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## Session 66PD

### Strategic Asset Allocation for Pension Plans

**Track:** Pension  
**Key words:** Investments, Pension Plans, Asset/Liability Management

**Moderator:** CRAIG A. VOELKER  
**Panelists:** MARK ABBOTT†  
BRYAN EDWARD BOUDREAU  
CRAIG A. VOELKER  
**Recorder:** CRAIG A. VOELKER

*Summary: Pension fund managers, due to changing demographics, changing investment landscape, and increased competition, must continually reexamine their allocation of funds across broad asset classes, and determine the most prudent mix of investments, given the myriad of factors involved. But the right answer is often elusive and debatable. Just what are the most important factors that should be considered? What process for evaluating these factors make the most sense?*

- *How fund managers go about the allocation decision, pension fund trends, and data*
- *Emerging analytical techniques*
- *The use of historical return data in the asset allocation process*

**Mr. Craig A. Voelker:** We're going to hear from Bryan Boudreau with Morgan Stanley and also from Mark Abbott. They will be discussing strategic allocations from a very broad perspective. They will look at how best to set an allocation between broad asset classes of a pension plan. Both speakers come at it from a stochastic modeling point of view and incorporate the liability side of these issues.

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†Mr. Mark Abbott, not a member of the sponsoring organizations, is a Senior Analyst at Global Advanced Technology in New York, NY.

**Note:** The charts referred to in the text can be found at the end of the manuscript.

**Mr. Bryan Boudreau:** We're going to talk about strategic asset allocation for defined-benefit pension plans. I work in a group called the Global Pensions Groups at Morgan Stanley, and we perform strategic asset allocation studies for insurance companies and for pension plans in the United States and abroad. We have an approach to strategic asset allocation that we think is interesting, and I'm going to talk about it a little bit.

First, is why strategic asset allocation? Why is it important? Why should your clients care about it? Why do our clients care about it? It has a profound impact on the corporation. From the corporation's perspective, a pension plan is an important obligation. The corporation makes a promise to its current and future pensioners, and so there's an obligation there. The true economic cost of the plan is not just what we actuaries calculate as the projected benefit obligation (PBO), accumulated benefit obligation (ABO), and total benefit obligation (TBO). In reality there's a promise made to the participants. That promise is secured by a pension fund. We have to make sure that we meet the requirements of Section 412. The true economic cost of the plan from the corporation's perspective is what they have to kick into the pension fund to keep the pension plan funded (in other words, to pay the pension promise). So the ultimate cost or the economic cost of the pension depends on the nature of the liabilities and on the nature of the investment policy. If you can earn more with the investments, the ultimate realized cost of the plan to the plan sponsor is cheaper. That's basically what we're driving at. That's a key reason why strategic asset allocation is important.

This present value of contributions, this economic cost of the plan, is not a symmetric function of funded status. People will often look at assets and liabilities and optimize on a surplus ratio. It's a little bit more complicated than that. Consider the case of a plan that's 100% funded, and then think of that plan moving from 100% funded to 120% funded. It's a good thing. You can go on a holiday for a while. You have a little bit of leeway in contribution policy. It's a lot worse to go from 100% funded to 80% funded. Things like the Pension Benefit Guaranty Corporation (PBGC) premiums crop up. There may be inflexibility. You might have to make a contribution at a time when it's not optimal, such as when the corporation may be short on cash flow. If you're a corporate plan sponsor, rating agencies might start to look at you. The point is that the economic cost of the pension plan, as a function of funded status, is an asymmetric function. We focus on minimizing the present value of contributions; and we take the focus away from looking at it purely as a surplus ratio. That'll become clear later on.

We talked about sources of asymmetry. You can't get at surplus. Essentially, you have to pay a deficit and you have to pay it quickly. You may have accelerated funding requirements. If you run up a big surplus, though, it's hard to get that out.

That surplus is not realizable at 100 cents on the dollar for the corporation. There's a big excise tax, and you have to pay income tax on that.

How do we set the strategic asset allocation? We say that if you're looking at investment policy, you must first start with the strategic asset allocation. We use a pyramid to describe the process. At the top is strategic asset allocation. There is the equity fixed-income split and the positioning of the fixed-income instruments (the duration of the bond). That is what we talk about as strategic asset allocation. You've got to get that right first, otherwise a lot of the manager searches and the subasset class allocation really isn't all that important. If you're designing an investment strategy or a policy, you have to start at the top.

In the middle of the pyramid is tactical asset allocation. That has more of a short-term focus. You would switch in and out of asset classes as they become rich and cheap, looking perhaps at subasset class allocation. If you were going to look at, 60% equity, how should that be allocated between small cap domestic, large cap domestic, and international? Those sorts of things fall under tactical asset allocation. I think Mark will be making some more comments about those sorts of issues.

Implementation is at the bottom of the pyramid. This would include the manager selection and the buy and sell decisions of the individual manager. For now we're going to stay on the top section of this pyramid.

To get at the investment policy, what do you need to know? There are three main things. First, you must know something about the liability. What are the liabilities today? It is a question that the actuary must focus on. He or she must apply actuarial valuation methods, calculating the accrued liability, the ABO, the PBO, and TBO. These issues are important but, from a longer term perspective, what are the liabilities going to be in the future? What is the rate of growth in the population? What is the rate of accrual? What is the nature of the benefits? Are they pay related? How predictable or certain are they? How uncertain are they? Later we will see that these issues have a pretty important implication for what the right strategic investment policy is.

What about capital market instruments? What can you invest in? Specifically, what are the expected returns on the asset classes? If we say that the liability is worth \$100 million at 8%, what does that really mean? It means that we're saying that the assets might earn 8% or that's a reasonable long-term-return assumption. How do we get there? We need more detail. What is the expected return on cash? What is the expected return on bonds? What is the expected return on bonds of different durations? How do those bond returns behave under different capital market

scenarios? How do equity returns tie in with fixed-income returns? What do we expect the average equity return to be? How is it correlated?

Then if we look at subasset classes, how are those correlated? Can we gain from diversification? How do you trade the results off in one scenario versus another? Here, I'm sure a lot of people are familiar with efficient frontier techniques for looking at asset allocation. Much of that literature was developed in kind of the asset-only framework. You look at different investment classes. You look at returns, expected returns, and standard deviations of returns. You also look at correlations. That's nice, but in the asset/liability framework, you need a different type of utility function. We'll talk about what we use for the utility function, and if anybody has any comments, they can tell us what they use for the utility function. A traditionally managed plan can realize savings. This is important to clients. The client can, over a long period of time, save a lot of money by optimally matching assets and liabilities by performing proper strategic asset allocation.

There are five key sources of savings. I'll go through each of them one-by-one in more detail. First, there is better asset/liability matching. Second, is increased fixed-income interest rate sensitivity. This means increasing the duration of bonds. We almost always end up with this recommendation for our clients. Third is optimizing equity exposure. That may mean more than 60%/40% and more or less than 60% equity. It depends crucially on the types of liabilities, the funded status of the plan, and things we'll talk about later.

The fourth source of savings is the rebalancing rule. A 60/40 rule may be fine to start out, but the pension plan is a dynamic sort of animal. The 60/40 may not be the appropriate asset allocation as the plan's funded status changes, as different capital market outcomes are realized, or if the surplus ratio expands or contracts. You can save money in advance. You can essentially get a more optimal policy by identifying in advance how you may rebalance.

Fifth is the optimal funding strategy. There is basically a difference between the minimum required and maximum of deductible contributions. Look at it from the corporation's perspective. Does it make sense to defer the contribution or does it make sense to put the contribution in right away?

**From the Floor:** I have a question on number two. Would your recommendation change depending on the relationship between short-term and long-term interest rates? I'm thinking of the current situation.

**Mr. Boudreau:** Yes. It's a good point. We'll get to it. The answer is basically yes, and we'll talk about why we make that recommendation.

The first source of savings. What decisions can you make to reduce the economic cost of the pension plan? The first one is to just look at asset/liability synchronization. The corporation can actually save money just by better matching assets and liabilities. Why does this work? Think about the situation where a corporation is 105% funded on a TBO basis, including new entrants. Let's say that TBO is calculated at 8%. If the corporation could essentially invest in an asset mix that each year returns 8%, the game is pretty much over because every time they do a valuation, they're going to be 105% funded on a TBO basis. They're never going to have to make another contribution. If you could find this perfect liability matching asset, we would strongly recommend investing in that.

Let's think of another asset. Let's say you have an asset that earns an expected return of 15% or 20%, but it has a lot of variability relative to the liability. That may not be a good asset to invest in. If that asset earns 18% or 20%, you build up the surplus, and you may end up 600% funded but it is not clear that you're going to get the value of that surplus back. That surplus is going to have a relatively low benefit to the corporation. In the scenarios, where you have the other side of that standard deviation where you earn 1% or 2%, you're going to become underfunded, and you're going to have to make contributions. You may also end up in a situation where you have a couple of years of bad performance, make a lot of contributions, and then the good years kick in. The surplus is locked in at that point, and you paid more on a cumulative basis than you should have. Just getting the asset/liability relationship to move more in tandem can save the corporation money just because you're going to avoid these costly underfundings.

The second source of savings is increasing the interest sensitivity of the fixed-income portfolio. This is very closely related to the first. It's actually a key way in which you can synchronize the asset values and the liability values. For the most part, the liabilities look like very long duration bonds. If you calculate the duration on just the cash flows, they are often 15, 18, or 20 years long. Even if you take into account the sensitivity or correlation with wage increases most of the time, for a plan that has a reasonable normal mix of active versus inactive, the liability duration is long. It's 12 or 14 years. In addition, you might have only 40% of your assets invested in bonds, so you don't have the same interest rate exposure, or what we call dollar duration exposure. Equities do not move with interest rates nearly as much as long bonds or liabilities do. What we find is that most pension plans that we look at are what we call short dollar duration. It means basically that on a market asset/market liability basis, the plan usually does not have in their assets as much exposure to interest rates as they should. Therefore, in situations where rates decline a lot, the economic value of the liabilities goes up much more rapidly than that of the assets.

Extending duration really has two effects. First, it does better synchronize the assets and the liabilities. You may go from a surplus ratio that vacillates widely as interest rates change to one that is more smooth. That, in and of itself, is a source of savings to the corporation because it's the underfundings that are hurting more than they are helping. Even if one has a relatively flat yield curve, by just extending the duration we find it reduces the expected present value of contributions. The other benefit is that over long periods of time the yield curve tends to have an upward slope to it, and so investing in longer durations also tends to increase the return on the fixed-income asset class, and that's going to reduce the cost of the plan. There's really sort of a two-pronged reason for why increasing duration strategically makes sense. Only one of those depends on the actual slope of the yield curve.

Let's talk a little bit about what these changes to investment policy actually look like. There is a little bit about the stochastic modeling aspect. We do an integrated stochastic simulation. What does that mean? It means that when we look at a client's pension plan we start with the current demographics. We start with the current valuation. We start with the current asset portfolio. We move that forward through time. How do we do that? We have a capital market simulation module in our model. We start with the current yield curve. We generate yield curves stochastically in the future, one quarter at a time for 30 years, so we generate 30-year paths. We do it 900 times. We have a stochastic yield curve generator. The yield curve essentially is the key link between the fixed-income assets and the liabilities. It drives a lot of the results that we get.

We also need to project equity returns. We link equity returns to the level of fixed-income rates. We essentially specify that equity returns have a certain yield premium over and above the long-term bond yield. We also need to take into account correlations between different asset classes. Those are reflected in our capital market model as well. Realize that actuaries will perform a projection of future demographics. That may be based on wage inflation of 4%. We have wage inflation in our model essentially as a stochastic variable. It's an important attribute of liabilities. You can project future cash flows, assuming a given rate of wage increase, but, in fact, there's mortality uncertainty. There are actuarial detrimental uncertainties. There are also salary increase uncertainties. We reflect the liabilities in our modeling stochastically as random variables as well. The key way that we do that is we have wages and wage inflation basically tied to the capital markets. We have a stochastic projection of the future plan demographics. We do an actuarial valuation on that.

**From the Floor:** Is there any correlation between your wage inflation and your bond yields?

**Mr. Boudreau:** There's a correlation. We use what we call an autoregressive process. Inflation is a first order autoregressive process, meaning essentially that wage inflation at time  $t$  is equal to about 80% of what wage inflation was at time  $t$  minus 1, plus a tendency to revert towards the short rate. If you have an interest rate path where interest rates start out at 5% on the short end, like they are now, and tend to go up towards 11% or 12%, wages are going to go up in that path. They will not be perfectly correlated but highly correlated.

We have stochastic liability projections, and we have stochastic demographic projections. We do the actuarial valuation at each point in time. We look at a given investment policy of 60/40 equity fixed-income and a duration of five. We will simulate the pension plan. We'll simulate the assets, the liabilities, the cash flows, the reinvestment, and then we'll do the actuarial valuation at each point in time and calculate the minimum required contribution. For each year in that scenario, we basically calculate the after-tax discounted value of after-tax contributions. The contribution generates a deduction. We treat the required contributions as a debt of the corporation. We discount it at the corporation's after-tax cost of borrowing. We do that for one path and then for 900 paths.

To compare among different investment strategies, we need to basically use some sort of risk/return framework. Let's talk about how it is we describe risk. What do we call risk, and what do we call return? In this framework, return is a reduction in the expected cost of contributions. We look at the present value of required contributions over all the scenarios and just take an arithmetic expectation. In Chart 1, by going up the vertical axis you reduce the cost of the pension plan. The objective is to go up.

We treat risk in the integrated framework as well. Risk in the integrated risk or the economic risk to the corporation of a bad investment strategy is that the corporation's going to have to make a high level of contributions. How do we measure that? We don't like standard deviation. Standard deviation is not a good measure for the statisticians here if the distributions are asymmetric or if they have fat tails. We basically like to look at a sort of realized measure. The risk is how bad are the contributions going to be in the worst 20% of scenarios? That's basically what we found on the horizontal axis.

In the asset/liability efficient frontier framework, just like in the standard asset-only framework, the objective is to move northwest on Chart 1. You want to go up to reduce the expected contributions, and you want to go left to reduce the cost risk.

In this particular case, we ran an actual pension plan. We kept the equity exposure at 40% just to isolate this duration component. What is the optimal duration? We

plotted the risk and return for each investment strategy, and we actually started with duration five, which is where the plan was currently. It turns out on Chart 1 that the optimal duration was 18 years. That is quite a bit longer than most of the plan sponsors are currently keeping their investment policy; nonetheless, if we look at the integrated assets versus liabilities, where the objective is to minimize the contributions and the contribution volatility, we would get that answer and that's fairly consistent. We rarely get cases where that answer is much less than 15 years.

The 60/40 question. What's the optimal equity exposure? It varies dramatically from plan to plan and company to company. We've studied plans where the exposure is no more than 30%. Actually we've studied plans in which it was 10% or 15% in the same framework. We've studied plans where it's closer to 90%. For the plan that we just looked at, and Chart 2 is a fairly typical kind of number or a typical kind of chart, we basically calculate the efficient frontier or the risk/return trade-off in the same way. We look at the expected cost and we look at the cost risk. For this plan we basically ran allocations all the way from 5% or 10% equity up to 100% equity. Northwest is the objective. Anything less than 40% on Chart 2 is inefficient. If you're beneath that 40%, on that dotted part of the line, it really doesn't make sense to have your equity allocation there because by increasing it, you can basically decrease the cost and decrease the risk. The efficient frontier starts at 40%.

From 40% to 60%, the trade-off is extremely vertical. What does that mean? It essentially means that by increasing the equity allocation from 40% to 60%, the decrease in the expected value of contributions is from \$460 million to about \$405 million. It is about \$55 million. The increase from the risk is minuscule. It goes from \$730 to \$740. The reduction in return or the reduction in cost per unit risk is very favorable, and that deteriorates as you start to increase.

**From the Floor:** Is Chart 2 based on the optimal duration from Chart 1, which was 18 years.

**Mr. Boudreau:** We run many combinations of equity return and duration. The 40% has an optimal duration of 18. The 60% may have an optimal duration of 16.

**From the Floor:** So, the 18 years was not a given for this chart.

**Mr. Boudreau:** That's right, and it actually varies. It varies depending on the individual.

**From the Floor:** I'm just wondering, from a client perspective, whether the asset allocation would be anywhere from 40% to 80%. They hired the outside



consultant, Morgan Stanley, to do this study and try to quantify the intuition. When it's all said and done, what is your experience as far as the client's reaction to this kind of study. I mean what kind of economic is being added to the client?

**Mr. Boudreau:** It depends. When we do the study, we basically find out that this particular client's at 60%. That's a pretty good result on this chart. They're going to look at it and say, "Thank you very much. It sort of confirms what we're doing." We've also looked at clients that have had 80% or 90% equity allocation where the study indicates that it is extremely risky. This should be much lower. We've had some clients dramatically reduce their equity exposure based on the study. We've also had some clients increase it slightly based on the study as well. This again is just a tool to really help the client assess what is the risk/return trade-off of changing their strategy. There is no right answer.

**From the Floor:** Your discussion seems to focus mostly on cash contributions. Does your analysis change for companies that are much more concerned with financial statement impact? The asymmetry would not seem to apply as directly, although there is some asymmetry from a financial statement.

**Mr. Boudreau:** Give me an example.

**From the Floor:** If your funded position fluctuates greatly, you can recognize some of the excess pension assets on your financial statement as income.

**Mr. Boudreau:** You can.

**From the Floor:** In the long term there is greater symmetry.

**Mr. Boudreau:** Realize that in *Financial Accounting Standard 87*, as it's written, you can essentially recognize the prepaid pension expense. It's questionable as to whether the prepaid pension expense asset is actually something that's realizable. If you had a corporation, for instance, that had most of its assets tied up in the prepaid pension expense, the analyst might have a hard time looking at that asset as having the same dollar. If you're looking at what's the real market value of the corporation in the stock market, is that as high a quality asset? Similarly, if you have a company that has pension earnings year in and year out, do those earnings have the same quality as earnings from other types of operations? It's clearly the case that when we talk to some clients, they are primarily concerned with earnings. They want to basically use a more symmetric type of measure. We tend to discourage that. We would tell them take a longer term look at what the plan is actually costing you as opposed to just purely what the accounting is showing. Clients want different ends of the spectrum.

In this particular case, anything from 40% to 80% looks pretty good. If this client were at 80% and considering going to 90%, we would say, "No way." If they were less than 40%, we would tell them that's pretty silly as well. We typically tend to show these in terms of cost reduction per increase in risk. It's one analytical tool that they have.

What are some of the sources? We said that this optimal asset allocation varies from plan to plan. Why does it change? I think the key reason is what we call the noise in the liability. If the liabilities are truly like bonds, and if the liabilities are extremely predictable, then what you can do is invest in a dedicated, immunized type of portfolio, and really lock in the asset/liability relationship. In that case, you can find a relatively low risk asset mix. It's going to be a low return asset mix as well, but it's an asset mix that is mostly bonds. If you want to incur some additional risk, you can move into equities. The price you're going to pay for the higher return is going to be a desynchronization of the assets and liabilities. That's in the case where liabilities are perfectly predictable, where liabilities truly are bonds, but they're not. Any pay-related plan is virtually impossible to predict and to dedicate or to immunize what the future cash flows are going to be because that depends on what's going to happen with future wages. The 4.5% wage increase assumption is just a mid-line assumption. If you look at what may happen over different scenarios in the future, wages may grow at 7%. They may grow at 2.5%. The point is, in the case of treating the actuarial projection, just using the mid-line, and dedicating against that is not really reducing the risk. You still have a lot of risk on the table you can't match, or that you can't dedicate. If that's the case, then suddenly these low-returning fixed-income assets really are not riskless anymore. It makes sense to look at other types of asset classes, such as equities that have a higher return and may actually diversify some of the asset/liability risk. The point is that if you have liabilities that have relatively high noise, or high uncertainty, such as a young population with almost all actives, it is usually a good candidate for a fairly high equity exposure. If you have a population where there is essentially a terminated plan or something like that, it's usually a good candidate for relatively high fixed income.

In Chart 3 we just split the actives and inactives into two separate plans and looked at minimizing the contributions. We looked at the actives only where the efficient frontier changes shape. It starts at 50% instead of 40% and it goes up to 90%. So more uncertain future liabilities mean that fixed income is actually a riskier asset. It does not match the liabilities as well. The model tells us what we can sort into it and it gives us a higher equity exposure.

If we take just the retiree portion and run the same type of analysis, we get an efficient frontier that is really between 10% and 20% of equity (Chart 4) These are

fairly extreme cases. We've taken sort of an average plan and split it up into a group of actives and group of inactives, but it illustrates the point. There is liability uncertainty. How much don't you know about the liabilities? How much can the liabilities not be immunized? This has an important impact on equity exposure.

The way to capture the surplus value. We're assuming a rather extreme case in the examples that we are looking at. There's zero value on the surplus. We're looking purely at minimizing the contributions. I think the other end of the spectrum, which is realizing surplus at 100% value is also inaccurate. We've had this discussion with clients many times, and some clients tend to think that the surplus to them has relatively little value. Others think that it has some value and that you can use it to increase benefits and buy off other types of cash wages. Some clients might think that there's potential merger and acquisition. You could always merge with a company that has an underfunded pension plan and extract the surplus that way. The point is, again, it's something that depends on the client's perspective, but the way to capture the surplus in the analysis greatly impacts the allocation to equities.

The equity risk premium is a discussion that we invariably get into. We have to. We wouldn't even be fulfilling our obligations as actuaries if we didn't talk about it. Historically, if you look at Ibbotson data, the types of equity risk premiums that you'd get if you just look over the long-term are probably 500, and might even be higher. Stocks have traditionally outearned bonds by 500 or 600 basis points. The kinds of numbers that we're currently running are closer to 300. We hear comments that the equity market is overvalued. Does the result still hold? Should I still be at 70% equity even if I think stocks are overvalued, and they're going to only earn 300 points more than bonds? It definitely impacts the answer. Obviously, more equity risk premium is going to give me a more favorable efficient frontier. Because it is relative to equity allocation, it's something that we need to sensitivity test, and we do.

The funded status of the plan. Extremely poorly funded plans are going to be making contributions anyway. It generally pays to go for a lot of equity. For plans that are around 100% funded, we tend to get less equity. Why? Synchronizing the assets versus the liabilities is more important because what you want to do is avoid the underfundings if you have bad equity performance. If you have a relatively low value of surplus, but the plan's extremely well-funded, it still makes sense. You'd be getting 20 cents out on the dollar if the surplus is huge, but it still makes sense. So, this is something that impacts the optimal equity exposure.

**From the Floor:** Would you change any of that if your liabilities were inflation indexed or payable in multiple currencies?

**Mr. Boudreau:** Yes, I would if they were in multiple currencies. You'd have to look at essentially the reporting currency or the currency that the plan sponsor makes its cash contributions in. You'd have to take exchange rates into account. The answers would definitely change. You would generally have to look at the economics of the corporation in the corporation's home currency. In that particular case, if a corporation had 50% United States and 50% Canadian type liabilities, it might make sense for the corporation to have 50% bonds in the United States and 50% Canadian bonds. It's going to have an impact. You have to convert back. You have to take currencies into account.

**Mr. Boudreau:** We touched on rebalancing rules. What we have done so far is we've shown what the risk/return efficient frontier looks like. Suppose you just look at static policies, or a policy where the equity fixed-income split is 60/40, the duration is 18, and you run that forward over time. You're taking the model, and you're projecting it and you're rebalancing to maintain that sort of strategy. That's just sort of one layer in the universe of potential strategies. You can also open up that universe and, instead of specifying your strategy as a mix and a duration, you specify a mix and a duration, and then a rule for changing that as you go forward. That is just one example of how that works.

Chart 5 shows the old efficient frontier on the right. That's basically fixed mixes. The left line is an improvement. We've said, let's start at a given equity fixed-income mix, but let's put in a rebalancing rule that essentially says that for every 1% increase in the surplus after you start the investment policy we will increase the equity exposure by 1.1%. This was just something that we iterated, too. We would test a whole bunch of these strategies. That 40% rule is starting out at 40% but increases by 1% for each 1% increase. It gives us a larger opportunity set and potentially more efficient strategies.

The last source of savings is a reason why companies should use this sort of stochastic analysis. It is the appropriate funding policy. What are the key points here? Overfunding the plan, or essentially putting money in and having that locked in at surplus makes it difficult to get out and it costs the corporation capital. That is something that you want to avoid. You want to avoid the underfundings. You want to avoid basically tying up money in the pension plan. On the other hand if the corporation's going to have to make the contributions anyway, then deferring them costs the corporation a chance essentially at a tax arbitrage. There's an opportunity to borrow in the capital markets using tax-deductible borrowing, and invest it in the pension plan where the assets grow tax free. If contributions are certain down the road, and the corporation is highly rated and is going to be around, and is not going to exercise their option to default on the pension plan (this

is terrible terminology, but that's mathematically what it is), then it may make sense for the corporation to put their funding in as quickly as possible.

**Mr. Voelker:** Bryan, on an earlier chart I saw the equity exposure or the equity efficient frontier ranging from 40% to maybe 80%. How do you help a client find themselves within that broad range of allocations?

**Mr. Boudreau:** It was between 40% and 60% and that's really a vertical efficient frontier. What we would do is show the client the values at that point, and we would show them 40%, 45%, and 50%. We'd show the expected present value of contributions on average i.e the return. How much will the return increase? Then we would show them how much the risk increases? And then we would just calculate a ratio. In some cases, the ratio is 20-to-1, and moving up the efficient frontier makes sense. The efficient frontier is concave, and that ratio deteriorates. It is a matter of management judgment. There's no hard-and-fast rule on that.

**Mr. Voelker:** If I understand the model, it's to optimize this allocation and to minimize the expected present value of future contributions.

**Mr. Boudreau:** Correct.

**Mr. Voelker:** I'm imagining that there are probably certain allocations, say, Allocation A and Allocation B, where Allocation A may have a lower expected present value of future contributions but a wider dispersion and a greater variance.

**Mr. Boudreau:** Yes.

**Mr. Voelker:** How do you rank Allocation A over Allocation B, given those two variables of a stochastic modeling?

**Mr. Boudreau:** It's a good question, and that's basically the reason why we like to use the contributions in the worst 20%, because as you change the mixes, you are changing two things. If you graph your present value of contributions across your scenarios, you are changing two things if you change the mix. If you go to a higher equity exposure, you shift it to the left. You're shifting essentially the modal point to the left. You're reducing it, but you're also widening it. You're changing the mean. You're also changing the dispersion. What we're doing by taking the worst 20% is capturing the combined effect of those two. We're basically reducing the change in both parameters to something that makes sense to the corporation. How bad is the contribution? We do vary, though. Sometimes we use the worst quintile. Sometimes the corporation's worried about the worst 5% or the worst 1%, and we'll do it.

**From the Floor:** You said the overall duration of the portfolio in your example should be around 18. Even a 30-year Treasury bond won't give you that high a duration.

**Mr. Boudreau:** No.

**From the Floor:** Are you suggesting zero-coupon bonds or does your duration measure of equities affect that number?

**Mr. Boudreau:** You can get people to argue that the duration measure of equities is 40. You can get people to argue that it's two. We treat it as four. It's not really doing very much to help out the dollar-duration situation. How do you get from your Lehman aggregate for five years to 18 years? There are a lot of different ways to do it. I think it's very rare that a client will say it is a good idea to go from 5 to 18 all at once. They could. There are some pension plans that are running at well in excess of 20 on their fixed-income duration. We've had clients say, well, how do we do this? You can do zeroes. You can invest in a portfolio at duration five to seven years and use some sort of a futures overlay. Some clients are thinking about doing that. Or 18 might be right, but you might use 13. We'll just invest in 30-year coupons. So, it sort of runs the gamut. If five is where they are, and 18 is where they should be, then anything in the right direction is an improvement, and we've seen clients go part of the way.

**From the Floor:** How do you determine frequency of rebalancing?

**Mr. Boudreau:** That is another good question. We basically just test it. Our model is done at quarterly intervals. We can test any sort of rebalancing which is done quarterly or less frequently than that. It's a matter of taking transaction costs into account. There's not all that much difference between doing quarterly versus annual.

**Mr. Voelker:** Mark Abbott is the director of marketing and consulting services at BARRA.

**Mr. Mark Abbott:** I'm going to talk a little bit about the tactical area but also touch on the strategic area in asset allocation. We've done a lot of work with interest rate sensitivity risk, and BARRA certainly spans the gamut in terms of investment strategies, going from equity to fixed income and even hybrids in between. We use a lot of risk measures. In terms of looking at this work, we have some divisions that are doing specific pension plan sponsor consulting, so this talk is actually going to be a composite of several of those areas. I titled it strategic use of key-rate durations and value-at-risk because sometimes I think that this area of tactical asset allocation

and even strategic asset allocation is probably up and coming in terms of its utilization.

Bryan has touched on a lot of these in detail. I'm going to cover them fairly quickly in the remaining time so there'll be more time for questions. We certainly believe that if you're doing economic valuation, you need to have, at least at the heart of your analysis, an arbitrage-free framework for the primary valuation of the assets and even the liabilities to get at the economic valuation. You certainly need to think about other extreme scenarios once you start to test and utilize some of your assumptions. We feel that you can get to the benchmark of the liability if you have a good liability model and actually create something that is going to do what I would call a static hedge, which would mean that if you had paths in the characteristics, you'd like to build a model that will allow you to choose an asset universe that can capture some of that path dependency and thus reduce some of the variability that you might see. Optimal asset allocation certainly should be done relative to this surplus volatility. You would very much like to reduce that volatility. As Bryan pointed out, there's a lot of benefits in the funding side if you do so. Then after you've done sort of your primary asset allocation, do some additional analysis for dynamic hedging. If you have an investment strategy that you're going to use, that's an appropriate time to really look at this key rate duration or the duration of the assets versus the liabilities and try to get them under control better.

I want to go towards the newest area in risk measurement, and that's value at risk. That is how it brings together all the different sources of risk using either historical or even projected correlations that exist in those different risk and return drivers. See if you can't get some additional optimal asset allocation from looking at it from that perspective rather than just using a quartile or a quintile measurement.

In terms of the arbitrage-free framework on the fixed-income side, you need to be able to price the embedded options, the path-dependent options and your zero-coupon bonds appropriately. You need a framework that builds up lattice methodologies for pricing pure options, American options, as well as the mortgage-backed securities and path-dependent liabilities.

In terms of getting this optimal portfolio, we can look at a progression here where you start with understanding the liability, constructing some benchmark to that liability, and doing an optimal asset allocation relative to the characteristics for liability. Once you've got the definitions for your general asset allocation, then you can go deeper down into specific portfolio sector segmentation issues, do some actual portfolio management, and come up with an optimal portfolio. This is essentially the whole approach. It is important to look at the liability if you can, if they're simple. In the case of a terminal case, you can certainly use cash-flow

matching. Even in the cases where that isn't true, if you have a model that looks at the correlated effects of inflation equity movement and interest rate movement, hopefully you can get a better understanding of the liability and come up with something that also, along each of those scenarios, does a fairly good job of matching cash flows. That would be a benchmark. You're not expecting to do anything better than that. Then you can focus on what additional information could be gained by doing something like tactical asset allocation where you give a little bit more leeway to managers using external managers.

Also quantify the risk characteristics and hopefully establish a benchmark portfolio that has the right embedded options to counter any options in the liabilities and then do some optimization over efficient frontiers relative to some risk profile. That brings up questions like what data are you going to use? How are you going to build your forecast? What are you going to use in driving for these future returns? What about future volatility. We have a lot of historical information, and, as you'll see shortly, that has changed if we look at different periods of time. There are many different models that are looking at these and the correlations using various weighting techniques. You are ultimately looking at a world where maybe one covariance matrix and one set of volatilities is not appropriate. Maybe you do need to drive this over many different sets of assumptions and; therefore, we have even different scenarios out there. I think this is actually an area of expertise. The more people work with this, the more comfortable they are with clients. This whole set of assumptions is critically important to the solution that you're going to then recommend.

Once you've actually come up with some relative levels of comfort in terms of the allocations that you're going to be permitted to use, then you can work within that context in terms of determining these optimal allocations. Sometimes you're going to be constrained, especially if you're being diversified. You might have extreme limitation in the amount of equity that you would go to. In a pension, you might have the opposite where you want to get as much equity as possible, especially if you have a youthful group there. Basically, you are looking at the asset sectors. Inside of the stock, there are different varieties of growth and value. There is large cap, small cap and many different foreign sectors you can move into. You have the different high-yield bonds that you can move into. There are mortgage-backed securities. In an asset allocation role, you can either be general, with fixed-income equity, or you can get down deeper into this sector segmentation. What level and amount of risk do you want to take in each of those areas. Mortgage-backed securities require a certain expertise that fixed-income zero-coupon bonds might not.



That brings you to integrating the resources and the systems that you're going to need to be able to manage this sort of information. We have a series of models that we use at BARRA from a simulations platform that can look at assets and liabilities, to an asset allocation model that allows you to input various return series from different asset classes segmented as finely as you want, to specific investment systems for both fixed-income and equity, and also even structured products. The key is you want to drive all of these such that you're going to get optimal information from those but then integrate them into your solution.

Let's move from just the general asset allocation that you might have in terms of general equity versus fixed income to the tactical asset allocation. You want to define exactly what it is, how you're going to work with any investment guidelines and then provide this information to external managers. For example, coordinate your forecasts of what might happen with the manager. You could use historical information. You could use hypothetical information. You might want to use some combination of those. Have a model that generates things based on these different assumptions through several sets of assumptions. See what's happening. A couple of years ago some people at Rogers Casey, which BARRA acquired two years ago, actually did a study on tactical asset allocation.

It looked at a period of time where the market had changed quite a bit, and if you did monthly forecasting or quarterly forecasting, you were going to see a higher return. This was based on actual performance of managers out there in the market. You would get a significant return increase and not much of an increase in terms of the volatility. Surprisingly, the actual equity portion of the portfolio stayed roughly the same in all of these different cases. If you're dealing with an external manager, they're typically good at one or two things. They're going to be looking at moving in sectors but not necessarily selecting optional assets within those sectors. They are really going to be playing the sort of general index movement game. We found from our studies that you typically don't have multiple expertise in one manager or in one product that they're going to provide to you.

You need to get a forecast set up for the asset return. You then want to construct a portfolio. You want to execute trades. You want to simulate this over many different economic scenarios and see what happens. You need to look at all of the different aspects of fixed-income movements and equity movements, making sure that you have all of the considerations for the complexities of those markets. Obviously, the more things you bring to bear, then technology will start to work against you, and you have to make simplifying assumptions to get at these solutions.

With tactical asset allocation, they're going to be looking at an asset class and just change the weightings amongst those asset classes. They will not change the characteristics too much, but that's actually another level of tactical asset allocation that one can look at. Mean variance and hard limits on actual exposure set up in the investment policy are the ways for these needs to be set or these limits to be driven in terms of risk. There are times when people are going to use these futures or options overlays to change the duration profile. In selecting managers, you need to look at their considerations for trade, fill, and execution.

Let's go back to the results that we found. It was kind of interesting. Prior to December 1987, managers were doing a really good job of exceeding their benchmarks. All these managers were using tactical asset allocation. However, we found that subsequent to 1987, managers have been underperforming the benchmark. The general indexes were doing so well that by moving around they were not adding much value relative to the index. The outperformance was exceptional during the earlier period, and subsequent to the market crash, there has not been much gain by doing the sector rotation in different tactical asset allocations that we see in the market. There have been a few exceptions but, in general, the same expertise that was there before the crash has not materialized subsequent to the crash. One of the reasons for that is the change in volatility. We can look at both equity and fixed income. This is historical volatility, not implied by the market pricing, but there has been a drastic reduction in a much higher degree of correlation in the markets. If you compare the monthly forecast of the two, 42% versus 29%, you might find attributing factors to this.

I want to look at some alternative ways of including additional information in your asset allocation. I'm actually moving more toward straight tactical asset allocation. I'm thinking of a hybrid, something between strategic and tactical, but you have a lot of risk sources that you might want to consider when you're trying to look at the return versus risk. How to incorporate those in a logical framework is still something that people are debating. Value at risk is a tool that has been used at the trading desks of banks for the last several years and it has been recommended by some of the regulators, the Bureau of Labor Statistics and other people, as tools to control capital exposure. I think it's actually not a bad way to look at asset/liability modeling risk for pension or insurance companies or even Treasury units of banks, if we were to have longer term horizons and model these risks. The measures of risk, like duration, are very short in nature. They're dynamic rebalancing. The limitations of applying value at risk include a horizon that is a critical concern that would be appropriate.

Duration certainly measures the change in the economic value, over the original value, given some rate change, and essentially duration is a good driver relative to

any of these risk drivers if you're looking at some short period of local movement, the dynamic rebalancing, and you are going to use some frequent method to look at your exposure of your liability relative to your assets. Bryan mentioned using this or translating this to dollar duration, which makes a lot of sense, especially given the funding nature of the liabilities. Dollar duration stabilizes the problem. You can take any of these different risk sources that we might have. You can look at the delta risk on the equity and the duration risk on the fixed income. You can apply some mortgage-backed securities and create prepayment duration where you look at the sensitivity and the change in behavior. These are some of the driving forces that I think one can use.

In terms of interest rate exposure, you can also look even deeper. Duration typically measures a parallel shock to the yield curve, but we've found a lot of success in stabilizing asset/liability dynamic rebalancing strategies by using key rate duration. It looks at the local shift of the yield curve. Let's suppose just the long-end changes, and the rest of the curve remains the same. Or perhaps the short-end changes. What's the sensitivity to the economic value of the pension plan if that were to happen? How does it affect the liability? How does it affect the assets? What's your net exposure at the surplus level?

If you're looking at simple fixed-income instruments, like a zero-coupon bond, you'd see that it is insensitive to interest rate shock in the short and the long end. However, all the price sensitivity of that is due to the discount rate at the 20-year region for the partial shock. The callable bond in Chart 6 denotes a premium coupon where it's more likely to be called. Thus, its sensitivity shifts the duration to the left, and shortens the life expectancy of the corporate bond. Applying this to liabilities is something that we're doing a lot of work with. Building up a model that really includes all of the driving forces of equity, like inflation and a foreign exchange, in an arbitrage-free way is what we've actually been working on with several plans to build up the valuation model for the dynamic rebalancing.

So what is value at risk? It's defined to be a maximum expected loss for some holding period at a certain level of confidence. There are many ways of actually driving it in the marketplace. People have used historical information or they've used pure Monte Carlo simulations, which has some sort of driving force. We tend to prefer a parametric method where the driving force is going to be the co-variance matrix that you've established, your initial economic valuation assumptions. That seems to give us a pretty good starting point in terms of risk, and then you can certainly use simulations or stress testing to get a better handle on how well it really applies. Distribution questions need to be answered. If you make some simplifying assumptions, you can at least start to get some answers. The assumptions are extremely important. The extension of duration is a way that we do the

parameterization. Once you start to get some results, you can actually get some ideas about how this measure of risk helps in allocating your capital and maybe influencing your returns on a risk-adjusted basis.

We have different risks—the different block of pension characteristics that we are going to run through the model and the assets that are backing them. We can come up with a profile and a distribution of the loss. What we want to do is at some holding period determine what the 1% loss might be given the current mix of assets. This is can be done in a correlation matrix. We did one that showed primarily fixed-income co-variances where we actually included mortgage-backed securities and some of the credit sectors.

As you start to build up your risk drivers, you need to enhance this to include that information as well. In an economic sense, you're able to look at the surplus and the economic present value of the asset versus the liability. We're doing it on an option-adjusted basis. We look at multiple sets of scenarios and then just averaging them back to get some impact of this methodology. We are using extensions of the model to include a lot of the considerations. We haven't done anything with the funding status. As Bryan was mentioning, that sounds like a very important part of the process. We focused more on the investment strategy to match a given liability's cash-flow requirements, but I think the key is to look at optimizing the risk-adjusted returns that you're going to need relative to minimizing the volatility of the surplus.

There is a way that you might slice and dice the different segments of the portfolio. We might have Treasuries, corporate bonds, and mortgage-backed securities in certain percentages. There are market-value weightings, if you will. We can look at the risk sources that we have associated with them, the key-rate duration exposure, any basis risk exposure, prepayment, equity, and credit exposures. We can add others that might be appropriate relative to funding down the road. I imagine those would be very important things to add to this. Do the same thing with the liabilities you happen to be working with and come up with the value at risk. That's now the expected loss for a certain holding period and a certain level of confidence for each of these asset classes. You'll look at the total risk that's going to now look at this diversification that is generated from the volatilities, the level of interest rates, and the variance/co-variance matrix that you have in this equation. Asset allocation is probably going to look at the risk capital that's associated with each of these assets and liabilities. Look at the returns that are being projected or that you've experienced. Do a risk-adjusted return on capital optimization at the long end to see how you should invest. Do this on a regular basis or with some frequency. I think that's going to be one of the ways that basically return can be enhanced while minimizing the risks to this underfunding situation.

If this methodology is used, we found that it can enhance the expected returns. It can still be used to control risk systematically. You can now look at the risk/return profile, and you can optimize that because you've now got a measure of risk that's really embedding the cost to capital. You're moving money from one asset class to another. You're including the risks associated with that in your optimization so you can find the right point on your efficient frontier in a straightforward way. Of course, you can still do this while satisfying your internal and external extreme. I can see a lot of applications for marrying this approach in asset allocation. It's going to allow you to incorporate alternative assets and alternative investments in one framework. You can have equity, fixed-income hybrids, and maybe some of the hedge overlays that you're talking about. They can all sort of be measured in one framework relative to your liability to get at the surplus, essentially controlling that growth or stabilizing that if you don't want to have growth.

I think we've made a lot of progress in applying this. We're seeing a lot more interest in value at risk from plan sponsors. We actually have an initiative right now. We did a study on risk and the perception of risk in a lot of pension plans at Rogers Casey and there is also a product that has come out of this that allows us to look at plan risk relative to some of the existing liability benchmarks out there. We call it total plan risk, and it's sort of at the general index level at this point in time. We're doing work at BARRA to also look down deeper at the segmentation level. We get into specific asset classes and specific country exposure in your asset allocation model life. We get into a lot of detail.

**Mr. Warren R. Luckner:** This value at risk issue is something that we've done some work on and, as I understand, the first generation of value at risk was for banks, and it was short term and looked at correlations over short-term time frames. One of the challenges was how it was going to be extended to longer terms. I'm wondering how that has been incorporated in your model.

**Mr. Abbott:** I think one horizon may not give you the best answer. You probably want to look at value at risk relative to multiple horizons, and different methods of determining value at risk are probably better for those different horizons. The method that we use, this parametric method, is good for up to a year. If you're going to go beyond a year, you certainly have more information in the underlying simulations that we used in this option-adjusted framework or the stochastic framework so you can dig down deeper and see what's happening along each of those paths. We are certainly including more of the rules that one might apply in dynamic rebalancing of the portfolio along those paths. Looking at the distributions is something we haven't done as much work on, but I think that certainly is going to stabilize the long-term exposures and hopefully reduce the value at risk that you have along these paths. I think extending value at risk to a multiple assumption, or

multiple horizon analysis is going to be necessary for a lot of the real long-term stabilization.

**Ms. Laurie E. Vance:** You said that the demographic assumption was a stochastic variable in your model. Are there constraints set up or is it correlated with capital markets at all?

**Mr. Boudreau:** Yes, the primary source of uncertainty in the demographic projection is the future wage increase. For instance, if you're running a pure dollars times service plan, we have the same demographics on 900 paths. If you have a final average pay plan, then your final average salary, your benefits, and everything in your demographics that determines the benefit amounts is going to be stochastic. That's the first part of it. The second part of it is that it is linked to the capital markets because essentially the way that we generate the wage increases is that they are tied over long periods of time to the level of interest rates. For instance, you can specify an average rate of wage increase that might be 4–4.50%. There's some variation around that, but if there are paths where interest rates start out where they are now and end up at 10% or 11% along the path, you're going to tend to have higher wage increases along those paths as well. So the capital markets are used to link.

**Ms Vance:** Is the population stable?

**Mr. Boudreau:** The number in the population is stable, and sometimes we run the demographics as stable, meaning the mortality and something like the withdrawal. Generally we run that as stable. We have in certain instances actually run those stochastic decrements as well.

**From the Floor:** Mark, would you critique this statement? The greater the diversification of the portfolio, the less the value at risk because all asset classes can't simultaneously devalue.

**Mr. Abbott:** I don't know the answer to that one. I think it really depends on what's going to happen. We certainly have to look at the historical information to make some assumption about the diversification effect, but if there were truly a catastrophic movement in the market—we've already seen that there has been a high degree of correlations. Recently in Asia we did some work for one of the major multinational insurance companies, and they were very fortunate that they were diversified because of the liability exposure that they had in those countries so that they had offset the losses that they saw on the asset side by similar condition in the liability. I think if you have truly diversified assets that match the liabilities, you're going to be much better off than if you're just looking at some general

diversification across the asset universe. I think matching for liabilities is a way to ensure lower value at risk, but there's no guarantee that if you do a good job of diversifying that, then all markets aren't going to move in a perfectly correlated fashion. We've never seen that, but certainly there's no guarantee.

CHART 1  
PRESENT VALUE OF FUTURE CONTRIBUTIONS  
Equity Exposure=40%

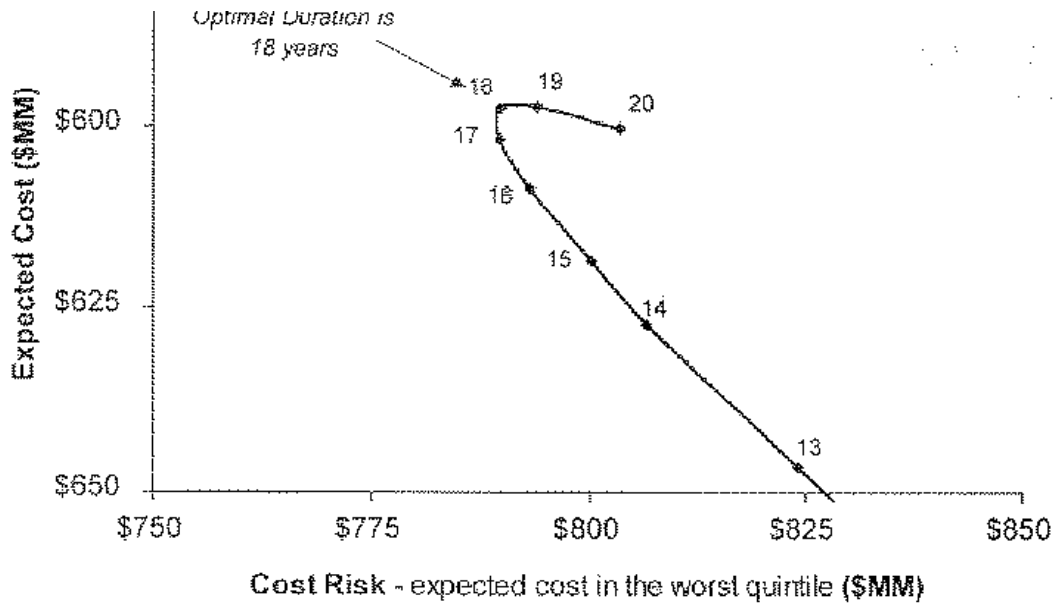


CHART 2  
EQUITY EXPOSURE  
Present Value of Future Contributions  
Optimal Duration

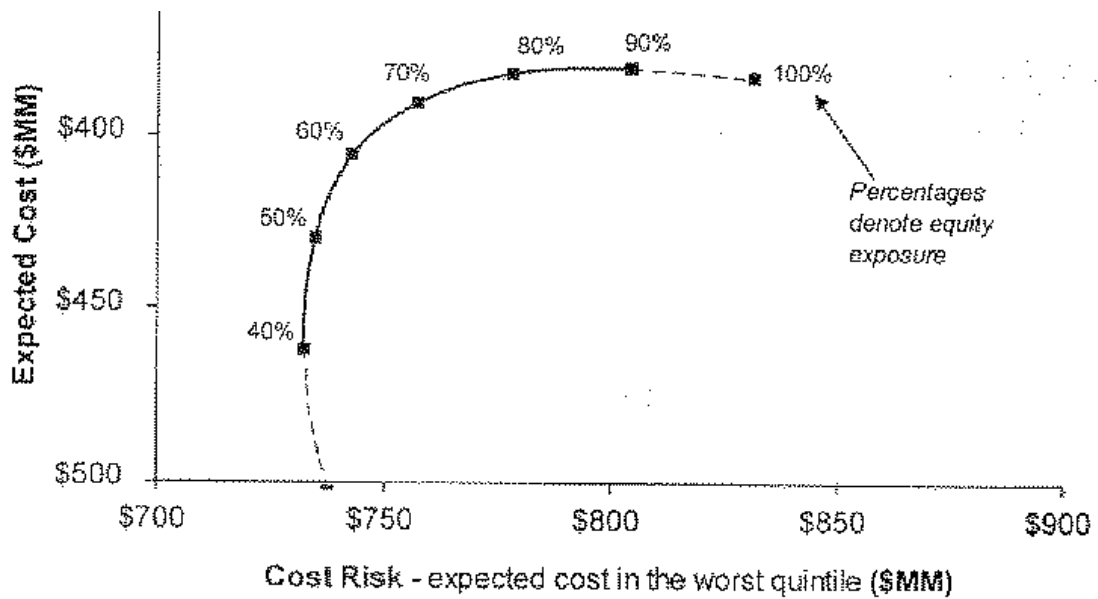




CHART 3  
ACTIVE MEMBERS ONLY  
Present Value of Future Contributions  
Optimal Duration

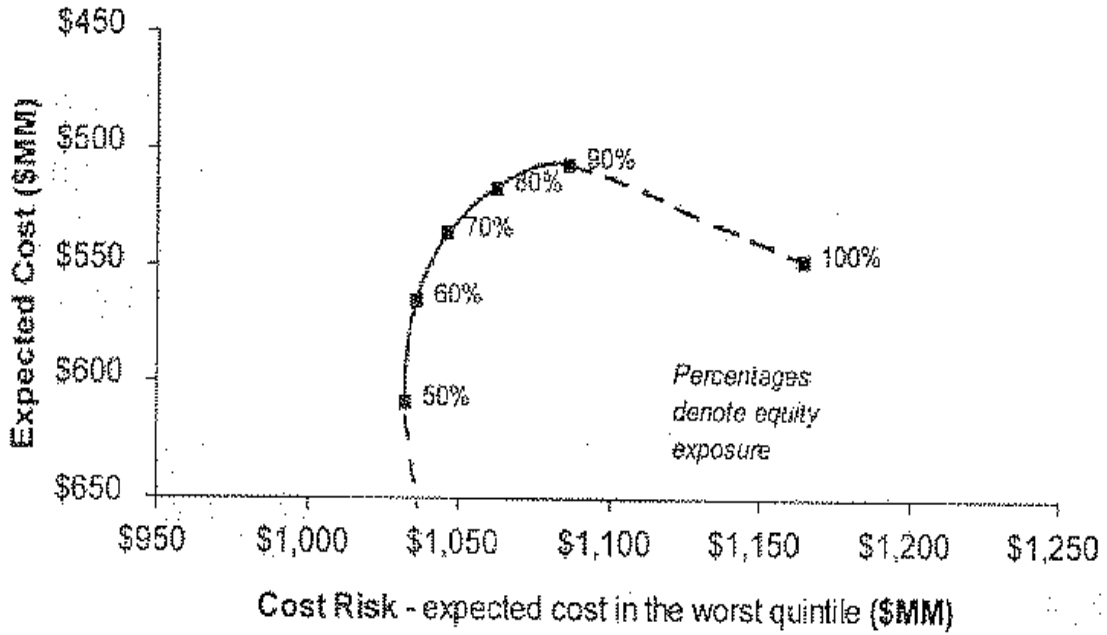


CHART 4  
RETIREEES ONLY  
Present Value of Future Contributions  
Optimal Duration

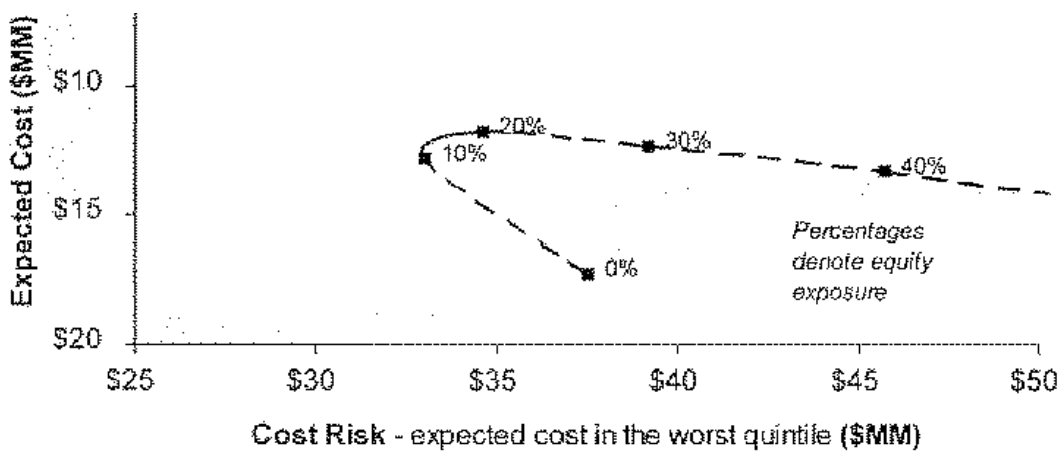


CHART 5  
DYNAMIC REBALANCING  
Optimal Duration, 0% Surplus Weight

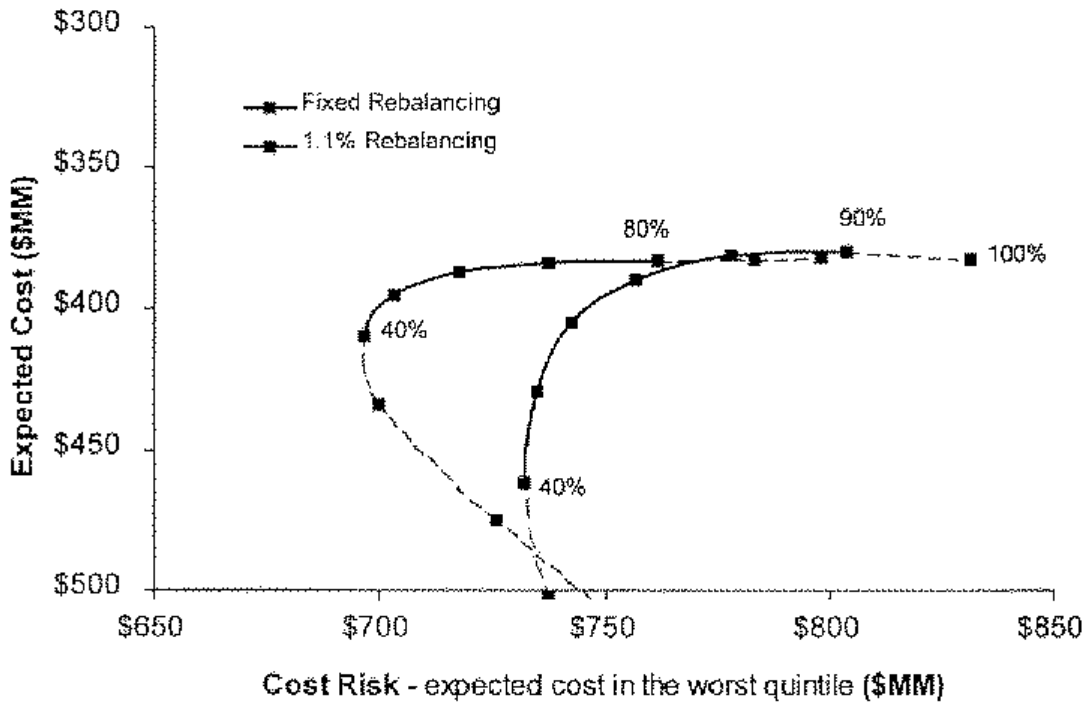


CHART 6  
KEY RATE DURATIONS  
9% VS 8% 30-YEAR CALLABLE CORPORATE BONDS

