1987 VALUATION ACTUARY
SYMPOSIUM PROCEEDINGS
SESSION 1 AND SESSION 2

CASH FLOW ANALYSIS TECHNIQUES

(TEACHING SESSION)

VALUATION CONCEPTS

Forms of Risk

MR. GREGORY D. JACOBS: Today we will talk about the valuation actuary concept, and when you leave this session you'll be an even better Valuation Actuary.

The first topic I want to talk about is the forms of risk. The Valuation Actuary's job is to analyze the risks that we undertake in the insurance business and the way we need to deal with them in setting our reserves. We're going to talk about three forms of risk: C-1, C-2, and C-3. The types of risks we face in the insurance business are the following.

1. Interest rate duration risk -- We know it as C-3. This is the main risk we're going to try to tackle today. Simply stated, an insurance company can be selected against when interest rates move. This anti-selection may cause a block of business to be unprofitable that was originally profitable, meaning that the assets backing the liabilities are not sufficient to cover the risk.

For example, we have the Single Premium Deferred Annuity (SPDA) funds that are being backed by the Government National Mortgage Association (GNMA). If it is properly matched -- that is, durations are equal, which we'll talk about -- this is a profitable situation in a constant yield curve or constant yield environment.

First, what if interest rates increase? The SPDA durations are short and that's because people lapse. Depending on the interest crediting strategy, there may be a run on the bank, making lapses move to higher levels than originally anticipated. If you go through a duration calculation, you end up with a shorter duration.

However, the GNMA durations lengthen because fewer people prepay their mortgages. Why would you want to prepay in a higher interest rate environment? The result of this situation is called disintermediation risk. That is one of the major risks that we're going to try to evaluate in this Valuation Actuary Symposium.

Second, what if interest rates decrease? The exact opposite happens. SPDA durations lengthen due to fewer lapses. Interest rates are down, and depending on the guarantees involved in the SPDA contract, there may be even fewer lapses than originally expected. On the reverse side, GNMA durations shorten because more people prepay their mortgages. When interest rates are declining, as we've had the last couple of years, we are faced with a reinvestment risk.

We generally price products or set reserves with a non-changing interest environment assumption. In this example, I'm trying to point out that if interest rates go up or down, you get selected against. The best possible situation involves the things we're currently doing in setting reserves -- and the examples we're going to show today will support it -- namely, that the reserves we're setting today are probably not adequate when interest rates move up or down. The Valuation Actuary's concern is how to make a good and sufficient opinion statement with respect to reserves when faced with the C-3 risk.

2. The second form of risk is the credit or default risk, otherwise known as C-1 -- again, an insurance company can suffer loss as a result of an asset that incurs a significant decrease in the market value or becomes worthless purely as a result of events other than movements in interest rates. We all know that when interest rates move up or down the market value of the bonds move down or up. What we're talking about here in terms of C-1 risk is the real default in the asset value or a market value change in the common stock.

For example, let's say we have Universal Life (UL) funds that are invested in the low investment grade quality bonds, such as junk bonds, or higher yielding bonds as they are called. As long as the bond pays its interest obligation, the UL contract holders will be credited with the competitive rate. The company makes its profit margins and everybody's happy.

What happens if the bond goes into default? Not only will the investment income be gone so that we can't credit the policyholder a competitive interest rate, but the market value of the bond will significantly decrease. We are faced with a real problem because the policyholder may want his funds, but our asset is virtually worthless. That's the classic C-1 risk. The Valuation Actuary's concern is: How do we make a good and sufficient statement when faced with the C-1 risk?

3. Our final risk is the pricing risk, known as C-2 -- Simply stated, an insurance company can suffer a loss due to unforeseen changes in experience levels with respect to mortality, morbidity, expenses and so on. It's a classic pricing risk. We assume that mortality is going to be a certain level and if it turns out to be at a higher level for unforeseen reasons, then we experience a loss. We need to be reserving for that or taking that into account in our reserving.

Let's look at a scary example. Any life insurance company with a significant amount of insurance in force should have mortality experience come in as expected if underwritten properly. The Acquired Immune Deficiency Syndrome, or AIDS epidemic has created an unforeseen mortality exposure that may produce significant losses. How are we going to reserve for that? I don't think we're going to walk away with the answers to that today, but the Valuation Actuary needs to be very concerned about the following question: How do we

make a good and sufficient statement as to reserves when faced with the C-2 risk?

Valuation Actuary's Job

The comment about making a good and sufficient statement came up three times, once for each of the risks, because that's the Valuation Actuary's job. That's what we're talking about here -- evaluating risks, quantifying them, and trying to set aside enough funds to make the regulators happy that we're going to stay solvent.

It is the Valuation Actuary's job to perform the following duties, and I hope you agree with them.

1. We should have the skills and tools necessary to measure the various forms of risk that I just outlined. Hopefully, after today we'll be a little bit further along in this area.

2. We should understand and obey the standards of practice established by the profession and the regulations regarding the measurement of risk. Again, we're going to try to tackle that during this session. We don't have real standards of practice, with the exception of New York Regulation 126, but during the present and past Valuation Actuary Symposia, we've begun a process which will someday result in standards of practice.

It's an ever changing world in which we live with an ever changing technology. We'll get you closer to feeling comfortable with the current standards of practice, but we're also going to tell you that there's more to be done.

3. It is very important to recognize that we must rely on key individuals in the company, such as the chief operating officer (COO), the chief executive officer (CEO) and the chief investment officer, for the continuation of stated policy and/or good business judgment in managing the company's affairs. When we sign our name on the actuarial opinion statement saying we that we think reserves are good and sufficient, I don't think that it's the Valuation Actuary's job to accept the responsibility that should really fall on the shoulders of the CEO, COO, and chief investment officer. They ought to be there, too!

4. We need to render an opinion as to the adequacy of reserves, taking into account the nature of assets supporting the reserves. That's what it's all about. Up to this point in the evolution of the statement of actuarial opinion, we've simply rendered an opinion as to the adequacy of reserves based on our view of our liability under the valuation laws in place, but we have never looked at the assets supporting the reserves. It's time to do that now because of the risks we're facing, especially the C-3 risk.

My next comment is short and sweet. It is not the Valuation Actuary's job to guarantee solvency. I know that there are several regulators here today, and I hope this is not a surprise to them. I don't think as a profession we are going to take the responsibility of signing the annual statement and saying that we guarantee that our company will never be insolvent.

My point here is that we are in the insurance business, which is a risk-taking business. Risk-taking situations are those in which some win and some lose. It's certainly not acceptable for insurance companies to fail, but it's also not acceptable to believe that we, by way of the Valuation Actuary, will create an environment in which insurance companies can't fail. We are going to evaluate the chances of insolvency by trying to quantify the risks and set up reserves under reasonable and plausible circumstances. I don't think that when you go back to your companies after this meeting that your CEO or your regulators are going to ask you to sign a statement that guarantees that your company will not become insolvent.

Statement of Opinion

Let's look at the statement of opinion. After we do all this risk analysis and quantification work, we're going to be asked to sign a statement of opinion. There seem to be two levels being discussed when it comes to the various opinions that we are going to have to

sign. The first level is reserves. Specifically, reserves make good and sufficient provision for all future obligations on a basis sufficient to cover reasonable deviations from expected assumptions. The key words here are reserves and reasonable. The second level is a little broader. Reserve plus designated surplus makes good and sufficient provisions for all future obligations on the basis sufficient to cover plausible deviations from expected assumptions. The key words here, obviously, are reserves, designated surplus, and plausible.

These are the two opinion statements that seem to be coming out of Valuation Actuary concept discussions. The unknowns are "reasonableness" and "plausibility." Current opinion is that reasonable means the probability of the reserves being inadequate is less than some percent greater than 1%. The point here is that we're not guaranteeing insolvency, but we're looking at a probability of an event happening, that event being insolvency, and we're going to try to make our reserves sufficient under reasonable circumstances, however defined. Also, I think that plausible means that the probability of the reserves and the designated surplus being inadequate is less than 1%. Since this is a much broader view of solvency, it is actually the probability of ruin that we are looking at. We should keep that probability down to less than 1% or so, certainly much lower than the probability of insolvency in the more narrow view of reserves and reasonableness.

some testing of 5% and also at 10%. I don't know what the right number is. Maybe we as a profession are going to have to pick a number. Maybe the regulators are going to have to tell us what it is.

Elements of Cash Flow

I have just set the stage for what the Valuation Actuary concept is all about, the risks we're facing and the statement of opinion that we're going to sign. The way we get there is through a cash flow analysis. We're going to be talking about this type of analysis for the remainder of the session.

Essentially, insurance (or liability) and asset cash flows are projected into the future under various interest rate scenarios. This is fairly straightforward. Some of the assumptions used in this projection are dynamic -- that is, they vary based on the particular interest rate scenario which exists at that point in the projection. The two key issues in these cash flow projections that are significantly different from normal reserving practices today are the use of multiple scenarios and the use of dynamic assumptions. Mr. Dicke will go into detail on the subject of multiple scenarios. Douglas C. Doll and Donna R. Claire will go into detail on the subject of dynamic assumptions.

First, I'll briefly go through the main elements of cash flow. The income components of cash flow on the liability side are premiums,

policy loan repayments (if that ever happens) and policy loan interest. Items that go out are benefit payments, surrenders, dividends, commissions, expenses, taxes and policy loans. In this analysis we have put policy loan cash flows on the liability side even though that's technically an asset on our balance sheets. That's because the investment people can't invest in policy loans -- that is, they don't control them. It's something that the liability people need to address, so I think that in most cash flow analyses you will see policy loan activity handled as a liability issue. Mr. Doll is going to talk about some of the functional relationships that exist on the liability side.

The income components of cash flow on the asset side are regularly scheduled bond maturities, mortgage principle and interest payments, coupons, calls, prepayments, stock dividends, real estate, rental income, liquidations and borrowed money. The outgo components are repayment of borrowed money and capital losses.

CASH FLOW ANALYSIS FOR VALUATION

MR. ARNOLD A. DICKE: As Mr. Jacobs has said, the goal of this presentation is to review in detail the process of valuation using methods of cash flow analysis and scenario testing. The process of valuation requires the actuary to obtain and verify information about the status of assets and liabilities, and to make assumptions as to their future development. In cash flow analysis the assumption choices are more complicated than in the traditional approach.

The actuary must select: scenario set, lapse functions, prepayment functions and the reinvestment function.

The cash flow approach also requires a study of existing assets, in force, and so on. The information on assets, in particular, is more extensive than for traditional valuation methods.

In past Valuation Actuary Symposia, the speakers gave only short discussions of the details of these processes because of time limitations. We have decided to take the time to discuss assumption setting and data gathering in detail. Furthermore, we have decided to be explicit. We will write down the exact functions and other assumptions that we have used and provide you with complete listings of data. We have tried to supply enough information to enable you to reproduce our results.

This approach has benefits, but also some potential drawbacks. Since we are trying to be thorough, some of you may find certain sections elementary. On the other hand, we have attempted to review current research areas, and these may be tough going for beginners. We hope the mix will be satisfactory.

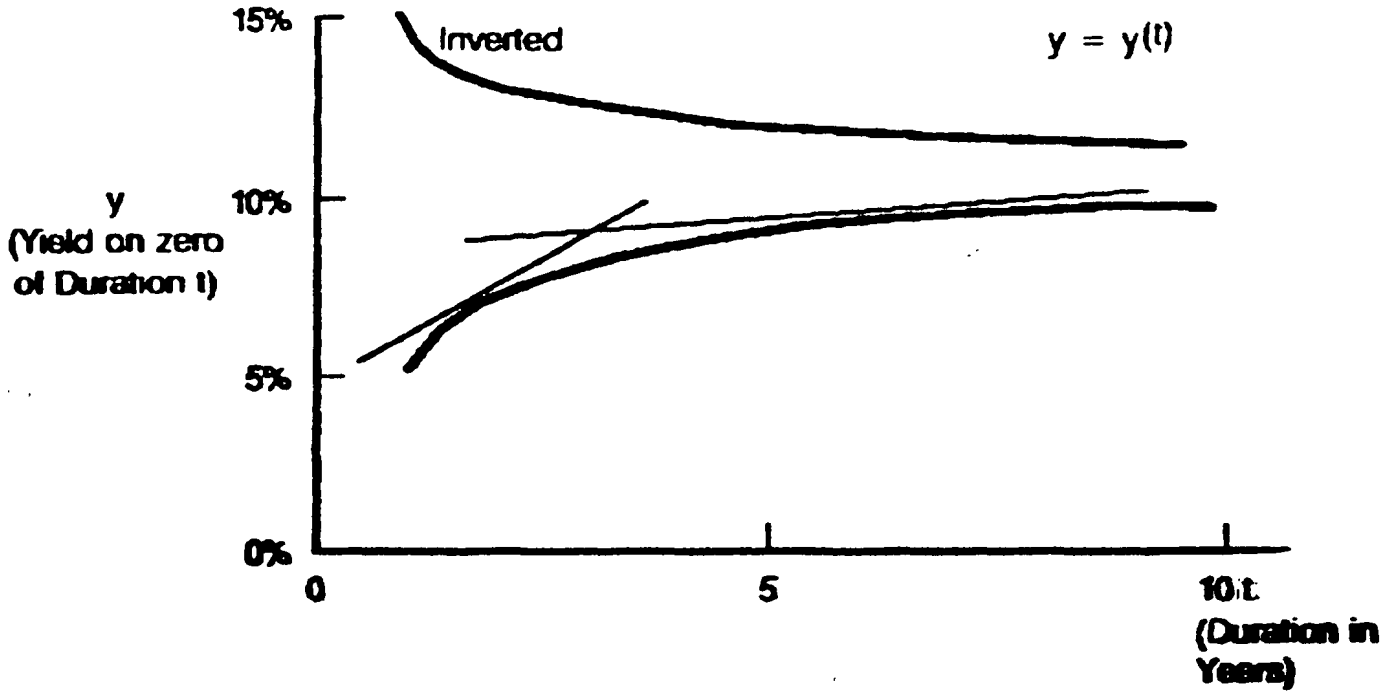
Definitions

Scenario testing may be used to study various risks above and beyond the interest rate risk. For example, Joseph J. Buff has recently looked at C-1 risk using this method. The method is useful whenever elements of the cash flow vary in response to environmental factors which the scenarios may simulate. Nevertheless, I will discuss only the C-3 risk.

The environmental factors of concern in C-3 risk are the risk-free interest rates at which money can be invested. An interest-rate scenario is properly defined as a sequence of yield curves. A yield curve, in turn, may be defined as a function showing the relationship of yield to duration at some point in time.

Slide 1 shows two yield curves, plotting yield versus duration. For the lower curve, the shortest duration bill rate is around 6%, while the 10-year bond rate is about 10%. Such a curve is called normal, in contrast to the inverted yield curve represented by the upper curve, for which short duration yields exceed those for long durations. Inverted yield curves are actually experienced -- in fact, a lengthy period of inversion occurred in 1981.

YIELD CURVES



A scenario is a sequence of yield curves, one for each period end in the future. A subscript is used to tell which period a given curve relates to. Thus y_0 represents the initial curve. Slide 2 shows the first 4 yield curves of a scenario. At time 0, the 90-day rate is 5% while the 10-year rate is 8%. Thus, y_0 ($\frac{1}{4}$) = 5% and y_0 (10) = 8%. As we move from time 0 to time 1, interest rates increase for all durations. Note that y_2 is a flat yield curve -- that is, it has the same yield for all durations -- namely, 9%. The yield curve at time 3, y_3, is inverted.

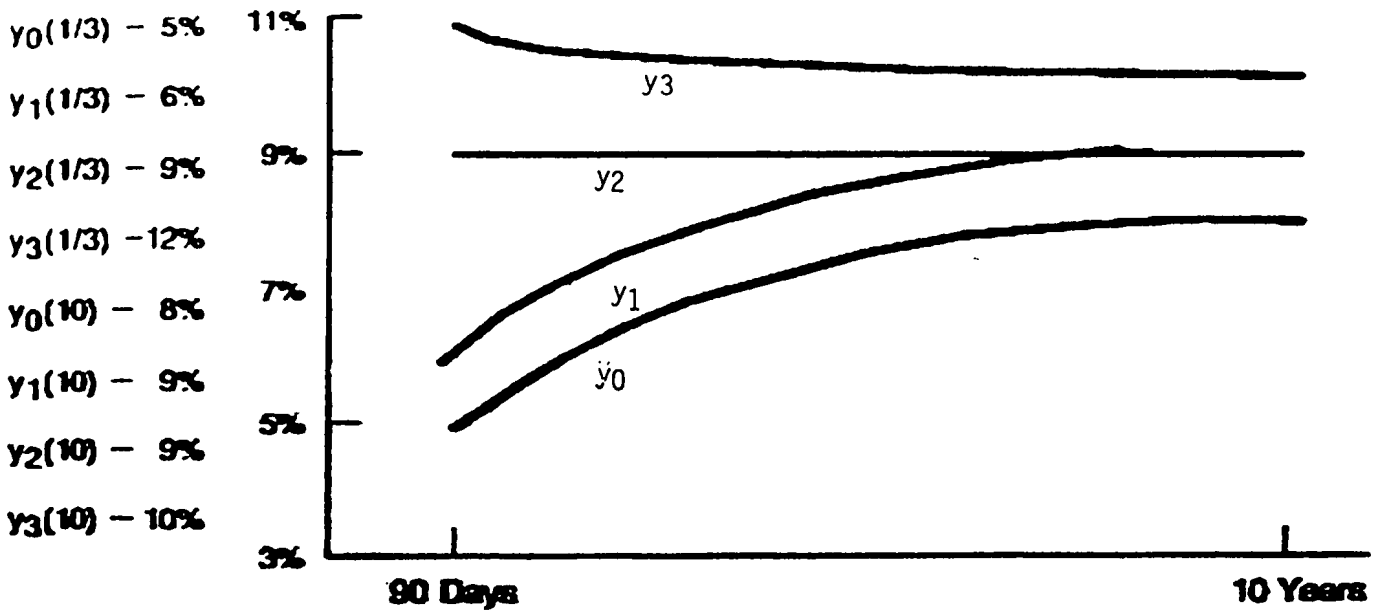
To summarize: A yield curve is a sequence of interest rates. A scenario is a sequence of yield curves. A scenario set is a sequence of scenarios. (If we need to, we will index the scenario with a superscript.)

Doing cash flow analysis requires choosing a scenario set. This can be done in several ways. One approach is arbitrarily to select a set of scenarios that seem to cover the possibilities. New York state has followed this approach in suggesting certain scenarios in Regulation 126. However, there are drawbacks:

- The number of possible scenarios is unlimited, so no single scenario is likely to occur in real life.

- There is no unique way to make a probability statement about the outcome of the testing.

SCENARIO



$y_0(1/4) = 5\%$ $\quad$ $y_0(10) = 8\%$
$y_1(1/4) = 6\%$ $\quad$ $y_1(10) = 9\%$
$y_2(1/4) = 9\%$ $\quad$ $y_2(10) = 9\%$
$y_3(1/4) = 12\%$ $\quad$ $y_3(10) = 10\%$

Apart from scenario sets suggested or mandated by regulation, actuaries are probably well advised to use an approach that attempts to capture statistical meaning. Two methods are in heavy use today: the transition probability approach; and the successive ratios model.

Transition Probability Approach

The transition probability approach begins by defining a universe of standard yield curves. Obviously, it is impossible to represent all possibilities. However, one can attempt to cover various interest rate levels and various shapes of the curve. To implement this method, one actuary studied 10-year T-bond rates and set up the yield curve universe to reflect the relative occurrence of these rates in last 10 years. He then looked at the frequency with which various 1-year T-Bill rates occurred together with each of his 10-year bond rates. In this way, he picked a small number of yield curves with same long-term but different short-term rates. Intermediate rates were set by fitting an exponential curve. This is only one approach, of course, and many consultants offer universes of curves together with historical or other validations.

Given the set of standard yield curves, the next step is to define a matrix of transition probabilities. Let p_{ij} be the probability of curve c_j following curve c_i. Obviously, the probability that <u>some</u> curve c_j will follow c_i must be one:

The transition probabilities are often set in consultation with investment officers in the company. Note that this is not a case of predicting interest rate futures. In fact, most of the time, probabilities of equal and opposite moves are set equal. There may be even more constraints on p_{ij}. One school of thought insists that opportunities for risk-free profit (known as arbitrage) should not be possible if p_{ij} is to represent the real world. Others say this constraint is too strong.

Once the transition matrix is set, the standard yield curve most like current actual rates, c_0, can be chosen, and Monte Carlo simulation used to pick the future yield curves, one period at a time. This process is continued until an entire scenario is defined.

The simulation is then rerun (starting with c_0 again and using the same transition matrix). Ultimately, 40 to 50 scenarios are chosen.

A note for small companies: Nothing in the process of determining the scenario set is company-specific. Thus a small company can "hitch a ride" on another company's work if the consultant is allowed to share a previously determined scenario set. A new scenario set will be needed, however, whenever market conditions represented by the initial curve change.

Successive Ratios Model

Next we turn to the other commonly used approach: A stochas model of the ratios of successive interest rates. Let $y_1, \ldots y_n, \ldots$ be sequence of historical interest rates.

1. First the ratios y_{n+1}/y_n are calculated for the last 10 years, for example, for one long and one short duration.

2. A distribution function is determined which models the frequency with which values of the ratio appear.

3. Correlations between the long and short rates are also studied historically. A bivariate distribution with the proper correlation coefficient is constructed.

4. Simulation in then performed on the bivariate distribution to get N pairs of rates for each scenario.

Work done by the Morgan Stanley group showed that a log normal distribution could be fit to the historical interest rates successor-ratio curve -- that is,

$$\log_e (y_{n+1}/y_n)$$

is normally distributed -- that is, x is normally distributed, where

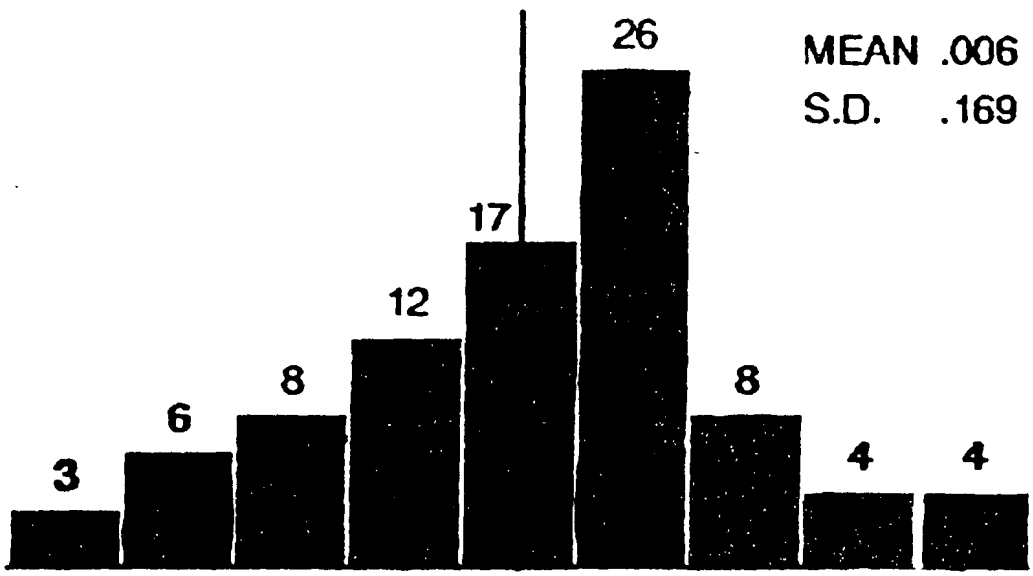
$$e^{x} y_n = y_{n+1}$$

The data shown in Slide 3 represents $\log_e (y_{n+1}/y_n)$. While the distribution is not precisely normal, it is close enough to justify this simplifying assumption. Historically the mean was about .006 and the standard deviation, .169.

Some real life parameters that adequately reflect the Morgan Stanley work are shown in Slide 4. Simulation was done using a bivariate normal distribution with these parameters. Two random numbers are used. The first is used with a simple normal distribution to choose a value for one particular rate, in this case the 90-day rate. To get the 10-year rate, a mean and variance are first calculated from the formula in Slide 4. Note that this formula involves both means, both standard deviations, and the correlation coefficient.

Finally, other rates may be set by interpolation. One interpolation formula is shown in Slide 4.

HISTORICAL 90-DAY TREASURIES



POSSIBLE PARAMETERS

90-Day T-Bills	Mean	0
	S.D.	.16
10-Year T-Bonds	Mean	0
	S.D.	.08
Correlation Coefficient		.7

Interpolation:

18-Month Rate
= 90-Day +60% (10-Year - 90-Day)

Three scenarios simulated using the bivariate log-normal distribution are shown in Slide 5.

Slide 5

GENERATION OF SHORT AND LONG TERM INTEREST RATES
FROM BIVARIATE NORMAL DISTRIBUTION

Ux=0, Tx=.16, Uy=0, Ty=.08, p=.70
STARTING POINT: TREASURY RATES, 4th QUARTER, 1985

	SCENARIO 1			SCENARIO 2			SCENARIO 3	
YEAR	90 DAY RATE	10 YEAR RATE	YEAR	90 DAY RATE	10 YEAR RATE	YEAR	90 DAY RATE	10 YEAR RATE
1	0.0717	0.1008	1	0.0717	0.1008	1	0.0717	0.1008
2	0.0526	0.0936	2	0.0795	0.1048	2	0.0783	0.1035
3	0.0586	0.1042	3	0.1033	0.1315	3	0.0686	0.0926
4	0.0687	0.1006	4	0.0982	0.1264	4	0.0721	0.1014
5	0.0811	0.1125	5	0.0762	0.1192	5	0.0846	0.0983
6	0.0628	0.1067	6	0.0914	0.1321	6	0.0860	0.1088
7	0.0752	0.1160	7	0.0817	0.1192	7	0.0802	0.1088
8	0.0792	0.1200	8	0.0787	0.1106	8	0.1188	0.1103
9	0.0649	0.1108	9	0.0971	0.1317	9	0.0913	0.1008
10	0.0567	0.1036	10	0.0917	0.1277	10	0.0986	0.1002
11	0.0674	0.1093	11	0.0921	0.1268	11	0.1119	0.1128

x, y are random variables:

$$f(x,y) = e^{\frac{-1}{2(1-\rho^2)}\left[\left(\frac{x-Ux}{Tx}\right)^2 - 2\rho\left(\frac{x-Ux}{Tx}\right)\left(\frac{y-Uy}{Ty}\right) + \left(\frac{y-Uy}{Ty}\right)^2\right]}$$
$$2\pi\ Tx\ Ty\ \sqrt{1-\rho^2}$$

90-day rate: $i_t \quad i_{t+1} = i_t e^x$

10-year rate: $j_t \quad j_{t+1} = j_t e^y$

MR. DOUGLAS C. DOLL: We're going to talk a little more about scenarios when we show some of the results that we get later from testing 40 scenarios. We'll also have more discussion about the significance of the number 40, although one very important reason for using 40 or 50 scenarios is that if you're going to show results for your scenarios, one line per results, you can get 40 or 50 scenario results on a single piece of paper!

Mr. Dicke just showed you three scenarios. Looking at his rates (it's the first time I'd seem them) it struck me that those are three pretty boring scenarios compared to the kinds of scenarios that you perhaps have created manually to test. One thing we've found when testing stochastically generated scenarios is that you sometimes get quite a few boring scenarios and only a few exciting ones. Another thing to note is that we found that the most extreme scenarios don't necessarily give you the most extreme results. That's something that you definitely want to keep in mind when you do scenario testing. A scenario that looks quite extreme as far as what the interest rates are going to do in the future may not give you the most extreme results. Sometimes it's those "boring" scenarios in which the rates are drifting up and down that give you the worst results.

The topic that I'm going to cover is called functional relationships. When we were putting this program together, we thought we would go

out and gather a lot of experience from companies, so that during this session we could tell you what assumptions would be reasonable to use when performing scenario testing. However, I ran into two problems when gathering this experience. First, is that, when I told people I was going to talk about functional relationships in Dallas, they thought I was going to talk about a certain prime time TV soap opera. Second, the experience simply does not exist. There's a little bit of experience out there, but not very much and not enough to enable us to stand here and say: "These are the assumptions you should use for functional relationships in doing scenario testing."

In prior symposia, this section was not called "Functional Relationships." It was called "Setting Assumptions." Actuaries are quite good at choosing assumptions. Here are three tried and true methods of choosing assumptions. The first is the dart board method. That's actually not a bad method, although it's somewhat crude. Many actuaries use this method in the early stages of doing scenario testing until they get familiar with the effects of assumption results. Once they get familiar with what assumptions will give what kind of results, then they can decide what results they want, and solve for the assumptions that will give them those results.

The second method is the Xerox or copying approach. We also can call this "let someone else to the work," or "let's use what someone else has gotten away with." This method might involve, for example, copying the assumptions that some other company has already used for

a successful New York Regulation 126 filing. It might involve copying the assumptions that were used in a case study in a symposium such as this, although I wouldn't suggest that for the assumptions that we will show you today. The copying approach is not necessarily bad if some judgment is used when you copy the assumptions.

Many of you are familiar with Delphi studies as a technique of getting an answer or a prediction in an uncertain environment. The Delphi method involves asking experts their opinions. You then go back and show them the opinions of other experts and then give them a chance to change their minds. The third method we may consider is similar to the Delphi technique. The Valuation Actuaries in this room are considered experts, and we ask their opinions as to what assumptions should be used. We can find out what assumptions are used in case studies in New York Regulation 126 filings and so forth. Finally, we may then reapply our judgment as to the rationality of these. This way we get what I'm going to call the third method of choosing assumptions -- rules of thumb.

Today, I don't have the facts and figures as to what experience has been on many of the functional relationships needed for cash flow testing. Therefore, I'm going to talk instead about using judgment to set the assumptions for these functional relationships. A few years from now, when the Valuation Actuary requirements become established, we will have a number of rules of thumb that might be acceptable.

The key elements to be considered when choosing functional relationships can be summed up as: relationships, consistency, and validation. Since these are interrelated assumptions, one assumpt will affect others. It is important for all the assumptions to be consistent, to hang together. I'll give some examples of this when describing some particular assumptions.

The word validation could have two meanings. First, the assumptions should validate reasonably to whatever experience is available. Second, the results obtained from a set of assumptions should validate reasonable results. For example, if a projection shows unreasonably high or low profits for a scenario (especially, high profits!) you should examine the assumptions to see if they make sense for that scenario. It may be that some modification is in order.

The Market Rate Assumption

The most important functional relationship in the kinds of asset/liability projections that most persons have been performing is the relationship between credited rates, market rates, and (when credit and market are different) the lapse rates. I want to spend most of this presentation talking about these three assumptions, and then briefly talk about a few other functional assumptions.

The market rate has been defined as the rate the policyholder can get by lapsing the policy and buying a comparable new policy. It doesn't

always have to be the rate associated with a new insurance policy rate. For example, in the late 1970s, the market rate that affected policy loans was not the dividend scales or policy loan rates of other policies, but the interest rates of non-insurance financial vehicles. Generally, however, the market rate will be the rate that competing companies are offering on similar products. In some fashion, this will be a function of what the competing companies can earn on their investments, and thus will be a function of the scenario interest rate.

When choosing a definition of market rate, keep in mind what the market rate is to be used for. If you intend to set your credited rate equal to the market rate, the market rate definition for projection purposes should match the definition for the way you intend to credit. For example, if your current credited rate is in the top 10% of competitors, you should not project forward at a median competitor rate, unless you have such future intentions (and if you allow for the possible lapses and other effects that might occur with a change in strategy).

When you perform your projections, you may find that in some cases the results are very sensitive to the market rate definition and sometimes not. Usually, a credit-the-market-rate strategy is very sensitive to the definition of market rate. A crediting strategy independent of market may be less sensitive to the market rate assumption, depending on the lapse rate function.

As I mentioned earlier, the market rate generally is based upon competing similar products, and, since we assume that the competition is rational, the market rate generally is a function of the competitor earned rate, which is a function of the scenario rate. The relationship between earned rated and market rate may not be rational, but there is a relationship.

When choosing the market rate assumption, the obvious first step is to choose one that reflects the current market situation. However, don't give too much weight to today's situation. The market does not always react as quickly as scenario rates do. Your projections are run for many years -- that is, the assumption should be one that makes sense for the long term. Therefore, it makes sense to pick an assumption that is consistent with results in the historical past. Looking forward, though, common sense should be applied. Assume that, in the historical past, there was little competition for a given product, and most companies tried to earn a 250 basis point spread. Now, there are more companies in the marketplace and the average pricing assumption is 100-150 basis points. In this case, the market rate assumption should reflect the anticipated narrow spread.

Typical market rate assumptions are based on a current interest rate and, sometimes, a rolling average interest rate. The rolling average would reflect that companies may be crediting interest based on their portfolio rate. A rolling average for a short period might also reflect a natural inertia in companies reducing rates. A common assumption,

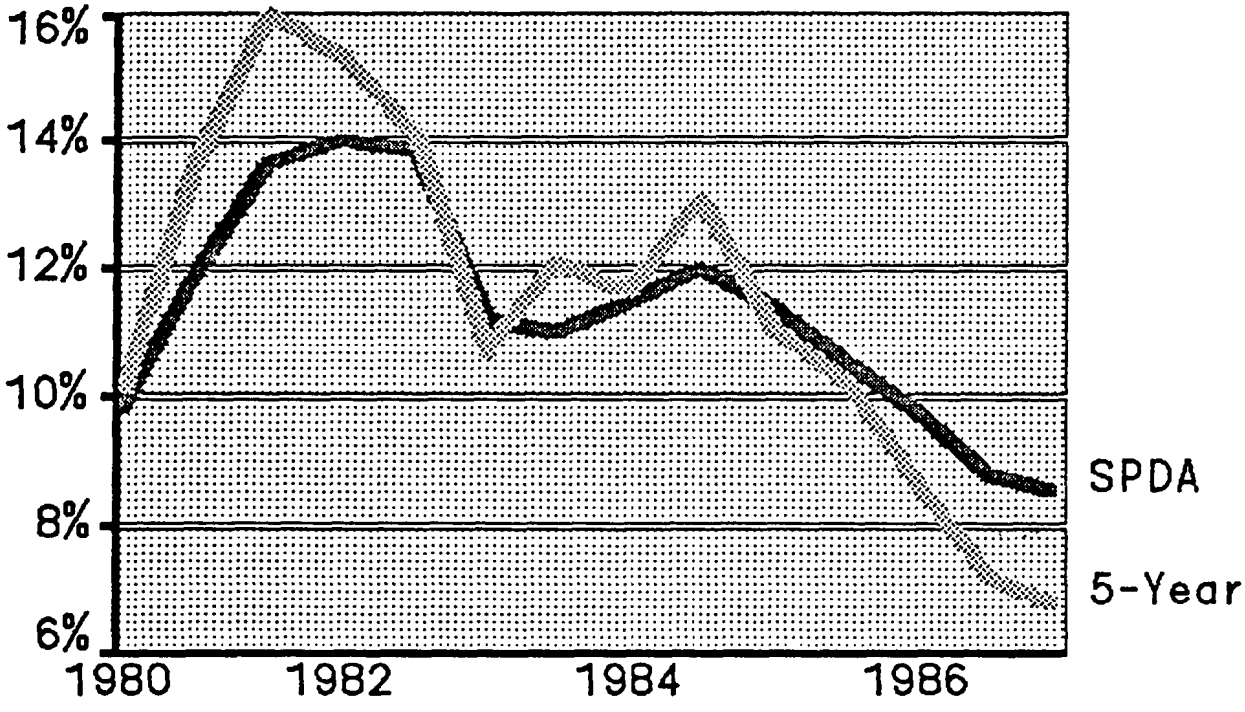
seemingly conservative, is that the market rate will be the higher of a current interest rate or a rolling average rate.

Slide 6 is a graph plotting a Single Premium Deferred Annuity (SPDA) competition rate against the effective yield of a 5-year Treasury bond. The SPDA rates were chosen from Best's Retirement Income Guide, and were available at 2 time points per year. A number of comments should be made about this graph before you draw conclusions from it.

1. I used a representative group of what I thought were competitive companies. Depending upon your market, a different group of companies may be more appropriate.

2. The Treasury rates are point-in-time. Since Treasury rates can fluctuate greatly month to month, it may have been better to look at a few months' average.

SPDA MARKET VS. 5-YEAR TREASUR

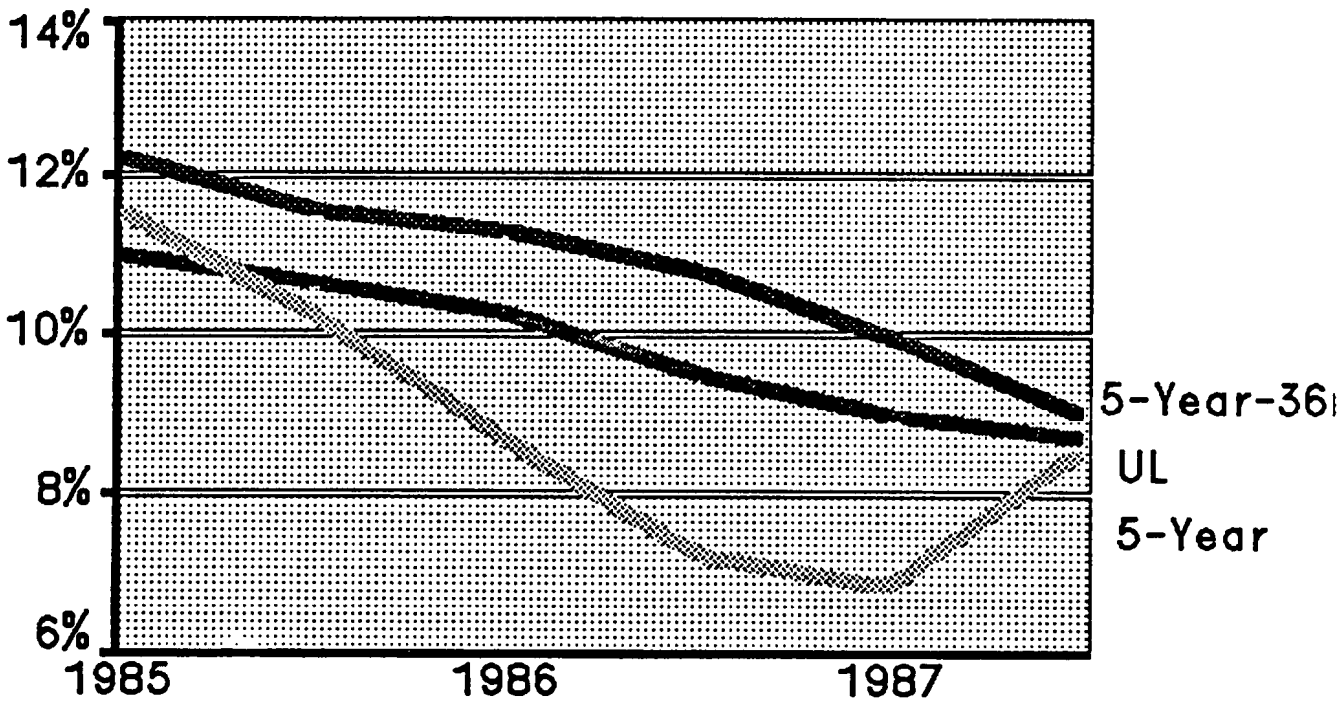


The graph shows that the SPDA rates have followed the 5-year Treasury rates reasonably well during the first few years. There does seem to be a deficit at the end of 1986, but much of that deficit currently is gone.

Slide 7 plots the 5-year Treasury rate against the median credited rate of a large group of universal life policies. Unlike the previous graph, we included information through July 1987. The "5-year 36-mth" line is the 36-month rolling average of 5-year Treasury bond rates. The average credited rate appears to be tracking reasonably well at 100 basis points less than the 36-month rolling average. If interest rates continue to rise, it will be interesting to observe the way the credited rates track against the 5-year actual rate.

For the case study, we ignored the graphs you just saw, and used the following. The case study market rate is the larger of 1-year Treasury rate or the 5-year rolling average of 5-year Treasury rates. This gave us a fairly high credited rate at December 31, 1986 of 9.64%, which had the nice characteristic of not being too far out of line with our average credited rate of 10.29%. Keep in mind that the purpose of the case study is not to show which assumptions necessarily are appropriate, but to demonstrate how a cash flow analysis might be performed.

UL MARKET VS. 5-YEAR TREASURY



Credited Rate Strategy

The next item to be discussed is the credited rate. I prefer to think of this not as as assumption, but as a strategy. The insurance company has the power to decide whether its crediting strategy matches what is in the cash flow projection. There are numerous strategies that could be used. Stanley B. Tulin lists eight classes of crediting strategies in his chapter in the Valuation Actuary Handbook. All the strategies key off of one or more of three rates.

1. Fixed rate -- This could be the initial guaranteed rate, a bailout rate, or the minimum guaranteed rate.

2. Earned rate less a spread -- This may appear self-evident, but can be tricky when trying to tie down the precise rate. It does not necessarily match the overall earnings rate, as I will explain when I talk about new money crediting strategies.

3. Market rate -- This is the market rate we just described.

In the real world, we see combinations of the three aforementioned rates. Companies attempt to credit both the earned rate and the market rate, and end up with a hybrid. The presence of a surrender charge may complicate matters further, since it is somewhat more safe to lower the credited rate if a surrender charge is present.

In the case study, the current credited rate is the earned rate less a 1.5% spread (after provisions for defaults and investment expenses). Recall that this credited rate is .65% above our defined market rate of December 31, 1986. As a sensitivity test, we did a projection assuming that we credited the market rate. The results may surprise you.

One feature to consider on a credited rate strategy might be to increase the spread for higher interest rates -- that is, let the credited rate be a multiple (less than one) of the earned rate. If this relationship were applied to the market rate as well, it could produce some reasonable answers.

New money crediting strategies are fun to project. Real life new money practice differs from theory. That's a little bit misleading, since I am not sure there is an authoritative theory. In my mind, the theory would have you credit interest to each policy based on its actual earnings. Theory doesn't always work very well. Negative cash flow in old buckets can produce anomalous results, such as decreasing credited rates in times of increasing interest rates. In practice, there are various ways to approximate this. Some of the methods may not have any theoretical basis. For SPDAs, a company may credit different interest rates to different policies based on year of issue, for example. The rates may have something to do with the earnings associated with the policies, but, in practice, a company may set the rates with some overall earnings spread in mind, and then

juggle the rates until everything adds up.

For universal life, a crediting methodology that appears to be gaining popularity is to credit the current rate on money received in a year for a period of 3-5 years, then roll it over into the new money rate at the end of the period. This method has the advantage of being programmable for projection purposes, since the credited rate can be keyed off the scenario rate, and you don't have to keep track of the earnings of several buckets of assets.

For projecting true new money, (for example, a block of SPDAs) with a program that doesn't do true new money, one possible method is to treat each new money class as a portfolio and do a separate projection for each. You would not be able to keep track of each bucket within a policy, but the policyholder probably will make his lapse decision based upon the average credited rate, not the rate being credited on new money.

In our case study, we had several years' issues that actually did have different credited rates, but the differences were not extreme, and we assumed that the differences would grade to 0 over a period of time. Therefore, we treated the block of business as if it credited interest on a portfolio basis.

There are some special considerations for dividend scales on par policies, beyond the issue of new money versus portfolio interest

crediting. These depend on each company's situation, but may include such items as pegged dividends -- namely, dividends prescribed to be no less than the prior year's dividend or than the dividend illustrated at issue.

Lapse Rate Function

We now have our credited rate and our market rate and it is time to develop a lapse function. At this point, if you are lucky, you will credit a rate equal to the market rate and thus not have to make an assumption. If you are not so lucky, it's time to get out the crystal ball.

As the Valuation Actuary Handbook describes, the lapse rate function is largely based on intuition and judgment, for two reasons. First, there is little experience available for many types of plans. For example, universal life has not been through an interest rate increase similar to that experienced several years ago. Second, today's environment is different from that of several years ago.

For par products, for example, the environment with regard to lapses is much different today from what it was in the late 1970s. It's probably appropriate to review the experience that occurred in those years, but you then have to use some judgment going forward as to what that means in today's environment.

There are several considerations to be made in developing a lapse rate function. If your product has a surrender charge it might be less sensitive to the credited rate/market rate differential than otherwise, and if the surrender charge is going to grade off in just a few years, the policyholder might take that into account and hold on to the policy longer than he otherwise would.

Policyholder/agent characteristics are important. A block of interest sensitive business sold by stockbrokers is probably going to have higher excess lapses than a block of policies sold by career agents. If the policy has a bailout provision, that's going to effect whether you have high excess lapses.

Less obvious considerations are "hidden" interest and aging of business. An argument can be made that par business is less sensitive to excess lapse because the credited interest rate is not obvious to the policyholder. Regarding aging of business, we don't have enough experience to prove this one way or the other, but there is a little bit of evidence to indicate, at least for one block of SPDA business, that as the business ages the excess lapses decrease over time.

The rationale for that is that there is a core group of policyholders that is just not sensitive to interest rates. When the market rate first gets higher than the credited rate, the very sensitive policyholders are going to lapse away. Eventually, you're going to decrease your

proportion of interest sensitive policyholders and increase the proportion of the non-interest sensitive policyholders in the block of business. I've heard an opposite argument which is that the longer the differential remains in force, the more disgusted the remaining policyholders get, and the more likely they are to lapse. So we need to see some more experience before we can make a definite decision one way or the other.

Here are some sample SPDA lapse formulas.

M = Market Rate

C = Credit Rate

SC = Surrender Charger

1982 C-3 Study: $5\% + (M-C)^{1.5}$, Max 75%

VA Handbook Ex: $15\% + 2(M-C)^2 - 3(SC)$

Case Study: $5\% + 2(M-C)^2$, Max 50%

The 1982 study done by the C-3 Risk Task Force used a function of total lapse rate equal to 5%, plus the difference between the market rate and the credit rate taken to a power of 1.5 with a maximum of 75%. In the Valuation Actuary Handbook there is chapter with an SPDA case study that uses 15%, plus two times the difference squared, minus three times the surrender charge.

Finally, in our case study, we used a base lapse rate of 5% and added

an excess lapse equal to two times the difference between the market rate and the credited rate squared, subject to a maximum of 50%. Suppose the differential between the marketed rate and the credited rate was 2%? Square that, and you get four. Two times that is eight, so the excess lapse was eight, which is added on to the 5%. The base lapse rate was assumed to be 5%, but we did increase that base lapse rate from 5% up to about 25% as the policies were assumed to reach retirement age. One thing to note about the function is that because it's a squared function, the excess lapse increases dramatically as the differential between market rate and credited rate increases. That seems to be fairly well accepted. It does match reasonably well the experience of a few SPDA writers in the early 1980s.

Policy Loan Utilization

Companies that are subject to a lot of policy loans probably have experience from the early 1980s, but that experience may not be reliable anymore, because the environment has changed for policy loans. Many companies now have direct recognition on their credited interest rate, or on their dividend scales of policy loans. Furthermore, we had a tax law change just a year ago that took away the deductibility of policy loan interest. This would lead you to believe that the policyholder is going to be less likely to take policy loans, but probably more likely to lapse than in the past. I don't have a sample formula for policy loans. A formula presented at the New York Society of Actuaries meeting showed an experience loan

utilization rate equal to the difference between the policy loan rate and the market interest rate taken to an exponent of 1.8. I've seen functions used for projections that are functions of a new policy loan as a percentage of unloaned values, and, alternatively, a percentage of the total available cash values. As a side comment, for single premium life products with a zero net cost loan, the policy loan assumption could be a key assumption in the cash flow analysis -- that is, it's not something that you should ignore and say that this is only appropriate to traditional policies.

Premium Suspension

There's very little experience available. Obviously, one consideration is whether you have a new money product or portfolio product. If you have a new money product the premium suspensions should not be greatly interest sensitive, although the lapse rate could still be problem if the policyholder looks at his overall credited rate. I was given a little bit of experience by someone regarding flexible premium annuities. There was a tax sheltered annuity plan where the market leader was experiencing premium suspension rates of 12-15%. Other companies in the same market that were crediting an interest that was 2 percentage points less than the market leader were getting premium suspensions of about 30-35%. Another example is of some Individual Retirement Accounts, or IRAs, in which one company crediting the market rate of interest was experiencing premium suspensions in the 25-30% range, and another company credited a rate one percentage

point less than the market was getting a premium suspension rate of about 50%, so apparently premium suspensions can be very sensitive to the credited rate of interest.

Expense Inflation

Expense inflation for life insurance policies is generally a valuation concern only for its effect on maintenance expenses. The general belief seems to be that this has a small effect on reserves. (For some casualty business where the particular claims might be based upon things that aren't fixed financial numbers, the inflation rate could be a very significant item.) The common assumption seems to be that inflation is going to equal the government bond interest rate less some percentage.

There's a nice graph in the textbook, entitled Pension Mathematics for Actuaries. It shows the relationship of inflation rates to government bond rates over a long period. Generally, for life insurance maintenance expenses, actuaries tend to add some offset for increasing efficiency, so that if the historical inflation rate has been a government bond rate less 2%, the assumption might be of a government bond rate less, let's say, 5%. In our case study we made a fairly innocuous assumption. We said that the inflation rate was going to equal the 5-year Treasury rate less 4%.

There's one factor that I haven't seen used very much in scenario

testing, but it could be a very important one, if you do have a scenario that gives you high lapse rates. To the extent that some of your maintenance expenses include overhead expenses, you may not be giving appropriate weight to your expenses. If you have a scenario where a large portion of your company's business is going to lapse away, then you need to look at the scenario and at what the total provision for maintenance expense is under that scenario and see whether that does give you an appropriate provision for overhead expenses.

Mortality

It's generally accepted that, if there are extra lapses on life insurance policies, that's going to increase mortality in the future, because some of those excess lapses are going to represent select lives. The people who are impaired are more likely to keep a life insurance policy since they're unable to get an equivalent policy elsewhere.

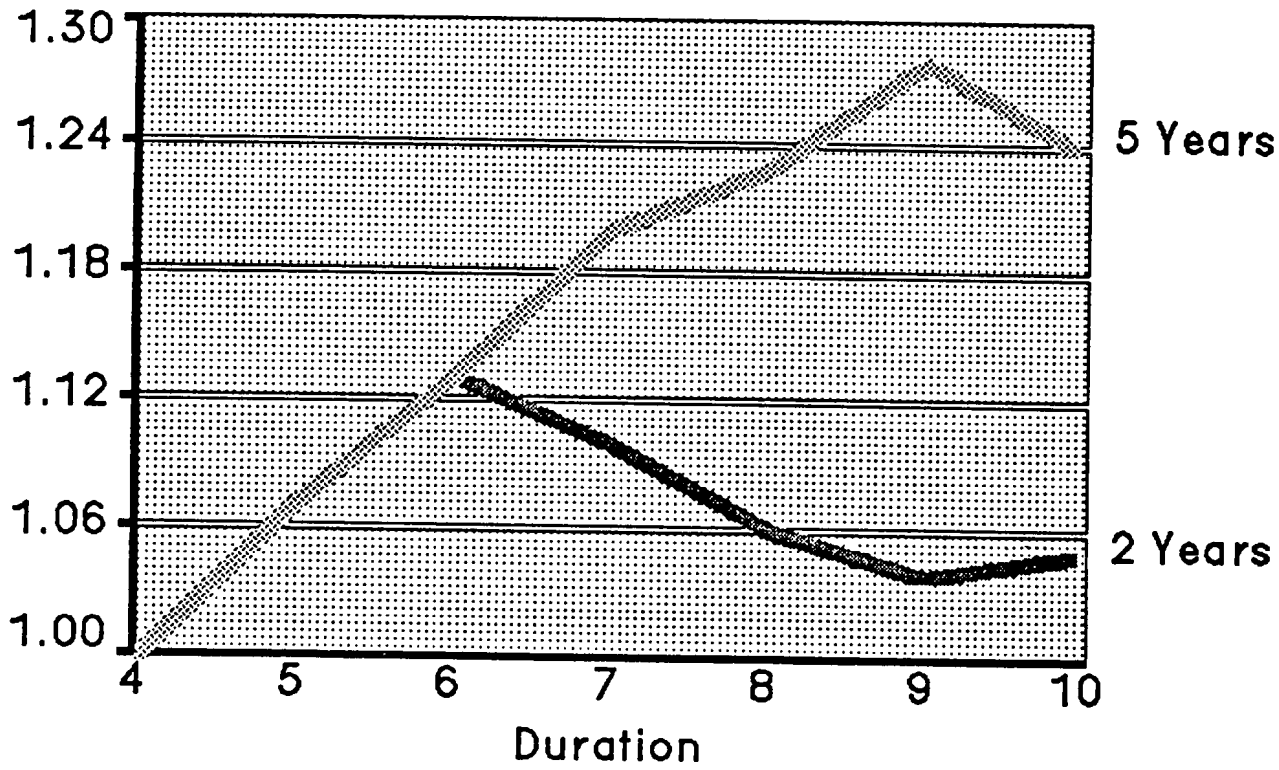
Usually, this excess mortality is dismissed as insignificant. However, it's not a difficult item to calculate. There are several models available for calculating excess mortality due to excess lapse. I did a couple of sample calculations for a life policy assuming 20% extra annual lapse and computing the extra mortality. For those familiar with the various methods, this particular calculation used the Dukes-McDonald Method. We assumed 50% efficiency. In other words, the excess lapsing policyholders were 50% efficient in selecting against

you. The results shown in Slide 8 are for issue age 55, although we did test a lower issue age and got about the same result. (In this particular case, we assumed the excess lapse would be starting in duration four.) According to the graph, if you have just two years of 20% extra lapse, the mortality, as a percentage of standard, goes up to about 112% then grades down from there. If you have 5 years of excess lapse, then the mortality in this particular case goes up to almost 130% of standard.

This example is meant to give you a little perspective on what excess mortality might mean for interest sensitive products. Consider a single premium life policy, where your expected mortality might be about 50 to 75 basis points of interest. If you have 30% extra mortality, that would represent 15 to 20 basis points of interest. Fifteen to 20 basis points generally is not going to kill you, but it makes bad things worse because it's happening on top of your already bad scenarios.

In closing, after you create your assumptions you're going to run them through scenarios. You're going to get some results. I want to emphasize one more time that you've got to look at the results and look at the interplay of the assumptions and see if the results are reasonable. I've often found, when trying to do a projection of an interest sensitive policy, that each assumption by itself seems to be quite reasonable. I do the projection, and the results just don't make sense. It usually is caused by one assumption not making sense

MORTALITY



compared to another assumption. You do have to review the assumptions to make sure that they're all consistent.

FUNCTIONAL RELATIONSHIPS: THE ASSET SIDE

Role of the Actuary and the Investment Officers: A Discussion

MR. DICKE: The next topic we are going to discuss is the investment side, the asset side of the balance sheet. In this area, one of the things we discovered was that the panel was not entirely in agreement on exactly what the actuary's role should be with respect to setting investment assumptions. We thought we should try to get some of the various opinions.

MS. CLAIRE: Mr. Jacobs and I had the widest difference of opinion which is probably the reason we're going to take up most of this discussion. Basically, it came down to the fact that I like money more than he does. I wanted the actuary to have a larger role in determining investment philosophy than he did. At the Equitable, one of my jobs is to determine the investment philosophy for my lines of business. In doing so, I not only indicate the type of assets I want, such as bonds, mortgages, real estate, but I also indicate what type of maturities, what type of cash on cash returns, the type of capital depreciation I'm willing to take and what type of risks I'm willing to take, in terms of both the quality of assets and the probability of not realizing our expected returns.

I think the actuary is uniquely qualified in terms of his or her background to do the cash flow testing both on the liability and the asset sides. When doing cash flow testing, the investment philosophy is a major issue. As we go through the case study, I think it's the actuary who can make a determination about such things as whether the cash flow volatility from mortgage backed securities is acceptable for the company. On mortgage backed securities, you're earning a lot of money but the risk of disintermediation or, on the other side, the asset being longer than you wanted, is fairly great.

I'm not saying the actuary should be alone in the process. He's got to work with the investment side. At the Equitable, for example, despite a slow start, the actuaries and investment people have over the years developed a very good working relationship.

MR. JACOBS: Ms. Claire and I are not so violently opposed to each other as to create a major controversy. I simply look at things from a consulting point of view.

I work mostly with insurance company actuaries, however, since I've gotten involved in asset/liability work, I have spent a fair amount of time with the investment personnel at insurance companies, and I've gained an enormous amount of respect for them. Sure, there are some poor performers in the investment area, but there are also some actuaries that perform poorly.

From my perspective, when I get involved in these kinds of projects, it's got to be a collaborative effort. As I said in my earlier presentation, one of our jobs as Valuation Actuary is to rely on other key people. Rely doesn't mean that we tell them what to do, but that we work with them. Most actuaries aren't nearly as qualified as Ms. Claire is on the asset side. Since we are not all Donna Claires, I really do think that there ought to be a collaborative effort. We can add a lot to the investment process. As actuaries, we have unique quantitative and technical analysis tools and we understand the full range of risks involved. Investment people have special knowledge about the investment risk. Ideally, we can work together to set the investment strategy, with investment people choosing the assets because that's what they do best, and with actuaries pricing products and setting reserves because that's what we do best. Even though they ought to be the ones who choose the assets, we can give the investment people guidelines. We can tell them some of the ramifications of choosing certain types of assets, maturity, structures, and so on. My point is that we ought to collaborate with the investment people as opposed to merely making demands on them.

In the meetings I have had with actuarial and investment people, I often come out more the friend of the investment people than the actuary. I've come away with a great deal of respect for what they do and their knowledge. They understand the risk just as well as we do. They look at it, however, from a different perspective. They understand modeling, but to them modeling is not "real world." They

have to look at what's going on in the marketplace every day and try to take advantage of market conditions. They have real assets that they're handling, whereas we model "made up" assets and look events that may happen to us out in the future. They understand that, but it doesn't quite hit home. We can help make it hit closer to home and they can help us understand some of the very volatile investment environment these days. The point that I want to make is that projects should be a highly collaborative effort.

MS. CLAIRE: I am in total agreement that the communication has to be there.

MR. DICKE: I'll make a comment from another direction and maybe get a little more controversy going here. Before we discuss who's responsible for it, we should ask: What is an investment philosophy? In one sense, the investment philosophy may be either an explicit or implicit one that's being used on a day-to-day basis by the investment department. In the process of doing a valuation, you need to make some assumptions about investment philosophy in the future. These assumptions may not match what the investment people are doing today. In other words, future investment philosophy is really an actuarial assumption and the actuary's going to have to take responsibility for it. He can consult with anybody he wants, and he probably should consult with somebody. He ought to know what the current investment philosophy is, but he also has to think about the possibility that other philosophies will be used in the future.

My point of view may not be comfortable to all the panelists here: The key question is whether you can do a valuation and find some current investment philosophy that will carry you through the future. So, the logical thing for an actuary to do is decide whether there are investment philosophies in the future that could be carried out by rational people, and then assume they will be done. Is that creating controversy, anyone?

MR. DOLL: You have to differentiate based on what these projections are going to be used for. One use is for statutory solvency, but then, you get to the other purposes which include management reporting. For statutory solvency, you really only need your investment philosophy to represent what the company actually intends to do for a period of one year. A year later you're going to do another valuation of the company. Presumably, if you can do projections today that show a given investment philosophy getting through all the scenarios, then you know that a year from now, you ought to be in a situation where that given investment philosophy will work. A year later, the company may change its investment philosophy, but, at that point in time, you're also going to do another valuation.

I'd also like to comment on the discussion about the role of the Valuation Actuary in setting the investment philosophy. The Valuation Actuary's role is to evaluate the effects of an investment philosophy. Senior Management's role is to choose the investment philosophy.

MS. CLAIRE: Just one more point. For the Case Study Life example, one thing we did do is check different investment philosophies and their effect on surplus. If you're not sure what your company is planning to do in the future, that's one way to check your sensitivity analysis to different philosophies.

MR. JACOBS: One last comment. I'd like to share an example which will show the importance of talking to the investment people. We went into one of our first asset/liability assignments and we set the investment strategy because we felt that with the help of the actuary we knew what we were doing. We said that we're going to invest in 5-year bonds because that's what they're currently doing. We ran our 50 scenarios and we looked at the results, some of which were atrocious. So there I was trying to come up with the appropriate reserve, but under some scenarios the results were ridiculous.

We brought in the investment officer, looked at results and tried to get him to buy into this whole process. You can imagine what he said: "This is bunk. I'm not going to invest that way when interest rates are moving." So I asked the key question, "How would you invest?"

We sat down with the projection and covered over the future periods. For each of the scenarios, he told us that if the interest rates did one thing he would invest in a certain way. We moved through each successive year and did the same thing. Now the investment officer

had created his own investment strategy for these future periods. We put these new strategies back into the model and we ran it again. His strategy got rid of virtually all of the bad situations. Now he can buy into the projection and feel comfortable with the results. I think that if we make a reserve opinion statement based on the absurd assumption that you're always going to invest in 5-year bonds, then nobody's going to buy into the opinion. Certainly, investment people aren't. That's a real life example of why I think we need to talk to our investment friends.

MR. DICKE: Mr. Jacobs will move to the topic of the reinvestment functions. First, let me clarify something. I hope that everybody understood that when Mr. Jacobs said we "covered over" the future periods, he meant he did not permit "looking ahead" in the scenario to see what's coming. You can only use current or past knowledge when you're making investment decisions. Any dynamic reinvestment function may only vary with respect to interest rates generated by the scenario up to that point in time. You can't know what future interest rates are going to be.

MR. JACOBS: That's a good point. We didn't let them have clairvoyance and see what the future is going to hold for them. As Mr. Dicke said, when I covered the scenario, I eliminated the future and asked, "This is where you've been, this is your asset mix how, what would you do?"

MR. GREGORY D. JACOBS: I'll talk briefly about the investment/reinvestment philosophy. This is one of the key assumptions that needs to go into a cash flow projection. I like to look at the investment/reinvestment strategy in three ways.

POSITIVE CASH FLOWS

The first one involves the way positive cash flows will be invested. The first method of investing positive cash flows is a continuation of the current strategy. If we invest in 5-year bonds, let's project investing 5-year bonds into the future and see what happens. The second method is to follow a stated policy. Some insurance companies have a fairly rigidly stated investment philosophy, which might be that we should try to keep our durations matched and not put more in certain types of assets than a certain amount and aim for a certain quality level. There is more latitude in this type of investment philosophy than in the previously defined philosophy.

The third possible method is market timing. That's where it's critical, in my opinion, to get the investment person involved. The investment officer looks at where interest rates are, where they have been, and what the market is doing. He makes an investment decision based on his views of the market and the available opportunities. It is a very active investment philosophy.

The final investment philosophy is one in which the investment officer will "do whatever is best." Actuaries will have to deal with this type of strategy whenever the investment officer has trouble describing his investment decision-making process. Modeling this strategy is very difficult. You need to understand how the investment officer thinks about his investment decisions.

The second phase of the investment/reinvestment function is the investing of negative cash flows. There are generally two strategies involved in dealing with negative cash flows. First, you can borrow funds. If you have a temporary cash shortfall, you can borrow to cover the shortage if you have a good line of credit. You need to reflect the cost of the borrowing in the projections.

Second, you may liquidate assets. You actually pick and choose certain assets that you have in your existing portfolio and liquidate them to cover the shortfall. The liquidation can involve specific assets or be a prorata liquidation across all assets.

The final phase of the investment/reinvestment function involves the way assets will be managed. This gets into the activeness of the asset portfolio. There seem to be two schools of thought. The first one is the classic buy-and-hold strategy. The second one involves trading or purposeful disinvestment. It used to be normal to buy assets and hold on to them until they matured. I'm not sure a lot of companies do that anymore. Why should we be projecting future cash flows

under a buy-and-hold strategy when in fact that's not what the current practice is? That's where we get into trading assets. A company can create two types of cash flows -- namely, cash flow from operations, and cash flow purposefully created by getting rid of assets because it's the prudent thing to do from an investment point of view.

As a Valuation Actuary, you need to deal with these three issues -- positive cash flows, negative cash flows, and asset management as you run through a cash flow analysis.

ASSETS

MS. DONNA R. CLAIRE: The first order of business on the asset side is to determine which assets are backing the products you are valuing. This should be consistent with what is stated as the investment philosophy as filed with your state. If you have a segmented portfolio, it's the assets in the segment. Some companies do not have segments, but have dedicated pools of assets instead. This is also easy to handle in that certain assets are identified as belonging to groups of particular products. If you do not have segmented assets, you have several choices -- set up a segmented pool (remembering the principles of fairness and equity) or use prorata shares of all assets. Some people have a tendency to pick the best assets for the products that have to be tested, but picking the best assets to test is not fair.

The second thing you have to do on the asset side is to obtain a listing of assets, probably from your investment department. If you're lucky, there will be an investment data base which you can access. For example, Equitable uses the Investment Management Information System software, which allows anyone in the company to access the asset data base.

It has been my experience after talking to a number of other companies that there are some pieces of information that are lacking in terms of the asset listings that can be obtained by the investment department. One company that I know had two people work full time for a number of months going back through the original agreements to put the call premiums and call dates into their asset listings. This job has to be meticulously done, and if you're not on good terms with the investment department, you may wind up with some resistance on the investment side to getting that information. However, as many companies now know, it is extremely important in modeling to have the call dates and premiums, considering we went through a period of falling interest rates where anything and everything that could be called was. If necessary, you can send over an actuarial student to get this information into the asset model on in force assets, and from there on in try to convince the investment department to put the information on at purchase.

Case Study Life Insurance was able to provide a listing of all the assets and calls. (See Slide 9) Your investment department listing may have to be "massaged" to put it into a usable form.

Slide 9

CASE STUDY LIFE INSURANCE COMPANY

Assets Backing SPDA Line

Group	Rating	Book Value	Market Value	Coupon Rate	Coupon Pay Dates	Maturity Date	Par Value	Yield	Call Date	Call Date
1	3A	2173605.75	92.375	8.1	010731	07312003	2130834.32	7.88100		
1	3A	792965.75	92.375	8.1	010201	07312003	7249942.91	7.98916		0
1	3A	2211011.02	91.750	8.0	010201	09152001	78504.42	8.20290		0
1	3A	1149484.72	101.125	8.5	051115	05151999	1121491.74	8.17555		0
1	3A	19716424.81	101.125	8.5	051115	05151999	1928965.80	8.21980		0

If you do have a lot of assets, you may want to combine the coupons into various categories, based on the coupon rate and maturity. For example, the farther the coupon rate gets away from the current coupon rates, the more likely an asset will be called if it is able to be called. Case Study Life appears to have a fairly straightforward portfolio. I'm going to discuss each type of asset by itself. Case Study Life's assets have been simplified considerably in order to make it easier to follow. In real life, I'd try to use as much detail as practical.

By the way, if it is absolutely impossible to get information on call provisions, you can use some general assumptions. You would assume all bonds have a 5-year call protection period, and after 5 years are callable, with a typical call premium of 6 months' interest, in year 6, grading down to 0 in year.

Treasuries

The first asset class is Treasuries, be it notes, bonds, bills, zeros, CATs, strips, TIGRS, and so on. They are all very straightforward. They're 100% guaranteed by the government and they are all non-callable. Treasuries are the perfect asset except for the fact that they don't earn enough interest to support the rates most insurance companies are crediting. The coupon declared on a Treasury, if any, should be counted in the cash flow, and it should mature for the par amount.

Incidentally, I would not use the amortization of premium or discount as a cash flow item considering it is not real cash. To go to the extreme, if you had bought all 10-year zeros to back a product which did have cash flows over the next ten years, you'd have to borrow or sell the asset in order to meet the cash flows. Therefore on a cash flow basis, it is better to recognize the premium or discount at maturity or sale of the bond.

Corporate Bonds

Corporate bonds used to be the most popular assets -- either public or private placements -- for an insurance company to invest in. Many companies still have substantial amounts of corporate bonds. The major problem with this asset is that it is generally callable. Most of the time you can get 5-year projections, and new 5-year bonds may not have any call provision. However, anything longer than that will most likely have some kind of call provision.

There is a level at which very few bonds will be called. You're probably fairly safe if rates stay within 1% of the interest environment at which it was originally purchased. However, most corporations are very much aware of the amount of interest they are paying out. If the bonds are in a callable period, corporations will compare the extra money that must be paid for a call premium versus the amount they're paying in interest currently. If there is more than a slight difference, they will call the

bond. One fairly simple approximation for when the bond will be called was used for Case Study Life -- that is, the bond will be called whenever the coupon rate of the bond is 2% greater than the current coupon rate. This is shown in Slide 10.

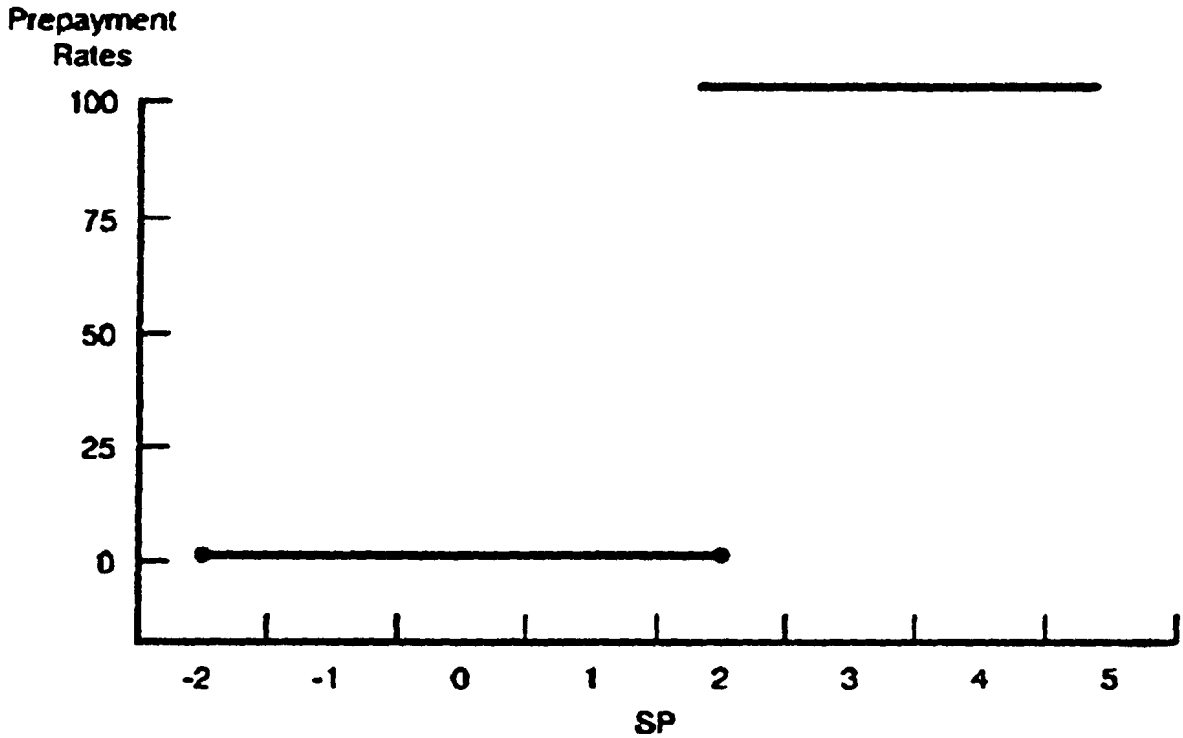
Another approximation is the following equation which is graphed in Slide 11: 25% the coupon rate for the corporate bond minus what the corporate bond is going for now minus .25 x call premium, with a minimum of 0 and a maximum of 100%. Either equation produces very high prepayments, which is what happens in real life. Very few of the callable bonds which were earning 13% a couple of years ago are still around. You can get more sophisticated by adjusting the equation for the maturity of the bond and also by adjusting for the fact that if the bond shortens the corporation can also reinvest in shorter term, lower yielding bonds.

One should also check other provisions in a corporate bond, such as sinking fund provisions. These provisions should also be modeled when applicable.

Commercial Mortgages

A number of companies, especially the larger ones, also have a decent sized commercial mortgage pool in their assets. Case Study Life did not. In general, these have characteristics similar to bonds in that they take coupons and pay back the principal at the end. Some of

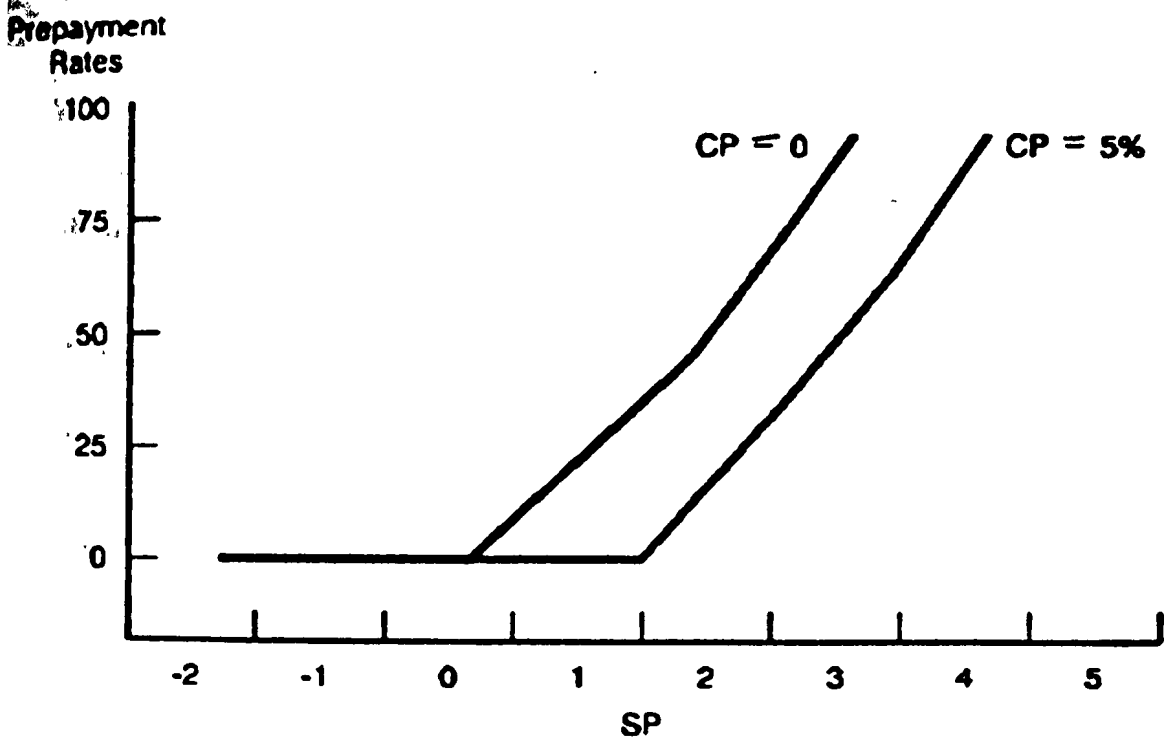
CALL RATE IN BONDS - METHOD ONE



SP – Spread Between Coupon Rates at Issues and Current Rate

ONE

CALL RATE IN BONDS - METHOD TWO



SP – Spread Between Coupon Rates at Issues and Current Rate

CP – Call Premium

these commercial mortgages do make sinking fund payments so you have to obtain that information from your investment department also.

Another area which you have to explore with the investment department is the prepayment provision. Commercial mortgages issued more than a few years ago contained fairly generous prepayment provisions. They allow the mortgagee to double up his principal and interest payment without any penalty. The penalty for early prepayment was as small as 5% in the first year, grading down by 1% a year. These mortgages would have to be modeled with this type of prepayment stream. Many of these mortgages have now been prepaid, and the new commercial mortgages may have a modern prepayment provision. This provision provides that if a company chooses to prepay the mortgage, the amount of the prepayment penalty is such that the mortgagor could take that money and invest it in T-Bills for the remaining period and still wind up with the same amount of interest. These could be effectively modeled as non-callable bonds, since there is little reinvestment risk.

Like public bonds, commercial mortgages have default risk. Commercial mortgages do not carry Standard and Poor ratings, but your investment department probably could give you equivalent ratings mortgages. Depending on the rating, a C-1 default risk charge should be subtracted, similar to corporate bonds.

Agricultural Mortgages

I have deliberately separated agricultural mortgages out because there are several companies that are heavily investing in them for their Single Premium Deferred Annuity (SPDA) and Universal Life portfolios. They are generally short mortgages, and can also be variable interest rate mortgages and thus would appear to be very well suited for a product that is interest sensitive. The problem is that many agricultural mortgages are defaulting: industry-wise this percentage is up to approximately 25%. Even in very good investment departments this percentage has been 10 to 15%. The C-1 charge against agricultural mortgages should be healthy enough to cover this type of default which, at this point, is even worse than junk bond defaults. This charge must be large enough to cover the interest forfeited, any opportunity loss when owning the property and a principal loss on sale of the asset. The needed holdback can be 75 basis points or more. The point is once the agricultural mortgage defaults, even if you do own the property, the property is probably not worth as much as the principal, and you cannot pay your Universal life or SPDA policyholders in corn, rice, or cows.

Government Backed Mortgages

Ginnie Maes, Fanny Maes and Freddie Maes (Government National Mortgage Association (GNMA) loans, Federal National Mortgage Association (FNMA) loans and Federal Home Loan Mortgage Corporation

(FHLMC) loans) have become some of the most popular investments for insurance companies. Their appeal is that they appear to give fairly high interest rates. The major problem with these loans is the duration risk. If you're buying new mortgages, these investments can last up to 30 years. They're currently being sold assuming a fairly high prepayment rate. If interest rates drop, this will not be the case and you will actually have an asset which has an average duration of more than 10 years. This may not be the type of assets that you really want in your portfolio to back short interest rate guarantees. In fact, early this year when interest rates started dropping, the market value of some of the current coupon GNMA dropped 40 basis points or more in a day. This can lead to substantial problems if it is your major investment.

Some companies buy high coupon GNMAs assuming the duration will be very short. The problem with this is that you're buying these GNMAs at a premium. Let's say you bought 12% GNMAs, you're assuming the duration of two years, so in this interest environment you're assuming you're earning 9% on your money if you buy them for 113. If instead interest rates drop more all these GNMAs may be prepaid in a year and you can actually suffer a principal loss on your GNMAs of up to the 13 that you paid above principal. On the other hand, if you had low coupon GNMAs, such as the 8%, and rates started rising, you may have thought you bought a 5-year asset and you really have a 17-year asset with no possibility of reinvesting the money at the higher rate. It is therefore very important for those who have any major amount of

money in GNMAs to model these correctly in terms of the effect of interest scenarios on the GNMAs.

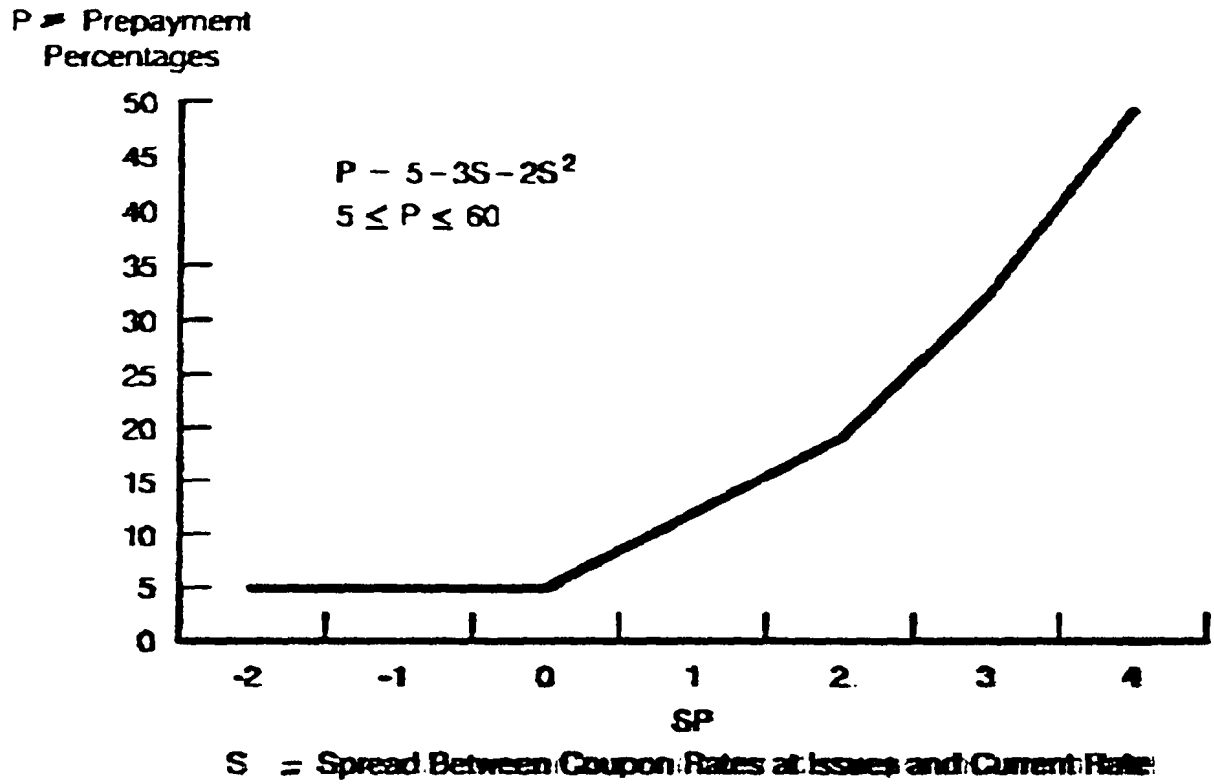
One equation to use for prepayments is: 5% plus the spread between the market rate and the coupon rate times 3, plus 2 times the spread squared. (See Slide 12.) This produces premium rates as seen in this graph which gets fairly high once you are out of the market. There are a number of factors that affect prepayment rates, such as people moving, how many years left to the mortgage, general economy in the area, employment statistics and so forth. The more mortgage backed securities you have, the more scientific you may want to get with your modeling.

Junk Bonds

Junk bonds have come to play a more important part in an insurance company's overall portfolio. Case Study Life had about 10% of its assets in junk, which is probably fairly typical. The highest concentration of below investment grade investments in a portfolio that I have seen is 43%, but several large companies also have junk bond portfolios ranging between 15 and 20%. This issue has caused much controversy in the industry between the haves and have nots.

Incidentally, there are very few companies who are not currently investing in some kind of junk. For example, there is one large insurance company which has publicly taken a stand against junk bonds; however, its investment department is investing in shares

PREPAYMENT ASSUMPTION OF GNMAs



leveraged buyout funds. These leveraged buyouts are also classified as junk.

Those heavily into junk claim that their investment people are above average in determining which of these will probably default. Unfortunately, insurance companies own over 1/3 of the junk assets, and I haven't come across an insurance company yet that will say that they're the ones who will be stuck holding the junk which finally defaults. If you're not totally into junk, it is probably acceptable in terms of modeling to subtract around 2-1/2% of the principal to cover default. If you are fairly heavily into junk, you probably should model more rigorously by determing what the effect would be of a recession (which various economists are predicting within the next two to three years).

Also, if you're into junk, check your diversification. If your junk is all in one industry, such as the airline industry, you may be more exposed to risk of adverse deviation and may want to hold higher reserves.

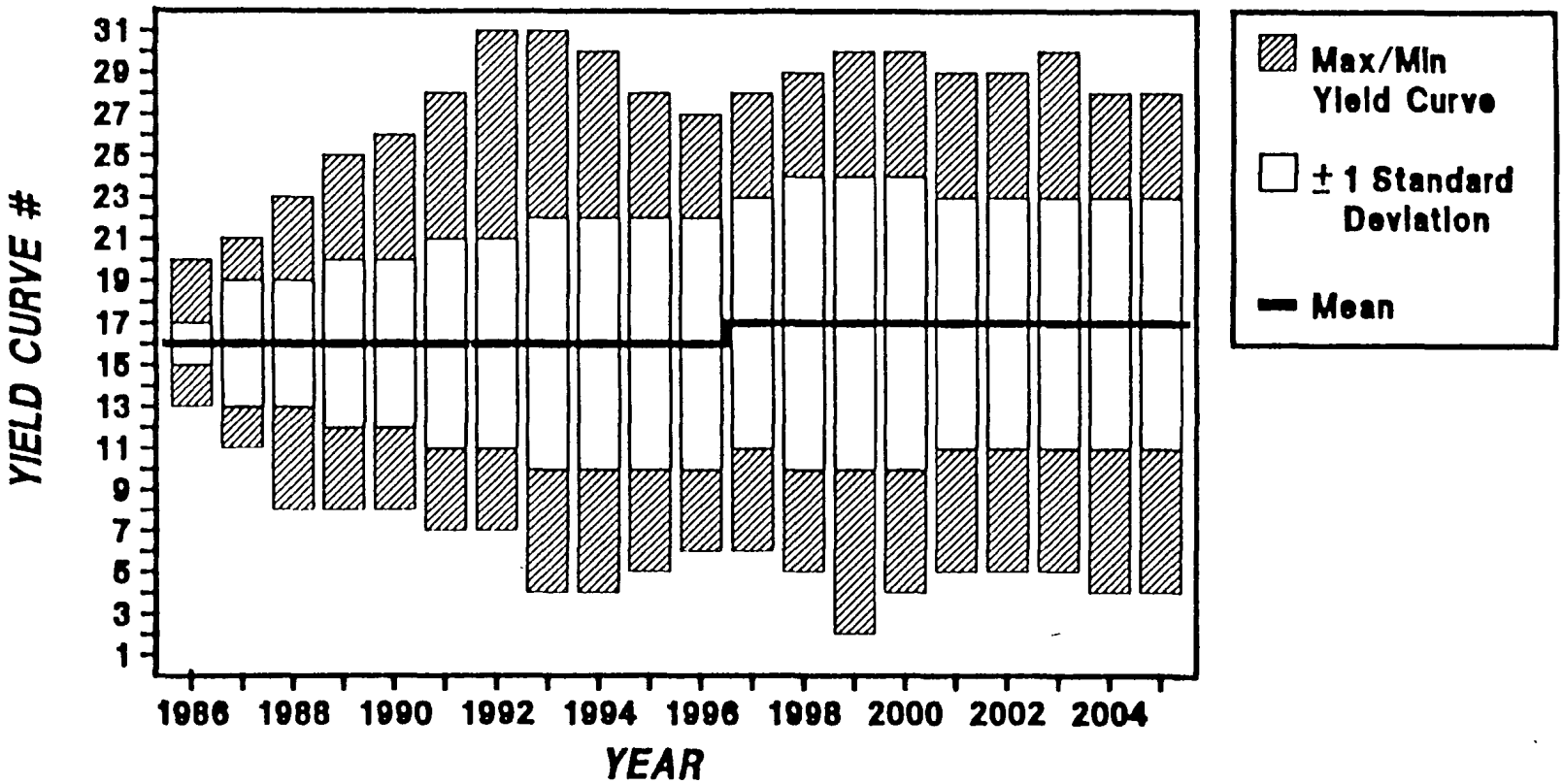
Real Estate

Case Study Life doesn't have any real estate in their portfolio. Real estate has been becoming more popular in the portfolios of interest sensitive products because the asset is inflation adaptive (hopefully, anyway).

There are, however, a number of problems in modeling real estate. First, in order to do the cash flow, you should check with your investment department as to the expected cash flows, not just expected average returns on this property over the expected holding period. In many instances the expected cash flows are fairly low. The second issue is, when do you assume that you sell the property? At least one company has a plan filed wherein they would sell the property at the end of 7 years. If this is actually what they do, this assumption can be used for modeling. Another company skirts the issue by assuming the property is sold immediately and then reinvests that money into 5-year bonds which are easier to model. Again this short cut is probably fine if you don't have that much real estate, but if you do you really should model the real expected cash flows.

The third issue is what the price will be when the real estate is sold. Many investment departments predict something like a 5% per year increase in the value of their real estate, totally ignoring interest environments. A better assumption in terms of modeling would be that the real estate would appreciate at the economic interest rate plus X% (for example, 3%). This amounts to assuming a real gain of X% (for example, 3%) per year in the value of the real estate.

CASE STUDY LIFE
Summary of Yield Curve Trials



Sample Cash Flow Based on Analysis

MR. GREGORY D. JACOBS: We are now going to look at a sample cash flow based analysis. This analysis will be performed for a company we will call Case Study Life. This analysis, however, is based on an actual company using their actual assets and their actual product.

The product we are going to study is a single premium deferred annuity (SPDA) because it's the simplest product to model and to illustrate. The product has expense charges. Surrender charges are 7% in the first year graded down to 0 in the seventh year. The guaranteed interest rate is 4%, and there is no bailout provision. The portfolio credited rate is currently 10.25%, which is a little on the high side for this time period.

Let's look at the existing business in force information.

In Force Information

Issue Year	Policy Count	000 Omitted Account Value	000 Omitted CARVM Reserve
1980	3,700	$ 92,500	$ 92,038
1981	4,000	116,500	114,752
1982	3,500	92,500	90,189
1983	3,000	85,000	82,024
1984	3,300	109,200	104,286
1985	5,500	128,900	121,809
1986	1,500	40,600	37,961
Total	24,500	$665,200	$643,059

is 50%, and the mortality assumption is the 1965-1970 Ultimate Male Table. The investment expense is 25 basis points. Other expenses are $30 per policy inflated at the 5-year treasury rate less 4%. This projection is an after federal income tax projection. We're assuming that the tax rate is 34% of the statutory gain, so it must be a stock company (no surplus tax).

The strategies tested are shown below.

Interest Crediting Strategies

1. Net Portfolio Earned Rate less 150 basis points
2. Market/Competition Rate (Greater of 1-year T-bill or 5-year average of 5-year Treasury Bond)

Investment Strategies

1. Invest positive cash flows in 30-year GNMA
2. Invest positive cash flows in 5-year A-rated corporate bonds
3. Invest positive cash flows in highest yielding security (up to 10 years)

   Negative cash flows are treated as borrowing at a rate of 1-year T-bill plus 100 basis points.

We are testing a lot of strategies here. You wouldn't normally do this many studies. We're doing it purely for illustrative purposes for this Symposium. The actual situation at this company was an interest

crediting strategy of a net earnings rate less a spread, and the investment strategy was 5-year A-rated corporate bonds.

Within each of these six strategies we did 40 randomly generated Monte Carlo interest rates scenarios or trials. One scenario or trial consists of moving from one yield curve to the next, where the movement was randomly generated given the constraints of a probability matrix. Each move was independent of the previous move. Each trial was independent of the other trials. Finally, each trial was given equal probability of occurring. We have not weighted the trials based on what we think may be possibility of occurrence. A summary of yield curves trials is graphically shown in Slide 13.

An example of trial 20 follows.

Example of Trial 20 Yield Curves

Year	Yield Curve #	Treasury Yield Rate			
		Short Term	3-Year	10-Year	20-Year
1986	16	6.29%	6.36%	6.96%	8.17%
1987	18	7.26	7.32	7.87	8.97
1988	21	9.49	9.53	9.85	10.49
1989	20	8.64	8.69	9.11	9.94
1990	20	8.64	8.69	9.11	9.84
1995	25	13.95	13.93	13.73	13.11
2000	26	15.33	15.29	14.95	13.87
2005	18	7.26	7.32	7.87	8.97

In 1986, we were at yield curve 16 which meant that short-term rates were 6.29%, 20-year rates were 8.17%. We threw the dice (that is, randomly generated movement); we let the transition matrix tell us where we're going to be, and in 1987, we jumped 2 yield curves. Now we're in yield curve 18 which was 7.26% short and 8.97% long. We did the same thing through the next 20 years. Looking at this particular example, it was one of increasing interest rates. Obviously, the other 39 trials tested exhibited different patterns. We took this interest rate environment and ran it through our interest-sensitive assumptions and our investment philosophies, and we ended up with some cash flows and profit results. We did this 40 times under each of the 6 strategies tested.

We're going to get into the results next, but first Mr. Doll is going to talk about the liability-side functional relationships that we used in this case study. Then Ms. Claire is going to talk about the asset-side functional relationships.

MR. DOLL: In the scenario/trials that we ran, you might have noticed that the mean yield curve stayed level for the most part. That's a function of the fact that the transition matrix doesn't assume there's any particular downward or upward trend in the interest rates, so the mean tends to stay in the same place. That's a little troublesome because in real life if you started out with a situation where interest rates are at an unusually high level, you might wonder if they're going to average that same level in the next twenty years.

MR. JACOBS: That was just a simplifying assumption that was made. The assumption implied that interest rates were as likely to go up as to go down. If your company thinks there's a trend that interest rates are headed up, then you ought to project them that way.

MR. DOLL: We've gone over the functional relationships twice. I think we've defined them sufficiently well, so I'm not going to elaborate on them except to make one point. In our particular case study, the credited rate at the starting point of the valuation is significantly above the market rate. Therefore, you might think that the market rate crediting strategy tests that we ran would probably not be very good. However, in this particular case study, we had so many bond calls in the first few years that the earned rate rapidly fell down to where the market rate became a factor. All in all, looking at the results of the 6 different sets we ran, the functional relationships did make pretty good sense.

MS. CLAIRE: Appendix C-Section 1, the Actuarial Statement of Opinion, is really a summary of Mr. Jacob's discussion on yield curve trends. In that Appendix, you'll notice the actual yield curve universes that were used along with the transition probabilities. Appendix C-Section 2 of the opinion statement goes through the description of the assets. Let me just briefly go through some of the asset items. You'll notice that Case Study Life has about 5% of their portfolio at the end of 1986 in the GNMAs and the rest in bonds.

This is reasonably representative of a small to medium-sized company. The breakdown by call provision shows that over half their assets were callable. Again, this is based on a real company, and it is the area that does cause the most problems. Also, Case Study Life had about 10% of their assets that were of Bankers' Blanket Bond (BBB) quality. The assets that you have to worry about most are the high coupon callable bonds. The bonds with 10% to 16% coupon rates did wind up being called in most of the trials that we ran. The actual asset portfolio used for Case Study Life can be found in Section 2 of the Actuarial Statement of Opinion. I recommend that you work in as much detail as possible when you are doing this testing instead of summarizing the assets to the extent done in this example.

MR. JACOBS: Now we're going to look at some results. The baseline situation was a crediting strategy of earned less a spread and an investment strategy of 5-year corporate bonds. We did a 20-year projection and looked at the accumulated surplus where we started the projection with assets equal to reserves.

The results are shown on the next page:

Results of 40 Trials

Earned less Spread/5-Year Corporate Strategy

(000 Omitted)

20th Year Surplus:

Mean	$ 90,644
Highest	135,814
Lowest	-86,135
Standard Deviation	42,721

Number of Negative Trials: 1

Probability of 20th Year Surplus Being less than $0: 1.7%

(Based on normally distributed results)

Additional Reserve Required to Make

Probability of Inadequacy less than 1%: $ 1,815

(0.3% of Statutory Reserve)

Some comments concerning these results are in order. The mean twentieth year surplus was about $90 million, which is a good sign. The highest surplus level of the 40 trials was about $135 million, while the lowest was $86 million. The standard deviation was $42 million, which means the results were not very volatile. The number of

negative trials out of the 40 was 1.

Next, I'll introduce a potentially new concept that maybe has not been used before in this context. The probability of the twentieth year surplus being less than 0 is 1.5%. I came up with this probability by assuming that the results were normally distributed. If this is a Monte Carlo simulation and the trials are in fact all independent, then one would surmise that we would end up with some sort of normal distribution of results. We need more research in this area. Other individuals have done some studies in which they've run thousands of trials in hopes of seeing if, in fact, the results were normally distributed. For the sake of argument, let's assume they are so that the rest of my presentation makes sense.

Another potentially new concept is the additional reserve required to make the probability of inadequacies less than 1%. To arrive at this number, I took the present value of the cash flows that were generated in each trial using the interest rate of that particular trial as the discount rate. I ended up with the present value of profits at the beginning of the projection period. Assuming again that the results were normally distributed, I used the standard deviation and the mean to determine the point at which the probability that the present values are less than 0 is no more than 1%. It turned out that I need to add $1.8 million dollars to my reserve to feel 99% confident that my reserves are adequate. The conclusion that I reached was that statutory reserves make good and sufficient provisions for all

future obligations on a basis sufficient to cover future reasonable deviations from expected assumptions.

The next item I'd like to go over is a comparison of results using different scenario generation methods. Mr. Dicke talked a little about the generation of scenarios. He pointed out that there seemed to be two schools of thought. Let's call these methods the Monte Carlo method and the lognormal method. We generated 40 interest rate trials using both of these scenario generation methods for the earned less spread/5-year corporate bond strategy.

The results are as follows:

Comparison Results

40 trials were run using two different scenario generation methods:

Monte Carlo -- Randomly generated using a starting yield curve, a yield curve universe, and a probability-of-movement matrix.

Lognormal -- Randomly generated using a starting yield curve, a volatility factor and a lognormal distribution function.

The results (looking at the 20th year surplus):

	Monte Carlo	Lognormal
Mean	$ 90,644	$ 83,369
High	135,814	136,826
Low	-86,135	-114,255
Standard Deviation	42,721	42,080

The differences between the results of these two methods are not significantly large to warrant a statement that says it makes a big difference how you create scenarios.

Let's move on and look at a summary of the results for all the interest crediting/investment strategies that were tested.

Results of 40 Trials

All Strategies
(000 Omitted)

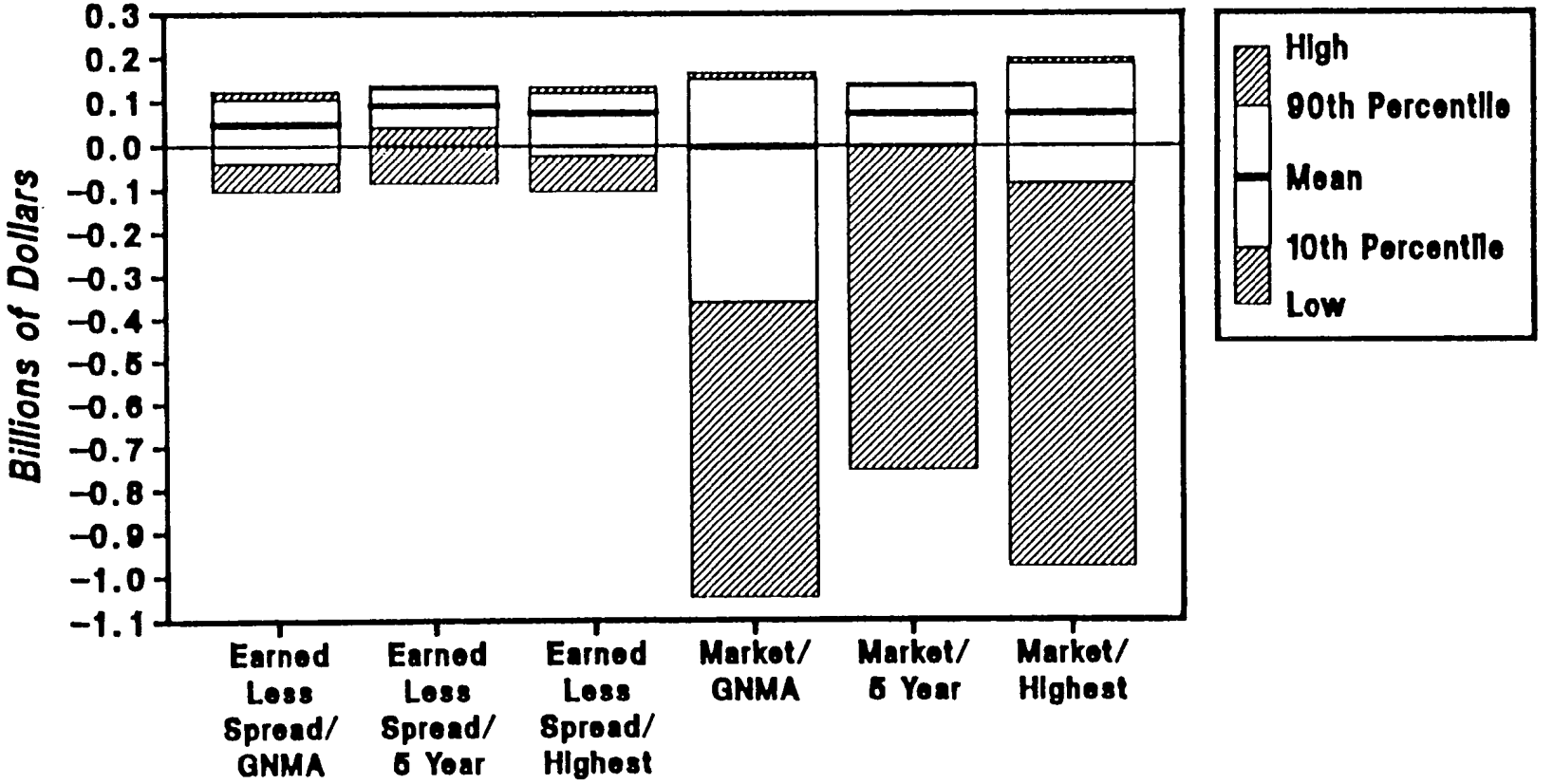
	Earned less Spread			Market		
Strategy	GNMA	5-Year	Highest	GNMA	5-Year	Highest
Mean 20th Year Surplus	$47,883	$90,644	$72,880	$3,371	$70,743	$71,553
Number of Negative Trials	9	1	5	11	4	6
Probability of Surplus Less than $0	20.1%	1.7%	9.2%	50.6%	31.2%	36.9%
Conclusion	?	Good & Sufficient	?	?	?	?

This table contains the twentieth year mean surplus, the number of negative trials, the probability that the twentieth year surplus is less than 0, and a conclusion. The conclusion deals with the ability to make a firm statement about the adequacy of the reserves. As can be seen, there are several questions concerning the conclusions that can be reached. The only strategy for which I personally can conclude reserves are adequate happens to be the one that this company is actually following -- earned less spread/5-year corporates. In all of the other strategies, I can't feel comfortable signing a good and sufficient statement with the probability of inadequacy.

Slide 14 contains a graphic summary of the results. These graphs are called boxplots. These boxplots capture some rather interesting information. The more compact they are, the less volatile the results are. This shows that the earned less a spread crediting strategy is much less volatile than the market crediting strategy. Also, the fraction of each boxplot that extends below the $0 line shows approximately the probability of the ending surplus being negative. Finally, all of these boxplots are skewed on the downside. That means that the results are not following a normal distribution. There is a longer tail on the probability distribution function curve on the down side than on the upside.

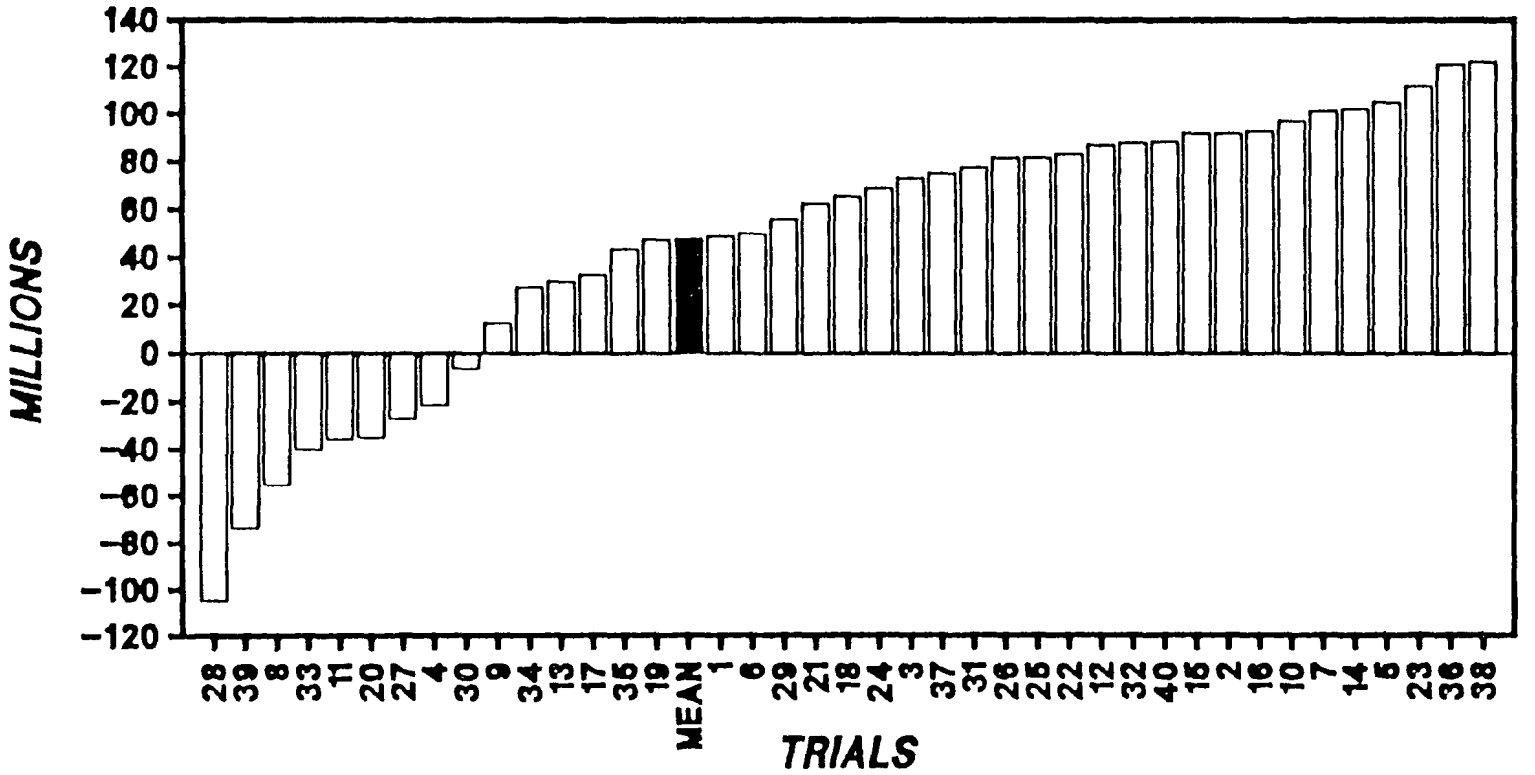
Let's look at a few more graphs showing the results of these studies. Slides 15 through 20 show the twentieth year surplus for each of the 40 trials, together with the mean, for each of the six strategies tested.

CASE STUDY LIFE
Summary of Results – Ending Surplus



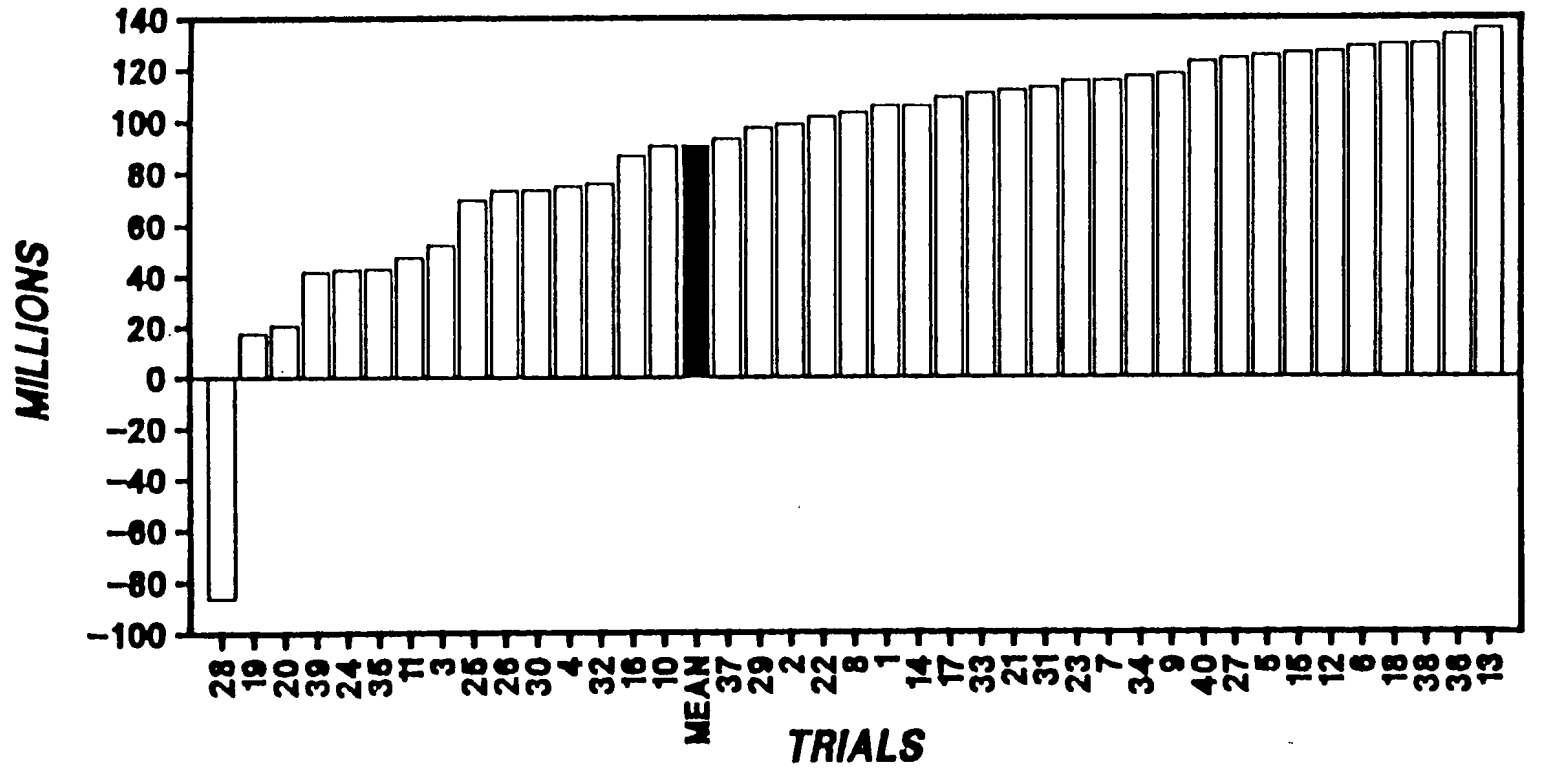
CASE STUDY LIFE
20th Year Surplus

Earned less Spread/Invest in GNMAs



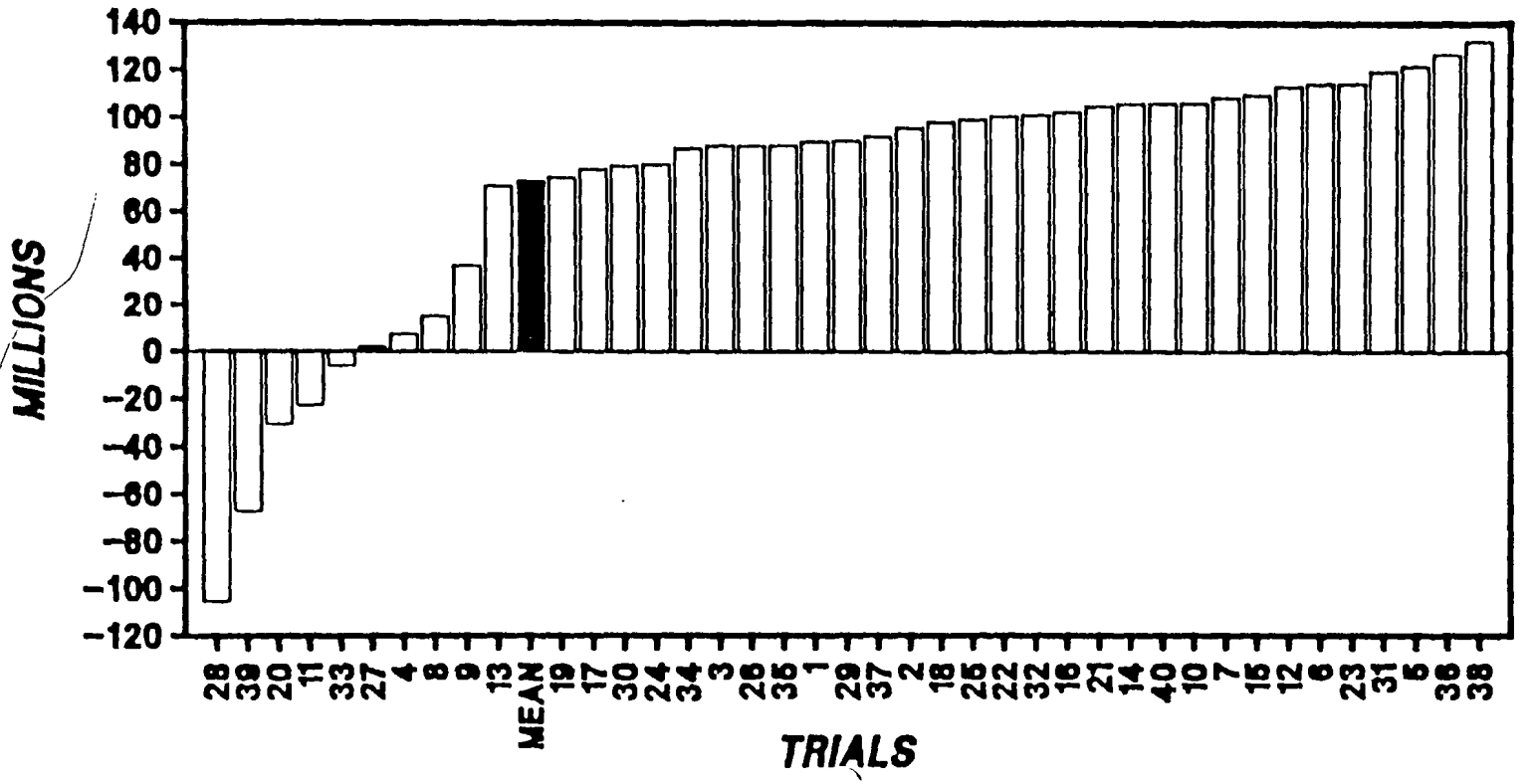
CASE STUDY LIFE
20th Year Surplus

Earned less Spread/Invest in 5 Year Corporates



CASE STUDY LIFE
20th Year Surplus

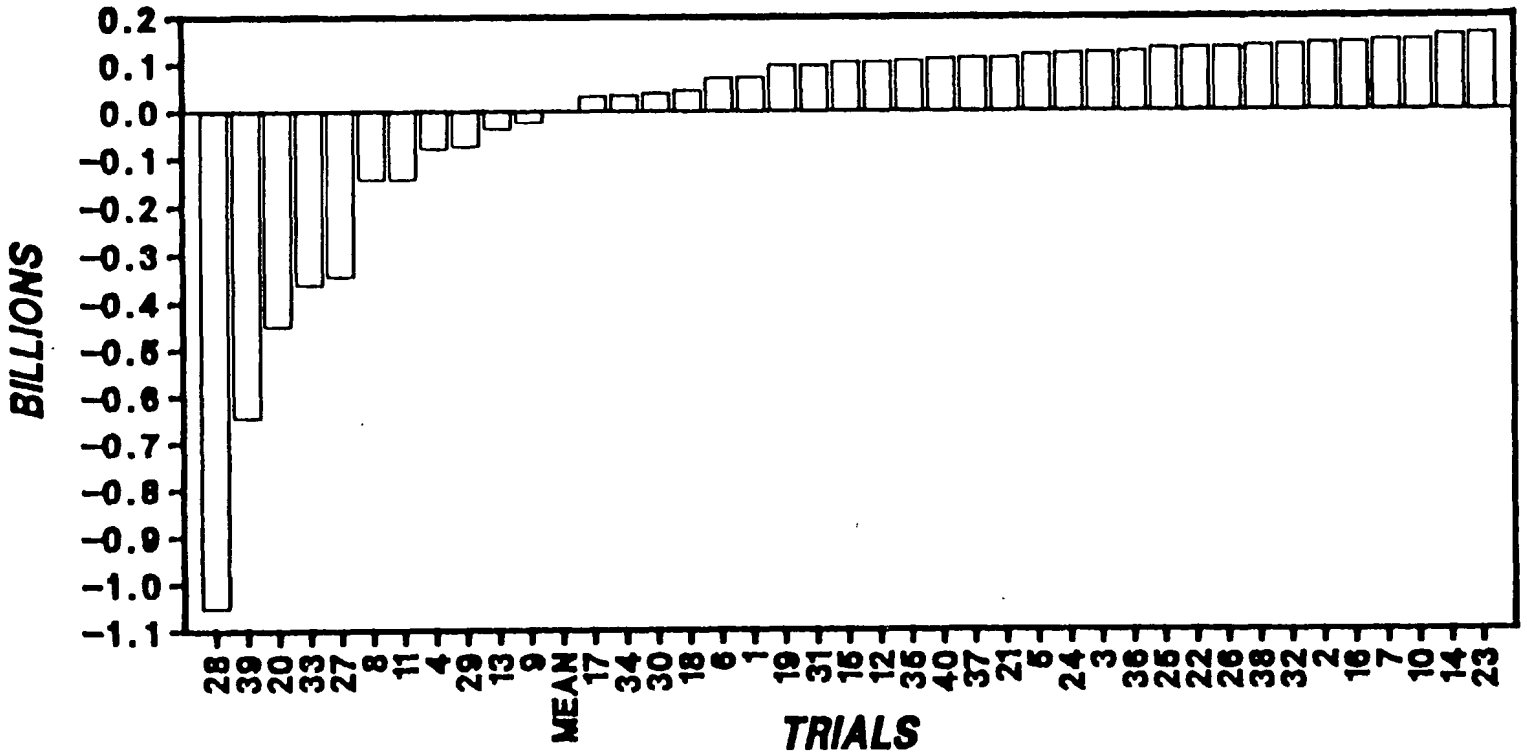
Earned less Spread/Invest in Highest Yield



TRIALS

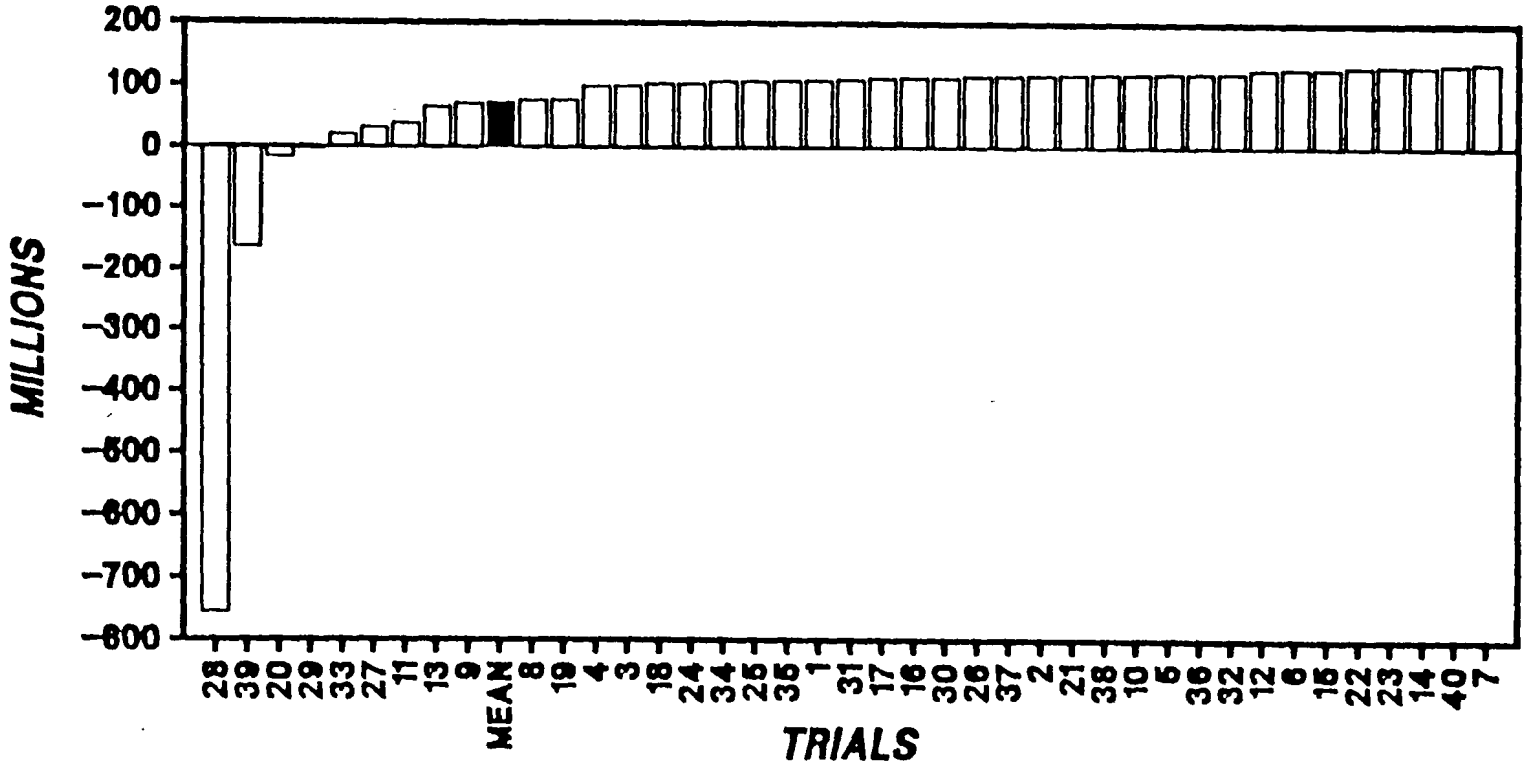
CASE STUDY LIFE
20th Year Surplus

Market/Invest in GNMAs



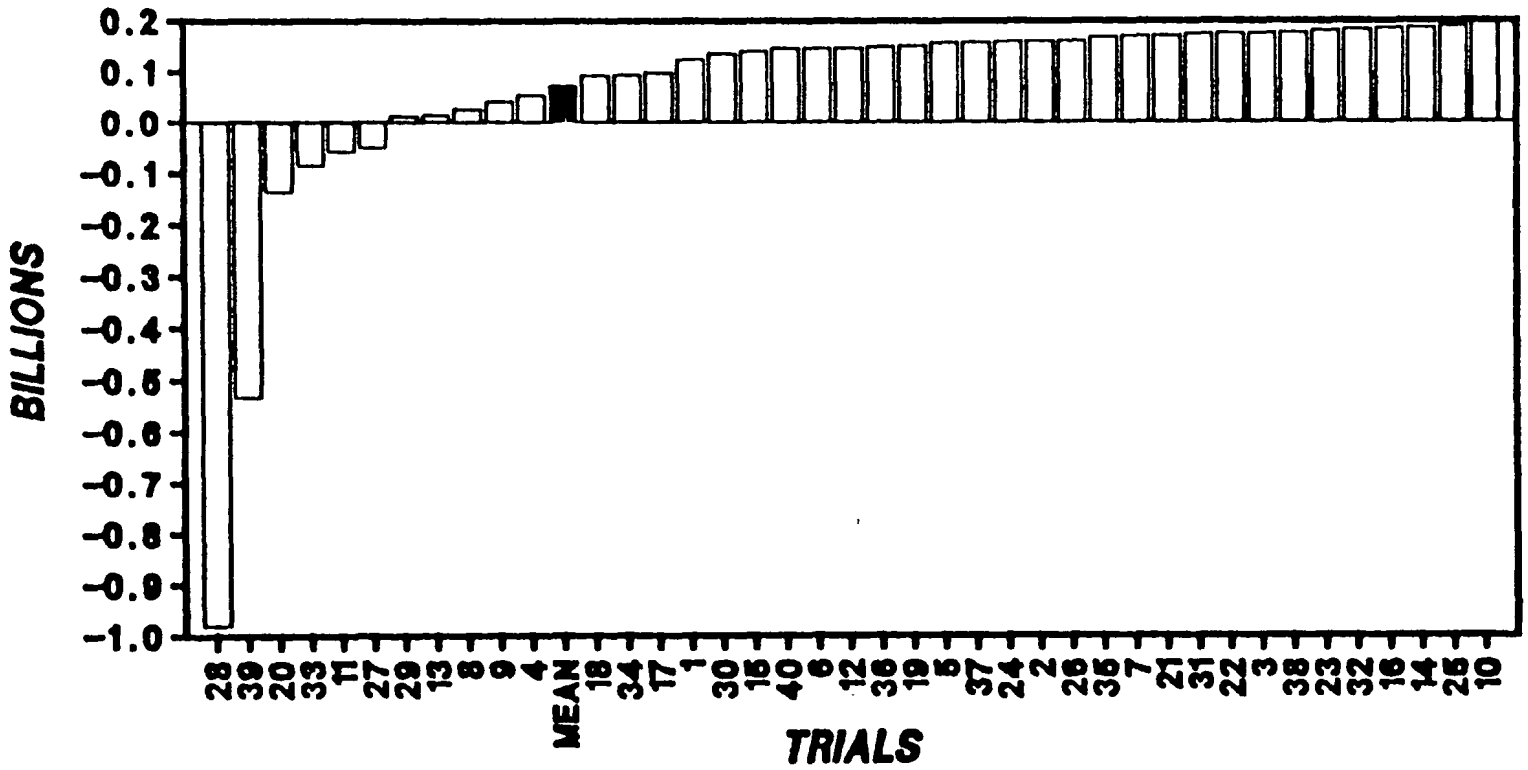
CASE STUDY LIFE
20th Year Surplus

Market/Invest in 5 Year Corporates



CASE STUDY LIFE
20th Year Surplus

Market/Invest in Highest Yield



The results are sorted from the lowest surplus figure to the largest. A few interesting comments are in order:

1. The worst trial in all strategy tests was trial 28. In this trial, interest rates increased sharply over a 7-year period and stayed at this high level for the next few years. At this high interest rate level, the yield curve was inverted.

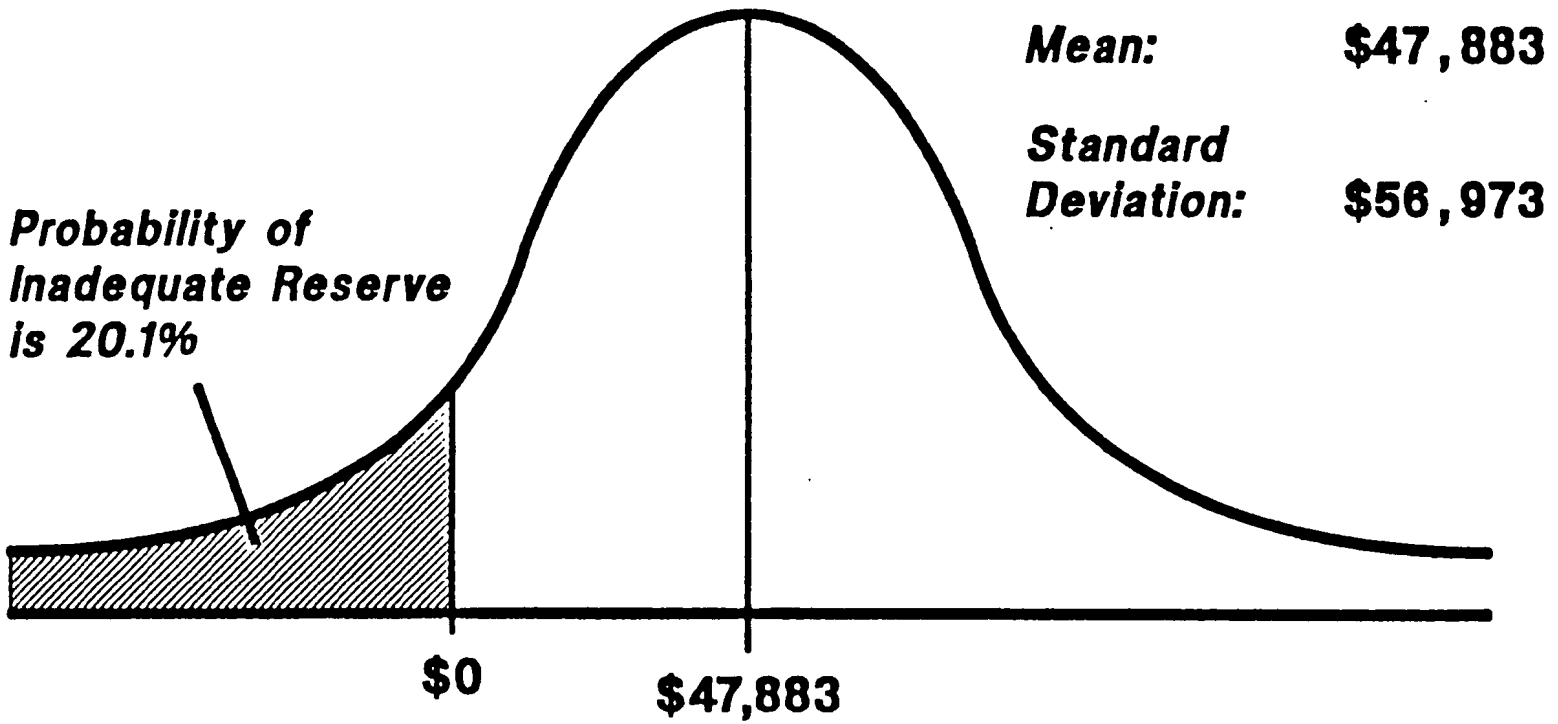
2. The losses are much more severe when the market crediting strategy is followed. This results from a "borrowing spiral." When the credited rate is the market rate, the functional relationship formulas dealing with excess lapses do not come into play and are not used. That is, if the product is always crediting at the market, there are no excess, market-induced lapses. Because there are no excess lapses (or no "run on the bank"), the company experiences enormous losses due to crediting the policyholders rates that far exceed its interest earnings. These losses are financed through borrowing which puts a further drain on profits.

Let's look at one last set of graphs. Slides 21 through 26 are a pictorial view of the "probability of inadequacy" concept I spoke of earlier. These are simply normal curves which show the area under the curve representing the probability that the ending surplus is less than $0.

CASE STUDY LIFE

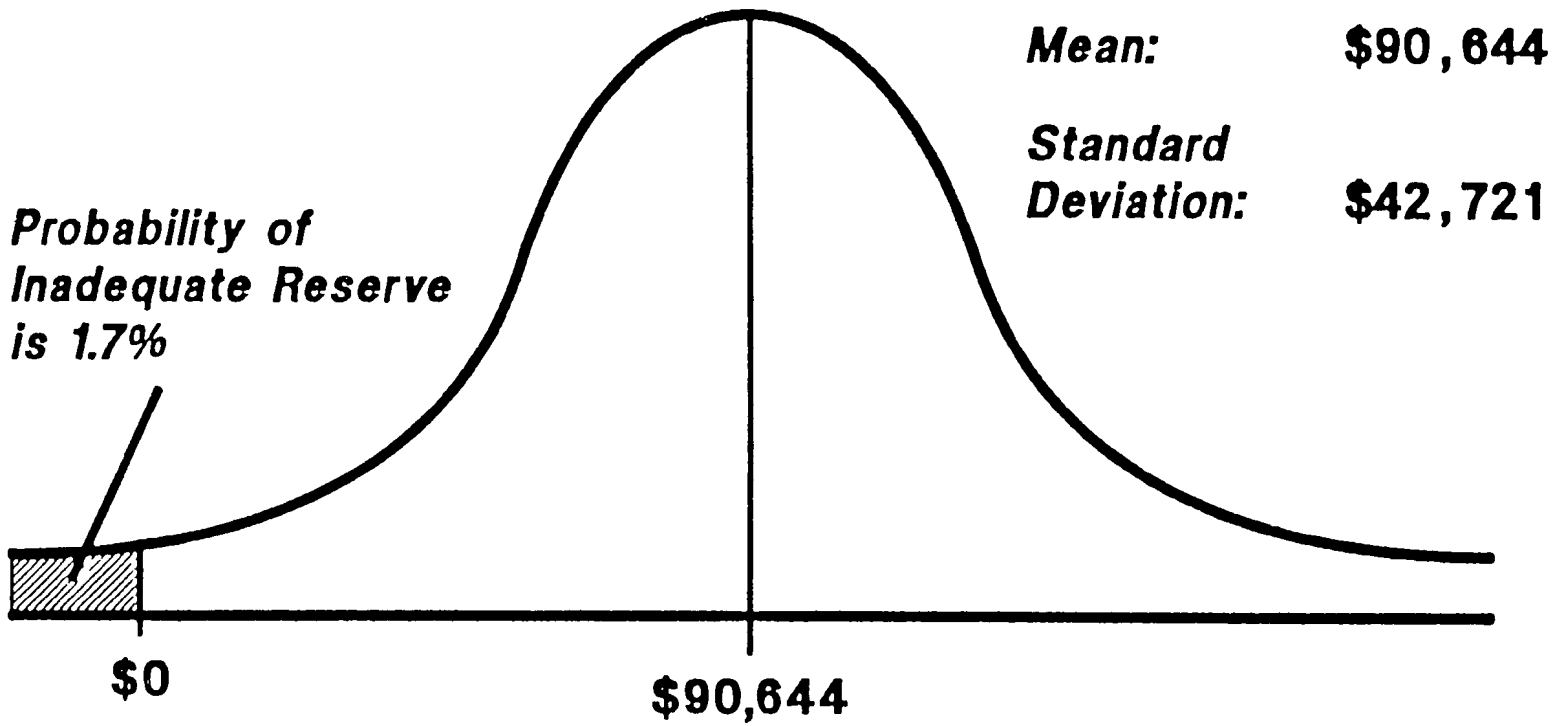
20th Year Ending Surplus

Earned less Spread/Invest in GNMAs



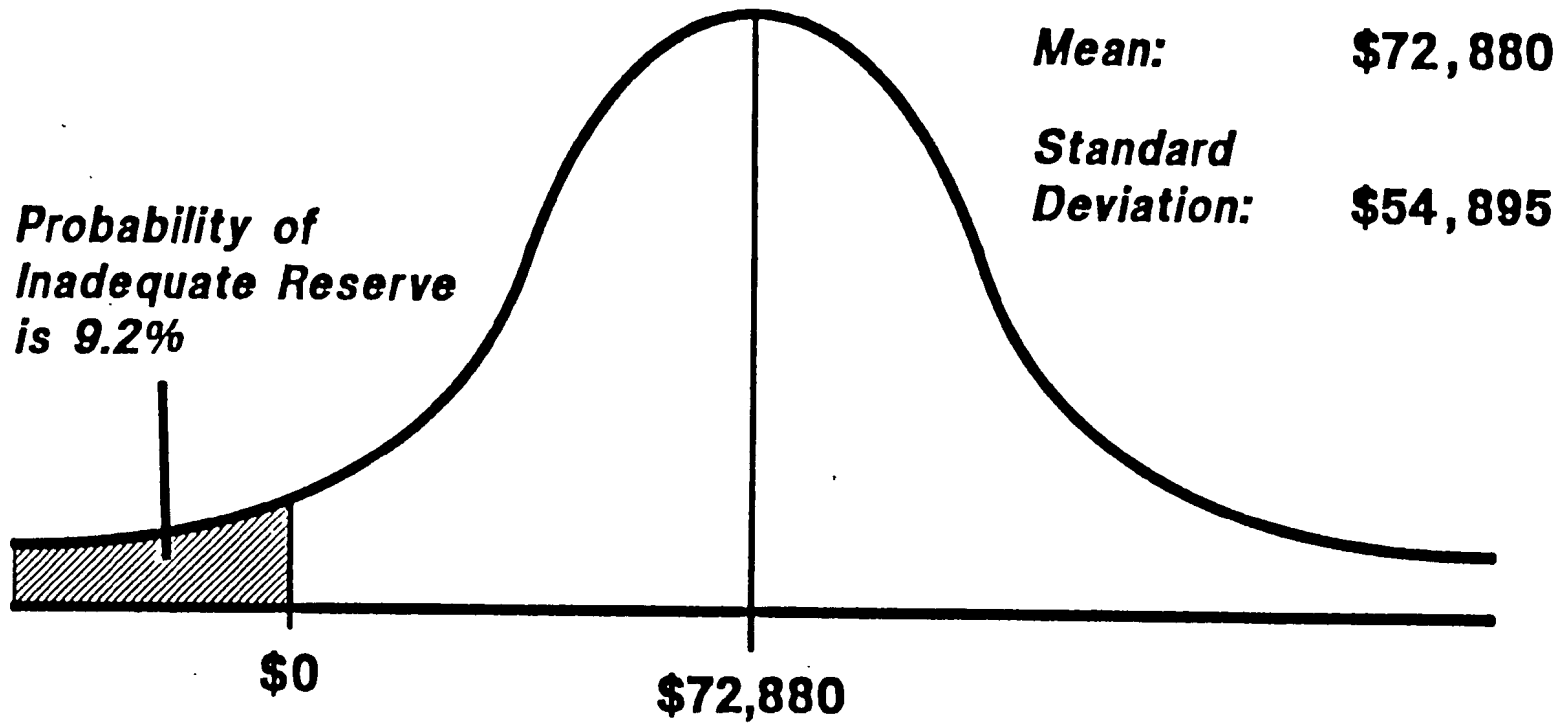
CASE STUDY LIFE
20th Year Ending Surplus

Earned less Spread/Invest in 5 Year Corporates



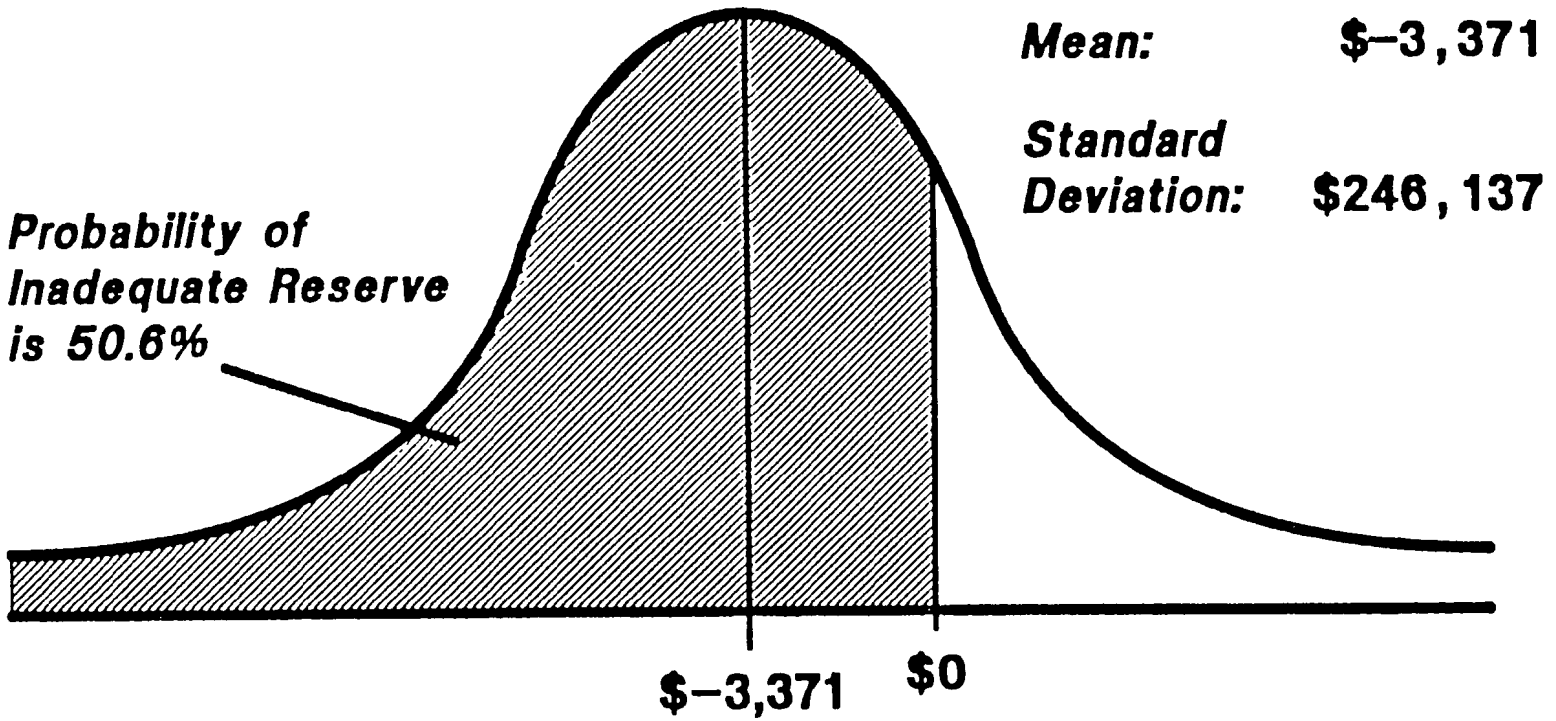
CASE STUDY LIFE
20th Year Ending Surplus

Earned less Spread/Invest in Highest Yield



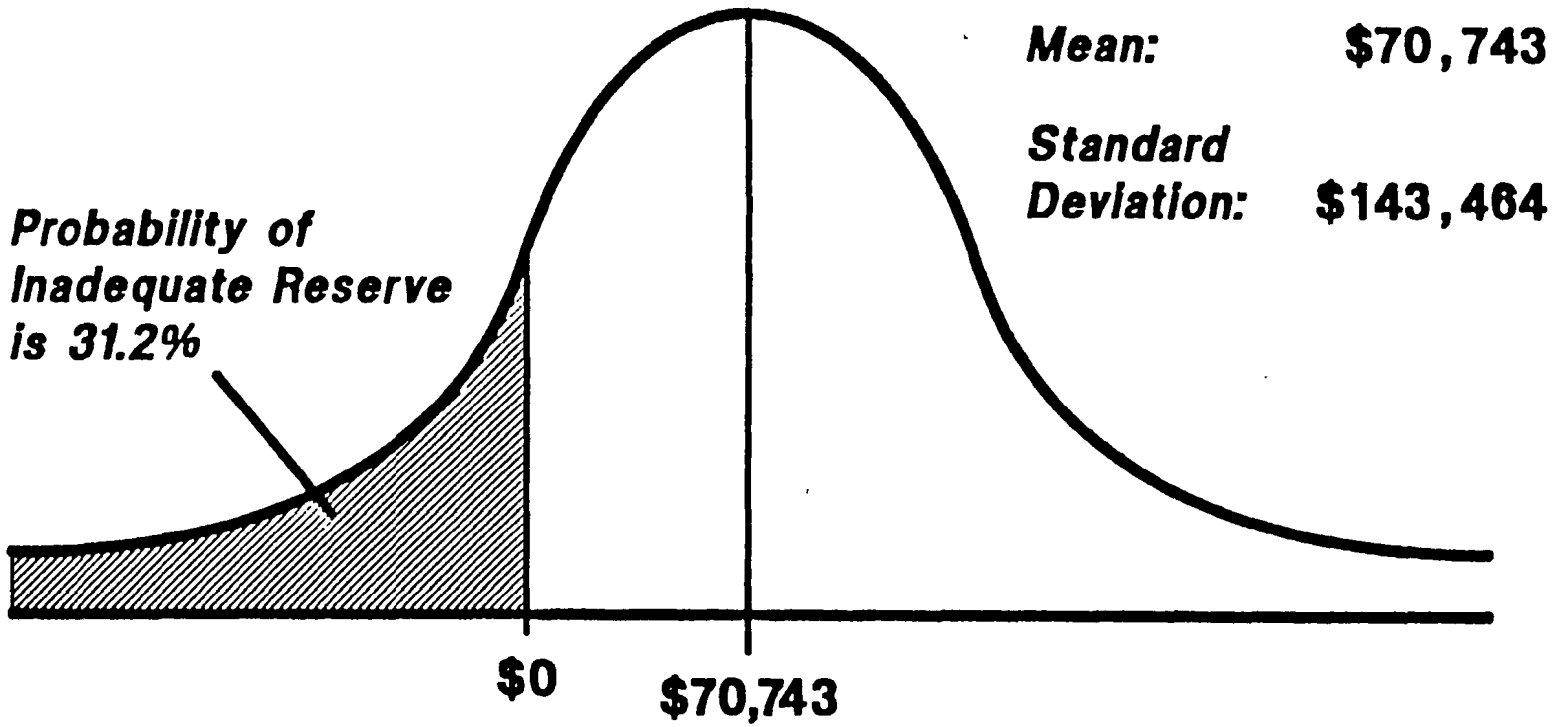
CASE STUDY LIFE
20th Year Ending Surplus

Market/Invest in GNMAs



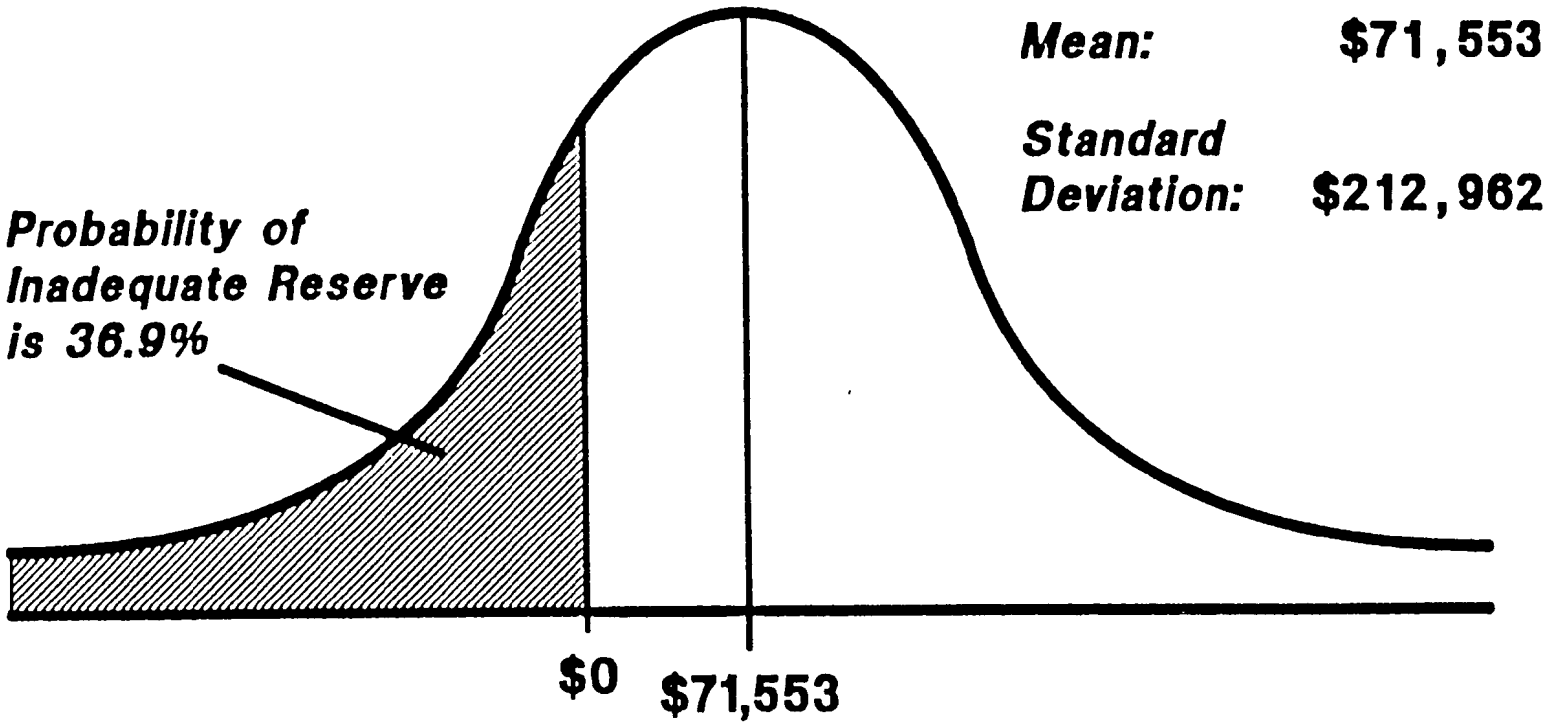
CASE STUDY LIFE
20th Year Ending Surplus

Market/Invest in 5 Year Corporates



CASE STUDY LIFE
20th Year Ending Surplus

Market/Invest in Highest Yield



In doing this analysis, I made a few assumptions (or took a few liberties). First, I assumed that 40 was a number large enough to allow the Law of Large Numbers to apply. Second, I made use of the Central Limit Theorem that states that if the sample is large enough and the mean and the standard deviation of the sample are known, we can use this mean and standard deviation to represent the distribution of the random variable in question. If you believe in all of this, then you can determine the area under the curve.

For all of these strategies, other than the baseline strategy, I would have a lot of problems signing a good and sufficient opinion. So, in each of these cases I would have to set up an additional reserve. How do you get that reserve figure? I used an approach that I mentioned a little bit earlier. Instead of accumulating these cash flows as ending surplus, take the present value of these cash flows to get a present value of profits. The discount rate used in the present value calculation needs to be the same as the accumulation rate used in the ending surplus computation. This discount accumulation rate is dependent upon the particular year and the particular trial we are experiencing in the study. With the distribution of the present value of profits and the normal distribution assumption, we can figure out how much extra reserve we need to set up today to meet certain confidence intervals.

The table below shows the additional reserve that is necessary to make the probability of reserve inadequacy less than 1%.

Strategy	Additional Reserve Required to Make Probability of Inadequacy Less than 1%
Earned less Spread/GNMA	$ 30,851 (4.8% of Statutory Reserve)
Earned less Spread/5-Year Corporate	1,815 (0.3% of Statutory Reserve)
Earned less Spread/Highest	20,486 (3.2% of Statutory Reserve)
Market/GNMA	166,162 (25.8% of Statutory Reserve)
Market/5-year Corp.	39,568 (6.2% of Statutory Reserve)
Market/Highest	109,104 (17.0% of Statutory Reserve)

Recall that reserves should cover reasonable deviations while reserves and surplus cover reasonable and plausible deviations. This analysis of additional reserve requirements can also shed some light on the second of these two opinion statements. If the company's surplus (at least that assigned to this line of business) equals or exceeds these additional reserve amounts, I would feel comfortable signing a good and sufficient opinion statement that the reserves and designated surplus cover reasonable and plausible deviations in experience.

One of the key points of my presentation is that with the technology we have used in creating these types of cash flow projections and the analyses that I've done here, we have the techniques that could be used to evaluate reserve levels and make some actuarial statements as to what the reserves ought to be to attain certain probabilities of reserve adequacy. Ultimately, when we get away from the current valuation laws, the analytical tools described today could be the mechanism that will allow us to come up with reserve numbers. Maybe

some of the people on the panel would like to make some comments.

MR. DICKE: In these different studies, the mean might be a reasonable estimate of the profitability. So, what we're saying here is that if you want to be 99% sure that you have enough assets, you may need to hold extra reserves even if your studies show that, on average, the business is profitable. The other point I'd like to make is that in all these cases we assume that a hard and fast crediting strategy and investment philosophy was followed. I would hope that what would come out of runs of this would be more flexibility in this regard. For example, if your management has been committed to investing in GNMAs, and if you have been nervous about that, this is a good way to prove to them that there's a potential problem in following that philosophy. You can't continue to follow that strategy for the indefinite future. I think that management would want to modify its investment philosophy and crediting strategies before being required to set up higher reserves.

MR. DOLL: I have a couple of comments that might help you understand why the results came out as they did. First, the assets in our case study had a lot of bonds that were callable in the first two years of the projection. Therefore, the reinvestment strategy had a lot of effect on the answer. Whereas if you had a much smaller percentage of callable bonds, the reinvestment strategy may not have made such a big difference. Secondly, crediting the market rate obviously had a lot worse results than crediting based on the spread.

We did have a fairly conservative market rate definition, being the higher of a 1-year Treasury rate or a 5-year average of a 5-year Treasury rate. I suspect that we may have gone a little bit overboard on our definition of market rate.

Also I want to make sure that you don't go away from here thinking that the technology for creating scenarios is absolutely perfect and free of assumptions. For the Monte Carlo method, there are assumptions involved in setting the initial curves and in setting the probabilities for going from one curve to the next. For the stochastic lognormal method, you have to make certain assumptions as to what the volatility will be. Certainly, you can look at historical experience for that, but you still have to decide whether you want to look at the last five years, the last ten years, the last twenty years or whether you want to make a judgment that volatility is going to be different in the future than it has been historically. And, there are some other assumptions that go into the calculation process, such as the correlation coefficient between the short-term rate and the long-term rate.

In addition, I'd like to point out that we have been working with 40 scenarios here. Forty is a pretty small number of scenarios. Regarding the one scenario that produced the very bad results, I noticed that it jumped up 15 yield curves in seven years. If you look at the probabilities, that doesn't seem like a 1 in 100 scenario, it doesn't even seem like a 1 in 1,000 scenario. I guess as a Valuation

Actuary, if I were looking at that, I would take little closer look at that scenario and say, "That's a very low percentage scenario that happened," and I'd probably throw it out. But that then leaves me to wonder whether I should have looked at more than 40 scenarios.

Mr. Jacobs mentioned that additional research needs to be done in this regard, and I'll second that. It seems that when you do sets of, say, 40 or 50 scenarios, you're looking at mean results that are pretty good, but when you start getting down to the tail of the probability distributions, perhaps they are not so good. Obviously, if you're looking for a 1% probability, you're not likely, running only 40 scenarios, to get the one in a hundred scenario. The technique of coming up with a distribution as in Slides 21 through 26 shows great promise for evaluating this. Perhaps, if you want to look at the 1% probability, you don't need 100 scenarios because you can extrapolate based upon the mean and standard deviation.

Something that Mr. Jacobs also mentioned and I want to emphasize is that I think more research needs to be done as to just what the distribution is. Our case study assumed that the distribution is normal. The actual results that we show here and some other work that both Mr. Jacobs and I have done indicates that when you do asset/liability projections, your gains generally are less than your losses. So, you tend to get a curve that is skewed toward the loss side, and not symmetrical like a normal distribution.

MS. CLAIRE: Just briefly, for all those who are doing the New York Regulation 126 filings, I was very pleased that when we repeated the study of Case Study Life using the 7 mandated scenarios, the results, although the numbers didn't match exactly, were quite similar. So, it is possible, if you cannot do the 40-50 scenarios, to at least have some idea of what's going on by just doing the New York scenarios.