1995 VALUATION ACTUARY SYMPOSIUM PROCEEDINGS

SESSION 15

Financial Performance Measurement

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FINANCIAL PERFORMANCE MEASUREMENT

MR. J. PETER DURAN: I'm an actuary with Ernst & Young in New York.

Our first speaker is Rich Daillak. Rich is vice president and actuary at MetLife. Rich is responsible for leading MetLife's financial management reengineering in the area of capital measurement, capital management, and business planning. Rich will speak to us about the MetLife experience with this topic.

Next is Hans Wagner, who's an FSA with Ernst & Young in Boston. He will be talking to us about setting target returns on capital. Hans is vice chairperson of the examination committee for Course F385, and he has assisted a number of major insurance companies in the area of capital deployment and capital management.

Finally, Alastair Longley-Cook is vice president and corporate actuary at the Aetna and has worked in many areas there including group, life, auto, homeowners, and investor relations. Alastair is a frequent speaker at meetings, and will talk to us about embedded value added and how that can be used in a capital management and performance measurement setting.

MR. RICHARD H. DAILLAK: Peter invited me to talk about a case study of reengineering financial performance management at my company, MetLife. Case studies are enjoyable to deliver, because they're basically stories. And in this particular instance, there are two stories to be told.

The two stories are about first, what we're doing, and second, how we're going about introducing these new capital management strategies (that is, how we do reengineering). The context to this story is not unique to MetLife. Let's first sketch some of that context.

From the vantage point of the 1990s, the pre-1970 era seems pastoral, with stable interest rates and homogeneous, simple product mixes. It was a good time to make money in the insurance business.

The 1970s to 1980s were marked by a number of changes. Upheavals included financial market deregulation, volatile interest rates, and product diversification. Business growth was a hallmark of this period: for example, we grew tremendously in our nonparticipating pension products, taking on assets, liabilities and risk. Organizationally, we decentralized by moving pricing, financial management, and financial reporting down into our business units.

In the 1990s, at many companies, asset issues arose with regard to real estate, commercial mortgages, or other asset classes. In response to failures or near failures, regulators introduced risk-based capital (RBC). Also in the 1990s, there has been a tremendously increased emphasis on earnings performance.

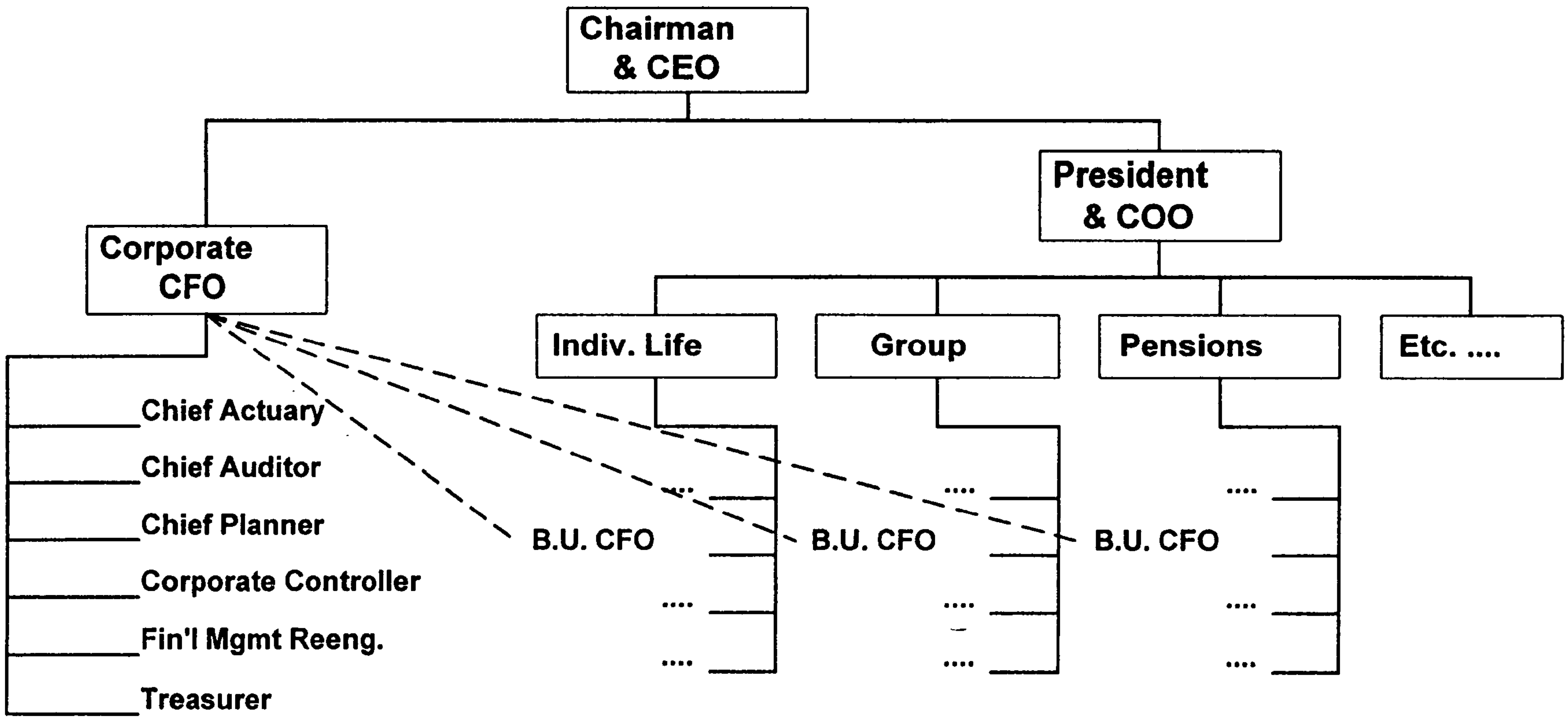
Let's return to the topic of decentralization. Chart 1 shows that MetLife is currently structured with several operating business units reporting up to our president and chief operating officer, who reports to the chairman. The chief financial officer (CFO) reports directly to the chairman, as well. The CFO directs corporate financial departments, such as actuarial, auditing, controllers, financial management reengineering, and treasury. So we have business units coming up one direction, and a corporate financial structure moving parallel to it. Within each business unit, there are business unit CFOs and product pricers. (I haven't put the pricing areas down on the chart.)

The dotted lines and straight lines are distinct. The business unit CFOs and the pricers have a straight line responsibility to their business units, but they also have a dotted line to corporate financial.

This decentralized structure created a need for corporate oversight. In response, quarterly profit management meetings were instituted, wherein business CFOs and pricers were required to review product pricing and profitability with corporate actuaries. However, it became difficult to look at each business unit and make sense of questions like, is your 50-basis-point-spread enough? Or, was

CHART 1

MetLife Today



your 10% of premium profit adequate? We needed a common yardstick for measuring profitability, so we considered a number of different alternatives.

Among the possible alternatives are embedded value and economic value added (EVA), two related measures that attempt to capture the true underlying value created in your business. They're very attractive, of course. Return on equity (ROE) and return on investment (ROI) are likewise important, in part because they're driven by the accounting system, and because external observers can readily look at them.

Because embedded value/EVA results are very sensitive to the assumptions used, you must discipline those assumptions carefully. This is difficult because embedded value/EVA is fairly new, and the means of disciplining assumptions are still weak, so we had some apprehension about using these measures now. Another consideration was that, as we entered into GAAP for mutuals, it was attractive to continue to focus on a GAAP measure and not introduce an entirely different approach. Taking all these considerations into account, we selected the ROE approach.

Overall, it's very easy to determine your company's total ROE. The real question is, what about the component lines of business? What about the products and product groups within those lines? To measure these, you must carve up equity differently than it may appear on the accounting books. The equity on the books of the company is historical. The question we are concerned with, however, is, where are you deploying your capital today? To answer this, you need a risk-based assessment of the amount of equity committed today to a line of business or product group.

To make this assessment, you can look to a proprietary measure or to the National Association of Insurance Commissioners (NAIC) RBC measure. Like many other insurers, MetLife had developed its own proprietary risk capital formula, but its application was the subject of some internal controversy. Then NAIC RBC came along, making risk capital no longer a theory, but the law, and providing a ready formula.

So, our measure of the amount of statutory capital needed to support a line of business is NAIC RBC times a specified, fixed percent. We notionally capitalize our lines of business, on a statutory basis, at a specified percent of RBC, and then translate that into GAAP, by computing the corresponding GAAP balance sheet and income statement. Then, in turn, GAAP ROE can be calculated.

This describes the technical approach. Now, let's discuss how these changes are implemented.

Our approach was to make this change part of our overall financial management reengineering effort. The essence of reengineering is to adopt a "process view." What this really means is, first determine the basic processes that you should perform, and then determine who should be doing them.

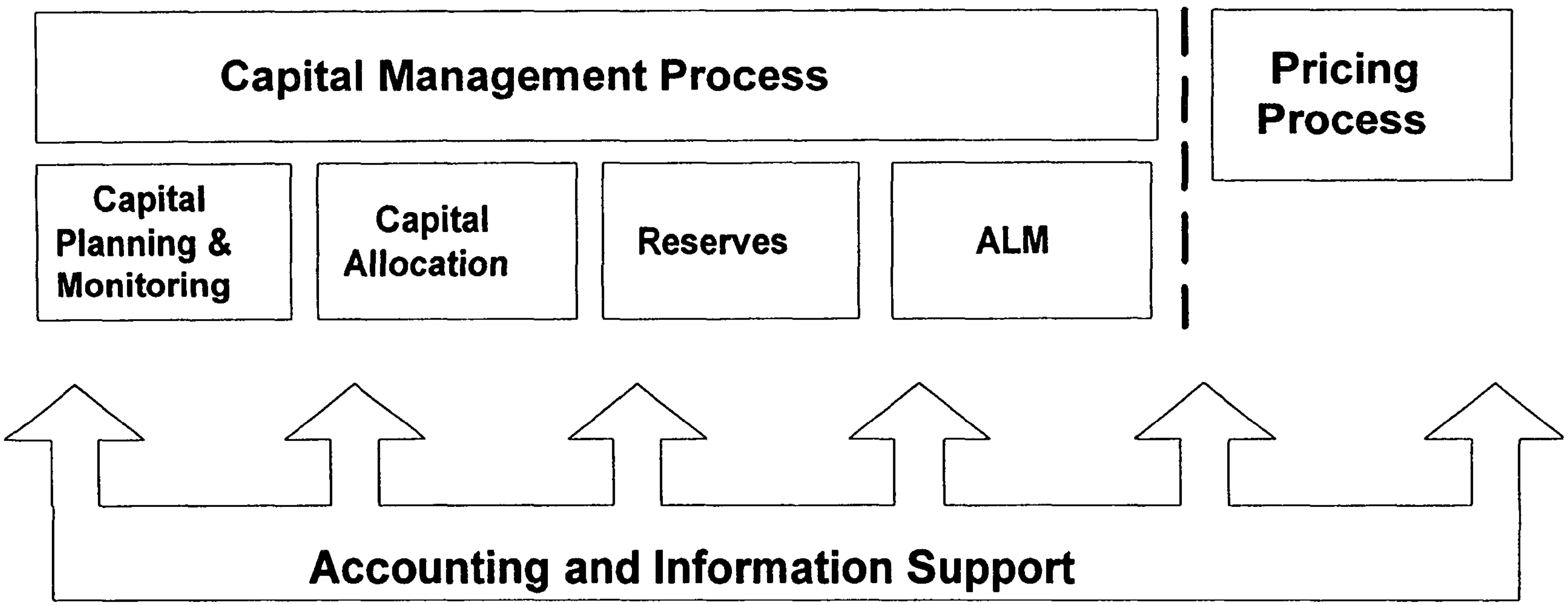
I've isolated a few processes that we are reengineering (Chart 2). The capital management process was decomposed into subprocesses like reserves and asset valuation. These determine your accounting capital. Asset/liability management determines how much risk you've assumed in relation to your liabilities. In capital planning and monitoring you decide how you're going to use capital, what kind of returns you're planning to get, and then you monitor your actual performance against that plan. This is where ROE/ROI comes in.

Capital allocation is something that surrounds planning and monitoring. It involves questions like, if this is how all my lines of business plan to perform. Should I step in and intervene from a senior management perspective and shift capital over here and throttle back an activity over there? Capital allocation, then, is essentially executive decision making. Pricing is clearly a related process, as is financial reporting, and all of these processes are supported by accounting and information systems.

How did we get the processes? By following a fairly standard reengineering methodology involving visioning, current state assessment, future state design, and transition planning. The vision team identified the high-level processes and subprocesses and created charters that described them, including how, in very broad terms, the processes should be conducted in the future. Steering committees were formed, consisting of sponsors and key executives who were to guide the changes. Current state assessment sought to find out how (if at all) the process was performed today. Future

CHART 2

Process View



state design means, "Let's elaborate the overall vision and figure out where we want to be tomorrow," which produces a more refined, detailed statement of the vision.

The transition plan is likely to involve progressive stages of implementation. For example, this year we might do one thing; next year we will do something better; the year after, we'll do something better still.

Chart 3 shows the factors that are needed for success. Let's highlight a few of the items. Any change, whether it's good or bad, is going to produce resistance. Sponsor commitment and support is absolutely essential to overcome this resistance.

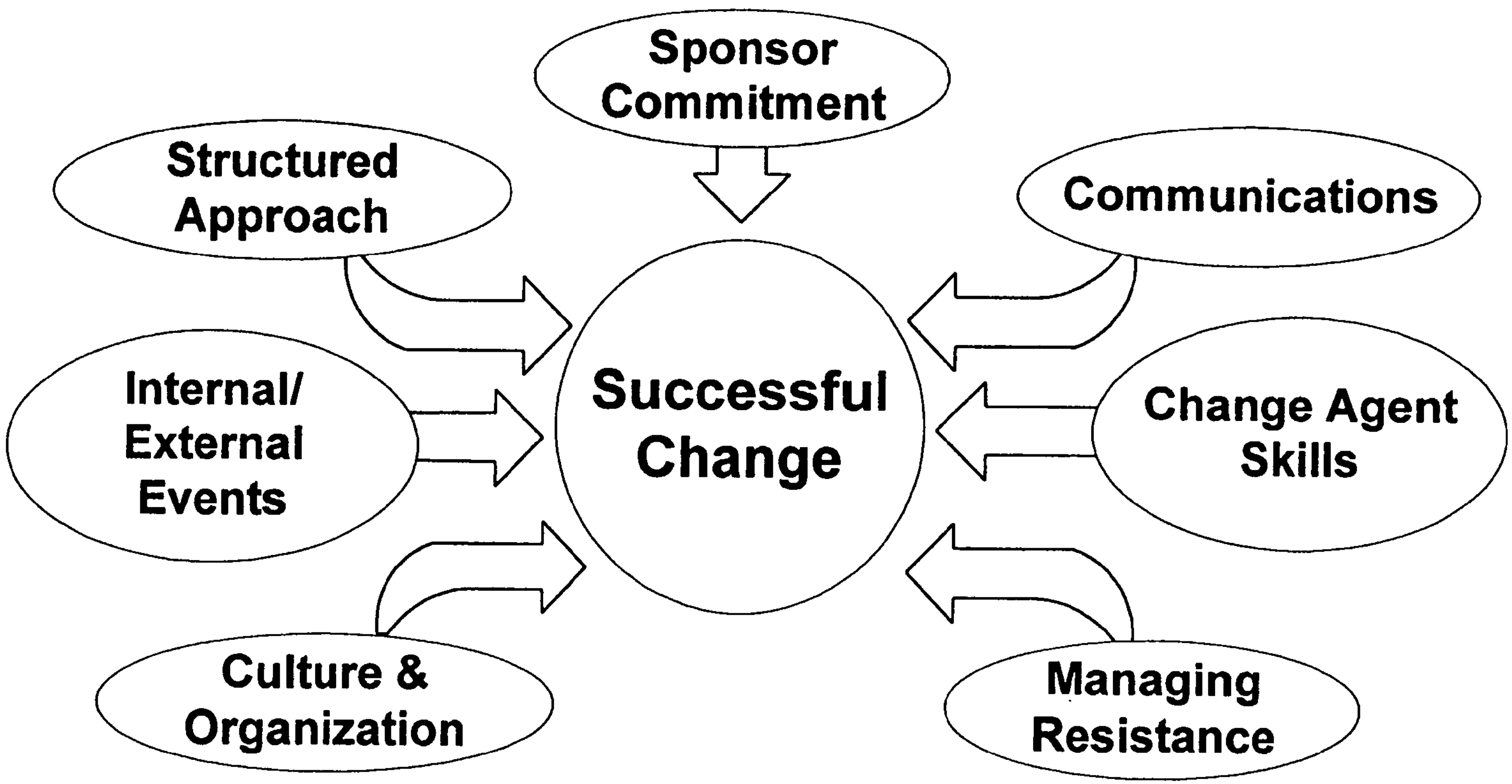
External events can be quite important. The introduction of NAIC RBC was an external event that brought to closure, in our company, a very long debate of the merits of risk capital. Another important external event, for us, was the creation and subsequent divestiture of our MetraHealth subsidiary. Mergers and acquisitions provide an intensive short course in financial management for people at every level of the company. Every merger valuation that we did took required risk capital into account.

Finally, let's summarize where we stand in the process today. We've done a preliminary run of our 1994 actual ROE performance by "product group." (Because individual products are not all managed independently, we aggregate them into groupings that are managed together, and measure risk-based ROEs for the group as a whole.) A team is in place to project ROEs for 1995-98 for these product groupings. The team members will be delivering the projections very soon. As they work, they are documenting the practical compromises needed to do such projections, and after the plan is complete and the team is debriefed, we may codify or selectively automate the process.

Let's finish with a short list of emerging issues: product group definitions, determination of required capital, taxes, and pricing. As results emerge and need explanation, some participants are calling for a finer-grained definition of product groups: the aggregates we first chose were somewhat too broad. With respect to required capital, the trend is definitely toward a more negotiated, rather than purely

CHART 3

Success Factors



formula-driven, determination of required capital. Taxes are a definite complexity. In the past, management has focused heavily on pre-tax performance; now, with ROE, after-tax results have taken on more importance. Finally, ROE only measures what has happened. Pricing, on the other hand, can help determine what will happen. Our next challenge is to implement these measures in pricing in order to get the type of results we want.

MR. HANS J. WAGNER: I'm going to talk about the general components of the capital management process, and then focus on how we might establish target returns. The target returns can be used either in the ROE context that MetLife is implementing as Rich described, or they could be used as hurdle rates in an economic value added or embedded value approach.

One possible way to structure a general capital management process is into a few different components. The first component is allocation, which was described very well in the surplus management session, and Rich described how MetLife has chosen to do it. I'll give a couple of brief illustrations of some of the impacts of different allocation techniques. Establishing target returns is the second component, and will be the heart of what I'm going to talk about. A couple of other components, which I won't touch on at all, are planning and budgeting, monitoring and analysis, and the formation, and structuring of capital.

Table 1 illustrates three different approaches towards allocating your existing capital to different lines of business. People might be more comfortable thinking of the first column labeled "historical" as retained earnings, or retained capital. This approach views where our capital position is after 50 years, 100 years, 150 years of operations, and rolling forward the historical accounting or business performance. In the historical approach there is no corporate segment. We haven't put in any assumed transfers from a line of business into a corporate area. The individual lines -- life, savings, and property & casualty (P&C) -- could be thought of either as business units or as separate companies. If they're separate companies, there will be extra constraints on how we can choose to allocate capital.

TABLE 1

Committing Capital

	Historical	Ratings-Based	Economic
Life	$1,200	$450	$375
Savings	300	800	875
P&C	500	350	250
Total	$2,000	$1,000	$1,500
Corporate	0	400	500
Total	$2,000	$2,000	$2,000

The ratings-based approach might be considered the external approach based on RBC, or a ratings agency formula. You can see that it differs very much in many cases from just a historical accumulation. If we'd been selling life insurance for 150 years, we would have had a lot of time to accumulate capital. We probably don't need all that capital to support the risks in the operation. Under the ratings-based approach, the corporate segment, or our free capital available for other uses in this illustration, might be about 400.

Finally, the right column shows an economic approach, or an internal assessment approach, to the assignment of the capital needed to support the risks in this particular set of business units. We can see that, in total, the economic capital for this particular illustration shows more free corporate capital than the ratings-based approach. That will vary company to company. And there are also some differences of opinion on individual lines. Economic bases may have less required capital for the life line, more for savings, and less for P&C.

Having these different capital levels, of course, will impact earnings, if we've actually allocated assets to match. Under the ratings-based approach, the life line's earnings will be lower than under the historical approach because there are less assets there. If we're going to measure ROE, however, the lower dollar amount of earnings is more than compensated for by having a smaller equity base (Table 2). Consequently, the life line seems to be performing with a much higher ROE under the ratings-based capital approach than under the historical capital-based approach.

TABLE 2

Measuring Returns

	Historical	Ratings-Based	Economic
Life	8.9%	13.8%	15.3%
Savings	19.3	11.0	10.6
P&C	11.0	13.1	16.0
Total	11.0%	12.25%	12.67%
Corporate	0	6.0	6.0
Total	11.0%	11.0%	11.0%

The ROEs under the economic capital approach are more in line with the ratings-based approach, but there are still important differences, which depend especially on our target return. If our target return for life operations is 14%, we're not quite reaching that on ratings-based capital, perhaps indicating that we don't want to have as much capital allocated to that line. We're underperforming, and we need to find ways to bring ourselves up to our target. On the other hand, by our economic measure -- our internal assessment -- the line is performing very well if its target is 14%.

How do we establish these targets? And what are some of their uses? There are lots of different techniques, and there are different pieces of what might go into a target return. Some of the uses would be the comparisons that we just looked at, or perhaps a performance measurement target where we're comparing the actual performance of the line of business to what we think it should be. Another use is to define our pricing goals in a way more consistent with financial performance and measurement goals. The traditional present value of profit over present value of premium-profit criterion does not address this issue well. Also, this could be used to set returns on investment including, of course, the commitment of capital required. In addition to individual product pricing, we can establish hurdle rates to help us judge whether to enter a new venture, a new country, or a new line of business.

There are different ways of setting these returns. One thing to look at might be the enterprise's cost of capital, which will have several different pieces. What is the cost of that capital? The weighted average cost of capital will consider not only equity financing, but also debt financing. And there are choices, such as, whether to target a surplus note, or a bond offering, for a particular project. In this case, our weighted average enterprise cost of capital is probably not what we want to use. We have a designated source of capital for the project, so we want to reflect that. Some choices for computing enterprise cost of capital -- i.e., the capital asset pricing model, arbitrage pricing theory, or dividend growth models -- are ways of getting beyond just saying, "Equity capital should earn 15%." They are techniques to reflect risk in coming up with equity capital costs.

The same approaches can be used at the project and business unit level. We'll speak shortly about the capital asset pricing model (CAPM), and how it can be used not only at the enterprise level, but also at the line of business level. Beyond these very economically driven theoretical approaches, particularly for a mutual company, desired growth rates are very important as has been often discussed in the literature.

Consider competitors' performance. This is partially just a reality check: "If everybody in the market is earning 10%, and your techniques are showing that you should be earning 15%, does that mean that everybody has chosen to pursue a bad market, or that there's something wrong with our technique?" It's a consideration to make.

Finally, let's discuss current performance. If you're establishing performance measurement targets that are part of incentive compensation, or for other use, you certainly can't expect a line that has been returning 5% for years to suddenly start returning 15%.

We will now start easing into the more technical aspects. The CAPM can be shown in many different forms. One particular form shows the risk-adjusted equity return is composed of a risk-free rate, plus a specific risk adjustment. This adjustment equals a risk adjustment factor (beta) times the difference between the overall market return and the risk-free rate (the equity risk premium). In attempting to use this structure we have several tasks. We need to determine the risk-free rate, the beta that is appropriate for the particular business unit or company, and the equity risk premium.

Risk-free rate determination has a couple of questions involved with it. In the traditional capital asset pricing use, which is pricing stocks, you assume that you can get in and out of the investment very easily so that short-term rates are normally used. However, if we're entering a new line of business, it's not necessarily a good assumption that we can get our capital back out and make an alternative investment quickly. So we might wish to choose a longer-duration risk-free rate rather then a short-term one. If we are choosing a longer duration, we have a choice between spot rates and yields. Spot rates are probably more theoretically pleasing, yields are easier to get and more explainable to a board of directors.

Treasury returns obviously aren't stable. If we're establishing a performance benchmark, how much volatility do we want to have in that performance benchmark? For a line that can reprice itself regularly, like guaranteed investment contracts (GICs) for example, you might want your pricing target rate to go up and down a lot. If you're pricing a new whole life product, you probably don't want to have a lot of volatility, or you'll drive your pricing actuary berserk. You may want to stabilize your selection of risk-free rate a bit.

Equity risk premium also has a few questions about it. Historically, it hasn't been stable either. There are some arguments about how to determine the equity risk premium. Recently there have been arguments that it has shrunk. If you look over the past 120 years, you might decide that the equity risk premium is about 7%. If you look just over the past ten years, you might decide it's as small as 2%, and that's a big variation on target return. So you need to review literature and make the choice that you think is appropriate. That's where the reality checks come in. Is the technique coming up with a reasonable approach?

We mentioned that the classic capital asset pricing model uses a short-term rate, and we might want to use a longer-term Treasury. We may vary the equity risk premium depending on the length of the Treasury rate we're using, so that our implied market rate is the same. If we review our basic formula, the market return has a beta of 1.0. If we choose a longer duration, and hence a higher-risk free rate, unless we adjust the equity premium, we're adjusting the implied market return. In practical terms we might want to leave the equity risk premium alone. Doing so has the impact of charging a little bit higher rate to recognize that there's a higher capital cost for that longer-term commitment, which may be an attractive answer.

Finally, our third piece is determining beta. Beta is a measure of volatility. For publicly traded companies we can find a consistent beta from a service like Value Line, Barra's or Standard & Poors. Since beta is a measure of volatility we can also look at actual historical volatilities relative to the market. These would ideally be volatilities in stock price which are fundamental to the capital asset pricing method, but historical returns and the volatility of those relative to the market can be a good proxy. Unfortunately, using these volatilities requires an awful lot of data. Generally companies won't have produced enough historical return information to use that technique. What is the alternative for nonpublic companies? It's using similar companies which are publicly traded as proxies.

If we're going to use the publicly traded company approach, the beta for a company will reflect the impact of its debt structure. You might wish to remove that element of financial leverage, and use an unlevered ("equity") beta.

Table 3 shows that the levered betas vary quite widely. Protective Life has a rather remarkably low beta of 0.29. I don't think I've ever seen that low a beta. Betas, similar to our other measures, are not completely stable over time. I saw a beta for Protective Life a couple of years ago of about 0.6 which is more within a normal range. The levered betas go as high as 1.45 for Aetna and CIGNA. There's a formula for unlevering beta that reflects the tax deductibility of debt payments. The formula shown at the bottom is for translating levered betas into unlevered betas. Taking on extra debt creates risks to shareholders; they demand a higher premium. There's more risk, more volatility. So that's why a levered beta reflecting debt is higher. It's from the shareholder perspective.

We are using levered beta because I am looking at total company returns, rather then trying to strip out the effective debt, and coming up with an equity target return. We can make some assumptions about the risk-free rate and the equity risk premium and derive target ROEs (Table 4). These ROEs

TABLE 3

Publicly Traded ß Examples

Company	Levered ß	Debt/Equity	Unlevered ß
Aetna	1.45	20.3%	1.28
CIGNA	1.45	23.9	1.26
Lincoln National	0.95	8.9	0.90
NWNL	1.71	31.3	1.42
Protective Life	0.29	38.1	0.23
Provident L&A	1.84	19.9	1.63
SAFECO	1.24	34.8	1.01
Torchmark	1.08	64.2	0.76
Transamerica	1.24	287.8	0.43
USLIFE Corp.	1.25	39.8	0.99

$ß_u = ß_l \times (E \div ((D + E) - \text{taxrate} \times D)$

are for illustrative purposes only. We assumed the risk-free rate of 6%, and an equity risk premium of 5%, ran these assumptions through the formula, and came up with target ROEs that we compared to actual 1994 ROEs that we got from industry media.

TABLE 4

Corporate Target ROE versus Actual ROE

Company	Levered ß	Target ROE	1994 ROE	Actual/Target
Aetna	1.45	13.3%	8.5%	0.6
CIGNA	1.45	13.3	9.5	0.7
Lincoln National	0.95	10.8	12.8	1.2
Protective Life	0.29	7.5	26.0	3.5
SAFECO	1.24	12.2	11.1	0.9
Torchmark	1.08	11.4	21.8	1.9
Transamerica	1.24	12.2	17.7	1.5
USLIFE Corp.	1.25	12.3	11.0	0.9

Target ROEs assume $R_f = 6\%$, $(R_m - R_f) = 5\%$

An issue that comes up in using the capital asset pricing method for this approach is that it's based on total return, which is a market-value concept not a book-value concept. Chart 4 is attempting to relate book-value performance to market performance. On the left side is the ratio of stock market value to book value. Our x axis is the actual to target ROE ratios, and we can see that it's a reasonably good predictor.

There may be a limit on how much benefit the market will give you. That is maybe why Protective Life is down; also remember its beta was extremely low at that particular point in time. Quite a few of the companies do have somewhat higher market-to-book ratios than would be applied by the formula. They may also have other things besides their current one-year performance that investors like. Management may be finding ways beyond only ROE to be adding value to the company.

The argument about total return versus book return is one of the theoretical challenges associated with capital asset pricing methodology. The capital asset pricing method also comes under general attack because it doesn't always work perfectly. There's no guaranteed formula that's definitely going to work, but the capital asset pricing method is a useful tool. No one has found a way that does a much better job than the capital asset pricing method .

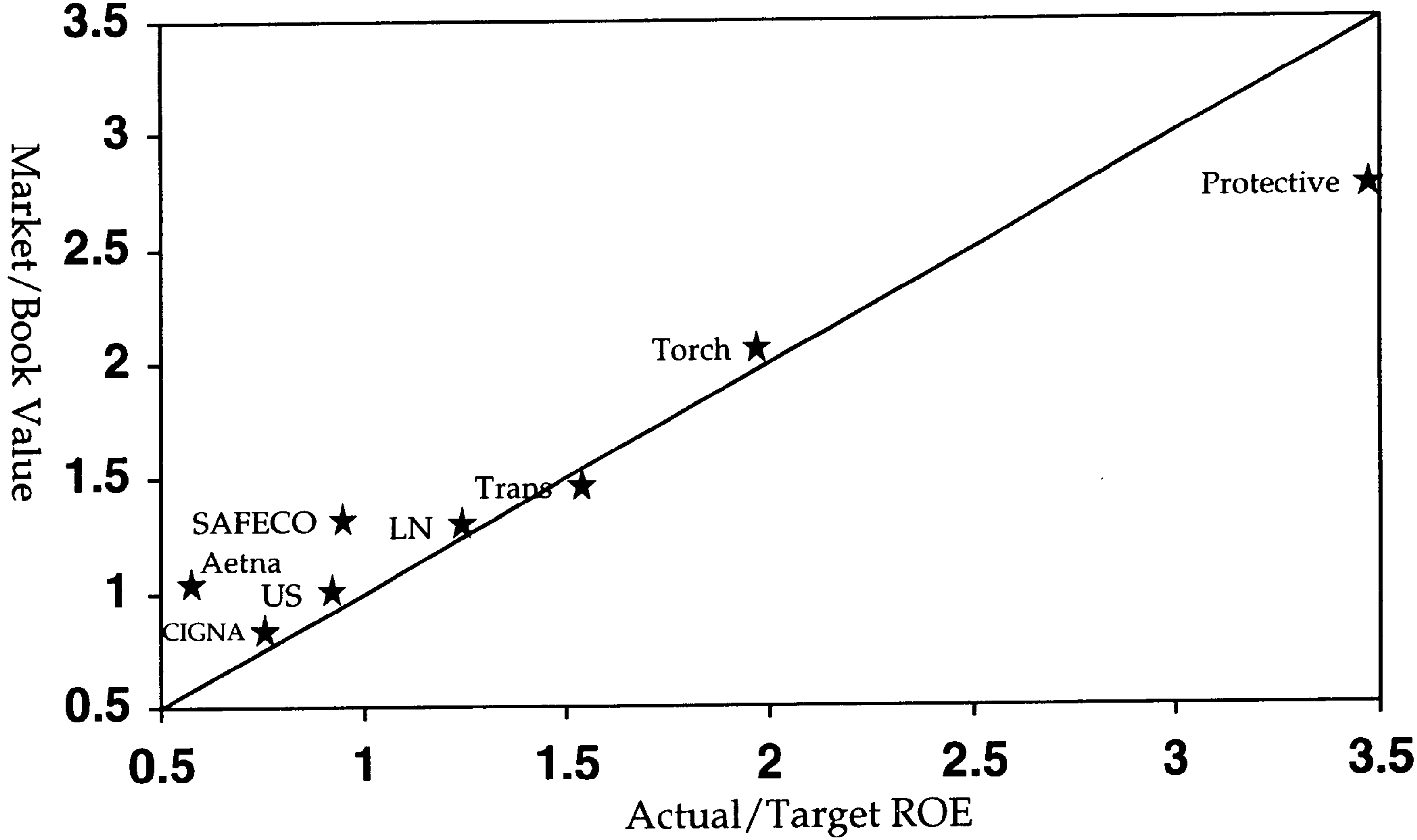
As was mentioned before, you might choose to allocate debt financing, which is generally cheaper than equity financing, to a particular business unit or to a particular project.

Regarding the impact of the capitalization level on the hurdle rate, there's not a completely clean way to say, "This company is more capitalized than others." It's another form of leverage. We have formulas for debt leverage, but we don't have formulas for the leverage associated with different capital levels. So if they're wildly divergent, there should be an adjustment to the hurdle rate.

If you are attempting to use the technique at the business unit level, finding comparable data for the proxy betas isn't the easiest thing. There aren't all that many publicly traded companies out there. You want to find those that are predominantly in the line of business that you're interested in. You

CHART 4

1994 Target Returns versus Market Valuation



should find a company that's predominantly in pensions if you're trying to measure the pension business unit, for example.

Finally, let's discuss treatment of taxes. The capital asset pricing method comes up with pretax returns to the investor, but the company earns returns after-tax. The treatment of surplus taxes for mutual companies and the treatment of core lines of business, in general, can lead to some very lively discussions.

MR. ALASTAIR G. LONGLEY-COOK: I'd like to introduce the concept of risk-adjusted economic value added as the most comprehensive financial performance measure that I can imagine. Time will tell whether it turns out to be useful in practice, but in theory, it meets the goals that we need to achieve.

I'm not going to spend much time on standard economic value added since there are a number of articles on the subject. It is starting to be used by several life insurance companies in this country, as a better measure of long-term economic performance than ROE or statutory earnings. We have started to introduce it at Aetna this year in our individual life and annuity lines. We're looking into it's application to group health and P&C. The hope is that, if we can use it across the corporation, we'll have that standardized yardstick that Rich talked about, which you need particularly for lines that have very different performance characteristics.

Economic value added (EVA) is change in present value of distributable earnings, defined here to be "statutory earnings after required surplus change." EVA can be expressed as a rate of return by dividing by value at the beginning of the year. Or, you can look at it as economic value added in excess of cost of capital. In other words, you subtract out the cost of capital rate, which Hans talked about, times initial value. Eventually you're comparing your value at time t to your value at time t-1 increased by the cost of capital. That's a slightly unusual way of stating it, but it will be useful later.

There are a number of ways expressing EVA. We're using one by Towers Perrin /Tillinghast in Chart 5. This is a good chart that they use to give some visual dimension to these concepts. If you start out with \$100 of value and end the year at \$115, it's useful to break down the \$15 into the opportunity cost of capital that we just talked about, and the actual change after that, in terms of both the in-force business and new business. We have found it very useful to analyze our individual lines in that way so you can also see what's driving those particular changes.

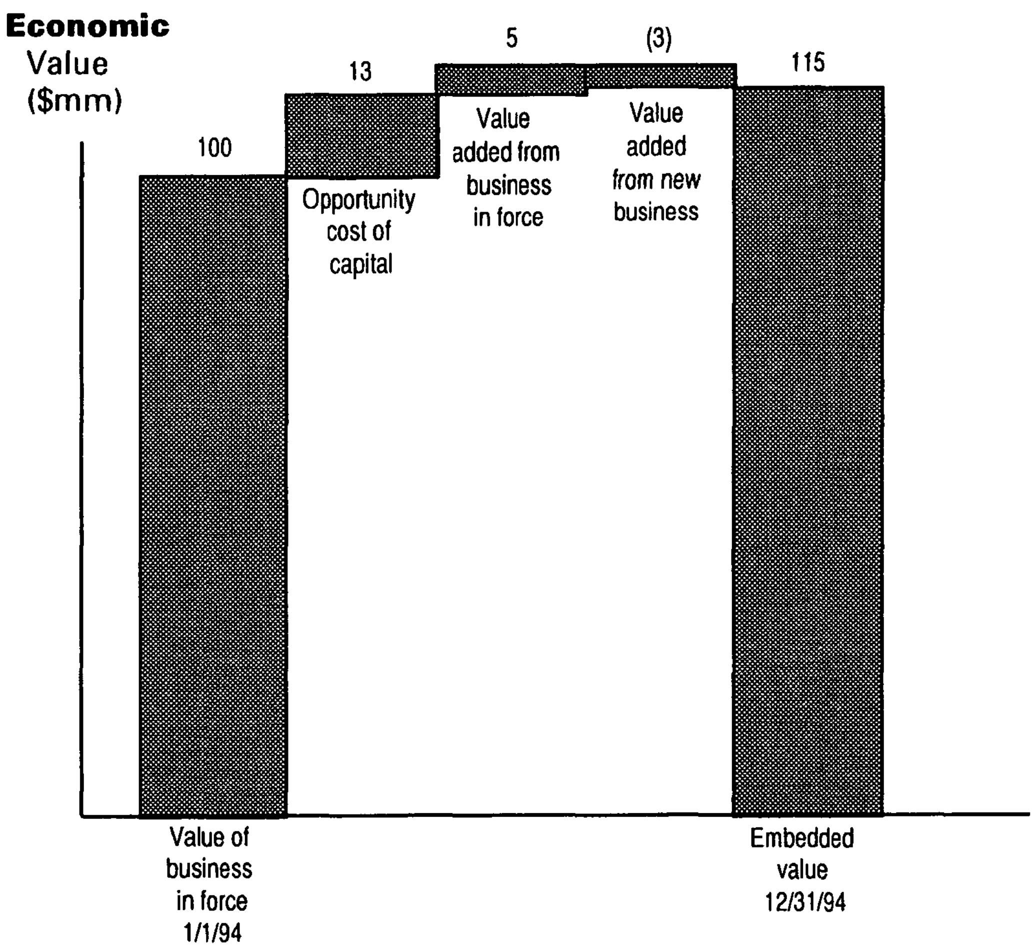
Although I'm a big fan of EVA, I do have some problems with it. I do not think it's completely risk adjusted for a couple of reasons. One, the surplus used in calculating the present value of distributable earnings and adjusting for cost of capital may be not calculated consistently across all lines of business. Hans referred to this problem. Two, to reflect change in risk exposure (e.g., the investment department decides to invest in nothing but junk bonds). Three, the present values are point estimates. They are usually based on your expected values with no recognition of variance around those points.

So let's take a look at what risk adjustments we might consider for these problems. In the first case, there is a situation, theoretically, where EVA calculated the way it was on the chart, would be properly risk adjusted. But all assumptions have to be true in order for that to occur. First of all, the EVA rate of return is normally distributed with a mean and variance. Second, the utility function is exponential. And third, V_{t-1} is equal to required surplus according to the formula in Chart 6. To achieve this required surplus must be directly related to the degree of risk aversion and the variance of earnings, and inversely proportional to cost of capital.

What I'd like to emphasize is that when we're looking at EVA, we really should not be looking at point estimates. Both V_t and V_{t-1} really should be looked at in terms of a distribution of possibilities. And that distribution is affected by future interest rates, mortality, withdrawals, and so forth. To handle this, we should look at the expected value of the economic utility value (EUV). This is an index that management should seek to maximize, either by increasing the expected values or decreasing the variance of those values. A parallel concept to economic value added in excess of cost of capital would be the comparison of EUV_t ,and EUV_{t-1} increased by the cost of capital. That's a

CHART 5

Financial Performance Scorecard



Value of in force, 1/1/94	$100
Embedded value, 12/31/94	$115
Increase in value	$15
Cost of capital	$13
Value added in excess of cost of capital	$2
EVA rate of return during year	15%

CHART 6

EVA Rate of Return in excess of Cost of Capital = $\frac{V_t - V_{t-1}}{V_{t-1}} - C$

Risk Adjusted Rate of Return[1] = $\frac{V_t - V_{t-1}}{V_{t-1}} - \frac{\alpha\sigma^2}{2V_{t-1}}$

Therefore, Risk Adjusted EVA in excess of COC = EVA in excess of COC iff:

$$C = \frac{\alpha\sigma^2}{2V_{t-1}}$$

or,

$$V_{t-1} = \frac{\alpha\sigma^2}{2C}$$

[1] See *REROSHE: The Concept of a Risk-Free Equivalent Return on Shareholder's Equity*, by Longley-Cook, *TSA*, Vol. XXXV, 1983; p 328.

comparison parallel to the one for EVA, but here it's expressed in terms of expected utilities. Increases are good, decreases are bad. If EUV_t is greater than EUV_{t-1} * (1 + cost of capital), you have increased the expected utility, and should be rewarded.

The best way to do those calculations is through stochastic testing. This is time-consuming, though good approximation techniques may expedite the calculations. As actuaries we've become enslaved to the personal computer, and tend to find solutions by brute force. That's often the most accurate method. But, we frequently have a situation where we have 20 PCs lined up cranking out cash flows, and the final results come in one hour before the deadline. You don't have any time to analyze. So, if we can move to more closed form, approximate solutions, we can spend more time analyzing and less time producing numbers. Closed form solutions are possible if we make certain simplifying assumptions as exemplified in Item A of Chart 5.

What if the value is not normally distributed? The case I want to spend some time on is a case common to life and annuities. When you look at the value as it's affected by changes in interest rates, it is usually negatively convex. So we might choose a parabolic function opening downwards that would represent negative convexity, where the "x" variable represents the change in interest rates, and then assume that the change in interest rates is normally distributed.

If those assumptions are reasonably valid, we can show, as demonstrated in Chart 7, that value after standardization has a chi-squared distribution with one degree of freedom. The normal distribution as we all know is symmetrical with expected value in the middle. What's interesting about the chi-squared with one degree of freedom is that its mode equals its maximum. Any change from current is a negative. That's the value you calculate based on your expected, let's say current interest rates. But due to mismatch, any change in interest rates up or down will decrease the present value of distributable earnings. So the chi-squared distribution is more appropriate than the normal.

We can show in Chart 8 that the expected utility of the distribution of values has a closed form solution. Using the parameters appropriate for time t-1 and t, which may be quite different, distributions might be different, so values of a and b in the parabola are different. If you plug those in you will get two values to compare: EUV_t, and EUV_{t-1} increased by the cost of capital.

The closed form solution has two factors. The second factor reflects the improvement due to increased expected value. That's standard economic value added theory. But the first factor is adjusting for the change in risk exposure. This is different from economic value added.

Historically, utility functions have not been used very much because of the difficulty in calculating alpha. Here's a method that I cover in my 1983 *Transactions* article, whereby, if we equate the **EUR**, where **R** is the actual (i.e., variable) total return, to EUR where R is the risk-free return, we get a value for alpha given by a formula, demonstrated in Chart 9.

CHART 7

Distribution of V

Assume:

$$V = a X^2 + b$$

and

$$f(X) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{x}{\sigma^2})^2}$$

Then a frequency function for V, g(V), can be derived using the change in variable technique: [1]

$$G(t) = P\{V<t\} = P\{aX^2 + b <t\} = P\{+\sqrt{(t-b)/a} < X < -\sqrt{(t-b)/a}\}, \text{ for } a<0$$

$$= 1 - \frac{2}{\sigma\sqrt{2\pi}} \int_0^{\sqrt{(t-b)/a}} e^{-\frac{1}{2}(\frac{x}{\sigma^2})^2} dx$$

Then

$$dG(t)/dt = \frac{-2}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2\sigma^2}(\frac{t-b}{a})} \frac{1}{2} (\frac{t-b}{a})^{-1/2} (\frac{1}{a})$$

$$g(V) = \frac{-1}{a\sigma^2 \sqrt{2\pi}} \left(\frac{V-b}{a\sigma^2}\right)^{-\frac{1}{2}} e^{-\frac{1}{2}(\frac{V-b}{a\sigma^2})} \quad , V \le b.$$

Which is Chi-square, with one degree of freedom for $z = \frac{V-b}{a\sigma^2}$

$$g(V) = \frac{-1}{a\sigma^2 \sqrt{2\pi}} z^{-\frac{1}{2}} \cdot e^{-\frac{z}{2}} \quad , z \ge 0$$

[1] See *Introduction to Mathematical Statistics*, by Paul G. Hoel, pg 123.

CHART 8

Calculation of E[U(V)]

$$E[U(V)] = \int_{-\infty}^{b} -e^{-\alpha V} f(-e^{-\alpha V})\, d(-e^{-\alpha V})$$

As $y = -e^{-\alpha V}$ is an increasing function of V then

$$f(-e^{-\alpha V}) = f(y) = g(V) \left| \frac{dV}{dy} \right| = g(V) \left(\frac{1}{\alpha} e^{\alpha V}\right)^{1}$$

and

$$d(-e^{-\alpha V}) = \alpha e^{-\alpha V} dV$$

Therefore

$$E[U(V)] = \int_{-\infty}^{b} -e^{-\alpha V} g(V) \left(\frac{1}{\alpha} e^{\alpha V}\right) \alpha e^{-\alpha V} dV$$

$$= \int_{-\infty}^{b} -e^{-\alpha V} g(V)\, dV.$$

Using the expression for g(V) from Attachment B, with $z = \frac{V - b}{a\sigma^2}$, and $a < 0$:

$$E[U(V)] = -\int_{0}^{\infty} e^{-\alpha(a\sigma^2 z + b)} \left[\frac{-1}{a\sigma^2 \sqrt{2\pi}} z^{-\frac{1}{2}} \cdot e^{-\frac{1}{2} z} \right] (a\sigma^2) dz$$

$$= -e^{-\alpha b} \cdot \frac{1}{\sqrt{2\pi}} \int_{0}^{\infty} Z^{-1/2}\, e^{-(2\alpha a \sigma^2 + 1)(z/2)}\, dz$$

$$= -(2\alpha a\sigma^2 + 1)^{1/2} e^{-\alpha b} \cdot \frac{1}{\sqrt{2\pi}} \int_{0}^{\infty} [(2\alpha a\sigma^2 + 1)Z]^{-1/2}\, e^{-(2\alpha a \sigma^2 + 1)(z/2)}\, dz$$

Setting $w = (2\alpha a\sigma^2 + 1)z$:

$$E[U(V)] = -(2\alpha a\sigma^2 + 1)^{1/2} e^{-\alpha b} \cdot \frac{1}{\sqrt{2\pi}} \int_{0}^{\infty} w^{-1/2}\, e^{-w/2} (2\alpha a\sigma^2 + 1)^{-1} dw$$

$$= -(2\alpha a\sigma^2 + 1)^{-1/2} e^{-\alpha b} \cdot \frac{1}{\sqrt{2\pi}} \int_{0}^{\infty} w^{-1/2}\, e^{-w/2}\, dw$$

$$= -(2\alpha a\sigma^2 + 1)^{-1/2} e^{-\alpha b}$$

[1] See *Introduction to Mathematical Statistics*, by Paul G. Hoel, pg 121.

Using total returns for large company stocks by month from 1926 to 1994, I calculated $\mu = 0.118$, $\sigma^2 = 0.0394$, and using R = 3.57 arrived at an alpha of 4.2. That's an alpha for returns. Chart 8 shows that you then translate that to an alpha for values by dividing by your beginning value.

Let's assume we have a line of business with the following statistics. The values increased again from \$100 to \$115 as in the first example. The sensitivity to interest rate changes has increased enormously, with a ± 3% change in interest rates reducing the \$100 by \$10 and the \$115 by \$35. We calculate values for a and b, for the two parabolas, one at the beginning of the year and one at the end, of $a_{t-1} = -11111$, $b_{t-1} = 100$, $a_t = -38888$, and $b_t = 115$. And we also need values for μ and σ for the interest rate distribution. Those were calculated based on ten-year Treasuries from 1950 to 1995. What results is a mean of zero, σ of 1%. Using a cost of capital of 13%, we get EUV_t = (1.22) (-0.00784) - 0.00956 and EUV_{t-1} $(1+c)$ = (1.057) x (-0.00853) = -0.00902. So what has happened? How do we interpret those? Well, the increased exposure to interest rate changes reflected in that higher first factor, the 1.22 versus the 1.05 shows that increased exposure translates into higher adjustment. The improvement due to the increased expected values is slightly more than the cost of capital. So the second factor is less negative. In combination, the increased risk outweighs the higher expected value and the index goes down. It decreases from -0.00902 to -0.00956. If you just did standard economic value added, it would look like value increased. However, once you adjust economic value added for the increased exposure to risk, you find it didn't.

In conclusion, there are three points I'd like to leave you with. Economic value added can be adjusted to reflect risk exposure by calculating the expected value of the utility of V. The most accurate method would be to run cash-flow models stochastically. The best method in my mind is to use closed form solutions, and they're obtainable using simplifying distribution assumptions.

MR. DURAN: I have a question for Alastair. This appears to be original research. Is this going to be published somewhere?

CHART 9

Calculation of α

Assume V is normally distributed with mean μ and variance σ^2. Then[1]

$$E[U(V)] = -e^{-(\alpha\mu - \frac{1}{2}\alpha^2\sigma^2)}$$

If the risk free rate of return is R:

$$E[U(V_0\{1+R\})] = -e^{-\alpha V_0(1+R)}$$

Equating, we get:

$$\alpha V_0(1+R) = \alpha\mu - \frac{1}{2}\alpha^2\sigma^2$$

$$\alpha = 2\frac{\mu - V_0(1+R)}{\sigma^2}$$

But in using the distribution of total returns on stocks we have assumed that $\Delta V/V$ is normally distributed and have calculated $\mu_{\Delta V/V}$ and $\sigma_{\Delta V/V}^2$. Now these means and variances are related by $\mu_V = V_0(\mu_{\Delta V/V} + 1)$ and $\sigma_V^2 = V_0^2\sigma_{\Delta V/V}^2$; therefore,

$$\alpha = 2\frac{V_0(\mu_{\Delta V/V} + 1) - V_0(1+R)}{V_0^2\sigma_{\Delta V/V}^2} = 2\frac{\mu_{\Delta V/V} - R}{V_0\sigma_{\Delta V/V}^2}$$

And since by similar calculations $\alpha_{\Delta V/V} = 2\frac{\mu_{\Delta V/V} - R}{\sigma_{\Delta V/V}^2}$

then

$$\alpha = \frac{\alpha_{\Delta V/V}}{V_0}$$

[1] See *REROSHE: The Concept of a Risk-Free Equivalent Return on Shareholder's Equity*, by Longley-Cook, *TSA*, Vol. XXXV, 1983; p 328.

MR. LONGLEY-COOK: It is original research and I'm going to pursue that. I'm very interested in feedback to this. I'd like to get this exposed and get some feedback from the actuarial community on it.

MR. DURAN: Great. Are there any questions for any of our panelists?

MR. STEPHEN N. STEINIG: Alastair, I have a question, I refer to all of this as "graduate level" economic value added. We've studied the use of "elementary school" value added. We have always had a hard time explaining to ourselves and to management the shifts from one year to another, particularly the shifts caused not by experience but by changes in assumptions. Do you believe the "graduate level" is the appropriate place to start because it gives you a more meaningful result?

MR. LONGLEY-COOK: We are at the elementary level, too. As I mentioned, we have implemented standard EVA in our individual lines. The result has been very positively viewed by management. Management was able to grasp what was being said, and learned a lot from the analysis we've done so far. What I talked about is only theory at this point. I hope that over time we can evolve to this. But I think it's something that we need to examine and see whether it really is useful, as opposed to just being theoretically satisfying. But, the more I think about major decisions made by corporations, and the ones we're making now, almost all involve decisions between two distributions of future earnings.

Let's assume you have a line of business that you decide to sell. You're trading a distribution of future earnings for a single point value. The problem is that a lot of decisions get made based on point estimates of the distribution. They ignore the upside and the downside potential of that line of business. You cannot evaluate the rightness or wrongness of point value decisions unless you do this kind of analysis. I would say that it's up to the actuaries and the risk managers to do this kind of analysis, and then report to senior management without getting too excessively involved in the details.

FROM THE FLOOR: I have a technical question for Alastair. In your formulas you define the total return as $(V_t - V_{t-1})/V_{t-1}$. What about the distributable earnings that occurred between those two time points? And if you revise the definition, would that effect your formulas?

MR. LONGLEY-COOK: Yes, I didn't get into that because I didn't want to get into standard EVA much. There are good articles on this. There's a good write up by Sue Collins in the February 1995 issue of *The Actuary*. In my example, I left distributable earnings for the year in V_t.

MR. ROBERT J. HONKOMP: If you are using the risk-adjusted economic value added approach as opposed to the standard economic value added, since you've already taken risk into account, shouldn't that influence the selection of discount rate?

MR. LONGLEY-COOK: Yes. In standard economic value added, you discount by the hurdle rate (as opposed to after-tax money rates, which is what you use in cash-flow testing). That's supposed to adjust for risk. As I mentioned, it doesn't do the right job. When doing risk-adjusted EVA calculations, it makes sense to use after-tax money rates for discounting.

MR. EDWARD C. JARRETT: Isn't your economic value added basically a distribution of the present value of distributable earnings, and not necessary an analysis of the distribution of the earnings over time? The distribution along the time span -- negative and positive periods -- as well as the present value, can be a very critical factor.

MR. LONGLEY-COOK: Yes, that's correct. These are all present values. Literally, you could end up looking at a series of distributions stretching into infinity and discounting all those back and adjusting those. Obviously, I haven't gone that route because we'd be back into the 20 PCs running all night. So that's a certain simplification. The question in my mind is whether these simplifications go too far and take away from the underlying precision. The next step is to try the method on various lines of business, and see whether those simplifications are good, or whether you lose underlying meaning.