.97	74.75	(1.08)
8.40	(1.24)	6.00	1.56	3.000	2.26	113.400	1.13	78.00	(1.42)
Median	(0.16)		(0.07)		(0.04)		0.23		(0.03)

Individual and Median z-Scores of the Pension Fund Liabilities calculated under Minimum Funding Valuation

Discount Rate		Salary Growth		Pension Increase		Mortality		Retirement Age	
Value (Pre/Post)	z-Score	Value	z-Score	Value	z-Score	Value	z-Score	Value	z-Score
6.20/3.60	1.68	4.00	-	2.000	(1.42)	75.600	(1.62)	52.00	1.77
6.59/3.83	1.12	4.25	-	2.125	(1.09)	80.325	(1.12)	55.25	1.13
6.98/4.05	0.64	4.50	-	2.250	(0.74)	85.050	(0.67)	58.50	0.60
7.36/4.28	0.23	4.75	-	2.375	(0.39)	89.775	(0.26)	61.75	0.15
7.75/4.50	(0.15)	5.00	-	2.500	(0.03)	94.500	0.11	65.00	(0.22)
8.14/4.73	(0.48)	5.25	-	2.625	0.34	99.225	0.45	68.25	(0.52)
8.53/4.95	(0.77)	5.50	-	2.750	0.72	103.950	0.76	71.50	(0.77)
8.92/5.18	(1.03)	5.75	-	2.875	1.10	108.675	1.05	74.75	(0.98)
9.30/5.40	(1.25	6.00	-	3.000	1.50	113.400	1.31	78.00	(1.15)
Median	(0.15)		-		(0.03)		0.11		(0.22)

Appendix 4

IAS 19 Accounting Valuation

This table displays the value of the pension fund liability calculated under IAS 19 assuming that each input ranges between plus and minus 20% of their base value, while all other inputs are held constant at their base values. The key inputs are the discount rate, salary growth, pension increases, retirement age, and mortality. Their base values are 5.6%, 5%, 2.50%, 65 and 94.5 years of age, respectively. The average and standard deviation pension fund liability and the ratio of the pension fund liability to the base case (L/Base) are reported in the remaining rows.

Discount Rate			Salary Growth			Pension Increase		
DR	Liability (L)	Ratio (L/Base)	SG	Liability (L)	Ratio (L/Base)	PI	Liability (L)	Ratio (L/Base)
4.48	189,589	1.51	4.00	99,005	0.79	2.000	118,048	0.94
4.76	170,900	1.36	4.25	105,130	0.84	2.125	119,916	0.95
5.04	154,174	1.23	4.50	111,617	0.89	2.250	121,824	0.97
5.32	139,193	1.11	4.75	118,488	0.94	2.375	123,773	0.98
5.60	125,764	1.00	5.00	125,764	1.00	2.500	125,764	1.00
5.88	113,717	0.90	5.25	133,468	1.06	2.625	127,798	1.02
6.16	102,901	0.82	5.50	141,624	1.13	2.750	129,875	1.03
6.44	93,183	0.74	5.75	150,257	1.19	2.875	131,998	1.05
6.72	84,444	0.67	6.00	159,394	1.27	3.000	134,166	1.07
Average	130,429	1.04		127,194	1.01		125,907	1.00
Std. Dev	35,950	0.29		20,671	0.16		5,517	0.04
Mortality			Retirement Age					
Mortality	Liability (L)	Ratio (L/Base)	Retirement	Liability (L)	Ratio (L/Base)			
75.600	58,242	0.46	52.00	166,315	1.32			
80.325	78,836	0.63	55.25	156,748	1.25			
85.050	96,725	0.77	58.50	146,825	1.17			
89.775	112,265	0.89	61.75	136,510	1.09			
94.500	125,764	1.00	65.00	125,764	1.00			
99.225	137,491	1.09	68.25	114,544	0.91			
103.950	147,677	1.17	71.50	102,803	0.82			
108.675	156,526	1.24	74.75	90,493	0.72			
113.400	164,213	1.31	78.00	77,559	0.62			
Average	119,749	0.95		124,173	0.99			
Std. Dev	36,235	0.29		30,335	0.24			

Appendix 5

Ongoing Trustee Valuation

This table displays the value of the pension fund liability calculated under ongoing trustee valuation assuming that each input ranges between plus and minus 20% of their base value, while all other inputs are held constant at their base values. The key inputs are the discount rate, salary growth, pension increases, retirement age, and mortality. Their base values are 7%, 5%, 2.50%, 65 and 94.5 years of age, respectively. The average and standard deviation pension fund liability and the ratio of the pension fund liability to the base case (L/Base) is reported in the remaining rows.

Discount Rate			Salary Growth			Pension Increase		
DR	Liability (L)	Ratio (L/Base)	SG	Liability (L)	Ratio (L/Base)	PI	Liability (L)	Ratio (L/Base)
5.60	125,764	1.64	4.00	60,286	0.79	2.000	72,196	0.94
5.95	110,903	1.45	4.25	64,016	0.84	2.125	73,259	0.96
6.30	97,912	1.28	4.50	67,966	0.89	2.250	74,344	0.97
6.65	86,543	1.13	4.75	72,150	0.94	2.375	75,451	0.99
7.00	76,580	1.00	5.00	76,580	1.00	2.500	76,580	1.00
7.35	67,840	0.89	5.25	81,271	1.06	2.625	77,733	1.02
7.70	60,163	0.79	5.50	86,237	1.13	2.750	78,909	1.03
8.05	53,413	0.70	5.75	91,494	1.19	2.875	80,110	1.05
8.40	47,470	0.62	6.00	97,058	1.27	3.000	81,336	1.06
Average	80,732	1.06		77,451	1.01		76,658	1.00
Std. Dev	26,754	0.35		12,587	0.16		3,129	0.04
Mortality			Retirement Age					
Mortality	Liability (L)	Ratio (L/Base)	Retirement	Liability (L)	Ratio (L/Base)			
75.600	38,993	0.51	52.00	114,282	1.49			
80.325	51,413	0.67	55.25	104,392	1.36			
85.050	61,551	0.80	58.50	94,839	1.24			
89.775	69,826	0.91	61.75	85,582	1.12			
94.500	76,580	1.00	65.00	76,580	1.00			
99.225	82,094	1.07	68.25	67,796	0.89			
103.950	86,594	1.13	71.50	59,189	0.77			
108.675	90,268	1.18	74.75	50,722	0.66			
113.400	93,267	1.22	78.00	42,355	0.55			
Average	72,287	0.94		77,304	1.01			
Std. Dev	18,535	0.24		24,557	0.32			

Appendix 6

Minimum Funding Valuation

This table displays the value of the pension fund liability calculated under minimum funding valuation assuming that each input ranges between plus and minus 20% of their base value, while all other inputs are held constant at their base values. The key inputs are discount rate, salary growth, pension increases, retirement age, and mortality. Their base values are 7.75% (and 4.50%), 5.00%, 2.50%, 65 and 94.5 years of age, respectively. The average and standard deviation pension fund liability and the ratio of the pension fund liability to the base case (L/Base) are reported in the remaining rows.

Discount Rate			Salary Growth			Pension Increase		
	Liability (L)	Ratio (L/Base)	SG	Liability (L)	Ratio (L/Base)	PI	Liability (L)	Ratio (L/Base)
6.20/3.60	81,986	1.62	4.00	50,490	1.00	2.000	47,222	0.94
6.59/3.83	72,456	1.44	4.25	50,490	1.00	2.125	48,012	0.95
6.98/4.05	64,170	1.27	4.50	50,490	1.00	2.250	48,820	0.97
7.36/4.28	56,928	1.13	4.75	50,490	1.00	2.375	49,646	0.98
7.75/4.50	50,490	1.00	5.00	50,490	1.00	2.500	50,490	1.00
8.14/4.73	44,753	0.89	5.25	50,490	1.00	2.625	51,352	1.02
8.53/4.95	39,748	0.79	5.50	50,490	1.00	2.750	52,234	1.03
8.92/5.18	35,282	0.70	5.75	50,490	1.00	2.875	53,136	1.05
9.30/5.40	31,452	0.62	6.00	50,490	1.00	3.000	54,057	1.07
Average	53,029	1.05		50,490	1.00		50,552	1.00
Std. Dev	17,274	0.34		0	0.00		2,339	0.04
Retirement Age			Mortality					
Retirement	Liability (L)	Ratio (L/Base)	Mortality	Liability (L)	Ratio (L/Base)			
52.00	121,796	2.41	75.600	21,522	0.43			
55.25	98,835	1.96	80.325	29,784	0.59			
58.50	79,678	1.58	85.050	37,325	0.74			
61.75	63,731	1.26	89.775	44,207	0.88			
65.00	50,490	1.00	94.500	50,490	1.00			
68.25	39,527	0.78	99.225	56,224	1.11			
71.50	30,480	0.60	103.950	61,457	1.22			
74.75	23,042	0.46	108.675	66,234	1.31			
78.00	16,953	0.34	113.400	70,594	1.40			
Average	58,281	1.15		48,649	0.96			
Std. Dev	35,884	0.71		16,790	0.33			

[1]Most schemes to be structured as trusts in order to avail of favourable treatment.
[2]Goode (1993, para. 4.9.7.) states that trustees must "exercise, in relation to all matters affecting the fund, the same degree of care and diligence as an ordinary prudent person would exercise in dealing with property of another for whom the person felt morally bound to provide and to use such additional knowledge and skill as the trustee possesses or ought to possess by reason of the trustees' profession, business or calling."
[3] Scott v National Trust for Places of Historic Interest or Natural Beauty (1980), cited in Delaney (2007).
[4] In the Irish context, Connell (2007) discusses the costs and sustainability of different proposals for pension provision, and refers to the plethora of assumptions which underpin each different proposal/model. Lane, Clarke and Peacock Ireland(2009), noted from the IAS 19 valuations of 29 Irish schemes reviewed, that widely varying assumptions were used in key areas across the schemes. Life expectancy assumptions adapted by the schemes surveyed ranged from 83.5 years to 87.1 years for a male and 86 years to over 90 years for a female. Discount rate assumptions (based on "high quality" corporate bond rates) ranged from under 5.6 per cent to 6.5 per cent; inflation assumptions ranged from 1.75 per cent to 2.5 per cent and expected return on equities ranged from 7 per cent to 9 per cent.
[5]Attain Consulting (2009), considers the impact of the discount rate, but no other key inputs, used in the actuarial valuation calculation of the deficits of pension schemes of companies quoted on the Irish stock Exchange.

[6] Defined Benefit schemes of certain public sector organizations are exempt from the funding standard.
[7] At the time of writing, the most recent version of ASP PEN 2 is effective May 2012, while the most recent version of ASP PEN 3 is effective July 2011.
[8] The most recent version.
[9] It remains unclear as to the legal ownership of any surplus which might arise as a result of a valuation exercise where contributions have been made by both the sponsoring company and the scheme members. This is a question to be resolved on a scheme by scheme basis, depending on individual scheme rules.
[10] Differences between reality and the actuarial assumptions used will occur frequently. Immediate recognition of these differences has the consequence that the total pension cost in the employer's financial statements may become hugely volatile. In order to reduce this volatility IAS 19 allows flexibility as to the recognition of certain of these actuarial gains or losses depending on their size relative to the overall assets/liabilities of the scheme. This is known as the corridor approach.
[11] Past service costs arise when an employer grants pension rights for service rendered prior to the establishment of the pension plan or when an employer grants an increase in pension benefits also for service rendered in past periods. Past service costs may be vested in which case they are recognized immediately as an expense/liability or they may be conditional on further future employment in which case they are recognized on a spread basis.
[12]Revenue approval is necessary if the pension scheme is to benefit from the favourable tax treatment available to revenue approved pension schemes.
[13] The exact formulae used to calculate the pension fund liabilities under minimum fund, ongoing trustees, and IAS 19 are presented in Appendix 1. Appendix 2 contains a description of the variables used in the calculation of the pension fund liabilities.
[14] Many of the actuarial firms also provide a range of related services- e.g. "consulting outsourcing and investment services".
[15] The range of each input is subdivided into four equally-spaced values, either side of the base case. For example, in the case of IAS 19 and the discount rate, the discount rate ranges from 4.48 to 6.72%, with a base value of 5.60%. We evaluate the pension fund liability under IAS 19 (with all other inputs held at their base values), using intervals of 0.28 for the discount rate over the range of 4.48 to 6.72% (i.e. (6.72 - 4.48)/8 is 0.28). Hence, the pension fund liability is evaluated where the discount rate is 4.48, 4.76, 5.04, 5.32, 5.60, 5.88, 6.16, 6.44, and 6.72. Since there is four equally-spaced values of the discount rate (and all other key inputs) either side of the base case (and thus nine in total), the median z-score presented in Table 4 is the z-score for the base case of each input (i.e. the fifth value). The z-scores calculated across the range of z-scores are presented in Appendix 3.
[16] That is, the z-score is calculated as $\left(z = \frac{X - \overline{X}}{s} \right)$, where X is the pension fund liability, X-Bar is the average pension fund liability, and s is the standard deviation pension fund liability. For example, if we assume a discount rate of 4.48%. The pension fund liability calculated under IAS 19 is €189,589, with an average (standard deviation) pension fund liability (over a range of discount rates from 4.48 to 6.72%) of €130,429 (35,950). The z-score is then calculated as $\left(z = \frac{189,589 - 130,429}{35,950} \right) = 1.65$ (See Appendix 3).
[17]Discount rate, salary growth and pension increases range from 1 to 12%. The retirement age ranges from 60 to 70 years of age, and mortality from 80 to 100 years of age. In the case of minimum fund valuation, the pre-retirement (post-retirement) discount rate ranges from 4.25% to 16.25% (1% to 12%).

[18]Such specialist training is not currently available as a matter of course to all trustees although pension scheme trustees are required to undergo some trustee training on being appointed as trustee.