Liability-Relative Strategic Asset Allocation Policies

M. Barton Waring
Managing Director and Head of the Client Advisory Group
Barclays Global Investors
San Francisco

The pension funding difficulties of the early 2000s highlighted the need for pension plan sponsors to adopt a different approach to investing plan assets in search of greater control over pension funding risk. Plan sponsors should do away with an asset-centric approach and substitute a liability-relative approach, controlling what really matters to the health of the plan (i.e., the net of the assets and the liabilities, the deficit or surplus). Because the liability can be hedged only with market-related (beta) risk, plan sponsors should segregate their beta and alpha decisions. In addition to hedging the liability, the beta decision seeks to balance the growth of the plan surplus against the risk to the surplus. The alpha decision, which is conditional on a plan sponsor’s skill at picking skilled managers, is used to seek alpha, or excess returns over the beta benchmark.

In this presentation, I will be discussing ways to think about and manage asset pools that exist to fund a liability. Naturally, for this conference’s purpose, I will be addressing the topic within a pension context, but this is actually a very general problem. A lot of what I will discuss here stems from things I learned nearly 20 years ago in the insurance context, where there is also a liability that has to be managed in conjunction with a pool of assets. Of course, the same ideas are relevant to others, such as individual investors who are funding their future retirement liabilities or foundations and endowments that are thinking about the present value of their spending rules.

The topics I will touch on boil down to the development of investment strategy and the decision about how much risk, and of what type, to take in the search for return. Strategy is about determining the policy portfolio and answering such questions as: What basic investment position are you setting up for the long term, what is your reference point against which you might make market-timing and security selection decisions, and what is the place that you come back to when you are not sure what else to do or when you think that markets may be in equilibrium? And like all decisions in finance, the answers will come down to identifying the exact risk and the exact return measures that are important in making the particular risk–return trade-off that is important to pension funding risk.

I will kick off my presentation with a brief discussion of the pension funding crisis. From there, I will move to an introduction of liability-relative investment policies and provide some tools for dealing with those matters, tools such as surplus asset allocation and surplus efficient frontiers. This area will be the main part of my discussion, but I will also cover some material related to duration matching and cash flow matching because they are important secondary tools for controlling pension funding risk. In addition, I will review accounting policies and practices that govern the so-called real world in which people operate and that seem to have an impact on many pension decisions.

The Pension Funding Crisis

Defined-benefit (DB) plans are in danger, and not just in the United States. For example, in the United Kingdom, virtually all corporate plans have been frozen to new entrants and are thus in an extended termination mode. One classic example in the United Kingdom often referred to is the Boots PLC plan, which closed its plan and went entirely to a cash-flow-matching solution with much fanfare (although
reportedly it has recently reverted to holding some modest amount of equities). In Australia, there are almost no active DB plans left. In the United States, many of the large institutional investment managers have been seeing a slow, but increasing, trickle of requests for cash-flow-matching and duration-matching solutions—things not seen much since the 1980s. Unlike in the 1980s, these requests seem to be motivated by the fear that the DB plan is too risky for the organization to sponsor. They also seem related to an undercurrent that “maybe we could get by without having a DB plan in our organization.”

Ultimately, the survival of DB plans seems to be in question because the unpredictable contribution expense levels for pension plans, as experienced with today’s standard risk control technologies, seem to leave sponsors believing that the risks are too high to sensibly bear. Most everyone would agree that DB plans are a tremendous social good and are a cost-effective form of compensation; they are a fabulous way of providing needed retirement income. The sad thing is that many people will not benefit from them in the future if investment advisors cannot learn how to run them in a manner that feels less risky to sponsors. Certainly, most people would hate to see policies that do not support and encourage DB plans, but the chief financial officers (CFOs) of sponsoring organizations need to be given tools to more completely control pension funding risks.

When I say “pension funding risk,” I am including within that term a whole set of issues that are completely interrelated. In essence, they are mathematical transforms coming from the same fundamental risk. Contribution risk and expense risk, and, in fact, all other metrics for pension risk, are direct functions of the level of pension surplus or deficit—the net of the assets and the liabilities in the plan. They sometimes seem delinked and separable because of the filters that happen as the economics of the pension plan flow through to the accounting numbers, but they are all manifestations of the same relationship between the assets and the liabilities. The key issue is that CFOs need tools for controlling the volatility of this surplus or deficit, which, in turn, will control the volatility of contributions and expense. That is really the topic of my presentation.

In addition, contribution policies and benefit level determination policies have some room for improvement. One of the points I will articulate in this presentation is that contribution policy is every bit as important, if not more important, than investment policy. And yet, very few organizations have an explicit contribution policy. Rather, their approach feels more like an ad hoc policy of minimizing the contribution that has to be paid each year. If benefits are priced on a full market or economic basis, they might be made on a basis that does not imply that they become too expensive to bear as a reasonable part of a total compensation package.

Finally, active management practices tend not to be as efficient as possible. Active management is a zero-sum game, and not all organizations can be successful at “playing” it. Those organizations that believe they can be successful at active management should explicitly decide how to incorporate it into their policy by using established risk–return optimization practices.

The bottom line is that to save DB plans, those of us in the investment management profession have to be on a mission to improve these basic investment and management practices. We have to help provide tools to control risk in these plans so that organizations can continue to sponsor them.

The heat may seem to be off a little bit now that we have a year of good returns behind us. But we should not be fooled. Market risk still exists, and an up year does not mean that down years will not happen anymore. Although the pressure might be lower now, this is a great time for us to think about how we can control the risk going forward.

### Liability-Relative Investment Policies

At least two-thirds of the concepts in this talk date back more than 20 years. For example, the notion that the liability is an economic or market liability and not just an accounting entry goes way back to the Jack Treynor, Patrick Regan, and William Priest book from the 1970s, which is also about the time ERISA was first adopted. Additionally, references to surplus efficient frontiers are found in the journals starting in the late 1980s and early 1990s.

I am a little bit at a loss to explain why these concepts have not been integrated more into common practice. This technology has been worked on at one time or another by many serious people, such as Jack Treynor, Martin Leibowitz, John Mulvey, Bill Sharpe, Roger Ibbotson, Edwin Elton, and Martin Gruber. These are all names that are very familiar to CFA charterholders. Yet, this technology has never really been integrated into the daily work of more than the smallest handful of practitioners. Perhaps the additional tools that I will talk about here will help make that happen, filling in gaps so that practitioners can more readily use the bigger-picture tools.

---

A good place to begin is to talk about how pension funds were managed in the past. Think about a pension plan for a moment as a simple “T-account”; assets would be on the left, liabilities on the right, and a net calculation of the surplus or deficit at the bottom. Pension plans, unfortunately, usually have this net on the bottom left of a T-account because they tend to operate with a deficit, whereas a surplus would appear on the bottom right.

Historically, asset/liability studies have not really lived up to the promise implied in their name. They actually have been just asset studies. In almost any asset/liability study, one will find that the investment centerpiece is an asset-only efficient frontier. As a follow-up to this asset-only investment step, the bulk of the energy and effort of the process is put into an intense Monte Carlo–based actuarial process analyzing just a few of the mixes from that asset-only efficient frontier—looking at the probabilistic ranges for expense, for contributions, and for other variables in future years, repeated for each of the studied asset-only mixes. That scenario is what has been called an “asset/liability study.” It is an asset study followed by a liability study, but it purports to coordinate the assets with the liabilities and barely does so at all.

It begs the question: Why take an asset-centric approach to the central problem of choosing the portfolio when what really matters to the health of the plan is the bottom line—the deficit or surplus, which is the assets minus the liabilities? When an asset-only approach is used, the objective function is to maximize the expected return of the assets while controlling for risk of the assets. But if one is worried about the health of the plan, the objective function should be to maximize the shrinkage of deficit (or growth of the surplus) while controlling risk or volatility in that same rate of shrinkage (or growth).

So, the goal, or objective function, for pension asset allocation decisions should be to maximize the health of the plan—shrinkage of deficit (or growth of surplus) while controlling volatility of the deficit (or surplus). This approach is not a very hard segue to make from an asset-only orientation. One good way to think about the asset allocation problem is as an optimization in which one is simply constrained to hold one extra asset class, which is an asset class held short relative to the other asset classes.

To conceptualize this approach more completely, I will begin with the asset-only frontier depicted in Figure 1. I will “build” this figure up from an asset-only to a surplus frontier, and at the end, I will add the active management dimensions.

The asset-only frontier has been the space where investment strategy has been conducted for several decades. Most everyone is familiar with it. This notion about thinking of the liability as an additional asset class held short is depicted by showing it as a diamond near the bottom of the figure, with an expected return value of opposite sign to that of the other assets because it is on the other side of the

---

**Figure 1. Illustration of Policy Questions for the Total Portfolio**

- **Expected Return**
- **Active-Risk Decision**
- **Surplus Frontier**
- **Surplus Beta Decision: Policy Portfolio**
- **MSV Portfolio**
- **Active Risk**
- **Expected Risk**

*Note: MSV = minimum surplus variance.*
The New World of Pension Fund Management

pension fund balance sheet. Additionally, some amount of risk is involved, which affects where on the x-axis the liability would appear. Later, I will discuss quantifying that risk, but for now, let me state simply that it is only the market-related, or beta, risks of the liability that can be hedged at all. So, for this part of the discussion, I am going to show only the portion of the risk that can be hedged, the market-related or beta risks of the liability. Non-market-related liability risks are, of course, not hedgeable with assets, so I can do nothing about them in the course of an asset allocation program.

That market-related model of the liability is sitting below the x-axis. Directly opposite to it, on the other side of the x-axis, is a combination of assets that hedges that liability as completely as it can be hedged. The risk of the assets will be exactly alike and of opposite sign to the risk of the liability, making for risk cancellation. If the risks and returns are identical, the composition of the assets underlying this position must also be identical.

Think of this offsetting asset position as the minimum-surplus-variance (MSV) portfolio, the lowest risk portfolio relative to the liability, which is the same as saying that it is the fully hedged portfolio. It is shown as the square found at the lower end of the surplus efficient frontier. As shown in Figure 1, the surplus frontier is found underneath the asset-only frontier. As it extends up and to the right from the MSV position, it becomes asymptotically closer to the asset-only frontier. Each position (other than the MSV position) involves taking on some investment risk relative to the liability—becoming less than completely hedged—in the search for higher return. So, the surplus efficient frontier presents alternative choices: How much, or how little, should the betas of the assets be hedged against those of the liability, and what are the return trade-offs made with that hedging decision?

The investor’s real issue is to decide how much surplus risk should be taken. In other words, if the decision is to absolutely minimize surplus risk, the MSV portfolio should be held. In that case, the market risk of the assets should equal the market risk of the liabilities. But to seek additional return from the market while accepting additional market risk relative to the liability, the pension plan would have to be invested at some point higher on the surplus frontier. The policy risk decision to move the policy portfolio to a position on the surplus frontier above the MSV portfolio is labeled on Figure 1 as the “surplus beta decision,” which is a less than perfectly hedged position.

2For illustrative purposes, I have exaggerated the difference between the asset-only and the surplus frontiers on this figure. Later in this presentation, I will show a more accurate real-world plot of these frontiers.

Although most of investment policy is about beta, or managing market-related risks between the assets and the liability, there is a second aspect of policy, which is about alpha. I will now transition to the second (lighter) set of axes drawn in Figure 1. This second set is centered on the point of the surplus frontier that represents the decision about the beta policy, or beta benchmark, for the plan. From that surplus beta benchmark, this second set of axes provides the dimensions for the active-return/active-risk decision. This is a decision, independent of the surplus beta decision, to seek pure, uncorrelated, nonbeta risk in the portfolio, which is typically done through active managers or through tactical asset allocation moves. Inside this second set of axes, an active frontier can be plotted that represents combinations of managers and sources of alpha. So, just as a policy decision was made along the surplus frontier, a policy decision is made on the active frontier. The question here is a parallel question: How much active risk, or alpha-related risk, is the plan willing to take in the search for return? The triangle in Figure 1 labeled “active-risk decision” represents an active-risk-budgeting or policy decision.

Remember that the active frontier is different in some very fundamental and very important ways from the beta-related frontier. The active frontier has a positive slope only if the sponsor has the skill to choose managers that, in turn, have skill at picking stocks. Without that skill, active management is a zero-sum game, and after fees and costs, it is a negative-sum game. When a plan sponsor claims to have this skill, evidenced by positive expected alphas from active management, the active frontier will slope upward. Otherwise, it will be flat or sloping downward by an amount equal to fees and costs.

So, expected active return ("expected alpha") is known formally to be a conditional expected return. It is conditional on skill at picking managers that have skill. This, of course, is a forward-looking assessment because history only gives evidence of skill in the presence of strong t-statistics. The unconditional expected return on alpha is zero, less fees and costs. But conditional on skill at picking skilled managers, the active frontier slopes upward, as I am showing it.

In contrast, for beta risks, greater risk does mean greater expected reward. This is an unconditional expectation. That is just basic capital markets theory. Think about the upward-sloping capital market line and the upward-sloping security market line. Also, beta can be purchased by a sponsor for very low cost in the form of index funds and equivalent derivatives. But expected alpha, by its very nature, is always relatively more costly.
Liability-Relative Strategic Asset Allocation Policies

I will come back to managing active risk and return later, but I will stay with market or beta risks for now. The decision about exposing one’s portfolio to these unconditionally rewarded risks is usually thought to be the central decision in investment strategy. I will spend most of my time on that decision in this presentation, but alpha must also be considered.

And large, organizations today are using just the asset-only frontier to manage their beta exposures across fully diversified asset classes, and in that framework, they have chosen policy allocations in quite aggressive equity-to-fixed-income proportions, such as 70/30 or 75/25. By contrast, the U.K. company that I referred to earlier, Boots, was concerned about its liability and went to a cash-flow-matching strategy. For all practical purposes, cash-flow-matching and duration-matching strategies can be interpreted fairly, and simply, as approximations to the MSV portfolio on the surplus efficient frontier. So, what gives? Why are there these two very different, almost polar, results depending on whether one looks at the policy decision from an asset-oriented view or a liability-oriented view?

My interpretation of this example and some others like it is that these sponsors are behaving as if they had only a binomial choice, where the first choice is to continue what they have been doing (which has been an asset-oriented practice resulting in an aggressive asset allocation policy) and the second choice is to go to cash flow matching (tying the assets directly and as precisely as possible to the liability). But one can recognize this choice in the context of this discussion as a decision between a high-variance policy on the asset-only frontier and a minimum-variance policy on a surplus frontier.

But the opportunity exists to make a richer decision: The high-variance policy on the asset-only frontier is not very different from a high-surplus-variance policy on the surplus efficient frontier. What about all the decision opportunities along the surplus efficient frontier lying between the MSV position and a high-surplus-variance position? Figure 1 can be used to illustrate this problem. Plan sponsors have a continuum of choices along the line indicated as the surplus frontier. They have choices about how much beta risk to take relative to the liability and about how much, or how little, to be hedged against the liability.

This view is a healthier way to look at these choices, and it requires just one minor change in perspective: to see all choices in terms of how much risk they create relative to the liability. Sponsors should be choosing to be somewhere between total cash flow matching (the MSV position on the surplus frontier) and their current position (a 70/30 mix) but examined on the surplus frontier, not on the asset-only frontier.

This little insight (i.e., that the decision should be liability relative either way) and the observation that the entire surplus efficient frontier is available to the sponsor are very important. If the sponsor does not like the experience of risk at 70/30 equity/fixed income, it can dial the risk down to whatever level it chooses, down to and including the MSV. My expectation is that faced with this more complete view of their decision-making opportunities, most sponsors will end up somewhere in the middle.

At this point, I am going to introduce some mathematics. Fortunately, these formulas are a lot easier to work with than they seem at first glance:

\[ L_0 R_{S(L)} = A_0 R_A - L_0 R_L, \]  

where:

- \( L_0 \) = current liabilities (dollars)
- \( R_{S(L)} \) = liability-relative return of the surplus
- \( A_0 \) = current assets (dollars)
- \( R_A \) = return on assets (percent)
- \( R_L \) = return on liability (percent)

In Equation 1a, the \( A_0 R_A \) term is the starting assets times the return on assets (i.e., the change of wealth in the portfolio in a given period). Similarly, the term \( L_0 R_L \) is the beginning liabilities times the return of the liability (i.e., the change of wealth on the liability side).

Subtracting the change of wealth on the liability side from the change in wealth on the asset side gives the change of wealth in the surplus, which is also known to be a product of a surplus return term and some valuation term to reference the return term against. (Some choices are available here, but I have chosen to make the return of the surplus relative to the liability in order to avoid the zero division problem that happens if I make it relative to the value of the surplus itself.) This combination is represented on the left side of Equation 1a as \( L_0 R_{S(L)} \). Note that I subscripted the return of surplus to indicate that it is in a liability-relative form. Dividing through by \( L_0 \), I have then defined this return of the surplus as:

\[ R_{S(L)} = \left( \frac{A_0}{L_0} \times R_A \right) - R_L. \]  

This formula should look very familiar, at least at first glance, to anyone who has studied the Sharpe–Tint paper on surplus optimization.\(^3\) It is identical, except that they scaled the return of the surplus by beginning assets rather than by the liability so that the adjustment term is the beginning liability divided by the beginning assets times the liability. In contrast, I am


©2004, CFA Institute • cfapubs.org

CFA Institute Conference Proceedings • 47
showing the liability-relative view, which is more useful: For a pension plan, all changes in wealth affect the sponsor’s ability to cover that liability. Pension plan management is inherently a liability-centric exercise.

The return of the surplus, then, is simply the difference between the changes in wealth of the assets and of the liabilities, scaled in such a way as to recognize the inherent leverage or deleverage induced into the system by the asset/liability ratio (A/L). It is the measure of success that plans ought to be tracking if their objective is to stabilize the net wealth of the plan.

By stabilizing the net wealth of the plan, I mean that the plan is stabilizing the change in the value of the deficit (or surplus). This is a mathematical result of the asset return being scaled up with the A/L. An MSV portfolio optimized using this definition of the return of surplus would thus ideally have no change in the surplus from period to period.

**The Policy Decision: How Much Surplus Beta?**

Using that notion of return to the surplus, I can develop the inputs necessary for a surplus efficient frontier more fully, and I can do so in a way that usefully captures both the beta and the alpha dimensions.

**Modeling Assets.** Again, the formulas are not nearly as bad as they may look at first. To begin, remember the basic capital asset pricing model (CAPM) premise (actually, I will only need the assumptions of the single- and multiple-index versions of the market model, not the full CAPM) that the return of any financial asset, instrument, or position can be expressed as a combination of the risk-free rate, a beta times a market return on a relevant benchmark, and an uncorrelated term, or alpha:

$$R_A = R_f + \beta_A r_Q + \alpha,$$  \hspace{1cm} (2a)

where

- $R_A$ = asset portfolio return
- $R_f$ = risk-free rate of return
- $r_Q$ = excess return of the total investable market (Portfolio Q) over cash

Equation 2a is simply a single-index version of the market model, intellectually close to the CAPM. Note that it is my notation to use a lowercase $r$ to represent excess returns over the risk-free rate. So, $r_Q$ is the excess return of the benchmark over the cash return; or, in other words, it is the market risk premium. Note also the beta is defined here relative to the investment choices across all investable asset classes, not just the S&P 500 Index (i.e., this is an investable version of a Roll beta, a very broad market beta).

So, Equation 2a is simply the sum of three basic terms: the risk-free rate, beta times the risk premium return, and alpha. No surprises there. Equation 2a implies that risk can always be expressed in terms of beta- and alpha-related components (and because alpha is, by definition, uncorrelated with beta, no covariance term is needed):

$$\sigma_A^2 = \beta_A \sigma_Q^2 + \omega_A^2,$$  \hspace{1cm} (2b)

where

- $\sigma_A^2$ = variance of the asset portfolio
- $\sigma_Q^2$ = variance of the market risk premium on the relevant benchmark
- $\omega_A^2$ = variance of the alpha

No surprise there, either. Notice that this framework stays right in the center of single-index-type models. There is nothing novel or “edgy” about this approach. Betas are about asset classes, they are about market-related risks, and they are about fully diversified portfolios. Alphas are about “undiversification,” they are about active management, and they are about portfolios that are not “on” the beta-related efficient frontier.

So, all portfolio returns can be described as some combination of a risk-free rate, a beta return, and an alpha return. The point is that two kinds of risk and two kinds of return exist. There is unconditionally compensated risk, which is the beta risk, and there is alpha risk, which is conditional on skill. Without skill, alpha risk is not compensated. Separating the two is important because they have different expected return characteristics and different costs and because they affect the overall portfolio return differently.

**Modeling Liabilities.** Modeling the liability side of the equation is not much different from modeling the asset side. After all, the liability is also just a financial instrument: the present value of a complicated set of future benefit payment cash flows. It also can be separated into its three basic components:

$$R_L = R_f + \beta_L r_Q + \alpha,$$  \hspace{1cm} (3a)

and liability risk is, therefore,

$$\sigma_L^2 = \beta_L^2 \sigma_Q^2 + \omega_L^2,$$  \hspace{1cm} (3b)

where $R_L$ is the return on plan liabilities and $r_Q$ is again the total market benchmark. Because the liability is heavily bond-like, in single-factor space, we would see a lower beta in this instance.

For many, this insight is a blinding flash of the obvious. Of course a liability, like any other financial asset or instrument, can be thought of in terms of its beta and alpha characteristics! Thinking along these lines is tremendously helpful and relieves much of
the difficult burden that in the past has been perceived to be associated with understanding and modeling the liability in the asset allocation context. Think about the complexities of the big Monte Carlo models maintained by many organizations for this purpose. They are not needed as soon as one recognizes the value of this insight. For purposes of maximizing the hedging relationships between the assets and the liabilities, these Monte Carlo models, which do not separate beta from alpha, cannot do as good a job despite their greater complexity and effort. I will come back to this idea shortly.

As clear and obvious as this notion seems once it is pointed out, I have experienced some resistance when making this point in the past. I think it is very hard to give up years of habit and to toss away a substantial investment in technology and knowledge that for so long has been thought to be useful. So, it may take a bit to internalize this notion, to “connect the dots” that the liability is subject to the same laws about the nature of return, risk, and valuation as any other stream of cash flows. To be sure, the liability’s cash flows are complex. But they are no more complex than the stream of cash flows for a large publicly traded company being valued by investment bankers for merger or sale, and that is a routine task. In those situations, incredibly complex cash flows are boiled down to a present value based on market-related or beta discount rates, and people are very comfortable with the result. We investment advisors not only can apply this approach to the liability, but I will also argue strenuously that if we do not, we will fail in our task of building methods to better control pension funding risks.

Let me make the argument now. Recall that the liability is a financial asset held short. It can be divided into those same two market-related components and idiosyncratic components as the assets. Here is the clincher: Because betas are correlated by definition, betas in long and short juxtaposition hedge each other. One can use the beta characteristics of assets to reduce total plan risk by hedging them against the beta characteristics of the liability! Alphas, in contrast, are uncorrelated with market exposures and cannot be hedged.

So, by using these very basic principles of corporate finance, looking at the betas of the assets and liabilities as components that can be separated, we investment advisors set up the opportunity to reduce risk to the pension surplus and thus to contributions and expense. And we will have a choice about how tightly to hedge. This is a valuable insight because it implies that the only part of that complex cash flow stream that is important for deciding the asset class, or market-related portion of the asset allocation policy, is the beta (market-related) part. Alpha decisions need to be made as part of policy, but because alpha does not (ordinarily) hedge other alpha or (ever) any beta, alpha decisions do not help with pension funding risk control to the same extent that beta decisions do. Alpha is important to a pension plan in its own right, but the big lever for risk control is beta.

So, the bottom line for the basic part of asset allocation work, dealing with the asset class allocations, is as follows: Although idiosyncratic risk (i.e., alpha risk) is certainly important, it usually cannot be hedged. (The exception is in cash balance plans that use beta plus alpha returns as crediting rates, but that is another discussion.) So, if I am going to try to hedge the liability with the assets, my first focus needs to be on trying to find the market-related risk components in the liability, the characteristics that I will want to hedge against.

**Economic Measures of the Liability.** At this point, I will sidetrack and talk about economic measures of the liability. To understand the betas and alphas of the liability, which are inherently economic measures, one must be prepared to understand the liability in a full economic context.

A difference often exists between book and market values for other assets and accounting entries. Not surprisingly, the same is also true for pension entries. Regulators impose a lot of constraints on how to value liabilities and many other pension entries for the various accounting books. But those book value limitations do not really control the true underlying market value. Few companies would manage or sell their real estate holdings at book value, for example. I am arguing that few companies should manage their liabilities on a book basis either.

The key when making economic decisions about the management of the surplus (and there can be no disagreement that setting the asset allocation policy for the asset classes is an inherently economic decision) is to use an economic, or market, measure of the liability. This has to be so. Think about it: Can a book value of the liability be hedged? Of course not. There is no asset portfolio that will hedge a smoothed, artificial liability value—a book value.

But we have an opportunity to hedge the true valuation of the liability that lies partially hidden underneath the thin veneer of book value. Why would we pass up that opportunity? We know that if the true market-related risk of the surplus (the assets minus the liabilities) is as thoughtfully hedged as we want it to be, then it must also be true that the book value risks must always follow. Thus, we have to take a market-related view. If we minimize or control the market, or economic, risks, then it must also be true that the book value risks, which always
follow economic risks, must also be minimized or controlled. Accounting always follows economics, sooner or later.

Once the future benefit payment cash flows have been estimated, the market value of the liability is largely a function of the discount rate. Remembering the basic equality from introductory corporate finance that the expected return is the same as the discount rate, which is the same as the cost of capital, we remember that if we estimate the cost of capital of the liability, we know its correct discount rate. And estimating the cost of capital is well understood to be a matter of understanding the market-related risks inherent in the cash flows. It is inherently a process that involves estimating the betas of the cash flows.

The cost of capital can be estimated in a lot of ways, so I have presented an example of one way, a way that I like to use, in Table 1. This method is relatively straightforward and gives a good “ball-park” answer. Furthermore, it is convenient in that it gives its answer expressed in percentages of the same asset classes that we are using on the asset side. So, it creates, in effect, an asset class model of the liabilities. But other people may find other cost of capital models to be useful for other attributes. All good models focused on the market-related risks of the liability should come up with similar answers.

My method involves first parsing the liability into a few different components to represent different groups of beneficiaries. Each group can have its cost of capital estimated separately, which is likely to improve accuracy somewhat. The retired lives and inactive lives, and even the accrued portion of the active lives, are very bond-like and are principally modeled as allocations among long bonds and long TIPS (the common name for U.S. Treasury Inflation-Indexed Securities). But for the future accruals on the active lives, and all accruals on the future lives, things start getting a bit more interesting. In those cases, one has to think about whether some part of the market-related risk might be equity-like instead of just bond-like, with growth related somewhat to the same macroeconomic factors that affect equity markets. Consequently, their expected return estimation will likely contain allocations to equities in addition to the bond components. Once each component has a model constructed, the discount rate is simply the weighted-average return of the asset classes in its model, calculated using the same consensus or equilibrium return assumptions as are used for the asset classes in the optimization process.

Once each component is estimated, it is a simple matter of first valuing that portion of the liability and then applying the percentage weights of each to their respective discount rates to find the weighted-average cost of capital across the entire liability. And in the course of the effort, I have simultaneously built a multifactor model of the beta characteristics of the liability. So, this is a delivery on my earlier promise to show how this approach can dramatically simplify the process of modeling the liability.

**Surplus Utility Function.** Equation 4a should look familiar. It is just a return, less lambda times a variance. It is a standard form mean–variance utility function.\(^4\) Here it is return of surplus minus lambda times the variance of surplus, giving “surplus utility”:

\[
\max (U_S) = R_S - \lambda \sigma_S^2,
\]

where

\[
U_S = \text{surplus utility}
\]

\[
\lambda = \text{a constant representing the degree of risk aversion}
\]

\(^4\)Editor’s Note: If Equation 4a is not familiar, John Campbell and Luis Viceira provide a good summary of utility functions. See *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors* (London: Oxford University Press, 2002). Additionally, and relevant to Equation 4b, Barton Waring previously published a paper with additional detail related to this framework for optimization. See M. Barton Waring, Charles Castille, Duane Whitney, and John Pirone, “Optimizing Manager Structure and Budgeting Manager Risk,” *Journal of Portfolio Management*, vol. 26, no. 3 (Spring 2000):90–104.

---

Table 1. Market-Related Risks Identification (percent)

<table>
<thead>
<tr>
<th></th>
<th>Retired Lives</th>
<th>Active Accrued</th>
<th>Active Future Accruals</th>
<th>Future Lives</th>
<th>Expected Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long bonds</td>
<td>100.00%</td>
<td>50.00%</td>
<td>30.00%</td>
<td>10.00%</td>
<td>5.00%</td>
</tr>
<tr>
<td>Long TIPS</td>
<td>—</td>
<td>50.00%</td>
<td>60.00%</td>
<td>70.00%</td>
<td>5.25</td>
</tr>
<tr>
<td>Domestic equities</td>
<td>—</td>
<td>—</td>
<td>5.00%</td>
<td>10.00%</td>
<td>8.25</td>
</tr>
<tr>
<td>Foreign equities</td>
<td>—</td>
<td>—</td>
<td>5.00%</td>
<td>10.00%</td>
<td>8.25</td>
</tr>
<tr>
<td>Discount rate (\sum w R_Q)</td>
<td>5.00</td>
<td>5.12</td>
<td>5.48</td>
<td>5.83</td>
<td>—</td>
</tr>
</tbody>
</table>
If I expand Equation 4a out using the CAPM formulas shown previously, some algebraic manipulation will produce Equation 4b:

\[
\max (1_i) = \left(\frac{A_0}{L_0} - 1\right) R_F + \beta_S \mu_Q - \lambda \beta_S \sigma_Q^2
\]

\[
+ \left(\frac{A_0}{L_0} \sigma_A - \sigma_L\right) - \lambda \omega \left[\frac{A_0^2}{L_0} \omega_A^2 - 2 \frac{A_0}{L_0} \omega_{A,L} + \omega_L^2\right]
\]

where:
\[
\mu_Q = \text{the equilibrium, or consensus, expected return of the total market across all asset classes}
\]
\[
\beta_S = \left(\frac{A}{L} \beta_A - \beta_L\right), \text{ or “surplus beta,” the weighted relative betas of the assets and the liabilities}
\]
\[
\omega = \text{the standard deviation of the alphas, subscripted to indicate the assets and the liability, respectively—residual risk}
\]

The important term in Equation 4b for the basic strategic asset allocation decision is labeled as $\beta_S$ or “beta-related surplus utility.” It is not that the residuals are unimportant; this representation of residual utility is actually quite useful. But my main focus here is on the key decision, which is how much beta risk to take.

Basicall,y this portion of the utility function determines the optimal amount of beta to use, and of course, it is expressed relative to the liability in the “surplus beta” term. Maximizing the expected return of the surplus at a given level of surplus risk using this type of utility function is perfectly parallel to the standard asset-only practice of maximizing the return of the assets at a given level of asset risk. It is just being done in a surplus context, including the liability as an asset class held short.

The surplus beta, $\beta_S$, is very familiar in form relative to the surplus returns: It is just the A/L times the beta of the assets minus the beta of the liability. For the MSV portfolio, the beta of the assets must be equal to that of the liability to create the perfect hedge. So, one can see that the decision variable for investment policy in the presence of a liability is how much “surplus beta” risk one takes relative to the liability, a term that is corrected for the leverage of the A/L.

### Which Measure of the Liability?

A lot of debate, and it can quickly get heated, centers on how broad a measure of the economic liability should be used. Many people argue that the accumulated benefit obligation (ABO) is the economic liability, but it is a relatively narrow measure that deals only (approximately) with liabilities that are accrued and owed as of now. An economic version of the ABO would essentially amount to the retired lives plus the accrued portion of the active lives. It is easiest to think about it as a termination liability: What amount would the plan have to have set aside today if it were to shut down the plan and allow no further benefits to accumulate? Although this is not the precise definition of the ABO, it is a useful definition for this purpose and has the benefit of being easy to communicate and understand.

I like to think about the entire liability as the proper measure of the economic liability, including the future accruals attributable to both current and future employees, because I think it is best to view pension plan financial management as a corporate finance problem where we want to manage the full present values of both sides of the economic balance sheet, not partial values. If I were valuing a business, I would certainly be looking at all anticipatable costs that are associated with the business on into the furthest parts of the future that I could see. These costs would include forecasts of labor costs and estimates of their present value regardless of whether the employees associated with those labor costs were yet identified.

Sometimes, I think that analysts confuse the legal liability and economic liability issues. There is legal liability for committed benefits to identified individuals but not to future employees, and often not for future accruals to current employees. But the economic decisions are not about managing legal liabilities but present and future values and, in the end, the path of expected future surplus.

For as far into the future as the plan is expected to exist, it is possible to estimate a present value to the stream of benefit payment cash flows that are generated by the plan, so there is an economic liability. And there is a partially offsetting opposing asset, which is the present value of contribution policy or of planned future contributions. One reason why the legal liability issue gets confusing, I think, is that the
required minimum funding level is associated with the legal liability for obvious benefit security reasons. But there is no need to provide funding today for economic liabilities that will not become legal liabilities until sometime in the future. Certainly, one would not want, or need, to fund the full economic liability today. I find that when I can make myself heard on this point, it helps people understand the importance and sensibility of focusing on the full economic measure of the liability.

So, for the asset allocation decision (but not for the funding level decision), when the plan sponsor is determining what mix of assets over the long term will best support the plan, the full, long-term economic liability should be used.

Asset-Only vs. Surplus Efficient Frontiers.

Earlier I showed a highly stylized version of the surplus efficient frontier as it relates to the asset-only efficient frontier. A real-world version of this graph is shown in Figure 2. This figure is still in “asset space,” so the axes are return of the assets versus risk of the assets. The liability model is down near the bottom of the figure as an asset held short. The lower end of the dark solid line is the portfolio of assets that has the same beta characteristics as the liability, the MSV portfolio, shown as a square. It is a direct reflection across the x-axis from the liability model.

Notice that an actual surplus efficient frontier is not very far away from the asset-only frontier. It is underneath the asset-only frontier because there is an implied constraint from having to include the liability among the asset classes, but it is not very far beneath it. I exaggerated the difference on the stylized version, Figure 1, to help illustrate this difference.

If the two types of frontiers are so close, is it even important to make the distinction? Other people who work with asset allocation policy have told me that they tried using a surplus efficient frontier on one or another occasion but stopped when they saw that it was so close to the asset-only frontier. They did not see what difference it made to use it if they could get to, say, 70/30 on either one. But I would argue that it makes a big difference for two reasons. The first reason is one of perspective: The set of sensible decisions appears different when one is looking at the problem from a surplus perspective, a perspective that starts with an understanding of the financial characteristics of the liability. For example, it is pretty hard to ignore the fact that TIPS bonds serve to model parts of the liability better than do nominal bonds. If TIPS bonds are in the liability model, it is natural to put TIPS into the asset portfolio as well. But in this dominantly asset-only world, the plan sponsor does not have to think that way. It has only been relatively recently

---

6These frontiers were prepared with assistance from Thomas Idzorek.
that sponsors have started to include TIPS as an asset class. So, plan sponsors think differently about the problem when they are in surplus space.

More importantly, the second reason is that once the surplus efficient frontier has been determined, a plan sponsor has a benchmark against which to measure the plan’s risk aversion and risk tolerance. The liability is the ultimate benchmark against which investment performance, in all its dimensions, must be measured. The risk that matters is experiencing investment returns different from the return of the liability, giving rise to the possibility of becoming “poorer,” or having a larger deficit. One can make a sensible decision to take such risk, and such a decision can be justified by a tolerance for that risk in the search for higher return. Markets exist because risk is fairly priced, so it cannot be said that this is not a fair bet.

With a surplus frontier, at least the plan sponsor is measuring the plan’s risk exposure by reference to that MSV point that ties the asset beta to the liability beta. In contrast, the asset-only space does not offer a reference point from which one can understand how much risk is being taken.

In summary, I am arguing that using surplus efficient frontiers is not about the destination. Rather, it is about the journey and the thought process leading up to a policy decision and, in particular, about the risk portion of that thought process.

**Surplus Frontiers in Surplus “Space.”** Instead of being shown as a surplus frontier in asset-only graphical space, where the axes are expected return on assets and expected risk to the assets, the surplus frontier can also be shown in a graphical space where expected return of the surplus is plotted against the risk of the surplus, as in Figure 3. In practice, this is a more usable space because it deals with the dimensions of the actual problem.

In this graphical space, the liability benchmark for a fully funded plan is at the lower left-hand corner, or the origin, and the surplus frontier extends up and to the right from there. For the remainder of my presentation, I will use this particular view.

**Importance of Funding Ratios.** I talked about the funding ratio earlier. It comes into the math for the return of the surplus, shown in Equation 1b, or better, Equation 4b. One can get a sense of the impact of being underfunded by inspection of Equation 1b. If \( \frac{A_0}{L_0} \) is less than 1, then there are two effects. First, the risk-free rates of the assets and the liabilities are not offsetting. In this instance, the surplus efficient frontier will no longer start at the origin. Rather, it will be moved down below the origin by the amount of that shortfall.

Second, in order to have a zero or a positive return to the surplus, the “surplus beta” must be zero or positive. For this to be true, the plan must have a higher asset beta than its liability beta. It is just a matter of leverage. If there are not as many assets as there are liabilities, the assets have to run faster to keep up. This surprise result is not immediately obvious without doing the math. Likewise, if the plan is overfunded, the assets could be delevered relative to the liability and invested in a relatively less risky position.

The impact of the funding ratio on the surplus frontier is shown in Figure 4. The three lines on this chart show how the A/L affects the position of the surplus efficient frontier. The top line is the same as in Figure 3, where there is a one-to-one ratio of assets to liabilities. The other two lines on Figure 4 show the movement of the frontier as the A/Ls are reduced, first to 75 percent and then to 50 percent. The frontier drops because of the netting of the risk-free rate term, as mentioned previously. Also, because these frontiers were created with the usual budget and long-only constraints, they do not reach to the y-axis. In
other words, with those constraints, there is no available zero surplus risk portfolio. Of course, by relaxing these constraints we could, and perhaps should, generate straight-line frontiers at all funding levels.

Furthermore, the worse the funding ratio is, the harder it is to have an expectation that investment earnings will prevent the plan from having a worsening deficit. In the extreme example (the lowest of the three frontiers in Figure 4 where A/L is 50 percent), no part of that line crosses the zero mark on the surplus return axis. In this case, there is no investment position that will create an expectancy that the plan’s deficit will stabilize or improve; it will get worse no matter what. For the middle of the three frontiers, one would have to invest aggressively, taking a substantial amount of surplus risk, to have an expectation of holding the deficit constant, and even more aggressively to have an expectation of improving the deficit. So, the A/L is important and shows the very real limitations on what a plan sponsor can do to fund a plan through investments.

These are “expectancies,” but the risk dimension around these expectancies can be illustrated further with another tool. Figure 5 is a tool that is affectionately nicknamed a “tulip” diagram. It shows the distribution of wealth over time. It is useful for comparing the expected return and risk projections of different investment policies. I will introduce it first in an asset-only context, where it is probably familiar, as shown in Panel A. In this familiar form, wealth is on the y-axis and is plotted on a log scale so that a constant rate of return becomes a straight line. The expected return is the middle line, but then I show confidence intervals around the expectancy. The intervals represent risk, showing it as a distribution of possible realizations. A more aggressive investment policy will then have a steeper mean than a conservative policy, but it will also have a broader distribution of possible actual outcomes.

Investors often say risk goes away over time. And it is true that distributions of returns do narrow over time. But as these tulip diagrams show, distributions of wealth, which is the real risk, accumulate and grow with time. So, these tulips become broader as one moves to the right in this diagram, although at a slower and slower rate.

As can be seen from the liability tulip in Panel B of Figure 5, the liability return model looks just like the asset return model, which makes sense because the asset model was intentionally chosen to be identical. But I am making a secondary point as well: The liability has a return, or a slope, and a risk, represented by the breadth of the tulip. For simplicity, I am only discussing beta, or market-related risks, here, but I could add some risk to represent idiosyncratic

---

Figure 5. Return Distributions

A. Asset Return Distribution\(^a\)

B. Liability Return Distribution\(^b\)

C. Surplus Return Distribution\(^c\)

\(^a\)Asset “tulip” MSV portfolio (mostly fixed income, asset beta is 0.405).
\(^b\)Liability “tulip” (mostly bond liability model, liability beta is 0.405).
\(^c\)MSV portfolio, A/L = 100%, \(\beta_s = 0\).
risk if I wanted to fully flesh out this point. By omit-
ting the residual risks, I am omitting both the
unhedgeable risks inherent in the liability and also
the risks associated with active management.

What happens if I subtract the liability tulip from
the asset tulip? Can I get a surplus return distribu-
tion? It turns out that I can, although I have to give
up the convenience of showing the y-axis on a log
scale; I am forced to use a linear scale. In this special
MSV case, the assets look just like the liability, so I
end up with a flat line, shown in Panel C. All the
confidence intervals are right on top of the mean,
consistent with the fact that this asset portfolio is a
perfect hedge of the liability, at least with respect to
market-related risk.

I will now use this new tool, the surplus tulip,
to examine the risk impact of having a low funding
ratio and will do so in situations where the assets
have higher betas than the liability (positive surplus
betas). Figure 6 shows three surplus tulips. Each
example was developed with a mix of asset classes
that was surplus efficient and that had an identical
60 percent equity allocation.

Note from the mathematics previously stated
that if I hold the beta policy constant but decrease the
funding ratio, the “surplus beta,” \( \beta_s \), will decline. I am
holding the asset-centric aggressiveness constant,
but doing so implies a declining level of aggressiv-
ness in the surplus for a decreasing funding ratio.

In this example, as the funding ratio deteriorates,
the surplus tulips show that the probabilities become
very slim that the deficit will be reduced to zero
through good investment returns. It would take
increasing amounts of good luck, of long-term
extraordinarily good returns, for that to happen. This
result is important to realize because one often hears
about plans wanting to “earn their way” out of being
underfunded. I am here to say vigorously that if a plan
is substantially underfunded, there are serious
limits on how much a plan can do to “earn its way
out” with investment returns. The only way to get
control in such a case is to increase contributions or
to decrease benefits.

Panel B in Figure 6, with about a 75 percent
funding ratio, might be representative of the funding
status that many CFOs are facing today. These plans
have typical asset allocation policies in the neighbor-
hood of 60 percent to 70 percent equities. At the
expectancy, the center of the distribution of possible
outcomes, such a plan could earn its way back to fully
funded status over a period of many years. But the
tulip also shows that this aggressive investment pol-
cy implies a significant chance that the deficit will
become much worse because realizations on the
downside, within normal ranges, could be very harmful to funded status! It all depends on just what happens in the market over the planning period. One has to have good luck to be in the top half of the tulip. Conversely, if this plan is unlucky, the bottom half of the tulip will be very painful.

What if a severely underfunded plan decided to try hard to improve its deficit through aggressive investing? It might become very aggressive, going, say, to a 90 percent equity asset allocation policy. Figure 7 shows what ranges of outcomes such a plan could expect given a 50 percent funding ratio. The picture is not encouraging. At the mean, such a plan could expect to maintain its deficit, not getting any worse off. It would take top-quartile performance (of the markets) for 20 years to eliminate the deficit. In contrast, the downside possibilities are indeed gruesome.

Figure 7. Distribution of Expected Future Surplus for an Equity Allocation of 90 Percent and a Funding Ratio of 50 Percent

This point illustrates that solving the pension funding problem is not solely about investment policy. It is also about what I am going to call "contribution policy" and "benefit policy." Today, there is really no established concept of contribution policy in regular use other than to minimize each year's contribution, which is an ad hoc policy of sorts. We need to develop one. A contribution policy of, say, 10 percent of payroll a year, which is not unlike many public employee plans, can be reduced to a present value and can be viewed as an asset on the economic balance sheet of the pension plan. Viewed in this way, and in fact if it were to be set and monitored in this way, contribution policy would work with investment policy to assure healthy future funded status. That situation moderates the pressure to use overly aggressive and risky investment policies.

Likewise, benefit policy can use some improved disciplines. Benefit changes, particularly increases, need to be carefully valued on a true economic basis and need to be justified for their compensation value and their contribution to an organization's ability to attract, retain, and motivate excellent employees. It is probably not fair to assume that under current practices all benefit awards have been made with a clear understanding of the true economic cost of the award. Overly large benefits put a load on the pension plan that may not be sustainable by the sponsoring organization over time.

Although it is admittedly painful to discuss either making increased contributions or decreasing the level of benefits, these pieces are inextricably interrelated with investment policy. All of it has an impact on the CFO's experience of pension funding risk.

Making an Investment Policy Decision Using Surplus Tulips. As investment professionals, we know that risk is related to return, but what is the risk that we should be looking at, and what return is relevant? For a pension plan, or any other investor whose assets exist to fund a liability, the relevant risk is the risk of becoming less wealthy. The return of interest is the expected growth path of wealth, or the expected rate of improvement of the deficit or surplus, and thus our objective function of maximizing return of the surplus (shrinkage of the deficit) while controlling surplus risk. These surplus tulips illustrate this risk-return trade-off well.

I have been illustrating their use by examining plans having different funding ratios. Now, I will show a highly simplified example of a policy decision for a particular plan in Figure 8 to illustrate how they can be used to help with the primary investment decision. To help illuminate my points, I will use the extreme example, the one with a 50 percent funded ratio.

Again, the figure shows different levels of aggressiveness: Panel A is for a plan with 60 percent in equity, and Panel B is for the same plan but with just more than 90 percent in equity. Of course, in a real asset allocation decision, the sponsor would examine more choices than just these two.

These two examples illustrate the risk–return trade-offs being considered by a sponsor making a policy decision. Clearly, the slope of the mean and the median expectations (the rate of improvement, in this case negative!) will droop less with an aggressive investment policy than with a more conservative policy, but it will also have a broader distribution of both upside and downside outcomes. Such are the choices that must be faced. There is no “right answer,” but an organization’s willingness to tolerate risk can be reflected in its decision about how conservatively, or how aggressively, to allocate.
Liability-Relative Strategic Asset Allocation Policies

Contribution and Expense Risks. Many times the CFO will express that his or her “real” risk is the risk of increased contributions, or the risk of increased pension expense. Those are certainly risks showing up in all their finality in the plan sponsor’s accounting statements.

But both contributions and expense are relatively direct functions of accounting surplus, and accounting surplus is a relatively direct function of economic surplus. If we properly control the economics of pension surplus, then we have controlled the shape of the accounting statements, and in all these important dimensions, we have controlled the contributions, expense, and liability level. As I discussed earlier, sooner or later the accounting always follows the economics.

It is a useful exercise for CFOs to go through this process, quantifying and thinking about pension funding risk using these tools and incorporating not only the investment decision but also contribution policy considerations and benefit policy considerations. From this effort, a complete picture develops for the full range of choice available for managing pension funding risk. If you manage the economics, you have managed the accounting.

The Role of Equities. After a discussion such as this, I am often asked about the role of equities in a pension plan, given that a pension is mostly bond-like. So, I will take a moment to address that question by pointing out three specific roles that equities can fill: hedging, leverage, and return.

Hedging. Although the liability is dominantly bond-like, any market-related model of the liability that includes future accruals has to have some small component of equities to model the market-related risk in those future values. Factors such as the health of the company, the size of the workforce, and the size of the pay package are all related to economic factors that are best modeled as equity-like exposures. Therefore, to properly hedge those exposures, a plan will need some portion of equities in its asset portfolio, even if it wants to invest at the MSV level and even if the plan is fully funded.

Leverage. If a plan is underfunded, the leverage issue comes into play. Equities will be necessary to get the plan up to a higher asset beta, which in turn and after being multiplied by the (less than 1) A/L provides the desired surplus beta. This could be a zero surplus beta for an MSV portfolio or any higher amount.

Return. Of course, the decision to hold more equities having a higher surplus beta could also be about seeking higher returns. The market has priced risk fairly, and one might make a conscious decision to seek more equity exposure than the minimum variance level. This exposure goes beyond hedging purposes and leverage purposes and into a simple desire for exposure to the market in the search for fairly priced return.

Accounting Policies and Practices

Often at the end of a presentation such as this somebody says to me that these ideas are well and good in theory but that in the “real world” they are part of ivory tower theory. What they mean is that the various accounting rules through which the pension fund gets reported into the GAAP financial statements are their reality, and they have not made the connection that this reality comes ultimately out of the “real” realities of the plan’s economics. As I have said several times, accounting ultimately follows economics.
I think it is helpful to compare and contrast an economist’s view of pension accounting and the accountant’s view of it. The accounting version of the pension plan T-account has invested assets on one side. They may be “smoothed,” or averaged, over some number of years; they may not be. On the other side, the liabilities include retired lives and active accruals for the ABO for the balance sheet and active future accruals to determine the projected benefit obligation (PBO) for calculating expense and contribution. Again, these liability values may have some smoothing in the form of sticky discount rates. They will deal only with present and past employees and participants. In contrast, the market never smooths the assets; therefore, an economist is strictly concerned only with unsmoothed market values.

Furthermore, on the liability side, an economist would always use a discount rate taken from the market; again, there is no smoothing. Also, if the desire were to understand the liability from a corporate finance perspective, the economist would include the present values of liabilities related to future lives so that all costs involved in valuation of this part of the total company were considered. If the desire were to study the plan from a corporate finance perspective and the “hidden” liability for the present value of future employees was being considered, an economist would also include an additional hidden asset—the present value of planned future contributions. It is “off the balance sheet” from a book value point of view, but it is an important part of the solvency of the plan.

The economist would thus look at things from the perspective of the markets and from valuations and would include things and use approaches different from what is reported on the books. But these differences are very important from the perspective of the market value of the liability and the solvency of the plan. So, rather than having a book value view, an economist has a market value view.

No corporate executive would take a book value for, say, the headquarters building and offer to sell the building at that price. The limitations of book values are well understood and include an acknowledgment that book values are not “real” values and that only market values are real. At the end of the day, what I am calling economic, or market, values are simply the values that any good management team would want to be using for its decision-making process. Hopefully, we can bring some of that same clarity we would have for a real estate holding to the book and market distinctions in pension plan accounting.

At this point, I will review some of the distortions, risks really, that happen under some of the current accounting practices.

**Nonmarket Discount Rate.** The discount rate for many purposes is smoothed in the sense that it does not get reset to market very often. This practice was originally motivated by a well-intentioned belief that doing so would take some risk out of sponsoring pension plans.

How could that be a bad thing? Think about it for a minute; it creates a very substantial distortion of the investment possibilities for the plan: *There is no hedging asset for a liability that does not have market volatility.* If the accounting distorts the sponsor’s view of the liability so that he or she cannot see a benefit of hedging the “real” market-related risks in the liability with the market-related risks in the assets, it is likely that the sponsor will not hedge. Today’s heavily equity-oriented strategies are proof of the validity of this concern. They are quite unhedged and disconnected from the liability.

If we want to smooth pension accounting entries, we should smooth the surplus, not the liabilities or the assets separately. Then, the sponsor could see and appreciate the hedging opportunities more clearly.

**Asset-Related Discount Rates.** The second distortion in the accounting system that I would like to discuss is one caused by the use of asset-related discount rates. For virtually all purposes, public plans use the expected return on assets as the discount rate. In corporate plans, a long-bond rate is used for discounting the liability for the balance sheet, but the expected return on assets is used to form the liability estimate from which the contribution and expense figures are calculated.

Of course, it requires a certain suspension of disbelief to agree that there should be two different discount rates and thus two different valuations for the liability. At least one of them has to give an answer that is not “real” because they both give different answers. But beyond that, using the expected return on the assets to value the liability is just simply—well, I will call it like it is—wrong. There is no dispute, or even any room for dispute, that the correct discount rate for valuing a stream of cash flows has to be tied to the market-related volatility in that stream of cash flows. The expected return of some assets held against the liabilities is simply not the right discount rate for the liabilities. This is just basic corporate finance and arises from some of the invariance principles. Yet, many involved with pension plan management are fervently committed to maintaining the use of the wrong discount rate.

This is a big deal, not a small one, because it leads to very big errors in valuation. Today, most plans seem to have an expected return on asset assumption of between 8.5 percent and 9 percent. But government long-bond discount rates are down in the low
5 percent range, and so the true cost of capital for a pension liability is, at most, in the 6 percent range (the market-related risk of the ABO or PBO is very heavily government bond-like, with perhaps a very small equity-like component). So, there is something like a 3 percent difference between the two rates.

Additionally, remember how long the durations are for liabilities. Although I prefer to work with separate real interest rate and inflation rate durations, many people often say the nominal duration for a pension liability is 15 years or more. If the discount rate is 3 percent too high, the liability is undervalued by something like 15 × 3 percent, or 45 percent, from its market value, not correcting for convexity.

This problem will be painful to repair. To fix it, going to a lower discount rate requires acknowledging that the liability really is larger than we have been reporting it previously. Restating the liability to a correct higher value will be experienced as if it were a debilitating one-time hit. Never mind that the reality is not being changed; only the perception of reality is being corrected. Certainly, any attempt to deal with this issue will probably have to be softened by being amortized over time, but it is ultimately a problem that must be addressed.

This is also a real day-to-day issue. So long as benefits are undervalued in this way, increases will be granted as if they are inexpensive and obligations will be taken on that in reality are far larger than they are perceived to be. It fosters a complete mispricing of the liability and thus of benefit decisions and substantially increases the opportunity for mismanagement of these excellent benefits programs.

**Required Rate of Return.** The third distortion caused by the accounting system that is worthwhile discussing here is that the investment strategy is itself often driven by something referred to as the “required rate of return” rather than by a trade-off of risk against return.

To illustrate how this situation occurs, I have drawn a thin horizontal line on Figure 9 to represent a target, or required, rate of return. The line is superimposed on both an asset-only frontier and a surplus frontier. For this purpose, it does not matter which space I am working in. This line represents the recommendation often made by the plan sponsor’s advisors for a required rate of return for the pension fund. That number becomes the input that controls the asset allocation policy decision with diminished regard for where that line crosses the efficient frontier. That is, the investment policy is being chosen without sufficient regard for the risk–return trade-offs that should govern choices made on that frontier. And because many sponsors are under pressure to report low liability values, which implies high required rates of return, the fact that the discount rate derives from the asset allocation policy creates a perverse incentive to invest aggressively.

In fact, until a year or so ago, when required rate of return assumptions were at 9 percent and 10 percent, I was seeing many of these rates completely above the efficient frontier. Think about what that means for investment policy! That is the kind of situation that can happen when a required rate of return becomes an input to the asset allocation process rather than an output.

This distortion ultimately traces back to the use of the wrong discount rate reference, the expected return on assets. A high required return on assets implies a high discount rate, which implies, in turn, a low liability value, which, in its turn, implies lower contributions and expenses in the current period. Incentives to reduce contributions and expense being what they are, plan sponsors end up taking a lot of uncomfortable and poorly considered investment risk.

The very term “required return on assets” suggests a fundamental misunderstanding of expected returns. One can desire some rate of return, but if it is above the risk-free rate, one cannot require a rate of return. And if one does set an investment policy having an expected return that is higher than the risk-free rate, then of course there is a distribution of possible realizations in what return will actually be achieved. In plain English, that means that there is risk. One cannot tell the markets what to produce, and there is in reality no such thing as a required rate of return in this sense of the term.

**Summary.** I think we all agree that the markets can tell us much more about what is “real” than can some of the artificialities used in ordinary day-to-day accounting. Unfortunately, sometimes it is easier to use book value data to make decisions, especially where valuation is as opaque as with pension plans. That is not a good thing.

---

**Figure 9. Illustration of Policy Questions for the Total Portfolio When the Target Is an Actuarial Required Return on Assets**

![Diagram of liability-relative strategic asset allocation policies](image_url)
Duration Matching and Targeted Duration

In discussions such as this one, duration matching and cash flow matching come up a lot. I will skip past cash flow matching, but I would like to spend a few moments discussing duration matching, where plans have some more flexibility.

I often characterize duration matching as an important second layer of surplus risk control. When duration matching and cash flow matching were done in the past, the portfolio was entirely matched to the liability (usually just the ABO and within the limitations of a cash and bond portfolio) in an attempt to hedge out the liability completely. As I have mentioned, this approach can appropriately be interpreted as the rough equivalent of an MSV policy. It involves taking no market-related risk against the liability and having no expectation of receiving any market-related return. It is a very constraining approach.

So, I would like to extend the topic of duration matching in a way that first ties in with a surplus efficient frontier decision so that the sponsor has an opportunity to decide how much market risk, and thus how much market return, should be in the portfolio. It boils down to thinking about how much equity should be in the policy. Then, once the plan sponsor has made that decision, he or she can think about duration matching in a manner incorporating the equity position.

Why do I say that this is a secondary approach, behind surplus asset allocation as the primary approach? Researchers have not come up with a theory for duration risk that trades off return and risk in the same way that expected return and risk are traded off in mean–variance space. Because plan sponsors have no comparable way to measure the trade-off with duration matching, they cannot form a solid basis for how much duration mismatch to have in their portfolios. So, the decision needs to be a second layer of risk control rather than the primary layer.

History of Duration Matching. Generically, duration-matching technology was developed first in the 1980s. Martin Leibowitz (with numerous co-authors) was one of the key thinkers in this area, but others were also involved in other aspects of duration research that I will refer to, such as Laurie Goodman and William Marshall. This technology came into popularity at that time under very different circumstances from those of today. At that time, discount rates for pension liabilities were much lower than market rates, rather than higher, as today. Remember, that was the era of high inflation and higher rates.

Consequently, it was possible to defease a plan with a duration-matching solution and “save” money. The asset-related discount rates were as wrong then as they are today, but at that time, they were overstating the true value of the liability rather than understating it as we see now. So, the ability to appear to save money and free up cash was driving interest in cash-flow-matching and duration-matching solutions.

Today, the situation is reversed, and it is fear of experiencing pension-related accounting surprises that drives the interest in duration-matching solutions. It takes more assets than most plans have on hand, and this fact may be acting as a “brake” on the desire of many plan sponsors to reduce risk with this approach.

Dual Durations. It is important to note that “duration matching,” as the term was traditionally used, presumed that the liability had a single, nominal duration, the same type of nominal duration that people are used to seeing with nominal fixed-income instruments. Nominal duration expresses the sensitivity of valuation changes with respect to changes in nominal yield.

But on reflection today, we can show that most assets actually have two durations because they have different valuation sensitivities with respect to the

8It is not clear who first invented the surplus efficient frontier, but Martin Leibowitz also wrote a lot about surplus asset allocation and optimization in the 1980s. See, for example, “Total Portfolio Duration: A New Perspective on Asset Allocation,” Financial Analysts Journal (September/October 1986):18–29, 77.
two main components of yield: inflation and real rates. Equities have two different durations, as do TIPS, and as it turns out, so do pension liabilities. About the only assets that do not have different real interest rate and inflation durations are nominal bonds. The irony is that nominal bonds are the exception rather than the rule despite the fact that it is with nominal bonds that all of us finance techies learned the science of duration! The bottom line, however, is that a good approach to duration management has to take both durations into consideration.

To illustrate what I am talking about, see Equation 5, the pricing equation for a highly stylized zero-coupon TIPS bond:

\[
PTIPS = \frac{F(1+r)^T}{(1+r)^T(1+i)^T} = \frac{F}{(1+r)^T},
\]

where

- \(P_{TIPS}\) = price of TIPS bond
- \(F\) = face value of bond
- \(i\) = inflation rate
- \(r\) = real interest rate
- \(T\) = time

The face value of a TIPS bond goes up with inflation, which is how investors are protected against inflation. If I decompose yield, the discount rate, into its two components of real interest rates and inflation rates, the denominator is \((1 + r) \times (1 + i)\). The \((1 + i)\) is, in effect, canceled against the same expression in the numerator. This cancellation leaves the right-hand term in Equation 5, which says that the price of a TIPS bond is just the face value over 1 plus the real rate to the power of time: \(F/(1+r)^T\).

What does this mean for price sensitivity of TIPS bonds with respect to inflation? One does not have to actually calculate the derivative of price with respect to change in inflation to see that there can be no price change with a change in inflation; inflation is not even in the pricing equation and cannot affect price. So, we know that TIPS bonds have a zero duration with respect to inflation changes.

But there obviously will be a nonzero duration with respect to changes in the real interest rate. So, TIPS have some positive number for real rate duration, and they have zero inflation duration. That information becomes very useful.

Here is another example of two different valuation sensitivities to the components of yield. Think about the liability valuation, again using a highly simplified and stylized valuation formula:

\[
PV_{Liability} = \sum_{t=0}^{T} \frac{CF_{active} (1 + i_{COLA})^t + CF_{retired} (1 + i_{COLA})^{t}}{(1 + r)^{t}(1 + r)^{t}}.
\]

This equation looks scary at first, but I will parse it out. In the numerator, I separated the active lives and the retired lives because they behave a little bit differently. The “final average pay” liability related to the active lives will grow with the wage inflation rate, which is closely tied to U.S. Consumer Price Index (CPI) inflation, not perfectly but closely. So, inflation is in the numerator for active lives.

For retired lives, inflation is also in the numerator if the plan has a cost of living adjustment (COLA) policy related to CPI. Most corporate plans do not have COLA policies, but most public plans protect beneficiaries against some or all inflation. Depending on which plan one is looking at, \(1 + i_{COLA}\) may or may not be in the numerator for the retired lives.

By decomposing the discount rate in the denominator again into \((1 + i) \times (1 + r)\), I get a lot of cancellation, with the exact amount depending on just how much inflation protection there is to the beneficiaries. So, inflation duration is likely to be moderate and might approach zero if the plan has a full COLA. It is safe to assume that inflation duration will be lower than real rate duration for any final pay plan having active lives.

So, pension liabilities have two durations: a low or moderate inflation duration and long real rate duration. By inspection of Equation 6, it is apparent that if one attempts to calculate a nominal duration for a pension plan by changing the denominator by a percentage point and determining the percentage change in valuation, what one is really getting is very close to a real rate duration, not a nominal duration. So, it is important when dealing with rate sensitivity for pension liabilities to use both durations.

Surprisingly, equity duration shows a similar pattern:

\[
P_{Equity} = \sum_{t=0}^{\infty} \frac{Dvd_0 (1 + i)^t (1 + (g - i))^t}{(1 + r)^t(1 + r)^t},
\]

where

- \(Dvd_0\) = beginning dividend
- \(g\) = growth rate of dividends


All I have done in Equation 7 is to take a version of the dividend discount model, which says price is equal to the summation over time of the dividend times the growth rate divided by the discount rate, and decompose the growth rate into 1 plus inflation and a real rate of growth. The portion of growth that is real shows up as \( g - i \). Then, of course, I used the same pattern as before and decomposed the denominator into a real rate and an inflation rate.

Although under the rigid conditions of the dividend discount model inflation appears to entirely cancel out, it is likely that this is an overstatement. I usually assume that equity inflation duration is low but not zero, which makes sense because companies make every effort to pass inflation changes through to their customers and are usually able to do so. But real rate changes are clearly more important to equity pricing, affecting valuation in a more substantial way. So, again, I see long real rate duration and short inflation duration.

Be careful with equity duration, however, because it is not as empirically demonstrable as bond duration. A lot of things affect equity prices other than the discount rate. It is pretty clear that equities have to have these sensitivities from a first-principles perspective, but it is difficult to see empirically behind the other causes of price changes. Regardless, I think most everyone will agree with the intuition behind it. The market-related risk of equities that we are accustomed to thinking about is risk over and above both of these components of the discount rate.

So, most assets have dual durations. It is only nominal bonds that do not. Knowing this fact, we know that we can match the weighted-average durations of the assets, including equities, TIPS bonds, and nominal bonds, in a manner appropriate to matching the liability so that we can remove interest rate risk. The math is straightforward once the problem is set up this way, and the solution is covered in the articles referred to in footnotes eight and nine. I urge those of you who work to control pension funding risks to become familiar with this technology.

### Conclusion

I said several times in this presentation that the plan sponsor has to answer only two questions to determine investment policy completely. First, how much market-related, or beta, risk should be taken, measured relative to the liability (surplus beta)? Second, how much alpha-related, or active, risk should be taken? Because asset allocation is about the beta decision, that is where I have chosen to spend most of my time.

The following are the key points I hope readers will take away from this presentation:

1. The opportunity to manage the hedge between the betas of the assets and liabilities can be used to manage or reduce investment risk to the plan, and plan sponsors should take advantage of it. But only the market-related risk in the liability can be hedged. Traditional methods of managing asset/liability risk have not taken advantage of this opportunity.

   It is actually easier to model the market-related risks in the liability in preparation for this hedging decision than it is to conduct the less-useful Monte Carlo study. Think of it as a cost of capital estimation problem, and the resulting output will simultaneously be a discount rate and a market-related risk model for the liability.

2. The objective function in making this hedging decision is to trade growth of surplus (or shrinkage of deficit) against risk to the surplus. I call this process “surplus asset allocation.”

3. Plan sponsors can use such innovations as surplus tulip diagrams to demonstrate the risk–return trade-off of different investment policies in the context of the overall health of the plan as measured by the surplus.

4. It is essential that plan sponsors develop intentional “contribution policies” and “benefit policies” and coordinate these with the investment policy decision. Investment returns are the weakest of the three levers available for influencing pension funding health.

5. A surplus-duration-matching, dual-duration-matching technology is a great secondary risk control method, backing up the surplus asset allocation decision. It is a risk control opportunity that plan sponsors cannot afford to leave behind.

6. Plan sponsors, as well as other investment professionals, should work to improve accounting practices and standards so that they do not create disincentives to making good economic decisions. These do not have to be part of GAAP reporting; they could stand separately as management tools. The importance of the pension plan to most organizations demands that the plan be managed better than it has been using GAAP perspectives.

7. Alpha is conditional on skill. The size of a plan’s active risk budget should be proportional to how good the plan sponsor, in combination with consultants and other advisors, thinks he or she is at picking managers that, in turn, also have skill.

8. The market-related portion of liability risk can easily be hedged against the assets, giving an opportunity to dramatically control that portion of pension funding risk. But the non-market-related portion, the idiosyncratic portion, of
liability risk cannot be hedged. There will always be some element of uncontrollable or idiosyncratic risk in the pension liability, whether it is mortality risk, the risk of overly generous benefit decisions, or whatever.

But a lot of that risk is uncontrollable only in the financial sense that it cannot be hedged. Much of it is controllable, in the decision-making sense, in the hands of management. Benefit policy and contribution policy are two excellent tools for managing that risk level, but they take little advantage of investment opportunities for their strengths.

Our job as members of the investment part of the team is to help control the financial risk, and for the most part, this is a “beta job” for which we should know the answers. And while we are at it, we can help management think clearly about the other risks as well.
The New World of Pension Fund Management

Question and Answer Session

M. Barton Waring

Question: Regarding Equation 4b, the surplus utility equation, should the beta for the liability and the beta for the assets be calculated against the same universe?

Waring: Yes. The beta should be by reference to the same portfolio. As I mentioned, the most general way to do this is to use a world market portfolio, what I call “Portfolio Q.” True, it is not possible to actually achieve the complete market portfolio because we cannot invest in some of its larger elements, such as human capital and residential real estate, but we should get as close to it as we can by using all the tradable and liquid asset classes that are available. The beta would be measured by reference to that for both the assets and the liability. In practice, because there are home country biases at work in most organizations that we deal with, we often have to use a more localized reference portfolio.

Question: You suggest that a plan with a funding ratio of less than 1 should invest more aggressively. Insurers would take the opposite view vis-à-vis their general account assets. Given the economic risk of the plan, which is carried by shareholders, how do you rationalize the pension strategy versus what insurers would do?

Waring: The question really asks for a justification for investing more aggressively when the plan is underfunded. When I set up the return of the surplus, one of the things you might recall that I mentioned was that if the goal is to stabilize wealth in the surplus (usually actually a deficit), then we come to the conclusion that the A/L and leverage become important. The result that is important to this question is that if the plan is underfunded, you have to lever up the asset side if you want the assets to track the liabilities at the same amplitude. In this way, the deficit, measured in dollars, is protected.

There is an alternative objective that you could have, which would be to not literally match the asset returns to the liability so that they always move together in the same amplitude. Rather, your objective could be that they always move in the same direction but only proportionally to each other. If you did that, then the mathematics relax a little bit and you no longer lever up the assets. But the dollars of deficit or surplus aren’t preserved in this latter case; only the proportion of deficit or surplus is preserved.

So, depending on your objective, you have a choice of either freezing the deficit in dollars or in proportions, and that decision controls whether you need to use leverage on the asset side. The first of these is the standard way that is seen most often in the literature. But I have worked with some groups with extremely low funding ratios. Often, they could not possibly imagine leveraging up enough to match that liability. For them, the secondary objective of protecting proportional liability coverage by the assets has been all they could hope to accomplish.

Question: Because most pension funds are equity centric, the correlation assumption between the assets and the liabilities seems to be central to the final asset allocation decision.

Waring: The correlation decision is central. The way I like to capture it is in the relative beta measure between the assets and the liabilities. Betas are all about correlation.

Because market-related return is proportional to the beta, beta is a very useful means of getting at the issue. It is the right measure for supporting our hedging decision because only betas or market-related risks can be hedged.

When one thinks about the pension policy in this way, one is almost certainly going to move toward a less aggressive position than the 70 percent equity positions that we commonly see today. We will probably see plans regressing back toward their historical mean, which is closer to a 50 percent equity allocation.

I do not think they will go all the way back to being fully matched or otherwise going to the MSV position, but I do think they are going to turn the dial back down to lower levels of surplus risk.

Question: What do you think about using interest rate derivatives for duration matching?

Waring: In modeling a typical plan, you might see inflation and real rate durations of roughly 17 years, more or less, and in a considerable range. They are quite long. In an asset-only world, this feels like a huge amount of risk. But if you really want to stabilize the economic deficit or surplus, then it is necessary to be that long in duration.

If an organization wants to minimize its interest rate related risks, it is going to have to achieve that duration somehow. There are not a lot of instruments out there that have 17-year durations. Consequently, it is going to take some method of using derivatives to lever up the duration to those levels. Some form of derivative usage is going to be necessary.