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## Alternative measurement bases in pension accounting: a simulation analysis

### Abstract

This paper explores the financial statement implications of alternative measurement bases underlying defined benefit pension accounting rules via a simulation analysis. Simulation analysis can be used to examine the effect of alternative discount rate assumptions on the strength of associations between an economic or generational accounting basis, an actuarial funding basis of measurement and two alternative accounting measurement bases of pension assets and liabilities: value-in-use and value-in-exchange. Accounting measures are found to be more highly correlated with economic unfunded pension liabilities when they are discounted using market instead of value in use rates. The value in use rates are also more highly sensitive to differences in funding method, real versus nominal interest rates and plan initiation dates. The findings suggest that the use of alternative measurement bases for pension reporting and funding involves a trade-off between the relevance and reliability of the resulting pension disclosures. The transparency of reported corporate pension exposure would be improved through enhancing the logical consistency between combining key discount assumptions and various measurement bases. We also develop policy implications concerning the appropriateness of alternative measurement bases in reporting by various types of reporting entity, and propose the re-classification of various liability and equity-related components of pension contracts.

**Keywords:** pension liabilities, measurement bases, accounting.

### Introduction

The objective of financial reporting is to provide useful information to investors and creditors in capital allocation decisions. However, the accounting rulemakers have not defined what measurement basis is appropriate to fulfill this objective. A current project of the IASB/FASB is to identify which measurement bases may be most appropriate for financial reporting. However, the application of standard accounting measurement bases (historical cost, fair value, net realizable value) does not appear to address the issue of liabilities where their amounts are based on cash flow estimates.

Addressing this question in the context of pension accounting is important for a number of reasons. First, there is now extensive evidence that capital market participants fail to account for the effect of unexpected changes in pension discount rate assumptions on UK firms' reported balance sheets. These findings challenge the efficient markets and rational valuation theories which underly fair value accounting and conflict with the conventional 'corporate finance' view underlying pension accounting rules that the sponsoring firm effectively 'owns' the entire pension surplus or deficit (e.g., Bulow, 1982). Second, these regulations are potentially value-relevant if the stock price returns around the time of regulation differ systematically across firms using significantly different pension discounting rates. Third, since pension liabilities are actuarial estimates, rather than known numbers, alternative bases of reporting, including both their

underlying interest rate and cash flow assumptions, are directly comparable and readily easily determinable. The purpose of this paper is to identify how alternative measurement bases can affect reported pension liabilities.

Actuarial valuations based on discounting principles are used in defined benefit pension plans to assess the extent to which pension benefits are covered by existing assets and to estimate future contributions to the scheme (Carne and Warne, 1987). Discounting involves making choices for its two data sources: forecasts of future cash receipts and payments, and an appropriate interest rate (Lovejoy et al., 1989). A variety of pension liability measures are associated with pension plans, which can differ for accounting, taxation and financing purposes. Interest rates can be based on either current market (or 'fair') value or use (from use and expected future benefits) value (Baxter, 1998). Thus, pension cost amounts reported in the income statement as required under pension accounting rules will not articulate with each other because discount rates are based on different underlying measures of the pension obligation<sup>1</sup>.

Prior research has also demonstrated that financial markets experience difficulties in valuing even just the defined benefit pension promises made by firms. Coronado and Sharpe (2003, 2008) find that stock prices of S&P 500 companies providing defined benefit pension plans were generally misvalued over their sample periods, while others (Picconi, 2006;

<sup>1</sup> Financial Accounting Standards Board, Statement of Financial Accounting 87 'Employers' Accounting for Pensions' or SFAS 87 and Accounting Standards Board, Financial Reporting Standard FRS 17, 'Accounting for Pension Costs' or 'FRS 17').

Hann et al., 2007; Franzoni and Marin, 2005) suggest that opaque accounting has caused firms to be undervalued relative to overfunded pension plans. By contrast, Jin et al. (2006, hereinafter, JMB) find that pension risk is associated with firm risk despite arcane financial reporting for pensions. They report that pension risk is reflected in the systematic risk of pension plan sponsoring firms, measured by beta from the capital asset pricing model (CAPM).

Schipper and Weil (1982) and Selling and Stickney (1986) demonstrate that the economic measure cannot be deducted from the reported unfunded prior service obligation without knowledge of the various actuarial methods and assumptions underlying the reported amounts. This paper extends this analysis by discriminating between competing (market or use value) rates used to discount pension assets and liabilities and examines their implications for explaining longitudinal effects of differential rate assumptions on pension liabilities and expenses<sup>1</sup>. We develop a simulation modeling approach based on Selling and Stickney (1986) to examine the time series correlations between alternative accounting measures of pension liabilities and this economic measure. We extend prior analysis by incorporating measures used in international and UK reporting, defining accounting pension liabilities (Winkelvoss, 1993); and evaluating the implications of these alternative measures for reported pension expenses. Enhancing the alignment of accounting pension liabilities with a general economic model improves the reliability of reported pension expenses.

Computer simulation models are used to generate the pension data and to study their sensitivity to various actuarial assumptions and funding methods used in practice, for occupational-based pension funds. The appropriateness of a simulation methodology is evidenced by its accepted use in actuarial science. This acceptance is probably due to the fact that the salient characteristics of pension environments can be easily quantified, and the specification of the stochastic variables relating to labor demographics can be based on large amounts of historical data. Simulation permits systematic study of each of the variables affecting firms' pension exposure (Selling and Stickney, 1986)<sup>2</sup>. The empirical research did not (or could not) control for differences in actuarial methods used (accumulated benefits vs. projected

benefits) to measure reported pension obligations and expenses. Thus, it is not possible to determine which pension obligation measure is most highly correlated with a funding model.

Prior pension simulation studies (Amen, 2007; Morrill et al., 2009) focus attention on the income smoothing patterns available under alternative GAAP, but ignored the shareholder equity impact of alternative pension liability values. This is the first study to provide a stochastic simulation analysis of the effect of alternative liability definitions on newer pension reporting rules, which focus instead on the balance sheet implications of alternative pension liability measures. This, in turn, has important consequences for identifying the extent of actuarial gains and losses charged to equity.

The rest of this paper is set out as follows. Section 1 defines the key terms related to the study. A description of the mechanics of the pension simulation and results of the main simulation analyses are presented and discussed in section 2. Section 3 discusses the criticisms of existing GAAP and presents sensitivity analysis. The final section provides a summary and conclusion.

## 1. Institutional background

Alternative methods can be used (e.g., accumulated benefits vs. projected benefits) to measure reported pension obligations. It is, therefore, not possible to determine which measure of the pension obligation is most highly correlated with market values. Allowing that simulated data is an adequate surrogate for what empirical researchers are unable to observe, one can examine the relative association of various accounting measures with an economic criterion. Selling and Stickney (1986) claim that this allows the research to make stronger statements about which accounting measure is most highly correlated with the present value of future cash flows, information that is potentially useful for accounting standard setters.

The presumption is that accounting measures which are the most highly correlated with the economic model in past periods are the most useful in predicting the economic measure in future periods. The sensitivity of the behavioral accounting patterns to differences in funding methods, growth rates of the plan population, interest rates and plan initiation dates is now examined. In the remainder of this paper, we examine the correlation between accounting-based pension liabilities (the ABO and PBO) with an economic-based pension liability (the EBO) under various assumptions.

Three measures of the pension plan obligation that are described and defined analytically in this section

<sup>1</sup> By contrast, relying on reported pension information in corporate annual reports permits study only of the particular set of actuarial assumptions selected by each pension plan.

<sup>2</sup> Alternative bases for measuring pension obligations raise more fundamental questions about the validity of differing underlying theoretical perspectives about the nature of the pension liabilities.

include (1) the present value of future economic benefits (EBO); (2) the continuation or projected plan liability (PBO); and (3) the termination or accumulated benefit plan liability (ABO). The first measure is used in calculating the present value of the expected pension obligation, the economic criterion in this study. The other measures are those defined under SFAS 87 for employer sponsor disclosure and recognition purposes, respectively. We also define the net periodic pension cost.

**1.1. EBO.** Winkelvoss (1993, p. 72) provides equation that expresses the EBO, which is alternatively defined as the present value of future benefits (PVFB). The most basic equation is for an employee, currently age  $x$ , who entered a plan at age  $y$  and anticipates retirement at the normal retirement age,  $r$ . The equation can be viewed as having three components: (1) a function that determines the accrual distribution made to the employee commencing in the year of retirement and ending upon death; (2) the probability that the employee survives in employment to retirement age; and (3) the appropriate present value discount factors:

$$EBO_x = B_r^* p_{r-x}^{(T)} v^{r-x} \ddot{a}_r, \text{ for } x \geq r \quad (1)$$

where  $B_r^*$  is the annual pension benefit at retirement;  $p_{r-x}^{(T)}$  is the termination probability;  $T$  is the probability that the employee, age  $x$ , survives in employment to age  $r$ ;  $v^{r-x}$  is the interest discount function from age  $r$  to the present;  $\ddot{a}_r$  is the present value at age  $r$ , of a life annuity due in the amount of one dollar payable at the beginning of that age;

$$(EBO)_x = B_r a_x, \quad (1b)$$

where  $B_r$  = retirement benefit payable for life;  $\ddot{a}_x$  = present value, at age  $x$ , of a life annuity.

This actuarial expression is intentionally oversimplified and understated by ancillary benefits such as vested benefits, disability benefits, and death benefits to a surviving spouse.

**1.2. ABO.** The ABO is the present value of accrued benefits to date. It is the method by which the minimum pension obligation to be disclosed in the balance sheet is calculated. It is calculated as follows (Winkelvoss, 1993, p. 178):

$$(ABO)_x = B_x \sum_{k=x}^{r''} p_{k-x}^{(T)} v^{k-x} \cdot (q_k^{(t)v} F_k + q_k^{(d)d} F_k + q_k^{(m)s} F_k + q_k^{(r)r} F_k), \quad (2)$$

where  $B_x$  = accrued benefit based on service, salary and the plan's benefit accrual rate determined at age  $x$ ;  $p_{k-x}^{(T)}$  = the probability that the employee, age  $x$ , will survive in retirement to age  $k$  when only the

mortality decrement,  $m$ , is considered (a decrement is an event that decreases the size of the work force).  $v^{k-x}$  = discount, at rate  $i$ , from age  $x$  to age  $k$ .  $q_k^{(t)}$  = probability of terminating employment at age  $k$ .  ${}^v F_k$  = value of termination benefit at age  $k$  (for model plan, termination grading function times mortality based life annuity deferred to age  $r$ ).  $q_k^{(d)}$  = probability of becoming disabled at age  $k$ .  ${}^d F_k$  = value of disability benefit at age  $k$  (for model plan, disability grading function times disabled-mortality based life annuity deferred to end of waiting period).  $q_k^{(m)}$  = probability of dying at age  $k$ .  ${}^s F_k$  = value of death benefit at age  $k$  (for model plan, survivor grading function times probability of having a surviving spouse times life annuity, reflecting age of spouse).  $q_k^{(r)}$  = probability of retiring at age  $k$ .  ${}^r F_k$  = value of retirement benefit at age  $k$  (for model plan, retirement grading function times life annuity).

From the perspective of evaluating alternative measurement bases in accounting, the ABO is closest to the net realizable value. This represents a realistic assessment of the pension exposure of firms where the obligation is immediately valuable. However, the ABO may not necessarily reflect an exit or entry price for a given portfolio of assets and liabilities to which the firm can settle. On the other hand, it is argued by some that the ABO is a more realistic assessment of the obligation in the event of corporate default, in so far as the put option to terminate pension exposure to third parties (e.g., government pension insurance guaranty funds) would most likely reflect the ABO.

**1.3. PBO.** For any employee, the PBO is a specified fraction, or percentage, of EBO. It is equal to the present value of prorated retirement benefits, where the proration is based on service. The PBO equation is (Winkelvoss, 1993, p. 181):

$$(PBO)_x = \sum_{k=x}^{r''} {}^{CD} B_{k-x} p_x^{(T)} v^{k-x} \cdot (q_k^{(t)v} F_k + q_k^{(d)d} F_k + q_k^{(m)s} F_k + q_k^{(r)r} F_k), \quad (3)$$

where  ${}^{CD} B_k = \frac{B_k}{(k-y)}(x-y)$  = accrued benefit projected to age  $k$ , prorated by the ratio of current service to projected service at age  $k$ .

Like the EBO, the PBO considers future salary and expected total years of service. However, the PBO uses accumulated service to date in computing the proportion of the EBO. There are two important differences between the ABO and the EBO. First, the pension benefit the employee would receive (based on accumulated service to date, current salary, and the current benefit formula) is used

instead of  $B_t$ , the pension benefit the employee is expected to receive (based on expected total years of service, final average salary). Second, the only decrement considered is the probability of mortality from the current date until retirement. In summary, as one moves from the EBO to the PBO to the ABO, fewer and fewer estimates of the future are required and, thereby, the reliability of the measure increases. By contrast, moving from EBO to ABO increases the representational faithfulness of the reported figure, thereby, increasing investor confidence in the relevance of the figure.

**1.4. Pension plan assets.** Selling and Stickney (1986) argue that, under normal circumstances, pension plan contributes cash to its pension fund so that the contributions plus earnings generated on investments by the pension fund will be sufficient to pay benefits to employees. The amount of assets in the pension fund at any date is determined by the funding pattern (or ‘cost method’) followed by the employer/sponsor and the return generated on pension fund investments. However, if the employer fully funds the pension, the assets in the pension fund will generally equal the pension obligation and there will be no unfunded (or over-funded) pension obligation. These conditions, however, seldom hold because pension plans use actuarial cost methods in funding their pension obligations that are based on actuarial assumptions different from those used in measuring the pension obligation; pension plans typically do not fund their pension obligations as they arise, and because realized rates of return on pension investments will not exactly coincide with rates assumed in measuring pension obligations. Thus, it is common for a pension plan to report a difference between the net assets available for benefits and the pension obligation (Selling and Stickney, 1986).

Although many funding patterns could be adopted to ensure that a sufficient amount of funds will be

$$(SC)_x = \left[ \sum_{k=x}^{r''} {}^{CD}b_{k-x} P_x^{(T)} v^{k-x} \left( q_k^{(t)v} F_k + q_k^{(d)d} F_k + q_k^{(m)s} F_k + q_k^{(r)r} F_k \right) \right] (1+i), \quad (4)$$

where  $b_x$  is the amount of the benefit accrued at age  $x$  for an entrant with an age of  $y$ .

**1.6. Interest cost.** The interest cost is the second component of the net periodic pension cost, and is based on the PBO for the purposes of SFAS 87. The discount rate must represent a current settlement rate and thus, will change whenever there is a material change in such rates. As the discount rate increases, the interest cost component of the net periodic cost decreases (and vice versa), since an increase in the discount rate produces a greater proportionate decrease in the PBO (Winkelvoss, 1993, p. 185).

available to satisfy the pension obligation, pension plans generally choose a method from one of two general families of methods; accrued benefit cost methods (ABCM) and projected benefit cost methods (PBCM). Under both families, the amount to be funded consists of the ‘normal cost’ (NC) for the period, plus amortization of any ‘prior service cost’ (PSC) that might exist. Both the Employee Retirement Income Security Act of 1974 (USA) together with subsequent amending legislation, and the Pension Act 1995 (UK) (as updated to 2005) require pension plans to fund their NC for the period, plus amortization of any ‘prior service cost’ (PSC) that might exist, as well as fund their NC plus a portion of their PSC each period. Different cost methods (that is, ABCM and PBCM), however, define different portions of the total amount to be funded as NC and PSC. Thus, while two pension plans might have identical work forces and pension plans, Pension plan A might fund its pension obligation using an ABCM while Pension plan B might use a PBCM. These pension plans will set aside different amounts of cash each year. Even though each funds its NC plus a portion of its PSC, the NCA is not equal to NCB, and PSCA amortized is not equal to PSCB amortized. However, the pension obligation on the liability side of the two pension plans will be the same. Thus, the assets set aside in the pension fund depend on the actuarial cost method used.

There are five components of the net periodic pension cost. These comprise the normal cost (or current service cost) under the cost benefit prorate method, the interest cost, the expected return on pension assets, the past service cost and the net actuarial gains and losses. Each of these terms is outlined briefly below.

**1.5. Normal cost (service cost).** The normal cost of a pension plan is defined as follows (Winkelvoss, 1993, p. 184):

**1.7. Expected rate of return.** The expected return on market assets is the third component of the net period pension cost. This interest rate is not intended to fluctuate substantially in the short term. If, however, pension plan assets are substantial, then there is an opportunity for the sponsoring pension plan’s management to exert some management over this element of the net periodic cost, a result not intended by the FASB (Winkelvoss, 1993). The FASB has subsequently amended the requirements of SFAS 87 (SFAS 158) with a requirement that pension assets and liabilities be fully reported on the

balance sheet, but has not addressed the consequences of this approach for the ‘smoothing’ approach which until now has provided analysts with a more predictable pattern of pension earnings.

**1.8. Prior service cost.** The prior service cost arises because upon adoption, employees are given credit for work performed prior to adoption, as if full plan benefits existed since their work force entry date. Prior service cost can arise if plan experience differs from anticipations: e.g., if return on pension plan assets differs from expectations or retirees live longer than expected. The former case is not considered here (i.e. it is assumed that the return on plan assets is stochastic, although one could argue that most of the variability in the unfunded pension obligation is caused by unexpected returns on pension assets and that they should, therefore, be treated stochastically).

**1.9. Actuarial gains and losses.** Under IFRS pension accounting, a corridor approach is required to account for actuarial gains and losses; actuarial gains and losses are recognized as either income or expense systematically over the remaining working lives of employees. However, an entity does not recognize actuarial gains and losses to the extent that the cumulative unrecognized amounts do not exceed 10% of the present value of the obligation (or, if greater, 10% of the fair value of plan assets). However, Winkelvoss (1993, 201) notes that the 10% corridor can produce some strange results, since it appears to result in a harsher treatment on higher funded plans with low volatile assets, relative to poorly funded plans with highly volatile assets.

By contrast, under UK GAAP (FRS 17), any actuarial gains or losses arising from any new valuation and from updating the latest actuarial valuation to reflect conditions at the balance sheet are required to be immediately recognized. However, recognition is not recorded against income but instead in the statement of total recognized gains and losses for the period. Actuarial gains and losses are also recorded separately for assets (expected rate of return and actual return) and liabilities (differences in assumptions or the effect of changes in actuarial assumptions), rather than netted off.

## 2. Stochastic simulation analysis<sup>1</sup>

This section examines the implications of competing explanations of pension liabilities for explaining the effects of differential rate assumptions on the magnitude of calculated unfunded pension liabilities

<sup>1</sup> The section assumes that the reader is familiar with the various time series pension measurements which are subject to the simulation analysis. Selling and Stickney (1986) and Winkelvoss (1993) discuss important concepts relating to the measurement of pension assets, liabilities and funding methods in more detail.

defined in section 1. The pension liability modeling is based on differing standard actuarial concepts of measuring the unfunded pension obligation, as outlined in Selling and Stickney (1986) and Winkelvoss (1993).

**2.1. Research method.** Simulation analysis is used to generate time series of each of the two accounting measures and the economic measure of employer sponsors' pension liabilities. Each datum point in the time series reflects the present value of future cash payments to plan participants (i.e., pension obligation), net of the present value of pension fund assets at that time. A different time series is generated for each of the four measures of the unfunded pension obligation. The sensitivity of these time series to various actuarial assumptions is examined by varying several parameters (discussed in the following section) of the simulation.

In summary, time series of three measures of the unfunded pension obligation are generated and examined in this study (Selling and Stickney, 1986):

$${}^U(EBO)_t^* = (EBO)_t^* - (Assets)_t, \quad (5)$$

$${}^U(PBO)_t^* = (PBO)_t^* - (Assets)_t, \quad (6)$$

$${}^U(ABO)_t^* = (ABO)_t^* - (Assets)_t, \quad (7)$$

where the superscript ‘U’ denotes the unfunded pension obligation.

Selling and Stickney (1986) claim that the first measure reflects the unfunded liability associated with future economic benefits. These include benefits accrued to date plus benefits expected to accrue over the remainder of the employee’s career. The second measure considers future salary, but does not fully reflect future service. The third measure is based on current salary and accumulated service to date. The actuarial cost method used for funding affects the amount of assets in the pension fund and is studied as an independent variable in the simulation. However, the measures employed in this study are based on probability estimates as defined by Winkelvoss (1993, p. 197).

**2.2. Mechanics of the stochastic simulation.** The stochastic simulation involves two steps. The first determines the number of employees hired at the beginning of each year (based on a random draw from an exponential distribution) and to create a record in the employee file for each employee hired. The employee record contains the following fields as defined in Selling and Stickney (1986, p. 279):

1. *Entry age.* It is assumed that employees enter sometime between the ages of 20 and 50 in 10-year increments.

2. *Current age.* The age of the employee at the beginning of the year.
3. *Status.* There are three statuses: young, middle-aged or retirement age.
4. *Current salary.* At the beginning of each year.
5. *Accrued benefits.* At the end of the year.
6. *Age at termination.* If terminated.

The second step updates each existing employee record each year to reflect current age and any stochastic change in status that occurred during the period. This latter step involves determining the probability of each change and then simulating the actual outcome.

**2.3. Independent variables.** To gain additional insight into the determinants of the pooled correlations between accounting and economic pension liabilities, following Selling and Stickney (1986), three parameters were treated as independent variables. We also consider the assumed mortality assumptions that underly the analysis.

1. *Funding method.* Accrued benefit cost method or a projected benefit cost method.
2. *Interest (discount) rate.* The interest, or discount, rate may be viewed as comprising a real rate and an amount for anticipated inflation. The anticipated rate of inflation varied from 1% to 20% over the study period but the real rate was from 2% to 10%. The interest used therefore was either the real corporate bond rate (fair value) or the average expected rate of return on the assets (value in use).
3. *Plan initiation date.* The plan initiation date was either 1981 or 1997.

Except for the growth stage of the pension plan, each independent variable was held constant. The choice of respective values for these independent variables was intended to reflect reality. Thus, a total of  $2 \times 4 \times 2 \times 2 = 32$  simulation runs were made, each for 30 years. The runs provided time series of the unfunded pension obligations under the three methods described earlier. Thus,  $32 \times 3 = 96$  series of unfunded pension obligations were obtained.

4. *Baseline mortality rate assumptions.* The analysis is based on the average standard mortality pension plan assumption for a male employee and/or a female employee, although the size and structure of the UK population is expected to undergo substantial changes. We report the results of changes in sensitivity to alternative mortality assumptions in section 3, below. Age and gender profiles for each generation are obtained from latest estimates produced by the UK Government Actuarial

Department (2007). Table 1 reports the age and gender profiles for the UK population changes based on replacement rate fertility. Twenty-year projections are made from 2006 to 2066.

Table 1. Projected size and age-gender distribution of the defined benefit pension plan

Age	Year			
	2006	2026	2046	2066
Panel A: Fraction of males in specified age groups				
0-19	0.2075	0.1678	0.1445	0.1202
20-39	0.2055	0.2349	0.2023	0.1683
40-59	0.2924	0.2685	0.2312	0.1923
60+	0.2946	0.3289	0.4220	0.5192
Panel B: Fraction of females in specified age groups				
0-19	0.1496	0.1342	0.1156	0.0962
20-39	0.2239	0.2349	0.2023	0.1683
40-59	0.3142	0.3020	0.2601	0.2163
60+	0.3123	0.3289	0.4220	0.5192

This table represents the average UK fertility and age dependency rate at around 30% for both genders<sup>1</sup>. The data estimates that the age dependency ratio is expected to increase at 2%, while the working population who bears most of the costs of funding defined benefit plan, is expected to decrease. Age and gender profiles for each generation are obtained from the UK Government Actuarial Department (2007). It is assumed that the size and age-gender distribution of the population is based on the latest available used by the UK Bureau of Statistics (2006) population projections (2006). Sixty-year projections are made from 2006 to 2066.

These assumptions imply a rapid ageing of the UK population, which is of relevance in evaluating the long-term financial sustainability of defined benefit pension plans but which is not taken account of under current financial reporting practices. Currently, 29% of UK males and 30% of females are aged 60 or older. By 2026, 33% of UK males and females will be in this age-group under constant fertility assumptions. By the year 2066 over 50% of the population will be 60 and older if the fertility rate remains constant.

**2.4. Stochastic simulation results.** Table 2, panel A presents the descriptive statistics; panel B shows the sample Pearson correlation coefficients for the unfunded pension liabilities. The correlations shown are between the three measures of the pension liability, the EBO, PBO and ABO. Any of the three measures of the unfunded pension liability could be used as the basis for comparisons. The EBO is used as the basis of comparison, because it incorporates more of the variables affecting the likely pension obligation (future service, future salary) not recognized by the FASB (1985, 2006).

<sup>1</sup> UK Government Actuary's Department, 2008.

Table 2. Panel A. Correlations of UPBO and UABO with the UEBO

This table reports the correlations between both the Unfunded Projected Benefit Obligation (UPBO) and the Unfunded Accrued Benefit Obligation (UABO) with the Unfunded Economic Benefit Obligation (UEBO) under various assumptions about the parameters.

	Pooled	Funding method		Real interest rate		Initiation date	
		Accrued	Projected	Nominal	Real	Year 0	Year 25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UPBO:							
Market value	0.9987	0.9990	0.9980	0.9998	0.9998	0.9980	0.9986
Value in use	0.7531	0.4080	-0.7740	-0.9180	0.0410	-0.7607	-0.7446
UABO:							
Market value	0.9936	0.9990	0.9900	0.9990	0.9760	0.9920	0.9980
Value in use	-0.4443	-0.4945	0.9760	0.5590	-0.5460	-0.4990	0.0395

Table 2. Panel B. Descriptive statistics – unfunded pension liability under alternative valuations

This table reports descriptive statistics for the pooled version of the three pension liabilities examined in this study: the Unfunded Economic Benefit Obligation (UEBO), the Unfunded Accrued Benefit Obligation (ABO) and the Unfunded Projected Benefit Obligation (UPBO). Each is calculated under differing US, UK and IFRS assumptions.

	UEBO	UPBO	UABO
Value in use			
Mean	\$568,210	\$293,427	\$221,140
Standard deviation	\$2,786,332	\$1065689	\$467,960
Correlation to UEBO	/	0.9924	0.9908
Value in exchange			
Mean	\$523,817	\$277,995	\$218,942
Standard deviation	\$2,418,548	\$934,625	\$444,042
Correlation to UEBO	/	0.9933	0.9907

The correlations shown in each column are based on aggregated, or pooled, data from all the simulations run in which the variable in the column heading is held constant (except for the first column). They reflect the data generated for all factorial combinations of growth rates, interest rates and plan initiation dates. The most obvious result in Table 2 is that the UEBO is always more highly correlated with the UPBO than with the UABO. The generally higher correlation for UPBO is not surprising given that it is a calculated percentage of the EBO. These results are also generally consistent with those obtained by Selling and Stickney (1986) and, thus,

provide a specification check on the main simulation results.

Table 3 reports the mean and standard deviation values of the net periodic pension cost, pooled across the presented consistently with Winkelvoss (1993, p. 193), but calculated under ABCM, PBCM or fair value scenarios. The reported pension costs are very sensitive to alternative assumptions and, are in general, much higher and more volatile under fair value assumptions. The fair value net periodic pension cost is not significantly higher than either the SFAS 87 or IAS 19 equivalent calculation under all scenarios, although as expected the volatility is higher.

Table 3. Components of pension expense – baseline case

This table reports the correlations between the pension expense reported under baseline assumptions, for each level of asset funding (ABCM, PBCM or fair value). The net periodic pension cost (8) is equal to the service cost (1) plus the interest cost (2), less the actual return on assets (5) plus any amortization and/or deferrals (7).

			Service cost	Interest cost	Expected return	Asset loss (gain)	Actual return (3-4)	Actuarial loss/(gain)	Loss/(gain) amortization	Net periodic pension cost
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: ABCM	SFAS 87	Mean	39,790	35,467	478	- 3,191	3,669	NA	0	71,587
		Std. dev.	592,552	84,524	113,135	35,719	118,106	NA	0	507,507
	IAS 19	Mean	42,010	25,846	2,850	937	1,913	NA	3,050	68,993
		Std. dev.	557,067	61,454	27,760	7,799	32,471	NA	43,308	531,120
	FRS 17	Mean	42,010	25,846	2,860	904	1,956*	3,859	NA	64,995
		Std. dev.	557,067	61,454	27,859	7,827	32,586	34,803	NA	565,976

Unit: \$

Table 3 (cont.). Components of pension expense – baseline case

			Service cost	Interest cost	Expected return	Asset loss (gain)	Actual return (3-4)	Actuarial loss/(gain)	Loss/(gain) amortization	Net periodic pension cost
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel B: PBCM	SFAS 87	Mean	12,987	36,362	-8,199	-11,185	2,986	NA	385	46,747
		Std. dev.	1,759,301	88,851	343,583	108,020	358,118	NA	5,674	1,430,593
	IAS 19	Mean	28,787	31,779	1,954	1,792	162	NA	10,698	71,103
		Std. dev.	1,654,420	130,645	80,451	20,574	97,116	NA	131,946	1,561,735
	FRS 17	Mean	28,787	31,779	1,961	1,798	163*	3,805	NA	58,605
		Std. dev.	1,654,420	130,645	80,737	20,647	97,461	29,348	NA	1,659,724
Panel C: Fair value	SFAS 87	Mean	-16,859	58,313	-26,027	-29,200	3,173	NA	282	292,302
		Std. dev.	4,678,366	176,589	918,701	286,760	954,461	NA	2,742	4,623,476
	IAS 19	Mean.	28,637	58,185	1,806	4,181	-2,375	NA	21,698	110,567
		Std. dev.	4,393,577	340,283	212,999	54,853	258,274	NA	257,975	4,565,323
	FRS 17	Mean	28,637	58,185	1,812	4,196	-2,384*	-581	NA	85,010
		Std. dev.	4,393,577	340,283	213,757	55,048	259,194	8,710	NA	4,405,520

Notes: The actual return under UK GAAP is not included in the calculation of net periodic pension cost as defined above but is instead written off against the Statement of Realized Gains or Losses.

### 3. Critique of SFAS 87 and sensitivity analysis

In this section we analyze the impact of overcoming certain technical deficiencies in the promulgation of extent pension accounting rules. We then consider the sensitivity of reported pension liabilities and expense to alternative, fair value based assumptions regarding mortality, inflation and investment risk.

**3.1. Critique of SFAS 87.** Winkelvoss (1993, p. 201) levels several criticisms at various aspects of SFAS 87 which he argues are inconsistent with a longer-term perspective. These include: the use of the settlement or ‘wind up’ rate for discounting liabilities; the use of benefit rather than salary service proration for the PBO; and the failure to prorate the projected benefit uniformly from entry age to each future decrement age. We briefly outline each of these criticisms below and then consider their implications for alternative measures of the pension liability and pension expense. Winkelvoss (1993, p. 202) also criticizes the amortization periods, disclosures and terminology but these criticisms are not considered here as they are relatively cosmetic.

**3.2. Salary versus benefit proration.** Winkelvoss (1993, p. 199) argues that the service proration methodology used for the service cost and PBO should be changed to a proration based on salary. This is more consistent with the view that pensions are a form of deferred wages. He also argues that the projected benefit should be uniformly prorated from entry age to each future decrement age. This is in contrast to the existing procedure of allocating benefits according to the plan’s benefit formula, which can vary across plans and, thereby, produce anomalous results.

Winkelvoss (1993, p. 201) further claims that the discount rate used for the interest cost should not be based on a so-called settlement rate that includes insurance company risk, expense and profit charges. He instead proposes that the discount rate be based on market conditions, i.e. the spot rate on investment-grade long-term corporate bonds as of measurement date, and taking account of the asset allocation policy of the plan.

The effect of discount rate changes, and other actuarial assumption changes, should be shown separate from the effects of experience differing from the underlying assumptions. By contrast, the 10 percent corridor around the larger of PBO or market-related assets can produce some strange results. Winkelvoss (1993, p. 203) instead proposes that the corridor be based on service cost. However, since FRS 17 does not allow for any corridor but instead requires immediate write-off of gains and losses to equity. This practice also contravenes clean surplus accounting.

Pension liabilities are not known values but based on actuarial estimates. Alternative assumptions exist concerning rates of plan termination, mortality, disability, salary and interest that may have a material impact on reported pension liabilities and expense. It should be noted that until recently, no pension accounting rules make any assumptions or require disclosures about these rates except the interest cost. However, in 2007 the Accounting Standards Board issued a ‘reporting statement’ which includes requirements for disclosure of the effect of sensitivities in key assumptions underlying FRS 17. The guidance therein specifically suggests that (ASB 2007, para 8) the ‘financial statements should include sufficient information about the principal assumptions the entity has used to measure

scheme liabilities to allow users to understand the inherent uncertainties affecting the measurement of scheme liabilities'). However, it is interesting that ASB guidelines leave the selection of both the degree of sensitivity and the format of presentation as a matter of choice for the reporting entity. More importantly, there are no requirements equivalent to this for analysts to understand fluctuations in assumptions concerning the growth in pension assets (i.e. the assumed expected rate of return on pension investments)<sup>1</sup>.

In this section, we briefly consider their sensitivity to adopting realistic assumptions regarding these parameters that are more consistent with a 'fair value' oriented funding and investment policies.

Since pension costs are usually directly proportional to the level of benefits, salary rates, disability rates and mortality rates, there is little long-term impact

on changes in these assumptions on either the reported liability or expense (see Table 1 for a discussion of our baseline assumptions). By contrast with the liability assumptions, interest rate changes can have a very significant impact on reported pension liability and expense.

Table 4 reports the effect of adopting the proposed changes above on the pension expense computed in Table 3. In this case, only the PBCM funding approach has been modeled. While the magnitude of the net periodic pension cost increases for value in use, it decreases for value in exchange. Moreover, the standard deviations of the net periodic cost components significantly reduce. Consequently, it could be argued that the proposed suggestions, if incorporated, would both increase the value relevance and the reliability of reported pension expense figures.

Table 4. Components of pension expense – incorporating suggested enhancements

This table reports the correlations between the pension expense reported under suggested assumptions, for PBCM asset funding level. The net periodic pension cost (8) is equal to the service cost (1) plus the interest cost (2), less the actual return on assets (5) plus any amortization and/or deferrals (7).

Unit: \$										
			Service cost	Interest cost	Expected return	Asset loss (gain)	Actual return (3-4)	Actuarial loss/(gain)	Loss/(gain) amortization	Net periodic pension cost
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PBCM	SFAS 87	Mean	26,374	24,879	-288	-3,032	2,744	-3,032	51	48,561
		Std. dev.	537,837	64,817	102,756	32,535	358,118	32,535	922	454,601
	IAS 19	Mean	28,679	118,491	1,943	680	1,263	680	2,832	48,609
		Std. dev.	506,297	50,784	25,191	6,917	97,116	6,917	39,232	485,022
	FRS 17	Mean	28,679	24,879	1,950	683	163*	683	NA	45,220
		Std. dev.	506,297	64,817	25,281	6,941	97,461	6,941	NA	512,141

Notes: The actual return under UK GAAP is not included in the calculation of net periodic pension cost as defined above but is instead written off against the Statement of Realized Gains or Losses.

In unreported tests, we also undertake some re-estimates of the pension liabilities reported in Table 2 based on alternative mortality assumptions, by shifting the composition of the workforce from older to younger members (Table 1). We find that the unfunded pension liability significantly increases, particularly when estimated using the EBO and the PBO. To the extent that ongoing demographic shifts are likely to continue to affect the magnitude of underlying pension liability estimates, and consequently projected pension expense, our baseline results as reported in Tables 2-4 should be treated with extreme caution. The sensitivity of these results to alternative assumptions may also explain the shift by UK

employers away from defined benefit pension plans for 'risk management' purposes (Klumpes et al., 2009).

## Conclusion

This paper evaluates the economic impact on firms' reported pension exposure arising from the conflict between reliability and relevance issues affecting various measurement bases that bear upon current deliberations on the conceptual framework underlying accounting standards in general and pension accounting in particular. We investigate the statistical relationship between alternative accounting-based measures of a pension plan's net pension liability and an 'economic' or expected cash flow measure, using alternative assumptions about the discount rate.

The study highlights major problem in producing a single set of internationally harmonized set of financial reporting standards affecting defined

<sup>1</sup> The EFRAG (2008) proposals also include reference to the estimated pension liability, and proposes that it should be based upon the ABO, discounted using the risk free rate. However, there is no specific reference made to the need for sensitivity of critical assumptions to alternative assumptions on pension assets, whereas there is more emphasis on the liabilities.

benefit-based pension liabilities. The most serious problem is the lack of consensus about how best to meaningfully describe the financial position today in respect of a pension obligation created in the past that will involve payments in the future. In response to both economic and legal pressures in recent years, accounting standard setting bodies in both countries have developed GAAP which incorporate various methods for dealing with this issue, in order to serve both stewardship and valuation purposes.

The lack of any consistent method of asset and liability measurement in existing GAAP also leads to conceptual difficulties which may limit their reliability and comparability to investors. However, this, in turn, raises significant unresolved issues in determining the 'fair value' of pension liabilities. Since fair value liabilities change constantly because of changes in the discount rate and other assumption changes, traditional concepts of loss recognition, income smoothing and accounting practices that vary across pension plan sponsors are no longer applicable.

The existence of major, unresolved accounting issues between existing matching-based US GAAP on the one hand, and the ASB's asset-liability approach on the other, highlights the continuing difficulties underlying pension accounting. The ongoing convergence, consolidation and globalization of the financial services industry also raise unresolved issues concerning the consistency in measuring insurance contracts and financial instruments.

By contrast, the alternative fair value 'constructive' method as proposed by the IASB is an evolving system, which focuses on assets and liabilities being measured consistently. Assets and liabilities should be additionally recognized on the balance sheet. The simulation analysis was motivated by the assumption that both employer sponsors require information about the 'true' economic liability and/or its value in the future for funding purposes.

We also examine the sensitivity of the choice of discount rates to changes in parameters that reflect differences in pension liability assumptions.

The results of the pension simulation show that the net difference between pension assets and liabilities when calculated with fair-value rates is more highly correlated with the economic measure than when calculated with value-in-use rates. Both measures are found to be more highly correlated with economic unfunded pension liabilities when they are discounted using market instead of value-in-use rates<sup>1</sup>.

The strength of association also differs substantially depending upon which funding method is used to calculate pension liabilities, the use of real versus nominal interest rates, and pension plan initiation dates. However, we also note that while the baseline mortality assumptions underlying the analysis are those based on latest available authoritative UK sources, there are moves to enhance the footnote disclosure of the sensitivity of these to changes in mortality assumptions. These results generally support the ASB's decision to change the rate used to discount pension assets and liabilities from that currently allowed under FRS 17. However, we conclude that the change interacts with the choice of pension liability measure. Moreover, the adoption of a fair value approach appears to reduce the correlation of reported ABO to the underlying economic measure, increase the volatility and amount of unrealized gains or losses that are charged against income or equity and cause the magnitude of reported pension expense to increase significantly. By contrast, an alternative value-in-use measurement basis, while leading to a higher reported pension liability, also identifies further classes of contingent equity which, if recognized, would significantly reduce the magnitude and volatility of reported pension cost components.

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<sup>1</sup> The 'EBO' concept is also most consistent with the concept of a 'pensions bulk buyout insurance' value that is increasingly important in regulated environments such as the UK. This is the additional premium that a defined benefit plan sponsor must pay order to fully insure against longevity, investment and inflation risks the pension fund benefits 'insured' by a third party. Since the EBO is the only measure that incorporates these risks it also the closest to a long-run, actuarially estimated 'fair value' for a pension liability.

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