

**1994 VALUATION ACTUARY
SYMPOSIUM PROCEEDINGS**

SESSION 10

Surplus Management

Charles D. Friedstat

Alastair G. Longley-Cook

David W. Carlson

Edward L. Robbins

SURPLUS MANAGEMENT

MR. CHARLES D. FRIEDSTAT: In planning for this session, I reflected that, over the past 20 years, surplus management in life insurance companies has been properly receiving increased amounts of attention. Twenty years ago, ratios of surplus to insurance liabilities or assets and early measures of risk exposure to surplus were the primary considerations for surplus adequacy. Comparison to surplus levels of peer companies was also common. Later, some of the more progressive companies began looking at the C-1, C-2, C-3, and C-4 risks and developing company specific required surplus formulas. By the late 1980s, use of these formulas became more common, and companies and regulators became more aware of the need for more surplus to maintain and grow their organizations. Surplus allocation among company lines of business also drew increased emphasis. A combination of an increased number of failures among life insurance companies, the growth of more complicated, riskier insurance products and investment vehicles, and the difficulty of accessing additional capital helped lead to regulatory requirements for cash-flow testing, risk-based capital measures, and likely in the near future, dynamic solvency testing. These subjects have all been discussed in detail at professional meetings, as well as possible strategies to increase surplus involving surplus notes, reinsurance, issuance of debt securities, and other measures.

This panel on surplus measurement will be different and will not deal with these subjects in the abstract. Rather we will view the surplus management process, at work in two highly rated companies -- one stock and one mutual -- and look at the similarities and differences in their approaches. Alastair Longley-Cook, vice president and corporate actuary for Aetna Life & Casualty will lead off. Next will be Dave Carlson, second vice president and actuary from Massachusetts Mutual Life. Ed Robbins, principal with KPMG Peat Marwick in Chicago, will discuss some recent research he has done in the area of risk theory applications to cash-flow testing and dynamic solvency testing, and give some implications of his findings to the surplus management process.

SURPLUS MANAGEMENT Practical Considerations

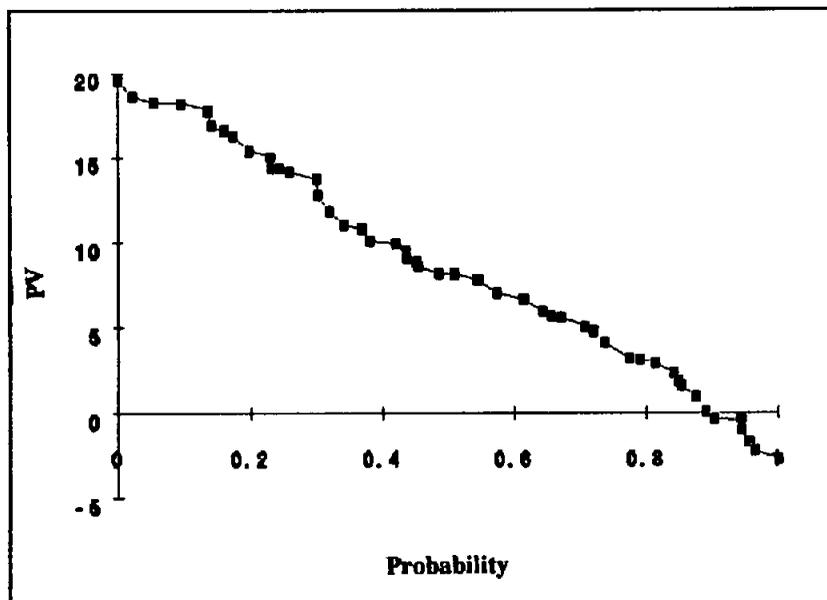
MR. ALASTAIR G. LONGLEY-COOK: When I was asked to speak about the practical considerations of surplus management, it was under the assumption that a large stock company like Aetna had grappled with these issues for decades and resolved the practical problems long ago. The first half of that assumption is valid; the second is not. We have made a lot of progress, but I cannot claim that all the practical considerations have been resolved. It may be helpful, however, for me to spend some time describing the problems and offering a pragmatic solution. As such, it represents my own thinking about large stock companies and does not necessarily reflect Aetna's position.

The problem can be described concisely as: How do you determine the appropriate amount of surplus for an insurance company and allocate it by line of business? It is a complex problem, and the solution is easier to describe than to implement. The theoretical solution, one you might find in a study note for instance, might read as follows:

1. Using asset/liability cash-flow models, stochastically perform dynamic solvency tests (or an "Analysis of Dynamic Financial Condition" as it is now called).
2. Rank present values of distributable earnings (PVDE).
3. Set surplus by line of business, S_i , equal to - PVDE for an acceptable percentile (e.g., 99%), and total required surplus, S , equal to $\sum S_i$.
4. Check interim values to assure no failures occur even when $S + PVDE > 0$.

For instance in Chart 1, with PVDE ranked in descending order, the negative value of PVDE at the 99th percentile becomes the surplus requirement for that line of business.

CHART 1



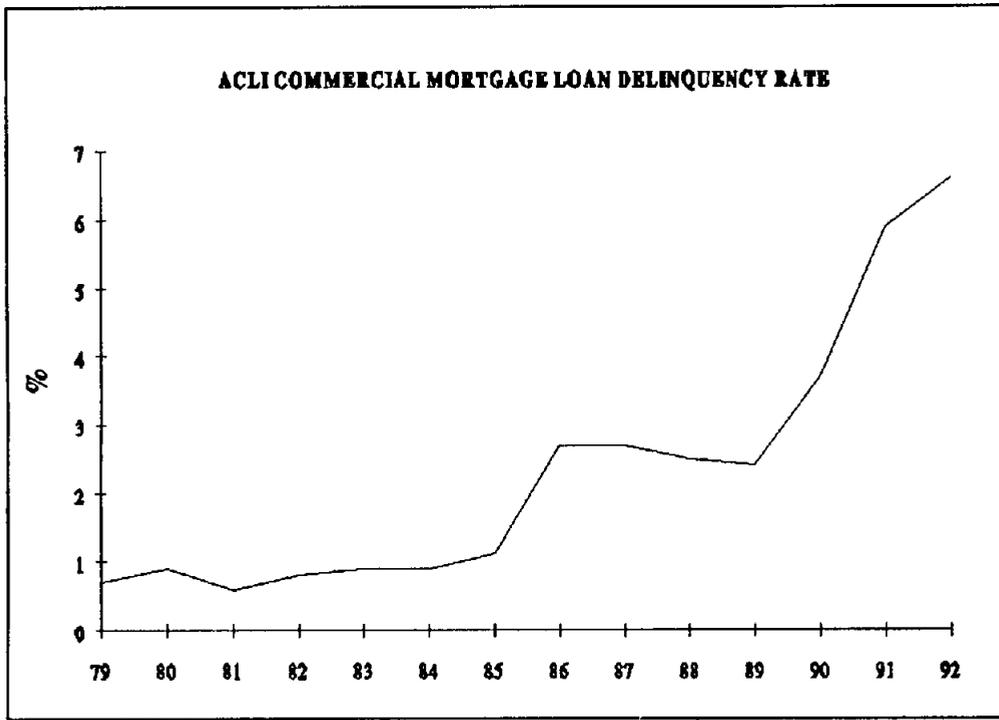
There are several problems with this theoretical solution:

1. Actual surplus, S , is likely to be determined by rating agencies and limits on ability to raise capital rather than internal analysis. Usually this standard is greater than the internal one, which is in turn greater than the NAIC Risk-Based-Capital (RBC) standard. These differences are due to differences in objectives: rating agency standards are heavily influenced by external perceptions and can be overly conservative in times of uncertainty; RBC is designed to identify troubled companies and therefore focuses on solvency-threatening events, not what companies should manage to.
2. This approach ignores synergy, covariance, and independence among different companies within a corporate cluster or different lines within a company. For instance, a corporation may find that rating agencies apply different, and inconsistent, standards to each company in the corporate cluster because of the affinity with the other companies. Such affinity could either hurt or help a

- company's rating. Also, what is bad for one line of business may be good for another, but the value of such synergy is hard to measure, let alone account for.
3. Communicating the results, and meaning, of such an analysis to senior management is often difficult. Senior management of a stock company, and Wall Street, are often more concerned with GAAP earnings than present values of statutory earnings. Management decisions will be made based on such analysis only if it is understandable and credible.
 4. Interest rates are not the only variables we should be concerned about, so the usual stochastic testing around interest rate movements does not span the universe of possibilities. We need to perform sensitivity testing to capture such variables as asset defaults. But what changes in other assumptions are comparable to the stochastically modeled changes in interest rates? The interrelationship between these variables is often intractable.
 5. It is the wild cards that often ruin companies. Life is not a random walk. Chaos Theory or Catastrophe Theory might be better than the linear, continuous view embodied in the models used for stochastic testing. Consider mortgage loan default rates. Chart 2 illustrates ACLI commercial mortgage delinquency rates from 1979 to 1992.

Imagine an actuary in 1985 choosing a volatility assumption for future possible delinquency rates. A 95% confidence level might take them to about 1.5%, certainly nowhere near where rates ended up in 1992. Even in 1989 the future escalation was unimaginable. Standard stochastic and sensitivity testing would have proven hopelessly inadequate.

CHART 2



6. As anyone who has done it knows, models are expensive and time-consuming to run. They are also very hard to validate. Even after all the runs have been performed, too few runs are in interesting areas: the tails.
7. The real world is fluid, but surplus standards cannot be continually revised to keep up with the rapidly changing exposures and circumstances. They are steamships trying to battle jet fighters.

A pragmatic solution employed by some companies to deal with such problems might involve the following:

1. Actual surplus is set by rating agency.
2. Internal standards are determined by a mixture of methods (e.g., risk theory, RBC).

SURPLUS MANAGEMENT

3. The difference is allocated or kept in a corporate account.
4. Performance is measured by ROE.

The following variation on this pragmatic solution addresses more concerns:

1. Assume that actual capital by legal entity (company within a corporate cluster) is a given, usually rating agency based. (Its determination in today's ratings-driven environment is solely a management decision as long as it is at least as great as internal standards indicate.) The goal then becomes equity in allocation by line of business.
2. Calculate PVDE for each line using in-force business only and "worst case" assumptions. "Worst case" is here defined as "possible but very unlikely."
 - For life and annuity lines use the asset/liability models used for valuation cash-flow testing but including required surplus.
 - For group health use current earnings (perhaps two years worth to allow time to raise rates and recoup deficits).
3. Set $S_i = -PVDE$ worst case. This is very different from stochastic testing. It lays bare the assumptions underlying the worst case.
4. Recursively adjust "worst case" assumptions until $\sum S_i = S$. Resulting assumptions are what the company is protected against. (Note that this method ignores synergy among lines, viewing capital as an investment rather than a shock absorber). There is a key difference between this approach and the usual proration or allocation to a corporate account. More information is available, information as to what the company is protected against that can be communicated to senior management or the rating agencies.
5. Add surplus for new business using the same tests. This is kept as a separate item in order to highlight the economic value added by new business. If it is negative, other alternatives should be considered. Finally step 4 can be repeated to line up to actual surplus including that required for new business.

If capital needs are analyzed in this way, the results can be used for several important purposes:

1. Performance measurement can be done two ways:
 - ROE. This is the standard investment view, but it should include the cost of capital.
 - Economic Value Added. By comparing PVDE at the beginning and end of the year, one can analyze changes by source: what was management responsible for and what was environmental?
2. Risk management can be facilitated. Exposing the assumptions underlying the worst case scenarios can and should lead to a discussion with management about the likelihood of those scenarios and what management can do to reduce exposures. Done properly the underlying assumptions of management's expected scenario can be challenged and complacency undermined. At the very least, concentrations of exposure can be discovered pointing management toward diversification.
3. Strategic planning can be based on disciplined analysis. As a result of economic value added analysis, senior management can determine the best use of capital. Ideally, capital can be allocated to those businesses or products that maximize economic value.

SURPLUS MANAGEMENT

MR. DAVID W. CARLSON: I work in the corporate financial area of Massachusetts Mutual Life. As a starting point, since my comments are going to largely reflect the process at my company, I think it will be useful in terms of giving perspective to provide some very brief background on our experience with surplus management. Over the last ten or so years, the process at Massachusetts Mutual has evolved from what I'd characterize as an essentially passive by-product of the pricing and earnings management processes to a point today that, while certainly not state-of-the-art, can fairly be characterized as prudently active and thoughtful. My notion is that this sort of evolution is probably not dissimilar to the manner in which surplus management has evolved at mutuals generally. My comments are, obviously, related most directly to the evolution and current state of the process at Massachusetts Mutual, but my sense, again, is that we're not atypical of mutuals as a group, so I'll be projecting some of my comments to mutuals generally.

One thing that was very apparent to me as I talked to others and did some background work in preparation for this talk is that surplus management can mean different things to different people. At the narrow end of the spectrum, it can be limited to identifying a measure of capital needs and using that benchmark for evaluating and managing the adequacy of actual capital. At the broad end, it's not too much of a reach to view the entire strategic financial management process as effectively a surplus management process. With full recognition that there's no right answer on the definition or scope of surplus management, my remarks will be broken down and organized around five interrelated pieces. I'll start out with a discussion of the strategic financial management framework, which provides a wrapper for the others, and then I'll spend a little time on each of the allocation process, defining surplus needs, structuring surplus in terms of the sources and costs, and finally, how you measure performance for surplus users, including setting return objectives.

And, again, the perspective will be that of a mutual company.

1994 VALUATION ACTUARY SYMPOSIUM

So, starting with the strategic financial management framework, I'll cover the context it provides, basic elements, and the role of surplus management.

It's important to view this framework as really providing the context for all of the other elements of the surplus management process. That is, a coherent and integrated surplus management process needs to have all of these other elements tie back to a similarly coherent and integrated strategic financial management framework. At a very high level, there shouldn't be anything particularly unique about this framework in a mutual company versus a stock. However, as we'll see pretty quickly, once you drop just below the highest level, you don't have to go too far before running up against the uniqueness of the mutual form of organization.

Staying at the highest level for a moment, the elements of the framework are obviously going to vary, but in one form or another, the keys are going to include context development and specific strategy components. At my company, the very high-level direction setting and context development comprises mission and vision statements that make clear why we're in business and where we want to be headed; environmental and competency assessments identify what's happening in the world that affects our business and what we're good at, respectively; and there's a high-level financial framework. Obviously, this is where surplus management comes into play, which I'll discuss in more detail.

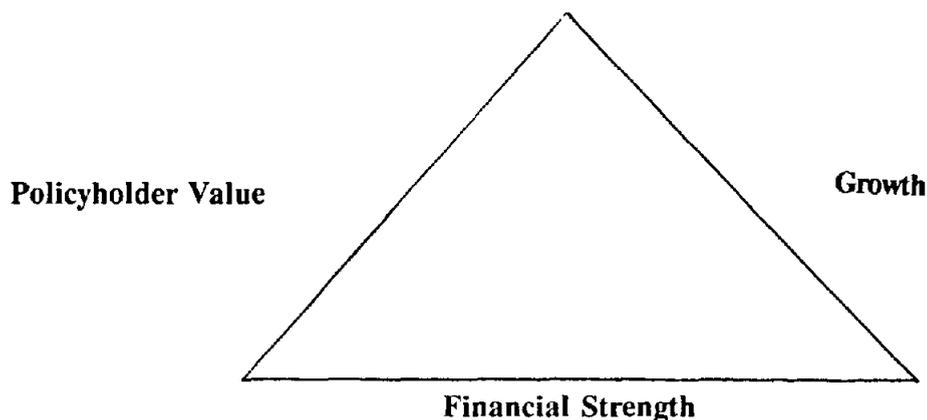
The specific strategy components comprise identification of discrete business units, market identification and evaluation, specific measures and objectives, tactics for meeting those objectives, and a clear tie to the high-level financial framework.

In whatever form this financial framework takes on, it seems clear that surplus management is going to be at its core. At Massachusetts Mutual, we've used this schematic (Chart 1) to portray our long-term financial management framework for the last couple years, and it has proven very useful as a vehicle for both

SURPLUS MANAGEMENT

characterizing our objectives and priorities and setting the context for all of our strategic financial planning. We could spend a lot of time on uses and dynamics of the triangle, but for purposes of this discussion, the key thing to note about it is that it provides a way of focusing the inherent tradeoffs for any mutual company. It's at this level that the uniqueness of the mutual form hits home. Although a stock company clearly worries about all three of these things, my sense is that the overriding driver that's vividly above all of them is the maximization of shareholder value. For better or worse, the policyholder or owner structure of mutuals means that that overriding driver doesn't exist, and mutual company managements and boards have the luxury or curse, depending on your perspective, of defining something else as the fundamental driver. While arguments could be made for any one of these three as the single substitute for shareholder value, the triangle embodies my company's decision to be driven by active management of the interaction between them rather than any single one. The central role of surplus in managing these tradeoffs is obvious: at a simple level, surplus is the source of funds for all three sides of the triangle, and in that sense the financial management framework represented by the triangle can be viewed as the vehicle for bringing surplus management into the strategic management process and vice versa. Furthermore, the triangle also helps focus the fact that the more predividend earnings and surplus growth you can generate, the bigger the reservoir of funds available for managing the growth/strength/value tradeoffs.

CHART 1



In bringing the high-level framework into play in actively managing the direction for the company, the classic first step is the process of allocating capital both in terms of identifying how the current capital base is used and in planning future direction regarding the use of capital. We'll look at that here in terms of quantifying uses, ordering opportunities, and the evolution of the process at mutuals.

In identifying and quantifying users of capital, the use of a risk-based assessment of the capital needed to support a given segment is becoming well-ingrained at my company, and my sense is that this is true for mutual and stock companies generally. I'll be commenting on risk-based formulas and other quantification tools more fully shortly, but in the context of the allocation process, it's important to make brief note of the issue. Specifically, although it's easy to identify the need for a risk-based measure of usage, there are many practical and philosophical issues that arise. There are no right and wrong answers to those issues, and the results and message in terms of strategic management of the company can be significantly influenced by the answers. There are several issues we've run into: what should the risk-based formula be; what multiple of baseline need should be used in quantifying allocations; should the multiples reflect differences in marketplace needs for financial strength; and should the allocations be on a marginal or proportional basis?

Although answering these questions is clearly more art than science, the way they're answered can have a significant impact on the picture created in terms of capital allocations. We have an example in our company where, because we're using a variation of the NAIC formula including its covariance adjustment, use of a marginal allocation method would result in one line appearing to use virtually no capital because our current C-1, C-2, C-3 mix results in increments in this line being largely correlated away. If we blindly followed such an allocation, our strategies would be to grow this business at all costs since any return on the apparently minuscule capital allocation would be huge on an ROE basis. Although the formula certainly isn't

wrong in rewarding diversification of risks, we've actively decided to moderate that sort of effect as we've defined our allocation quantification tools.

The main point is that, although quantification of risk-based need in some form has to be a part of the allocation process, large elements of professional and common sense judgment are still going to be required in using the results to manage the company.

Once current capital allocations are quantified and the universe of strategically acceptable opportunities for growing, sustaining, and exiting current businesses and entering new ones are identified, a rigid quantitative process might call for deploying capital to the most attractive opportunities first, and working your way through the list until the capital is used up. Clearly, there is going to be a lot more to the process than that, even in a publicly owned company with a vivid focus on maximizing shareholders' ROE. Most important, although the line isn't clearcut, some sort of distinction needs to be made between core businesses that are central to the execution of the company's strategies and peripheral opportunities that start to look more like investments. For core businesses, the judgment on appropriate capital allocations will be an integral part of the company's overall strategic plan, not a simple risk- or return-based comparison with other investments. On the other hand, as you move along the spectrum from clearly core activities to activities or opportunities that are peripheral to the strategic plan to activities that start to look like simple investments of capital, the manner in which you evaluate those activities should look more like the sort of straight risk/return analysis that would be used for any nonstrategic investment.

At the risk of overgeneralizing, I think it's fair to say that mutual companies in general have not historically been active in understanding and managing the allocation process, but that is changing for a number of reasons.

1994 VALUATION ACTUARY SYMPOSIUM

It's not worth spending a lot of time on this historical less-than-proactive management of the allocation process, but I think it's helpful in terms of providing perspective on the changes of the last few years to briefly note the attributes of the mutual form that fostered the relatively passive approach.

The lack of external pressure from public or private owners with a clear financial stake in performance is well-recognized and understood.

In turn, this lack of owner-driven pressure can be viewed as having left no imperative for aggressively and actively reviewing the attractiveness of various users of capital.

And finally, I think it's reasonable to say that there has been a large amount of inertia around the necessarily core traditional life business that dominated the product portfolios and balance sheets of mutuals, and that inertia often made the question of actively evaluating the grow/sustain/scale back/exit decision essentially irrelevant.

Clearly, much of this has started to change in the recent past. Although the form of ownership is still the same in most cases, it seems clear that there is a trend towards more active, conscious, and aggressive evaluation of the users of capital. There are many well-recognized reasons for this in terms of product and marketplace changes, changes in the broader financial services industry, the aftermath of the early 1980s extremes in interest volatility, and increasingly sophisticated financial management. Most recently, the asset-quality-driven focus on capital levels has heightened awareness even more, but that focus is best viewed as the latest stage in a process that has been building for some time rather than a dramatic change in direction.

The last point I'll make on the allocation process, and it ties back to the earlier discussion of the overriding importance of an active strategic financial management framework, is that that framework is crucial for providing the right context for an

active allocation process. Using my own company as an example, while the analytical tools for identifying users of capital and assessing their effectiveness have been evolving for some time, it's only in the fairly recent past that the strategic wrapper for using those tools has started to provide the right context for making the most of our analytical capabilities. We're by no means at the end of the line for a lot of reasons, but the basic structure is in place, and there is a fairly clear commitment to making the process work in a way that will help ensure the company's viability and vitality going forward.

Turning to the issue of quantifying surplus needs, the mechanical aspects of identifying risk-based requirements are increasingly well-ingrained across all companies. Massachusetts Mutual has transitioned from using our own formula as the key quantification tool to using the NAIC formula in two forms, one with a couple of modifications and one without. Although the clear stance of anyone commenting on the NAIC formula is that companies should use their own since the regulatory one is aimed at a purpose different than managing a company, we've effectively ignored that chorus. First, the necessarily subjective nature of much of what lies behind any such formula means that there's no right and wrong answer as long as the formulas are rational. Second and more important, for better or worse, we need to be mindful of the NAIC results in managing our financials whether we use them as our definition or not; so we decided to avoid having two different formulas. I think it's well-understood that many other companies are using the NAIC formula in one way or another.

The possibility of extending the models used to do reserve adequacy testing to identify adequate capital levels for existing business is, in my mind, a very reasonable and straightforward exercise. In interpreting the results of our reserve models, we've used a probability threshold to define statutory adequacy, and at a simple level, all you're doing when you extend that to evaluating capital adequacy is increasing the threshold probability, and thus the level of assets that you're looking for. We've

done some of this already at Massachusetts Mutual. However, limiting the exercise to existing business is a much different issue than bringing prospective strategies and business growth into the picture. I'll address that in a moment.

Jumping back to formula-driven measures, a key issue, which is vividly focused when you're using the NAIC formula, is the multiple of baseline need that you manage to. This is another point where a well-defined strategic plan should provide the right context for sorting the question out. If that plan includes in one form or another statements regarding the importance of such things as ratings, policyholder or owner expectations, perceived financial strength in your target markets, and public perceptions generally, then the context for defining an objective for the multiple is there. Again looking at Massachusetts Mutual, our very high-level belief statements include a vision of unquestioned financial integrity, which leads us very directly to the general ballpark in which we should be targeting our NAIC multiple.

Beyond the mechanical approach of defining risk-based need in one form or another based on a point-in-time snapshot of current risk exposure, the Academy's initiative of a couple years ago put on the table the idea of extending asset adequacy analysis tools to evaluate current surplus in the context of current risk exposure and the future direction of the company. Although the jury is still out on how far the idea of developing a rigorous quantitative report to management on surplus adequacy can be taken, I believe that the starting premise -- that is, that regulators, actuaries, and in particular, company managements need to be forward-looking not only in terms of current risk exposure but also in terms of business plans as they evaluate surplus adequacy -- is right on target. That premise reinforces the point that the quantitative aspects of surplus management, including needs definition, need to tie back to the big-picture strategic wrapper.

For mutuals, when you tread into this area, you very quickly run into the unique series of tradeoffs I alluded to earlier under Massachusetts Mutual's high-level

SURPLUS MANAGEMENT

financial management triangle: Who is the company being managed for in terms of value to current policyholders versus building strength for the future versus building surplus to fund growth? The triangle doesn't, obviously, provide any silver-bullet answers, but it does, again, provide a framework for focusing the issues.

In terms of how Massachusetts Mutual's actual processes bring strategic planning and quantitative analyses together in judging surplus needs, we certainly aren't near the sort of all-encompassing stochastic or multiscenario sort of analysis contemplated by the initial Academy paper. However, we do use reasonably rigorous five-year financial plans that are developed in concert with strategic plans to accomplish much of what the Academy paper contemplates. Although it's done one line of business and one or two scenarios at a time, the iterations we go through in trying to get to a total company strategic financial picture, including current surplus needs that fit together in a coherent manner, provide management with the sort of informed picture that would be created under the Academy approach.

Turning to the issue of surplus structure, my notion, heavily influenced by the activities of my company in the recent past, is that this is an aspect of surplus management where there has been much recent progress in terms of mutuals moving into corners of the world of finance that most of the financial services world, other than mutual insurers, has been in all along. I'll touch on general structure issues, sources, and cost analysis, and note increased mutual focus.

Clearly, the issue of surplus structure in terms of sources and costs has not historically been an explicit consideration for mutuals. With the capital raising essentially limited to retained earnings, the sort of capital structure analysis employed by much of the rest of the world didn't apply. The key challenges have been, going back to the triangle again, to balance value provided to current policyholders with retaining funds for strength or growth, and to maximize predividend earnings

1994 VALUATION ACTUARY SYMPOSIUM

available to split up among these three sides of the triangle. This is why surplus management and earnings management have historically been interchangeable.

Although there is an element of capital structure evaluation implicit in a proactive process for evaluating options for maximizing earnings, it's fair to say that, for the most part, traditional source and cost-of-capital analysis has been foreign to mutuals.

I've broken recent efforts by mutuals to move beyond retained earnings as the sole source of capital down into two categories: actions that can be viewed as effectively revealing capital for regulatory purposes that already exists from an economic point of view, and actions that involve accessing truly new outside capital. The line between these isn't quite as clear as it's portrayed, but the key is that the sources in the second category represent truly new funds that come in a regulatory capital form based on the capital markets' perception of the future prospects for the company. The only one of these that I'll mention in any detail is the one that has been the source of much activity and attention over the last year or so, mutual company surplus notes. Massachusetts Mutual and a handful of other generally large companies took advantage of ideal market conditions in terms of absolute rates, spreads, and market appetite for insurers to carry out roughly ten transactions late in 1993 and early in 1994. In our case, we actually did two transactions for a total of \$350 million, representing just under 15% of our total surplus. Surplus notes clearly aren't the answer for everyone, but with the right market conditions and a company profile that the markets will find attractive, they're the prime example of creative new sources in structuring surplus.

Turning to the cost side of the capital structure issue, the costs associated with internally generated funds can, as I alluded to before, be viewed as being an implicit, admittedly deeply buried, part of the processes through which divisible surplus is determined and predividend earnings are managed or maximized.

For the newer, more creative sources, it seems clear that the cost-of-capital analysis needs to be similar to that used by other financial institutions in judging the optimal capital structure. It would clearly overstate reality to say mutuals as a group are now generally involved in this sort of active evaluation of optimal capital structure, but the evolution in that direction seems fairly clear. My company is probably a good example of one that has moved moderately in this direction, having done a simple but classic cost-of-capital versus expected-benefits analysis to get comfortable with adding the 15% to our capital base in the form of surplus notes. And, following through on our experience in that transaction, we have a new perspective as we look at other capital structure options in the context of our strategic and financial management framework.

In terms of companies that have moved further along the spectrum, the Equitable example would seem to represent the end of the line when you consider the financial gymnastics it went through to eventually get to its initial public offering (IPO). I think it's important to note, though, that as evidenced by the number of companies doing surplus notes, divesting of lines of business, and so on, there is a lot that can be done in terms of creative capital analysis and structuring that falls far short of the demutualization scenario.

The last aspect of the surplus management process that I'll touch on is the issue of measuring performance and setting return objectives. Although there are no easy answers, this aspect of mutual surplus management is probably the most straightforward of those I've discussed. On the measurement side, it seems clear that an active strategic management and surplus allocation process is going to ultimately require a meaningful ROE measure. It could be earnings related to some base other than allocated capital, but ROEs fit in most directly with the idea of managing the effectiveness of users of the equity base. The difficulties here are well documented in terms of both identifying a meaningful earnings measure and settling on the right equity mutual GAAP may help some, but the jury is still out on whether this will buy

us much, especially when you consider it in light of the cost of implementation. The adjusted statutory numbers that many mutuals use already can also be useful, but the bottom line is that the difficulties associated with getting the right earnings measure mean ROE results need to be used with caution.

In terms of setting objectives for whatever measure is identified, it seems clear that a rigid hurdle rate for all opportunities is generally not going to be appropriate. Tying in to growth rates is a possibility that would fall out of a well-integrated strategic financial planning process. An additional possibility by itself or in combination is to use relative objectives. My company has spent quite a bit of time in this area, with the idea being to replace investor expectations with an indication of "best of class" or top quartile. The difficulty we've encountered is probably no surprise -- finding meaningful, consistent data to compare to -- but we're comfortable at this point that it makes most sense to define return objectives on a relative basis.

In summary, as I indicated at the start, surplus management can mean different things to different people. It seems clear, though, that regardless of how you look at it, the approach of mutual companies in general is evolving quite rapidly, and the environment is such that that evolution can be expected to continue for at least the near-term future.

SURPLUS MANAGEMENT

MR. EDWARD L. ROBBINS: I think that every so often some of us older actuaries need to get into a good technical research project, just to clear out the cobwebs. I just finished a fascinating project in collaboration with Sam Cox. Sam is an FSA on the faculty at Georgia State University. We tackled a problem that has been expressed to me more than once from corporate actuaries of large life companies. And let me express the problem.

You're running, for example, 100 stochastic cash-flow-testing scenarios, and it's easy to feel good about where the location of the distribution is. You can even get a feel for the standard deviation when you run 100 stochastic scenarios. The difficult thing to understand is the characteristics of the tail of the distribution. You'll run 100 scenarios and maybe 97 will be successes, three will be failures. That doesn't tell you a lot. And yet, the adverse tail, or what I would call the ruin tail, is the really interesting part of the distribution. The tail is arguably what you're really trying to understand.

Anyway, spoken in more statistical language, it's the area under the tail that you're really interested in. And then perhaps in the second step, you try to change your strategies and run things again to see if the area under the tail has been reduced.

Often, if you mention this to an actuary, you'll get the reaction, "So why can't you just run a bunch of stochastic scenarios? Say, run 10,000 of them and get enough credible hits in the ruin tail. Well, the problems with that are several. One is, of course, the enormous amount of time and cost involved. And the other is that you might be working with a difficult variable. The typical variable, the simple kind that you might be looking at, is "present value of distributable earnings." But you might be using another variable that's more difficult to handle with stochastic approaches.

For example, your variable might be "the lowest risk-based capital multiple over the first ten years of the time horizon." That is, you're measuring the low water mark on your multiple over the first ten years. There you have a bunch of subsets of the tail. You have the "company action level event" and so forth down the line. And you have even less credibility now that you're looking at the credibility of various bits and pieces of the ruin tail.

By the way, while we're on the risk-based capital issue, let's spend another moment on it and talk about how it relates to the so-called dynamic solvency concept (now known as the dynamic financial condition concept). The Dynamic Solvency Task Force initially identified eight areas of additional research necessary to support the efforts of the actuary. And the task force members have narrowed it down to three major areas. The third area of the three is credibility/reliability. Two of the questions that were put forth in this area were, "How much confidence can you place in a model?" and, "How credible are various measures of financial condition sensitivity or solvency?" Well, in this presentation we're really attending to the second point. Let me repeat it. How credible are various measures of financial condition sensitivity or solvency? So the Dynamic Solvency Task Force was very interested in this area of research. And what I'm reporting on speaks to that issue.

An important point I want to stress is that, once you're at the point of being close to regulatory intervention by means of the risk-based capital thresholds, arguably you are ruined. You have the runs on the bank. You have shut-downs of sales. And the regulator is camping out on your door. Thus, you have some real problems. What Sam Cox and I have been attempting to do is to use the information from the entire distribution of cash-flow-testing scenarios (we ran 100 stochastic tests initially) and basically fit a curve to it, a continuous and differentiable probability density function.

And the set of requirements that we put on such a curve is that it must replicate the first four moments of your pragmatic distribution. The pragmatic distribution is the

distribution you get from 100 stochastic scenario runs. If the first four moments, respectively, of the probability density function you're creating equal the first four moments of your pragmatic distribution on the variable you're testing, you have a pretty good fit. Sam let me in on a conventional wisdom secret among the scientific statistical actuarial community. And that is, once you've achieved accuracy to the four moments, you have a pretty good fit. You can go out to five or six and get a better fit. But four moments, if you consider that your curve is more or less shaped like the distribution that you have, will probably give you a pretty good fit.

These are the characteristics of the first four moments. The first moment gives you the mean. The second moment fixes the variance and standard deviation, in other words, the spread of your distribution. The third moment gives the direction of skewness, if you have a skewed distribution. And the fourth moment gives the degree of skewness. Anyway, those four moments were about as far as we went out in our work. We could have gone further if we had wanted. Well, I've been talking in generalities up until now. Let's cut to the chase. What did we do? What were our objectives? What did we accomplish?

Well, first, our objective was to figure out, if by means of the application of risk theory approaches to curve fitting of a pragmatic set of stochastic cash-flow-testing distributions, we could get reasonable estimates of the characteristics of the ruin tail. One of the hoped for building blocks we wanted to use was the assumption that the success part of your curve tells you something about the ruin tail, also. You can use some of that information to get a better fix on the ruin tail. Basically we were dealing with the following statistical environment: credibility in the success part of the curve, lack of credibility in the failing part of the curve. With that situation we felt that we could get some pretty good results from our approach.

Then, second, we fit a probability density function to it. The probability density function that we thought might fit the best is something that looks somewhat like

your typical present value of surplus type of curve. We used a single premium deferred annuity and ran 100 scenarios. We ended up using a gamma density function. The gamma density function looks like a mirror image of the distribution of present value of surplus. The gamma distribution is skewed to the right, while present value of surplus is skewed to the left. So by a mere transformation of the variable we felt we could get a pretty good fit from what we call a weighted average of gamma distributions.

We ended up redefining the variable. The new variable starts with obtaining the maximum present value of surplus (Chart 1). And we figured that, based on the stochastic runs that we did, you could pretty well estimate a maximum present value of surplus. You can only make so much profit, but your losses can be very skewed to the left. And in what we did, we used a value of \$15 million based on what we saw as the maximum present value of surplus. We did a little transformation, and now we have something that looks like a gamma distribution skewed to the right. The new variable is now \$15 million minus present value of surplus.

Let's take a look at the gamma density function (Chart 2). Your simple gamma density function has two constants, that is, two parameters, lambda and alpha:

ATTACHMENT A

$$f(x) = \frac{e^{-\lambda x} \lambda^{\alpha} x^{(\alpha-1)}}{\Gamma(\alpha)}$$

CHART 1

Distribution PV Surplus

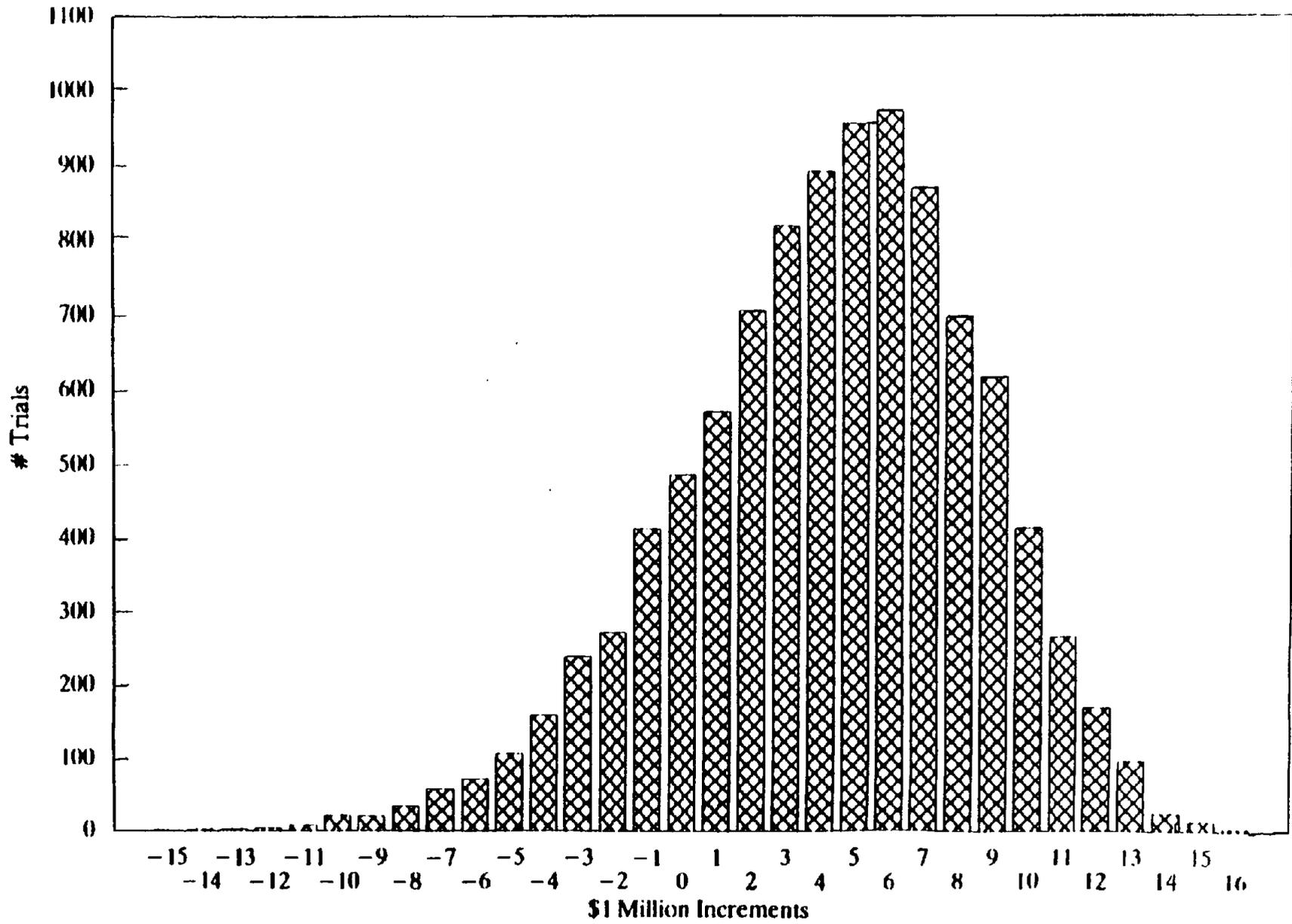
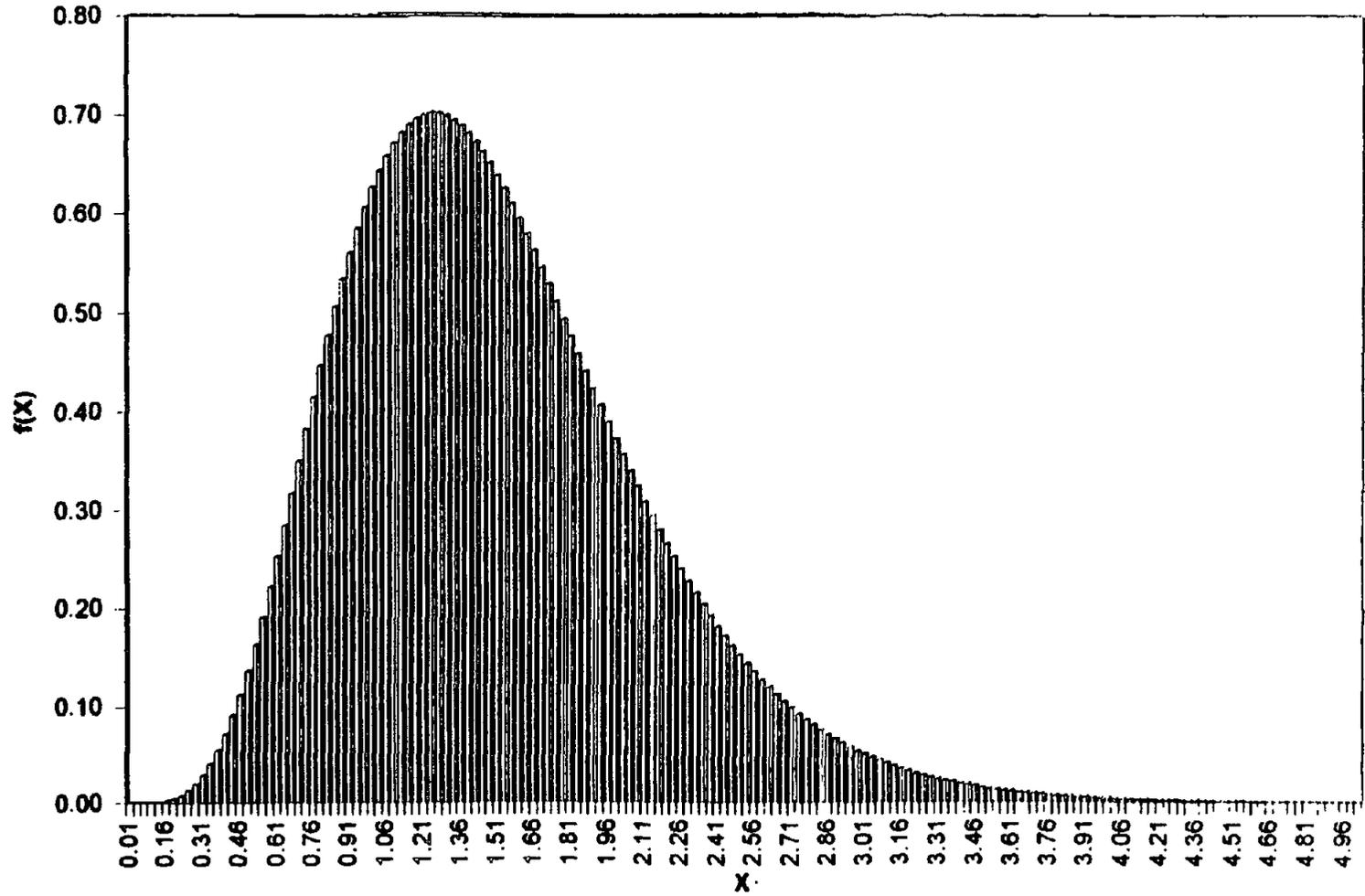


CHART 2

Gamma Distribution



And by expanding that into a mixture, or blend, of gamma density functions, you end up with as many parameters as you want, i.e., accuracy to as many moments as you want. So, for example, just take a blend of two gamma density functions, the first function of X times P1, plus the second function of X times P2, where P2 is 1 minus P1. This gives us an alpha and a lambda in function one, and an alpha and a lambda in function two. What that means is, you can actually then calculate the first four moments of your pragmatic distribution of 100 scenarios, and you know that the K-th moment of your gamma probability density function looks like that:

ATTACHMENT B

$$E[X^k] = \frac{(\alpha + k - 1)^{(k)}}{(\lambda^k)}$$

And with the blended gamma density function, the K-th moment is P1 times this item, plus P2 times the other item.

The "upper K" in parenthesis is not an exponent. It's the old "Part 2" declining product expression. In other words, E of X squared is alpha plus one times alpha over lambda squared. Now you have your four moments. Think of four equations, that is, equation number K, and K going from 1 to 4. You've got your pragmatic K-th moment on the left, and that equation on the right. You've got four equations and four unknowns. And you can solve them. It's not as easily solvable as a

polynomial, but you can solve them. Excel has a "solver" routine, and you can also develop your own types of calculators that solve for those four equations and four unknowns. This solves for the parameters that will obtain for you the first four moments that you want.

As a matter of fact, I'm going to go back just a bit here for a moment, you can even make P_1 a variable. And now you have five parameters. P_2 is 1 minus P_1 . So you could solve for five moments in that same form.

That was our approach using the gamma density function mixture. We also tried an approach that some of you might remember as the Esscher approximation and Edgeworth series. I'm not going to slog through all the complexities of the Esscher approximation, because it's rather lengthy and complex.

But these are the basic three steps. You transform your probability density function into a new probability density function and you have F' . You know the cumulative distribution function of A , in other words, the probability that your variable is going to be less than or equal to A . And if A is the point you're measuring, you solve for a transformed distribution F' , such that A is the mean in the distribution F' . You calculate F' of A under what they call the Edgeworth series. Then, once you get F' of A , there is a transformation linkage to go back to F of A . We were able to derive the series of transformations.

Let me just take a moment to discuss the Edgeworth series. The Edgeworth series is an ingenious device. It calculates the cumulative distribution function of any variable, in terms of the normal distribution and its derivatives, and the successive moments of the distribution that you're looking at. You don't need to know the probability density function of your distribution. You just need to know the successive moments of that distribution for the number of terms of the Edgeworth series that you want. The Edgeworth series is not a rapidly converging series. As

a matter of fact, it's not a completely converging series at all. But the Edgeworth series for a value of a variable A , where A is pretty close to the mean of your distribution, gives pretty good results with just about two or three terms.

So one of the elegant properties of the Esscher/Edgeworth approach is you never have to fit a probability density function to it at all. All you need are the successive moments of your pragmatic distribution, and get your spreadsheets going. We also looked at an approach called the normal power method, which I won't go into in detail. Sam Cox did most of the work on that. But it really requires only what the Esscher/Edgeworth approach requires.

Let's get away from the formulas for a moment, and just show you some results. Table 1 on the left, is my transformed variable. The \$15 million here really means zero surplus. Remember that we're looking at present value of distributable surplus, and \$15 million minus that present value is basically the variable that we're working with. So if you'd like to, you can write in a zero next to the 15,000, and a -7,000 next to the 22,000, to give you a present value of surplus X -value.

We ran 10,000 scenarios, in order to obtain a so-called "true" F of X , to measure against the alternative approaches. And you'll notice that, once you get up to the very high probabilities of success, it gets pretty accurate. Right around the \$15 million point it's not quite as accurate as one might like. And we figured if we had gone out maybe two or three more moments, we could have nailed it. We could do that.

I'll make the statement that these techniques are not as much forecasting devices as much as they are indicators of differences in results between different sets of input. Of course, the input differences can be due to either experience assumption differences or strategy differences. In any event it will show us to some extent the differences in ruin tails between different strategies. So, for example, you could take

TABLE 1

x	"True" F(x)	Gamma Blend	Esscher	Normal Power
15,000	0.86	0.83	0.82	0.83
16,000	0.90	0.87	0.86	0.87
17,000	0.93	0.91	0.90	0.91
18,000	0.95	0.93	0.92	0.93
19,000	0.97	0.95	0.94	0.95
20,000	0.98	0.97	0.96	0.97
21,000	0.98	0.98	0.98	0.98
22,000	0.99	0.99	0.99	0.98

a 40-scenario stochastic run, and find the areas under each risk-based capital threshold for your first set of runs. Then, next step, change your strategy. It could be investment strategy, interest crediting strategy, whatever. Then rerun your stochastic scenarios using the same random beginning number. And take a look at how the picture may have changed, how you improved the picture.

We've been into the era of the valuation actuary for a few years now. And we're arguably still in the stone age when it comes to the total predictive value of cash-flow testing. Additionally, the predominant input variable is the set of new money interest rates. We haven't been varying the other variables to any great extent at this point. Additionally, as Alastair indicated, it may often be the wild card, the nonstatistical events that could cause a company to go under. We realize all that. But we think this ruin tail analysis could be pretty useful in attempting to understand the dynamics of how likely a company would be to get into trouble. We may not be quite there yet, because the underlying variables might not be behaving in a realistic manner yet inside our models.

We're particularly interested in how the rating agencies might respond to this type of analysis. It would appear that they should be vitally interested in a company going through the exercise once, then changing its strategies and showing the improvement. It should be directionally pretty good.

To some extent as Sam and I embarked on this project, we had no idea whether the concepts we were working on had any merit at all. And to that extent we were somewhat pleased with the final results. One of the things Sam did part way through the project was to see what kinds of research had been done on the subject before. And he found out two things in particular. Number one, the normal power series approach has been used in property/casualty work fairly extensively. Number two, Europe is ahead of us in this exact area. European actuaries are using this type of technique right now. So I'm not sure whether that was good news or bad news for our efforts. It certainly indicates that the pursuit of the subject matter is worthwhile.

MR. MICHAEL E. MATEJA: Listening to the speakers' comments made me think that it's déjà vu all over again. I think I've been dealing with this general subject for about as many years as I care to remember. One thing that was conspicuous and left out of all the comments or considerations about surplus is what I would call management risk. We used to call it management error or mistake. Now I think of it as management stupidity. All of this is really impossible to put into any formalistic kind of approach. But I think when you factor in wild cards, which I agree is a relevant issue, and throw in management on top of it; you have considerable difficulty in terms of finding a discipline to help you control this whole process. I once had an opportunity to discuss the idea of a management factor in this, and I dare any actuary, corporate or otherwise, to go to his or her management and say: "I've got a scale of one to ten here, where do you put yourself in terms of competency?" With that I'll bow out.

MR. LONGLEY-COOK: I think that's an excellent point, Mike. And that's exactly the problem. You can't derive a formula or figure to management competency. You certainly wouldn't want to for your own interest. But I think when I'm talking about wild cards and the use of assumptions different from what has been used, I'm trying to get at that. I think you can talk about management being either more or less competent. But that's something beyond our control. What we can control is how much management understands the risks that it's running. And I think if actuaries are to blame for company failures or problems, it is in the area of relying too much on the past and projecting that past, and not challenging both the investment managers or other managers to take another look at the underlying assumptions. You can go ahead and put all your investments in CMOs, but if you do that and if interest rates drop, here's what happens to prepayment rates. Also, what happens to your reinvestment? And through that kind of discussion, maybe you can provide for a type of awakening that can perhaps prevent a management error.

I realize I'm sounding extremely naive. That's not the way those discussions usually go. The way those discussions usually would go is, "Don't confuse me with the facts." That would be the response to that kind of discussion. But I still think it's our duty. That's why I keep coming back to the point that coming up with a regulatory filing is not the end product of what we're spending our time here in either reserves or surplus management. It's trying to open up lines of communication with management people, so that they can manage better.

MR. FRIEDSTAT: I think that's the key issue. Regardless of how management people rate themselves, if they could be objectively rated from one to ten, if we can give them more information in a way that they can understand and which would improve their decision-making power, whatever their abilities are, that's really the goal of strategic surplus management.

MR. C. PHIL ELAM: Could you elaborate on how you would measure economic value added?

MR. LONGLEY-COOK: There are a couple of papers and good material on this in a study note. What I'm using here is basically a change in present value of distributable earnings where you have built in surplus requirements and new business. Therefore, you are really looking at a picture of what your line of business, your company, or your legal entity is worth at the beginning of the year and the end of the year. How much has that changed? Some of that change may be due to different interest rate assumptions or other assumptions. If you hold some of those assumptions fixed, you can see what's causing the rest of that change.

This is a method of accounting that's used quite a bit in Europe, and is being used in this country by companies that are owned by European companies. Not surprisingly, it is one that a number of companies are experimenting with, and I personally hope to see a lot more use of it in the future. I think the main problem

1994 VALUATION ACTUARY SYMPOSIUM

with the approach is that it relies on assumptions with regard to future variables that could be very sensitive. Also, present values are a difficult concept to communicate to senior management. That shouldn't keep us from working with it and learning from it, and I think using it is a much better measure of performance than return on equity.

If you are a stock company like Aetna, then most performance measurement is based on return on shareholder equity on a GAAP basis, over one period of time. And that has a lot of flaws. It's very short-term oriented and not risk adjusted.