# Public Pension Plan Funding Policy

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## Executive Summary

While contributions to public defined-benefit plans calculated under traditional actuarial methods are not necessarily sufficient to make a plan actuarially sound, the financial economics solution to the funding issue is worse than the problem. The traditional methods for public plan funding need to be improved to avoid cost methods that exclude material liabilities, asset methods that allow for excessive smoothing, amortization methods that allow perpetual negative amortization and amortization payments that are less than the interest on the unfunded actuarial accrued liability (UAAL), and unrealistic assumptions.

Financial economics is not the solution for public pension plan funding because the unit credit cost method is unreasonable for pay-related plans, immediate amortization of gains and losses is unrealistic, basing contributions on the change in the market value of liabilities (MVL) is too volatile, not allowing smoothing of investment gains and losses for the actuarial value of assets (AVA) would produce an unacceptable level of volatility, and the use of a risk-free discount rate would require an increase in contributions to an unacceptable level. To fix the problems with traditional actuarial methods for public plan funding such as perpetual negative amortization and unrealistic assumptions, the amortization method should provide for amortizing the UAAL over a closed or fixed period or by a fixed date, because otherwise the UAAL is allowed to grow until infinity and the responsibility for paying it is passed on to future taxpayers, and the best-estimate for the net investment return assumption should include a reduction for the volatility drag on the long-term expected return and a reduction for the expenses paid out of the plan assets.

Consideration should be given to a new funding method that would make the recommended contribution for funding purposes for public defined-benefit plans subject to an overriding minimum contribution (OMC) calculation. The required contribution would be the greater of the amount determined using traditional methods and the OMC. The OMC would be a new funding method not already in existence. The OMC is based on the normal cost plus a fraction of the benefit payments. The fraction used in the OMC is based on the funded ratio. The OMC would avoid the problems with traditional methods that use inadequate amortization methods and excessive smoothing.

Rather than applying the theory of financial economics for funding public plans, it would be more appropriate to continue to use the traditional methods with improvements to the amortization methods and the investment return assumption selection process. The rate of return assumption should reflect the impact of volatility on the compounded return and the amortization of the UAAL should be accelerated to avoid perpetual negative amortization.

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## Introduction

A current topic of much debate in the actuarial community is the use of financial economics (FE) for public pension plans. Defined-benefit (DB) public pension plans use traditional actuarial methods for their valuations, while most private defined benefit plans use FE methods as described in a paper by Dr. Jeremy Gold and Dr. Lawrence Bader.[1] Over the last several years, many proponents of FE have advocated for public plans to adopt FE methods. The debate became more heated when the American Academy of Actuaries considered issuing a public statement requiring the disclosure of the market value of liabilities (MVL) for public pension plans. This position is popular with proponents of FE, but unpopular with the overwhelming majority of actuaries who work on public plans.

While contributions to public defined-benefit plans calculated under traditional actuarial methods are not necessarily sufficient to make a plan actuarially sound, the financial economics solution to the funding issue is worse than the problem. The traditional methods for public plan funding need to be improved. There is a need to establish rules for funding contribution calculations to strengthen the actuarial soundness of public plans. The rules would require plan sponsors to make progress toward full funding, without requiring full funding. At least for mature plans that are below 60-percent funded using the market value of assets, the amortization payment should be based on a descending amortization period, with a minimum amortization payment of the interest on the unfunded actuarial accrued liability (UAAL). The suggested improvements to traditional funding methods and assumptions include selecting a rate of return assumption that reflects the impact of volatility on the compounded return as well as accelerating

[1] Bader, Lawrence N., and Jeremy Gold, "Reinventing Pension Actuarial Science," *The Pension Forum*, Volume 15, Number 1, January 2003, available at: http://www.soa.org/library/newsletters/pension-forum/2003/january/pfn0301.pdf.

the amortization of the UAAL. As a starting point for discussion, consideration should be given to a new funding method that would make the recommended contribution for funding purposes for public defined benefit plans subject to an overriding minimum contribution (OMC) calculation. The required contribution would be the greater of the amount determined using traditional methods and the OMC.

## Financial Economics Does Not Apply to Funding[2]

### The Financial Economics Method

Pension actuaries evaluate the present value of expected cash flows from a pension plan using various methods and assumptions. FE liability measurements utilize the unit credit cost method, with no salary increase assumptions.[3]

Actuaries often value cash flows from pension plans differently from the way in which capital markets value similar cash flows from fixed income investments.[4] FE would require pension actuaries to value pension liabilities like fixed income investments. The FE rate of return for discounting the liabilities is the rate that would apply to a portfolio of fixed-income investments.

FE does not include the risk premium for equities in the liability discount rate because using a higher discount rate for portfolios that include more equities implies that arbitrage exists. The position of FE proponents is that there is no opportunity to profit from arbitrage because markets gravitate to an arbitrage free state. FE takes a market-oriented approach to DB plans. It takes the market view for the accounting, funding, and investments. FE investment policy supports 100-percent bond portfolios.

FE measures pension liabilities using methods and assumptions that can result in liabilities that are significantly higher than pension liabilities measured using traditional actuarial

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[2] Texas Pension Review Board, Biennial Report 2007-08, available at: http://www.prb.state.tx.us/pls/reports/biennial/Biennial%20%202008.pdf.

[3] Lowman, Thomas B., *Back to the Future:* "Is the cure worse than the ill?*,"* *The Pension Forum*, Volume 15, Number 1 January 2003, p. 14.

[4] American Academy of Actuaries, *Pension Actuary's Guide to Financial Economics*, 2006, available at: http://www.actuary.org/pdf/pension/finguide.pdf.

methods. Proponents of FE suggest that not only should the MVL be disclosed, this measurement should be used to determine funding amounts and it should be the basis for the preferred asset mix decision.

FE proponents make a case against traditional actuarial methods arguing that they under-price pension liabilities and allow excessive smoothing as well as deferral of cost recognition. FE proponents further argue that problems with traditional methods also include the use of investment return assumptions that are too high, amortization methods that allow for payments on the unfunded liability to be less than the interest and an amortization period that can be reset annually, resulting in perpetual negative amortization. The issues with traditional methods make FE seem like a reasonable alternative.

What happens when a public pension plan follows the methods of FE? Jeremy Gold and Gordon Latter developed a method for converting liabilities under traditional methods to FE.[5] The traditional actuarial accrued liability (AAL) is converted to the accrued benefit obligation (ABO) by multiplying the active AAL times a factor to remove the impact of the salary increase assumption, and adding the active ABO to the liability for inactive members. The ABO is converted to the MVL. The resulting MVL is significantly greater than the ABO and generally greater than the AAL. The MVL earned in a year is the difference between the MVL at the end of the year and the MVL at the beginning of the year, which is significantly greater than the actuarially required contributions reported under traditional methods. Opponents of FE would argue that the liabilities that result from using the risk-free discount rate are extremely volatile because the risk-free rate is a volatile short-term rate.

[5] Gold, Jeremy, and Gordon Latter, *Marking Public Pension Plan Liabilities to Market*, The Pension Research Council 2008 Symposium, May 1, 2008, available at: http://www.pensionresearchcouncil.org/conferences/conf-2008.php.

**The FE vs. Traditional Methods Debate**

A description of the FE versus traditional methods debate can be found on the Web site of the National Association of State Retirement Administrators (NASRA), an association that does not support the FE point of view for public plans:

> *A movement is afoot that would require public pension plans to calculate and publish their market value of liabilities, also known as the plan's termination liability. A termination liability requires using a risk-free rate of investment return—generally around 4 percent to 5 percent—to discount liabilities, rather than a return based on a diversified portfolio, which is generally 7 percent to 8 percent. Corporate pension plans are required to calculate a MVL, chiefly so that in the case of bankruptcy or sale of the firm, the plan's liabilities are known.*
>
> *Primary arguments against requiring public pension plans to calculate and publish a MVL are 1) public entities, such as states and cities, are essentially perpetual and will not go out of business or be acquired; and 2) participants in public pension plans generally are entitled to continue accruing benefits once those benefits have been established. MVL opponents believe that these factors render a MVL figure irrelevant. MVL opponents further believe that one consequence of a MVL would be to significantly, and needlessly, inflate the plan's current and projected required costs.*[6]

NASRA strongly opposes the application of FE to public plans. Concurrently, most public plan actuaries favor the traditional methods to the FE approach.[7] Concerns expressed by public plan actuaries are that the FE approach does not include future pay increases in the AAL; FE can create a false impression that a plan is underfunded, and conventional methods produce more stable contribution rates.

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[6] National Association of State Retirement Plan Administrators, *The Market Value of Liabilities Issue*, available at: http://www.nasra.org/resources/MVL.htm.

[7] Gabriel Roeder Smith & Company, *Valuing Public Pension Plans: Comparing Financial Economics with Conventional Approaches*, GRS Insight, April 2008, available at: http://www.gabrielroeder.com/news/pdf_insight/insight2008_04.pdf.

Lawrence Bader and Jeremy Gold support FE for public plans, taking the position that traditional methods undervalue public pension liabilities. They recognize that if public plans sponsors immediately shifted to 100-percent bonds, or if the interest rates for valuing liabilities for funding purposes were to change to lower risk-free rates, the contribution rates would skyrocket. Bader and Gold propose a gradual shift to FE for existing plans and using FE to value proposed benefit improvements and new tiers of benefits to mitigate the impact.

Bader and Gold point out the risks of continuing to use traditional methods:

> *Current funding and investment practices are costing taxpayers dearly. We are not directly addressing the losses of the past few years, which we can all hope are temporary, but the poor decision-making that stems from failure to understand the risks of equity investment. For example:*
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> - *Governments issue pension obligation bonds to capture what they mistakenly believe is an arbitrage gain from the excess of expected pension fund returns over their borrowing cost. There is no real economic gain, only some profits for investment bankers, lower costs for current taxpayers, and additional risk borne by future taxpayers.*
> - *Governments underprice employees' pensions by anticipating risk premiums, and they share "excess" risk premiums earned with employees, further loading risks onto taxpayers for which they stand to earn no rewards.*
> - *Intergenerational risk-sharing is thwarted by each taxpayer generation's inclination to take winnings off the table and let the losses ride.*
> - *Risk has a cost, a cost that is overlooked by current accounting and actuarial standards and therefore by most public plan stakeholders. Correct recognition of that cost would greatly alter much public plan practice and improve the lot of tomorrow's taxpayers.*[8]

Under the FE view, public plans using traditional actuarial methods have an intergenerational mismatch of risk and reward. The consequences of mismatch can be especially harmful with public plans where one generation of taxpayers bears the risk, whereas the prior

[8] Bader, Lawrence and Jeremy Gold, *The Case Against Stock in Public Pension Plans,* Oct. 19, 2004, available at: http://www.pensionfinance.org/papers/publicplaninvestment.pdg.

generation enjoyed the advantage. In some cases, the public plan mismatch can cause public officials to make unwarranted benefit liberalizations that will prove harmful to future generations of taxpayers.[9] The traditional view summarized in presentations by Paul Angelo is that funding using FE does not improve intergenerational equity.[10]

**Discount Rates**

The use of FE to determine the MVL requires using a discount rate such as 4 percent to 5 percent that is significantly lower than rates under conventional approaches that are typically 7 percent to 8.5 percent. The FE method produces significantly greater liabilities from using the lower discount rate.

The proponents of FE argue that the equity risk premium needs to be excluded from the expected return of the portfolio to determine the rate at which to discount the liabilities. Since the liabilities are illiquid, some opponents of FE would argue that an illiquidity premium would need to be added back in to the discount rate, offsetting part of the reduction from excluding the equity risk premium. FE proponents would argue the opposite, that the illiquidity premium would make the liabilities greater.

Proponents of FE argue that the discount rate should be lower for well-funded plans and greater for severely under-funded plans, including lower discount rates for plans of financially secure plan sponsors and conversely greater discount rates for plans of less financially secure plan sponsors. This is based on comparing the liabilities in a well funded plan with a financially

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[9] Burrows, Edward E., *Defined Benefit Plans Accounting, and Funding: Financial Economics vs. Pension Tradition*, October 2004, available at: http://www.soa.org/files/pdf/FE%20vs%20PT-10-9-04.pdf.

[10] Angelo, Paul, *Financial Economics and Public Retirement Systems*, October 8, 2007, available at: http://www.nasra.org/resources/MVL/AngeloNCTR.pdf.

secure sponsor to highly rated debt, and the liabilities in a poorly funded plan with a less secure sponsor to lower than investment grade debt. The approach used by the Governmental Accounting Standards Board (GASB) for selecting the discount rate is the opposite: Under GASB 43 & 45, well-funded plans may use higher discount rates.

**Cost Method**

FE uses the unit credit cost method, a method that excludes liabilities for future pay increases. Conventional approaches use methods such as entry-age normal (EAN), projected unit credit (PUC), or the aggregate cost method that include projected pay in the liabilities. For plans that are not pay-related, PUC and the unit credit method are the same. For public plans, it is appropriate to use methods that project salary, with costs shown as a percent of projected payroll. According to the PRB Guidelines for Actuarial Soundness, the allocation of the normal cost portion of contributions should be level as a percent of payroll over all generations of taxpayers, and the funding of the unfunded actuarial accrued liability (UAAL) should be level or declining as a percent of payroll over the amortization period. The FE cost method, which is the unit credit cost method with no assumption for pay increases, is a funding method not matched for most public plans. The unit credit cost method produces a normal cost pattern that increases significantly as a percentage of pay.

**Amortization Methods**

Proponents of FE cite the flaws in the amortization methods used under traditional approaches as a reason to use the FE method. Traditional approaches allow for payments on the unfunded liability that are less than the interest. For example, if the unfunded liability is $1

billion using 8 percent interest, and the amortization payment is $30 million, the payment is less than the interest of $80 million. The FE method has no amortization of unfunded liabilities; there is immediate recognition of all changes in the liability.

The following is an example of how assumptions can be changed under traditional methods to make an actuarially unsound plan appear to be sound, based on the amortization period being less than 40 years. The development of the years to fund the UAAL for a sample plan with a funded ratio of 60 percent is shown below.

**TABLE 1**
**Amortization Period Calculation**

| **Years to Fund the UAAL** | | |
|---|---|---|
| **(1)** | **Total Contribution Rate** | **9%** |
| **(2)** | **Normal Cost (NC) Rate** | **6%** |
| **(3)** | **Amortization Rate: (1) - (2)** | **3%** |
| **(4)** | **Covered Payroll** | **$1,000,000** |
| **(5)** | **NC: (2) x (4)** | **$60,000** |
| **(6)** | **Amortization Payment: (3) x (4)** | **$30,000** |
| **(7)** | **Total Contribution: (5) + (6)** | **$90,000** |
| **(8)** | **Actuarial Accrued Liability (AAL)** | **$2,000,000** |
| **(9)** | **Actuarial Value of Assets (AVA)** | **$1,200,000** |
| **(10)** | **Unfunded Actuarial Accrued Liability (UAAL): (8) - (9)** | **$800,000** |
| **(11)** | **Amortization Period** | **36 years** |
| **(12)** | **Interest Rate Assumption** | **8%** |
| **(13)** | **Payroll Growth Rate Assumption** | **6%** |

Using a reasonable payroll growth assumption of 4 percent instead of 6 percent, the amortization period would be over 100 years and the plan would not be considered actuarially sound. By using a payroll growth assumption to 6 percent, the amortization payment is sufficient to amortize the UAAL in 36 years. If the only criteria for actuarial soundness were an

amortization period under 40 years, this plan would be considered actuarially sound, as the result of using a payroll growth rate assumption of 6 percent. The only place that this assumption is used is in the calculation of the amortization period.

In this example, just by increasing the payroll growth assumption, suddenly it is possible to amortize the UAAL in 36 years rather than a period greater than 100 years. The amounts of the initial amortization payment and the UAAL did not change. The $30,000 payment is still less than the interest on the UAAL, which is 8 percent of $800,000, or $64,000. This is the type of example used by FE proponents to make a case for not having any amortization at all.

The problem is not with the amortization, but with the use of an amortization method with unreasonable assumptions. It would be preferable to use amortization methods under conventional approaches with reasonable assumptions, in a manner that avoids perpetual negative amortization, than to use the FE method which has no amortization. The FE method of immediate recognition of all changes in the liability is unreasonable for public plan funding.

**Contribution Requirements**

The contribution requirements under traditional approaches are based on the sum of the normal cost plus an amortization payment. The contribution requirement under FE is the difference in the liabilities at the end of the year and the liabilities at the beginning of the year. The FE method would produce an excessively large and extremely volatile contribution because the cost changes from any gains and losses, plan changes, or assumption changes would need to be recognized in a single year. The FE method for determining contribution requirements is, thusly, unreasonable for public plans.

**Asset Smoothing**

The FE method uses the MVA, which should be disclosed. The conventional approach is to allow the use of either the MVA or a smoothed actuarial value of assets. The use of a smoothing method reduces the volatility in contribution rates due to short-term investment gains and losses. Stable and predictable contribution rates are preferable to volatile rates for public plan financing. Therefore, this FE method of not allowing smoothing of investment gains and losses in the asset method is unreasonable for funding public plans.

**Asset Mixes**

The typical asset mix for public plans is a balanced portfolio with a mix of equities and fixed income investment vehicles. Proponents of FE argue that the typical asset mix includes excessive equity exposure. In periods when fixed income investments outperform equities, the FE position on investment policy can appear to be true in hindsight. Switching from a balanced portfolio to 100 percent fixed income investments solely in response to a severe short-term downturn in the equity markets would not be sound long-term asset management.

**Issues with Traditional Methods**

For funding purposes, traditional actuarial methods tend to slightly understate the liabilities and FE methods tend to significantly overstate the liabilities. Traditional methods allow for the selection of investment return assumptions that are based on weighted averages of expected annual returns, which overstate the expected return on a portfolio because of volatility and variance drain. The suggested improvement for the traditional method would adjust the portfolio return for volatility.

Traditional methods also allow for unlimited smoothing of investment gains and losses that could potentially distort the actual unfunded liability measurement. An improvement to the traditional method would allow asset smoothing with reasonable constraints on the smoothing period and the corridor around the MVA. Traditional methods allow for amortization methods that pay less than the interest on the unfunded liability and resetting of the amortization periods that can result in perpetual negative amortization. An improvement on the traditional method would require more rapid amortization for severely underfunded plans.

The proponents of FE use the flaws with traditional methods as strong arguments for using FE for funding calculations. Proponents of FE would have funding calculations based on the MVL, no smoothing of investment gains and losses, and no deferral of costs. Rather than moving to the FE method, the appropriate method for public plans is to use the conventional approaches with minor improvements. The improvements could include selecting a rate of return assumption that realistically reflects the impact of volatility on the compounded return; allowing the smoothing of investment gains and losses within limits such as a maximum of five years of smoothing with the smoothed value subject to a corridor of 80 percent to 120 percent of the MVA; and at least for plans that are below 60-percent funded, requiring accelerated amortization payments and descending amortization periods, with a minimum amortization payment of the interest on the unfunded liability.

**The 100-percent Fixed-Income Investment Mix**

Bader and Gold are advocates for public pension funds being invested 100 percent in fixed income.[11] They suggest that public plans' sponsors should try to be ahead of the curve when it comes to shifting toward 100-percent fixed income to avoid being left holding equities after most other funds have moved to bonds. Opponents of the FE investment policy point out that a portfolio invested 100 percent in bonds would have a significantly lower long-term expected rate of return than a portfolio with a more traditional mix of 70 percent in equities and 30 percent in fixed income. To make up for lower investment earnings, contribution requirements would be greater. Another problem with a 100-percent fixed income mix is that its risk/reward tradeoff is less than optimal, so it does not even appear on the efficient frontier.

For the asset mix decision, FE methods tend to place too much emphasis on fixed income investments with low returns. On the other hand, determining the asset mix based only on the risk and return characteristics of the assets ignores the fact that considering the liabilities changes the efficient frontier. Investments that may not be on the efficient frontier when only the assets are considered may have characteristics that match the underlying liabilities sufficiently so that the risk of extreme volatility in contribution rates and funded ratios can be reduced significantly by including them in the portfolio. The appropriate asset mix for public plans is a balanced portfolio that includes equities, based on an analysis that includes consideration of the underlying liabilities.

A shift to 100 percent in fixed income is too costly of a decision because the fund would be locking in lower rates of return than could be achieved with more equity exposure, resulting

[11] Bader, Lawrence and Jeremy Gold, *The Case Against Stock in Public Pension Plans*, Oct. 19, 2004, available at: http://www.pensionfinance.org/papers/publicplaninvestment.pdf.

in significantly less investment earnings and higher contributions. The appropriate method is to consider the underlying liabilities in an asset/liability modeling study, and look at risk not just as the standard deviation of returns on the asset portfolio, but consider all the risks, including the risk of extreme volatility in the contribution rates and funded ratios. When it comes to funding calculations and asset mix decisions, the traditional methods are far superior to FE. While there are some minor areas of improvement needed for traditional methods, the FE solution is worse than the problem with conventional approaches for public plans. To make sure that methods and assumptions are reasonable, public plans in Texas should continue to use conventional approaches rather than FE for the funding policy and the investment policy. Unlike FE, traditional methods have a real world application in public pension plans.

**Conclusions on the Use of FE for Funding Public Plans**

The use of FE for funding public plans would unnecessarily increase the contribution requirements. It would unnecessarily restrict the asset portfolio to fixed income investments. While disclosure using FE is not unreasonable, the use of FE for the funding policy and investment policy is unreasonable for public plans. The flaws with conventional approaches that are pointed out by FE proponents can be fixed with minor improvements to the traditional methods. FE methods have applications to corporate pension plans that do not apply to public plans, such as calculating a liability for a plan termination, a merger or an acquisition. Public plans in Texas should resist using FE methods for funding and investment policy and continue to use traditional methods.

Actuaries should use their own professional judgment on the issue of FE disclosure. It is not unreasonable to disclose the MVL. Without any regulatory agency such as GASB or any

rating agencies currently requesting MVL disclosure, it is not necessary to disclose the liabilities using FE methods. The FE proponents refer to the liability measurement as the MVL, but there is no active market for public pension plan liabilities. FE should not be used as basis for funding calculations or the asset mix decisions because the contribution requirements would be excessive and the asset returns would be unacceptable. What is needed is an improved traditional method to address the flaws with conventional approaches that are pointed out by FE proponents.

## Traditional Actuarial Funding Methods[12]

### Pension Funding

Pension plans are funded based on the equation: contributions equal benefits plus expenses minus income ($C = B + E - I$). Actuarial methods and assumptions are used to predict the benefits, expenses, and income in the equation. Actuaries determine the recommended contributions for sound funding of the plan. Pre-funding allows for assets to be built-up to pay for future benefits. Actuarially sound systems are pre-funded. Pay-as-you-go funding makes contributions as benefits become due. Pay-as-you-go systems are not actuarially sound. Using the $C = B + E - I$ formula, pay-as-you-go funding means the income equals zero, requiring greater contributions in the long run. With pre-funding, the income reduces the amount of contributions needed. To determine a schedule for *C*, it is necessary to project $B + E - I$. To project *B*, it is necessary to make actuarial assumptions.

### Actuarial Assumptions and Methods

Actuarial assumptions and methods are selected by the board of trustees of a retirement system based on advice from the system's actuary. The recommended assumptions are based on the results of experience studies that compare actual to expected results. Assumptions can be economic assumptions or demographic assumptions.

The assumptions for inflation, the net investment return, the payroll growth rate, and salary increase are economic assumptions. Demographic assumptions include rates of retirement,

[12] Texas Pension Review Board, Biennial Report 2007-08, available at: http://www.prb.state.tx.us/pls/reports/biennial/Biennial%20%202008.pdf.

including early and late retirements, turnover or withdrawal rates, and rates of death and disability, including duty and non-duty. Higher rates of duty death and disability apply to public safety plans. Actuarial assumptions should be reasonable and realistic in the aggregate.

The typical public plan is a pre-funded plan that uses the entry-age normal (EAN) cost method, five-year smoothing to determine the actuarial value of assets (AVA), an 8 percent investment return assumption, amortization as a level percent of pay, and a 4 percent payroll growth assumption. The net investment return assumption is equal to the inflation assumption plus a net real rate of return of about 3.5 percent to 5.0 percent. Inflation is a component of the rate of return and the salary increase assumptions. The inflation assumption is also used for the cost-of-living adjustment (COLA) assumption. For the inflation assumption, most plans use 3.0 percent to 4.0 percent. The average increase in the consumer price index (CPI) from 1926 through 2007 was 3.17 percent. The payroll growth assumption is typically in the 3.0 percent to 5.0 percent range and is equal to the inflation assumptions plus productivity gains typically in the 0.0 percent to 1.5 percent range. The payroll growth assumption is used in the calculation of the amortization payment for plans using the level percent of pay method. The salary increase assumption is equal to the inflation assumption plus assumed productivity increase plus merit increases. The merit increase assumptions vary by years of service, with greater merit increases typically assumed earlier in the career.

**Actuarial Cost Methods**

The most common actuarial cost method, EAN, is a method of splitting the present value of benefits (PVB) into the actuarial accrued liability (AAL) and the present value of future normal costs (PVFNC). The AAL is based on projected pay and current service. The method

defines the normal cost as a level percent of pay from entry age until retirement. EAN generally puts more of the liability into the AAL and less into PVFNC than other methods.

The second most common method, the projected unit credit (PUC) cost method, is also a method of splitting the PVB into the AAL and the PVFNC is based on projected pay and current service. The normal cost for each member increases as the member approaches retirement age. PUC generally puts less of the liability into the AAL and more into the PVFNC than EAN.

The traditional UC method is not suited for pay-related plans. UC is a method of splitting the PVB into the AAL and the PVFNC where the AAL is based on current pay and service. The NC for each member increases significantly as the member approaches retirement age. UC puts significantly less of the liability into the AAL and more into the PVFNC than EAN and PUC. UC is reasonable for plans with benefits that are based on dollar amounts rather than percentages of pay, for frozen plans, or for plans with no active members.

The aggregate method is used less often. The aggregate method sets the AAL equal to the AVA so there is no UAAL. All of the cost comes from the PVFNC, there is no amortization of the UAAL. With the AAL set equal to the AVA, there is an implied funding ratio of 100 percent unless disclosed using another method.

**Asset Methods**

To determine the AVA, most plans use a five-year smoothing period and others use the market value of assets (MVA) or a different smoothing period. The MVA is the value at which assets could be traded on the market. The AVA is used for actuarial valuation and could be the MVA or a smoothed value. A smoothed value phases-in gains and losses to reduce volatility.

The AVA is used to calculate the unfunded actuarial accrued liability (UAAL) using the formula: AAL - AVA = UAAL. By smoothing the effect of short-term volatility in the MVA, short-term asset gains and losses recognized over a period of years and the resulting smoothed value is subject to corridor around the MVA, such as ± 20 percent.

The AVA is equal to the MVA plus deferred losses minus deferred gains. A reasonable asset method must recognize differences from the MVA in a sufficiently short period and must produce an AVA within a sufficiently narrow range around the MVA. Almost all plans limit smoothing to a maximum of five years with a corridor not outside of 80 percent to 120 percent.

**Amortization Methods**

The amortization method is the process for making payments on the unfunded actuarial accrued liability (UAAL). For the plans with an amortization method, most use a level percentage of payroll and others use a level dollar method. The level dollar method produces a greater amortization amount than the level percent method.

A common amortization method is to recalculate the amortization period with each valuation. The recalculated amortization period method starts with the contribution rate as a percent of pay and calculates a normal cost (NC) rate, then the difference between the contributions and the normal cost determines the funding period for the amortization of the unfunded actuarial accrued liability (UAAL). In theory, the recalculated period would decrease by one each year, but in many cases the amortization period has decreased by less than a year or in some instances, even increased. The recalculated basis is used by most plans.

For plans that do not recalculate the amortization period each year, most use an open basis and others use a closed basis. An open-amortization period or open basis for determining the amortization period resets the period with each valuation. A closed amortization period or closed basis uses a fixed period that decreases by one each year. The period is 30 years for the annual required contribution (ARC) under GASB No. 25.

Most plans recalculate the amortization period with each valuation based on the current level of contributions. Other plans use the level percent open method that can result in perpetual negative amortization or the level dollar open method that can result in the UAAL never being completely amortized. A few plans use the level percent closed method that results in negative amortization for the first part of the schedule or the level dollar closed method that results in a decreasing UAAL that becomes fully amortized.

**Summary of Traditional Actuarial Funding Methods**

The actuarial methods and assumptions used by a typical public plan are the entry age normal (EAN) cost method, five-year smoothing to determine the actuarial value of assets (AVA), an 8 percent investment return assumption, and a 4 percent payroll growth assumption. The most common amortization method uses a level percent of pay with a recalculated amortization period. Using the recalculated basis, the amortization period is recalculated each time a new actuarial valuation is performed based on the contributions available to amortize the UAAL. Public pension plans use conventional approaches based on sound actuarial methods.

## Suggested Improvements to Traditional Methods[13]

Most public plans are in good shape and traditional actuarial methods seem to work relatively well under many conditions. The traditional methods may not be sufficient in all cases, such as when the funded percentage falls below 60 percent. To strengthen these plans, there's a need for rules that require plan sponsors to make progress toward full funding without actually mandating it.

For mature public plans that are less than 60-percent funded, the amortization payment should be based on a descending period, with a minimum payment of the interest on the unfunded actuarial accrued liability (UAAL). As a starting point for discussion, consideration should be given to requiring an overriding minimum contribution (OMC) and a recommended contribution that is the greater of the amount determined using traditional actuarial methods and the OMC. To ensure that public pension plans are more accurately reviewed for fiscal soundness, improvements are recommended for regulating cost, asset and amortization methods.

The cost method should calculate liabilities on a projected basis, including pay increases and cost-of-living adjustments (COLAs). It should calculate benefits on a projected basis and reflect all plan provisions in the liability calculations. Unlike projected-unit-credit and entry-age-normal methods, the unprojected unit-credit method doesn't reflect projected benefits in the liability and isn't a reasonable actuarial cost method for ongoing pay-related plans with active members. Any method that excludes benefit features such as a deferred retirement option plans,

[13] McCaulay, Philip Martin. *"Funding Public Pension Plans,"* Contingencies, January-February 2009, pp.50-54.

overtime included in the benefit calculation, or regularly granted COLAs shouldn't be considered reasonable. It would be preferable to have liabilities for contingent COLAs based on investment gains are included in the liabilities for funding purposes. If they are not included for funding purposes, the liability for contingent COLAs should still be calculated and disclosed.

The asset method should minimize the smoothing of investment gains and losses. I would recommend limiting the period for smoothing gains and losses to five years, and setting the value range from 80 to 120 percent of market value.

**Avoiding Perpetual Negative Amortization**

The amortization method should be regulated to provide for amortization of the UAAL over a closed or fixed period or by a fixed date, rather than allowing unlimited restarts of the amortization period. The amortization method required under the Employee Retirement Income Security Act (ERISA) of 1974 is level dollar amortization over a fixed period. This section of ERISA does not apply to public plans.

Traditional public plan amortization methods work for closed groups, but the payroll growth assumption in open groups combined with constant resetting of the amortization period can lead to perpetual negative amortization in which payments are never sufficient to pay the interest on the UAAL. This is analogous to a nontraditional mortgage product in which a borrower makes payments that are less than the interest, except that the mortgage has a property serving as collateral for the debt while the UAAL has no such underlying asset. Also, most

mortgages that did allow negative amortization had limits. Many of these mortgages only allowed negative amortization for five years or less and had terms to recast the payment to a fully amortizing schedule if the principal grew to a pre-specified amount, such as 110 to 125 percent of the original balance.

For actuarial soundness, funding of the UAAL should be level or declining as a percent of payroll. The intention of an amortization method is to have methods that make progress on funding the UAAL, not to allow methods that result in the UAAL continuing to increase to infinity. The most common amortization method is based on a level percent of payroll over an open period that can be reset with each valuation. This can lead to perpetual negative amortization of the UAAL - a situation in which the payments made to amortize the UAAL are never sufficient to pay the interest on the UAAL.

In the following example of perpetual negative amortization in a pension plan, the negative amortization is allowed to continue for at least 30 years, thereby allowing the UAAL to grow to 186 percent of the original balance.

**TABLE 2**
**Negative Amortization Example**

## Perpetual Negative Amortization

| Year | UAAL (millions) | Amortization Amt. (millions) |
|---|---|---|
| **0** | **$100** | **$5.5** |
| **10** | **$123** | **$6.7** |
| **20** | **$151** | **$8.3** |
| **30** | **$186** | **$10.2** |

- Example of perpetual negative amortization: 8% interest, amortization period reset each year
- Initial UAAL = $100 million, 30-year amortization, payroll increases 4% per year

In order to avoid the increased possibility of a perpetual negative amortization, it is recommended that the amortization method be regulated. Rather than allowing a period to be reset each valuation, a fixed period or a specific date should be set for an amortization period. For example, instead of an open or rolling 30-year amortization, with the ability to reset the period to 30 years every year in the future, the method should be based on a closed or fixed 30-year period, or amortized to a specified year in the future.

This change would require additional considerations regarding the amortization method going forward. There would need to be consideration on the treatment of new bases for plan changes and gains and losses after the initial period was set, for example, new amounts could be rolled into the remaining initial UAAL base and amortized over the remaining period, or new bases could be established with new closed amortization periods for those bases. There would need to be consideration regarding at what point, if any, the method could be allowed to be changed to a rolling period, such as when the remaining amortization period gets down to the 10- to 15- year range.

**Developing the Overriding Minimum Contribution (OMC)**

Contributing either the annually required contribution (ARC) or the recommended contribution under traditional actuarial methods will not necessarily ensure a plan's actuarial soundness. Guidance from the Governmental Accounting Standards Board and the Actuarial Standards Board allows for methods and assumptions that can result in no progress being made on the amortization of the UAAL and a deterioration of the plan's funded ratio.

Instead, it is recommended that all contributions be tested against an OMC calculation (and that this calculation be applied automatically to all plans that are less than 60 percent funded). Doing this, plans could avoid unreasonable payroll growth assumptions and perpetual negative amortization from the extension or resetting of amortization periods. Because it would use the market value of assets (MVA), it would avoid the distortions caused by excessive smoothing of investment gains and losses. An OMC calculation that is independent of amortization and asset-smoothing methods can also help preserve funded ratios. The proposed required contribution would be the greater of the amount determined using traditional methods and the OMC.

For example, the OMC for a public pension plan can be expressed as a function of the normal cost (NC), the beginning-of-year funded ratio (FR), and the expected annual current year benefit payments (BP), as shown below:

**TABLE 3**
**The Overriding Minimum Contribution (OMC)**

| **Funded Ratio (*FR*)** | **Overriding Minimum Contribution (*OMC*)** |
|---|---|
| **$0\% \leq FR < 50\%$** | ***NC* + *BP*** |
| **$50\% \leq FR$** | ***NC* + [(1 – *FR*) / *FR*] *BP*, not less than 0** |

The OMC is the NC plus the FR factor times the BP. The FR factor is the ratio of one minus the FR divided by the FR, with a maximum of one. The NC and expected BP would include interest adjustments to match the timing of the contributions. The FR would be based on the ratio of the MVA to the actuarial accrued liability (AAL).

The formula for the OMC is derived by assuming that, when the FR is less than 100 percent, the rate of asset growth should equal or exceed the rate of liability growth to avoid an actuarially unsound scenario. The ratio of the expected MVA at the end of the year, MVA1, to the MVA at the beginning of the year, MVA0, must be greater than the ratio of the expected AAL at the end of the year, AAL1, to the AAL at the beginning of the year, AAL0.

The assets are increased for net investment earnings (i) and contributions (CONTRIB), and reduced for BP. The liabilities are increased for interest at the same rate as the assets (i) plus the NC, and reduced for the BP. The FR is the ratio of the beginning of year assets to liabilities, $MVA_0$ divided by $AAL_0$.

(1) $MVA_1 / MVA_0 \geq AAL_1 / AAL_0$

(2) $MVA_1 = MVA_0 (1+i) + CONTRIB - BP$

(3) $AAL_1 = AAL_0 (1+i) + NC - BP$

(4) $FR = MVA_0 / AAL_0$

Substituting equations (2) and (3) into equation (1) produces the following results.

(5) $[MVA_0 (1+i) + CONTRIB - BP] / MVA_0 \geq [AAL_0 (1+i) + NC - BP] / AAL_0$

(6) $(1+i) + [CONTRIB - BP] / MVA_0 \geq (1+i) + [NC - BP] / AAL_0$

(7) $[CONTRIB - BP] / MVA_0 \geq [NC - BP] / AAL_0$

Substituting a rewritten equation (4) into equation (7) produces the following results.

(8) $MVA_0 = (FR) (AAL_0)$

(9) $[CONTRIB - BP] / [(FR) (AAL_0)] \geq [NC - BP] / AAL_0$

(10) $[CONTRIB - BP] \geq (FR) [NC - BP]$

(11) $CONTRIB \geq (FR) [NC - BP] + BP$

(12) $CONTRIB \geq (FR) (NC) - (FR) (BP) + BP$

(13) $CONTRIB \geq (FR) (NC) + (1 - FR) (BP)$

To determine the OMC, formula (13) is normalized by dividing the right side of the equation by the FR, so that for a plan that is 100-percent funded, the OMC is still just the NC. This formula will make the funded ratio gradually converge toward 100 percent over time.

(14) $OMC = (NC) + [(1 - FR) / FR] (BP)$

The formula for the OMC is subject to the constraints that the result is not less than zero for plans with relatively high FRs and not greater than NC plus BP for plans with FRs of 50 percent or less.

The formula with the constraints is summarized below:

Overriding Minimum Contribution (OMC)

$OMC = NC + BP$ where $0\% \leq FR < 50\%$;

$OMC = NC + [(1 - FR) / FR]\ BP$, not less than \$0, where $50\% \leq FR$

$\$0 \leq OMC \leq NC + BP$

For example, a plan with \$2 million in liabilities and a market value of assets of \$1 million is 50-percent funded at the beginning of the year. Suppose the NC is \$100,000, the BP are \$200,000, the cash flows are at the beginning of the year, the interest rate assumption is 8 percent, and the contributions determined under traditional methods are \$140,000. The FR would be expected to decline to 49 percent at the end of the year, based on an AAL1 of \$2,052,000 and the MVA1 of \$1,015,200. Using the OMC of \$300,000, the NC plus the BP for a plan 50 percent funded, the expected FR would be 58 percent, based on an AAL1 of \$2,052,000 and the MVA1 of \$1,188,000.

Using the same numbers as the previous example but with starting assets of \$1.6 million and contributions determined under traditional methods of \$110,000, the FR would be expected to decline from 80 percent to 79 percent at the end of the year, based on an AAL1 of \$2,052,000 and the MVA1 of \$1,630,800. Using the OMC of \$150,000, the NC plus 25 percent of the BP for a plan 80 percent funded, the expected FR would be 82 percent, based on an AAL1 of \$2,052,000 and the MVA1 of \$1,674,000.

The following tables show examples of the OMCs for plans with the same NC and BP, but with different FRs.

**TABLE 4**
**Example of OMC Calculations When BP > NC**

| NC | Expected BP | FR | FR Factor | OMC |
|---|---|---|---|---|
| $1,000,000 | $2,000,000 | 50% | 100.0% | $3,000,000 |
| $1,000,000 | $2,000,000 | 60% | 66.7% | $2,333,333 |
| $1,000,000 | $2,000,000 | 70% | 42.9% | $1,857,143 |
| $1,000,000 | $2,000,000 | 80% | 25.0% | $1,500,000 |
| $1,000,000 | $2,000,000 | 90% | 11.1% | $1,222,222 |
| $1,000,000 | $2,000,000 | 100% | 0.0% | $1,000,000 |
| $1,000,000 | $2,000,000 | 110% | -9.1% | $ 818,182 |
| $1,000,000 | $2,000,000 | 120% | -16.7% | $ 666,667 |

**TABLE 5**
**Example of OMC Calculations When BP = NC**

| NC | Expected BP | FR | FR Factor | OMC |
|---|---|---|---|---|
| $1,000,000 | $1,000,000 | 50% | 100.0% | $2,000,000 |
| $1,000,000 | $1,000,000 | 60% | 66.7% | $1,666,667 |
| $1,000,000 | $1,000,000 | 70% | 42.9% | $1,428,571 |
| $1,000,000 | $1,000,000 | 80% | 25.0% | $1,250,000 |
| $1,000,000 | $1,000,000 | 90% | 11.1% | $1,111,111 |
| $1,000,000 | $1,000,000 | 100% | 0.0% | $1,000,000 |
| $1,000,000 | $1,000,000 | 110% | -9.1% | $ 909,091 |
| $1,000,000 | $1,000,000 | 120% | -16.7% | $ 833,333 |

The OMC results in a funded ratio (FR) that converges toward 100 percent. As a minimum, underfunded plans should make contributions that increase the FR. Overfunded plans should not be required to maintain their overfunded status and should be allowed to make contributions that are less than the normal cost (NC). Plans with 100 percent FRs should contribute the NC to remain 100-percent funded.

This formula was developed to make sure that the contribution doesn't allow the funded ratio to deteriorate for plans with unfunded liabilities. As a starting point for discussion, consideration should be given to making the recommended contribution for funding purposes subject to an OMC calculation.

**Funding Target**

It's not necessary to target 100 percent funding as the ultimate goal. The UAAL amortization period doesn't need to descend to zero but could descend for 10 years and then become a rolling 10-year amortization period.

There are several reasons for not funding at the 100 percent level. When a plan is below 100 percent funding, there's no question about ownership of any excess. The contributions carry through the plan to cover the last remaining member. Who really owns any surplus in a public plan is not clear. At one extreme, there is the "last man standing" philosophy held by a few individuals, with the belief that the last retiree or survivor alive in pay status gets what is left over. There is also the belief that any surplus would go to the plan sponsor, but these are contributory plans, so the surplus would need to be shared with the members in a manner that is proportionate to the contributions. The administration of any surplus-sharing calculations would be very complex. Also, pressure to improve benefits once the funded ratio is 100 percent or greater can reduce a plan sponsor's interest in increasing the funding. Full funding allows plan sponsors and members to take a contribution holiday. As funding levels improve, there is less pressure to offer the same level of contributions. When an employer has a contribution holiday,

the money is routed to other projects. When that money is required again for a pension system, it creates friction with other priorities. The marginal utility of each dollar must then be weighed against the pension needs and the needs of the competing project. Given these issues, fully funding a plan is not the ultimate goal. Instead, the real objective is placing the plan on a firm financial and actuarial footing. It is recommended that plan sponsors be required to make progress toward 100-percentfunding, without requiring them to 100-percent fund.

**Selecting a Best-Estimate Range for the Investment Return**[14]

The net real rate of return assumption is typically in the 4.5 percent to 5.5 percent range. The interest rate assumption is the sum of the inflation assumption and the net real rate of return. It is not reasonable to add the estimates at the high end or the low end of the ranges. The interest rate assumption is typically in the 7.5 percent to 8.5 percent range, net of investment expenses. A lower interest rate assumption will typically *increase* liabilities. A higher interest rate assumption will typically *decrease* liabilities.

There are differences of opinion about the correct capital market assumptions, and whether the forecasted equity risk premium will materialize. While there is general agreement on the expected return on fixed income investments, there is a wide range of opinions about future expected returns on equities.

[14] McCaulay, Martin, FSA, EA, MAAA, "Selecting a Best-Estimate Range", response to the Actuarial Standards Board's Requests for Comments on ASOP 27, March 31, 2008.

Warren E. Buffett wrote the following observation about pension plan investment assumptions in the Berkshire Hathaway Inc. 2007 Annual Report.[15]

> *I should mention that people who expect to earn 10 percent annually from equities during this century – envisioning that 2 percent of that will come from dividends and 8 percent from price appreciation – are implicitly forecasting a level of about 24,000,000 on the Dow by 2100. If your adviser talks to you about double-digit returns from equities, explain this math to him – not that it will faze him. Many helpers are apparently direct descendants of the queen in Alice in Wonderland, who said: "Why, sometimes I've believed as many as six impossible things before breakfast." Beware the glib helper who fills your head with fantasies while he fills his pockets with fees.*

Buffet points out that the annual compounded gain on price appreciation in the Dow Jones Industrial Average in the 20th century was 5.3 percent and dividends continue to run around 2 percent. Allowing for expenses of 0.5 percent, Buffet concludes that equities would produce no more than a 7 percent nominal return. An unrealistically high investment return assumption results in inadequate funding.

When Bader and Gold apply the theory of financial economics to actuarial science, the conclusion is that the interest rate used to discount the pension liabilities should be based on a

[15] The Berkshire Hathaway Inc. 2007 Annual Report is available at: http://www.berkshirehathaway.com/2007ar/2007ar.pdf. The discussion of pension plan assumptions is on pages 18-20.

rate appropriate for the underlying liabilities and not on the asset mix[16]. Bader and Gold state that selecting an interest rate based on the asset mix incorrectly includes the equity risk premium in the liability discount rate.

Gold presents an example in which a public pension plan lowers costs by changing the asset mix to include more equities, lowering the liabilities and the contribution requirements, a scenario in which the plan sponsor, the plan members, and the actuary all appear to win. Gold points out that it is the taxpayer who ends up paying the extra cost of understating public pension plan liabilities.[17]

The challenge is to find the appropriate balance between costs assigned to current taxpayers and costs assigned to future taxpayers. Using too high of an interest rate understates pension liabilities, and the result is future taxpayers paying for a relatively greater share of the costs compared to current taxpayers. Using too low of an interest rate would overstate pension liabilities, and the result would be current taxpayers paying for a relatively greater share of the costs compared to future taxpayers. The selection of the interest rate needs to be balanced to consider intergenerational equity.

Actuarial Standard of Practice No. 27, *Selection of Economic Assumptions for Measuring Pension Obligations*, defines the best-estimate range as the narrowest range within which the actuary can reasonably anticipate that the actual results, *compounded* over the measurement

[16] Bader, Lawrence N. and Jeremy Gold, "Reinventing Pension Actuarial Science," *The Pension Forum*, Volume 15, Number 1 January 2003, available at: http://www.soa.org/library/newsletters/pension-forum/2003/january/pfn0301.pdf.

[17] Gold, Jeremy. 2003. "Risk Transfer in Public Pension Plans," *The Pension Challenge: Risk Transfers and Retirement Income Security* eds.: O.S. Mitchell, K. Smetters, Chapter 6.

period, are most likely to fall. The recommendation is to determine the long-term compounded annual rate of return by taking the expected arithmetic annual return and adjusting it for variance drain or volatility drag, resulting in a reduction of about one-half of the variance. [18]

Risk is measured using the standard deviation. Using the standard deviation of a portfolio, a best-estimate range of the long-term compounded rate of return would be developed and expressed as a range between the 25th and 75th percentiles of the expected results, with the range around the expected compounded return plus or minus one-tenth of the standard deviation. The single-point estimate is then selected from within this range.

**Approximate Best-Estimate Range of Annual Compounded Rate of Return =**

**Expected Annual Return – [Variance / 2] ± [Standard Deviation / 10]**

$= \mu_p - .5\ \sigma_p^2 \pm [\sigma_p / 10]$

For example, suppose a portfolio with mix of 50-percent domestic equities and 50-percent domestic fixed income has an expected arithmetic annual return of 7.50 percent and a standard deviation for the portfolio of 10 percent. The approximate expected annual compounded rate of return is $\mu_p - .5\sigma_p^2$, or 7.50% - [.5 $(10\%)^2$], which is 7.00 percent. The approximate best-estimate range is $\mu_p - .5\sigma_p^2 \pm [\sigma_p / 10]$, or 7.00% ± [10% / 10], which is a range of 6.00 percent to 8.00 percent.

[18] The variance is the standard deviation squared ($\sigma^2$).

Just as the geometric mean is less than the arithmetic mean when the returns are not identical, the compounded return is lower than the expected annual return because of volatility. The reasons for the volatility drag are explained in an article by James D. MacBeth.[19] The variance drain would be about half the variance of the portfolio. For example, a sample portfolio of 100-percent equities with an annual expected rate of return of 10.0 percent and a standard deviation of 20 percent will have variance drain of about 200 basis points, and the compounded expected return is about 8.0 percent. Exact formulas for the compounded return after adjusting for the variance drain were developed by de La Grandville.[20]

To improve on the estimate for the variance drain, a factor of 0.46 could be used instead of one-half. Using the 0.46 factor reproduces the results from the exact formula developed by de La Grandville within about two basis points for portfolios with standard deviations less than 17 percent. Standard deviations that are greater than 17 percent are found in portfolios that are more than 90 percent invested in equities, an uncommon occurrence in pension funds.

**Figure 1**
**Formula for Rate of Return**

**Annual Compounded Rate of Return =**

**Expected Annual Return – [0.46 (Variance)]**

$= \mu_p - 0.46\ \sigma_p^2$

[19] MacBeth, James D. (1995). "What's the Long-Term Expected Return to Your Portfolio?" *Financial Analysts Journal* September/October 1995, Vol. 51, No. 5: 6-8.

[20] de La Grandville, Olivier (1998). "The Long-Term Expected Rate of Return: Setting It Right." *Financial Analysts Journal*, Vol. 54:No. 6, 75-80.

For example, a sample portfolio of 100 percent equities with an annual expected rate of return of 10 percent and a standard deviation of 20 percent would have variance drain of about 200 basis points, and the compounded expected return would be about 8.2 percent before expenses.

The best-estimate range of the expected return is the range in which the results are more likely to fall.[21] This is the range from the 25th to 75th percentile, or the inter-quartile range. The inter-quartile range would be constructed using the long-term expected standard deviation, which will decrease over time. The inter-quartile range for the 50-year compounded rate of return would be the return plus or minus the standard deviation, divided by 10.

A formula exists for the amount of reduction in the standard deviation over time.[22] After 50 trials, the standard deviation will be reduced by dividing the original standard deviation by $50^{1/2}$. Using Chebyshev's theorem, the half of the results that fall in the inter-quartile range must be within $1/(2^{1/2})$ standard deviations of the mean. [23] This is similar to the result for a normal distribution where 50 percent of the results are within about 0.7 standard deviations from the mean. The formula for the corridor for the inter-quartile range after 50 years is one divided by the product of $50^{1/2}$ times $2^{1/2}$, or one divided by $100^{1/2,}$ $100^{1/2}$ equals 10.

[21] Actuarial Standard of Practice No. 27 (ASOP 27), Selection of Economic Assumptions for Measuring Pension Obligations, Section 2.1.
[22] Chuli, Roy M. *Quantitative Analysis: An Introduction*. CRC Press, 1999, p. 424.
[23] No more than $1/k^2$ of the values are more than $k$ standard deviations away from the mean.

Based on the asset mix, the expected compounded-return assumption before expenses can be developed by taking the expected annual return and subtracting about one-half, or 0.46, of the variance[24]. The inter-quartile range can be developed by using a corridor within one-tenth of a standard deviation around the expected compounded return.

**Figure 2**

**Formula for Return Range**

**Best-Estimate Range of Annual Compounded Rate of Return =**

**Expected Annual Return – [0.46 (Variance)] ± [Standard Deviation / 10]**

$= \mu_p - 0.46\ \sigma_p^2 \pm [\sigma_p / 10]$

For example, for a sample portfolio with 60 percent in equities and 40 percent in fixed-income investments, with an annual expected return of 8 percent, a standard deviation of 12 percent, and expenses of 30 basis points, the net expected compounded return is in the 5.8 to 8.2 percent range, with a best-estimate of about 7 percent.

The following table shows the best-estimate range for real rates of return, the range between the 25th and 75th percentiles, for sample portfolios of various equity and fixed-income mixes. These amounts are before subtracting expenses.

[24] The variance is the standard deviation squared ($\sigma^2$).

**TABLE 6**
**Real Rate of Return Ranges**

| Equity Percent | Fixed Income Percent | Arithmetic Annual Real Return | Standard Deviation | 25th Percentile Annual Real Return | Expected Compounded Annual Real Return | 75th Percentile Annual Real Return |
|---|---|---|---|---|---|---|
| 1% | 99% | 0.8% | 0.8% | 0.7% | 0.8% | 0.9% |
| 10% | 90% | 2.2% | 3.1% | 1.9% | 2.2% | 2.5% |
| 20% | 80% | 3.3% | 5.2% | 2.7% | 3.2% | 3.7% |
| 30% | 70% | 3.8% | 6.8% | 2.9% | 3.6% | 4.3% |
| 40% | 60% | 4.3% | 8.5% | 3.1% | 4.0% | 4.8% |
| 50% | 50% | 4.8% | 10.3% | 3.3% | 4.3% | 5.4% |
| 60% | 40% | 5.3% | 12.1% | 3.4% | 4.6% | 5.8% |
| 70% | 30% | 5.8% | 14.0% | 3.5% | 4.9% | 6.3% |
| 75% | 25% | 6.0% | 15.0% | 3.5% | 5.0% | 6.5% |
| 80% | 20% | 6.2% | 15.7% | 3.5% | 5.0% | 6.6% |
| 90% | 10% | 6.5% | 17.0% | 3.5% | 5.2% | 6.9% |
| 100% | 0% | 7.0% | 19.2% | 3.4% | 5.3% | 7.2% |

For a portfolio with 75 percent in equities and 25 percent in fixed income, the arithmetic annual real return for the portfolio is 6.0 percent and the standard deviation is 15.0 percent. Using these assumptions, the expected compounded annual real return is 5.0 percent, with a best-estimate range of 3.5 percent to 6.5 percent before expenses.

Investment expenses need to be subtracted from the expected return to produce the net return. Total expenses for defined-benefit plans are typically about 30 basis points, or 0.3 percent of plan assets.[25] Rebalancing the portfolio can add a premium to the return if the assets have very low correlations.[26] The reduction from variance drain can theoretically be partially offset by rebalancing the portfolio.

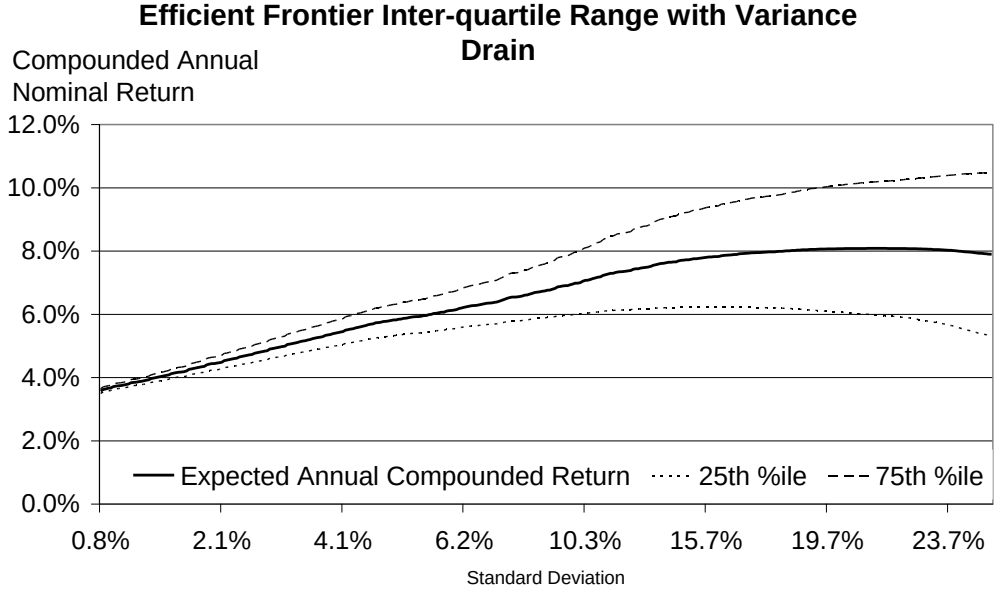
[25] Source: Center for Retirement Research at Boston College, "Why Have Some States Introduced Defined Contribution Plans?," January 2008.

[26] Stein, David, Ph.D., Parametric Portfolio Associates, "Structuring Emerging Market Portfolios for Long-Term Growth," presentation to Texas Association of Public Employee Retirement Systems, March 15, 2008.

The following efficient frontier graph is based on the Callan Associates 2008 capital market assumptions.[27] The graph shows the efficient frontier after adjusting for variance drain, with the expected annual compound return on the x-axis and the standard deviation on the *y*-axis. The inter-quartile range is shown by using a corridor of one-tenth of the standard deviation around the expected compounded annual return.

The returns shown are before subtracting expenses. As the volatility increases, the compounded return peaks then starts to decrease, as the volatility drain from the extra risk reduces the expected return to be below that of less risky portfolios.

**Figure 3**
**Efficient Frontier with Variance Drain**




Note: Data created using 2008 capital market assumptions from Callan Associates, adjusted for variance drain.
Source: Texas Pension Review Board

[27] Callan Associates provided their 2008 capital market assumptions to the Employees' Retirement System of Texas (ERS) on Feb. 26, 2008. Callan Associates used an inflation assumption of 2.75 percent. The average CPI increase for 1927 through 2006 was 3.2 percent.

The expected net annual compounded rate of return and best-estimate ranges for sample pension fund portfolios of 50 percent to 100 percent equities and 50 percent to 0 percent in fixed income investments are shown below, after subtracting assumed investment expenses of 30 basis points. For example, for a sample portfolio with 60 percent in equities and 40 percent in fixed income investments, with an annual expected return of 8.0 percent and a standard deviation of 12.0 percent, the net expected compounded return is in the 5.8-percent to 8.2-percent range, with a best-estimate of about 7.0 percent. The expected net annual compounded rate of return for the sample pension fund portfolio of 100-percent equities and 0-percent fixed income investments, with an annual expected return of 10.0 percent and a standard deviation of 20.5 percent is in the 5.7-percent to 9.8-percent range, with a best-estimate of about 7.8 percent.

**TABLE 7**
**Net Compounded Rate of Return Ranges**

| Equities | Fixed Income | Annual Expected Return Before Expenses | Standard Deviation | Expected Net Compounded Return | Best-Estimate Range |
|---|---|---|---|---|---|
| 50% | 50% | 7.6% | 10.4% | 6.8% | 5.7% to 7.8% |
| 60% | 40% | 8.0% | 12.0% | 7.0% | 5.8% to 8.2% |
| 70% | 30% | 8.5% | 14.0% | 7.3% | 5.9% to 8.7% |
| 80% | 20% | 8.9% | 15.7% | 7.5% | 5.9% to 9.1% |
| 90% | 10% | 9.2% | 17.0% | 7.6% | 5.9% to 9.3% |
| 100% | 0% | 10.0% | 20.5% | 7.8% | 5.7% to 9.8% |

## Conclusions and Recommendations

To sum up, there should be consideration for making the recommended contribution for funding public plans subject to an OMC calculation. When determining the actuarial value of assets, the recommendation is to limit the period for smoothing gains and losses and limiting the corridor or range around the market value to prevent excessive smoothing from distorting the results. Regarding actuarial cost methods, all of the plan provisions should be reflected in the liabilities. The OMC would be sufficient to keep plans progressing toward full funding.

Public pension plans need oversight in regard to their actuarial soundness. The methods used to examine and calculate assets need to be regulated to avoid cost methods that exclude material liabilities, asset methods that allow for excessive smoothing, and amortization methods that allow perpetual negative amortization and amortization payments that are less than the interest on the UAAL.

The amortization method should provide for amortizing the UAAL over a closed or fixed period or by a fixed date, because otherwise the UAAL is allowed to grow until infinity and the responsibility for paying it is passed on to future taxpayers. The point is to make progress on funding the UAAL, not to allow it to grow to infinity. This would also mean limiting restarts of the amortization period. The best estimate for the net investment return assumption should include a reduction for the volatility drag on the long-term expected return and a reduction for the expenses paid out of the plan assets. Based on the asset mix, the expected compounded return assumption before expenses can be developed by taking the expected annual return and

subtracting about one-half, or 0.46, of the variance. The inter-quartile range can be developed by using a corridor within one-tenth of a standard deviation around the expected compounded return. Rather than applying the theory of financial economics for funding public plans, it would be more appropriate to continue to use the traditional methods with improvements to the amortization methods and the investment return assumption selection process.

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## Appendix I – Capital Market Assumptions

The portfolio arithmetic annual returns and standard deviations used in this paper were derived using data on individual asset classes from the Callan Associates 2008 capital market assumptions.[28]

**TABLE 8**
**2008 Capital Market Assumptions**

| Asset Class | Annual Nominal Return | Annual Real Return | Standard Deviation | Yield |
|---|---|---|---|---|
| Broad Domestic Equity | 9.00% | 6.25% | 16.90% | 2.10% |
| Large Cap | 8.85% | 6.10% | 16.40% | 2.20% |
| Small/Mid Cap | 9.85% | 7.10% | 22.70% | 1.20% |
| International Equity | 9.00% | 6.25% | 19.20% | 2.00% |
| Emerging Markets Equity | 9.60% | 6.85% | 31.20% | 0.00% |
| Domestic Fixed | 5.25% | 2.50% | 4.50% | 5.25% |
| Defensive | 4.00% | 1.25% | 2.30% | 4.00% |
| TIPS | 4.90% | 2.15% | 6.00% | 4.90% |
| High Yield | 7.00% | 4.25% | 11.50% | 7.00% |
| Non U.S.$ Fixed | 5.15% | 2.40% | 9.60% | 5.15% |
| Real Estate | 7.60% | 4.85% | 16.50% | 6.00% |
| Private Equity | 12.00% | 9.25% | 34.00% | 0.00% |
| Absolute Return | 6.50% | 3.75% | 9.70% | 0.00% |
| Cash Equivalents | 3.50% | 0.75% | 0.80% | 3.50% |
| Inflation | 2.75% | | 1.40% | |

[28] Callan Associates provided their 2008 capital market assumptions to the Employees' Retirement System of Texas (ERS) on Feb. 26, 2008. Callan Associates used an inflation assumption of 2.75 percent.

## Appendix II - Expected Return and Standard Deviation

For a given asset mix, the expected annual real rate of return ($\mu$) is the weighted average of the real returns of the included asset classes included.

$$\mu_p = w_1 \mu_1 + w_2 \mu_2$$

For a mix of 60 percent domestic equities and 40 percent domestic fixed income, with expected real returns of 6.25 percent for equities and 2.50 percent for fixed income, the expected annual real rate of return is 60 percent of 6.25 percent plus 40 percent of 2.50 percent, or 4.75 percent.

Expected annual real return: $\mu_p = 60\%(6.25\%) + 40\%(2.50\%) = 4.75\%$

Section 2.2 of ASOP 27 defines inflation as general economic inflation, or price changes over the whole of the economy. The assumed inflation of 2.75 percent is added to the assumed annual real rate of return to get a nominal assumed annual rate of 7.50 percent.

Expected annual nominal return: 4.75% + 2.75% = 7.50%

The formula for the standard deviation ($\sigma$) uses the weighted average of the variances for each class and a term that includes the correlation coefficient ($\rho$).

$$\sigma_p = [w_1 \sigma_1^2 + w_2 \sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2]^{1/2}$$

For a mix of 60-percent domestic equities and 40-percent domestic fixed income, with standard deviations of 16.90 percent for equities and 4.50 percent for fixed income and a correlation coefficient of 0.2, the standard deviation for the portfolio is 13.67 percent.

$$\sigma_p = [60\%(16.90\%)^2 + 40\%(4.50\%)^2 + 2(60\%)(40\%)(0.2)(16.90\%)(4.50)]^{1/2} = 13.67\%$$

Standard deviation = 13.67%

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