# PENSION PLAN ASSET VALUATION METHODS[†]

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*Abstract:* Various asset valuation methods are used in the context of funding valuations. The motivation for such methods and their properties are briefly described. Some smoothed value or market-related methods based on arithmetic averaging and exponential smoothing are considered and their effect on funding is discussed. Suggestions for further research are also made.

## *Actuarial Valuations*

Special methods are often used to value the assets of pension plans. The choice of method should be consistent with the aim of the pension plan valuation. When solvency is being investigated, pension plan assets must be measured at the value at which they would be realized in the market. Specific methods are also prescribed in various jurisdictions for valuations that are carried out to verify compliance with maximum funding regulations or for accounting valuations. In the following, funding valuations are considered. Funding valuations are carried out to compare plan assets and liabilities and determine suitable contribution rates from a going-concern perspective. We also restrict ourselves to defined benefit plans.

Practical methods of valuing pension plan assets for funding purposes have been described and classified, notably by Jackson & Hamilton (1968), Trowbridge & Farr (1976, p. 88), Winklevoss (1993, p. 171) and in the recent survey by the Committee on Retirement Systems Research (1998). Market-related methods are used most frequently. The current market value of plan assets is used or else some average of current and past market values is taken in an attempt to remove short-term volatility (a smoothed value method). Market-related methods are based approximately on the economic valuation of both asset and liability cash flows by reference to the market. Pension liabilities are discounted at market discount rates, suitably risk-adjusted, or at the rates implied in asset portfolios that are dedicated or matched by cash flow to these liabilities. Pension liabilities, specially for active plan members with projection for future salary increases, are not perfectly immunized and volatility in asset values may not be fully reflected in liability values. Market values of plan assets are therefore averaged over short intervals to remove such volatility. Comparison of the pension plan liability and asset values provides a consistent measure of the unfunded liability so that contribution rates may be set to secure the long-term funding of pension benefits.

A more traditional asset valuation method, which was popular in the United Kingdom until recently, is the discounted cash flow method. Fixed-income securities, and pension liability cash flows matched by these securities, are valued by discounting cash flows at

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the same rate. The difference between income from plan assets and outgo (benefits and expenses) in each year is viewed as a surplus of cash that is reinvested in the asset portfolio held by the pension fund. Accumulating projected net proceeds at the rate of reinvestment return would give an accumulated value of the surplus (or unfunded liability) in the plan. Asset and liability cash flows are discounted at that rate yielding present values of assets and liabilities, the difference between these values being the present value of the surplus of asset over liability cash flows (or unfunded liability) in the plan. Contributions may then be determined such that, when reinvested at the assumed rate of return, they liquidate the unfunded liability (Funnell & Morse, 1973). The method has also been used to value equities, under the Dividend Discount Model possibly with term-dependent dividend growth assumptions (Day & McKelvey, 1964).

***Properties of Asset Valuation Methods***

For funding purposes, an actuarial asset value is not an estimator of the fundamental worth of pension plan assets and is not superior to the market value. Asset valuation methods should satisfy certain desirable properties, irrespective of the methodology employed. The actuarial asset value should lead to a consistent, objective, realistic as well as stable measurement of the unfunded liability in a pension plan.

The consistency property refers to the fact that the values placed on assets and liabilities must be comparable since pension plan valuations involve the comparison of asset and liability cash flows and the subsequent determination of an unfunded liability and contribution rate. For example, historic book (cost) values of assets are not generally relevant relative to future pension liabilities. Fair pricing of assets and liabilities should be consistent by virtue of the no-arbitrage principle. Smoothing asset prices may arguably distort the comparison of asset and liability cash flows and the measurement of the unfunded liability. Nevertheless, asset values may be smoothed to remove impermanent fluctuations in security prices, driven by speculators or short-horizon investors, if it is believed that such volatility is not reflected in pension liability values and is irrelevant to long-term planning for retirement benefits. Excessive smoothing would not be acceptable, particularly as the plan sponsor's financial planning tends to be over a shorter term and will be influenced by volatile market conditions which cannot be ignored altogether. If an asset valuation method is not consistent with liability valuation, then systematic gains or losses will emerge, and such a method would not be acceptable, for example under the Standard of Practice for Valuation of Pension Plans of the Canadian Institute of Actuaries (1994, para. 5.01).

Pension plan assets should also be valued in an objective way. Market values of assets are objective in the sense that, absent accounting errors, two actuaries will employ the same value. Unsmoothed market values are clearly understood by financial managers, accountants and the sponsor's shareholders. If averaging techniques are used, their variety and opacity, specially if they are changed frequently, may appear to be somewhat arbitrary. Smoothed asset values would certainly not be objective for the determination of solvency. If equities are valued using the Dividend Discount Model, values become highly sensitive to the choice of dividend growth assumption and the smoothing effect may not be very transparent (Dyson & Exley, 1995). Details of any smoothing method

should be disclosed according to Actuarial Standard of Practice No. 4 of the Actuarial Standards Board (1993) and should presumably be applied systematically and rationally.

Asset values must also be realistic. The primary objective of funding valuations is to determine a reasonable rate of contribution rather than to place an absolute value on plan assets, but the asset value must nevertheless remain in some proximity to market values. Market values are relevant because market conditions do affect the plan sponsor, who ultimately contributes to the pension plan. Asset values that are off-market and distant from market conditions lead to artificial values of unfunded liability and contribution rates.

Asset valuation methods also stabilize and smooth the pension funding process. Actuarial valuations for funding purposes aim at measuring the shortfall (or surplus) of assets over liabilities so that contribution rates may be calculated in order to make good these shortfalls and secure assets to meet pension liabilities as and when they are due. Firms sponsor pension plans on a voluntary basis as well as through competitive pressures in the employment market. But plan sponsors are motivated to fund defined retirement benefits in advance when the contributions required are stabilized and spread over time, so that the costs arising from the uncertainty of long-term pension provision are not immediately borne. (It is not generally desirable however that the accounting pension expense be smoothed.) An unfunded liability is often defrayed over a number of years for that reason. Short-term variations in asset prices conflict with this stability objective. A fundamental reason for using special methods to value assets in the funding valuations of defined benefit pension plans is therefore to moderate volatility in asset values and generate a stable and smooth pattern of contribution rates (Anderson, 1992, p. 108; Ezra, 1979, p. 40; Winklevoss, 1993, p. 171).

The effect of the asset valuation method on the dynamics of pension funding is significant. Asset liability models turn out to be sensitive to the specification of the asset valuation method (Kingsland, 1982). Asset allocation decisions should not be based on the outcome of a funding valuation but may be influenced by the assessment of liability and assets and by the unfunded liability that is reported after such an actuarial valuation. The asset valuation method should not therefore lead to wrong investment decisions (Ezra, 1979, p. 110; Dyson & Exley, 1995). The way in which assets are valued certainly affects the timing of contributions, as the emergence of asset gains and losses depends on the value placed on plan assets. This has an indirect effect on the ex post cost of pension provision. Asset gains and losses are also amortized but it is often considered that this is not powerful enough to dampen their volatility and stabilize contributions, and consequently asset valuation methods themselves may need to incorporate a smoothing quality (Anderson, 1992, p. 108).

### *Smoothed Value Methods*

Many smoothed value methods comprise a form of arithmetic averaging of market values. Exponential smoothing of market values is also common. Whatever form of smoothing or averaging is employed, a simple average of the market values at different points in time cannot be used. The market values must be adjusted. First, the time value of money must be considered and present values must be used. Second, allowance must

be made for intermediate cash flows in the fund by adding contributions and subtracting benefit payments and possibly expenses (Anderson, 1992, p. 110).

The survey of the Committee on Retirement Systems Research (1998) supplies descriptions in general terms of various methods that are used in practice. One such method is the "Average of Market" or "Average Value" method. When arithmetic averaging is used, the market value of assets is also known as a "Moving Average of Market" with a typical averaging period of 5 years being used. As stated in the survey of the Committee on Retirement Systems Research (1998), this method may be shown to be equivalent to the "Deferred Recognition" (or "Adjusted Market") method. The latter defines the asset value as being the current market value of assets to which is added a portion of previous years' asset losses that have been deferred and are as yet unrecognized (Winklevoss, 1993, p. 173). One may further show that these methods are equivalent to a particular instance of a third method, the "Write-up" method. Under the Write-up method, a written-up or anticipated asset value is calculated as the previous year's actuarial asset value, adjusted for cash flows and written-up at some interest rate. An additional adjustment in line with the current market value of plan assets is subtracted from the anticipated value. The additional adjustment represents the recognition of a portion of previous years' losses.

Variants of these methods using exponential rather than arithmetic smoothing may also be developed. The exponential smoothing version of the Average of Market method is in effect an exponentially weighted infinite average of adjusted market values. This method is most commonly used in the equivalent Write-up format, with the additional adjustment in this case being a fraction of the difference between the current market value and the anticipated or written-up asset value. This is the usual version of the Write-up method. Sometimes the additional adjustment is only made so that the resultant actuarial asset value remains within a corridor of the current market value (Winklevoss, 1993, p. 174). The Write-up method is also known as a "Weighted Average" of the current market value and the anticipated or written-up asset value. It is also possible to formulate exponential smoothing in an equivalent Deferred Recognition style: the current market value is adjusted by adding an exponentially weighted average of the present value of past asset losses.

Analysis shows therefore that many asset valuation methods are equivalent (at least asymptotically, i.e. when initial conditions are ignored). The essential difference lies in whether arithmetic or exponential smoothing is employed. Averaging asset values leads to asset gains and losses being deferred. Arithmetic smoothing methods recognize gains/losses (along with interest) gradually over a moving interval, usually of 5 years. Exponential smoothing methods are unusual in that declining portions of asset gains and losses are deferred in perpetuity. This is not as inadvisable as may first appear. Smoothing using an infinite exponentially weighted average is perhaps more natural than averaging over a finite moving interval. Asset gains and losses emerge randomly and continually and are never completely removed in any case.

### *Asset Gain/Loss Amortization*

Once the actuarial asset value is determined, the unfunded liability in the plan may be calculated, along with any actuarial intervaluation loss that has emerged. This actuarial loss is based on the smoothed asset value (rather than the current market value) and is therefore a smoothed loss. Contributions are calculated so that these smoothed actuarial losses are amortized over some future interval, typically 5 years. Asset gains and losses are therefore deferred, and hence smoothed, twice, first by the asset valuation method and then by the gain/loss adjustment method. The method of asset valuation must therefore be chosen along with the method by which gains and losses are amortized. Trowbridge & Farr (1976, p. 73) thus refer to the "consistency between the asset valuation and the techniques of actuarial gain or loss adjustment".

It may be shown mathematically that there is considerable symmetry between an arithmetic averaging asset valuation method and the usual fixed-term amortization of gains and losses. One may choose not to directly amortize gains and losses but instead spread them forward over a moving term, as in spread-gain actuarial cost methods (Berin, 1989, p. 63; Aitken, 1994, p. 326) or as discussed by Trowbridge & Farr (1976, p. 85), Bowers et al. (1979) and Owadally & Haberman (1999) among others. It may then be shown mathematically that there is an identical exponential smoothing mechanism that is employed in the gain/loss spreading method and in exponential smoothing asset valuation methods.

It would appear intuitively that these exponential smoothing techniques lead to smoother contribution rates by contrast with moving arithmetic average methods and fixed-term amortization schedules. The smoothness of contribution rates when gain/loss spreading is used within the Aggregate and Frozen Initial Liability methods is indeed observed by Trowbridge & Farr (1976, p. 62). Hennington (1968) states that "The smoothness of the annual contribution is determined not only by the method for determining asset value but also by the actuarial funding method. […] An actuarial cost method involving a spreading of actuarial gains and losses makes it easier to use some of the market value methods." Berin (1989, p. 28) notes that the valuation of assets at market is less "risky" if a spread-gain funding method is used. Owadally & Haberman (1999) also find that spreading is more efficient than the direct amortization of gains and losses in the sense that more stable contribution rates and funding levels may be achieved.

### *Stochastic Modeling*

Further analysis of asset valuation methods requires some consideration of the stochastic volatility of the returns on plan assets. Some simplifying assumptions are necessary. We have not considered separate categories of assets but have assumed that markets are efficient and that overall rates of return on assets held in the pension fund are independent and identically distributed from year to year. We assumed constant inflation and a stationary plan membership with known mortality and salary increases. Only asset gains and losses emerge as a consequence. For the sake of simplicity, it was also assumed that valuations occur regularly with a fixed valuation basis being used and that the only benefit is a pension at normal retirement age. It is then possible to decompose the unfunded liability into losses each year, obtain recurrence relations for the unfunded

liability or for the loss and then derive the first two moments of the market and actuarial values of plan assets, of the contribution rate and of the intervaluation loss when the pension funding process becomes stationary.

Some interesting results may be obtained. Gains and losses emerge randomly owing to the volatility in investment returns. But if the asset valuation method is well-defined and if the actuarial assumption as to returns on plan assets is unbiased and is borne out on average, then it may be shown that the expected or average gain or loss that emerges is zero, which satisfies the criterion for consistency. The variance of the funding process exhibits dependence on the asset valuation and gain/loss adjustment techniques. They have a complementary actuarial smoothing function and consideration should be given to their combined effect. It is apparent that excessive smoothing through very long amortization and averaging periods leads to instability in the pension funding system, which is reasonable because gains and losses are not removed fast enough and they accumulate. Indeed, the funded ratio (market value of plan assets as a percentage of actuarial liability) becomes more volatile if more smoothing is applied. Contribution rates do become more stable as longer averaging periods are used or as gains/losses are amortized over longer periods, but too much smoothing leads to contribution rates becoming more volatile and is therefore inefficient. If funding is stable, whether exponential or arithmetic smoothing asset valuation methods are used, it is possible to show that the actuarial asset values do not diverge from, and are less variable than, the market value of plan assets. The actuarial asset values remain realistically close to market values, but exhibit less volatility.

### *Conclusion*

Numerical work appears to indicate that typical arithmetic averaging periods of up to 5 years (along with gain/loss amortization periods of up to 5 years) appear to be efficient in terms of stabilizing both the funded ratio and contribution rates in pension plans, which lends support to current actuarial practice. If exponential smoothing is used, such as when asset values are being written-up with adjustment, and gains and losses are being spread indirectly rather than amortized, then a combination of a spreading period of up to 5 years and a weighting in excess of 20% on current market value is efficient.

Mathematical modeling requires many simplifying assumptions but is useful in analyzing valuation methods and in understanding the intricate relationship between actuarial cost methods, gain/loss adjustment and asset valuation. More research, using numerical simulations and realistic models, is required to compare the various asset valuation methods and to investigate the effect of practical factors such as the IRS 20% corridor rule and the choice of averaging periods. Scenario and stochastic modeling are necessary, as is the use of historical rates of return and economic time series asset models. Further research on this subject is important so that actuaries are better able to address their clients' needs. With published objective research, actuaries can justify their methods and techniques to other professionals and can consequently represent their clients better and influence the standards set by accountants, regulators and lawmakers.

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