RECORD, Volume 24, No. 1*

Maui I Spring Meeting
June 15B17, 1998

Session 16PD
Asset Allocation: The Final Frontier?

Track: Investment
Key words: Asset/Liability Management, Investments

Moderator: ANTHONY DARDIS
Panelists: MICHAEL H. HANEY
STEVEN C. HUBER
ANDREW R. YOUNGH
Recorder: ANTHONY DARDIS

Summary: Many insurance companies, due to a competitive environment and a changing investment landscape, are reexaming the allocation of funds across broad asset classes. Companies must continually assess whether they are putting their money to work in a prudent fashion. Given the myriad of factors and constraints that enter the picture, the right answer is often elusive.

Mr. Anthony Dardis: We=re going to be looking and focusing on practical aspects of asset allocation. We=re delighted to have a very distinguished panel of some of the finest practitioners in the industry. Andrew Young is from Morgan Stanley, Michael Haney is from Lincoln Investment Management, and we have Steve Huber from Aetna.

Our session=s going to be ordered as follows: Andrew Young will be first and will discuss emerging trends in insurance company asset allocation. Then Michael=s going to look at some of the specific elements to investing the surplus account. We=re going to finish with Steve who=s going to be saying a few words about fixed-income portfolio strategies, including looking at the very interesting topic of how do we use historical data for asset allocation purposes? I think our panelists are going to be saying things that are going to be of interest to both life and property and casualty practitioners, and I think even pension practitioners will find some of this of interest.

HMr. Young, not a member of the sponsoring organizations, is Principal of Morgan Stanley, Dean Witter, Discover & Company in New York, NY.

Note: The charts for this session are not available online. Please contact Linda Blatchford at lblatchford@soa.org or call 847/706-3564.

We structured the session so that we're going to have some formal presentations first, and then we're hoping to have time for questions at the end. Andrew is head of the Portfolio Transaction Group in New York, and before joining Morgan Stanley he was with Goldman Sachs for eight years.

Mr. Andrew R. Young: I'm going to discuss some of the trends in asset allocation for insurance companies. First, I'd like to address asset allocation versus asset/liability management. In my mind they're the same thing. Asset/liability management is trying to optimally arrange your assets and your liabilities, but generally you have a lot more flexibility in arranging your assets than your liabilities. What asset/liability management boils down to, at least in the short run, is how do you select your assets or allocate your assets to maximize the return and minimize the risk of the overall enterprise? I'm going to use asset allocation and asset/liability management interchangeably in this presentation.

I'm going to discuss some of the traditional approaches to asset allocation, such as development of asset allocation, immunization, and the mean variance efficient frontier. Then I'm going to discuss what I think is a recent enhancement to those approaches which is very important simulation approach. I'm going to give a fairly detailed case study about an annuity business and how a property and casualty company might do asset allocation for taxable/tax-exempt assets. Finally, I'll provide a summary.

Chart 1 shows the recent history of U.S. life insurance assets and some key developments in asset/liability management. Insurance assets have grown almost exponentially at a very rapid rate, and during that time, all of the fundamental approaches to asset/liability management have been developed. It wasn't until almost 1950 that the simplex method, or the first approach to linear programming, was developed. A few years after that, in 1953, the efficient frontier was first described. Those approaches were applied incrementally. In the early 1980s, for the first time, linear programming was applied on a wide scale to fixed-income portfolios and designing optimal portfolios became practical.

More recently, in the last couple of years, we've been able to expand the linear approach to handle more nonlinearities in our problems that we're trying to solve. I think that happens because of the even quicker increase in computer power. Computer power is growing even faster than life insurance assets, (Chart 2) and it's finally getting to a point where we can examine some more interesting issues.
In the traditional asset/liability approach, the objective of the immunization approach is to reduce the sensitivity of the surplus to parallel shifts in interest rates. Chart 3 shows a portfolio before immunization. If interest rates rise, both the assets and liabilities decrease in value, but the assets decrease in value by more until the surplus

evaporates. After immunization, as shown in Chart 4, the assets and liabilities are parallel. The company is immunized to a parallel shift in interest rates. The way you achieve that is you force the assets to have the same dollar duration as the liabilities or the same dollar value change per basis point change in interest rates. Even though it's traditionally applied to parallel shifts in interest rates, it can also be applicable to other economic factors. So, you could also immunize the portfolio so that the surplus doesn't change with regard to some small changes in the yield curve or any other factor. When people talk about immunization they're only talking about parallel shifts in interest rates. It's a fundamental development because it recognizes the importance of the liabilities. This is allocating your assets in the context of your liabilities, not in an asset-only framework.

What are some of the pitfalls of immunization? There's a tendency to produce a barbell portfolio. The asset cash flows don't match up very well with the liability cash flows, and that's a problem because that means that even though they have the same sensitivity to a parallel shift in interest rates, the sensitivity to a nonparallel change in interest rates can be very different. This is a sign that you have risk in your asset allocation that you didn't consider when you originally formulated the problem.

Immunization often selects mispriced or miscategorized issues. It tries to find the highest yielding portfolio that it can with the same dollar duration as the liabilities. The way it's going to do that is it's going to buy the cheapest securities it can find, regardless of whether or not they're a good value. It doesn't address the acceptable level of risk for the company, and it's not capable of answering the question of whether it would be worthwhile, except in some risk mismatch, because it would offer you a higher returning portfolio. It doesn't give you any perspective on the right level of risk and it can't handle evolving liabilities. It assumes that the liabilities are fixed cash flows and are not changing over time. It approves many assets based on structure alone. It's difficult to include callable bonds in an immunized portfolio because their duration changes when interest rates change. Callable bonds may be a perfectly valid investment and may offer the best value, but it's going to be difficult for this kind of analysis to handle those. It doesn't recognize the ability of the company to change strategy depending on its level of profitability. The right asset allocation strategy will change over time as the surplus and profitability of the company and its basic businesses are changing.

Another traditional approach is the efficient frontier. There are really two definitions. It is the highest expected return for any given level of risk that defines the upper half of the efficient frontier in Chart 4 or the lowest level of risk for any given level of return, which is usually the way that it's solved. The lowest level of risk for any level of return is a quadratic program, which Markowitz first illustrated in 1953. You can construct the frontier subject to linear constraints. Chart 5 shows two uncorrelated assets, Asset A and Asset B. Asset A has a higher return, but it's riskier, and Asset B is

a safer asset. If you have a portfolio that includes both of those assets, you'll have higher return and lower risk than Asset B by itself. So, there's a lower risk portfolio that involves a combination of assets because they're uncorrelated, and they're not as likely to underperform at the same time.

Portfolios that aren't on the efficient frontier are suboptimal. Chart 5 shows where an inefficient portfolio would be. It's inefficient because you can achieve the same level of return at a lower risk, if that's what you want or, if you're comfortable with that level of risk, you could keep the same level of risk and have a higher return. That's why portfolios that aren't on the efficient frontier are suboptimal. The best portfolio in the efficient frontier depends on an individual's risk/return trade-off. These are all portfolios that are efficient. It's impossible to tell somebody, based on the analysis we've done so far, which one of those is preferable. It depends on the company's return requirements and risk aversion.

The efficient frontier is constructed under some very important assumptions. One assumption that you need to build the efficient frontier is expected return on the assets, and that's difficult because historical returns are poor indicators. Some assets actually have negative historical return, but nobody believes that those assets are priced in the market, assuming that they would have a negative return going forward. Nobody would buy them, so historical returns are not a good indicator of future returns, and you have to find other methods of extracting equilibrium returns from the pricing that you see in the market.

Risk is another very important assumption in the efficient frontier analysis. It uses standard deviation of return as the definition of risk or investors typically have more complicated definitions of risk that may involve risk of ruin or risk of having profitability fall below some threshold level that isn't exactly related or even closely related to the standard deviation of return. Standard deviation may not be a good measure of risk, but it's used to construct the efficient frontier. Risk depends on values over time, not just at the horizon. When we build the traditional efficient frontier, there is the standard deviation of return over some time horizon. What we really care about in a company that's operating in the real world is how bad things get at any time during that time horizon, not just at the end. If we run into a capital-constraining environment in the middle, that may impact our ability to continue to operate the business the way that we would like to.

Returns also aren't normally distributed. Mean standard deviation isn't the only characteristic that you need to describe the return on these various assets. Finally, expertise can affect the perception of risk. Companies that have skill in certain assets may be able to perform the specific security selection better. Even though that asset class has the same historical risk for all investors, as a practical matter, it may have

less risk for investors who have skill in that particular asset class and more risk for investors who don=t have skill in that particular asset class.

What are some of the implications of this? There=s a market price of risk in an optimal portfolio. That means that adding an extra dollar to any asset class should provide the same incremental risk in the overall portfolio, if the portfolio is efficient. In a suboptimal portfolio, you can enhance your return with constant risk by shifting exposure from asset classes where there=s a high risk for a given incremental return to asset classes where there=s a low risk for an incremental return. Investors only get paid for nondiversifiable risk. So if you have an asset class that=s very risky, you might expect to get paid for that risk by investing in that asset class, but if there=s another asset class that=s available in the market that=s perfectly negatively correlated with that asset, then an investor could construct a riskless portfolio by combining those two asset classes. Those returns on those asset classes should be riskless returns, as opposed to risky returns because the market is going to be priced as though investors are doing the smart thing and building efficient portfolios. Therefore, asset/liability management is essential to the profitability of insurance companies.

I=m going to talk about a simulation approach next. This is something we=ve been doing a lot of work on lately. It=s an extension of the efficient frontier framework. We=re going to build an efficient frontier but we=re going to have different definitions of risk and return. We=re going to simulate the operations of the company. We have to have a model of company operations and incorporate a much broader range of factors than just the portfolio. It incorporates the growth of the company, a certain risk, such as a changing economic or regulatory environment and changes in corporate strategy. It also incorporates randomness in interest rates and other capital markets and randomness in liabilities. There may be randomness in surrender rates for annuities, which is the business I=m going to talk about. There are other kinds of randomness that affect the liabilities. You have much more flexibility in your risk and return measures under this approach, and because it=s an efficient frontier style approach, it can offer more insight into the appropriate level of risk than an immunization can offer. It can also offer some first steps with hedging the profitability of a company. The con of this approach is it=s much more time intensive.

I=ve just described two approaches. There=s a fairly direct methodology for solving both those problems. There=s software available in the market that can solve them both in a matter of seconds. These are much more difficult to construct, and the problem that you=re trying to solve requires much more time to actually solve.

Chart 6 shows the annuity simulation and how you do simulations of an annuity company. The scenario is stable rates. The portfolio yield=s going to decline even

though rates are stable because rates have been declining already, and there's a higher coupon embedded in the company's portfolio. The investor's yield, therefore, is going to drop over time as higher-coupon bonds mature. The gains in the portfolio are going to erode over time, but nothing too disastrous is happening.

What happens, though, if rates rise? If rates rise, the payout yield (shown by the dashed line in Chart 7) that the company can afford to pay its investors is going to fall below the benchmark rate or the market rate. That means that new entrants into the market are going to be able to pay a higher rate to policyholders than an existing company, and that means there's going to be an incentive for policyholders to surrender. If policyholders do surrender, then when they take their money out at par, the company's going to have to sell bonds, and it's going to have a capital loss which it's going to have to make up. That would be a very serious outcome.
In a falling rate environment, shown in Chart 8, the income and revenue is going to decline as the coupons in the portfolio mature, and the company may have to support a minimum payout rate if it has any kind of policy guarantee. It may not be earning enough on its portfolio to make good on that guarantee. It might have to pay that out of surplus, and that would also be very serious.

Chart 9 shows the current risk profile of this company. If interest rates stay where they are, they're profitable. If interest rates fall, there's going to be decreased profitability because of the policy guarantees and a lower return. If interest rates rise, then there's going to be losses from surrenders and also a loss on the investments because they'll have to be sold to a market. That's the analysis of the company as it stands. How do we use that to hedge profitability? When we say hedging profitability, what do we mean? One thing we might mean is we could require a minimum annual profitability from the company. We want to change the portfolio or purchase some derivatives to guarantee that our income won't fall below a threshold of $10 million. That's a pretty severe constraint because there's a lot of different random events that could be occurring in here that might be too expensive to insure. As an alternative, you can specify a confidence of various constraints. You might say that you want to be 95% sure that you are always going to earn at least $10 million under any of these situations. If you do hedge, you take the thin line in Chart 10 and you can transform it into the thick line where you have protection through floors and protection through puts. As such, your risk of having a loss is eliminated. In order to do that, you had to purchase the hedge, and the hedge had a cost to it. Under the current interest rate environment, you've actually hurt your profitability. There are two different ways to offset that cost. One is by structuring options. You have options that help you out if interest rates fall and options that help you out if interest rates rise. You might want to buy mutually exclusive options so that you only have protection in one of those scenarios. It's less protection, but it may be enough to practically fulfill your needs, and it can reduce the cost. The other thing you can do is

buy higher yielding but, riskier, assets to increase the yield of the portfolio and offset the cost because you've eliminated some other risks that you were facing in the portfolio.

How do we look at increasing an allocation to risky assets? Chart 11 shows a fixed duration constant. It's a portfolio with a duration of five. It looks like an efficient frontier. It has a definition of risk on the x-axis, a definition of return on the y-axis, but the return and the risk have different definitions. Return is the mean surplus over all the simulations that you do, and risk is the mean surplus in the worse decile or the worst 10% of simulations that you do. We got away from requiring standard deviation as a measure of risk, and also return on the assets. We're measuring risk and return through their effect on the company as it's going to operate over time. That's a fundamental enhancement. This curve that we've drawn so far isn't actually an efficient frontier. It's just a tracing. We always have a portfolio with a duration of five, and we increase the equities from zero to 10%, 20%, 30%, and 40%. We're just trying different portfolios, running them through our simulation and drawing a line through them.

We can try that at different durations. We can try a duration of five, six, seven, and there will be three different tracings. We didn't have to do any optimizations. We did have to build a simulation of the company, but we haven't actually minimized the risk for any level of return yet. We have some data that can help us pick the lowest risk portfolio for each level of return, and there actually is an efficient frontier with a minimum risk under this framework. The key variables for constructing this efficient frontier are just the equities allocation and the portfolio duration. Each point on this frontier has a different equity allocation and duration. It's not going to be five, six, or seven.

The duration is going to be near the duration seven for the higher return, efficient portfolios line. It's going to be near the duration six for the lower return efficient portfolios line. The definition of efficient frontier is the same, but the mathematics are very different because there's no closed form, analytic solution that's going to derive that efficient frontier. I'm going to talk in a second about what some of those methodologies are.

In this second case study, a property and casualty company must determine its taxable/tax-exempt allocation (Chart 12). The relative proportion of taxable and tax-exempt assets is generally set by the company's tax department to equilibrate the alternative minimum tax, and it's done under the assumption of certain liabilities and certain interest rates. In actuality, the results of a property and casualty company are very volatile. The company's either going to be profitable because there are no catastrophes or very unprofitable if there's a catastrophe. Whether the company's

profitable or not is going to affect their need for tax-exempt income. So if they knew in advance that they would be profitable or not, they could do a much better job of this allocation. Unfortunately, they don=t know in advance. They have uncertainty in their liabilities.

Furthermore, if they wind up not having a need for tax-exempt income, and they have to sell the municipal bonds, they may have to do that in an adverse, low-interest rate environment, which means that they=re going to take assets that they wouldn=t have had to pay any taxes on and pay an immediate capital gains tax. That=s a very significant cost to them. There is a simple strategy that the tax department would recommend for an allocation, and when we follow through on this approach and we add randomness in the capital market and randomness in the liability, we find that the optimal allocation for these companies is generally lower than the naive approach would suggest.

How do we actually solve these problems? We have to use an iterative technique. Chart 13 is an example of a simulated annealing process. It=s an optimization procedure developed in the 1980s by physicists. It=s an analog of slowing, uniformly, cooling the substance to make it strong, because if you cool something slowly, you get much better properties than if you cool something quickly, and there=s an analog in the simulated Mune process of that cooling.

Before simulated annealing, you derive a first pass at an optimized portfolio. You change it randomly. The first portfolio score that you=re starting with has an objective value of x. You change it randomly, and you score it. You run it through your simulator. It has a score of y. Is y better than x? Did that portfolio score better? If it did, then you keep it. You've done something good. You have got improvement in your measure of success. You take that new portfolio, and you start working with that to see if you can improve on that. If it=s worse, then you stay with the original portfolio. That=s what you=d normally think of. You=re just going to make random changes in the portfolio, and if it=s better, you keep it. If it=s worse, you get rid of it.

What simulated annealing says is make a change over here, and even if it=s worse, you can sometimes accept that modified portfolio anyway. What affects whether you accept it or not? If it=s only a little bit worse, you are more likely to accept it and work with that than if it=s much worse. If the temperature is hot, then you=re not very discriminating, and you=ll take things that are worse. If the temperature is cool, then you=ll only take things that are better, and you won=t take things that are worse at all. The temperature is cooling over time. It starts out hot and cool. So, that=s why it=s an analog of the cooling processing.

The reason why you need that is because these scores rating how good the portfolio is random. It depends on the outcome of your simulation. You don=t want to get stuck in a rut where you=re assuming that a portfolio is the best portfolio just because it had a particularly fortuitous set of random numbers when you measured its score. You want to discount that somewhat, and if you have another portfolio that=s almost but not quite, as good, you would want to consider that portfolio as possibly being the optimal portfolio. If you score each portfolio again, you=re going to come up with a different score than you came up with originally anyway. Because you don=t know exactly how good these portfolios are, you=re evaluating to a random simulation. If you want to come up with the best portfolio, you have to be willing to take a step back sometimes in order to have a better chance of converting to something that makes sense.

There=s a further enhancement on that, which is a genetic algorithm (Chart 14). A genetic algorithm has most of the same hallmarks. It=s a generalization of simulated annealing. Instead of just having one portfolio that you work with, you have several, and your mutation=s going to be more complicated because you can take two different portfolios and combine them and maybe come up with a third portfolio that has the best attributes of both. So, you have your initial population. You change and evaluate it. Some of them survive, and some of them don=t. It=s another approach to solving these difficult nonlinear problems. Computers have gotten cheaper and more powerful, so now we=re able to try some of these methods for which we didn=t have the resources to be able to solve ten years ago.

In summary, because of the capabilities of asset allocation and asset/liability management, the starting premise is that all models are wrong; some models are useful. These are tools for asset allocation. They=re never going to include all the factors that are going to affect the way the business really operates, and if the results don=t make sense, it=s possible that we have to change our view about reality. If we think about it long enough, we find that the results do make sense, and it=s possible that there are very important actions for a business that we haven=t included in the model that we need to think about because it=s not really addressing the way that our business actually operates. The goal of asset allocation is to incorporate the fundamental elements of the way that we=re actually doing business when we make this selection. Issues illuminated by asset/liability management include risk/return trade-offs with different asset classes and different asset investment strategies, product mix, and pricing decisions. The way we price products depends on what the optimal portfolio is for managing against those products and what we can hope to earn on that portfolio**C**the right level of capitalization. How much capital do we really need to hold against the business, and what are the risks if we increase or reduce capital? The benefits of risk securitization are transferring some of the liability risk off the balance

sheet. Instead of changing the assets, maybe the right thing to do is to change the composition of our liabilities a little bit on the margin.

The analysis needs to be carefully considered, has to be framed around key decision variables that the company has control over, has to be able to account for all the constraints that the company has on the way that they do their business, and it has to recommend a final portfolio that=s achievable in the market. It doesn=t do any good if it recommends a 100% allocation to an asset class with only $10 million outstanding liquidity that you could hope to get your hands on. Regarding the use, the question is, why now? There=s a broader range of analytic techniques. We can do realistic modeling of actual problems that are much more relevant to the company than the immunization or efficient frontier approach. Computational power now exists to utilize those techniques. We have the techniques and the power to solve them.

So why do we care about this? We care because of increased competition in the market, and in order to continue to be successful we have to get as much as we can out of our portfolio in the context of the risk we=re willing to take.

Mr. Dardis: Mike Haney is going to talk about asset allocation specific to investing the surplus account. Mike is with Lincoln Investment Management, which is the investment division of Lincoln Financial Group. He has been there since 1991.

Mr. Michael H. Haney: As Tony said, I=m going to speak about asset allocation for the surplus account. This is an exercise that the Lincoln just went through, so I thought we=d share some findings from our exercise in that endeavor. The goal of asset allocation is recommending a strategy that will produce the best "return" for a given amount of "risk." I put *risk* and *return* in quotations because, as we found through this, the real goal of asset allocation is getting definitions of return and risk. Once you=re given that, everything falls into line, and you can do your job much more quickly and efficiently. Another important thing is to consider the constraints that the company or the investor is willing to face. The reason we started out with the surplus account is it doesn=t have the liabilities backing it. Surplus can handle more risk than a product line can because, again, you=re not so concerned about the liabilities themselves.

Let's get on to the meat of this and try to ask ourselves, What do we mean by return? Total return is a nice concept. It includes both income and price appreciation. This usually has to do with equity or equity-like assets. Mezzanine investments, and those sorts of securities, tend to have very high total return associated with them, but they also seem to have a lot of volatility in that total return. It bounces around a lot from period to period. Current income, mostly made up of fixed-income assets, is something that product lines are very interested in. Insurance companies, in general,

like to have a lot of income associated with any portfolio that we might recommend. Taxes and investment expenses are other things that influence what we're actually going to receive as a company. Expenses, in particular, vary by asset class. A good comparison would be a public corporate bond versus emerging market equities. You're going to pay a lot for emerging market equities, not so much for something like a public corporate bond. When you're trying to construct a strategy, you want to decide what information you're going to need up front.

Now we'll go on to risk. What do we mean by risk? Standard deviation of total return is our classic definition of volatility. It's very hard to get somebody, especially a senior manager, to sit down and tell you that their risk tolerance is 4.6% standard deviation. They just don't think like that. What we found is helpful is presenting a slew of alternatives for senior managers to look at and to think about. Another thing that we found through this exercise was balance sheet event or statutory volatility. Many asset classes, particularly, fixed-income asset classes, have very little statutory volatility in that you don't have to mark those asset classes to market on your balance sheet. Even if the price is moving all over the place, it's not going to show up on the balance sheet. So, you're not that concerned about that volatility unless you sell that asset class. Another thing you want to think about when you're computing something like balance sheet volatility is the amount of turnover in a portfolio. If there's an asset class where the portfolio gets turned over one or more times per year, you're going to have more volatility than an asset class with a buy-and-hold strategy. That's very important.

There are a couple of other definitions of risk that we came across in our work. Some of them measure the downside risk, which is the worst possible return that the surplus portfolio would have at a 95th or a 99th percentile. That was something that management was very interested in knowing about so they could get a level of comfort with it. They could know, if things really went bad, how bad could they go. Another one that we found through this exercise had to do with the correlation with large cap stocks like the Standard and Poor's (S&P) 500. They were very interested in the effect on the surplus portfolio of an instantaneous shock to the S&P 500 of down 10% to down 25%. We found that producing those numbers and comparing them to a current surplus portfolio was beneficial. Two or three recommendations really seemed to help management understand how your recommendation is stacking up to what we're currently doing. This helps us answer the question, Does it make sense for us to pursue one of those strategies?

What constraints should we consider in this exercise? The most important is the rating agency risk-based capital ratio. The last thing you want to do is recommend a strategy which, as soon as you implement, gets your company downgraded. It really doesn't help your credibility very much. With surplus, you're really only dealing with CB1 risk. It is the only risk factor that you're concerned with here. As we found

through this work, which was very enlightening, the CBI charges vary not only by asset class, but also by rating agency. You have to really track four or five different rating agencies and their factor, so that when you recommend a strategy you can ensure that you're not going to violate the threshold ratio that your company has determined for any one of those. While S&P might think one asset class is fine, A.M. Best might not like it that much. If you're only tracking one of them, you could end up exceeding the limit for another one.

Another very important constraint is the investment law of your state of domicile, especially as it relates to the treatment of international securities. Different states set different limits as to how much can be invested in international assets. That's something you want to be aware of. There is also the basket clause. Unclassified assets end up in the landfill or the basket. You want to make sure that you don't exceed the limits on the basket, especially in surplus, because we assume we can take more risk in surplus. More of the assets tended to end up in the basket or could have ended up in the basket. Company-specific constraints should also be considered. This is an area that you want to get a handle on. Some minimum level of current income is what we looked for so that we could try to make sure that any portfolio strategy that we recommended abided by the minimum income constraint that the company might have had.

There are also production constraints. Some of the less liquid asset classes, mortgage loans, and private placements tend to have limits on how much you might be able to produce in a given year or how much you might be able to dispose of in a given year. You don't want to make a recommendation that you want to increase your private placement portfolio by 50% when there's no way, given your current staffing, that you would be able to do that.

Once we pull all this information together, we're going to look at a constrained optimization program. Andrew Young talked about the efficient frontier, and that's really what we're talking about. We are trying to produce an efficient frontier but with many different constraints and many different objectives. We're trying to maximize return for different levels of risk while following all the constraints. As I said, what you call return and what you call risk are going to drive how this optimization program is going to work. There are too many constraints, and they're too interrelated to be able to try it on an ad hoc basis. You really need an optimization program in order to handle that. The level of high yielding assets that your company is comfortable with is going to drive how much current income you're going to be able to get. The life company or your insurance company might say I want very high income, but you and the corporation might not be comfortable with the amount of high yield that it is going to take to get you there. There's this trade-off that you're going to see that shows up when you start to look at current income, total

return, risk-based capital, and any company-specific constraints that you might impose or want to have imposed. The return and the risk measures that you're going to use in your optimization are all going to be based on asset class assumptions. We have to make assumptions about what we think the future's going to be.

What assumptions do we need to make? The asset class assumptions, like I said, will depend on the definitions of risk and return. You need expected return, standard deviation, and correlation if you're interested in doing a total return optimization.

If you have two assets that are less than perfectly correlated, then the total portfolio variance is going to be less than the sum of the variances. This is why you like to get as many asset classes as you can. In our example we had somewhere around 15 different asset classes. Some asset classes that you thought maybe weren't that attractive when you looked at them solely on a return or an income basis had a lot of value in a portfolio context because of their diversifying properties. A good way to test this and your assumptions is to start changing the return assumptions. Let's say that I'm off by 2% on my expected return. How much would that change the allocation to any given asset class? What we found with some asset classes is there is some minimum level that you're going to always want to hold because it has very nice diversifying properties. That way, you can kind of get a feel for minimums and maximums that you might want to allow in a particular portfolio.

If you're interested in the statutory treatment or the current income approach, you need an estimate of what you think the expected income return is going to be and how that asset class is treated in your company and on the balance sheet. It recognizes the turnover that occurs in the portfolio and also the type of asset class that it is and how the statutory accounting principles apply to that asset class.

Chart 15 reflects some of the information that we got out of our case study. I thought it was very interesting. If you constrain current income at 5% and then maximize our net after-tax total return, always maintaining this level of current income, we get the efficient frontier shown by the diamond line on Chart 15. Then we moved up to 5.5%, and that gets us all the way up here to the top line. By moving from 5% to 5.5% that's a current income trade you're not afraid to make at any level of risk because it tends to be total return enhancing. However, if you want to go from 5.5% to 6%, you start to drop down, although not much at the lower levels of risk. It starts to widen out as you get up into higher levels of risk. The reason this happens is because you're forcing yourself into more and more fixed-income assets which tend to have high current income but low total return expectations. This is preferred over the long haul from a total return perspective.

In the extreme, if you want to force a 6.5% current income, you're going to force yourself to the efficient frontier, and even here the opportunities represented by the x for taking the risk are limited. You're not going to be able to extend much beyond 5.5%. Remember that this is total return volatility. Those asset classes just aren't going to be available for you, depending on how much current income you're going to demand of a portfolio. This was very helpful for us because, in a way, it very clearly illustrates the cost that we know exists in going from current income and total return. That helps management make that decision.

You could run these sorts of reports for different levels of high yielding assets. If you wanted to let high yield go from 5% to 7% to 10%, you would see different sorts of efficient frontiers, as well as different rating agency thresholds. You could run these for different rating agency thresholds to see what would happen if we pushed a little bit more on the rating agency front? Where would that take us? You would get another set there. All that information is useful when you present it to management to help them get an understanding for the trade-offs that they need to make when they make those decisions. It puts it in pretty clear terms for them. So that was our case study.

Mr. Dardis: To finish off the formal presentations we have Steve Huber from Aeltus Investment Management. Steve is going to talk about fixed-income portfolio strategies and also look at how useful history is in predicting the future for asset allocation? I think Steve's going to be covering quite a lot in his talk.

Mr. Steven C. Huber: Aeltus is a wholly-owned subsidiary of Aetna. We function as an independent money manager for Aetna and we also manage its general account assets. We also have outside institutional assets, mutual fund assets, and alternative investments such as collateralized bond obligations (CBOs). We function both as an insurance company manager, and a total return manager for outside funds.

I'm going to talk about active strategies, passive strategies, and optimal asset allocation strategies, but I'll focus more on the first and the third because we don't do a lot of the passive management strategies and the optimization techniques that were covered quite a bit by Andrew in his talk. Active management strategies fall into five categories and we use all five.

Interest rate anticipation, which is taking positions based on interest rate moves, is also called duration management. There is also valuation analysis and credit analysis. The fourth strategy is yield spread analysis. Finally, the use of derivatives has gotten to be more a part of the investment landscape recently.

Interest rate anticipation, which is duration management, requires the use of a lot of liquid securities and good quantitative tools to measure duration and convexity. It

especially requires a lot of good information on technicals in the marketplace such as flow of funds or whether hedge funds are moving out the yield curve or down the yield curve. One thing that we found and that you find in the market is that interest rates tend to move in the short term more on technicals and on flow of funds than they do on fundamental factors such as inflation or economic reports. So that's what you need to be aware of when you play in duration management.

Surveys like the Market Vane Sentiment Survey, which looks at current asset allocation, and the J.P. Morgan survey, which basically looks at whether money managers are long or short in their indexes, can have a lot of predictive power as to where the market's going to move in the short term. We found that you want to be away from the herd. For example, when the sentiment indices are showing, everyone is long, you most likely want to be short duration because when everyone moves from a long position to a short position that can move the market a long way fairly quickly. Going against the herd has a lot of benefits, although in the recent market that we've seen, we just hit the lows once again since 1977. A long bond hit is now in the 550s. Everyone seems to be long duration, and I probably can't argue with that stance for the short term.

We allow our portfolio managements to use duration management, but we have carefully set up risk constraints. For example, some managers can go a quarter year on either side of their benchmark. Other managers can deviate up to two years from the benchmark, depending on the type of portfolio.

There is also valuation analysis. Everyone knows the present value function. The price of a bond is the present value of cash flows discounted at Treasury rates. For non-Treasury bonds, you need an additional discount factor to take the risks on the underlying security into account. For example, there is credit risk and option risk, put options or call options, or liquidity risk.

When investing, you use things like option-adjusted spread techniques, or when you look at put bonds or call bonds, you look at the implied volatility in those put bonds and call bonds. One thing we, and other people, have found, which is no secret in the marketplace, is that put bonds have tended to trade very cheaply at very low implied volatilities. We use that strategy to add a lot of put bonds to the portfolio. That has gotten a lot more fairly priced over the last few years, but those are the sorts of things that you can look for in the market to try to add value.

You can look at different markets now for trading risk factors. You didn't have the opportunities in the past, but now if you want to look into call risk, and you can take on call risk in the callable bond market, in the mortgage market, or in the swaptions market. You need to look at each of the markets and see where the risk is most

cheaply priced. We found that it was in the mortgage market, and that was probably the case up until maybe three, four, or five years ago when rates went down; now that risk is more fairly priced. The risks or the prices of the risks get out of whack on a daily or weekly basis, depending on market technicals.

With credit analysis you look at industry prospects, which is earning estimates; cyclicality; growth outlooks for industries; financial analysis, which would look at cash flows across different companies; earnings coverage ratios. You also want to look at nonfinancial factors such as quality of management, and covenant provisions in the securities.

Yield spread analysis gets at what we've already talked about. You want to look at relationships between yields in different sectors and get compensated for the risks based on volatility risk (which would be option risk) and liquidity risk.
Let's discuss the use of swaps, options, futures and derivatives. A popular derivative is structured notes. Structured notes would be taking securities such as a corporate bond which has an embedded convertible option where you can convert it into equity, a call option, or a put option. You have opportunities now to buy those in structured form where the equity conversion option is stripped out as is the call risk and the put risk. You can buy a bullet security or a non-option security, often at wider spreads than you can see on the bullet securities in the marketplace. The give-up for the increased spread would be a give-up in liquidity. So you need to decide whether you can take on the elicited risk and whether the yield spread that you're getting makes up for that illiquidity.

I did mention that you see derivatives trade in different markets. You want to look at securities that you're buying and strip out each of the risk alternatives and try to buy those risk elements in the cheapest markets. In other words, unbundle the security into the option components, and find the market, such as a swaptions market, or the callable bond market, where it tends to trade the cheapest.

Another opportunity for structured notes these days is in the CBO market. These are securities similar to collateralized mortgage obligations (CMOs) in the mortgage market. Instead of having mortgage-backed securities as the underlying collateral, you have emerging market bonds and high-yield bonds. Instead of tranching prepayment risk, you're tranching credit risk. You have the opportunity to buy equity securities, which would take the first losses from the underlying collateral, all the way up to AAA or AA type securities, which would be a last loss position.

We've structured three CBOs, and we've also been a buyer of some of the equity in these fields. There can be a lot of value in CBOs depending on your underlying view of the underlying sectors backing the collaterals. You need to look at these on a deal-

by-deal basis because there are a lot of risks in CBOs. The main thing to do on these is to get comfortable with the underlying collateral managers, because they can help add a lot of yield to the portfolio while taking measured risks, getting some upside if you're playing in the equity.

Passive management strategies, or buy and hold, only makes sense to me when it is good from an economic standpoint. If you were to sell securities and take capital gains, and if the taxes you're paying on the capital gains detract more from the returns than active management would add to the returns, then I think you're better off with buy and hold. For the most part, that's the exception and not the rule. If you're not getting value over buy and hold, then most likely your investment managers are not adding value, at least over the long term. There can be underperformance in the short term, but over a long-term horizon, you should be able to add value over a buy and hold strategy.

One thing that's interesting which is a quasi-passive strategy would be enhanced indexing. That's where you closely match your benchmarks, but you give yourself some flexibility to take risks versus a benchmark to try to add some value, and you constrain your risk to be close to the benchmark. You most likely will earn a return over the benchmark.

There are also structured portfolio strategies. Andrew talked about immunization and cash-flow matching in some depth, but, from my standpoint, these can add a lot of value in terms of understanding the concepts. The main thing to do is determine your risk tolerance. If you're more risk averse, you probably want to layer more toward the immunization cash-flow matching side of the spectrum. The other spectrum would be total return management or pure total return management. More than likely you want to be somewhere between the two, and it's really an individual company call as to where you want to be on that risk/return spectrum.

We'll talk a little bit about historical data and variable forecasting models and then get into some optimal asset allocation models. Historical data is used to estimate returns on assets and estimate risk on assets in terms of standard deviations or volatility of assets. We also look at correlations on underlying assets. As Andrew pointed out, significant problems exist when using historical data to predict the future. For example, if you were using historical data in 1993 to estimate mortgage prepayments, odds are that not only were you wrong in your prepayment estimates, but you were wrong by a multiple and not by an error term because a lot of things happened in that time frame that caused mortgage prepayments to really spike up. If you're using historical data, you should look at using some type of subjective override to look at the environment, to determine what factors from historical data are still there, and then make a subjective estimate after you do the historical analysis.

There are two things to be careful of when using historical data. First of all, take into account changes in the environment that we talked about, and that gets to the mortgage example. Another risk, and something that we're probably seeing in some sectors of the market, is people thinking that everything in the environment has changed. That's what we've seen in the high-yield market, and the stock market in the last few years. You might often hear that it's a different environment. We're not in the late 1980s or early 1990s, when we had the high defaults. The environment has changed and the underlying risks are different. I'd be careful about that type of thinking. Many things have changed since then, and I think you want to take into account long cycles when you look at historical data. Historical data can prove useful just to remind us that even though we're in a good environment today, the risks are not absent. I think we've seen that in recent stock market activity.

Chart 16 shows historical returns versus volatility, and the thing that really sticks out in this chart is the value in BB and B securities. Much of that is due to a lack of broad sponsorship in the sectors over the last several years, although we're getting more sponsorship in BBs and Bs recently. Any time there are barriers to participating in a sector, there is usually a lot of value there. For asset allocation, in addition to looking at quantitative measures of asset allocation, I'd suggest looking at some of the softer factors such as where do barriers exist to being in a market? I think you'll find a lot of value there.

The key question to ask in high yield and when you look at Chart 16 is whether this points out that BBs and Bs still have an upside. Is there a good risk/return trade-off or have they overshot the targets, and they're going to come back. My assessment is that there's still room to go, that there's still a lot of value in high-yield securities. Many of the artificial barriers are broken down because we've seen a lot of pension funds and insurance companies become players in the high-yield market, as well as the CBO bid for high-yield bonds. Some of the barriers are broken down, but I think there's still some value in the market. One thing you can be sure of about the bond market, as opposed to the stock market, is that there is a limit to how high returns can go. Even though we've seen spreads come down dramatically over the past several years, you know spreads aren't going to go down to the level of Treasuries. So, there is a limit to how high returns can go, and Treasury returns are limited by the fact that you know Treasury returns are not going to go below zero. Japan is trying to prove us wrong on that as they get close to zero. I think a lesson is that reversion-to-the-mean strategies probably work better in fixed-income securities than they do in equity securities. I think the managers who have tried to play the mean reversion techniques over the last several years have found themselves out of a job.

The point of Chart 17 is just to prove that one thing is obvious: when you have a sector where spreads are compressing, and you like that sector, you're better off on the long duration part of the sector because the high-yield market is a very highly sloped line on the risk/return standpoint. You get a lot of extra return for each given unit of risk in a tightening spread environment. There is one data point that looks like it's out of line, the BB five- to seven-year point which is on the Treasury line. That's most likely due to a couple large defaults in that sector of the market.

The point of Chart 18 is to point out that correlations are not constant over time. This shows the correlations between U.S. Treasuries and Athe excess return on BBs@ which would represent the amount by which BB securities outperform Treasuries over that time horizon. What that points out is the lag in high-yield spreads. As rates go down, high-yield spreads tend to widen. There's a dampening effect and the opposite happens. As yields go up on Treasuries, high-yield spreads tend to narrow, and that is why there is a negative correlation. If you look at this during different time periods, the correlation is not constant. If you look at historical data and use a constant correlation factor, that will most likely be a very rough analysis, and there could be some errors in the output to that analysis.

What we've seen recently are Garch models which take into account that correlation is not constant. To make the asset allocation models more robust you can do simulations or correlations similar to the way interest rate simulations have been done for years; that is, calculate standard deviations and correlation coefficients, simulate the correlations through time, and use those as input to your asset allocation model.

Chart 19 shows that volatility over longer time horizons tends to be lower, such as when you look at the coefficient of variation. Standard deviations, of course, would be higher over a longer term horizon, but when you look at the coefficient of variation, standard deviation divided by the mean, the mean is increasing much more than standard deviation. Over longer time horizons, that would tend to decrease.

Variable forecasting models include simple regression models or Garch models, which we've talked about. These are time series models where correlation is not treated as a constant, and arbitrage pricing theory (APT) models. In the context of variable forecasting models, these would be multiple regression models and nonlinear models such as neural networks, which are just starting to come into their own.

Optimal asset allocation models include the Markowitz efficient frontier model and APT model. The concept of the efficient frontier for a given level of a risk is to maximize return. For a given level of return, the concept is to minimize risk.

Chart 20 shows the efficient frontier applied to the sectors of the market we've been looking at which are BB securities from the high-yield market, AA securities, and also Treasuries, broken down by maturity bucket. Since BBs have provided such good historical returns, the BBs are very close to the efficient frontier. This tells you that the optimal portfolios would be dominated by positions in BB securities. A caveat is that this is based on historical returns which, as I said earlier, has flaws. When you do efficient frontiers, especially for insurance company portfolios, you need to make sure that you constrain the efficient frontier analysis to take into account any limits you have on high-yield securities. You must also take into account the matching that you need versus the liabilities. There is also diversification constraints, because it's not prudent to put all your securities into BB 10–15-year securities.

The APT model is a very robust model. It's not only used in fixed income securities, but it is also used very often in equities. It enables you to pinpoint factors that determine returns and set up a model based on those factors. What you're trying to do is maximize your expected return less your risk where your risk is defined as the variance of return weighted by a utility factor. Depending on where you are on the risk/return spectrum, you can put in a value to put yourself in a more risky portfolio or a less risky portfolio. The constraint with this is that the more you increase the number of factors, you're increasing the computation complexity in a more than linear fashion. The difficult part of APT analysis is determining what factors have real predictive power on the return you're looking at and also determining the appropriate correlations to use for those factors?

Asset allocation models are becoming more robust but are still wrought with limitations. For example, you may lack historical data with meaningful length. For example, when you look at emerging markets there's not a lot of history in emerging markets. It's hard to make predictions based on historical data in terms of defaults for emerging markets or spreads for emerging markets. By choosing different starting dates or holding periods, you can significantly affect the results. You can think about the high-yield market. For example, you look at the 1992–98 time frame, you'll get significantly different results than if you look at the 1987–98 time frame because of the large spike in defaults, plus the 10% that we saw in 1990–91. Also, some historical events included in the study may not reappear under current economic conditions.

Standard deviation punishes both upward and downward risk. Not all risk is bad. If you have upward deviation, it fits into the definition of risk, but from a business standpoint it's really not risk, at least in the way most companies think of it. That's another thing to be careful of. It's difficult to predict a catastrophic situation. For example, if you think about the high-yield market, and if we hadn't seen that spike in defaults in 1989, 1990, and 1991, the momentum we saw during that time period

would have continued, and you'd most likely see high-yield spreads on top of investment grade corporate spreads. If there was a coming catastrophe, that would not be envisioned. I think you need to look at potential catastrophic situations, because a lot of your returns are not going to be made by picking up the extra few basis points on asset allocation models. It is going to be avoiding the catastrophic situations that strike the markets.

When you think about the catastrophes or near catastrophes that we've had in the markets, you might remember the commercial mortgage debacle in the late 1980s, the high-yield problems in the early 1990s, and then the mortgage prepayment problems that hit companies with a lot of derivative securities, specifically interest only (IOs) in 1993. If you avoid those asset classes, you can really have quite good results even by being fairly risk averse in your other portfolios. While models are important, don't forget to overlay them with some type of reality check, and look for factors in the environment that would tell you where the next debacle may be.

Mr. Dardis: We'd be delighted to hear the audience's feelings about asset allocation, what other companies are doing, what people are seeing in the theoretical and practical side of things, any personal thoughts.

Mr. Clark A. Ramsey: I have two questions. The first one is for all the panelists. I think each one of you mentioned that standard deviation is, in many ways, an inadequate measure of risk. Do any of you have any experience with or comments on the use of downside semi-variance or lower partial moments to evaluate riskiness?

Mr. Haney: I haven't had any experience with it directly, but I know it's something that we've been looking at. You substitute the problem of estimating standard deviation in a sense for your minimum acceptable return, plus you also increase the problem's difficulty. That method of optimization is much more difficult to solve than a quadratic or a linear. There are things out there on the market that will do it, but you still have to come up with the minimum acceptable return. Is that achievable in the current market condition that we're working in now? It has some promise, I think, but it, too, has its limitations.

Mr. Young: If you have an asset class with a higher expected return and a marginally higher risk, that could actually decrease the risk of your company because the extra return that asset provides is a buffer against any of the negative outcomes in that asset class. We like to filter it through a model of the operations of the company and measure the impact of the returns on that asset and what they mean for the company.

Mr. Ramsey: I have a second question for Steve Huber, in particular, although any of you are certainly welcome to answer it. Grant's Interest Rate Observer recently

indicated that there=s very significant risk in the high-yield bond market for a couple of reasons. One of them is a very significant volume of new issues. Another one is a higher proportion of issues that are going the zero-coupon route, possibly indicating an inability to meet current interest payments. Many of the high-yield bonds are currently held by mutual funds as opposed to the insurance companies and savings and loans that held them earlier. I believe the thought there is that the mutual funds will not have the ability to hold high-yield bonds in a downturn like insurance companies did in the early 1990s. Steve, you seem to be optimistic about the high-yield bond market as possibly offering a lot of value. I just wondered if you could comment on that.

Mr. Huber: The high-yield bond market has provided a lot of good returns recently, but I hope I didn=t come across as too optimistic. I like the asset class from a long-term horizon, but if you look at the default rates that we=ve seen recently, you would have seen that Moody=s default rate for the trailing 12 months just increased from, I think, 1.8% defaults, closer to the historical average that=s up around 2.5%. The increase in defaults has been mainly due to a lot of the Asian securities and the problems we=ve seen in Asia. The high-yield market is going to be very highly correlated with the stock market. I think there has been too much complacency in the high-yield bond market in terms of projecting overall default levels. I=m a proponent of investing in CBOs to get exposure to the asset class, but when you look at CBOs being marketed at 2% long-term default rates, I think that=s probably too low a default rate, and something on the order of 3% might be more appropriate. From a high-yield standpoint, it=s an asset class you want to be involved in, but there are going to be bumps in the road, especially if the stock market keeps going like it has been recently (dropping 200 points in one day). I think if we see a correction in the stock market, we could see a pretty large correction in the high-yield market as well. If that=s the case, you don=t want to be in the lower rated high-yield bonds. You want to be in the BB bonds. If you=re in the zeroes, or if you=re in the lower portion such as the subordinated notes or B- notes, you=ll probably take a hit, probably close to the order of the equity market. You probably want to be in the high-yield market, but you'd want to keep your duration short, and you probably want to keep your quality higher in high yield. I like the market from a longer term standpoint. If you=re going to be a player in it for a two-, three-, or four-year horizon, the extra yield you=re getting in the market just makes the breakeven spreads quite compelling when you look at it over the longer term horizon.

From the Floor: Given the equity nature of high-yield bonds, do you pay much attention to the duration of the bonds?

Mr. Huber: We do, but I don=t think a lot of people pay much attention to it. We have our high-yield portfolio manager constrained to be within about a quarter year to

half a year of the high-yield index. When we think that high-yield spreads are likely to widen out, we'll want to stay in the shorter maturity securities such as two- to three- to four-year securities. If we really like the market and spreads are wide, we would go into zeroes because when you're in the spread-narrowing environment, it's the zeroes that are going to get the big kick. You want securities with a long spread duration. We keep a constant allocation to the high-yield market in our insurance portfolios. We don't move that allocation around, but within that set allocation we would tend to move higher quality, lower quality, and also short duration, long duration, to either take a defensive posture or an aggressive posture.

Mr. Stephen A. J. Sedlak: Given that we have a risk-based capital requirement, arguably there's some kind of difference in capital cost to carry various securities. The efficient frontier chart showed that BBs was the best place to be. Did that have any recognition of a differential capital cost between so-called high-yield and the higher quality securities?

Mr. Huber: No, it didn't. That's based on total return. I think the most difficult thing about investing insurance portfolios are the constraints you have such as the risk-based capital charges. What's also difficult are the limits on high-yield securities because the rating agencies really stay focused on that. I think if you're with a company that does not have capital constraints, you're very fortunate, but I think those companies are few and far between. What you need to do is look at what the most efficient use is for some of the risk-based capital. I guess you have the option of using that in terms of a barbell for risk-based capital and putting money in equities and then in higher grade corporates. Or, you could take a more bulleted approach and put a higher level in high-risk securities and keep it all in the BB bucket. I believe there is a 4% charge in BB and 9% in B.

The other thing you might want to look at that we've looked at is using structured notes to lower your risk-based capital charges. For example, you can buy equity-linked notes issued by a AAA issuer, like Fannie Mae, and that will give you the upside of the equity market. Or you can structure them in swap form where you get the total return of a high-yield index or a BB index, but they're backed by an issuer such as Fannie Mae. You can structure those to get NAIC 1 treatment. Depending on your liquidity preference, there are some efficient ways to play in the sector, but there's a cost in terms of what you give up in liquidity.

Mr. Steven P. Miller: I have a question for Mr. Huber on the Garch models. When you model the correlation coefficient as a random variable, I assume there's a correlation of those random variables, which, apparently, is held constant. My question is whether that second order of complexity ends up being worthwhile in the modeling or are you just moving it a little further down the line?

Mr. Huber: That's a very good question. That's the next iteration in the analysis. It's similar to the trend going from duration to convexity to DB3 risk. It's important, but I think looking at that factor doesn't provide the extra kick that you get from just taking a step down to look at the random variable in terms of changing correlations. I don't know very much about Garch models. It's something our quantitative area is looking at, but I would say that it is going to evolve over time. These techniques are new, and I think you are going to get to that level of complexity.

Mr. Russell A. Osborne: This question is for Andrew. You talked about the problems with maximizing or optimizing to the weaknesses in your model. Something we've struggled with is when you've run hundreds of scenarios, and you're trying to maximize a risk/return trade-off, how can you funnel this massive amount of information into a small number of measures that can help you understand what's driving your results so that you can be on the lookout for this occurrence of optimizing to the weakness in your model?

Mr. Young: Part of the calibration of using the model is it produces an optimal portfolio, and when it builds the efficient frontier, it's encapsulating it in your measure of risk and your measure of return. At some point, you have to look at the exact composition of that portfolio and see if that makes sense. A good place to start is the portfolio that your company already has. That has evolved over a long time. If the portfolio that suggests it is optimal is very different from that portfolio, that could well be the case, but you're going to be a lot more suspicious of that than you would be if it tells you that you're on the right track. There are incremental changes that you can make here and there. Let's say you have very limited allocation to the mortgage sector of the market, and the optimization comes back and says that you should have half of your portfolio in the mortgage sector of the market. Then you're going to wonder if that's really true. It could very well be that, combined with your business, the negative convexity of the mortgages would be disastrous. That would lead you to think about the elements of your company that you didn't include in your model that led it to pick those mortgage securities when they don't really make sense for your company.

From the Floor: Suppose that you have a model where interest rates are a stochastic variable, but defaults on assets are not. If you assume, as you should, that if you take on additional risk, like CB1 risk, you're going to get a commiserate extra return that's going to more than pay for the expected defaults, and you're modeling those defaults deterministically like you would mortality rates in such a model. Then, the optimizer you use is going to come out with the answer that you ought to invest in the riskiest possible asset because you're always going to get an expected excess return as you move to the higher yielding instruments.

Mr. Young: That's right. There's also a risk that the model's going to exploit your capital markets model.

From the Floor: But that's just one simple example. The concern I have is that when you build this model that's so complex, there are all sorts of little deterministic assumptions that are built into your model that are hiding, maybe waiting to trick you if you believe in the statistical summaries that you got from running hundreds of scenarios. It seems like we need more tools or more measures to look at.

Mr. Young: You're never going to get away from garbage in-garbage out.

Mr. Haney: It has helped to limit that sort of behavior. We sort of use a judgment overlay because if you look at an asset class like equities, it might want to put too much in one particular asset class like an internationally emerging market. What we try to do is temper that and get to a notion of more normal allocations across equities. In the literature they call that more of an efficient band as opposed to an efficient frontier. Because the assumptions are so sensitive, you really should move the portfolio up and to the left to get in that efficient band as opposed to trying to be right on the efficient frontier at any one point. What we've done, in that sense, is by using those other constraints and then overlaying some judgments, you temper the hard edges or knife-edge problems that you're going to encounter in any optimization.

Mr. Young: One way that you can test that is by using your capital markets model to price all of the different investments that you have and see if there are any irregularities in the way that it's pricing the assets that you're using as allocation alternatives from the way that they're priced in the market. If so, does that reflect your view that there's good or bad relative value in those assets, or do you think that those assets are, more or less, fairly priced, and you have to adjust your capital markets model?