POLICY report

Goldwater Institute

No. 236 | March 31, 2010

$50 Billion Tidal Wave: How Unfunded Pensions Could Overwhelm Arizona Taxpayers

By Andrew G. Biggs, resident scholar, American Enterprise Institute

EXECUTIVE SUMMARY

In a period when financial markets and institutions have appeared near collapse, the accounting methods used by public employee pensions effectively ignore risk. These accounting methods, which are used by public pensions in Arizona and around the country, allow pension fund managers to assume that high returns can be earned through stocks and other investments without taking any market risk. As a result, the true market value of Arizona pension shortfalls that must be funded by taxpayers is understated by around half of what the pension funds have reported.

If Arizona's public pension liabilities were priced on a fully risk-adjusted market basis, which most financial economists believe is the best representation of costs to the taxpayer, these plans would be about 41 percent funded, versus the 77 percent level Arizona pension accounting statements report. On a risk-adjusted basis, unfunded public pension liabilities would exceed $50 billion, roughly $8,300 per Arizonan, dwarfing the $10 billion funding shortfall the funds acknowledge. A more accurate depiction of the funding status of Arizona pensions will help policymakers design better public pension policy for the future.

This paper makes three policy recommendations. First, legislators should require that public-sector pensions report the true market value of plan liabilities. So-called actuarial values currently reported by pension plans in Arizona do not truly reflect the risk that premium markets would assign to pension liabilities.

Second, states like Arizona that automatically adjust pension contribution rates based on plan funding measures should set such adjustments according to the fully risk-adjusted market value of plan liabilities, not the actuarial value.

Third, states must shift public-sector pensions toward defined-contribution plans. Under these plans, the government makes contributions to employees' retirement accounts that are managed by employees. This would be the full extent of taxpayer liability to government employees.

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Introduction

A key to good public policy is for policymakers to value resources extracted from the public as much as taxpayers themselves do. Almost any candidate for public office would agree with this principle. Yet economists almost universally argue that accounting methods applied to public-sector pensions work contrary to this view, imposing costs and risks on the public that taxpayers themselves would not choose to take. Alternative methods based on financial economics are more rigorous and make the valuation of public pension liabilities, and the risks that pension managers take through their investment choices, consistent with the views of taxpayers. When viewed through this lens, public pension liabilities are far larger, and their investment policies far riskier, than traditional actuarial techniques would lead one to believe.

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This paper analyzes two perspectives on public pension accounting. The first perspective, variously called the "actuarial method" or "expected-cost analysis," is currently the predominant approach for analyzing public pension financing. The second perspective, called the "financial economics" or "market valuation" approach, originated in the financial world and is posing an aggressive challenge to long-accepted methods.

These two methods differ not only in terms of details and techniques, but more importantly, in terms of the overall goal of analyzing pension financing. The actuarial approach focuses on making a "best guess" of how a pension program's finances will evolve over time. This best guess actually involves a great deal of research regarding the number of employees and retirees, the life expectancies of retirees, survivors and the disabled, and myriad other variables affecting the plan.

But the most important difference from the financial economics approach is how the plan's investment fund is treated. The actuarial approach tries to determine the most likely path for a pension's investment fund — the expected return — and then reports how the pension's finances will evolve if the investments follow the best-guess path. This method, however, does not account for the possibilities of better or worse returns, and better or worse outcomes for the fund.

The financial economics approach relies on the insight from financial markets that, despite the infinite number of ways an investment might play out in the *future*, there nevertheless exists a single best price for that asset *today*. Extrapolating

from this insight, there is a single value that can be ascribed to a public pension's funding status that accounts for uncertainty regarding future investment returns. These market-based valuations generally show much poorer funding levels for public-sector pensions.

The choice between these approaches has significant implications for the reported funding level of public-sector pensions in Arizona and around the country, and thus on important choices facing both policymakers and the public.

Arizona's public-sector pensions - the Arizona State Retirement System (ASRS), the Arizona Public Safety Personnel Retirement System (PSPRS), and the Arizona Corrections Officer Retirement Plan (CORP) - are not poorly funded relative to typical public-sector pensions around the country. But the accounting techniques used in Arizona's pension programs, like public-sector plans nationwide, provide a distorted view of the funding adequacy of these plans. Techniques that show the market valuation of Arizona's pension funding - that is, the costs that financial markets would charge to bear the risks born by ASRS, PSPRS, and CORP - would show these plans to be significantly underfunded; thereby posing a large contingent liability on the state government and the taxpayers of Arizona. Viewed from the market perspective, which is designed to value pension liabilities the way that Arizonans themselves would value these costs, the need for reform of pension financing becomes clear.

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Arizona Public Employee Pensions

Arizona has three main pension plans for public-sector employees. The majority of public employees participate in ASRS. Police, firefighters, and other related professions take part in PSPRS. Prison employees participate in the affiliated CORP. Most references in this paper will be to the ASRS due to its larger size, but points made with reference to ASRS apply qualitatively to PSPRS and CORP as well. Calculations of the market value of pension liabilities are made for all three plans.

The Arizona State Retirement System is the largest state employee pension plan in Arizona. There are currently 548,000 members, including 97,000 retirees, survivors, and disabled beneficiaries. These beneficiaries received $1.9 billion in benefits for the fiscal year ending June 30, 2008.[1]

ASRS was founded in 1953 to provide retirement and disability benefits to state employees. The program was initially modeled after the Arizona State Teacher's Pension, which was active from Arizona's statehood in 1912 until the plan merged with ASRS in 1954. This original plan worked as a defined-contribution plan, in which the state and employees contributed to retirement accounts. In 1971, ASRS

became a defined-benefit plan after the legislature and 80 percent of the membership agreed to the change. ASRS also sponsors a retiree health plan. Today, 36,000 members are enrolled in ASRS-sponsored medical plans and 30,000 in dental plans.

Contribution rates

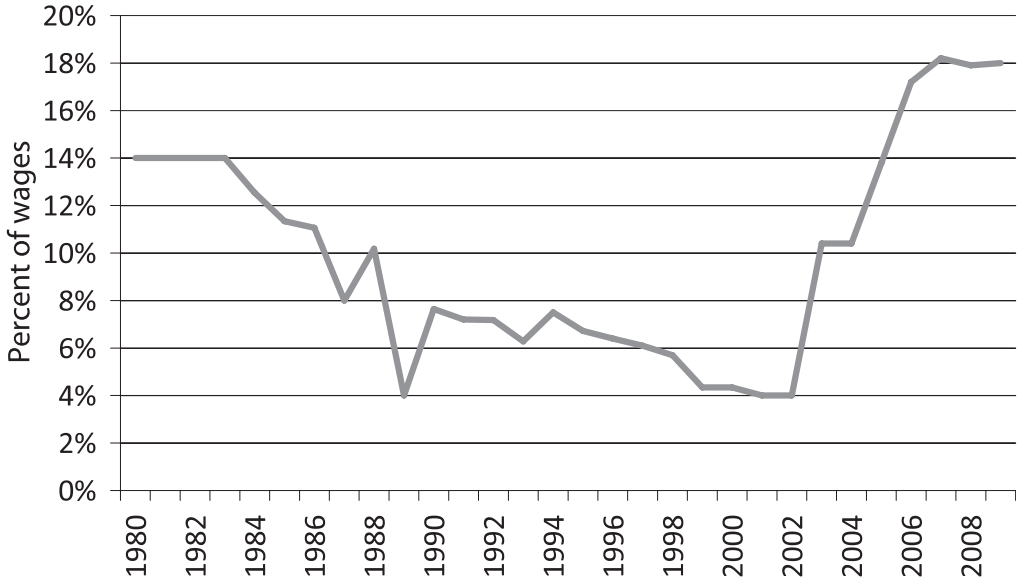
Contributions to ASRS are split evenly between employers and employees. The contribution rate is calculated annually to cover the normal cost of the program, which represents the present value of future benefits generated in that year, plus amortization of the plan's unfunded liability over the next 30 years.

The combined employer/employee ASRS contribution rate for 2009 was 18 percent of pay. This rate has varied significantly over the past three decades, but is projected to remain near current levels in the future. Assuming the workforce remains stable in size, total contribution rates are projected to range between 18 and 20 percent of pay over the next decade.

Arizona's pensions have one feature that may help bring reform over time: as costs increase, employee contributions automatically rise.

Unlike many other states, Arizona's pensions have one feature that may help bring reform over time: as costs increase, employee contributions automatically rise. This does not reduce the plan's large unfunded liabilities; rather, it shifts a part of them to state employees rather than to taxpayers. This produces a generational inequity among plan participants: older workers with more accrued benefits are protected against market downturns, but part of that protection is provided through higher contribution rates required for younger employees with fewer

Figure 1: ASRS Combined Employer/Employee Contribution Rate, 1980-2009



Source: ASRS FY 2008 Financial Report

accrued benefits. There seems little reason that younger workers should pay much higher contribution rates for the same benefits older workers receive.

Retirement age and benefit calculation

ASRS participants are eligible for unreduced retirement benefits:

- at age 65 with any number of years of service;
- at age 62 with 10 or more years of credited service; or
- at any age at which the sum of years of service and age equals 80; an individual beginning work at age 21 and working steadily thereafter, for instance, could retire with unreduced benefits as early as age 51.

In addition, participants age 50 or older with five or more years of service may claim benefits at a reduced level.

The ASRS replacement factor depends upon the number of years of service, ranging from 2.1 percent for individuals with less than 20 years of service to 2.3 percent for individuals with 30 or more years of employment.

In ASRS, like most defined-benefit pensions, benefits are calculated by multiplying the number of years of service by final salary by a percentage replacement factor. For participants who began service prior to 1984, final earnings are equal to the highest 36 consecutive months of earnings in the final 120 months of employment. For participants beginning service in 1984 and later, final earnings equal the highest 60 months of consecutive earnings in the final 120 months of service. The ASRS replacement factor depends upon the number of years of service, ranging from 2.1 percent for individuals with less than 20 years of service to 2.3 percent for individuals with 30 or more years of employment. Benefits under the PSPRS and CORP plans are calculated along similar, though more generous, lines.[2]

Asset management

Oversight and investment policy for Arizona State Retirement System are provided by a nine-member Board of Trustees. In addition, statutes enacted by the Arizona State Legislature require that ASRS make investments in accordance with the "prudent expert" rule. State statutes also stipulate certain constraints on how ASRS funds may be invested.

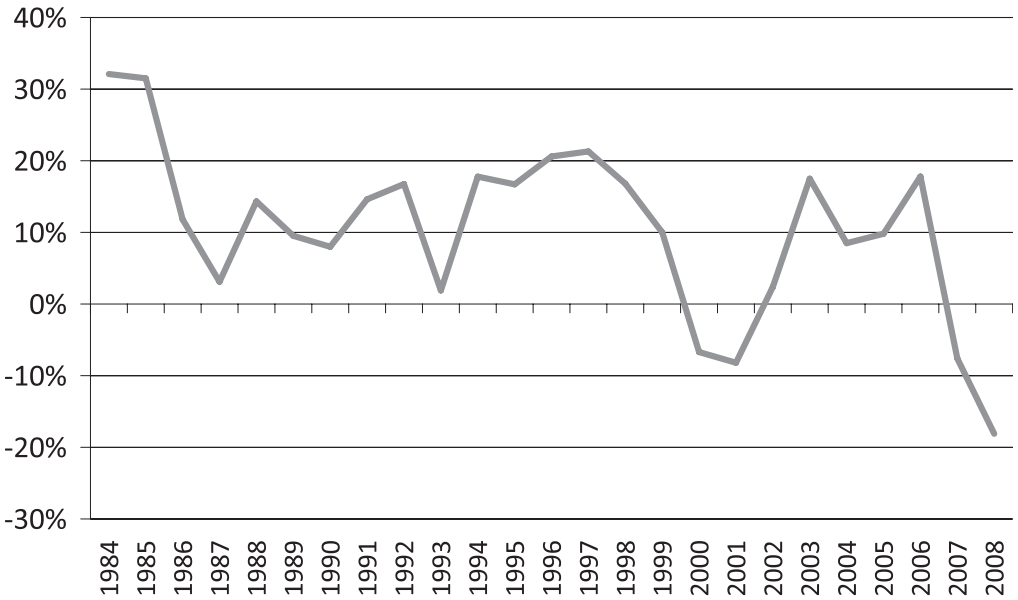
As of June 30, 2009, ASRS assets totaled $20.8 billion. This portfolio is allocated among several asset classes. While the percentage of the portfolio held in each asset class varies from year to year based upon individual investment performance, the ASRS board sets asset allocation targets. Currently, around half of ASRS assets are intended to be invested in U.S. stocks, with the remainder in domestic fixed-income investments, foreign stocks, real estate, and private equity

Table 1: ASRS Portfolio Targets

Asset	Percent of total
U.S. equity	40-50
U.S. fixed income	21-31
International equity	13-30
Real estate	4-8
Private equity	3-7

Source: Arizona State Retirement System, Comprehensive Annual Financial Report for Fiscal Year Ended June 20, 2008 (2008).

Figure 2: ASRS Annual Returns, Fiscal Years 1984-2008



Source: 2009 ASRS FY 2008 Financial Report

Including the effects of inflation, the real compound annual return equals approximately 6.7 percent. For the future, ASRS assumes a nominal investment return of 8 percent.

investments. The latter two asset classes have become more common in recent years for both public-and-private-sector pensions and come with the potential for higher returns but, as we have seen in the case of real estate over the past several years, considerable risks.

Over the last 24 years, ASRS investments have produced an average annual return of 11.7 percent, with a standard deviation of annual returns of 12 percent. Including the effects of inflation, the real compound annual return equals approximately 6.7 percent.[3] For the future, ASRS assumes a nominal investment return of 8 percent, net of all investment fees and expenses.[4]

Legal Protections for Arizona Public Pension Obligations

In Arizona, as in many other states, public employee pension benefits are guaranteed by law, legal precedent, or the state constitution.[5] Article 2, Section 25 of the Arizona State Constitution declares that "[n]o bill of attainder, ex-post-facto law, or law impairing the obligation of a contract, shall ever be enacted." The ruling in the 1965 case of *Yeazell v. Copins* found that pension benefits must be calculated based upon rules in effect at the time an employee was hired. This implies that the government's ability to alter rates of pension accumulations is limited to new hires. If the state shifted to an entirely different pension funding model, such as a defined contribution plan, it may be possible for future benefit obligations to be incurred under the new plan's rules. But already-accrued benefits must surely be paid.

More recently, Article 29 of the state constitution, adopted in 1998, made explicit that "[m]embership in a public retirement system is a contractual relationship that is subject to article II, section 25, and public retirement system benefits shall not be diminished or impaired."

Arizona public pension benefits cannot be reduced even in the defined-contribution plan where benefit reductions are explicitly called for in the event of underfunding.

This provision was tested in November 2009 for around 1,700 retirees in ASRS who were covered under the previous defined-contribution plan, which was superseded by the current defined-benefit plan beginning in the 1970s. Employees in the ASRS defined-contribution plan built up account balances during working years, which were converted to monthly annuity payments at retirement. The plan's legislation explicitly authorizes benefit increases if the plan's funding ratio rises and benefit reductions if the funding ratio falls below 95 percent. With the plan's funding ratio at 77 percent, ASRS administrators queried the state attorney general regarding the permissibility of benefit reductions.

The Attorney General's Office responded that Article 29 of the Arizona Constitution superseded prior legislation allowing for benefit cuts:

> The plain language of Article 29 of the Arizona Constitution prohibits the reduction of benefit payments to System members.... If there are insufficient funds to pay benefits to System members who retired on or after July 1, 1981, those benefits would be payable from the Plan trust fund. If there are insufficient funds to pay benefits to System members who retired before July 1, 1981, the State is liable for the shortfall, and a legislative appropriation would be necessary to satisfy the obligation.[6]

In short, Arizona public pension benefits cannot be reduced even in the defined-contribution plan where benefit reductions are explicitly called for in the event of underfunding.

While it is convenient to refer to public pension liabilities as akin to state government bonds, experience shows that public pension benefits are in fact lower risk even than explicit government debt. For instance, in the mid-1970s, New York City's financial crisis forced it to cut 61,000 jobs and freeze employee wages while inflicting losses on its bondholders, yet it never failed to pay full pension benefits. Likewise, Orange County, California in the 1990s declared bankruptcy and was forced to cut 1,600 public-sector jobs and default on $1.1 billion of bonds. Nevertheless, the county paid vested pension benefits in full.

As researchers Robert Novy-Marx and Joshua Rauh note:

> State constitutions often build in protections for government-sponsored pensions suggesting that their priority may even be higher than that of general government debt and that the default probabilities of state pension obligations are at least as low as those of state general obligation debt.[7]

Estimating a pension plan's funding adequacy demands detailed knowledge of the plan's current functioning as well as projections of a wide variety of demographic and economic variables – essentially, the core exercise is a simple comparison of the plan's assets to the plan's liabilities.

Following Novy-Marx and Rauh, this analysis assumes that Arizona pension benefits are virtually riskless, with a probability of default similar to that of U.S Treasury bonds.

Traditional actuarial methods, most economists believe, do not adequately account for the fact that public pension obligations are liabilities that must be paid under almost any circumstances. In this way, public pensions differ from corporate defined-benefit pensions or federal programs like Social Security, which may be reduced to varying degrees. Funding a fixed liability with a risky investment portfolio raises issues that standard actuarial methods do not easily handle.

The Actuarial Method for Measuring Pension Funding

While estimating a pension plan's funding adequacy demands detailed knowledge of the plan's current functioning as well as projections of a wide variety of demographic and economic variables, the core exercise is a simple comparison of the plan's assets to the plan's liabilities. The *ratio* of assets to liabilities is often referred to as the funding ratio, while the *difference* between assets and liabilities is referred to as the plan's unfunded liability. The unfunded liability represents the dollar shortfall facing the program.

Calculating pension liabilities involves, first, estimating benefit payments in future years and, second, discounting those future payments back to the present to make them comparable to the current value of the pension plan's assets. Dollars in the future are worth less than dollars today due to the effects of inflation and the time value of money. Discounting accounts for the differences in value of dollars

today versus dollars in the future. The present value of a dollar amount paid in the future equals the future value divided by one plus the interest (or discount) rate, compounded by the number of years until the liability must be paid.[8]

The central question in the market valuation debate is the correct interest rate at which to discount future benefit obligations back to the present. This choice is crucial: a high discount rate reduces the present value of future liabilities, thereby raising the plan's funding ratio, while a lower interest rate increases the present value of liabilities. But which rate is correct?

The approach used by public-sector pension plans is referred to as "actuarial valuation" or "expected cost analysis." This method discounts future benefit obligations at the interest rate the plan's investment portfolio is assumed – or "expected" – to earn in future years. In the Arizona public-sector pensions, ASRS assumes an annual investment return of 8 percent while PSPRS and CORP assume an annual return of 8.5 percent. Both return assumptions are typical for public-sector pension plans.[9]

To illustrate, imagine a plan that owes a lump-sum payment of $10 million in 15 years. The plan assumes that it can earn an average nominal return of 8 percent on its investments. The present value of plan liabilities would be

$$\frac{\$10{,}000{,}000}{(1+8\%)^{15}} = \$3{,}152{,}147.$$

Given that Arizona pension plan liabilities are in the billions of dollars, the stakes in this debate are far from academic.

The funding ratio equals the current value of plan assets divided by this discounted present value of plan liabilities. So long as current assets were in excess of $3.15 million the plan would generally consider itself fully funded.

If, by contrast, the discount rate were only 4 percent, the present value of the plan's liabilities would equal $5.55 million, 76 percent larger. Given that Arizona pension plan liabilities are in the billions of dollars, the stakes in this debate are far from academic.

Table 2: Actuarial Funding Statistics for ASRS, PSPRS, and CORP Plans; Values for ASRS Estimated Based Upon 2008 Values

	Assets ($ billions)					
	Actuarial	Market	Liabilities	Unfunded liability	Discount rate	Funding ratio
ASRS 2009	$28.36	$20.40	$ 35.74	$7.38	8.0%	79.3%
PSPRS 2009	$5,45	$4.12	$7.99	$2.54	8.5%	68.2%
CORP 2009	$0.96	$1.58	$1.31	$0.275	8.5%	82.6%

Actuarial funding status of Arizona public pension plans

Table 2 reports the funding status of the three Arizona pension plans as of late June 2009. As noted earlier, Arizona's pensions and other public-sector plans calculate plan funding ratios and unfunded liabilities using an actuarial valuation of plan liabilities, which differs from (and is generally significantly lower than) the market value of such liabilities.

In addition, most public-sector pensions, including Arizona's, do not use the market value of plan assets in such calculations. Rather, they use a measure known as "actuarial assets." The actuarial measure of assets "smoothes" fluctuations in asset returns so that funding ratios do not change sharply from year to year. Arizona plans smooth their returns over a 10-year period, which is longer than the five-year period that is typical for public plans. As a result, recent market declines will not be fully incorporated into Arizona plans' asset measures until late in the next decade.

Arizonans face public pension financing shortfalls that would double the state's explicit outstanding debt.

For ASRS, for instance, return smoothing means that in fiscal year 2009, assets are assumed to have earned an "actuarial return" of 2.99 percent versus the -18.26 percent return that was realized in the market. The actuarial value of ASRS assets exceeds the market value by 39 percent, while PSPRS and CORP actuarial assets exceed the market value of assets by 32 and 36 percent, respectively. Despite this, because of rising costs due to the regular increase in retirees and other beneficiaries, unfunded liabilities have increased and ratios of actuarial assets to liabilities have declined.

ASRS has an actuarial funding ratio of 79.3 percent, while PSPRS reports a funding ratio of 68.2 percent and CORP a healthier ratio of 82.6 percent. The unfunded liability of the ASRS plan is $7.4 billion, while the unfunded liabilities for the PSPRS and CORP plans are $2.5 billion and $275 million, respectively. Total reported funding shortfalls for the three plans equal $10.2 billion.

For context, Arizona's total debt for state agencies as of July 2008 was $10.4 billion.[10] Thus, Arizonans face public pension financing shortfalls that would double the state's explicit outstanding debt. As this analysis will show, $10.2 billion is a conservative estimate of Arizona's public pension debt.

ASRS annually reports a market value of plan assets; when the market value of assets is divided by the actuarial value of plan liabilities the ASRS funding ratio equals 57.1 percent (ratios for PSPRS and CORP are 51.5 and 60.7 percent, respectively). The only difference between the market and actuarial valuations in this case is that the market value is not smoothed. In both cases, liabilities are calculated on a non-market basis that does not account for the cost of risk.[11]

The following section analyzes how "binding" this implicit pension debt is. This question is important for two reasons: first, if unfunded pension obligations are binding state liabilities, it is reasonable to compare their size to that of Arizona's explicit state borrowing. Second, if pension obligations are binding, this status favors valuation methods derived from the financial economics literature. Market valuation methods show Arizona public pension liabilities to be significantly larger than the $10.2 billion figure reported above, implying that their true value is many times larger than Arizona's outstanding state debt.

How important is market risk?

The actuarial approach, which relies on the expected return to fund assets, makes no accounting for market risk. Market risk is such that even a supposedly "fully funded" plan is unlikely to be capable of paying the full benefits it has promised.

Financial analysts use "Monte Carlo" methods to simulate the behavior of investment assets. These methods use computers to generate thousands of investment returns with characteristics similar to those assumed for an investment portfolio. While any given simulated return is not meaningful, the distribution of returns allows for a "dry run" of an investment approach, providing information unobtainable using the expected-cost approach.

Given that ASRS has a current actuarial funding ratio of only around 67 percent, it should not be surprising that the plan is unlikely to pay full benefits in the future. So long as investments are risky, there is no funding level that will truly guarantee that benefits can be paid without some recourse to taxpayers.

ASRS projects that its assets will return an average of 8 percent above inflation. ASRS does not specify any assumptions regarding investment risk, although from 1984 through 2009, the ASRS portfolio had a standard deviation of annual returns of 12 percent. To see what these assumptions imply, this author generated 10,000 sample paths for the ASRS investment portfolio and calculated the likelihood it would be sufficient to pay the benefits promised by the program.

Given that ASRS has a current actuarial funding ratio of only around 67 percent, it should not be surprising that the plan is unlikely to pay full benefits in the future. What is surprising, though, is that the Monte Carlo simulation showed only a 5 percent chance of ASRS's assets being sufficient to pay promised benefits, even if investment returns average 8 percent in the future.

Even more surprising is that the plan would be unlikely to meet its obligations even if "fully funded," meaning that the value of ASRS assets equals the present value of plan obligations. Even if fully funded today, the ASRS investment fund is sufficient to pay scheduled benefits only 42 percent of the time.

The reason is simply that the average, or mean, return is higher than the typical, or median, return. The average return equals the sum of all returns divided by the number of returns, and is skewed upward by small numbers of very high returns;

the median return equals the midpoint of returns, such that half of outcomes are higher and half lower. If the average return is just sufficient to meet benefit obligations, the median return will fall short. Even if pension assets were *double* the "full funding" level, there would be an almost one-in-ten chance of the plan being underfunded in practice due to variations in investment returns.

So long as investments are risky, there is no funding level that will truly *guarantee* that benefits can be paid without recourse to taxpayers.

A Contrast of Actuarial Valuation versus Financial Economics

The dispute between actuarial traditionalists and financial economists is in practice about interest rates—specifically, the appropriate rate at which to discount future benefit liabilities back to their present value. Actuarial methods base their discount rate on the projected rate of return on plan assets, which for Arizona plans ranges from 8 to 8.5 percent.

Criticisms of Actuarial Valuation

The value of a liability is what it is; whether that liability is backed by stocks or bonds has no impact on that value.

Writing in the *American Economic Review*, University of Illinois professor Jeffrey R. Brown and Federal Reserve economist David Wilcox state, "Finance theory is unambiguous that the discount rate used to value future pension obligations should reflect the riskiness of the *liabilities*."[12] In the economic view, as Novy-Marx and Rauh point out, "The way the liabilities are funded is irrelevant to their value." The value of a liability is what it is; whether that liability is backed by stocks or bonds has no impact on that value.

Discounting a nearly riskless liability using a high interest rate derived from a risky portfolio of stocks and bonds understates its true value. Remarks from Donald Kohn, the vice chairman of the Federal Reserve Board, are worth repeating at length:

> For all intents and purposes, accrued benefits have turned out to be riskless obligations. *While economists are famous for disagreeing with each other on virtually every other conceivable issue, when it comes to this one there is no professional disagreement: The only appropriate way to calculate the present value of a very-low-risk liability is to use a very-low-risk discount rate.*
>
> However, most public pension funds calculate the present value of their liabilities using the projected rate of return on the portfolio of assets as the discount rate. This practice makes little sense from an economic perspective. If they shift their portfolio into even riskier

> assets, does the value of the liabilities backed by their taxpayers go down? Financial economists would say no, but the conventional approach to pension accounting says yes. Unfortunately, the measure of liabilities that results from this process has a real consequence: It pushes the burden of financing today's pension benefits onto future taxpayers, who will be called upon to fund the true cost of existing pension promises.[13]

Defenders of the expected-cost approach respond that government-sponsored plans are inherently different from private-sector pensions because governments cannot go out of business. If a public pension runs short of funds, taxes can be increased. The Government Accounting Standards Board (GASB), which sets accounting guidelines for public-sector pensions in its Statement 25, argues:

> Because governments have the power to tax — a right in perpetuity to impose charges on persons or property — they have the ability to continue operating in perpetuity.... The relative longevity of government is reflected in the long-term view applied in governmental financial reporting.[14]

On its face, this claim seems tautologous: a public pension's financial reports should disclose the degree to which the plan may have to rely on additional taxes to meet obligations. The fact that the plan can rely on additional taxes should not justify understating the plan's potential need to do so.

The government does not have a capacity to bear risk on its own. Rather, government functions as a pass-through entity that transfers risk between different stakeholders, which include taxpayers, public employees, and those who receive funds from the government.

Nevertheless, there is potentially some merit to this argument. In a seminal paper, Kenneth Arrow and R.C. Lind concluded that the government has risk-bearing advantages over the private sector such that uncertainty can effectively be ignored in cases in which risks are both small and uncorrelated to the government's other liabilities.[15]

But public pension liabilities clearly do not satisfy the Arrow-Lind criteria: they are large relative even to government's explicit debt and strongly correlated with other economic factors affecting the government's financial health.[16] As recent experience has shown, pension funds are likely to decline at the same time that government's capacity to support them is at its weakest.

More broadly, the GASB outlook inappropriately anthropomorphizes the government, treating it as an individual that can bear risk separately from the population it serves. But, as the Congressional Budget Office (CBO) points out, "The government does not have a capacity to bear risk on its own."[17] Rather, government functions as a pass-through entity that *transfers* risk between different stakeholders, which include taxpayers, public employees, and those who receive funds from the government. The implication of this, as CBO has argued in contexts

ranging from student loan guarantees, to bank deposit insurance, to guarantees against market risk for Social Security personal accounts, is that governments should value risk the same way that their stakeholders do: using market signals and market prices.[18]

From a financial economics point of view, each citizen effectively holds a small part of a public pension plan's assets and owes a small part of the plan's benefits. For that reason, potential costs to citizens are best reflected in prices charged in financial markets.

Were this not the case, *all* financial transactions involving risk should be conducted through the government, since it seemingly has the ability to deliver returns generated by highly risky investments with no market risk. A moment's thought shows why this is false: government cannot itself absorb financial risk but instead must pass it off to citizens. This is the underlying logic of a financial economics perspective on pension funding.

The market value approach

One practical complication in calculating market prices of public pension liabilities is that plans generally release only the present value of their summed liabilities, discounted at the portfolio's expected rate of return.

Financial economics argues that public pension liabilities should be discounted at an interest rate appropriate to their nearly riskless status. Here, ASRS, PSPRS, and CORP funding ratios are calculated using a discount rate based on U.S. Treasury bonds.

One practical complication in calculating market prices of public pension liabilities is that plans generally release only the present value of their summed liabilities, discounted at the portfolio's expected rate of return. Annual liabilities in nominal dollars are not made available. However, in practice, the present value of a public pension's stream of future liabilities can be approximated by a single lump-sum payment taking place around 15 years in the future.[19] That is to say,

Table 3: Risk-adjusted funding ratios and unfunded liabilities for ASRS, PSPRS, and CORP plans (assets and liabilities in billions)

	Actuarial assets	Liabilities	Funding ratio	Unfunded liability
ASRS	$28.36	$66.70	43%	$38.34
PSPRS	$5.45	$15.98	34%	$10.54
CORP	$1.31	$3.17	41%	$1.86
Total	$35.12	$45.32	41%	$50.74

Source: Author's calculations assuming 3.6 percent discount rate. ASRS 2009 assets and liabilities are approximated from the 2008 ASRS actuarial valuation.

the center of mass of plan liabilities flowing from this year through all future years lies approximately in the 15th year hence. To find this single value, the reported present value of plan liabilities are compounded forward at the plan's expected rate of return over a 15-year period. By discounting this future value back to the present at a risk-adjusted interest rate, this analysis can approximate the market value of the plan's liabilities.

No market interest rate perfectly captures the risk characteristics of a state employee pension plan.[20] As noted in previous sections, this paper assumes that Arizona public-sector benefits carry approximately the same default risk as U.S. Treasury bonds. Based on the U.S Treasury yield curve as of late November 2009, the nominal yield over 15 years would be approximately 3.6 percent.

The market valuation process is illustrated using ASRS. Compounded forward for 15 years at the expected return of 8 percent, the $35.74 billion present value of plan liabilities translates to a future value of $113.38 billion. Discounted *back* to the present at a 3.6 percent risk-adjusted interest rate, the present value of ASRS benefit liabilities is approximately $66.70 billion, almost twice as large as the expected-cost present value calculated using an 8 percent discount rate. The actuarial value of plan assets divided by the risk-adjusted value of plan liabilities produces a funding ratio of 43 percent, versus the 79 percent funding ratio using the current actuarial method. Likewise, the ASRS unfunded liability rises from $7.4 billion to $38.3 billion.

Cumulatively, Arizona public pensions are approximately 41 percent funded and face unfunded liabilities in excess of $50 billion on a market valuation basis.

Table 3 details funding ratios for the ASRS, PSPRS, and CORP plans when liabilities are discounted using the yield of U.S. Treasury bonds. As noted above, using market pricing, the ASRS plan would have a funding ratio of 43 percent and an unfunded liability of $38.3 billion. The PSPRS plan would have a funding ratio of 34 percent and an unfunded liability of $10.5 billion, while the smaller CORP plan would have a funding ratio of 37 percent and an unfunded liability of $1.7 billion.

Cumulatively, Arizona public pensions are approximately 41 percent funded and face unfunded liabilities in excess of $50 billion on a market valuation basis.

Two points are worth noting. First, these figures are the values that financial professionals would place on ASRS's assets and liabilities and that financial markets should bear in mind when considering the risk of Arizona's overall state government finances. Second, even these figures might be considered optimistic, as these calculations are based on smoothed "actuarial asset" values rather than the market values of plan assets. Using the current market value of plan assets as well as the market value of plan obligations, current unfunded liabilities would exceed $60 billion.

Criticisms of the financial economics approach

A core criticism of the financial economics approach to determining public pension funding levels is that it lacks grounding in the real world. Keith Brainard, the research director of the National Association of State Retirement Administrators (NASRA), argues that:

> the application of market valuation would in the short term lead to lower funding levels, which [proponents believe] is a more realistic reflection of funding levels, but they would be lower based on the use of a lower investment return assumption. The investment return assumptions used by most public pension plans are based on reasonable expectations of future returns that also are consistent with the historic returns that public pension plans have experienced. While there may indeed be a lower figure as a result of applying a risk-free rate of investment return, that does not necessarily produce a more realistic reading of the plan's funding condition.[21]

A core criticism of the financial economics approach to determining public pension funding levels is that it lacks grounding in the real world.

Likewise, Brainard argues that:

> [a]ctuaries should want their work product, and that of their professional colleagues, to reflect reality. Requiring disclosure of market value of liabilities does not meet that standard and threatens to diminish this venerable profession.

Brainard's specific argument — that market valuation assumes investments earn a riskless interest rate even if funds are invested in assets with much higher expected returns — makes the actuarial approach appear more realistic.

But this is an incorrect characterization of market valuation, which makes no assumptions regarding returns paid on plan assets. Rather, as noted above, financial economics merely argue that the discount rate applied to a future liability should be independent of the assets set aside to fund that liability.

More broadly, the charge that financial economics techniques are unrealistic derives from the need to understand and accept the sometimes confusing theoretical background to these pricing methods. In the following section, this paper articulates an alternate financial economics pricing method based on real-world financial products. This method also shows that market valuation *can* incorporate attributes of the plan's underlying assets. Doing so, however, shows that contrary to the actuarial approach, investment in risky assets *increases* rather than decreases a plan's funding gap.

An Alternate Pricing Method

In simple terms, a public pension holds a portfolio of risky investments today that it guarantees will be sufficient to pay promised benefits in the future. If the assets fail to be sufficient to pay promised benefits at retirement, the pension plan — and implicitly, taxpayers — make up the difference.

This structure has all the hallmarks of investment products known as "put options." A put option gives the holder the right to *sell* a given asset for a given price at a given time, effectively guaranteeing that an asset will be worth no less than a certain amount at a stated time in the future (a "call option," by contrast, gives the holder the right to buy an asset at a given price at a given time).

Purchasing put options would allow a public pension to guarantee that participants would receive promised benefits while insulating taxpayers from potential costs. In lieu of such options being purchased, the guarantee against market risk falls on taxpayers. However, the value of such options, even if not purchased, tells us the implicit cost being placed on the public.

Purchasing put options would allow a public pension to guarantee that participants would receive promised benefits while insulating taxpayers from potential costs.

The following example based on ASRS funding illustrates the options pricing approach.

The dominant method for pricing put options is known as Black-Scholes, introduced by Fischer Black and Myron Scholes and further developed by Robert Merton.[22] The Black-Scholes formula requires only a small number of inputs, making it relatively easy to implement in practice. The required inputs for a put option are:

- The current value of the portfolio. In the case of ASRS, this would be $23.9 billion.[23]
- The "strike price." This is the value at which the holder of a put option may sell the underlying asset. In the case of ASRS, this would be $113.4 billion, the future value of ASRS liabilities approximated in preceding sections.
- The length of time between when the option is issued and when it may be exercised. In this case, that period would be 15 years, the midpoint of ASRS's future benefit obligations.
- The standard deviation of returns on the portfolio, which indicates market risk. The standard deviation of annual ASRS returns since 1984 has been 12 percent.
- The riskless rate of return. In this case, it would be the approximate 15-year yield on U.S. Treasury bonds, or 3.6 percent.

The mathematics underlying Black-Scholes are complex, but in practice are not difficult to calculate.[24]

A put option guaranteeing that the ASRS portfolio of $28.36 billion can be sold for no less than $113.38 billion in 15 years would carry a price tag of $37.98 billion. If coupled with the existing asset portfolio of $28.36 billion, future benefit obligations would be fully guaranteed for participants and fully funded for taxpayers. That is, willing market participants — not retirees or taxpayers — would carry the risk that ASRS's investment portfolio would fail to achieve 8 percent annual returns in coming years. The cost of truly fully funding ASRS benefit obligations thus would be $66.34 billion — the sum of ASRS's current assets and the option guaranteeing against market risk.

The market valuation funding ratio is the value of assets on hand — $28.36 billion — to the $66.34 billion full cost of funding future benefits. That ratio is 43 percent, almost precisely what the use of risk-adjusted discount rates predicts.[25] Thus, the basic financial economic approach is hardly unrealistic: public pension plans could hedge their investment risk today if they wished, using products widely available in financial markets. For such a guarantee, they would pay *at least* as much as the $37.98 billion indicated here.[26]

One advantage of an options pricing approach is that it allows for changes in the investment portfolio to affect the price of the guarantee against market risk, and thus the overall funding ratio.

One can argue about the parameters involved — the proper riskless interest rate might be slightly lower or higher than the yield on state government bonds; the future volatility of the ASRS investment portfolio might be slightly higher or lower than in the past — but reasonable upward or downward adjustments in parameter values would have only small effects on the outcome.

That outcome is that ASRS's funding status, calculated on a basis in which both taxpayers and beneficiaries would be protected against adverse market outcomes, is far poorer than is commonly understood. The legal guarantee against ASRS falling short of its ability to pay full benefits is recourse to tax increases on Arizona citizens. The market value of such a guarantee is around $38 billion, about $5,800 per Arizonan, implying that Arizona citizens are unknowingly subject to pension risk of that value.

The effect of portfolio choice on pension funding ratios

One advantage of an options pricing approach is that it allows for changes in the investment portfolio to affect the price of the guarantee against market risk, and thus the overall funding ratio. At the funding levels prevalent for most public pension plans, these effects are very small because the guarantee is so likely to be exercised. But at higher funding levels, the effects of portfolio choice are significant, and clearly show that the traditional actuarial method's implication that "higher risk equals better funding" is false.

For instance, imagine that the ASRS current assets were three times higher, at $85.1 billion. Assuming investment in the current ASRS portfolio, with an

assumed standard deviation of returns of 12 percent, ASRS's market-priced funding ratio would be 70 percent. However, if the portfolio were shifted to lower-risk assets with a standard deviation of just 3 percent, the funding ratio would rise to 95 percent. Likewise, if ASRS shifted to an all-stock portfolio with a standard deviation of returns of 20 percent, the funding ratio would decline to only 57 percent. Higher risk equals higher costs.

A riskier portfolio increases guarantee costs because a larger share of returns would be in the extremes — either very high or very low. Very high returns would mean that the plan would be overfunded, in which case Arizona law allows for a Permanent Benefit Increase (PBI). But in the equally likely case of very low returns, the guarantee would bear a larger share of ASRS costs. This shows very clearly the cost that financial markets ascribe to risk, a cost the current actuarial method not only ignores but reverses.

Recommendations

Actuarial valuation methods give current policymakers a false sense of confidence in public pension funding and discourage them from taking action today. In addition, actuarial methods encourage pensions to shift to riskier investment portfolios.

Actuarial valuation methods allow a pension to claim the investment on a risky portfolio before those returns have been realized. In doing so, they artificially increase the funding level of the plan relative to what financial markets would assess. These methods give current policymakers a false sense of confidence in public pension funding and discourage them from taking action today. In addition, actuarial methods encourage pensions to shift to riskier investment portfolios.

A current debate between actuarial professionals and financial economists concerns whether market valuation techniques better capture the shortfalls facing public pensions and the costs of risky investment strategies. This paper has argued that market valuation better represents the true costs to taxpayers, and has proposed an alternate valuation technique based on options pricing that captures how changes to pension fund portfolios can alter funding ratios.

While market valuation shows the potential costs of a risky portfolio, these techniques do not necessarily imply that public pension funds should never hold stocks. If stock returns and wage growth are correlated over the long term — as a simple neoclassical economic growth model would imply — then holding some stocks may help hedge against pension costs.[27] Nevertheless, most financial economists argue that a pension's portfolio should consist principally of assets, such as bonds, that have a known payoff with a duration similar to that of the liabilities being backed.

Pension costs implied by market valuation techniques are significant. The already-large actuarial unfunded liability of $10 billion for Arizona public-sector pensions would rise to over $50 billion under market valuation techniques. Some

oppose market valuation for this very reason: that public pension shortfalls, and thus implicit costs to taxpayers, appear much larger under this approach.

But this approach is myopic: the best hope for public pensions, as well as for state budgets and the taxpaying public, is for policymakers to bring pension costs under control as soon as possible. Doing so will be difficult, given the binding nature of pension obligations and the long timeline for reforms to take effect. But the longer action is delayed, the more embedded these shortfalls become and the more difficult and disruptive they will be to address.

To this end, some policy recommendations follow. First, legislators should require that public-sector pensions report the market value of plan liabilities. Plan managers may not agree that market valuation is the best approach, but it is difficult to argue that it does not convey useful information to policymakers and the public. It is possible that the actuarial profession will eventually require disclosure of market valuations, but it does not make sense to wait.

The best hope for public pensions, as well as for state budgets and the taxpaying public, is for policymakers to bring pension costs under control as soon as possible.

Second, Arizona and other states that automatically adjust pension contribution rates based on plan funding measures should set such adjustments according to the market value of plan liabilities, not the actuarial value. Doing so would not reduce these liabilities, but would reduce the threat to future taxpayers. Such a step may have the additional benefit of making state employees more aware of the true costs of the program and may provide public-sector employee unions, which represent the interests of both workers and retirees, the incentive to mediate greater equity of treatment between the two.

Third, while incremental reforms make sense, ultimately states like Arizona should shift public-sector pensions toward defined-contribution plans, which dominate in the private sector. Under "DC pensions," as they are called, the government makes a fixed contribution to employee retirement accounts, generally through an employer match of employee contributions. Employees manage accounts and reap the gains (or losses) from any market risk they choose to accept.

One cannot expect public-sector employees to welcome such a change. After all, under current programs they are effectively guaranteed high returns on their contributions without taking any market risk. A defined-contribution plan cannot match this. But public-sector pensions are so wholly unsustainable on a financial basis that such comparisons are not particularly meaningful.

The government match to a defined-contribution plan can be as small or as generous as lawmakers wish, but the important factor is that its value be *known*. DC pensions make government obligations a stable and predictable expense while encouraging more prudent management of investment assets. Most important, under a DC pension system there is no unknown but significant contingent liability looming over state taxpayers.

NOTES

1. Details on ASRS derive from Arizona State Retirement System, *The Strategic Plan of the Arizona State Retirement System: For the Period of July 1, 2009-June 30, 2012*,http://www.azasrs.gov/content/pdf/Strategic_Plans_for_Operations_Management.pdf; Arizona State Retirement System, *Actuarial Report on the Valuation of the Plan as of June 30, 2008* (Denver: Buck Consultants, January 14, 2009); and Arizona State Retirement System, *Comprehensive Annual Financial Report for Fiscal Year Ended June 30, 2009* (2009), http://www.azasrs.gov/content/pdf/financials/2009_CAFR.pdf.

2. For public safety personnel, final earnings equal the highest three consecutive years out of the last 20 years of credited service. For individuals with 20 to 25 years of service, benefits equal 50 percent of average monthly compensation for the first 20 years of credited service, plus 2 percent of average monthly compensation for each year of credited service between 20 and 25. Participants with more than 25 years of service receive a benefit equal to 50 percent of final earnings plus 2.5 percent of final earnings for each year of service above 20 years, to a maximum of 80 percent. Participants with less than 20 years of service are subject to a 4 percent reduction in benefits for each year of service below 20 years.

For corrections officers, final salary equals the average of the highest 36 consecutive months of salary within the last 120 months of service. Benefits are calculated on the following basis: participants with less than 20 years of service, 2.5 percent of average monthly salary times years of credited service; participants with 20 to 25 years of credited service, 50 percent of average monthly salary for the first 20 years of service plus 2 percent of final earnings for each year of service between 20 and 25; participants with 25 or more years of service, 50 percent final salary plus 2.5 percent of final salary for each year of service above 20 years, to a maximum of 80 percent.

3. Arizona State Retirement System, "Investment Returns" (fact sheet, August 30, 2009), http://www.azasrs.gov/content/pdf/fact_sheets/Investment_Returns.pdf.

4. Leaving broader methodological issues aside, it strikes this observer as troubling that a complex portfolio, net of all the various and sundry investment fees, would be assumed to earn an annual return of precisely 8 percent. This return assumption clearly appears to be a top-down projection, rather than one built from projections of returns on individual components of the portfolio, netted of their individual management fees.

5. For details by state, see Morrison & Foerster, LLP, and Greenebaum Doll & McDonald, PLLC, *Index by States: Extent of Protection of Pension Interests* (draft, September 25, 2007), http://finance.ky.gov/NR/rdonlyres/275A2978-5DDE-4138-A7F5-AF02D17D7F97/0/Statebystatememo10.pdf.

6. Office of the Attorney General, State of Arizona, "Attorney General Opinion by Terry Goddard, Attorney General, to Paul Matson, Director, Arizona State Retirement System--Re: Management of State's Defined Contribution

Retirement System" (no. I09-009 [R08-059]), November 24, 2009), https://www.azasrs.gov/content/pdf/AZ_Atty_Gen_Opinion_SysMem_Bene.pdf.

7. Robert Novy-Marx and Joshua D. Rauh, "The Intergenerational Transfer of Public Pension Promises" (Chicago GSB Research Paper no. 08-13, September 2, 2008).

8. $PV = \frac{FV}{(1+r)^n}$, where *PV* equals the present value, *FV* the future value, *r* the interest rate, and *n* the number of years.

9. The majority of state and local public pension plans around the country assume an 8 percent return on plan assets. While a number of other state plans assume an 8.5 percent future return, as of 2006 no plans assumed a return above 8.5 percent. The lowest return assumption as of 2006 was 7.0 percent, according to the Boston College pension data set.

10. Benjamin Barr, "Living Debt Free: Restoring Arizona's Commitment to its Constitutional Debt Limit" (Phoenix: Goldwater Institute Policy Report no. 235, January 5, 2010, http://goldwaterinstitute.org/article/4293).

11. Arizona State Retirement System, Actuarial Report on the Valuation of the Plan as of June 30, 2009 (Denver: Buck Consultants, January 28, 2010), http://www.azasrs.gov/content/pdf/Plan_Valuation.pdf.

12. Jeffrey R. Brown and David W. Wilcox, "Discounting State and Local Pension Liabilities," *American Economic Review* 99 (2009): 538-42.

13. Donald L. Kohn, Statement at the National Conference on Public Employee Retirement Systems Annual Conference, New Orleans, Louisiana, May 20, 2008. Available at http://www.federalreserve.gov/newsevents/speech/kohn20080520a.htm. Emphasis added.

14. Government Accounting Standards Board, "Why Governmental Accounting and Financial Reporting Is—and Should Be—Different" (white paper, undated).

15. Kenneth J. Arrow and R.C. Lind, "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review* 60 (1970): 364-78.

16. Investment downturns are correlated with broader economic declines, such that pension fund values will drop at the same time that falling business activity reduces government's other sources of revenue and increase the need for government transfer payments such as unemployment insurance.

17. Congressional Budget Office, *Estimating the Value of Subsidies for Federal Loans and Loan Guarantees* (Washington, D.C.: Congress of the United States, August 2004), http://www.cbo.gov/doc.cfm?index=5751. This study contains an extensive discussion of the treatment of risk of government programs, extending beyond federal loan guarantees. See also "Railroad Retirement Board Investments," in Office of Management and Budget, *Analytical Perspectives: Budget of the United States Government*, *Fiscal Year 2004* (Washington, D.C.: Executive Office of the President of the United States, 2004), 471, http://www.whitehouse.gov/omb/budget/fy2004/pdf/spec.pdf, and Congressional Budget Office, "Evaluating and Accounting for Federal Investment in Corporate Stocks and Other Private

Securities" (Washington, D.C.: Congress of the United States, January 2003), http://www.cbo.gov/ftpdocs/40xx/doc4023/01-08-03-Stocks.pdf.

18. For background, see Deborah Lucas and Marvin Phaup, "The Cost of Risk to the Government and Its Implications for Federal Budgeting," in Deborah Lucas, *Measuring and Managing Federal Financial Risk* (Chicago: University of Chicago Press, forthcoming).

19. See M. Barton Waring, "Liability-relative Investing," *Journal of Portfolio Management* 30, no. 4 (2004), and M. Barton Waring, "Liability-relative Investing II," *Journal of Portfolio Management* 31, no. 1 (2004).

20. Brown and Wilcox (2009) discuss these issues in greater detail.

21. "What's the Debate About? Should Public Pension Plans Disclose a Market Value of Liability?" symposium moderated by Andy Peterson, *The Actuary Magazine* 5, no. 6 (December 2008/January 2009).

22. Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* 81, no. 3 (May-June 1973): 637-54; Robert C. Merton, "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science* 4 (no. 1, 1973): 141–83. Merton and Scholes received the 1997 Nobel Prize in Economics for their work (Black would also have received the prize, but due to his death was ineligible).

23. Here I use the actuarial value of assets for comparability with published calculations, although strictly speaking, the market value of assets should be used.

24. The Black-Scholes price of a call option is equal to

$$C_0 = S_0 N(d_1) - Xe^{-rt} N(d_2)$$

where

$$d_1 = \frac{\ln(S_0 / X) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$$

and

$$d_2 = d_1 - \sigma\sqrt{T}$$

and

C_0 = the call option price

S_0 = the purchase price

$N(d)$ = the probability that a random draw from a standard normal distribution will be less than the value d;

X = the exercise price

e = the base of the natural log function (2.71828)

r = the riskless rate of return

σ = the standard deviation of the log of gross portfolio returns

T = *the length of the option, or the time until maturity*

The put-call parity relationship implies that the put option price is equal to

$$P = C_0 + PV(X) - S_0 = C + Xe^{-rt} - S_0$$

where P equals the put option price, and $PV(X)$ equals the present value of the exercise price.

25. A small difference in funding ratios arises because the discount rate-based market valuation approach implicitly assumes that pension fund managers also sell a call option giving up the right to asset returns in excess of those needed to pay promised benefits, using the proceeds of the sale to partially offset the purchase of the put option. If the sale of a call option is included the funding ratios will be precisely the same. In practice, most pensions allow for benefit increases if asset returns are above projected levels, making a put option-only approach more realistic.

26. In practice, long-dated options tend to be somewhat more expensive in financial markets than predicted by the Black-Scholes models, so true market costs of funding ASRS would likely be higher. Moreover, both market valuation and actuarial valuation of pension liabilities assume benefit costs to be fixed based on a set of assumptions with regard to inflation, wage growth, mortality, and other factors. While variation in these factors could increase or decrease plan costs, protecting against this variation through market instruments would almost certainly increase total costs.

27. Deborah Lucas, "Valuing & Hedging: Defined Benefit Pension Obligations—The Role of Stocks Revisited" (no. 169, Money Macro and Finance Research Group Conference 2006).

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