InvestmentInsights

The Investment Research Journal from BARCLAYS GLOBAL INVESTORS

I.07

JANUARY 2007
VOLUME 10 ISSUE 1

DON'T KILL THE GOLDEN GOOSE

Why DB retirement plans CAN AND SHOULD BE SAVED, *and* HOW TO DO SO

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This article originally appeared in the January/Februray 2007, volume 63 number 1 issue of the *Financial Analysts Journal*. It is reprinted here with permission from CFA Institute, ©2007 CFA Institute. The *FAJ* can be found online at www.cfapubs.org.

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EXECUTIVE SUMMARY

Defined benefit plans are like a goose that lays golden eggs—monthly retirement income at a decent level, guaranteed for life. The gradual disappearance of these plans is a tragedy for employees and for society, since they are the only practical way to provide an adequate retirement benefit.

Unlike defined contribution plans, DB plans offer forced savings, the sharing of longevity risk through annuitization, institutional-quality investment strategies, and institutional fee levels. A back-of-the-envelope estimate shows that, from longevity risk-sharing alone, a given dollar amount of retirement benefit is 35% cheaper to provide through a DB plan than through a DC plan. And since most DC participants retire with balances so low that they merely supplement Social Security income, they aren't really retirement plans at all.

But DB plans are disappearing because many employers perceive that the financial risk of sponsoring them is unacceptable. They point to the "perfect storm" of 2000–2002, during which equity prices fell by 50% from peak to trough, while the present value of pension liabilities rose dramatically due to the decline in long-term interest rates. However, this perfect storm occurred only because DB plans were poorly hedged. If assets had been selected with market-risk exposures closer to those of the liability, little damage would have ensued.

To save DB plans, sponsors should use existing—but often poorly understood—technology to hedge certain market-related risks in the liability, and "surplus optimization" to rationally take additional risk in pursuit of higher returns.

In hedging, one must understand that the liability represents someone else's asset and can be modeled like any asset: as the sum of the riskless rate, exposures to various market risks (in this case, inflation risk and real interest rate risk), and a residual or alpha portion. A portfolio of nominal Treasury bonds and inflation-protected securities can be designed to hedge the liability quite satisfactorily.

The hedge portfolio is, however, too low-yielding for most sponsors. Surplus optimization, which is like asset-only optimization but with the liability included as an asset held short, should be used to allocate across equities and other risky assets. Sponsors can try to add value by taking "surplus beta risk," that is, equity or equity-like risk not needed to hedge the risks in the liability, and by taking active (alpha) risk. By holding assets that are closer to the liability in terms of their risk exposures, DB plans can be saved because the risk of sponsoring them will have been managed to acceptable levels.

Introduction

We could be seeing the beginning of the end of the most-valuable and well-conceived employee-benefit program ever devised—the final pay defined benefit (DB) pension plan. If these plans really do disappear, that would be a tragedy for employees and for society, and—we'd argue—that it would also represent a loss to employers of one of their most valuable compensation and negotiation tools.

What is the threat? Many US sponsors of DB plans say they are considering shutting their plans to new entrants and limiting ongoing accruals to existing participants, a so-called "soft freeze." A few have even threatened to terminate the plans completely, with no further accruals even for current employees: a "hard freeze." Some plans have already done so, and a few more have filed for bankruptcy, in high-profile moves to offload their liabilities to the Pension Benefit Guaranty Corporation (PBGC) so as to avoid the ongoing labor cost associated with these benefits. Certainly, very few sponsors are starting new DB plans. Sponsors are telling us that if the proposed change to mark-to-market accounting for pension assets and liabilities is adopted, this will accelerate the nascent trend.[1] And if we look abroad, our plan sponsor cousins in the UK seem to have anticipated this malaise and have entertained it to an extreme: most corporate defined benefit plans there are now closed to new entrants, and will "wind up" over time as existing participants slowly work their way through the system.

Why? From our conversations with sponsors, we think it is because DB pension plans are perceived as too dangerous, exposing the balance sheet and income statement to volatility that the sponsor doesn't feel able to control, and exposing the cash-flow statement to wildly fluctuating demands for supporting contributions. Many sponsors, both corporate and public, don't see the risks as being manageable. And there is a sense that these plans

1 Since this was first written, the Pension Protection Act was passed, moving us closer to a mark-to-market system for funding; FASB is still reviewing its standards for GAAP accounting.

are more costly than can be justified. These concerns have been repeated often enough to take on the appearance of truth, and for many executives it seems to be a foregone conclusion that the DB plan has to go.

While experience to date using conventional pension management technologies does justify these concerns, the problem is in the technology used to manage risk and cost. It is not intrinsic to the basic DB plan structure. The good news is that we do, in fact, have better technologies today than we have been using in the past for managing these risks and controlling these costs, and we'll summarize these technologies later in this paper: DB plans don't have to feel "out of control."[2]

The actuarial cost management and asset-liability management (ALM) technologies that are in widespread use now are daily proving themselves inadequate to their tasks, and those who use them share the perception that DB plans are not controllable. So until these newer technologies are more widely understood and adopted by most pension plan advisors, the perception is understandable, even if incorrect.

This is an unnecessary tragedy if it leads sponsors to consider terminating their plans, because DB plans are the only way that adequate retirement benefits can be provided to most employees. The emerging substitute for these plans—defined contribution (DC) plans—have many flaws and, while beneficial to some employees, stand no chance (in today's practical DC environment) of providing anything like an acceptable retirement income for most workers. While the difference between DB and DC outcomes doesn't have to be as great as it actually is, low contribution rates, misdirected purchasing practices for investment management services, liberal participant loan policies, and other matters effectively cripple US defined contribution plans. With median balances of $44,000 at retirement, *they aren't retirement plans at all.*[3]

The basic elements of the financial technology required to manage pension risks and costs have been around, and in the literature, for a long time. These elements have only needed to be synthesized into a general approach to cost management and to investment policy management in order to be put to work. This synthesis has been accomplished over the last couple of years; our goal in this article is to outline its key ideas and to demonstrate that controlling the costs and risks to an acceptable level is within the reach of any plan sponsor. We hope to encourage sponsors to continue to offer DB pension benefits, and we know that they need to feel in control of their risks and costs if they are going to do so.

We begin by comparing DB and DC plans, for the purpose of motivating our claim that it is important to save DB plans. We then show how a pension liability can be understood in terms of its economic or market-related components, i.e., understanding it in terms of risks that we can do something about. With this understanding, we can begin to understand and control the benefit level—and thus the cost level—for these plans, and to match assets to the liability in the dimensions of financial risk that matter, creating what financial economists call a "hedging portfolio." These dimensions include not one, but two, interest rate–related risk factors or durations—inflation duration and real interest rate duration.[4] In addition, there is an opportunity to

2 We'll digest rather than repeat these technologies in this article. They deal with economic views of the liability and lessons from economic accounting with respect to both risk and cost control, and surplus optimization and dual-duration matching of that economic view of the liability with respect to risk control. For more complete but more technical discussions, see Waring (2004a and 2004b), Siegel and Waring (2004), and the unpublished manuscript cited as Waring (2007).

3 Waring and Siegel (2006). In theory, virtually everything a DB plan does could be done in a DC plan. In practice in the US today, DC plans aren't anywhere close. Other countries do better; Australia is a good example with its 9% mandatory contribution level.

4 Strictly speaking, there are more than two interest rate–related risk factors or durations at work here, but these are the two that matter most and on which our discussion will focus.

hold equities and other risky assets—in judiciously chosen quantities—for the purpose of enhancing returns in what financial economists call the "risky-asset portfolio." The key is to first hedge the liability with the hedging portfolio, and then, in an effort to enhance returns, to hold risky assets (such as equities, etc.), but only to the extent that the resulting downside risk—the possibility of a rise in pension expense and contributions—is acceptable to the sponsor.

The social as well as personal benefits of a meaningful system for spreading one's working life income over one's entire life are hard to overstate.

To accomplish this, we show that "surplus" optimization, which is like asset-only optimization but with the liability treated as an asset held short, is the fully general model that enables managers to accomplish this task. Both true economic risk and actual accounting risk will then be much more under control than ever before.

Empowered with these tools, sponsors can provide retirement benefits that are secure, meaningful in size, and appropriate in cost, and not dependent on extraordinary savings and investment behavior by individuals. The social as well as personal benefits of a meaningful system for spreading one's working life income over one's entire life are hard to overstate. And through salary negotiations, these benefits can be shared between employer and employee, producing a "win" for both parties, relative to a replacement DC plan.

The advantages of DB over DC: "Gains from trade"

Unlike typical DC plans, DB plans regularly create a number of *gains from trade*—a familiar concept from Economics 101. When two parties trade, both parties expect to be better off, and in some transactions they are *much* better off. (Consider a farmer with only meat and no potatoes, and another farmer with only potatoes and no meat.) In this section, we identify the sources of the gain from trade in DB plans and we provide a worked example in which we put a rough dollar value on it.

The trade in this case is of labor for total compensation, and the opportunity for this gain lies in the level and regularity of the deferred (DB plan) component of compensation and how its payout is structured: Rather than *immediate* compensation for a part of their labor, participants in a DB plan accept a professionally managed *deferred* compensation scheme, *guaranteed for the rest of their life*. If they had received the deferred compensation as current compensation, they would have been individually responsible to save a substantial part of it, invest it wisely and at low cost, and then find an exit strategy upon retirement that protects against the risk of outliving one's money. Instead, the DB plan does all this savings and annuitization for them. It reduces the employee's retirement savings requirements, ties the employee more tightly to the employer, and creates other benefits.

Both parties benefit, as the lagniappe of the gain from trade is inevitably shared, a natural outcome of labor negotiation. (We don't need to know the exact split of the gain from trade between employer and employee to make our point.) In other words, both the employee and the employer get more than they pay for, as a result of participating in and sponsoring the plan.

Let's acknowledge that it is theoretically *possible* to design and sponsor a DC plan that incorporates design features to match each of these advantages

of a DB plan (higher, forced contribution rates; no loans; sponsor management of policy and active investment decisions; institutional-level fees; sponsor annuitization of balances at retirement). A dollar of contribution could produce an identical level of ultimate benefits if all were set up appropriately to that purpose. But this is easier said than done, and we don't see it happening any time soon. As a result, when a DC plan replaces the DB plan in US practice today, these gains from trade are forgone: both parties are wasting money, destroying value, and dramatically reducing the employee's retirement income replacement ratio below what it could be.

LONGEVITY RISK AND THE INSURANCE PRINCIPLE: ANNUITIZATION

Longevity risk is the risk that one will outlive one's money. To manage this risk as an individual, an employee would have to save enough to live at the desired level of comfort to the extreme outer limit of his or her possible life span, say age 105 or so. In contrast, a DB plan, with its fairly priced sponsor-provided annuitization, needs to be funded only to the employee's *life expectancy*, a much younger age and thus a much smaller amount of required savings. This is the biggest advantage of current DB plans, and it makes it vastly less costly, in present value terms, to fund a retirement than it would otherwise be.

This is because, in a shared-risk pool such as a DB plan, those who die sooner help "pay" for those who outlive their life expectancy. A large pool can be run as if each participant's life span were almost perfectly predictable, since the pool manager need worry only about the average life expectancy across the group, not about individual deviations from it. This elimination of risk through pooling of lives is known as the insurance principle.

We can measure the savings from the insurance principle very easily. First, we determine the amount that is required to fund a single-payment life annuity for a male retiring today at age 65.[5] This annuity is assumed to pay $100,000 per year for the rest of the annuitant's life. Using "modified" life tables that account for projected increases in life expectancy, we calculate that a sponsor would have to set aside $1,180,000 to fund this annuity at current interest rates.[6] This figure is a good proxy for what a DB plan annuity might cost today in market value terms.

We then compare this price to the value of a bond portfolio that the retiree would have to accumulate on his own to provide this exact same level of unannuitized annual income on a riskless basis over the 40 years from age 65 to our maximum age example of 105. The amount that would be needed in the bond portfolio, at current interest rates, is $1,802,431.

Compared with what is needed to provide this income to an unannuitized retiree, an annuity requires *35% less accumulated savings* to provide the same guaranteed lifetime stream of payments! A DB plan thus creates a very substantial "gain from trade" by providing a convenient and fairly priced mechanism for annuitization.

That's a huge gain from trade. Sponsors owe it to themselves and their employees not to throw it away.

So in very round numbers, DB plans enjoy a 35% cost advantage over the "plan" that is implicit in most DC plans today, the plan of just setting aside unannuitized savings. And while in theory an annuity option could be added to a DC plan, in practice most DC plans just don't foster sufficient accumulation for the benefit of annuitization to be meaningful even if offered.[7]

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5 The same analysis would apply if we assumed a mid-career age instead of age 65.

6 We use the RPA 2000 mortality table, which is also mandated by the Pension Protection Act. It has mortality improvement projection through 2014. The relevant interest rate is the full forward rate curve for Treasury bonds; as of this writing (October 2006), the Treasury yield curve is relatively flat and close to 4.8% for 10- to 30-year bonds, so we use 4.8% as the assumed interest rate, getting an annuity factor of 11.8.

The large magnitude of this gain shouldn't be a surprise: As George Burns is reputed to have said, "If you live past 100, you've got it made. Very few people die past that age." Few people live to their maximum possible age, and a few people live only a short time after their retirement. The rest lie somewhere in between, spread out over time, the average being at the predicted life expectancy, more or less. This is the basis for the insurance principle, and it means that there would be a lot of unspent or "excess" deferred compensation if everyone were actually "fully funded" in their conventional non-annuitized DC plans, an excess that doesn't happen with a DB plan.

But here is the point: woe be to you if you do live past your life expectancy but your money is all in a DC plan, unannuitized—and spent.

OTHER "GAINS FROM TRADE" IN DB PLANS

SKILLFUL INVESTMENT MANAGEMENT

There are some smaller, but still important, gains from trade as well. Defined benefit plans are generally managed by an in-house staff of skilled investment professionals, and they, in turn, place the assets with a number of other carefully chosen outside investment managers. The in-house professionals' most-important tasks are to allocate among asset classes so as to be "on the efficient frontier," at a risk-appropriate location, and to select managers that have a fair expectation of earning a positive active return after fees and costs. The efficient frontier represents the combination of asset classes that delivers the highest possible expected return at a given level of risk.

In contrast, almost all DC plan investors—employees managing their own money—cannot get to the efficient frontier for lack of appropriate asset-class building blocks, nor can they identify a risk-appropriate location on it. They don't have the knowledge, and even if they had it, they typically lack the tools to build a portfolio on the frontier. It isn't reasonable to ask employees to be their own chief investment officer, when they have presented themselves as experts in the job they're doing, not in managing investment portfolios. Lifestyle funds, earlier referred to by the more-descriptive but less-marketing-driven name "pre-mixed strategic asset allocation fund families," were originally developed to address this issue, but are still only used by a small portion of the DC population.[8]

And participants have neither the skill to select "good" managers nor access to any beyond those on their list, so it is likely that their realized alphas will be negative in the amount of fees and costs, plus random noise.

A significant gain from trade, then, arises from the difference in investment return between a professionally implemented portfolio on the efficient frontier at an appropriate risk level, and the almost

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7 While a retiree could replace this employer-provided annuity with a commercial annuity, it isn't clear that it would be an advantage to the employee, even presuming that the employer shares in the gains from annuitization. Individual purchases of annuities are often subject to high sales loads. Often the annuity tables are "tilted" against purchasers, to protect or over-protect the insurer from annuitant selection bias. Of course, insurance companies also want to profit, so they will charge a "spread" or risk charge. There is risk—insurance companies offering annuities, while regulated, are usually regulated in a book-value rather than a market-value framework, giving rise to substantial credit risk over the long life of an annuity. And as we can observe, few employees actually arrange annuitization on their own, in any event.

8 These tools supporting better investment policies, which include proper asset-class "building blocks" consisting of index funds and thoughtfully chosen active funds, as well as families of pre-mixed asset allocation funds that are on the efficient frontier by design (today usually called "lifestyle" or "lifecycle" funds), are described in Waring and Assaf (1992), Waring (1994), Waring, Siegel, and Kohn (2004), and Waring and Siegel (2006). To the best of our knowledge, Waring and Assaf (1992) is the first incidence of these tools and configurations in the literature, and draws on work performed by Waring and presented to clients and at conferences as early as 1989, suggesting that lifestyle funds may owe their origin to this effort. If others were independently working on the concept before then, which wouldn't surprise us, we'd like to know about it.

surely inefficient and random portfolio that results when employees cobble one together on their own from whatever funds the sponsor has made available.

This DC plan disadvantage could be reduced through greater reliance on well-engineered lifestyle funds (but so far in the US there are few such funds that deserve that description). There are technologies for increasing the use of these types of funds, but they still have not been widely applied.

WHOLESALE INVESTMENT FEES AND OTHER COSTS

Even if they had no greater investment skill than the employees, professional investment managers of large sponsor asset pools can take advantage of volume pricing. Investment fees are high for individual investors, much lower for institutions.[9] The average fees for US equity funds in most DB plans are well under 0.50% per year, while many retail mutual funds (as used in most DC plans) come in well above 1% per year.

This difference in fees and related investment costs is another component of the gain from trade in DB plans, and is quite large. If a DB plan pays an average fee of 0.5%, and DC plan participants pay 1.25%, that difference compounds to 23.2% of a given amount of invested capital over a working lifetime of 35 years.[10] That's another big savings for a DB plan relative to a typical DC plan—and we haven't counted the post-retirement years!

DB and DC plans compared

Our discussion of the gains from trade in DB plans, and of the various risks that need to be managed, enables us broadly to compare DB and DC plans as they exist in the US today. Exhibit 1 summarizes the advantages and disadvantages of DB and DC plans from the viewpoint of the employee.

Defined contribution plans have many features that are appealing to employers: The out-of-pocket deferred component of employee compensation, and particularly the employer contribution, or "match," is always far less in a DC plan than the contributions required in DB plans (a switch to DC may represent a reduction in total compensation, and that reduction may not be apparent to all employees); administrative costs tend to have been shifted to the employees; and they're always "fully funded" in an accounting sense from the sponsor's perspective (but watch out—they're not anywhere near fully funded with respect to the retirement income needs of the employees, as we'll soon note).

From the employee perspective, DC plans are flexible (in that employees who cannot afford to save are not required to do so), while providing a tax-advantaged savings vehicle for those who can save larger amounts. Employees can borrow against them. They are entirely portable by design, and nothing—other than poor investment returns—can take away the value that an employee has set aside. For many employees, especially those in industries in which a typical career path involves having many employers,

9 Funds offered in DC plans are typically retail mutual funds, with retail pricing. A commingled trust fund (CTF) structure, which may follow the same strategy as a given retail mutual fund but with lower fees and other expenses, can be used to achieve cost savings for DC plan investors. While this opportunity is well known, it is not as widely used as one would expect, probably because it generates objections from the record keeper—who is often also the mutual fund provider.

10 Calculated in a stone simple manner, this assumes a zero investment return. Of course the investment path in a pension plan is more complex, with continuing cash flows, but our estimate is both directionally correct and sized at least somewhat appropriately.

11 At extreme levels of underfunding, investment risk is shared with the employee because a sufficiently underfunded plan will be taken over by the PBGC, which pays only limited benefits. Of course the PBGC is currently in a substantial deficit position, with no clear requirement that the federal government must stand behind it. And for public employee plans, there is no PBGC protection at all. If the Pension Protection Act proves effective, most plans will be healthier going forward, although there may be pain for some in the nearer term.

Exhibit 1

DC PLANS COMPARED AND CONTRASTED

Characteristic	DB Plan	DC Plan	Advantage (from employee perspective)
Investment Characteristics			
Quality of investment strategy	Good to excellent	Poor for typical participant	DB
Can investment strategy be customized to employee's personal situation?	It doesn't need to be; the success of the investment strategy doesn't impact the benefit the employee receives	Yes	DB
Cost of investment management	Low	High	DB
Who keeps unexpected investment gains?	Sponsor (may share gains with employees if overfunded)	Employee	DC
Who keeps unexpected investment losses?	Sponsor[11] (may share losses with employees if bankrupt)	Employee	DB
Funding and payout characteristics			
Forced savings	Good to excellent, and it gets better as service gets longer	None	DB
Portability	Very limited	Yes	DC
Ability to hedge longevity risk	Excellent	Usually none; however, employee can hedge this risk by buying annuities upon retiring[12]	DB
Ability to hedge timing of retirement risk	Excellent	Limited	DB
Can contribution rate be customized to employee's personal situation?	No	Yes, but only up to maximum contribution limits	?
Can employee borrow against plan balance?	No	Usually	DC
Can plan be bequeathed?	No	Yes	DC

12 Some DC plans offer annuities as an investment option, but usually they are commercial annuities, not fiduciary annuities provided by the sponsor. Commercially provided annuities, especially when purchased on a retail basis, can carry relatively high embedded fees for sales and risk charges, and carry credit risks that aren't present with a fully funded DB plan operating under ERISA and the (standard) provisions of the Pension Protection Act of 2006. Today, a large segment of the annuity business is run as if it must carry huge costs on every deal, and consequently it builds little scale despite the wide need for well-priced product. We hope that we will see standardization of contracts and annuity tables in this industry, which will improve transparency, comparability, and thus cost competitiveness and volume.

portability is the decision variable that trumps all others. (However, the authors imagine that there are really very few industries in which portability truly serves the employers' interest, which is to retain experienced employees.)

Defined contribution plans as they exist in the US today are really savings (asset) plans, and don't give much consideration to the difficulty of providing a guaranteed lifetime income to all plan participants, including the longest-lived or least-prudential among them.

If we are going to have DC plans, we had better run them well. In our writings, we've supported efforts to improve DC plans, by suggesting fund choice designs that are both mean-variance efficient—maximizing the expected portfolio return at each given level of risk—and cost efficient.[13] These designs, alluded to earlier, are a family of well-engineered, pre-mixed asset allocation funds (lifestyle funds), communicated to employees in a manner that emphasizes the special benefits of being on the efficient frontier. We're pleased to report that our proposals are meeting with growing acceptance, and where used, these funds are proving their ability to make DC plans more effective, although such designs still represent only a small share of total DC plan assets.

But DC plans as presently constituted have some profound shortcomings, several of which we've already noted. We've focused on life expectancy risk, lack of investment skill, and high investment costs, but the question of forced savings is equally important, perhaps even more so.

A large proportion of employees contribute little or nothing to the DC plans that they're offered, and today in the US, they cannot legally be required to contribute more. And what is saved is often borrowed out through loan provisions or otherwise withdrawn for legally allowed purposes. Unless their contributions increase dramatically as they age, few DC participants will have an accumulation at retirement sufficient to provide a meaningful contribution to their retirement income, and will have to rely solely on other savings and their Social Security benefits (we present the remarkable data on this, in a moment).

In contrast, DB plans have the tremendous advantage of providing forced savings at a level sufficient to pay for a meaningful retirement benefit. The savings rate is not transparent to the employee, however, so it doesn't come with a perception that it is forced—even though it should be clear to all that the accumulated savings represented by the retirement plan promise can only represent a form of deferred pay. While the same savings rate could be required explicitly in a DC plan, there is just enough of a libertarian streak in the American public that it is unlikely that mandatory contributions will ever become a reality.

Let's revisit the notion that DC plans are always "fully funded." While DC plans appear from the point of view of the *employer's* balance sheet to be fully funded—there will never be any net balance sheet liability associated with them—that is not the whole picture of funding status.[14] From the *employee's* perspective, he or she is only rarely fully funded to a level that will provide anything

13 See Waring and Siegel (2006).

14 We sometimes joke that, by construction, the employees are always fully funded in a DC plan—but they might not like the benefit level! Such gallows humor calls attention to the difference between the liability associated with a desired level of retirement spending and that which would be provided by most DC plans.

like an acceptable retirement income replacement ratio. The *retirement liability* of the vast majority of employees in today's US DC plans will not be fully funded in a manner meaningfully equivalent to even the most parsimonious DB plan. Instead, the retirement liability is barely funded at all; the data are shocking.

The Employee Benefits Research Institute reports that the *average* DC plan balance is $150,000 at retirement, which converts, at the annuity rate discussed earlier, to a meager $11,775 annual income supplement for life. And that is the average of a highly skewed distribution: The *median* (half of the retirees have more, half have less) balance is only $44,000![15] It's not far from the truth to say, based on this observation, that for most employees, today's DC plan has very little retirement income value. And for most participants, the money just gets spent; no annuities are purchased at all. Social Security, with little augmentation, is all that most DC plan participants can expect.

Taking all these factors into consideration, it's clear that few employees can ever expect a secure and prosperous retirement, with reasonable income replacement, using the DC plan structure alone; for most, it is at best a very small contributor to retirement income. It is small enough that we are kidding ourselves when we even speak the phrase "defined contribution *retirement* plan." As they are typically configured today, they aren't retirement plans at all, but modest savings plans. They might *supplement* DB plans or other retirement income in small ways, but they are not replacements for them.

If a DC plan is all that you have, it can be improved; but given a choice (and in today's regulatory and practical environment), even a DB plan with comparatively limited benefits provides a much better retirement than any but the most generous, well-designed, and appropriately annuitized DC plans that we see in practice today. And we're saying this cautiously: *We don't actually see* many such DC plans, although perhaps they may be out there somewhere! Certainly we could do with more of them.

THE GREAT VALUE OF DB PLANS: CONCLUSION

We hope we've persuaded you that a sound retirement program really does require a DB plan as a keystone component. Defined benefit plans provide a more effective means of spreading one's *working life* income over his or her *entire* life than do today's DC plans. Defined contribution plans as they exist in the US today are really savings (asset) plans, and don't give much consideration to the difficulty of providing a guaranteed lifetime income to all plan participants, including the longest-lived or least-prudential among them.

Higher savings rates and efficient annuitization, sufficient at minimum to cover the retiree's core expenditures, are required to achieve that goal. The DB plan is perfectly suited to this task; DC plans seldom even try, and when they do, it is usually with more modest contribution levels and with commercial annuities. Now let's turn to the question of how to manage DB plans effectively, so they can continue to serve, or begin to serve again, as one of the legs of the "three-legged stool" of retirement security. What does a sponsor have to do to manage the risks and costs of sponsoring these plans?

What are the risks and costs of DB plans? How can they be managed?

We acknowledge that many sponsors experience the risks and costs of DB plans as unmanageable and overwhelming—but if one applies sound investment and management risk control principles, it just isn't

15 There is a small caveat: this refers to the balances in the plan in which the individual is a participant at time of retirement, so it doesn't take into account DC balances that he or she might have from plans associated with previous employers. It doesn't change the point being made: even if actual totals were twice these single plan figures, it is still way too little. At any rate, one's last employer is typically also the employer one worked for the longest, and at the highest rate of pay.

so. Here, in grossly shortened form to demonstrate their simplicity, are the principles for investment risk control:

1. ***The hedging portfolio:*** A sponsor should hedge those risks that can be hedged. In formal finance language, hold some portion of the portfolio in a "hedging portfolio" designed to hedge out the primary risks of the liability (which are mostly related to real interest rates and inflation). This need for hedging reinforces our prescription that we should look at the liability in economic, rather than in traditional actuarial, terms.

2. ***The risky-asset portfolio:*** If desired, take additional risk, beyond simply hedging, to try to achieve excess returns that will help pay for the plan. Again in formal terms, one can hold a "risky-asset portfolio," found by moving upward and to the right along the surplus efficient frontier. (The surplus efficient frontier is the analogue to the asset-only efficient frontier, but with the pension liability held short, so that the mean return and variance of return are for the pension *surplus*, assets minus liabilities.[16]) This would mean, for example, holding an equity portfolio and/or other securities that are expected, at least on average, to outperform the liability-hedging portfolio). And we'll note that these risky assets can be held *without* abandoning the goal of having the asset portfolio hedge out all of the interest rate–related risks of the liability (i.e., the liability can be completely hedged *and* the portfolio can also be exposed to risky assets at *any* place on the frontier!).

3. ***The alpha portfolio:*** For those sponsors that want to seek additional value from active management decisions and that have the special skills required, there are also opportunities.

Readers who are experienced with investment theory will recognize this as a form of the "two-fund separation theorem," here stated in the form that is required whenever there is a liability.[17] It is also an easily understood framework for articulating the idea and results of surplus optimization.

Since DB pension liabilities are mostly bond-like in nature, the primary risks that can be hedged include inflation risk and real interest rate risk (and perhaps a small amount of equity-like risk). So for now, it suffices to say that if you were to fully hedge these two interest-related risks by holding a liability hedging portfolio with similar exposures, you're something like 80% of the way to a riskless pension plan. The risks are no longer unmanageable (most have been managed), nor are they overwhelming.

There are other risks that *cannot* be hedged, of course.[18] But the risks that remain need not be all that large if properly managed.

And if, on top of that, you consider exposing the portfolio to some measured amount of *market* risk through a risky-asset exposure—which, after all, is fairly rewarded in expectation—you are clearly in control of that decision and can choose as much or as little additional risk as you are comfortable with taking: You are "in charge" of that risk. We think most sponsors are comfortable taking on a measured amount of risk, for a fair purpose such as increasing their expected return; and if that risk is properly controlled, there is little need to avoid it.

In fact, today nearly all sponsors hold a good deal of equities and other risky assets. Some sponsors who want to reduce overall pension risk might decrease this particular risk exposure, but there is no reason to expect risky-asset holdings to go away.

There is, however, every reason to expect to see sponsors begin to hold a hedging portfolio,

16 For plans that are in deficit, we are still best off for semantic consistency in thinking of assets minus liabilities as the pension "surplus," but with a negative value.

17 The two-fund separation theorem was introduced by Tobin (1958). A form for the two-fund theorem in the presence of a liability is explored by one of the co-authors in a draft white paper (Waring and Whitney 2007). See also Sharpe (2004) for a classic but technical exposition.

canceling the interest rate risks held short in the liability with opposing long positions. This risk-reduction opportunity is too important, and too easy to implement, to pass by once it is identified.

disconnected from the economic "ground truth." But third, over time, *the accounting must always follow the economics*. It can't be otherwise. So if you manage the economics you have also managed the accounting!

The need for hedging reinforces our prescription that we should look at the liability in economic, rather than in traditional actuarial, terms.

What about cost control? We'll get to that in a moment, after discussing the nature of the liability and of the risk-control solution more completely.

AN ECONOMIC VIEW OF THE LIABILITY

The first element of "new" technology that's needed to manage DB plan risk and cost is an *economic view of the liability.* The only risks that are helpful to know about are the risks that can be hedged through investing the assets, that is, those risks in the liability that are *market-related* (i.e., correlated with the returns of assets or indices available in the markets). This means that we need to set aside the actuarial and accounting views of the liability, and re-discount the cash flows at appropriate, market-related rates, and we need to understand how these market-related values, economically sensible measures of periodic pension cost,[19] and economically required contributions change as market interest rates change.

It doesn't make sense to use the accounting values as drivers of this risk-control process, as they are often heavily smoothed and otherwise manipulated. Why? First, you cannot hedge a smoothed liability (no matching asset is available); and second, the accounting numbers may be somewhat

Let's use this notion, first, to develop a "model" of the liability to use in our surplus asset allocation policy work. This will give more detail to our highly summarized version of the hedging process described above. We hope you'll pardon our brief digression into asset and liability return models, which require a few Greek letters. Let's start by noting that every liability is someone else's asset. So our "economic" model of the liability will have the same form as a model of the return on an asset or portfolio of assets. The simplest and most familiar such model is the single-factor capital asset pricing model of Sharpe (1964) and others:

$$R_{port} = R_f + \beta_{port}\, r_{mkt} + \alpha_{port} \qquad (1)$$

which links the movement of the price of an asset or portfolio ("*port*" in the subscript) to the excess return (risk premium) of the stock market.

Researchers after Sharpe noted that many assets are sensitive to risk factors other than the movement of the stock market. Interest rates and other risk factors are important too. So a *multi*-factor model of an asset might be:

$$R_{port} = R_f + \beta_1 r_1 + \beta_2 r_2 + \beta_3 r_3 + \ldots + \alpha_{port} \qquad (2)$$

18 These unhedgeable, residual, or "alpha" risks all have to do with estimating non-market factors that affect benefit levels and benefit timing in the participant population. With good estimation practices, the errors should be unbiased over time, that is, mean zero (and the volatility should be small if dealt with each year). The big one is usually thought to be mortality risk. Using ordinary unmodified life tables, sponsors routinely experience longer-living employees and thus surprise costs, which is not a mean-zero experience. Modified life tables, incorporating an estimate of increasing life expectancies, should go a long way toward returning this error to a mean of zero and making this risk also feel more "under control." However, there is likely to always be some error here. Such risks also include the possibility that benefits will be negotiated upwards and other liability "surprises" as prior years' estimates of pay, population, and other variable require updating.

19 An economically sensible version of what actuaries refer to as "normal cost." See footnote 30.

Fund-of-hedge-funds data is much less prone to survivorship bias than individual hedge funds. In addition the alphas do persist beyond the 1990s (by which time most database providers have become quite diligent in maintaining the records of the funds that disappeared).

where β_1, β_2, etc. are generic terms for the systematic, market-related, risk factors that influence the return on portfolio p. A risk factor can be called systematic if you can obtain the return on that factor with an index fund, or with a portfolio constructed according to some other simple, mechanical decision rule. Thus, nominal or real interest rates, and inflation, are systematic risk factors in just the same sense that exposure to the stock market is a systematic risk factor.

A DB pension liability is the present value of a set of forecast cash flows to be made for benefit payments, so its size is mostly influenced by interest rates, much more than by the stock market or other factors that might come to mind. Moreover, the nominal interest rate has two major components: (1) the inflation rate that is expected over the life of the bond (denoted by i), and (2) the *real* interest rate, or nominal interest rate minus inflation (denoted by r).

It is important to distinguish in this analysis between the real interest rate component and the inflation component, because a DB pension liability is differently sensitive to each. For example, the liability for an active employee whose pension is based on final pay is very sensitive to the amount of inflation experienced between the time a unit of pension benefit is earned and the time the final rate of pay is determined (because wage inflation affects final average pay). In contrast, once the pension payment is set at time of retirement (one that is made in nominal terms, with no cost of living adjustment or "COLA"), it is not sensitive to inflation.

So we have to keep track of the sensitivity of the overall DB plan liability (L) to each of the two major components of the nominal interest rate. We can get this "pretty good" model of the liability's return as the sum of the risk-free rate, in this case one appropriate for the long term of the liability, $R_{f(LT)}$, and two factor returns related to capital appreciation returns when real interest rates or inflation levels change:[20]

$$R_L = R_{f(LT)} + \beta_r(\Delta r) + \beta_i(\Delta i) + \alpha_L \qquad (3)$$

Putting some plausible numbers from a typical corporate plan to equation (3), the liability would have a return as follows:

$$R_L = R_{f(LT)} + (-15)(\Delta r) + (-8)(\Delta i) + \alpha_L \qquad (4)$$

Note that we have reduced the liability model to only two factors (other than the long-term risk-free rate): (1) sensitivity to real interest rates and (2) sensitivity to inflation, plus (3) a non-factor residual return, or alpha (unhedgeable as discussed above). There is some method to our reductionistic madness: the first two of these happen to be the same two risk factors that we can hedge through investment policy; of course, the alpha or residual liability risks cannot be hedged, but rather must be managed through non-investment-related business practices.

Here is the payoff to understanding the liability return: If we can hedge away these two interest rate-related risks in the liability by holding a "hedging portfolio" on the asset side, we have eliminated most of the risk of sponsoring a DB plan.

HEDGING THE MARKET-RELATED RISKS IN THE LIABILITY: "DUAL DURATIONS"

We now need to find this investment portfolio that, as fully as possible, hedges the real interest rate risk and inflation risk exposures in equation (4). This task turns out to be surprisingly simple. As we showed in Siegel and Waring (2004) and Waring

20 For an investor with a long-term liability, such as a pension fund, long-term Treasury bonds are safe, and short-term bonds (usually referred to in finance as yielding the risk-free rate) are risky. See Modigliani and Sutch (1966). Thus we frame this equation in terms of the "long-term risk-free rate," which is the yield to maturity on long-term Treasury bonds or "strips" (principal-only bonds). In the notation of Ibbotson Associates (2006), the long-term risk-free rate consists of the short-term risk-free rate plus a "horizon premium," the extra return required by investors for investing in long-term rather than short-term Treasuries.

(2004a), *all* assets have two durations—separate sensitivities to real interest rate risk and to inflation risk—not just the single, ordinary duration used to measure the sensitivity of the price of a nominal bond to changes in nominal interest rates. Only for nominal bonds do the two durations happen to have the same numerical value, a natural result of having a fixed cash flow in the pricing formula numerator. For *all* other assets—equities, inflation-indexed bonds (TIPS), real estate, and so forth—and for liabilities, which are after all just someone else's asset, *the two durations differ*.

TIPS are the clearest example of this "dual duration" property of investment assets: their sensitivity to changes in the real interest rate is much like that of a nominal bond of comparable maturity, while their sensitivity to changes in inflation is essentially *zero*. In other words, because all of the cash flows in a TIPS bond are fully indexed to inflation, the price of a TIPS bond does not change when the inflation rate changes. The dual duration of a typical long-dated TIPS may be written as the ordered pair (15, 0), meaning that the real interest rate duration of the TIPS bond is 15 "years" (or more expressively, percent; that is, its price falls by 15% for each one percentage point rise in the real interest rate); and the inflation duration of the TIPS bond is zero.

The dual duration of a nominal bond of comparable maturity can thus be written (15, 15). The pension liability described in equation (4) has a dual duration of (15, 8).[21] And equities, as proxied by the S&P 500 index, have a dual duration that has been estimated by one of the authors at approximately (8, 0).[22]

FIRST EXAMPLE: A HEDGING PORTFOLIO ONLY, WITHOUT ANY EQUITIES IN THE PORTFOLIO AT ALL

It is not too big a leap from this discussion of the liability's dual durations and the fact that all assets also have dual durations, to then find an asset-liability portfolio that is fully hedged to the liability in both dimensions of duration. This solution, sometimes called the liability-matching portfolio (located at the extreme left end of the surplus efficient frontier), is a hedging portfolio only (with no risky-asset portfolio), using only nominal bonds and TIPS (i.e., no equities or any other risky-asset portfolio), is developed in Siegel and Waring (2004): the plan is assumed to have a liability with a dual duration of (17.5, 7.6) and assets equal in dollar size to the liability.[23] A portfolio of fixed income investments that is fully hedged to the liability, by also having a dual duration of (17.5, 7.6) if fully funded, would consist of 51.6% in nominal bonds with a duration of 15.00, and 48.4% TIPS with a real interest rate duration of 20.17.[24]

"This is quite a large weight in TIPS," we observed, and these are also quite long real interest rate durations—longer than what the US Treasury bond market typically has to offer. However, "strips" and/or leverage (through swaps or futures

21 We've dropped the minus signs in the transition from equation (4) to the current discussion because it is conventional to do so.

22 See Waring (2004), which originally estimated equities as closer to (0, 17). Based on research since that time, he is convinced that the (0, 8) values in the text are an improvement over that earlier figure.

Equity duration is a challenging issue for many analysts, who often argue that it is zero. Yet these same people will quickly estimate stock-bond correlations as 0.3 or 0.4. If equities have a non-zero correlation with nominal bonds, then, mathematically speaking, they must have a non-zero nominal duration! And if equities have a non-zero correlation with TIPS, which is easily demonstrated mathematically, then they must have a non-zero real interest rate duration. And both taken together suggest a difference between real rate duration and inflation duration. So, while it isn't yet possible to estimate or measure equity durations with the precision we are accustomed to when calculating bond duration, it is possible to satisfy oneself that these estimates used are in the right ballpark.

23 These estimates are for a prototypical pension plan (not any specific actual plan) and are from Goodman and Marshall (1988).

24 Since one can vary the durations of the bond portfolios at will, one can also vary the holdings weights so that the total fixed income (bonds plus TIPS) portfolio still has a dual duration of (17.5, 7.6). Thus there is a whole "family" of solutions, not just the one solution shown here.

contracts) can often be used to achieve the needed durations through an appropriately engineered and maintained overlay.

MOVING FROM THE EXTREME: ADDING EQUITIES TO THE MIX

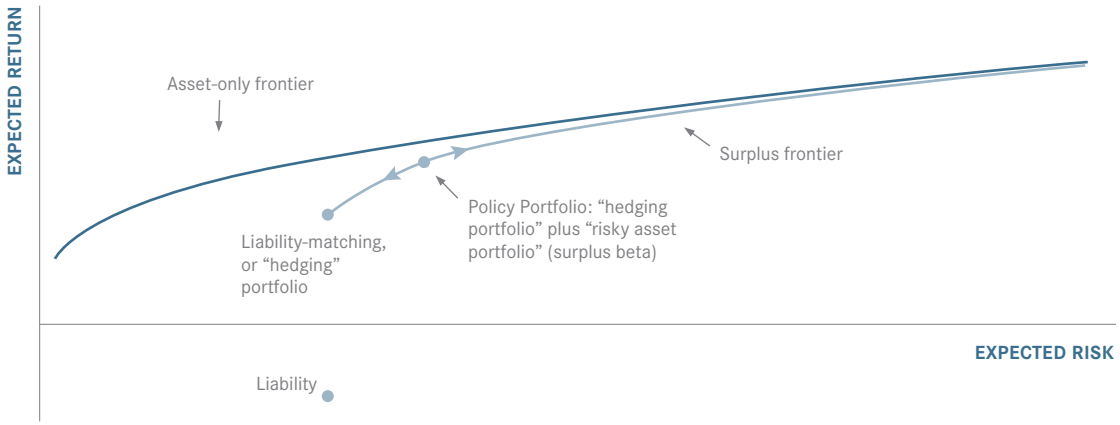
Some analysts would stop here, having found a way to build a portfolio of pension assets that is fully hedged to the liability in both dimensions of duration. However, just about all pension plans also include exposures to the full range of market instruments beyond those required simply for hedging the liability. These market instruments include equities and other risky assets, sometimes held in large proportions. We now need to incorporate the possibility of holding this "risky-asset portfolio" into the analysis.

Most readers are familiar with the concept of an efficient frontier. Exhibit 2 shows asset-only and surplus (asset minus liability) efficient frontiers. The asset-only efficient frontier is a curve that extends from the lowest-risk, lowest-return portfolio (which consists mostly of cash) at the lower left corner to the highest-risk, highest-return portfolio at the upper right corner. From among the portfolios on this frontier, there is no single best portfolio; the portfolio that is best for a given investor depends on the risk aversion of that investor.

The same principles apply to a surplus efficient frontier, used for developing an asset-liability policy portfolio. The fully hedged pension portfolio, with real interest rate risk and inflation risk essentially eliminated, is just the minimum-risk point on the surplus efficient frontier shown in the exhibit as the liability-matching or hedging portfolio. (Note that the liability is seen below the x-axis as a mirror image of this minimum-risk portfolio.) The pension manager may, and usually will, wish to choose a riskier point on the frontier in the hope of earning a higher average return over time, which—if successful—will reduce the plan's contribution requirements. Such a portfolio combines the hedging portfolio with the risky-asset portfolio. We sometimes describe this risky-asset position in terms of its "surplus beta," to make the point that it is risk taken on that is surplus to that needed to simply hedge the liability. How much surplus beta risk should be taken depends on the risk tolerance of the sponsor: The sponsor is in total control, able to choose from *zero* surplus beta exposure all the way up to a great deal of it.

Exhibit 2

ASSET-ONLY AND SURPLUS EFFICIENT FRONTIERS (IN ASSET SPACE)



There are two or three second-order things happening as we introduce this risky-asset portfolio into the mix, and they need to be followed for a complete understanding of how this surplus optimal solution varies from current practice. First, equities and most other components of the risky-asset portfolio have among their many risk factor exposures both real interest rate risk and inflation risk factors, the physical assets. This reduces the degree of dependence on interest rate derivatives for providing long dual-duration exposures.

In other words, because of the very long durations required to match the liability, we have to free our minds of the strictures of investing only in physical assets in order to get the factor exposures that we want. After all, it isn't *capital* asset allocation, but

The fully hedged pension portfolio, with real interest rate risk and inflation risk essentially eliminated, is just the minimum-risk point on the surplus efficient frontier shown as the liability-matching or hedging portfolio.

dual durations. So some portion of the liability's dual-duration hedging portfolio factor weights might actually come from the risky assets. Waring (2004a, 2004b) discusses the mathematical details of this interaction. But it is just a matter of parsing the various risk factor exposures and keeping track of them so that at the end of the day we hold the liability-hedging and risky-asset exposures that we want.

Secondly, if we want to physically hold, say, one-half of the portfolio in risky assets, then we can only hold just the other half of the portfolio in bonds, which is our primary source of dual-duration liability-hedging risk exposures. If this is the strategy chosen, the durations of those bonds are going to have to increase by a factor of two in order to provide all required hedging (less any contribution to the dual durations found in the risky-asset portfolio, as noted in the prior paragraph). And we may not be able to get such long durations by holding ordinary bonds (that is, in the "physicals" market); we may have to look to the futures and swaps markets.

And to take this a step further, we can purchase equity exposure using futures contracts, seamlessly replacing index funds and simultaneously freeing up cash with which to purchase more long-duration

the allocation of our *risk* exposures, that is important. While some might be tempted to refer to this approach to investing as "leverage," that isn't really the best term. It is simply managing the assets so that they have the risk-factor exposures required to provide the desired blend of hedging portfolio and risky-asset portfolio, an ordinary exercise in risk-control technology.

HOW MUCH SURPLUS BETA RISK SHOULD THE PLAN SPONSOR TAKE?

Capital market theory tells us that the market-related risk represented by a fully diversified portfolio is rewarded in expectation by higher excess returns, with the expected excess return proportional to the amount of beta risk (in this case, surplus beta risk) taken. So you start at the extreme left end of the frontier, with no risky-asset portfolio and zero surplus beta, and progressively move "up" the surplus efficient frontier, considering higher and higher risky-asset portfolio exposures, with their corresponding higher expected returns, until you are unwilling to take on any additional risk.

Your motivation is the hope that you will achieve those higher expected returns, and that they will help reduce the contributions and economic pension

expense required to pay for the plan.[25] But of course the beta risk that you take on is genuine risk: If "risk happens" (if the market goes down), it will result in *higher* contributions and expense, not *lower*. This is the risk/return tradeoff faced by a plan sponsor.

taking more risk may be justified if there is a margin of safety in corporate cash flows available to make additional pension contributions if there are disappointing returns.

The question of how much surplus beta risk to take is most appropriately evaluated at the enterprise level, by assessing the ability of the enterprise to tolerate additional pension contributions if "risk happens."

Today's portfolios seem to average 70% or more in equities and other risky assets. One may question whether this represents a greater exposure to risky assets than many sponsors are really willing to tolerate. We know that sponsors are aware that higher *expected* returns come with these exposures; we hope, but we cannot be sure, that they are aware of the downside risk—namely that, in the event of poor returns, future contributions may be increased.

The question of how much surplus beta risk to take is most appropriately evaluated at the enterprise level, by assessing the ability of the enterprise to tolerate additional pension contributions if "risk happens." This ability is related to the size and probability of the potential pension shortfall from bad investment returns, compared with the size, profitability, and variability of profitability of the rest of the organization (and to the expected correlation between poor investment returns and tough times for the sponsor parent). Merton (2006) does a good job of discussing these issues. If the entire organization would be stressed by bad pension investment performance, it will probably tolerate less risk, and vice versa. So sponsors who are healthy and wealthy, and who have pension liabilities that are small proportional to their overall balance sheet, may be more willing to take on market risk than those that are less healthy and well. In other words, Sponsors will differ widely in their risk tolerance based on such factors, so we should expect to see widely varying exposures to risky-asset portfolios across different sponsors. Today that isn't the case, an indicator that traditional approaches and technologies aren't working well.

TODAY'S INVESTMENT POLICIES UNDER CONVENTIONAL ALM PRACTICE, COMPARED

How are plans doing under today's conventional ALM technologies, compared with this surplus optimization approach? Not so well. We observe that most sponsors today seem to take quite a bit of surplus beta risk, with total exposures to equities and equity-like assets bunching quite tightly around 70%+ of the assets. Further, very few sponsors hold a hedging portfolio—as evidenced by the fact that the fixed income benchmark is nearly always the Lehman Aggregate or some other relatively short-duration equivalent—leaving these plans massively exposed to risk from interest rate decreases, to facilitate an equally large bet on interest rate increases in the hope of restoring full funding.

We've seen the damage caused by the quite ordinary bear market in equities and decrease in interest rates that happened in 2000–2002 to plans with exposures

25 The accounting measure called "pension expense" today is a net value, including normal cost, investment returns on the assets, interest cost on the liability, and actuarial gains and losses. The fact that these items are netted to a single value called "pension expense" is somewhat controversial and may be addressed by FASB.

such as these. This damage was the fully predictable result of conventional actuarial ALM technologies: *Of course* the funding status and the expected contribution levels of such plans were hurt badly with so little hedging and so much equity exposure. It was well within the possibility set in any period that equities could fall by 50% from peak to trough and that long-term interest rates could fall by three percentage points, and it was virtually a certainty over a reasonably long period of time. And it could happen again, yet the traditional technologies promoted, and still promote, these risk exposures.

We believe that sponsors who understand the true risk/return tradeoffs in pension asset management will want to (1) match the dual durations of the assets more closely to the liabilities, holding a very good hedging portfolio, (2) hold smaller risky-asset portfolios, taking somewhat lower levels of surplus beta risk than typically found in current practice (i.e., they might want their investment policy to be more "connected" to the liability), and (3) consider whether (and how) they should incorporate sources of expected alpha from active management (discussed in the next section). These are the three decisions that have to be considered by any sponsor seriously concerned about bringing under control those pension-funding risk exposures that arise from investment policy.

Just to be clear, we're not saying to abandon equities; quite the contrary. Getting out of equities altogether would be an extreme position, as much so as taking the large doses of equity risk that we see in many pension plans today. If held in reasonable quantities, equities and other risky assets can help pay for the plan, in *expectation*, at risk levels that most sponsors would find perfectly acceptable.[26]

THE ALPHA DECISION FOR THE ASSET PORTFOLIO

The third investment policy decision for sponsors is whether to try to increase their returns by skillfully taking on active risk, *alpha* risk. Alpha risk—and alpha returns—are independent of and incremental to the surplus beta risk we've been primarily discussing.

The search for alpha is a legitimate search, as long as one fully understands the ground rules. While this is not the place for an extensive discussion of alpha and active risk, we'd remind readers that every dollar of alpha is earned at the expense of some other investor: active management is a zero-sum game. Only the most skillful investors can win this game, other than by chance. This doesn't mean that you can't earn alpha; it just means that to do so you have to take it away from someone else. In practice, this means that plan sponsors must have skill at picking managers who, in turn, have skill at picking securities or at making other investment "bets."[27]

While adding active return (alpha) is highly desirable, it is by no means a foregone conclusion that one will succeed at it. It's perhaps the most difficult task in finance, but the reward to those who succeed is (obviously) a higher realized return and thus a lower required pension contribution. For sponsors *who have the required skill*, there is an unambiguous improvement in their pension funding risk/return tradeoff. At all levels of analysis, the pension fund can be expected to be better off.

SUMMARY: WHAT RISKS HAS THIS APPROACH CONTROLLED?

The technology we've outlined makes it possible to sponsor a DB plan at manageable levels of risk. Note that we *don't* claim to have eliminated *all* risks. But we have (1) nearly eliminated some risk,

26 This is not the same thing as saying that the real cost, risk-adjusted, is changed by holding equities. It isn't. Risk premia from the risky-asset portfolio are not relevant to the discount rate used in valuing the plan; only the expected return of the liability-matching or hedging portfolio is relevant.

27 These are the Two Conditions of Active Management, from Waring, et al. (2000), and Waring and Siegel (2003), but with managers instead of securities as the unit of selection.

(2) taken controlled amounts of other risks, and (3) noted that there are some modest risks that remain that cannot be controlled through investment policy.

(1) We have *nearly* eliminated the risks of mismatch in investment performance between the asset portfolio and the liability, through our hedging portfolio. But while duration measures sound precise, there are some estimation errors in assessing the dual durations of the liability, and on the asset side, of the dual durations of equities and other non-fixed income assets. The resulting mismatch errors should be of only modest consequence in most cases, and will get smaller over time as estimation technologies improve.

(2) And we've shown how to *control* how much additional risk we intentionally take, by changing our exposures to the risky-asset portfolio.

While we haven't discussed it at length in this paper, the sponsor also has the ability to control the amount of risk to which it is exposed from the search for alpha, or above-benchmark returns, through active management decisions.

And (3), we mentioned that the residual or alpha risks in the liability cannot be hedged. Such risks include the fact that people keep living longer than some actuarial tables predict, and the possibility that benefits will be negotiated upward. Alpha risks in the liability cannot be hedged through investment strategy because they are not correlated to any possible investment (including asset alpha). They must be addressed by managing the pension promise in a businesslike manner, using actuarial tables that estimate what life expectancies will be rather than what they are now, and with hard-headed benefit and pay decisions based on benefit valuations computed at market, or economic, rates rather than on traditional actuarial rates.

So the liability's inherent rate risks should be eliminated so far as it is possible to do so, through the hedging portfolio, and its residual risks should be controlled as far as possible through more careful liability forecasting and benefit-level management.

And with respect to the other types of investment-related risks—surplus beta risk from the risky-asset portfolio and alpha risk from active management—the sponsor might not choose to eliminate them, but it *can control* both to whatever level it is comfortable with.

And being in control is a good thing.

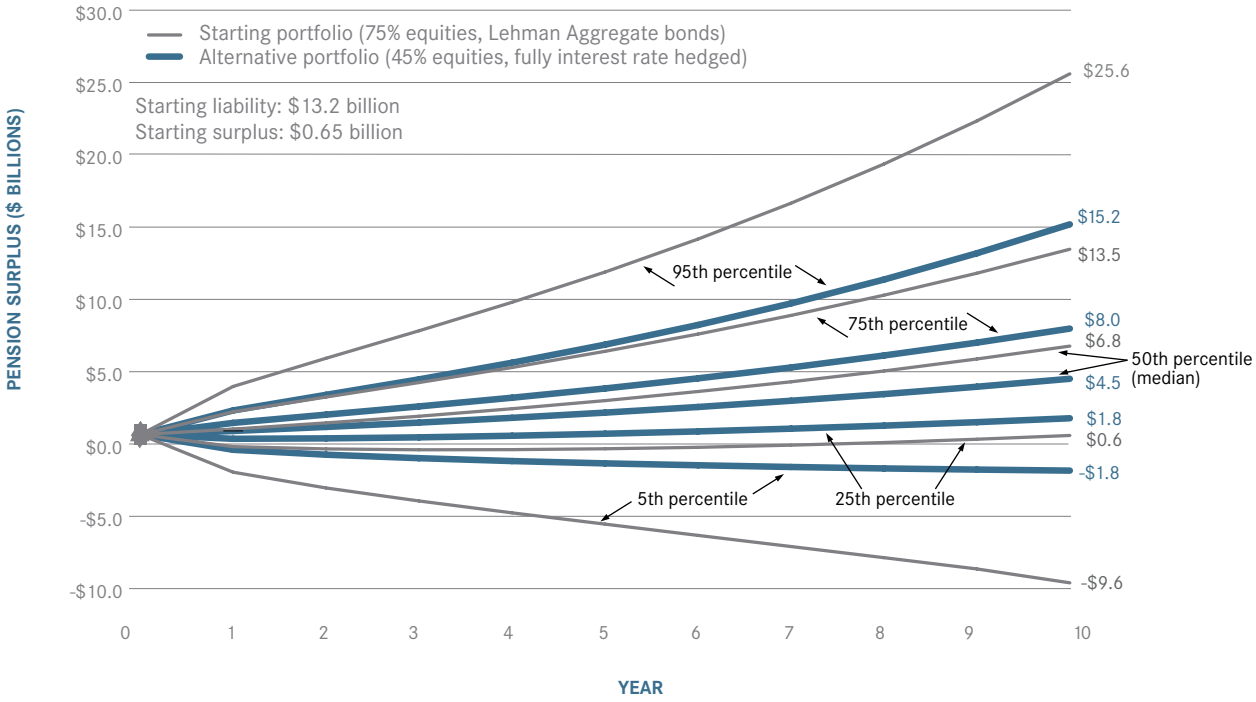
REDUCING SURPLUS RISK: A WORKED EXAMPLE

The risk/return tradeoff facing the employer that is considering moving from a risky to a lower-risk pension investment policy is illustrated in Exhibit 3. The exhibit shows two probability distributions of the pension surplus for a typical corporate DB plan with an initial (economically valued) liability (in year zero) of $13.2 billion, with a small economic surplus. One of the probability distributions is for a starting portfolio such as is typically generated from conventional ALM approaches, consisting of 75% equities and 25% nominal bonds benchmarked to the Lehman Aggregate (thus not duration matched in the two dimensions of duration); the other is for an alternative portfolio built using the approaches espoused here, a lower-risk and fully dual-duration-matched mix of a hedging portfolio and a risky-asset portfolio, with only 45% in equities and 55% in a mixture of nominal bonds and TIPS, incorporating the dual-duration matching principle. (The two distributions are overlaid in the same diagram.) Forecast future contributions are not deducted, since these are interactive with investment results; to include them would hide big portions of the true risk/return tradeoff implied by the investment policy decision being made *today*.[28] We don't show any estimate of liability alpha risk, because we want to focus clearly on risk and return tradeoffs related to investment policy.

The central line in each probability distribution represents the 50th percentile, or median, scenario. Compared with the starting portfolio, the better hedged and more conservative alternative portfolio naturally has a lower median outcome (dollar value

Exhibit 3

PROBABILITY DISTRIBUTIONS OF PENSION SURPLUS, OVER TIME, WITH 75% AND 45% EQUITY MIXES



of the surplus); in year 10, the median outcome is lower by $2.2 billion ($4.6 billion instead of $6.8 billion). Thus the effort to reduce risk has the exact downside that one would expect: if you lower your exposure to risky assets, you increase the *expected* (we show the median) contributions to the plan measured at some future point in time—lower average or median growth of surplus does translate into higher expected contributions to the plan.[29]

But there is an offsetting *benefit* that accompanies this lower expected asset return and higher expected contribution level: you *reduce* contributions under poor equity return scenarios. If "risk happens"—if the market goes down—the funded status, and thus the contribution requirement, won't be damaged as much as it would have been if one held the more aggressive policy portfolio. The lowest line in each probability distribution, representing the 5th percentile or 1-in-20 worst-case scenario—a proxy for risk—improves tremendously with the less-risky alternative portfolio. In this scenario, the alternative portfolio produces a $1.8 billion deficit at the end of 10 years, a much better outcome than the $9.6 billion deficit produced by the original strategy and the old technology.

28 However, the probability of needing additional contributions in the future to support today's funded ratio or level of surplus, given an investment policy decision also made today, is a direct readout from this chart. Specifically, at any point in time, a vertical cross section of the chart represents a probability density function (the difference of two lognormal distributions). Thus the portion of that cross-section line under a line drawn at the level of today's funded status represents the probability of additional contributions being required at that point in the future as a result of downside investment risk, and the area above represents the probability of reduced future contributions from good returns (relative to holding only a fully hedged zero surplus beta portfolio). More generally, the probability of future contributions being required can be determined from this distribution for any funded ratio or level of surplus. This dramatically aids the sponsor's ability to make a proper risk/return tradeoff between different investment policies.

29 This is not a reduction in the "present value of future contributions," to be clear, but in the "expected future value of the then-present value of future contributions." While a mouthful, the distinction is important.

We think it is pretty clear that, despite the lower expected or median return, most sponsors would prefer the alternative distribution, the nicer one resulting from using these modern tools, over the distribution provided by the conventional actuarial ALM methods!

Back to cost control: "But DB plans are just too expensive!"

Okay, let's circle back to cost control. We've heard from sponsors who feel that, despite their understanding of the availability of tools to better manage the *risks* of DB plans, these plans are just too *costly* (where "cost" has the proper economic, not actuarial, definition that we've been using all along; in our experience, sponsors intuitively use the correct notion in conversation even if they can't precisely define it).

And we'd better take a moment to *precisely* define economic cost, "cost" for short, in this context. Each year that the employee works, of course, there is a portion of total compensation that represents the accrual of pension benefits (another year of service, perhaps a real pay increase, perhaps an inflation increase). We don't have space in this discussion to show in detail how to measure this year-by-year accrual of pension liability, but it suffices to say that one can define a measure of it that meets a financial economist's sensibilities.[30] To give some precision to the idea of this yearly cost, we'd note that it is the *change (from all sources) in the present value* of a particular measure of the pension liability, from one period to the next, $PV_t - PV_{t-1}$. This is the cost that is relevant to decision making, and it is the cost that we seek to control.

Periodic economic pension costs are obviously directly related to benefit levels. So what do you do if you conclude that your plan's economic costs are too high? You refine the benefit policy so that the costs are in line! Maybe your plan's especially generous 2.5 multiplier on years of service, multiplied by final average pay, just works out to be too expensive; combined with cash payroll and other benefits the sponsor concludes that total compensation is beyond that which is required to attract, retain, and motivate the employees. Or maybe it's not—in which case maybe the economic cost of your pension plan isn't too high after all. Your call.

So, if the economic cost of the pension plan is too high, work with the employees to set a level of benefits, and thus a level of economic cost, that *isn't* too high. Try 1.5 times years of service; or make other adjustments to change the true or economic present value of benefits. Some benefit features are very expensive: for example, providing full inflation protection through a cost-of-living allowance, or COLA, will likely add 50% or more to the economic cost of a basic, fixed benefit. Such benefit features are highly prized, of course, but may not be affordable in all contexts.

And we don't mean to trivialize the effort with which benefit-level adjustments are negotiated, or the strength of feelings that may be involved; it won't be easy (actually, the same is true for contribution-level increases, another means of balancing a troubled plan!). But there is room for all to agree on a level of benefits and a level of costs that is appropriate—but only if the cost can be made meaningful

30 Actuaries refer to this periodic cost as "normal cost" or "service cost." It is a function of what is sometimes referred to as the "full economic liability," which can be broken down into smaller, component measures of the liability. Without discussion, we'll point out that it is one of these smaller measures that is usually used for cost purposes and contribution purposes.

Cost is one of several elements of "pension expense," along with interest costs, investment returns, and supplemental costs. Interest cost and investment returns are not really costs in any strict sense of the word. Supplemental costs are simply the changes in the liability required to reflect updates and improvements in estimates of mortality, length of service, etc.

While actuarial normal cost measures won't usually be the same as a market or "economic cost" measure, there is a functional relation, albeit complex, between the two: Actuarial measures have to follow the economic measures, at least over long periods of time. The cost is what the cost is, regardless of accounting, and it will show up even if manipulated for deferral. Relating actuaries' and accountants' versions of all pension measures to economic measures is a full subject in itself, treated in Waring (2007).

and transparent to all the constituencies, that is, an economic view of pension cost rather than a traditional actuarial view.

After all, a reduced benefit is still much better than a replacement DC plan, with all of its typical design shortcomings. And if such a compromise makes the DB plan sustainable over the long term, and if it also protects the economic viability of the job itself where it would not otherwise have remained tenable for the long term, then a reduced benefit has to be agreed to be a "win" for both sides.

It is hard to discuss such tough choices, but we must because the alternatives could be even more difficult. Let us acknowledge these are conversations that no one, either in labor or in management, wants to start. They are just too difficult. Discussions about greater contributions or reduced benefits are bound to be wound up in passion and anger. Until recently, such conversations were simply out of bounds, not held in polite company. But today it is becoming clearer that for the benefits of DB plans to be sustainable, benefit and contribution formulas must be set with an eye on true economic cost, and in the context of total labor cost.

The bottom line is simply this: Pension benefits are just a component of total labor cost, and as such, total compensation must be sufficient to attract, retain, and motivate the work force, but no more—if the employer is to remain competitive and if jobs are to remain secure. And, once that level is set, if benefits are to be secure, then the portion that is in the form of deferred pay (pension benefits) must actually be paid for (that is, set aside as it accrues) using an economically reasonable method of calculating required contributions. While labor and management will always have opposing views on exactly what the level of total labor cost should be, they will surely agree with these general principles and repeatedly prove that they can find agreement on other tough issues. And we're totally confident that labor and management will negotiate better decisions if they are given better information, *economic* information about year-by-year pension costs, required contributions, and the accumulated present values of liabilities.

And with these observations, we can see that the DB plan can be made to be cost effective and can be saved, even if the current benefit levels are too expensive, by revisiting benefit levels based on *true economic costs,* in context of the total compensation package.

Conclusion

THE NEED TO USE ECONOMIC RATHER THAN ACTUARIAL MEASURES

Note that we've been discussing the liability in purely economic terms, with infrequent reference to actuarial or accounting conventions. It is our strongly held belief that if the risks in the liability are going to be managed successfully, and if the costs in the liability are going to be negotiated and set at arm's length, this economic view of the liability is the only one that provides useful decision-making insight. We'd acknowledge, however, that the actuarial and accounting views represent pressures on the CFO that are "real," or at least that are perceived as real today—even though they are no more real than many other "book values," which typically are inherently stale, smoothed, or otherwise artificial. It is the search for "more real" measures that is driving the move toward mark-to-market accounting, and it is our argument that this is a good thing for sponsors, not a bad thing.

We often say that if a sponsor manages the true economic risks and costs of the pension plan, the accounting risks and costs will be managed also. We also acknowledge that this isn't a point that has been made by the actuarial and accounting professions in the past, as they've treated the traditional actuarial values as if they were in fact real, and have asked sponsors to give their values that level of dignity. But few sponsors are fooled by this, having participated in too many discussions in which assumptions—and thus the measures—were

changed, for purely cosmetic reasons. Those sponsors have inevitably, and appropriately, become skeptical of the reported valuation, expense, and contribution values. And in their intuition, they know that these liabilities must have true, or central, values—the "law of one price" is not lost on most well-trained executives. One wonders how it got lost in pension accounting.

It is to those insightful sponsors that this paper is most addressed: They know that true value is neither created nor destroyed by the accounting system, but only by real economic or market transactions and occurrences. The "real" economic impact of the pension plan on the sponsor will come out sooner or later, regardless of efforts to manipulate it in the short term. In another paper now being written (Waring 2007), one of us is showing in detail how the economic and accounting versions of the balance sheet, income statement, and cash-flow statement entries for the liability are related, with a goal of assisting in more detail those who face these pressures.

Not only is mark-to-market accounting (the current buzzword for economic accounting), not "more risky," but it will actually improve sponsors' ability to manage their plans more effectively, with less economic risk and less cost, because it will enable sponsors to make benefit decisions, contribution decisions, and investment decisions that are better informed by the economic reality of the plan.

Mark-to-market, then, is not destructive, but constructive: You can't manage what you can't see, and it is economic accounting that lets a sponsor "see" what is really happening inside the plan.

SAVING DB PLANS

We are deeply disappointed that there is a pension underfunding crisis. The technology needed to manage pension plans with a minimum of risk and cost has been available, at least in concept if not in practical application, for decades. Little that we have to say is literally new, although we've connected the dots in ways that haven't been fully connected before and have made the technology practical and usable (particularly in terms of combining detailed economic views of liability measures with surplus optimization). Most sponsors, most consultants, and almost all actuaries simply just didn't use the technology even though the basics were known, favoring traditional ALM studies and traditional actuarial cost methods instead. As a result, sponsors are exposed to a lot of surplus beta risk, hoping that a rising stock market will eliminate or sharply reduce the need for pension contributions. And they are also exposed to a lot of real interest rate and inflation risk for lack of understanding the immediate benefits of holding an asset portfolio that is hedged to the liability. Both exposures have had painful consequences, 2001 and 2002 being the poster-child examples. Yet a portfolio with the same expected returns could have been held, with much less risk, using the new toolkit.

We now want to help make sure that these sponsors, in desperation to control what wrongly appears to be uncontrollable, don't kill the goose that lays the golden eggs. This "golden egg" is the DB retirement plan, best understood as an institution that spreads employees' working life income over their entire life, providing security in non-working later years.

There is no other practical way to achieve this redistribution of income over time or for the employer to share in the benefits. And, as demonstrated by the failure of DC plans to achieve adequate savings rates, there is also no other lawful way to force employees to save enough to retire. You have to "do it for them," through a DB plan.

LET'S KEEP THE GOOSE HEALTHY!

We've described the "gains from trade" that arise from the sharing of risk and other features that are characteristic of today's DB plans. We've noted that this gain is large, and that it can and should be shared by the employee and employer, providing "wins" for both parties.

Let's not allow the "gains from trade" in the DB pension plan to be tossed away on the grounds that the risks and costs of the plan are too overwhelming to be managed. They're not.

The techniques needed to manage them are known and have been described here, albeit briefly. For the sake of our employees, and for our own sake to bolster competitive advantage in a labor market that increasingly cherishes secure retirement benefits, let's keep the goose that lays the golden eggs healthy, or make her healthy where she is not. Let's strengthen defined benefit plans using technologies that make their risks manageable and cost effective, and that will enable such plans to thrive for generations to come.

The tools to control risk and cost are right in front of us. The need is urgent. Don't kill the golden goose.

References

Goodman, Laurie S., and William J. Marshall. 1988. "Inflation, Interest Rates, and Pension Liabilities," Chapter 6 in Arnott, Robert D., and Frank J. Fabozzi, editors, *Asset Allocation: A Handbook of Portfolio Policies, Strategies, & Tactics*. Probus, Chicago, 1988.

Ibbotson Associates. 2006. *Stocks, Bonds, Bills, and Inflation 2006 Yearbook*. Morningstar, Inc., Chicago.

Merton, Robert C. 2006. "Allocating Shareholder Capital to Pension Plans." *The Journal of Applied Corporate Finance* (Winter).

Modigliani, Franco, and Richard Sutch. 1966. "Innovations in Interest Rate Policy." *American Economic Review* (May).

Sharpe, William F. 1964. "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk." *Journal of Finance* (September).

Sharpe, William F. 2004. *Macro-Investment Analysis: Equilibrium.* Found at http://www.stanford.edu/~wfsharpe/mia/eq/mia_eq1.htm on August 15.

Siegel, Laurence B., and M. Barton Waring. 2004. "TIPS, the Dual Duration, and the Pension Plan." *Financial Analysts Journal* (September/October).

Tobin, James. 1958. "Liquidity Preference as Behavior Towards Risk." *Review of Economic Studies* 25, no. 2 (February): 65–86.

Waring, M. Barton, and Michael J. Assaf. 1992. "A Strategic Approach for Selecting Plan Investment Options." *Profit Sharing* (December).

Waring, M. Barton. 1994. "401(k) Investment Strategy: Déjà Vu All Over Again." *The Journal of Investing* (Summer).

Waring, M. Barton. 2004a. "Liability-Relative Investing." *Journal of Portfolio Management* 30, no. 4 (Summer).

Waring, M. Barton. 2004b. "Liability-Relative Investing II." *Journal of Portfolio Management* 31, no. 1 (Fall).

Waring, M. Barton, Duane Whitney, John Pirone, and Charles Castille. 2000. "Optimizing Manager Structure and Budgeting Manager Risk." *Journal of Portfolio Management* (Spring).

Waring, M. Barton, and Laurence B. Siegel. 2003. "The Dimensions of Active Management." *Journal of Portfolio Management* (Spring).

Waring, M. Barton, Laurence B. Siegel, and Timothy Kohn. 2004. "Mind the Gap: Why DC Plans Underperform DB Plans, and How to Fix Them." *Investment Insights* 7, no. 1 (January). San Francisco: Barclays Global Investors.

Waring, M. Barton, and Laurence B. Siegel. Forthcoming 2007. "Wake Up and Smell the Coffee." *Journal of Investing*. (Also published in *Investment Insights* 9, no. 3 (June 2006). San Francisco: Barclays Global Investors.)

Waring, M. Barton, and Duane Whitney. Forthcoming 2007. *The Two-Fund Theorem in the Presence of a Liability.* Draft working paper. San Francisco: Barclays Global Investors.

Waring, M. Barton. Forthcoming 2007. *A Rosetta Stone for Pension Accounting.* Manuscript in progress.

Investment Insights

Published by Barclays Global Investors
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San Francisco, CA 94105

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