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Notes for Contributors are contained on pages 75–76.

ASSET IMPAIRMENT AND EARNINGS MANAGEMENT: INFLUENCE OF AUDIT QUALITY

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ABSTRACT

Portuguese listed firms (as well as all EU companies) have been required to use IFRS and consequently IAS 36 – 'Impairment of Assets' – since 2005. Therefore, this paper examines empirically the effects of IAS 36 on asset impairment reporting, investigating whether IAS 36 reduces the magnitude and restricts the timing of reporting asset impairment. Additionally, we also analyse the influence of audit quality on the use of the asset impairment test as a tool to manage earnings. We use an OLS regression model to examine the effect of the asset impairment on earnings management for a sample of 33 non-financial-listed Portuguese companies from 2002 to 2010. We find that IAS 36 does not affect the magnitude of the reported asset impairment. Additionally, the results suggest that impairment firms are engaging in either 'big bath' or 'income smoothing' behaviour. Our findings also suggest that firms audited by Big 4 firms take significantly more impairments than firms audited by non-Big 4 firms. Furthermore, the results show that when there are incentives to under-report earnings, the likelihood of taking an asset impairment will increase more for firms audited by a non-Big 4 audit firm than for firms audited by a Big 4 audit firm. The findings based on this study provide useful information for the International Accounting Standards Board and other standard setters. The results also provide useful information to investors in evaluating the impact of IAS 36 on earnings quality.

INTRODUCTION

The writing down of accounting values that are not recoverable, whether due to obsolescence, physical damage or market conditions, is a long-lived convention in historical cost accounting. Since the adoption of the European Union (EU) Fourth Directive requirements into Portuguese company legislation, there has also been a legal obligation to account for impairment losses on non-financial fixed assets. Until recently, however, there was little guidance on how to detect impairments and carry out the appropriate accounting. Consequently, impairment accounting has been, to a certain degree, at the discretion of each reporting entity.

Since 1 January 2005 all listed EU companies must prepare their consolidated financial statements in accordance with International Financial Reporting Standards (IFRS) (Regulation, European Commission, 1606/2002). Therefore, Portuguese listed companies must also use the International Accounting Standards No. 36 (IAS 36) – 'Impairment of Assets' – to evaluate whether the assets have been impaired.

The objective of IAS 36 is the reflection of the true value of a firm's assets on its balance sheet. More specifically, IAS 36 is designed to ensure that assets are carried at no more than their recoverable amount and to define how the recoverable amount is calculated. Assets to which IAS 36 applies include long-term assets, long-term investments and intangible assets.

IAS 36 was intended to provide more structure on the determination and reporting of asset impairments. However, its effect on the characteristics of reported asset write-offs is unclear *a priori*, as implementation requires inherently subjective estimates. In particular, firms need to assess whether the carrying amount of assets (i.e. the value on the balance sheet) does not exceed the true or real value. If the carrying value of the asset exceeds the recoverable amount, impairment is necessary. Nevertheless, with the test of impairment, managers are able to exercise their discretion over the calculation of this recoverable amount (Caplan and Harris, 2002). Consequently, the standard provides managers with considerable discretion about how to assess the true value (recoverable amount) of the firm's assets. This means that the recognition of an impairment loss is based on the management's judgement about the necessity of the recognition of this loss. For example, firms can take an impairment loss when earnings are particularly high in order to smooth income, or, alternatively, they can 'take a bath' by recording an impairment loss when earnings are already poor (Alciatore, Dee, Easton and Spear, 1998, p. 1).

Empirical research also suggests that firms use their discretion over asset impairment to manage earnings (e.g. Francis, Hanna and Vincent, 1996; Rees, Gill and Gore, 1996; Sevin and Schroeder, 2005; Van de Poel, Maijoor and Vanstraelen, 2009; Zucca and Campbell, 1992). For example, using United States (US) data Francis et al. (1996) investigated a sample of firms making write-offs between 1989 and 1992, including some described as restructuring charges. They found factors associated with both earnings manipulation and asset impairment to be important determinants in write-off decisions.

Since the recoverable value is difficult to obtain objectively, management can discretionally assess the magnitude of the write-down to affect the reported profit (Andrews, 2006). By applying an impairment test in practice, a large amount of

factors need to be determined for the impairment calculation, including the value in use, the carrying amount and fair value. These factors, used in an impairment test, depend on several assumptions made by management, since it is responsible for preparing the initial impairment calculation. The auditor is only obliged to check this calculation. A key element of the financial reporting process is to guarantee an independent verification of the financial statements prepared by the firm's management (Chan, Ezzamel and Gwilliam, 1993). It is widely known that external auditors play a central role in ensuring the integrity of the financial reporting process (e.g. Cohen, Krishnamoorthy and Wright, 2004; Johl, Jubb and Houghton, 2007; Vafeas, 2005). Previous research shows that higher audit quality is associated with higher earnings quality (e.g. Becker, DeFond, Jiambalso and Subramanyam, 1998; Francis, Maydew and Sparks, 1999; Balsam, Krishnan and Yang, 2003). However, Jonhson (2007) and Pannese and DelFavero (2010), for example, express concerns about auditors who may lack the necessary training in valuation methods for estimating fair values. They suggest that the most important opportunities to manage earnings are present in the area of cash flow projections.

Summing up, prior to the issuance of IAS 36, no explicit guidance existed on accounting for the impairment of long-lived assets. This absence of explicit guidance for asset impairments allowed substantial management discretion over amounts, presentation and timing of impairments. However, post-IAS 36, management presumably would have less discretion in reporting higher amounts of asset impairment losses and in the timing of when to report asset impairments since it provides some structure and rules that can be enforced by auditors. Therefore, it is expected that IAS 36 would reduce the magnitude and restrict the timing of reporting asset impairments.

From a different viewpoint, the issuance of IAS 36 may not eliminate or reduce management discretion in the timing and amount of asset impairments. In fact, the approach of the International Accounting Standards Board (IASB) in IAS 36 gives management substantial flexibility to exercise judgement in determining and reporting impairment losses. There are some areas of IAS 36 in which its application is subject to the judgement and assumptions of management, such as the definition of impairment indicators, the estimation of future cash flows from the use of the asset, the asset grouping level at which testing and measurement occurs, and the depreciation methods chosen for the asset. Therefore, this study investigates these two viewpoints and analyses the effect of IAS 36 on asset impairment reporting. It investigates whether IAS 36 reduces management's discretion over asset impairment magnitude and timing. Additionally, we also analyse the influence of audit quality on the use of the asset impairment test as a tool to manage earnings. Using a sample of thirty-three Euronext Lisbon non-financial firms over a period of nine years, from 2002 through 2010, we find that IAS 36 does not affect the magnitude of the reported asset impairment. We also find evidence that firms impair their assets more often when earnings are unexpectedly low or high. This suggests that impairment firms are engaging in either 'big bath' or 'income smoothing' behaviour. Our findings also suggests that companies audited by Big 4 firms take significantly more impairments than firms audited by non-Big 4 firms, suggesting that non-Big 4 auditors give firms more discretion to engage in income-increasing earnings

management by postponing asset impairments. Additionally, the results show that when there are incentives to under-report earnings, the likelihood of taking an asset impairment will increase more for companies audited by a non-Big 4 audit firm than for firms audited by a Big 4 audit firm.

This study makes some interesting contributions to the existing literature. First, asset write-offs can be an important corporate event due to the amounts involved and their implication on firm performance and market value (Bartov, Lindahl and Ricks, 1998; Hirschey and Richardson, 2002). Second, the issue of whether IAS 36 constrains management's discretion in recognising asset impairment losses does not appear to have been investigated in the prior literature. Third, standard setters need to know which standards and which accruals are being used to manage earnings. Such information will highlight areas in need of corrective action by the standard setters. Therefore, information as to whether IAS 36 is being used to manage earnings, via asset impairment write-offs, would be useful for the IASB and other standard setters. In fact, if the asset impairment rule is being used as a tool for earnings management, both the asset value and the level of earnings reported in the financial statements may be distorted. The findings of this study should be of interest to regulators and investors, who are concerned about earnings management and improving the quality of financial reporting. Since 2005, listed groups in Ireland have been required to prepare their consolidated financial statements in accordance with IFRS. This study should be of interest for Ireland too. The importance of accounting practices for asset impairments is heightened during periods of ongoing economic uncertainty as a result of the need for companies to reflect the loss of economic value in a timely fashion through the mechanism of asset write-downs.

This paper is structured as follows. In the next section, we give a brief overview of IAS 36 – 'Impairment of Assets'. Following that, we provide an overview of the literature review and develop testable hypotheses. We then present the variable measurement and describe the research methodology. Next, the sample selection process and characteristics of the sample are presented. The results are reported and discussed, and we provide sensitivity tests in the following two sections. Finally, we conclude the study.

BACKGROUND OF IAS 36 – 'IMPAIRMENT OF ASSETS'

One of the important regulatory requirements of financial reporting is that the carrying amounts of assets, which are disclosed in financial statements, should not exceed their recoverable amounts.

Before IAS 36, Portuguese listed companies generally wrote down an asset when there was evidence of permanent impairment in the ability to fully recover the asset's carrying amount. However, accounting standards generally did not address when impairment losses should be recognised or how they should be measured, and thus different practices were followed. Managers had the opportunity to estimate how much and when to record asset impairment losses. This gave management some ability to manage their firm's earnings in their own or their firm's best interest.

The IASB objective in issuing IAS 36 was to provide greater comparability and consistency in the accounting treatment of impairment of assets. In particular, this standard sought to address:

- The criteria for when to test for the existence of an impairment
- The level at which to group assets in impairment tests
- The measurement basis for determining the existence of an impairment
- The measurement of the impairment
- The presentation of the recognised amount

The objective of IAS 36 is to prescribe the procedures that an entity applies to ensure that its assets are carried at no more than their recoverable amount. An asset is carried at more than its recoverable amount if its carrying amount exceeds the amount to be recovered through use or sale of the asset. For these cases, the asset is described as impaired and the standard requires the entity to recognise an impairment loss.

An entity shall verify at each reporting date whether there is some indication that an asset may be impaired; if it exists, the entity shall estimate the recoverable amount of the asset. Therefore, the accounting principle is to test each asset for impairment loss, in order to determine if there are indications in both the internal and external environments that the asset might have been impaired. However, irrespective of whether there is any indication of impairment, goodwill and intangible assets that have indefinite useful lives should be tested at least annually for impairment.

If there is any indication that an asset may be impaired, the recoverable amount shall be estimated for the individual asset. If it is not possible to estimate the recoverable amount of the individual asset, an entity shall determine the recoverable amount of the cash-generating unit to which the asset belongs. Determination of the cash-generating unit is left to the management's judgement.

The recoverable amount of an asset or a cash-generating unit is obtained by choosing the higher value of two options: the fair value less costs to sell, and the value in use. The value in use is defined as 'the present value of estimated future cash flows expected to arise from the continuing use of an asset and from its disposal at the end of its useful life' (International Accounting Standards Board, 1998, s. 6).

According to IAS 36, the following elements shall be reflected in the calculation of an asset's value in use:

- An estimate of the future cash flows the entity expects to derive from the asset
- Expectations about possible variations in the amount or timing of those future cash flows
- The time value of money, represented by the current market risk-free rate of interest
- The price for bearing the uncertainty inherent in the asset

- Other factors such as illiquidity that market participants would reflect in pricing the future cash flows the entity expects to derive from the asset

If, and only if, the recoverable amount of an asset is less than its carrying amount, the carrying amount must assume the value of the recoverable amount. That reduction is an impairment loss. An impairment loss must be recognised immediately in the profit and loss account, unless the asset is carried at a revalued amount in accordance with another standard (for example, in accordance with the revaluation model in IAS 16 – 'Property, Plant and Equipment').

Although the intention of the impairment accounting regulations by IAS 36 is to avoid the overstatement of assets on the one hand, and to allow companies to reflect impairment recovery on the other hand, concerns have been expressed in the literature that companies may manage earnings opportunistically through impairments (Francis et al., 1996; Rees et al., 1996; Sevin and Schroeder, 2005; Van de Poel et al., 2009; Zucca and Campbell, 1992).

In fact, the above discussion reveals that substantial assumptions and estimates are generally required to implement IAS 36. Thus, the standard's effect on managerial discretion exercised to arrive at reported write-offs is unclear. Similarly, the standard's criteria for determining an impairment (e.g. the use of expected future cash flows) may or may not enhance the mapping of economic declines into the reported decreases in asset values.

Summing up, IAS 36 seems to give substantial latitude for management to select the timing and amount of asset impairment. As referred to previously, the impairment loss is measured as the difference between an asset's book value and its recoverable amount. However, in most cases, the recoverable amount must be estimated, and the estimation process usually involves a forecast of future net cash flows the company expects to generate from the asset's use. So, for example, if a company underestimates future net cash flows, the recoverable amount is understated. This has two effects: (1) the current year's income is unrealistically low due to the impairment loss being overstated and (2) future income is unrealistically high because depreciation, depletion and amortisation are based on understated asset values. As a result, reducing management discretion over the timing and amount of asset impairment by the issuance of IAS 36 is somewhat questionable.

LITERATURE REVIEW AND TESTABLE HYPOTHESES

Earnings management is the intentional intervention in the external financial reporting process with the intent of obtaining some private gains (Schipper, 1989). It 'occurs when managers use judgment in financial reporting and in structuring transactions to alter financial reports to either mislead some stakeholders about the underlying economic performance of the company or to influence contractual outcomes that depend on reported accounting numbers' (Healy and Wahlen, 1999, p. 365).

There are a number of reasons why management might adjust earnings in such a way that the adjustment might have either a positive or negative effect on the users'

ability to predict a firm's performance (e.g. management compensation contracts, debt contracts, stock market, and political and regulatory requirements). One technique that explains management incentive in managing earnings through the use of asset impairments is the 'big bath' hypothesis. Strong and Meyer (1987) argue that through cleaning up the balance sheet and reducing equity, a company can boost future profits and increase per-share return. So, management might choose to take all negative adjustments to income in one year in an effort to 'clear' the accounting records (Cameron and Stephens, 1991). By taking significant write-downs all in one year, management could be signaling that better times are ahead. In the case of asset impairments, this reasoning is particularly appropriate, since an asset impairment results in decreased depreciation expense in the future.

Income smoothing is another technique that explains management incentive in managing earnings through the use of asset impairments. It describes an earnings pattern in which management aspires to maintain a steady and predictable rate of earnings growth. Consequently, a firm with an impaired asset might choose to adjust earnings downward in a year when earnings from ongoing operations are unusually high but are not expected to be as high in future years, or it might time the loss recognition to coincide with a non-discretionary gain.

Therefore, firms could record an impairment when earnings are particularly high to smooth income, or, alternatively, they could 'take a bath' by accelerating an impairment when earnings are already poor to maximise profits in future periods. This flexibility suggests that impairment decisions could be strategically used by managers to adjust the timing and amounts of charges to income (Alciatore et al., 1998).

IAS 36 and Earnings Management

Empirical studies suggest that the demands for authoritative guidance on accounting for asset impairments appear to be based on a notion that management takes advantage of the discretion afforded by the accounting rules to manipulate earnings (Francis et al., 1996; Van de Poel et al., 2009). Earnings could be manipulated either by not recognising impairment when it has occurred or by recognising it only when it is advantageous to do so. Moreover, since managers have incentives to manage earnings and investors are unable to undo these manipulations, an authoritative guidance on asset impairment was needed. Therefore, IAS 36 was issued in order to restrict management's opportunities of managing earnings through asset impairment decisions. As a result, we expect that the issuance of IAS 36 restricts management's discretion over the magnitude of the reported asset impairment loss.

Prior to the issuance of IAS 36, no explicit guidance existed on accounting for the impairment of long-lived assets. This absence of explicit guidance for asset impairments permitted substantial management discretion over amounts, presentation and timing of impairments. However, post-IAS 36, management presumably would have less discretion in reporting higher amounts of asset impairment losses and in the timing of when to report asset impairments since the standard provides some structure and rules that can be enforced by auditors. So, this study posits that the issuance of IAS 36 restricts management's discretion over the magnitude of the reported asset impairment loss and the discretion over when to report such events.

Therefore, it is expected that IAS 36 would reduce the magnitude and restricts the timing of reporting asset impairments. Therefore, we hypothesize that:

H_1: IAS 36 reduces the magnitude of impairment losses relative to pre-IAS 36.

However, IAS 36 leads to the need for more professional judgement, therefore bringing a higher degree of subjectivity in the valuation of non-financial fixed assets in the financial statements. This subjectivity provides opportunities for management to manipulate earnings. Asset impairment losses affect the magnitude of the accruals, because they lower the reported earnings while they have no influence on the cash flows from operations. Therefore, accounting for impairment loss provides significant scope for earnings management (Alciatore et al., 1998; Ball, 2006; Bini and Bella, 2007), and, according to Zucca and Campbell (1992), earnings management can be seen as a possible explanation for the timing and amount of discretionary impairments. Two techniques that explain management incentive in managing earnings through the use of asset impairment are the big bath and income smoothing. The unexpected earnings direction specifies which technique will be used when managing earnings. The big bath technique is adopted in periods of unexpected negative earnings, whereas the income smoothing technique is adopted in periods of unexpected positive earnings (Zucca and Campbell, 1992).

Asset Impairment and 'Big Bath'

The 'big bath' hypothesis suggests that if earnings are extremely low, managers are likely to take income-decreasing accruals to further reduce current earnings so that (1) the probability of appearing better in the future will increase, and (2) a lower benchmark for subsequent evaluation will be established (Murphy and Zimmerman, 1993; Pourciau, 1993; Guidry, Leone and Rock, 1999).

Therefore, for firms with unexpected negative earnings (big bath firms), reporting additional asset impairment losses would lead to a better accounting performance in future periods. By reporting asset impairment losses in the current year, future depreciation expenses would be reduced, which would increase the reported net income in future years. Also, the return-on-asset ratio would increase in the future since the non-financial fixed asset amounts would decrease and earnings would increase. Therefore, by using fewer resources to achieve higher earnings, these companies may be perceived by the market as better performers.

Some studies corroborate the big bath hypothesis. For example, using US data, Zucca and Campbell (1992) found that the majority of the firms surveyed wrote down their assets in a period of already below normal earnings (the big bath hypothesis). Chen and Lee (1995), studying US oil and gas companies in the mid-1980s, found that the likelihood of a write-down was larger for firms with accounting losses before the write-down. Rees et al. (1996) found that management acts opportunistically in the year of the write-down to improve reported earnings of future years for a sample of US firms. Riedl (2004) also provided evidence of the relationship between big bath reporting behaviour and the reporting of asset impairment losses. Also using US data, Jordan and Clark (2004) found evidence that companies with unusually low earnings in a year similarly reported a large impairment loss, which

is suggestive of big bath accounting. Spear and Taylor (2011) concluded as well that under-performing US firms tend to take larger write-downs than other firms, which may indicate opportunistic big bath accounting by these firms. Yoon and Miller (2002), using a sample of South Korean firms, found that when the operating performance is extremely poor, some firms tend to take a big bath. For a sample of Taiwanese listed firms, Chao (2006) concluded that firms with extremely low earnings tend to take a big bath by reporting a larger magnitude of asset write-offs. Dai, Mao and Deng (2007) examined whether Chinese-listed firms with negative earnings manipulate earnings by the impairment of assets and they found evidence that listed firms with negative earnings have taken a big bath. Finally, in Europe, Van de Poel et al. (2009) studied whether the IFRS goodwill impairment test is used by European firms as a tool to manage earnings. Using a sample of listed companies in fifteen EU countries with financial statements prepared under IFRS for the period 2005–2006, their results support the fact that companies typically take their impairments when earnings are unexpectedly low (big bath accounting).

Therefore, managers may have incentives to take a 'big bath' in periods in which pre-write-down earnings are below expectations to improve future reported performance. An asset impairment test may provide managers with the necessary discretion to engage in this form of earnings management. Therefore, we hypothesize that:

H_2: Firms are more likely to recognise an impairment loss when their earnings are unexpectedly low, *ceteris paribus*.

Asset Impairment and 'Income Smoothing'

Income smoothing is another technique that explains management incentives in managing earnings through the use of asset impairment. According to the income smoothing hypothesis, management seeks to reduce the variability in the trend of reported income with accounting decisions (Eckel, 1981). Various reasons have been suggested as to why managers might attempt to smooth earnings. They may believe that smooth earnings are more highly valued or that smooth earnings minimise the risk of possible debt and dividend covenant violations. That is, smooth income creates an impression of reduced risk in the eyes of the participants in the financial markets. Therefore, the income smoothing hypothesis predicts that managers will tend to use income-decreasing accruals in a year when earnings are unusually high. Thus, a firm with an impaired asset might choose to adjust earnings downward in a year when earnings are unusually high but are not expected to be as high in future years, or it may time the loss recognition to coincide with a non-discretionary gain. In this manner, management could smooth income and increase predictability of a firm's performance.

Prior literature shows that asset impairment losses have been used to smooth earnings (e.g. McNichols, Wilson and DeAngelo, 1988; Kinney and Trezevant, 1995; Zucca and Campbell, 1992). Using US data, McNichols et al. (1988) found that firms have more impairment of assets when their earning level is higher or lower than others, which suggests that firms have an incentive to smooth earnings. Zucca and Campbell (1992) found that 25 per cent of the US firms surveyed

offset the write-down with other gains or unusually high earnings (the income smoothing hypothesis). Jahmani, Dowling and Torres (2010), using US data, tested whether management deliberately selects the timing of goodwill impairment recognition as a means to smooth the company's earnings. Their results suggest that most companies are attempting to manage the volatility of earnings by avoiding taking impairment losses in the period studied to avoid exacerbating the losses. Van de Poel et al. (2009) studied whether the IFRS goodwill impairment test is used as a tool to manage earnings. Using a sample of listed companies in fifteen EU countries with financial statements prepared under IFRS in the period 2005–2006, they obtained results supporting the fact that companies typically take their impairments when earnings are unexpectedly high (smoothing).

Managers have incentives to smooth earnings in case of high unexpected earnings and to under-report earnings by the maximum. An asset impairment test may provide managers with the necessary discretion to engage in this form of earnings management. Therefore, we hypothesize that:

H_3: Firms are more likely to recognise an impairment loss when their earnings are unexpectedly high, *ceteris paribus*.

Asset Impairment and Audit Quality

Auditing is considered an important monitoring mechanism (Jensen and Meckling, 1976; Watts and Zimmerman, 1983). Therefore, the auditing process is supposed to serve as a monitoring device that reduces management incentives to manipulate reported earnings. Although auditing is an important way to limit earnings management, its effectiveness is likely to vary with the quality of the auditor (Becker et al., 1998).

Audit quality research has focused primarily on differences between big firm auditors and non-big firm auditors. Several studies suggest that higher quality (big firm) auditors reduce the level of accrual earnings management (e.g. Becker et al., 1998; Caneghem, 2004; Gul, Lynn and Tsui, 2002; Gul, Tsui and Dhaliwal, 2006; Jordan, Clark and Hames, 2010; Krishnan, 2003; Lin and Hwang, 2010) and big audit firms used more conservative accounting methods (Chung, Firth and Kim, 2003; Basu, Hwang and Jan, 2002).

Therefore, high-quality audit firms are more likely to detect any overly optimistic assumptions in the impairment test and accordingly force firms to adjust these conjectures downwards. Similar to preventing income-increasing earnings management, high-quality auditors are expected to be more likely to constrain income-decreasing behaviour in cases of unexpectedly high earnings (Van de Poel et al., 2009). As a result, we hypothesize that:

H_{4a}: Big 4 audit firms restrain the use of discretionary asset impairment losses to take a 'big bath'.

H_{4b}: Big 4 audit firms restrain the use of discretionary asset impairment losses to smooth earnings.

However, other studies suggest that auditors are less likely to adjust earnings management attempts when accounting standards are imprecise or require judgements (Healy and Wahlen, 1999; Nelson, Elliott and Tarpley, 2002; Nelson, 2003). Watts (2003) argues that assessing fair values requires managers to estimate future cash inflows and outflows and those estimates are unlikely to be verifiable and contractible, thus, valuations based on them are likely to be manipulated. As a result, auditors may not contribute to reducing earnings management.

VARIABLE MEASUREMENT AND RESEARCH DESIGN

Measuring Dependent and Independent Variables

- ***Asset impairment*** (*Impairment*), the dependent variable, is measured as the reported asset impairment amount for firm *i* in year *t*, deflated by the total asset.
- ***IAS 36*** – we use a dichotomous variable that equals 1 if the firm is subject to the rules of IAS 36, and 0 if not.
- ***Big bath*** (*Bath*) – following Bartov (1993), Francis et al. (1996) and Riedl (2004) as a proxy for big bath behaviour, we use an indicator variable that equals 1 if the change in a firm's pre-write-down earnings divided by lagged total assets is below the median of non-zero negative values, and 0 otherwise. In this case earnings are unexpectedly low.
- ***Income smoothing*** (*Smooth*) is also used an indicator variable to proxy income smoothing. This variable is equal to 1 if the change in a firm's pre-write-down earnings divided by lagged total assets is above the median of non-zero positive values for this variable and 0 otherwise.
- ***Audit quality*** (*Big4*) – consistent with prior research (e.g. Becker et al., 1998; Chen, Lin and Zhou, 2005; Chi, Lisic and Pevzner, 2011; Li and Lin, 2005; Lin, Li and Yang, 2006; Rahman and Ali, 2006; Sun, Liu and Lan, 2011), we measure external audit as a dichotomous variable equal to 1 if the auditor is a Big 4 audit firm (Deloitte Touche Tohmatsu, Ernst & Young, KPMG or Pricewaterhouse-Coopers), and 0 otherwise.

Regression Models and Control Variables

The first hypothesis states that IAS 36 reduces the magnitude of asset impairment relative to the magnitude of asset impairment pre-IAS 36. We estimate the following ordinary least squares (OLS) regression:

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \varepsilon_{it} \quad (1)$$

Where:

- $Impairment_{it}$ = reported asset impairment amount for firm *i* in period *t* deflated by the total assets of the same year *t*

- $IAS\ 36_{it}$ = 1 if the observation for firm *i* collected in year *t* is subject to the rules of IAS 36, and 0 if not
- ε_{it} = residual term of firm *i* for period *t*
- β_0 is a constant, β_1 is the coefficient

Hypothesis H_2 states that IAS 36 restricts the timing of reporting asset impairment such that the number of firms with negative (positive) unexpected earnings that have reported asset impairment will be fewer post-IAS 36 than the number of firms with negative (positive) unexpected earnings that have reported asset impairment pre-IAS 36. The following OLS regression is used to test hypothesis H_2:

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Bath_{it}) + \beta_3 (Smooth_{it}) + \varepsilon_{it} \quad (2)$$

Where:

- $Impairment_{it}$, $IAS\ 36_{it}$ and ε_{it} = as defined previously
- $Bath_{it}$ = dummy variable: 1 if the change in firm *i*'s pre-impaired earnings from year *t-1* to *t*, divided by total assets at year *t-1*, is below the median of non-zero negative values, and 0 otherwise
- $Smooth_{it}$ = dummy variable: 1 if the change in firm *i*'s pre-impaired earnings from year *t-1* to *t*, divided by total assets at year *t-1*, is above the median of non-zero positive values, and 0 otherwise
- β_0 is a constant, β_1 to β_3 are the coefficients

Additionally, we also analyse the influence of audit quality on the use of the asset impairment test as a tool to manage earnings, by estimating the following OLS regression:

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Bath_{it}) + \beta_3 (Smooth_{it}) + \beta_4 (Big4_{it}) + \varepsilon_{it} \quad (3)$$

Where:

- $Impairment_{it}$, $IAS\ 36_{it}$, $Bath_{it}$, $Smooth_{it}$ and ε_{it} = as defined previously
- $Big4_{it}$ = dummy variable: 1 if the auditor is a Big 4 firm and 0 otherwise

To examine the potential interaction effect between audit quality and income-decreasing incentives, we include interaction terms between the *Bath* and *Smooth* variables and the *Big4* variable, by estimating the following OLS regression:

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Bath_{it}) + \beta_3 (Smooth_{it}) + \beta_4 (Big4_{it}) + \beta_5 (Bath_{it} * Big4_{it}) + \beta_6 (Smooth_{it} * Big4_{it}) + \varepsilon_{it} \quad (4)$$

Given that earnings management, audit quality (Big 4/non-Big 4) and the interaction of these variables are not the only factors affecting the asset impairment decision, we also evaluate the association between these variables and asset impairment, after controlling the impact of other relevant variables. Several control variables are introduced to isolate other contracting incentives that may influence management's accounting choices. Previous studies suggest that firm leverage (*Lev*), growth options (*Growth*) and size (*Size*) are associated with the asset impairment decision (Beatty and Weber, 2006; Francis et al., 1996; Lemans, 2009; Zang, 2008; Zucca and Campbell, 1992). Additionally, we also control the crisis period by including the crisis variable (*Crisis*).

The association between earnings management, audit quality and interaction between these two variables and asset impairment, controlling the impact of other relevant variables, is estimated using the following OLS regressions:

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Lev_{it}) + \beta_3 (Growth_{it}) + \beta_4 (Size_{it}) + \beta_5 (Crisis_{it}) + \varepsilon_{it} \quad (5)$$

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Bath_{it}) + \beta_3 (Smooth_{it}) + \beta_4 (Lev_{it}) + \beta_5 (Growth_{it}) + \beta_6 (Size_{it}) + \beta_7 (Crisis_{it}) + \varepsilon_{it} \quad (6)$$

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Bath_{it}) + \beta_3 (Smooth_{it}) + \beta_4 (Big4_{it}) + \beta_5 (Lev_{it}) + \beta_6 (Growth_{it}) + \beta_7 (Size_{it}) + \beta_8 (Crisis_{it}) + \varepsilon_{it} \quad (7)$$

$$Impairment_{it} = \beta_0 + \beta_1 (IAS\ 36_{it}) + \beta_2 (Bath_{it}) + \beta_3 (Smooth_{it}) + \beta_4 (Big4_{it}) + \beta_5 (Bath_{it} * Big4_{it}) + \beta_6 (Smooth_{it} * Big4_{it}) + \beta_7 (Lev_{it}) + \beta_8 (Growth_{it}) + \beta_9 (Size_{it}) + \beta_{10} (Crisis_{it}) + \varepsilon_{it} \quad (8)$$

Where:

- $Impairment_{it}$, $IAS\ 36_{it}$, $Bath_{it}$, $Smooth_{it}$, $Big4_{it}$, $Bath_{it} * Big4_{it}$, $Smooth_{it} * Big4_{it}$ and ε_{it} = as defined previously
- Lev_{it} = the ratio between the book value of all liabilities and the total assets of firm *i* for period *t*
- $Growth_{it}$ = book value of equity divided by market value of equity at the end of *t*
- $Size_{it}$ = logarithm of market value of equity of firm *i* for period *t*
- $Crisis_{it}$ = is a dummy variable which is equal to 1 during the crisis period (Financial crisis: 2007–2008; European sovereign debt crisis: 2010)
- β_0 is a constant, β_1 to β_{10} are the coefficients

Control Variables Explained

Watts and Zimmerman (1986, 1990) argue that accounting choices are affected by a firm's debt contracts. Previous studies suggest that the larger a firm's debt ratio, the more likely its managers are to engage in manipulation (e.g. DeFond and

Jiambalvo, 1994; Jiang, Lee and Anandarajan, 2008; Sweeney, 1994). A large impairment loss charge will have a negative impact on the financial structure and debt covenant of a firm, because it reduces the amount of assets and, at the same time, it flows through the income statement into retained earnings, thus lowering stockholder equity. Consequently, highly leveraged firms may try to avoid violations of debt covenants by reducing the effect from asset impairment losses (Beatty and Weber, 2006; Zang, 2008).

Following IAS 36 guidelines, firms with an excess amount of book value over market value are more likely to incur asset impairment charges. In addition, Beatty and Weber (2006) argue that firms with more growth options are less likely to have impaired assets; therefore, they are less likely to take annual asset impairment losses. The impairment test under IAS 36 requires managers to consider not only backward-looking but also forward-looking information when they evaluate assets for impairment. Beatty and Weber (2006) find that firms with more growth options are less likely to take a write-off.

Francis et al. (1996) and Lemans (2009) find that larger firms are more likely to write down asset value. Nevertheless, larger firms are subject to closer scrutiny by the investment banks and analyst community, which may lead to more efficient processing of accounting information, and fewer managerial incentives to manipulate the impairment charge (Chao, 2006).

At times of economic uncertainty and persistent slowdown in financial markets and in the real economy, it is likely that assets may generate lower cash flows than previously expected. This could, in turn, increase the likelihood of booking impairment charges as carrying amounts may not be fully recoverable. As such, the crisis may act as the triggering event for impairment testing and the recognition of write-downs. Therefore, it would be expected that the volume of impairments would have increased during the crisis period.

SAMPLE SELECTION AND CHARACTERISTICS

The initial sample includes all companies whose stocks are listed in the main market, Euronext Lisbon. A total of 52, 50, 48, 51, 51, 51, 50, 49 and 52 companies were listed at the year end of 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009 and 2010 respectively (454 firm-year observations in total).

Foreign companies (30 in total) are excluded. Companies not having shares listed in the previous year and companies whose shares were delisted in the following year are also excluded (76 in total). Companies with missing data (six in total) are also excluded. Financial companies (45 in total) are excluded, too. As a result, the final sample size is 33 non-financial companies per year and, thus, 297 observations in total. This reduced number of observations may influence some results. Nevertheless, this limitation is an immediate consequence of the small size of the Portuguese stock market.

Information on asset impairment magnitude, audit quality (Big 4 audit firm or non-Big 4 audit firm), net income, total assets, total liabilities and total shareholders'

equity (book value of equity) are collected from the annual reports and corporate governance reports of each firm. Both annual reports and corporate governance reports are available online at www.cmvm.pt. We obtain stock price data from Euronext Lisbon, which enable the measurement of the variables growth and firm size.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 presents the sample descriptive statistics for the variables used in this research. The *Impairment* variable represents on average 1.3 per cent of the total assets of the company (with a median of 0.000). About 24 per cent of the firms adopt the big bath technique (*Bath*). The analysis of Table 1 also shows that about 19.4 per cent of companies adopt the income smoothing technique (*Smooth*). *Big4* auditors are used by 70.3 per cent of the sample firms. The *Lev* variable represents on average 4.362 of the total assets of the company (with a median of 1.965). The descriptive statistics of the *Growth* show that, on average, firms in our sample exhibit a relatively low investment opportunities level with a mean of 0.351 (with a median of 0.637). The mean of firm size (*Size*) is about €1.146 million with a minimum of €1,740 and a maximum of €16.347 million.

TABLE 1: SUMMARY OF DESCRIPTIVE STATISTICS (NUMBER OF OBSERVATIONS: 297; PERIOD: 2002–2010)

Variable	Mean	Median	Minimum	Maximum
Impairment	0.013	0.000	0.006	0.236
Bath	0.240	0.000	0.000	1.000
Smooth	0.194	0.000	0.000	1.000
Big4	0.703	1.000	0.000	1.000
Lev	4.362	1.965	0.284	8.259
Growth	0.351	0.637	-56.742	10.525
Size	20.195	20.205	16.971	24.450

Impairment is the asset impairment magnitude for firm *i* in period *t* deflated by the total assets of the same year *t*; *Bath* is a dummy variable which takes a value of 1 if the change in firm *i*'s pre-impaired earnings from year *t-1* to *t*, divided by total assets at year *t-1*, is below the median of non-zero negative values, and 0 otherwise; the *Smooth* dummy variable takes a value of 1 if the change in firm *i*'s pre-impaired earnings from year *t-1* to *t*, divided by total assets at year *t-1*, is above the median of non-zero positive values, and 0 otherwise; *Big4* dummy variable takes a value of 1 if the auditor is a Big 4 firm; *Lev* represents the ratio between the book value of all liabilities and the total assets; *Growth* is the book-to-market ratio; *Size* represents the firm's size.

Spearman correlations between the explanatory variables are documented in Table 2. The binary variables (*IAS 36*, *Bath*, *Smooth*, *Big4* and *Crisis*) are not included in the table, given that the Pearson correlation coefficient is not computed to nominal variables.

TABLE 2: PEARSON CORRELATION COEFFICIENTS MATRIX

	Impairment	Lev	Growth	Size
Impairment	1			
Lev	-0.270***	1		
Growth	0.025	-0.512***	1	
Size	0.219***	-0.177***	0.191***	1

Impairment is the asset impairment magnitude for firm *i* in period *t* deflated by the total assets of the same year *t*; *Lev* represents the ratio between the book value of all liabilities and the total assets; *Growth* is the book-to-market ratio; *Size* represents the firm's size.

*** Correlation is significant at the 0.01 level (2-tailed)

The analysis of Table 2 shows that there are some significant correlations between the variables. The asset *Impairment* is negatively associated with leverage (*Lev*), suggesting that highly leveraged firms tend to have lower amount of impairment loss. *Size* is positively correlated with *Impairment*, suggesting that large firms have high asset impairment magnitude, consistent with Francis et al.'s (1996) findings. A negative correlation between *Lev* and *Growth* indicates that firms with high leverage tend to have smaller investment opportunities. *Size* is negatively associated with *Lev*, suggesting that larger firms have lower leverage constraint levels. *Growth* is positively correlated with *Size*, suggesting that larger firms have higher investment opportunities. Correlation coefficients are, in general, low (below the 0.9 threshold) (Tabachnick and Fidell, 2001), suggesting the absence of serious statistical problems related with multicollinearity.

Regression Results

Table 3 presents OLS regression estimates for the equations developed in the section on variable measurement and research design.

The primary question of interest is whether or not the issuance of IAS 36 reduces the magnitude of asset losses relative to that before the application of IAS 36. A statistically significant and negative value for β_1 in these equations would suggest that IAS 36 decreased the reported asset impairment magnitude. However, the results indicate that IAS 36 did not have a significant effect on the reported asset impairment magnitude. This result is not surprising, since the IASB's approach in IAS 36 gives management substantial discretion about how to assess the true value (recoverable amount) of the firm's assets.

We find a positive relationship between both *Bath* and *Smooth* variables and asset impairment losses, suggesting that firms impair their assets more often when earnings are unexpectedly low (big bath) or high (smooth). These results are similar to Zucca and Campbell's (1992) conclusion that write-off firms are engaging in either big bath or smoothing behaviour.

We also find that the relationship between Big 4 and asset impairment is significantly positive. This means that firms audited by Big 4 firms take significantly more impairments than firms audited by non-Big 4 firms. Therefore, this finding is not consistent with the notion that Big 4 audit firms mitigate earnings management more than non-Big 4 audit firms. However, this result is consistent with some

TABLE 3: REGRESSION RESULTS (NUMBER OF OBSERVATIONS: 297; PERIOD: 2002–2010)

	Dependent Variable: Impairment							
Independent Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Income-decreasing incentives								
Constant	-0.017	0.019	-0.009	0.101**	0.055	0.053	-0.028	0.223***
IAS 36	0.019	0.077	0.053	0.067	0.086	0.065		0.034
Bath		0.208***	0.217***	0.203***		0.210***	0. 219***	0.186**
Smooth		0.221***	0.209***	0.222***		0.201***	0.170**	0.207***
Audit quality								
Big4			0.180**	0.317***			0.101*	0.213***
Interaction variables								
*Bath * Big4*				0.041				0.082
*Smooth * Big4*				-0.139**				-0.289***
Control variables								
Lev					-0.202***	-0.222***	-0.199***	0.201***
Growth					-0.002	-0.001	-0.005	-0.056
Size					0.103*	0.106*	0.099*	0.110*
Crisis					0.110*	0.108*	0.105*	0.106*
R-squared	7.50%	13.91%	15.87%	18.27%	11.36%	15.67%	17.52%	20.25%
Adjusted R-squared	6.94%	12.82%	14.02%	16.05%	10.09%	13.08%	14.31%	18.87%
F-statistic	13.226***	13.212***	10.233***	9.398***	13.025***	10.130***	8.782***	9.899***

Impairment is the asset impairment magnitude for firm *i* in period *t* deflated by the total assets of the same year *t*; *IAS 36* takes a value of 1 if the observation for firm *i* collected in year *t* is subject to the rules of IAS 36, and 0 if not; *Bath* is a dummy variable which takes a value of 1 if the change in firm *i*'s pre-impaired earnings from year *t-1* to *t*, divided by total assets at year *t-1*, is below the median of non-zero negative values, and 0 otherwise; *Smooth* is a dummy variable which takes a value of 1 if the change in firm *i*'s pre-impaired earnings from year *t-1* to *t*, divided by total assets at year *t-1*, is above the median of non-zero positive values, and 0 otherwise; *Big4* is a dummy variable which takes a value of 1 if the auditor is a Big 4 firm; *Lev* represents the ratio between the book value of all liabilities and the total assets; *Growth* is the book-to-market ratio; *Size* represents the firm's size; *Crisis* is a dummy variable which is equal to 1 during the crisis period (Financial crisis: 2007–2008; European sovereign debt crisis: 2010).

*** Significant at the 1 per cent level; ** Significant at the 5 per cent level; * Significant at the 10 per cent level

studies that show that auditors are less likely to require adjustments when the amounts involved are subjective (e.g. Braun, 2001; Nelson, Smith and Palmrose, 2005). In the same sense, other authors (Healy and Wahlen, 1999; Nelson et al., 2002; Nelson, 2003; Nelson, Elliott and Tarpley, 2003) suggest that auditors are less likely to adjust earnings management attempts when accounting standards are imprecise or require judgements. Since IAS 36 involves estimation of parameters such as cash flow and discount rate by the managers, the subjective component in the determination of the amount of impairment loss may give rise to earnings management opportunities. This result seems also to be consistent with the long list of corporate failures, which indicates that management have often engaged in earnings management, and Big 4 audit firms have not been effective in identifying and preventing unscrupulous accounting practices.

Additionally, the results show that the coefficients on the interaction term between the *Big4* indicator and the *Smooth* variable have a negative sign. This finding suggests that when there are incentives to under-report earnings, the likelihood of taking an asset impairment will increase more for firms audited by a non-Big 4 audit firm than for firms audited by a Big 4 audit firm.

We find a negative relationship between *Lev* and asset impairment losses, suggesting that highly leveraged firms may try to avoid violations of debt covenants by reducing the amount of impairment loss. Therefore, existing debt covenants may introduce higher scrutiny on financial reporting processes including the exercise of accounting discretion with respect to IAS 36 impairment testing.

As in Beatty and Weber (2006), Francis et al. (1996), Haron and Atan (2010), Lemans (2009) and Zang (2008), we find that large firms (*Size*) have a higher amount of impairment loss. This means that larger firms are expected to recognise more and bigger asset impairment losses than smaller firms.

We find a positive relationship between *Crisis* and asset impairment losses, suggesting that firms recognise a higher amount of impairment loss during the crisis period.

Results suggest that *Growth* does not affect the amount of impairment loss.

Sensitivity Analyses

To ensure the robustness of our results, we perform several sensitivity checks. The first sensitivity analysis tests the impact of using alternative measures for the asset impairment (*Impairment*) variable on regression results. As in several studies (e.g. Beatty and Weber, 2006; Lemans, 2009; Van de Poel et al., 2009), the *Impairment* variable is determined using a dichotomous variable equal to 1 when the firm records an asset impairment loss and 0 otherwise. The results (not reported here) of the regressions, using alternative measures to measure *Impairment* (asset impairment) earnings management, have implications on the *Bath* and *Lev* variables, which lost significance level (from $p < 0.01$ to $p < 0.10$) in Models (2), (6) and (8). The other results remain unchanged (at coefficient signal and significance level).

The next sensitivity analysis examines the effect of influential observations on the results. Where outliers are found (namely in the variables *Impairment*, *Lev* and *Size*), a winsorisation method[1] is used to test the robustness of the results. Extreme values (defined as values that are more than three standard deviations away from

the mean) are replaced by values that are exactly three standard deviations away from the mean. The results (not reported here) do not differ from results presented previously in Table 3. Thus, the influential observations do not affect the results.

We also test the impact of using alternative definitions for the *Size* and the *Growth* variables on the results of Models (5), (6), (7) and (8). Thus, we use the logarithm of the market value of equity instead of assets as a proxy for *Size* and the ratio of the market value of the firm to the book value of its assets as a proxy for *Growth*. The results (not reported here) of the regressions considering alternative variable definitions have implications on the *Bath* variable, which lost significance level (from $p < 0.01$ to $p < 0.05$) in Models (7) and (8). In addition, they have also implications on the *Size* variable, which is no longer statistically significant in Models (6), (7) and (8).

Overall, the several sensitivity analyses conducted largely corroborate the results presented in Table 3.

SUMMARY AND CONCLUSIONS

Since 1 January 2005 all public companies listed on regulated capital markets within the European Union, such as Euronext Lisbon, have been required to use IFRS as a basis for preparation of their consolidated financial statements. Consequently, since 1 January 2005 Portuguese companies listed on Euronext Lisbon have been required to use IAS 36, which deals with the impairment of non-financial fixed assets.

IAS 36 prescribes the procedures that a company should apply to ensure that its assets are carried at no more than their recoverable amount, namely the higher of the amount to be realised through use or sale of the asset. This standard aims at enhancing the usefulness of the information reported on financial statements. However, IAS 36 provides managers with considerable discretion about how to assess the true value of assets. Since the recoverable value is difficult to obtain objectively, assessing the magnitude of impairment loss may affect the reported profit. In fact, the subjectivity in applying an impairment test provides opportunities for management to manage earnings, which can lead to a distorted image in the financial statements that are provided to its users. There is significant evidence that the impairment of assets decision is influenced by managers (e.g. Beatty and Weber, 2006; Francis et al., 1996; Riedl, 2004; Spear and Taylor, 2011; Van de Poel et al., 2009). Summing up, it is expected that IAS 36 would reduce the magnitude and restrict the timing of reporting asset impairments. However, the decision of writing down the value of assets and the magnitude of impairment loss allows management of listed companies to exercise judgement in determining the recoverable value of assets, and provides a good chance for managers to opportunistically manage the reported earnings. Thus, this study investigates these two viewpoints and analyses the effect of IAS 36 on asset impairment reporting. It investigates whether IAS 36 reduces management's discretion over asset impairment magnitude and timing. Additionally, we also analyse the influence of audit quality on the use of the asset impairment test as a tool to manage earnings. Using a sample of 33 Euronext Lisbon non-financial firms over a period of nine years, from 2002 through 2010, we find that IAS 36 does not affect the magnitude of the reported asset impairment. This

result is not surprising, since the IASB's approach in IAS 36 gives management substantial discretion about how to assess the true value (recoverable amount) of the firm's assets. We also find evidence that firms impair their assets more often when earnings are unexpectedly low or high. This suggests that impairment firms are engaging in either big bath or smoothing behaviour. Our results also suggest that firms audited by Big 4 firms take significantly more impairments than firms audited by non-Big 4 firms. This result seems to suggest that non-Big 4 auditors give firms more discretion to engage in income-increasing earnings management by postponing asset impairments. Additionally, the results shows that when there are incentives to under-report earnings, the likelihood of taking an asset impairment will increase more for firms audited by a non-Big 4 audit firm than for firms audited by a Big 4 audit firm.

Moreover, the results also reveal lower impairment loss when leverage is high, and higher impairment loss management during the crisis period and when firm size is high.

The findings of this study make the following contributions. First, the results appear to suggest that Portuguese listed firms use asset impairment as a tool to manage earnings. This result seems to suggest that IAS 36 does not contribute to improved financial reporting quality. Second, the findings are relevant for standard setters, suggesting that they should consider opportunities for earnings management in setting accounting standards, mainly in the case of the impairment of assets standard. Prevention of earnings management is needed to further ensure comparability of accounting numbers. Finally, investors may also benefit from the findings because they provide insight into the impact of IAS 36 and Big 4 audit firms on earnings quality.

This study has, however, some limitations. First, this study, similar to all asset impairment studies, uses the entire amount of the impairment rather than estimating the unexpected portion since the unexpected portion is unobservable. If some of the impairment is expected, using the entire impairment amount introduces measurement error, which causes biased and inconsistent estimates of the models' coefficients. Therefore, using the total impairment amount could limit the conclusions that are drawn from this study. Second, the reduced number of observations may influence some results, too. Nevertheless, this limitation is an immediate consequence of the small size of the Portuguese stock market. Third, we focus only on the consequences of a single accounting standard, and the overall effect on the quality of financial reporting will be the net consequence of applying many accounting standards. Finally, our sample is of listed companies of a single country, and further investigations using listed firms of other countries are necessary.

NOTES

[1] The winsorisation method is considered quite good at identifying outliers in a normal sample (Hair, Anderson, Tatham and Black, 1998).

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STABILITY AND CHANGE IN MANAGEMENT ACCOUNTING: AN EXPLORATORY STUDY OF THE USE OF STANDARD COSTING IN AN IRISH MANUFACTURING COMPANY

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ABSTRACT

This paper examines the simultaneous presence of both stability and change in management accounting practices by exploring the use of a traditional technique, namely standard costing, in an organisation. The study is framed by literature concerning routines and rules, and the data were gathered by means of a case study. This paper contributes to the literature by providing empirical evidence of the interactions of management accounting routines and rules in a relatively traditional environment. The analysis reveals that change to stable routines can occur but, at the same time, these routines can become further embedded within an organisation.

INTRODUCTION

> The methods remain the same. It's just the operation of it that has changed.

The above comment was made by a management accountant at Engineering Ltd (detailed later) when asked about the standard costing system used by the company. This paper attempts to make sense of, in terms of routines and rules, how such simultaneous change and stability in the standard costing system may occur.

Standard costing has been in use as a control system since the late nineteenth century (Kranowski, 1977; Fleischman and Tyson, 1998) and it is often regarded as a 'traditional' management accounting practice. It operates by establishing standard costs, which are estimates of what it should cost to produce an item under efficient operating conditions. The resulting costs are used for cost accumulation purposes

and are compared to actual costs at the end of a period to evaluate efficiency. The need to be able to accurately determine inputs and related costs means that standard costing is best suited to repetitive business processes, typically in the manufacturing sector (Johnson and Kaplan, 1987; Fry, Steele and Saladin, 1998). However, the relevance of standard costing to modern manufacturing has been questioned by many academics (e.g. Johnson and Kaplan, 1987; Bruggeman and Slagmulder, 1995). It is argued that many characteristics of modern organisations (e.g. cost structure, just-in-time (JIT) manufacturing, flexible processes) are incongruent with standard costing (Johnson and Kaplan, 1987; Monden and Sakurai, 1989; Sulaiman and Mitchell, 2005; Zoysa and Herath, 2007). Yet, despite the criticisms and a widespread management accounting change debate in the literature, standard costing remains a popular management accounting practice with high levels of usage (e.g. Clarke, 1997; Fry et al., 1998; Guilding, Lamminmaki and Drury, 1998; Chartered Institute of Management Accountants, 2009). Fry et al. (1998) argue that the continued use of standard costing is due to the absence of superior systems, while Pierce and O'Dea (1998) contend that new techniques are simply being used to supplement rather than replace traditional systems.

The continued use of standard costing as a practice is not the main focus of this research study; rather how it has (or has not) remained a relatively stable management accounting practice in organisations is the issue of interest. Put another way, this study uses an empirical examination of standard costing to address the broader question of simultaneous change and stability in management accounting practices. Much has been written about how management accounting practices can become stable, or routinised, in an organisation (see for example, Burns and Scapens, 2000; Quinn, 2011; van der Steen, 2011). Indeed, routines by definition embody stability (Feldman and Pentland, 2003; Becker, 2004), but change is also possible. However, as noted by Pentland, Haerem and Hillison (2010), empirical research on routines is relatively scarce. Given both the seemingly stable nature of standard costing (as portrayed in text books) and the opening remark in this section which suggests it can change when used in an organisation, it is hoped that this study can provide empirically based interpretations of both change and stability.

The remainder of the paper is structured as follows. The next section briefly reviews the extant literature on organisational and management accounting routines. In particular, the nature and varying dimensions of routines are described and the characteristics of rules are also detailed. The subsequent section describes the research method employed and the case company. The findings and discussion are then presented. In conclusion, some limitations of the present research, as well as implications for future research, are considered.

LITERATURE REVIEW: ORGANISATIONAL ROUTINES AND RULES

In the past twenty years, an expanding body of research has emerged which seeks to define, understand and conceptualise management accounting change. Many researchers (e.g. Burns and Vaivio, 2001; Sulaiman and Mitchell, 2005) suggest that the publication of *Relevance Lost* by Johnson and Kaplan (1987) ignited the debate on

the subject of management accounting change, as it prompted the development and use of 'new' and 'advanced' management accounting techniques and also spurred a re-examination of the role of management accounting and management accountants in organisations. In particular, the advent of *Relevance Lost* questioned the relevance of management accounting and the ability of traditional practices to deliver and meet the information needs of managers in modern organisations. Indeed, the issue of 'relevance' continues to interest researchers as evidenced by some recent publications (e.g. Otley, 2008; Bhimani and Bromwich, 2010; Scapens and Bromwich, 2010).

Several theoretical approaches have been adopted by researchers to explore different aspects of management accounting change. Broad studies of management accounting systems have tended to use structuration theory (see for example, Macintosh and Scapens, 1990, 1991; Scapens and Roberts, 1993; Jack and Kholeif, 2008; Coad and Herbert, 2009). The new institutional sociology branch of institutional theory has been used to study the convergence of management accounting practices in response to such external influences as political pressures, regulatory changes and cultural factors (see for example, Collier, 2001; Modell, 2003; Seal, 2006; Tsamenyi, Cullen and Gonzalez, 2006; Nor-Aziah and Scapens, 2007). Indeed, various institutional approaches have been utilised by management accounting scholars in recent years (see for example, Soin, Seal and Cullen, 2002; Dillard, Rigsby and Goodman, 2004; Siti-Nabiha and Scapens, 2005; Tsamenyi et al., 2006; Lukka, 2007). In particular, the concepts of routines and rules from old institutional economics (OIE), have been embraced as a way of interpreting change (and/or stability) in management accounting practices (see for example, Burns and Scapens, 2000; Quinn, 2011; van der Steen, 2011). Consequently, as change and stability in a management accounting practice is the focus of the current study, the concepts of routines and rules are utilised to provide an appropriate theoretical base.

A particularly useful starting point in an exploration of routines and rules in management accounting is the work of Burns and Scapens (2000). They define routines as 'the way things are done' (2000, p. 5), which can be contrasted with rules, 'the ways things should be done' (2000, p. 6). A detailed account of Burns and Scapens (2000) is not given here, save to say that their framework proposes that through the interactions of routines and rules over time, relative stability in management accounting practices can be explained. Change is also possible, although Burns and Scapens suggest that any such change is more likely to be evolutionary in nature, unless some 'major external change' is experienced (2000, p. 13). However, Burns and Scapens' (2000) study did not set out to explicitly describe the exact nature or dimensions of routines and rules. Indeed, a precise understanding of such phenomena is still elusive and there have been many calls for further empirical research (see for example, Pentland et al., 2010; Quinn, 2010, 2011). The following subsections provide an overview of the contribution of a number of researchers to date to the efforts to better understand the nature of routines and rules.

Organisational Routines

Many scholars have provided useful contributions to the debate concerning the nature of routines (see for example, Feldman and Pentland, 2003; Becker 2004, 2005; Pentland and Feldman, 2005, 2008; Hodgson, 2006, 2008; Pentland, 2011). A common theme

in much of this work is the conceptualisation that routines have two dimensions; in other words, they have both an 'action' and a 'structural' element. For example, Winter (1995, pp. 169–170) distinguished between a 'routine in operation at a particular site' and a 'routine *per se* – the abstract activity pattern', denoting routines as having more than one 'layer'. In summarising the organisational literature, Becker (2005) described the two layers of routines as: 1) an observable surface layer, and 2) an underlying generative layer which cannot be observed. While the generative layer is subject to constant minor changes, which may give rise to multiple surface layer performances of a routine, the core 'purpose' of the routine remains the same (Becker, 2005; Pentland et al., 2010). Similarly, Feldman and Pentland (2003, p. 101) state that 'organisational routines consist of two aspects' or dimensions, namely (1) the ostensive dimension and (2) the performative dimension. They contend that the ostensive dimension of a routine 'may have a significant tacit component' which moulds the perception of what the routine is and 'may exist as a taken-for-granted norm' (Feldman and Pentland, 2003, p. 101). They suggest that 'the ostensive incorporates the subjective understandings of diverse participants' (Feldman and Pentland, 2003, p. 101) and they describe it in later work as 'abstract, cognitive regularities and expectations that enable participants to guide, account for and refer to specific performances of a routine' (Pentland and Feldman, 2008, p. 286). In contrast, the performative dimension of a routine is 'the specific action(s) taken by people' (Feldman and Pentland, 2003, p. 102) 'at specific times, in specific places' (Pentland and Feldman, 2008, p. 286).

More recently, Pentland (2011, p. 281) outlines four characteristics of routines, which he states 'provide … an easily applicable test of whether a given phenomenon qualifies as an organisational routine':

1. Routines are repetitive.
2. A recognisable pattern of action occurs.
3. The actions are interdependent.
4. Multiple actors are involved.

While these characteristics may act as a useful test to ascertain whether or not observed actions may constitute a routine, the unobservable component of routines – the abstract patterns which underlie actions – must also be acknowledged (Feldman and Pentland, 2003; Becker, 2005; Pentland, 2011).

Volkoff, Strong and Elmes (2007, p. 839) propose that a dimension of a routine may be embedded in technology 'in the form of system-executed transactions – sets of explicitly defined steps that require specific data inputs to automatically generate specific outcomes'. It is clear that many management accounting tasks might be described in this way (e.g. product costing, budgeting and variance analysis) and it is interesting that Volkoff et al. (2007) contend that this 'material' dimension of routines, as they term it, is different from the ostensive dimension as, rather than being 'idealized and abstract', it is 'concrete and specific' (Volkoff et al., 2007, p. 840). This point is revisited in the next section.

Englund and Gerdin (2008, p. 1131) refer to a 'conceptual disparity' in studies concerning routines in management accounting, where some view management

accounting systems as modalities (i.e. structures) which are drawn on to produce practices, whereas others view the systems as recurrent practices (i.e. actions). They argue that combining both conceptualisations in the same study not only creates confusion, there is also a risk of 'social structure and action becoming conflated and potentially we may draw erroneous conclusions about structural change and stability' (Englund and Gerdin, 2008, p. 1131). However, as outlined above there is considerable support in the literature for viewing management accounting routines as having a dual nature, comprising both structural and action dimensions. Thus, for the purposes of the current study it is proposed that management accounting practices may be considered routinised in many organisational contexts, and can be conceived as both observable actions (performative dimension) and underlying abstract patterns (ostensive dimension).

Organisational Rules

As outlined above, Burns and Scapens (2000, p. 6) define rules as 'the way things should be done' and suggest that rules are more formal in nature than routines. Although they do not state it explicitly, they seem to imply that rules are more likely to be written and precede routines. Since the work of Burns and Scapens (2000), there has been limited examination of rules within management accounting (an exception is Oliveira, 2011) as the majority of empirical studies in the literature have tended to focus on routines (see for example, Quinn, 2011; van der Steen, 2009, 2011). The emphasis on routines as opposed to rules may be due to the fact that, as proposed by Pentland and Feldman (2005), rules are conceived as artefacts of routines. They argue that while any artefacts of routines may be thought of as influencing the performances of routines, there will always be 'open' contextual factors which may limit the potential to actually follow what the rules say (Pentland and Feldman, 2005, p. 797).

Hodgson (2006, p. 18) describes rules as 'socially transmitted and customary normative injunctions or immanently normative dispositions, that in circumstances *X*, do *Y*'. This definition begins to convey the more rigid or fixed nature of rules versus routines. Reynaud (2005) also notes a key difference between rules and routines: rules are arrangements awaiting interpretation, whereas routines are rules already interpreted. If a routine is an interpretation of a rule, a question arises on whether the 'interpretation' may be conceptually similar in nature to the ostensive routine as proposed by Feldman and Pentland (2003). However, as noted by Oliveira and Quinn (2012) and as outlined in the previous section, a routine by definition requires repetition. Thus, an interpretation of a rule could not alone be equated to the ostensive dimension of a routine as no repeated actions have yet occurred. As repetition is often associated with management accounting practices, it might be argued that rules (which do not have a repetitive element) may be less important that routines in studies of such practices. However, as noted by Oliveira and Quinn (2012), some management accounting tasks may never actually become routines, as insufficient repetition occurs; thus there may be a 'rule' which guides how the particular task is to be done. Furthermore, Oliveira and Quinn (2012) propose than rules are potentially important components in the eventual formation of routines. This is not to suggest that rules are the only factor which may determine

the eventual routines, nor that rules are a fixed or unchanging phenomenon (see also Morgen and Olsen, 2011).

Rules can be considered to be either formal or informal. In brief, a formal rule is typically codified in some way, for example traffic rules, whereas an informal rule is more constitutive in nature although it may become regularised and/or codified over time (Searle, 2005). Oliveira and Quinn (2012, p. 20) avoid this formal/informal classification by contending that rules are cognitive structures which 'have been accepted by organisational members'. In the current paper, we also avoid any informal/formal distinction of rules, instead focusing on the notion that rules are essentially un-interpreted initially, but form cognitive structures in actors' minds that may, over time, result in routines being formed. According to Oliveira and Quinn (2012), an important step in how these cognitive structures (i.e. rules) may become routines over time is the interaction with (and reinforcement by) the 'material routines' of Volkoff et al. (2007), as outlined earlier. Volkoff et al. (2007) view the material dimension of routines as the hard-coding of the underlying rules into information technology (such as enterprise resource planning (ERP) systems). Although Volkoff et al. (2007) do not explicitly use the term 'rules' in their discussion, their definition that 'organisational routines are embedded in the ES [enterprise system] in the form of system-executed transactions – sets of explicitly defined steps that require specific data inputs to automatically generate specific outcomes' (Volkoff et al., 2007, p. 839) implies that they are referring to rules. The reasoning for this is twofold: (1) these material 'routines' are intended to define transactions and their sequence, and (2) on their own, such systems-embedded phenomena do not meet the essential criteria of a routine as set out earlier (see Pentland, 2011). Although these material routines may be conceptually more akin to rules, we adopt the term 'material routines' here as used by Volkoff et al. (2007).

In summary, whereas repetition is deemed an essential feature of routines, recurrence is not necessary for rules. However, as put forward by Burns and Scapens (2000), and more recently by Oliveira and Quinn (2012), rules may be an essential component in bringing about change to practices, such as those within the domain of management accounting. Furthermore, rules are also important to underpin routines in a more formal way (see Oliveira and Quinn, 2012), as well as guiding actors when practices have not become routinised. The case company, which is featured in this paper and is detailed in the next section, experienced new rules in the form of a newly implemented ERP system, thus making rules an essential feature of the analysis. Furthermore, the nature of the business sector implied some traditional (and routinised) management accounting practices were in use. Thus, the concepts of both routines and rules are utilised in our analysis.

RESEARCH METHOD

Having outlined some useful theoretical constructs around routines and rules, this section now turns to the empirical case study. The research approach is outlined first, followed by some details regarding data collection and analysis. The section concludes by presenting details regarding the case company.

Research Approach

The objective of this study is to examine the presence of stability and change in management accounting practices by exploring, through the lenses of routines and rules, the use of standard costing in a manufacturing company. While routines and rules have received considerable attention in the literature, there is still a need, as noted by Pentland (2011), to tease out their complexities by the conduct of more real life studies. As a case study approach facilitates the exploration of phenomenon in a real life context, it was deemed the most appropriate means of data collection for this study (Atkinson and Shaffir, 1998; Yin, 2003).

Scapens (2004) identifies four possible roles for researchers in a case study. In this study, a visitor role was adopted. Several visits to the case site were made and the empirical data were collected primarily through semi-structured interviews. Given the exploratory nature of the study, interviews with four key participants in the company were conducted, namely the managing director, a management accountant, an assistant management accountant and a financial analyst. All interviews were digitally recorded with the permission of the participants. All participants were forwarded an outline interview guide in advance of each interview. This guide was divided into three main sections:

- The purpose/role of management accounting in the organisation
- Change(s) to management accounting
- The operation of, and changes to, standard costing at the organisation

The first two sections focus on the role, context and uses of management accounting practices generally in the case company, while the third part of the interviews particularly examined the uses of the standard costing system. In addition to interviews with the key participants, access to company documentation and files was forthcoming to support interview data.

In keeping with other studies of organisational/management routines, the interview transcripts and other data were analysed using an interpretive approach. This involved examining data for evidence of both routines and rules. In particular, the process of how certain management accounting practices were performed was extracted from the data to determine whether or not they could be classified as routinised as per the four criteria of Pentland (2011). In turn, if management accounting practices were deemed routinised, then data were analysed for evidence of any changes to the practices over time and how rules came into play in these changes.

Case Company: Background

An electrical product manufacturing company, referred to here as 'Engineering Ltd', was selected as the case site for a number of reasons. First, access was likely to be forthcoming through personal contacts of the authors. Second, the company operates in a business sector which implies that its management accounting practices are likely to be more traditional and less subject to radical change (see later for more detail). And, third, as the company had updated its management information systems using an enterprise resource planning suite (namely SAP), there was the

potential to find evidence of change to management accounting practices and to the role of management accounting in the organisation (Granlund and Malmi, 2002; Scapens and Jazayeri, 2003). This implementation of SAP had the potential to alter standard costing, as well as how standard costing data were collected, stored and updated. Having made initial contact with Engineering Ltd, access was agreed for an exploratory study of management accounting practices at the company, with a particular focus on standard costing.

Engineering Ltd was established in the late 1970s, has an annual turnover in the range of €50–€100 million and employs approximately 300 people. It is a subsidiary of a European electrical product manufacturing group. Since 2005, the European group has been wholly owned by an Indian multinational, which itself is part of a United States (US) global conglomerate group. Engineering Ltd manufactures a range of electrical products which are sold globally. Due to the specialised nature of the products and a repetitive production process, the company has always used standard costing. The standard costing system has recently been embedded into the SAP software, which was installed at the instigation of the US parent. Engineering Ltd's costing system focuses on the direct costs of raw materials and production labour and, like all companies in its sector, the company prices products based on direct costs plus a margin. As the standard direct costs are the basis of prices offered to customers, standards are revised on a monthly basis – a feature of the new SAP system is an inflationary adjustment to standard costs for projecting prices for products that are typically manufactured within one month. This monthly revision of standards also permits an accurate evaluation of direct materials usage and wastage, which is important as the materials (primarily metals) make up a significant proportion (approximately 70 per cent) of total costs. The cost structure of the company has remained very stable over the years with direct labour representing approximately 20 per cent and overheads being approximately 10 per cent of total costs.

Before describing the standard costing system of Engineering Ltd, it is important to note that, given the objective of the study, we place less emphasis on the intricacies of the technique itself and more on its routinised nature, and how this routinised nature may change (or remain relatively stable). Further, while at the outset of this study we contend that it is reasonable to term standard costing a routine in Engineering Ltd, the case evidence will be evaluated in light of Pentland's (2011) defining characteristics of a routine in order to evaluate the appropriateness of our contention.

FINDINGS

It was clear from evidence presented in the interviews that management accounting plays, and is perceived to play, an important role in the operation and management of the company. Reports produced by the management accounting department are used throughout the organisation for cost management, pricing and decision-making purposes; as the managing director comments: 'I would see the role of management accounting as being very important … their [the management accounting

department's] work really does span the entire organisation.' Members of the management accounting department were anxious to explain how their activities are embedded across the organisation and provide 'information that drives the business' (management accountant). Furthermore, the role of management accounting in Engineering Ltd embraces more than the traditional product costing role and is responsive to the needs of the business, as conveyed by the quote below:

> As our raw materials consist mainly of oil, copper, aluminium and steel, we generally have a lot of working capital tied up in stock (approximately €4.5 million). So getting our stock valuation correct is very important, but I have also seen a big move in focus to cost control in the last 18 months. With the slowdown generally in the economy, controlling costs is paramount if you want to remain competitive. … The majority of our time is focused on managing costs. That means understanding where they come from, why, and how we can reduce or eliminate them in the future. … It's no good capturing costs correctly if they are spiralling out of control. Knowing your costs and their behaviour means we can provide better information for making decisions (assistant management accountant).

It is acknowledged that the role of management accounting has changed somewhat over the years. As the management accountant explained, in the past the management accounting function produced reports but did not necessarily participate in subsequent decision making. Currently, the accounting function is at the heart of decision-making activities, as the management accountant is a part of the core management team. He attends all management meetings, assisting in the interpretation of the accounting information and participating in shaping the future direction of the business. This increased importance of management accounting at Engineering Ltd is by and large due to the fact that the company operates in an increasingly competitive environment, which requires a much shorter production cycle than before and requires much greater interaction and cooperation between all departments concerning decision making:

> The whole organisation must be on its toes to ensure production runs smoothly. Working in tandem means everyone must communicate. That means for us in management accounting we have to keep up to date with production managers … and we have to be fully aware of what is happening plant-wide. When you are aware of what's happening in a particular department you can provide them with better or 'tailored' information (management accountant).

The evolved role of management accounting is accepted and embedded in the organisation, as the managing director comments:

> Now I expect the management accountants to communicate with me and all other members of staff on any issue that arises. Accountants possess too much knowledge to work in silence. Their information is priceless in modern organisations.

In terms of what has prompted the changed role of management accounting in Engineering Ltd, a number of factors can be identified from the interview data. First, as outlined above, the competitive environment required increased response times

and enhanced cost management, which necessitated changes in the information generated by the management accounting department and the interactions of the management accounting department with other units in the organisation. Second, the organisation became part of a large global group in recent years, which has resulted in increased reporting requirements to group headquarters. As the management accountant explained, group headquarters are not interested in summary information; they conduct ongoing detailed interrogation of financial data and they expect the management accounting department to be able to explain and analyse all information. This requires the management accounting staff to constantly interact with units across the business, as they need to fully understand what is going on. This finding is consistent with that of Yazdifer, Zaman, Tsamenyi and Askarany (2008), who reported that becoming part of a multinational group can increase the demands on management accounting and prompt change. A third facilitator of change in Engineering Ltd has been the introduction of the SAP system, which was required to meet group reporting demands. The amount of information maintained by the SAP system enables the management accounting department to produce reports which examine quality, capacity and productivity and are more useful to the various units of the business: 'it has changed the way we work and the reporting capabilities of the management accounting department … it means we can add more to the firm' (assistant management accountant). This is also consistent with much prior research (e.g. Booth, Matolcsy and Wieder, 2000; Caglio, 2003; Scapens and Jazayeri, 2003; Burns and Baldvinsdottir, 2005).

While change was experienced regarding the role of management accounting in the decision-making processes of the organisation, standard costing remained in use as the key cost accumulation and control practice. In many ways, this is not surprising as Engineering Ltd has not experienced alterations in its manufacturing processes or cost structure, two perceived catalysts for change in management accounting practices (see for example, Otley, 1985; Johnson and Kaplan, 1987; Bruggeman and Slagmulder, 1995; Jazayeri and Hopper, 1999). Additionally, standard costing remains prevalent in the industry, given the widespread use of cost plus pricing and the subsequent need to control costs to protect margins. Combined, these factors create an environment where the continued use of standard costing is likely. Managers across Engineering Ltd demand information for accurate product pricing and cost control and their standard costing system, through the establishment and revision of standards and the calculation and investigation of variances, can meet these information needs. Thus, accuracy of standard setting and meaningful variance analysis are as important as ever:

> I would say here in Engineering Ltd that, due to global competition, the basics need to be better than ever to succeed. And that means for us having a very accurate standard costing system so we can quote products and get business that gives us an adequate margin. Also, standard costing allows us to track and monitor costs, which is of increased significance in very competitive markets. Our margin really depends on us keeping to the quoted cost the sales guys give customers. So accurate product costing, and actually keeping in line with those costs, is a huge part of what we do in this department (management accountant).

However, while some elements of the standard costing system (i.e. setting standards, and so on) have remained stable, others have changed: 'The methods remain the same. It's just the operation of it that has changed' (assistant management accountant). Ultimately, the introduction of the SAP system has rejuvenated the reporting capabilities of standard costing as is evident in the following quotes:

> The amount of data it holds means I have access to information I never had before. And that means we can create reports that we simply couldn't with our old IT [information technology] system. … Now I have information on every aspect of the company (management accountant).

> SAP is even making our standard costing system better, with the database of information it holds. We are getting reports of greater detail on a wider variety of issues. Standard costing is more important in Engineering Ltd than ever before. It's amazing how SAP has improved the system (financial analyst).

> The way the whole standard costing system works here means you have a huge amount of interaction with the engineering department. … With SAP, interaction is more efficient; you are not running back and forward (management accountant).

> The data contained in SAP produces reports that all inter-link. … We can use reports than concern things like quality, capacity and productivity when we are examining variance reports. … SAP allows variances to be put in perspective. It's no good keeping to standards if your quality goes out the window (management accountant).

As well as facilitating more relevant reports, the introduction of SAP also improved the timeliness of information outputs so that it is 'now as close as you'll get to live data streaming' (assistant management accountant). Furthermore, since the introduction of SAP, standard costing reports are more widely available and more staff can access the information system. This has fostered a clearer understanding of standard costing within the broader organisation:

> Since the reports are available throughout the firm, standard costing is more accepted. People in other areas know what it's all about. They understand how important it is to have an accurate system. That makes our jobs as management accountants easier when we are ringing up annoying people for information, because before they didn't really care but now they know it impacts on them too, so they are much quicker with getting back to us. It's giving standard costing justification in the company (management accountant).

Additionally, how standard costing is used post-SAP facilitates greater organisational interaction and communication and shapes the way the management accounting department interfaces with other departments in the organisation:

> Well since the reports generated from the standard costing system are now being used throughout the company, I suppose you could say the standard costing is tying the organisation together. And this is what is forcing more communication with the accountants. … The variety of reports means more people are indirectly using the

> system, and this means more people are calling on the accountants for their advice (financial analyst).

As portrayed thus far, there have been some changes in the way standard costing is used at Engineering Ltd post-SAP. However, there was never any consideration of moving away from standard costing for the purposes of planning, control and decision making. As previously outlined, Engineering Ltd operates in a market where basic commodity-type raw materials are used in the manufacturing process. And, given that these raw materials constitute about two-thirds of the final product cost, the market creates a level playing field for pricing by adding a margin to the direct costs of production. The following quote from the assistant management accountant conveys the market scenario quite well:

> We operate a simple cost plus system, but so does the whole market. When we quote a price, that price is basically the standard costs plus a margin. Then out of our margin we pay our overheads. That's how the market works [for] our particular goods.

Thus, standard costing is at the heart of management accounting and decision making at Engineering Ltd. There is some evidence of the evolving role of management accountants (which is not the key focus of this study), and there is clear evidence of continuity of traditional management accounting practices, namely standard costing. Standard costing has been used since the company was established over 30 years ago, and while the fundamental operations of the technique remain unchanged, if we dig deeper some change in the standard costing practices have taken place. Even following the introduction of SAP, the centrality of the standard costing system within Engineering Ltd seems assured:

> We are moving into an environment that is getting tougher and tougher to survive in. That means an increasing focus on working capital and cash flow management just to keep going. These fundamentals may be out of fashion at the moment, but as economies tighten and more businesses go to the wall the basics will come back to being management's first thought, you know, like maintaining margins and controlling costs. … In tough times you have to get back to the fundamentals of running a business. And the accountants harbour these fundamentals, so management accounting is getting more and more important, and that's not going to change (managing director).

> With competition growing like it is, a big emphasis will be placed on maintaining margins and containing costs and that means our work will become even more important. … And with that being the focus for us now into the future, we'll hang on to standard costing (management accountant).

In summary, Engineering Ltd, although experiencing organisational change in terms of both a new parent company and a new ERP system, portrays a relatively stable set of management accounting practices. In particular, the continued use of a traditional management accounting technique (i.e. standard costing) seems to fit well with both the company's cost structure and the nature of the industry. Therefore, substantial changes to management accounting were not evident. It could be argued that standard costing is sufficient for the needs to Engineering Ltd and that

change is unlikely. However, this does not paint a complete picture. The next section analyses the story from Engineering Ltd in terms of management accounting routines and rules, and conveys how change and stability go hand in hand.

DISCUSSION

The previous section depicts management accounting at Engineering Ltd as being grounded in standard costing (a traditional management accounting practice). To an external observer, it would be all too easy to conclude that management accounting practices have not changed. This would, of course, not give the full picture of the complex actions and interactions that in fact constitute the constant development of management accounting practice within the organisation. Ultimately, change to management accounting practices did occur, but in a way which supported the existing routines (Burns and Scapens, 2000), while also adapting to new material routines as introduced by the SAP software. The remainder of this section focuses on the analysis of the practice of standard costing at Engineering Ltd, using the theoretical constructs of routines and rules which were presented earlier in the literature review. This analysis aims to provide an interpretation of the elements of stability and change regarding the use of standard costing at Engineering Ltd which were outlined in the Findings section above.

Stability

As noted previously, Engineering Ltd has always used standard costing and thus, at the outset of this study, it had been assumed that the tasks around standard costing at the company could be termed 'routine'. Based on the empirical data presented in the Findings section of the paper, we can now conclude that standard costing is indeed a routinised practice. Taking Pentland's (2011) defining characteristics of routines, standard costing at Engineering Ltd readily satisfies each:

- *Repetitive* – standard costing has been in use for more than 30 years on a continuing basis.
- *Recognisable pattern of action* – while there may have been hundreds of standard costs and reports prepared each month/year for varying reasons, an overall pattern of action can be identified.
- *Interdependent* – several examples of how standard costing is used as an input for further decision making were revealed.
- *Multiple actors* – the empirical data presented in the previous section highlighted how standard costing information is widely dispersed and utilised by many actors.

Given the apparent steadfastness of standard costing at Engineering Ltd, we contend that we could describe these routines as being institutionalised (Burns and Scapens, 2000). Almost 90 per cent of total costs in Engineering Ltd comprise materials and labour, with materials consisting predominantly of market-priced commodities.

This business context creates an environment in which a traditional management accounting technique is not only technically sufficient and meets the informational need of managers, but also over time has become the tacitly accepted way of doing things for management accountants and managers at the company. This environment fosters little motivation or need to adopt some of the 'newer' management accounting techniques and thus a strong, stable and potentially institutionalised set of routines was developed and maintained. Prior literature indicates that such routines are unlikely to undergo major change except in the case of external shocks or internal power structures (Burns and Scapens, 2000). Burns and Scapens (2000) describe a takeover as an example of an external shock which could cause existing routines to become undone. In the case of Engineering Ltd, a takeover did occur in 2005 but the new owners were a larger multinational in the same industry. As a result of the takeover, the SAP software was implemented, leading to greater interaction between standard costing routines and other organisational routines (Feldman and Pentland, 2003; Pentland, 2011). Although both the takeover and the information systems change provided potential for large-scale change in management accounting routines, on the surface this did not happen. In other words, despite the potential for change, the ostensive routines around standard costing appear to have remained quite stable. However, this does not mean change cannot occur. Indeed, Burns and Scapens (2000, p. 22) state 'change and stability are not mutually exclusive processes' and so the next subsection seeks to identify aspects of change.

Change

Above we have established that standard costing (as a routinised management accounting practice) is deeply engrained at Engineering Ltd and the ostensive routines around standard costing are quite rigid and taken for granted. The performative dimension of these same routines may (or may not) be the same as the ostensive dimension (Feldman and Pentland, 2003). Given the long history of standard costing at Engineering Ltd, it is likely that all actors (management accountants and others) share a commonly accepted perception (Feldman and Pentland, 2003) of what constitutes routines, i.e. they understand and accept the general principles of standard costing as the way things are done (the ostensive routines). At the same time, the fact that the ostensive routines are understood, accepted and unquestioned does not mean that there are strict codified procedures as to how to perform these routines. Thus, actors may not perform the routines in a strict, rule-like, unconscious way (Feldman and Pentland, 2003). Over time, however, and as outlined below, the interaction of the ostensive and performative dimensions of a routine can maintain, modify or create routines, while at the same time providing a guiding or reference point for behaviour (Feldman and Pentland, 2003).

The case evidence suggests that the performative routines and ostensive routines associated with standard costing in Engineering Ltd were similar. We base this observation on a number of facts:

- Standard costing had always been practiced at Engineering Ltd
- Standard costing was incorporated into their legacy systems
- The relatively stable nature of Engineering Ltd's operations

While the legacy system referred to by the management accountant may have had standard costing practices of the company incorporated as material routines (i.e. within the program code), this cannot be verified as this system had since been replaced by SAP. However, all interviewees recounted how important SAP was to the continued (but changed) use of standard costing at the company. Indeed, prior literature has highlighted that the introduction of information systems such as SAP can bring accompanying change to management accounting (Scapens and Jazayeri, 2003). At Engineering Ltd, the introduction of SAP not only encompassed the ostensive dimension of existing routinised standard costing practices, but also introduced new material routines within the SAP configuration (Volkoff et al., 2007). As management accounting staff at the company became familiar with the capabilities of SAP, these capabilities (embodied in the software as material routines) brought about change in standard costing practices. In other words, as the standard costing capability of SAP was utilised, new performative routines emerged over time, which were based on existing ostensive routines and new rules. For example, SAP resulted in 'new' performative routines such as more detailed and timely cost and variance reporting routines, as well as more regular updating of standards by management accountants. As a result of SAP, as one management accountant put it, 'standard costing is now more accepted.' This can be explained by the relative similarity between the existing ostensive (and deeply embedded) routines around standard costing and the supporting material rules within SAP. These material routines, although eventually bringing about new ways of doing things (performative routines), solidified, formalised and distributed what were already accepted and taken-for-granted routines. Yet despite the apparent post-SAP stability and broader acceptance of standard costing as a routinised management accounting and organisational practice at Engineering Ltd, change to those same practices did occur. This finding echoes the work of, for example, Burns and Scapens (2000) and Feldman and Pentland (2003), who both clearly outline how change and stability go hand in hand. It also suggests that there may be multiple levels at which routines can be analysed, as suggested by Vromen (2011). More specifically, at a high level of analysis we could say that routines in Engineering Ltd have not changed as standard costing is still performed. However, if we drill down to a lower level of analysis, we have revealed how aspects of the tasks and components within standard costing have changed (see also Pentland et al., 2010).

In summary, as originally suggested by Burns and Scapens (2000), the routinised nature of management accounting practices may offer potential interpretations of why stability is often a common feature in a management accounting context. However, as our study of standard costing, which is a traditional (and stable) management accounting practice, has shown, change to highly routinised practices is always possible. Based on the evidence from Engineering Ltd, we contend that change to existing routines is more likely to occur when new rule-like structures (material routines in this case) emerge. Eventually, through repeated action these material routines may create new routines; in other words, in the case of Engineering Ltd new ways of doing old tasks materialise.

CONCLUSIONS

The purpose of this paper was to explore, in routines and rules terms, how a traditional and routinised management accounting practice, such as standard costing, can be deeply embedded (i.e. stable), but yet also encompass change. The evidence from Engineering Ltd, albeit a single exploratory study, offers some insights into the dynamics of existing routines and how the introduction of new material rules may potentially support and solidify these routines. However, as was outlined, the nature of Engineering Ltd's industry sector is one which has a relatively stable cost structure and is unlikely to require the application of complex or 'new' costing techniques. Thus, not unexpectedly, we found that changes, although present, were not of a revolutionary type (Burns and Scapens, 2000). Research in more dynamic business sectors would be useful to further enlighten the interactions of existing routines and new (material) rules.

The case study presented in this paper has some limitations. First, the case was exploratory in nature and was relatively small scale. This limits the nature of the findings and a similar but more extensive longitudinal study would be useful. Second, as indicated above, the nature of the business sector studied meant that there was little opportunity to explore routines and rules in a dynamic environment. Third, the interviews were concentrated primarily around management accounting staff. Broader organisational interviews would enhance the evidence reported here, but such interviews were not forthcoming in Engineering Ltd based on the access agreed.

Despite these limitations, this paper presents empirical evidence of simultaneous stability and change in a management accounting practice. The management accounting practice which was the focus of the study was standard costing, which may be perceived as a very traditional, stable practice, and the analysis revealed that such a practice can embody change – albeit in a way which underpins the existing ways of doing things (i.e. the ostensive routine). Thus, the paper also contends that while new management accounting practices may be de rigueur, traditional management accounting practices are worthy of further study in the efforts to delve more deeply into the concepts of routines and rules in management accounting.

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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.

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 making 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. A DC scheme defines the contribution to be made by the employer and the employee rather than the benefit promised on retirement. DC schemes do not have an employer guarantee (all investment risk is borne by the employee). In the absence of this guarantee, pension payments are a function of the employee's 'accumulated pension fund' on his/her retirement date.

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 DB 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 or, in some instances, non-existent (see O'Brien, Woods and Billings (2010) for example in the case of International Accounting Standard No. 19 (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 scheme's 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"' (*Scott v National Trust for Places of Historic Interest or Natural Beauty* (1998), quoted in Delaney, 2007, p. 458). 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 DB 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. Second, 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 the most sensitive assumptions under each calculation basis are.[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 & 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. The third section describes our methodology and approach. The following three sections discuss our principal findings and the practical implications. The final section concludes.

WHY ARE ACTUARIAL LIABILITIES CALCULATED?

The valuation of a DB 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 for the purposes of their annual trust report to the members of the pension scheme, and to review contribution rates. Finally, in the case of a DB scheme, a valuation may be required for the purposes of the financial statements of the sponsoring company, to recognise 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 DB 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 emphases in the produced results.

Existing literature recognises that there can be considerable discretion in the choice of assumptions used to estimate pension liabilities. This is reflected in a debate within the actuarial profession on alternative valuation approaches to pension scheme assets and liabilities. MacDonald (1993), in his discussion of the actuarial valuation exercise for the purposes of determining the solvency or otherwise of a life insurance business, recognises that a valuation basis is an extremely simple model of the future, usually modelling interest and inflation as constants, but that actual experience is unlikely to resemble the model used, either quantitatively or qualitatively. Pemberton (1998) argues that the traditional actuarial discounted cash flow approach to valuing pension fund assets and liabilities, which is largely based on discounted cash flows, can differ significantly to the value of pension fund assets using current market prices. He also, however, questions the pricing approach which uses current market prices on the basis that this approach has serious limitations in both a theoretical and practical sense. Connell (2007) refers to the plethora of assumptions which must be examined in assessing different proposals/models for future pension provision. Attain Consulting (2009), in a study of the valuation of scheme surpluses/deficits for financial reporting purposes, considers the impact of the discount rate (which is based on long-term corporate bond rates) used in the actuarial valuation calculation of the deficits of pension schemes of companies quoted on the Irish Stock Exchange. The author argues that the deficits on such schemes estimated at the time of the report to be €3.5 billion or between 12 per cent and 14 per cent of the market capitalisation of the sponsoring companies, and would have represented 40 per cent of the market value of the companies if bond yields had not risen in 2008.

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 minimum funding standard (MFS), 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 section 44 of the Pensions Act 1990) in order to set out the minimum assets that a DB 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 below) to which the members would be entitled, 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 DB 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 PEN 3 and ASP PEN 2), issued by the Society of Actuaries in Ireland (2012 and 2013) 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 realisable 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/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 ten 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 Society of Actuaries in Ireland (2008) recommends that to improve benefit security the minimum funding legislation be strengthened by requiring that liabilities be valued on an 'economic basis' (present value of the benefit promise based on prevailing yields on government fixed-interest stock of a suitable term and realistic

estimates of mortality, including allowance for future mortality improvements). This significantly higher figure would be divided into a minimum funding level with a requirement to repair under-funding below this level over a nine- to twelve-month period and a higher 'target funding level' (Society of Actuaries in Ireland, 2008, p. 4.5) with scope to address under-funding below this level over a longer (fifteen-year) period. Provisions were introduced (Social Welfare and Pensions Act 2012) strengthening the funding standard by requiring the preparation of a Funding Reserve Certificate, which effectively states whether the scheme could meet its liabilities if interest rates were to fall by 0.5 per cent (or such other rate as the Minister for Social Protection may direct). With effect from January 2016, DB schemes will be required to hold a risk reserve as a protection against such investment return volatility.

The Trustee Valuation

Section 56 of the Pensions Act 1990 (supplemented by S.I. No. 301 of 2006) requires the trustees of a DB 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 three or three and a half years, depending on the nature of the scheme and when it was established. With effect from 23 September 2005, the period between valuations became three 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 in Ireland, 2010)[8] sets out the blueprint for actuaries carrying out a valuation for the purposes of section 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, the sensitivity of the results to the assumptions chosen are set out 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 an 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 DB plans in the financial statements of the sponsoring company is a complex matter. The complexity arises because the employer must, in each accounting period, recognise 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 that are difficult to determine in advance (mortality, return on investments, etc.), the calculation of the expense which should be recognised in an accounting period is not straightforward. As the sponsoring company potentially carries the risk of any shortfall arising on a DB scheme (i.e. if amounts contributed by both the employer and the employee, together with the net investment return on such contributions are 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 needs to be recognised 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 could also be required to be recognised as an asset in its financial statements.

The International Accounting Standard No. 19 (IAS 19) (International Accounting Standards Board, 2008) provides the internationally recognised guidance on accounting for and disclosure in financial statements of DB 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 recognises an expense when the employer consumes an economic benefit arising from the services provided by the employee in exchange for employee benefits.

Accounting for DB plans is complex because actuarial assumptions and valuation methods are required to measure the balance sheet obligation/asset and the income statement expense. The plan liabilities (the DB 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 realisable value or market value). The DB obligation is measured on an actuarial basis and discounted to present value. This requires assumptions on mortality, both during and after employment; rates of employee turnover, disability and early retirement; the proportion of plan members with dependants who will be eligible for benefits; and claim rates under medical plans. The liability must then be discounted back to the current valuation date using the yield on high quality corporate bonds (AA).

Lane Clarke & 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.

Table 1 summarises the principal characteristics of the MFS, trustee and IAS 19 valuation models.

TABLE 1: COMPARISON OF THE THREE VALUATION APPROACHES TO MEASURING PENSION FUND PERFORMANCE

This table summarises 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	Realisable 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

(*Continued*)

TABLE 1: (*CONTINUED*)

	Valuation Approach		
	Minimum Funding Standard (ASP PEN 3)	***Trustees Ongoing Valuation (ASP PEN 1)***	***Accounting Approach (IAS 19)***
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

METHODOLOGY AND APPROACH

We construct three valuation models, one for each valuation basis (MFS, trustee and 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 three 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.

TABLE 2: BASE CASE

For comparative purposes, we construct a base case incorporating the key assumptions set our below. The base case data facilitate comparison across the three valuation models and are 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)

(*Continued*)

TABLE 2: (*CONTINUED*)

Base Case Characteristic	Value
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

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 if not what are the most sensitive assumptions under each calculation basis. 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[9] of each approach using a wider range of key inputs. The relative sensitivity of each valuation result to changes in constituent assumptions becomes apparent as well as the capacity for significant variation in reported results depending on the 'final mix' of assumptions adopted.

THE SUBJECTIVITY OF THE VALUATION PROCESS

Under a typical Revenue-approved DB pension scheme,[10] the annual pension entitlement of a scheme member at normal retirement age is calculated as follows: $N/60$ * pensionable 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 pensionable employment completed by the scheme member; this cannot exceed 40 years. The member may opt to take part of his/her 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 pensionable employment equals the number of years the member will be in the scheme if he/she 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 the final pensionable salary for every year of completed service subject to a maximum of 40/60.

2. Pensionable salary is expected salary on retirement or some average salary, calculated based on expected annual earnings over a number of years up to the date of retirement. Expected salary at the 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 used in this paper this will be ignored.
3. The annuity factor is calculated based on the 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 spouse's 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 the base data outlined in Table 2.[11]

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 (see Table 2). The row 'Valuation' contains the value of the pension fund liability calculated for each model.

	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[i]	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[ii]	0.184 based on investment growth rate (7%)	0.256 based on corporate bond rate (5.6%)

(*Continued*)

TABLE 3: (*CONTINUED*)

	Individual Valuation Component Calculations		
	Minimum Funding Standard Valuation	***Trustees Ongoing Valuation***	***IAS 19 Valuation***
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	—	—

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

[ii] Discount factor (pre-retirement prescribed investment return) is 7.75 per cent; discount rate (post-retirement prescribed investment return) is 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 (MVA) to reflect the gradual transfer out of equities to fixed interest stocks in the 10 years prior to normal retirement age.

TSL = Total service liability; PSL = Past service liability

The MFS valuation calculates the lump sum required to meet the future pension entitlements of the scheme member (details in Table 2) based on completed years of pensionable service to date (ten years) and current pensionable salary. Her 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 lifespan 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 member's 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 pensionable service to date and future years of service to retirement.

Finally, the IAS 19 valuation is calculated as a pro rata percentage 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 submission of the Society of Actuaries in Ireland (2008) 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 & Peacock Ireland (2009) research discussed earlier indicated, there is significant opportunity to manage this particular calculation within the range of what might be considered 'acceptable' assumption settings.

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 spouse's 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/her obligations to scheme trustees and scheme members and his/her desire to avoid confrontation (e.g. on contribution rates) with the sponsoring company, which may directly or indirectly be paying the actuary for his/her services and to whom the actuarial firm may be providing a range of related services.[12] 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 held (in particular by the Society of Actuaries in Ireland (2008), i.e. that the standard is too low and should be strengthened. This view of the Society of Actuaries in Ireland 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 regulator's 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 that 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.

SENSITIVITY ANALYSIS

Having established that the three valuation models produce different results, we 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 20 per cent from its base value, while holding all other inputs constant at their base values.[13] 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 pension fund liabilities adopting the trustee valuation approach and Appendix 6 shows the equivalent MFS calculations.

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.[14] 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 grow 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 and vice versa. 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. By way of example, consider an individual who lives to 103.95 years of age. His/her pension fund liability is calculated as €147,677 or 1.17 times (see Appendix 4, column labelled '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 per cent 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: SENSITIVITY OF PENSION FUND LIABILITY TO CHANGES IN KEY INPUTS

This table displays the median z-score of the pension fund liability calculated under the 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 $\left(z = \frac{x - \bar{x}}{s}\right)$, 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, we 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 4 (column 3) and Appendix 5 present the same analysis for 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) and 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 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 discussed 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, changes in the discount rate have 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 one-unit change in each key input.[15] This exercise is performed for all three models. Coughlan, Epstein, Ong, Sinha, Hevia-Portocarrero, Gingrich, Khalaf-Allah and Joseph (2007) and Blake, Khorasanee, Pickles and Tyrrall (2008) show that the pension fund liability changes on average between 3 and 4 per cent when they assume life-expectancy changes by one year. Along similar lines, May, Querner and Schmitz (2005) and Gohdes and Baach (2004) show that a 1 percentage-point change in the discount rate (for example between 4 and 5 per cent) changes the value of the pension fund liability on average by 15 per cent. 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 per cent), but more sensitive to changes in the discount rate (the average percentage change in the pension fund liability is 35.21 per cent).

TABLE 5: AVERAGE PERCENTAGE 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%

PRACTICAL IMPLICATIONS FOR SCHEME GOVERNANCE

The deviation in valuation results across the three valuation models and the inconsistencies demonstrated by the sensitivity analysis in terms of how the individual models are impacted by changes in constituent key inputs are interesting for a variety of reasons. They highlight the challenge to ensure that every care is taken to ensure that actuarial assumptions adopted on key inputs are based on sound principles. It could be argued that they provide opportunities to manage a reported valuation result. They certainly pose challenges for trustees charged with governance of pension 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-incentivised pension schemes do not have a long history in Ireland (dating back only to the 1960s). 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 their being of the view that they do not have a grievance. In any event, recent pronouncements by the Pensions Board (2009) would seem to suggest that inadequate funding due to aggressive assumption setting is not only possible as our paper demonstrates but is, in fact, a harsh reality notwithstanding the absence of litigation.

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. Given that there is ongoing robust debate on optimal valuation approaches within the actuarial valuation itself, and there are external factors, such as discount rates significantly impacting on pension schemes' reported results, the importance of regulation to monitor and control the subjectivity of and increase the transparency of the actuarial valuation process is paramount.

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 those 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 assumptions on a valuation result, they cannot contribute fully to an informed debate on appropriate contribution rates, investment strategies, discretionary bonuses and so on, and accordingly cannot discharge their trustee obligations entirely. This necessitates greater 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 also makes it necessary for all trustees to have quite specialist knowledge on the alternate methods of valuations and the reasons for the significant differences that can arise between these valuations.

The accounts preparation and audit exercise coupled with the actuarial valuation processes are relied upon 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. 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

This research highlights, rather than provides any clear solution to, the complexities of pension scheme valuations. A streamlined, simplified and transparent process acceptable to all stakeholders would require multi-faceted research carried out in conjunction with the overall development of pension policy. In the meantime however, while the minimum funding standard valuation is being heavily criticised, 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 depart from the policy of a standardised valuation so long as realism in setting prescribed assumptions is considered a priority.

NOTES

1 Most schemes are 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* (1998), 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 & Peacock Ireland (2009) noted that from the IAS 19 valuations of 29 Irish schemes reviewed, 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 organisations 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 January 2013.

8 The most recent version.

9 A z-score is a statistical measurement of a score's relationship to the mean in a group of scores. A z-score of 0 means that the score is the same as the mean.

10 Revenue approval is necessary if the pension scheme is to benefit from the favourable tax treatment available to Revenue-approved pension schemes.

11 The exact formulae used to calculate the pension fund liabilities under MFS, 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.

12 Many of the actuarial firms also provide a range of related services, e.g. consulting, outsourcing and investment services.

13 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 per cent, with a base value of 5.60 per cent. 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 per cent (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 are 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.

14 That is, the z-score is calculated as $\left(z = \frac{x-\bar{x}}{s}\right)$, 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 per cent, 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 per cent) 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).

15 Discount rate, salary growth and pension increases range from 1 to 12 per cent. 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 per cent to 16.25 per cent (1 per cent to 12 per cent).

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 the minimum funding standard valuation is presented as Equation (1), where AF and AR are the annuity factor and annuity rate respectively. All variables are defined in Appendix 2.

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

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

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.

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

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

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

Finally, the IAS 19 valuation is calculated as a pro rata percentage 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.

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

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

APPENDIX 2: VARIABLE DESCRIPTIONS

Variable	Description
TSL	Total service liability
PSL	Past service liability
m	The number of years of pensionable service completed to date
CS	Current salary
IR	Expected rate of inflation
y	Number of years to retirement
r_{pre}	Pre-retirement discount rate
r_{post}	Post-retirement discount rate
P	Expected lifespan 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 in Ireland
r	Discount rate
SG	Salary growth
n	The number 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-retirement) and 4.50% (post-retirement) under minimum funding valuation), 5%, 2.50%, 65 and 94.5 years of age, respectively. The individual z-scores are calculated as follows $\left(z = \frac{x-\bar{x}}{s}\right)$, 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)

(*Continued*)

APPENDIX 3: (*CONTINUED*)

Discount Rate		Salary Growth		Pension Increase		Mortality		Retirement Age	
Value	*z-Score*	*Value*	*z-Score*	*Value*	*z-Score*	*Value*	*z-Score*	*Value*	*z-Score*
5.88	(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 (DR)			**Salary Growth (SG)**			**Pension Increase (PI)**		
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 the 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) are reported in the remaining rows.

Discount Rate (DR)			**Salary Growth (SG)**			**Pension Increase (PI)**		
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 (DR)			Salary Growth (SG)			Pension Increase (PI)		
DR	*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

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