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INVESTMENT STRATEGY FOR LIFE INSURANCE PRODUCTS

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Recorder: MARK WILLIAM GRIFFIN

- Products
  - Universal life
  - Fixed premium interest-sensitive whole life
  - Traditional insurance
  - Paid-up insurance riders
  - Pour-in options
- Investments
  - Bonds/mortgages
  - Equity kickers
  - Real estate
  - Joint ventures
- Statutory considerations
- Portfolio versus new money

MR. JOSEPH J. BUFF: The subject of this presentation is a way to study interest rate risk using stochastic methods. The particular technique reviewed projects asset and liability cash flows across a set of interest rate scenarios. The cash flows on the asset and liability sides interact dynamically in an approximation to the behavior of a real-world insurance operation.

This approach to modeling C-3 risk is called "stochastic" because the interest rate scenarios are generated by a random walk process. The random walk is driven by an underlying probability distribution for yield curve changes from period to period. In essence, this methodology considers the future behavior of interest rates to be a random variable.

Insurance cash flows are taken to be a function of the interest rate scenario. Thus the future net cash flow of the insurance operation is itself a random variable. Other financial variables, such as accumulated surplus, or return on investment, are also seen to be random variables.

Note that some immunization or portfolio insurance techniques are intended to remove the dependence of future profitability on future yield curve movements. However, many insurers do not seem prepared to actively manage their portfolios so as to maintain an immunized position over the years to come. Without ongoing immunization, the "random" behavior of future profitability is more than a

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theoretical consideration. It is, in fact, a major practical concern, as the history of the life insurance industry in the United States over the last decade clearly demonstrates.

The function relating net cash flows to yield curve scenarios is quite complex. The "function" is the entire set of models and assumptions used to project the cash flows by scenario. Stochastic interest rate modeling is a Monte Carlo approach to understanding the relationship between the assumed distribution of yield curve behavior and the consequent distribution of life insurance solvency or profitability.

In stochastic modeling, the result for an individual scenario is not a complete datum of useful information. Rather, the distribution of output over a range of scenarios becomes a single quantum of information. Instead of relying on unsupported assumptions as to the output distribution, or using summary statistics from a limited number of scenarios whose statistical credibility is in question, we run enough scenarios to obtain statistically credible results.

For this approach to be truly useful to those who advise, regulate, or manage insurance companies, several specific issues must be addressed:

1. What distribution for yield curve changes should be used?

2. How should cash flows, and other financial statistics, be related to yield curve movements?

3. How many scenarios should be run in order to develop statistically credible information on the output distribution?

4. How can the output distribution implicit in a large number of scenarios be readily presented for analysis and discussion?

All of these questions can and have been answered in a practical and cost-effective manner. The answers flow from research and development among actuaries, university faculty, and investment specialists. Some of this research and development is recent, while some of it can be traced in the literature over the last ten or twenty years.

I will be elaborating on a particular approach to stochastic modeling being used more and more by Tillinghast and our clients. A synopsis of this approach can take the form of the following answers to the four questions above.

1. Yield curve transitions can be modeled by a two-factor log normal process. This technique is supported by many years of research on Wall Street and in academia. The log normal model can be calibrated using assumptions which can readily be derived from historical experience.

2. Cash flows can be projected as a function of interest rates using a scenario projections model. Such models are commercially available, and some insurers have developed their own. One reference for this general approach is the text of New York Regulation 126. A number of presentations on asset/liability management, which discuss scenario testing, can be found over the last few years in the *Record* of the SOA.

3. The number of scenarios needed for statistically credible results depends on the type of information desired. Approximately 40 or 50 scenarios tend to produce reliable information on means or medians. To effectively measure the gain and loss tails, more scenarios are needed. This does not seem surprising. Recent research suggests that to obtain credible information on the 10th or 90th percentiles (as in testing for reserve adequacy), approximately 200 scenarios are sufficient. The current generation of personal computers allows one to perform this volume of computational effort at an acceptable cost and with acceptable turnaround time.

4. The quantity of raw output data rises in direct proportion to the number of scenarios analyzed. However, stochastic modeling resolves this issue. The important "data" do not lie in the raw output from individual scenarios. Rather, they lie in the distribution function indicated by those data. The output distribution is measured graphically. The key advantage of using a histogram or bar graph to present the range of results is that a single graph is used, regardless of the number of scenarios included in the sample. Thus, as the number of scenarios increases, we do not face the problem of an "information explosion." Rather, we are presented with the opportunity of a more credible, and hence more reliable, management information system. The graph fits on one piece of paper whether we use 40 scenarios or 4,000. Truly, a picture is worth a thousand words.

The basic idea of cash flow scenario projections is to model the dynamic relationships between asset and liability cash flows, as driven by interest rate volatility. (More general approaches to cash flow scenario testing than the one under discussion may look at other risks, such as the C-1 risk, or a combination of risks.)

Graph 1 illustrates the year-by-year net cash flows in a single interest rate scenario. We need to concentrate on the total cash flow net of receipts and disbursements, as this represents the net amount to invest or disinvest. Graph 1 shows a situation in which cash flows are generally positive.

A main point of scenario testing is the importance of the scenarios one uses. Since profitability is generally a function of future interest rate trends, the output of the projections model depends on the scenarios one inputs. Different sets of scenarios produce different output statistics and may lead to different conclusions about risk and reward exposures.

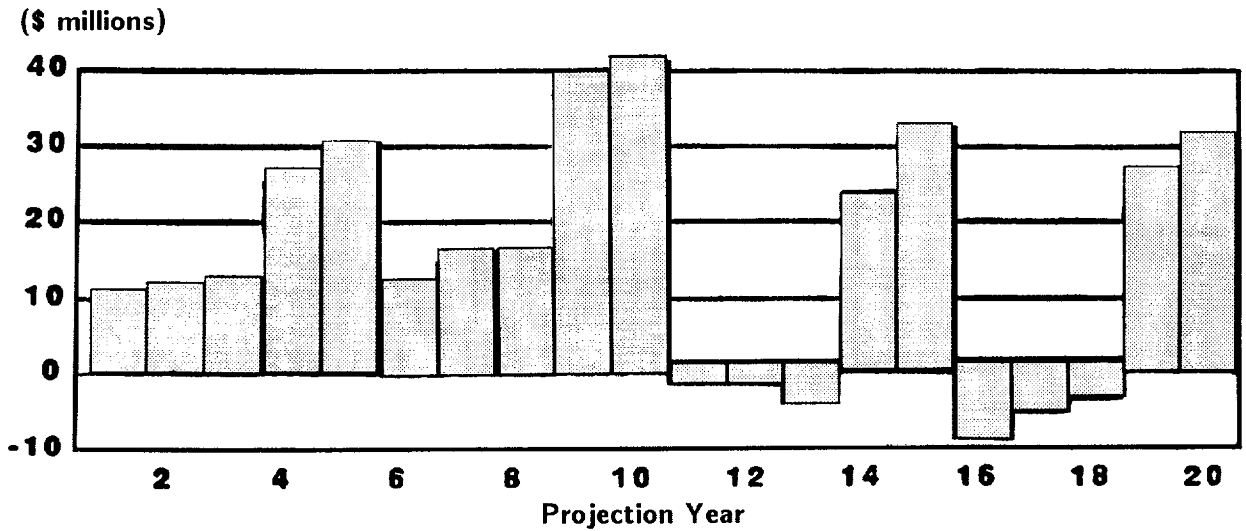
There are two broad types of scenarios. Deterministic scenarios are made "by hand," that is, using personal judgment. Stochastic scenarios, again, follow a random walk model. Neither approach is necessarily superior to the other in all situations. In fact, the two are complementary.

One can see from Graph 2 that deterministic scenarios are usually easy to draw. Graph 2 illustrates a couple of the deterministic scenarios suggested in New York Regulation 126.

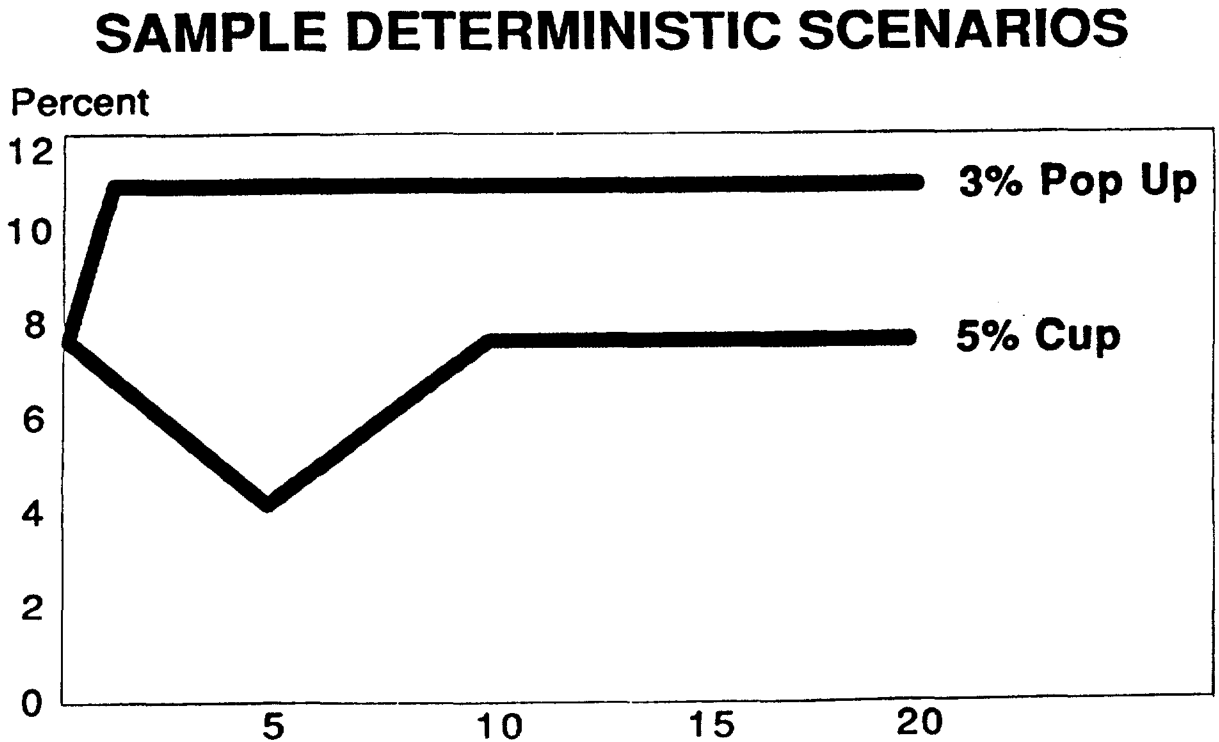
The strengths of the deterministic approach include the ease of describing, communicating, standardizing, and reproducing the scenario set. In addition, by concentrating on individual deterministic scenarios, one can develop a practical nuts and bolts feel for how an insurance operation might behave.

GRAPH 1

NET CASH FLOWS
Level Interest



GRAPH 2


SAMPLE DETERMINISTIC SCENARIOS
Percent
12
10
8
6
4
2
0
5
10
15
20
3% Pop Up
5% Cup

Graph 3 pictures a couple of representative stochastic interest rate scenarios. One can see that these indeed look like "random walks." The general appearance of these stochastic scenarios seems more in line with the episodic upward and downward trends in interest rates that we have actually experienced. Since stochastic scenarios are each a random sample from a highly complex random variable distribution, it is true to say that "no two are the same."

The stochastic approach has its own advantages. When doing deterministic modeling, there is often extensive discussion and disagreement over just which scenarios to use. This is avoided by stochastic modeling (although, as mentioned above and elaborated on below, one needs to choose a distribution for the random walk process). Since stochastic modeling is done by computer, it is relatively easy to generate a large number of scenarios. In fact, the point of stochastic modeling is to concentrate on the distribution or range of the output rather than on single scenarios. Since each stochastic scenario is a single "draw" of a random variable, just as in the roll of a pair of dice, each outcome you obtain empirically is assigned equal "likelihood." The useful information is obtained by studying the relative frequency of different results. This is why it is important to run enough scenarios to get statistically credible information.

Let us elaborate on the analogy of rolling an ordinary pair of dice to emphasize this point. One can consider the sum of the number of dots on the upwardfacing sides of the two dice as the "output," as in playing craps. Using Monte Carlo sampling, one can estimate the frequency distribution for the possible answers, 2 through 12. There are 36 different results one can get from a roll of the dice. Each of these "scenarios" is equally likely. The information relevant to a craps player comes from analyzing the range of results from many rolls of the dice. A "credible" number of tosses of the dice will show that 2 occurs about one thirtysixth of the time, while a 3 occurs about two thirty-sixths of the time, etc.

The same principle is at work in stochastic modeling. Each scenario sample is "equally likely." The relative frequency of different output results will be demonstrated by how often each result appears in a large set of samples.

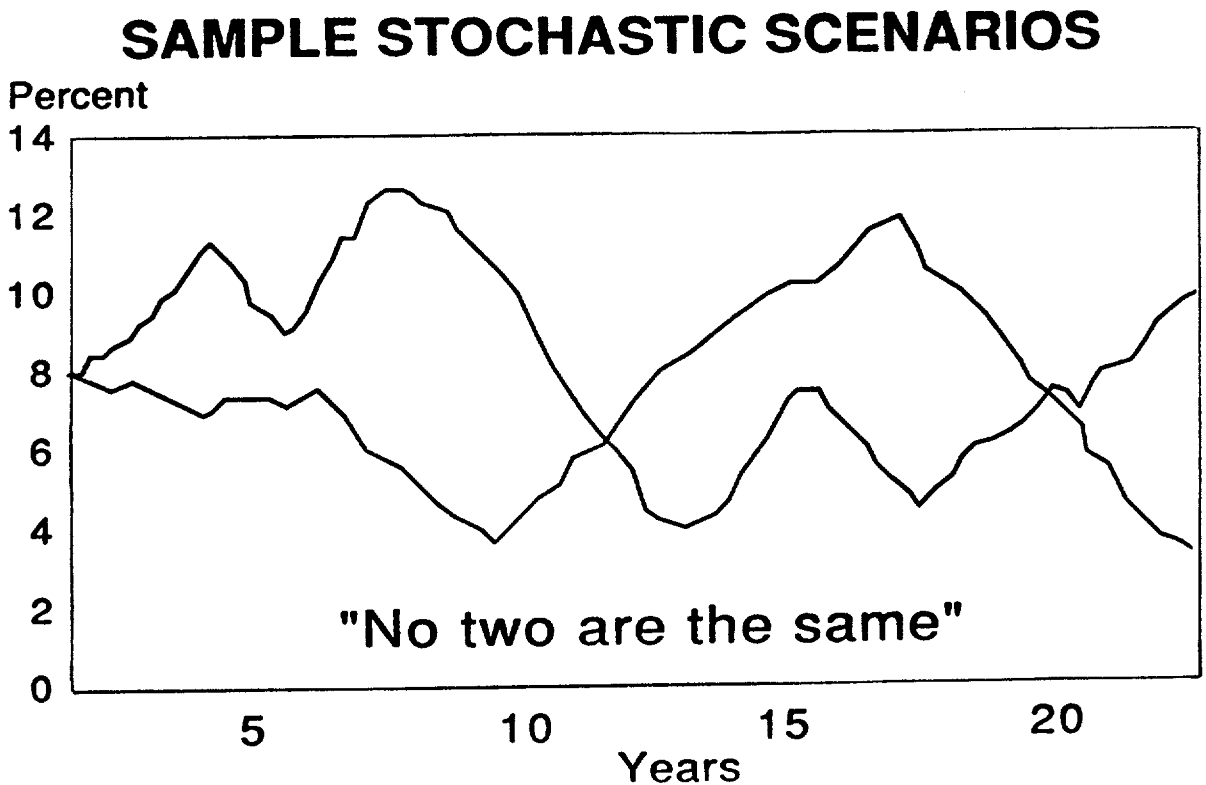
There are some specifications to use as a guide in choosing which distribution to use for a stochastic analysis. Since measuring C-3 risk is the basic problem, one should be able to avoid implicitly forecasting future interest rates. The yield curve shapes and changes contemplated by the chosen distribution ought to tie in with real world economic history. Similarly, the calibrating assumptions needed by the random walk generator ought to be derivable from experience.

The log normal model, which was first proposed years ago, continues to be the subject of active research on Wall Street and in academia. The basic idea of the log normal model is that the natural logarithm (i.e., log base e) of the ratio of consecutive interest rates is a normal variable. The mean is zero, and the standard deviation is specified by the user as the "volatility assumption."

Graph 4 addresses the crucial question of how well the log normal model actually works. This graph is a histogram plot of the relative frequency of the natural log of the ratio of ten-year Treasury bond rates one quarter apart.

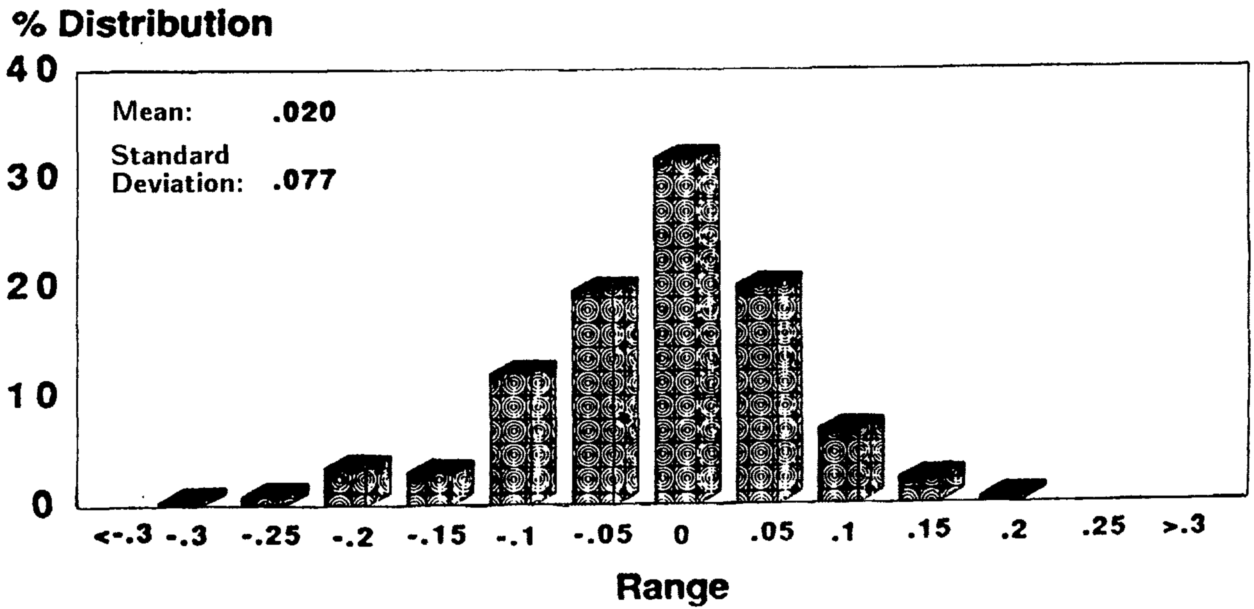
Observe that the fit to a normal bell curve is quite good. The mean of .020 is quite close to zero, indicating that in the aggregate over time there may have

GRAPH 3


SAMPLE STOCHASTIC SCENARIOS
Percent
14
12
10
8
6
4
2
0
"No two are the same"
5
10
15
20
Years

GRAPH 4

LOG OF RATIO OF QUARTERLY RATES
10-Year Treasuries 1/66 - 12/85



been no directional bias in the data. (However, a detailed analysis of this question is beyond the scope of this discussion.) Recall that the mean and the standard deviation completely specify a normal variable. The standard deviation can be measured from the same database, and has been about .077 for the last twenty years when interest rate changes are measured one quarter apart.

A similar analysis has been performed for 90-day Treasury bill rates. The data fit a normal bell curve less well, but the fit is still very useful. It is possible that short-term political or economic factors cause distortions in the 90-day rates. It is also possible that the higher volatility of the short-term rates causes more sampling noise.

This indicates that Treasury rates have indeed behaved very much like a log normal variable over the last twenty years. This result is particularly important because the log normal model was first proposed at least twenty years ago! It does not predict interest rates. Rather, it predicts the distribution process followed over time by period-to-period changes in interest rates.

Table 1 presents actual historical Treasury rate quarterly volatility experience. Not surprisingly, interest rate volatility varies over time and is higher for short-term rates. Importantly, the log normal model provides a way to quantify and discuss this volatility in specific mathematical terms.

With regard to how the log normal model operates, the sample mean of .020 for the log of the ratio implies that a starting interest rate of 10.00% would have an expectation of changing to 10.20% one period later. In practice we usually assume the mean is, in fact, zero. Using the rule of thumb for a normal variable, that two-thirds of the results will lie within one standard deviation of the mean, we can get a feel for what the volatility assumption does. If the volatility is .10, and the starting rate is 8%, then about 66% of the time the next interest rate will fall between 7.20% and 8.80%.

So far we have discussed the log normal model in the context of a Treasury rate for a given term-to-maturity. For better modeling of C-3 risk, one needs to take account of yield curve slope as well. This is done using a two-factor version of the log normal model. Both short and long rates are modeled as log normal variables. They are partially correlated, and the correlation coefficient can be measured from historical data to have been about 70%. This allows the model to take account of occasional yield curve inversions.

Practical C-3 risk modeling makes use of yield curves for many sectors of the market. Treasury rates can serve as a base from which to project rates for corporate bonds of different quality, mortgages, etc. Assumptions as to these sector spreads can be derived from experience or selected with the assistance of investment specialists.

Now, in the future the mean, standard deviation, and correlation coefficient statistics may differ from the past. However, we do know the effectiveness of the log normal distribution based on experience, and we do know how to calibrate the model based on experience. In fact, experience statistics from different periods are a guide to the sensitivity testing one might wish to perform in a detailed C-3 risk study.

A string of yield curves can be generated as a single random walk scenario, using a series of independent samples from the log normal distribution. To do

TABLE 1

HISTORICAL VOLATILITY EXPERIENCE

Period	90-Day Rates	10-Year Rates
1970-74	17%	7%
1975-79	13	5
1980-84	22	10

this you would specify the starting yield curve, select volatility assumptions, generate a sequence of independent samples (z_t), and then calculate random walk yield curves sequentially ($l_{t+1} = l_t \times e^{z_t}$).

One approach to summarizing the output from stochastic modeling is the use of graphs. Graph 5 shows one type of graphic presentation, plotting the range of results as a bar graph. In addition to the best and worst outcomes, the graph highlights the 90th and 10th percentiles. This gives an idea of what the gain tail and loss tail look like.

Graph 6 demonstrates how graphs can be used to support the management decision-making process. Here we are comparing the range of results for accumulated surplus for a representative single premium deferred annuity (SPDA). Two investment strategies are being compared, namely three-year bonds and ten-year bonds.

Which strategy is preferable? The choice one is led to make is not just a function of the stochastic model used, or the number of scenarios run, or the way you choose to present the output data. The choice of strategies also depends on management's perception of how to trade off risk and return when running the company over time. Here it is probably best not to rely on mathematical techniques such as utility theory, unless the utility function one resorts to can be clearly demonstrated to be consistent with real world professional judgment and business decision-making. A healthy dose of common sense is a good place to start.

Graph 7 reinforces the point that the information one obtains from scenario testing is very dependent on the set of scenarios you choose to test. Graph 7 compares the range of accumulated surplus for a typical annuity product for two scenario sets. The first set is the seven deterministic scenarios mentioned in New York Regulation 126. The second is a set of forty scenarios generated by the log normal model with representative assumptions.

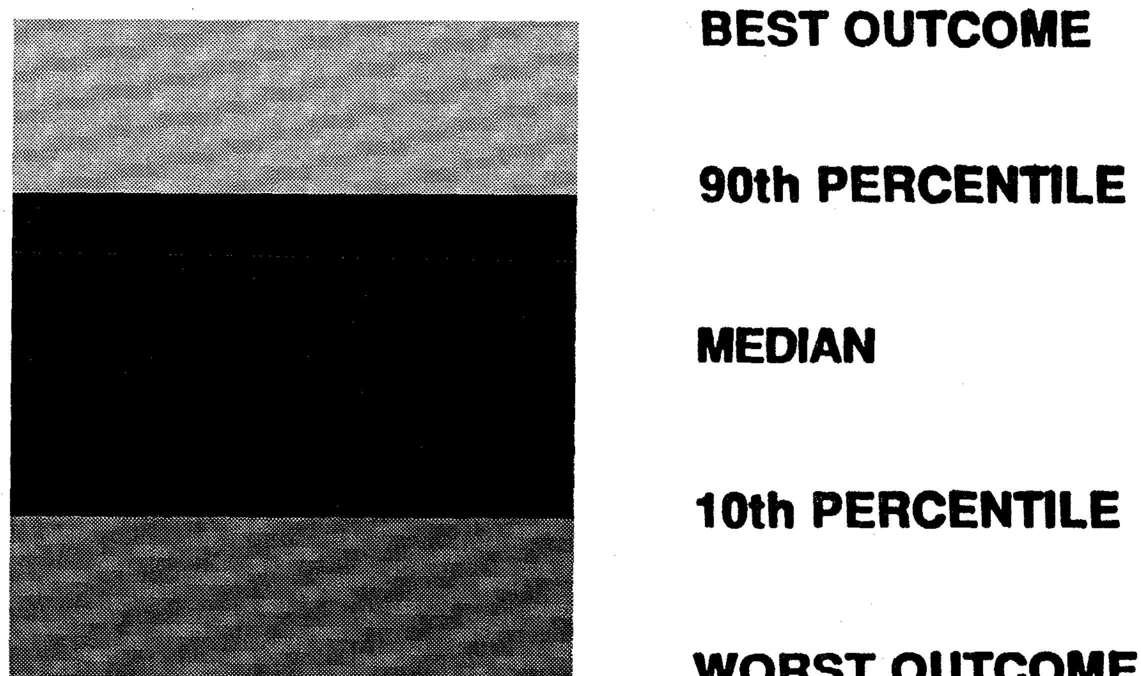
Note that the log normal scenarios indicate substantially more downside risk than the deterministic scenarios. This is largely because the deterministic scenario set does not include such a varied range of interest rate ups and downs as the stochastic set. In particular, the deterministic set used here always assumes rates are constant after the first ten years. In addition, none of the individual scenarios in the deterministic set has interest rates moving to levels that are sometimes above and sometimes below the starting rates.

Graph 8 gives more insight into the different sorts of scenarios one can get when running dozens of scenarios from the log normal model.

The comparison between the deterministic set and the log normal set emphasizes the importance of using the right kind of scenario for the job to tie into the "real world" capital market, to properly represent the risk/return opportunities, and to produce truly meaningful management information.

How many scenarios are enough? "Enough" means enough to develop statistically credible results from the Monte Carlo sampling. Not surprisingly, more scenarios are needed to get good information about the tails of the distribution, than suffice to estimate the mean.

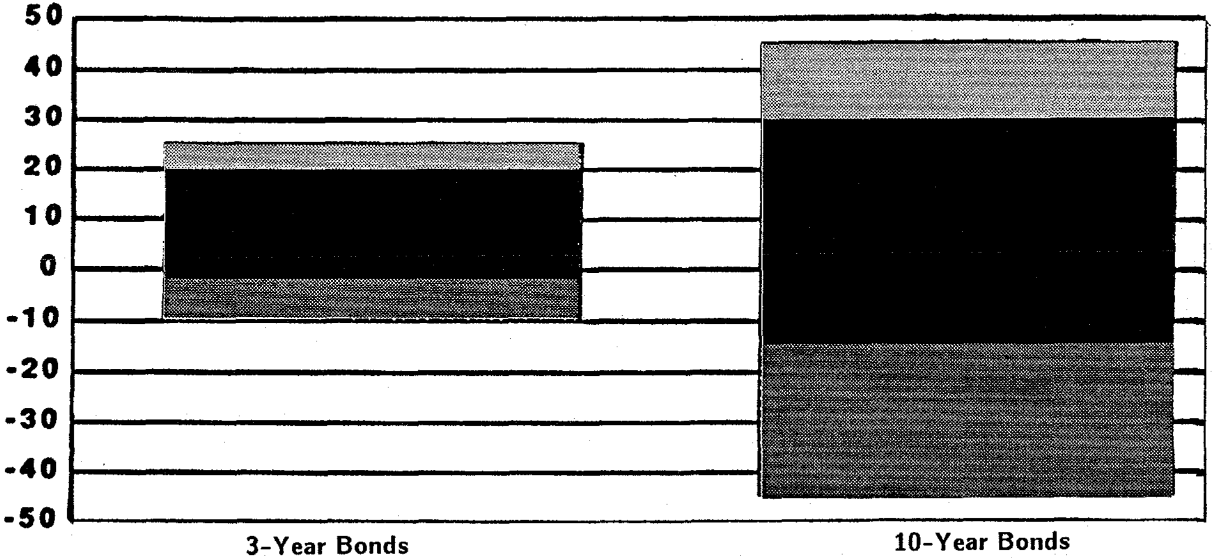
SIMULATIONS OUTPUT GRAPHIC SUMMARY



GRAPH 5

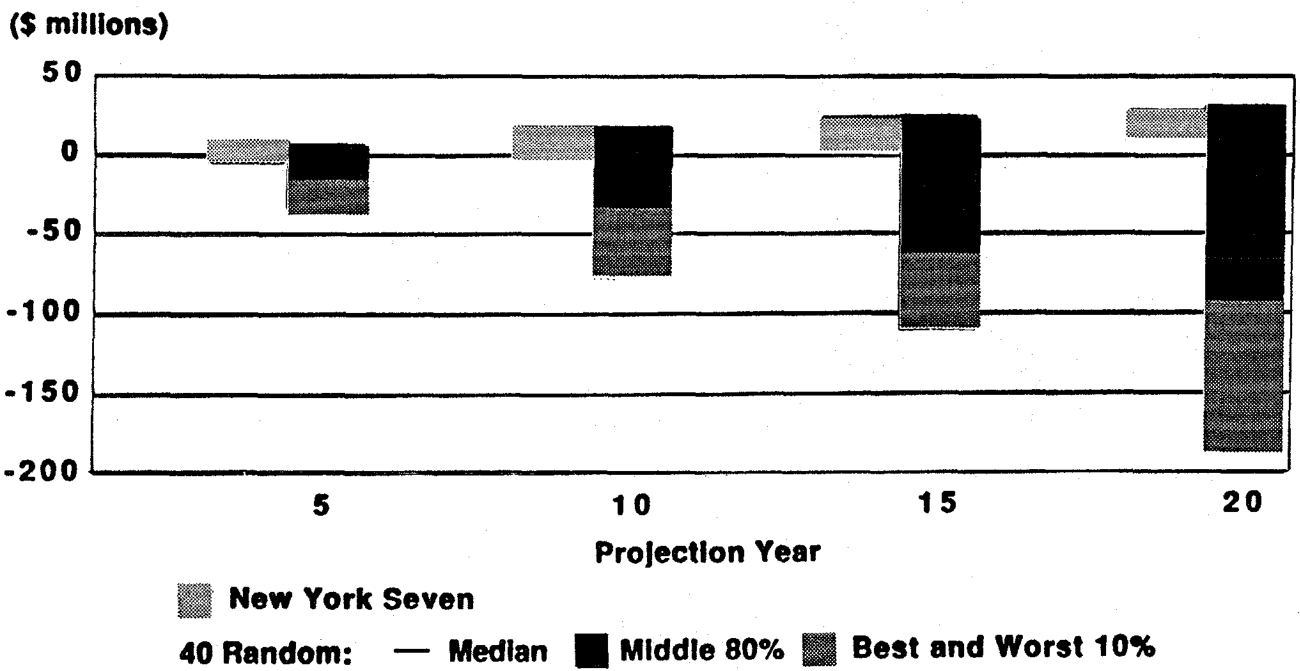
GRAPH 6

SPDA SAMPLE SIMULATIONS STUDY
Ending Surplus ($ millions)



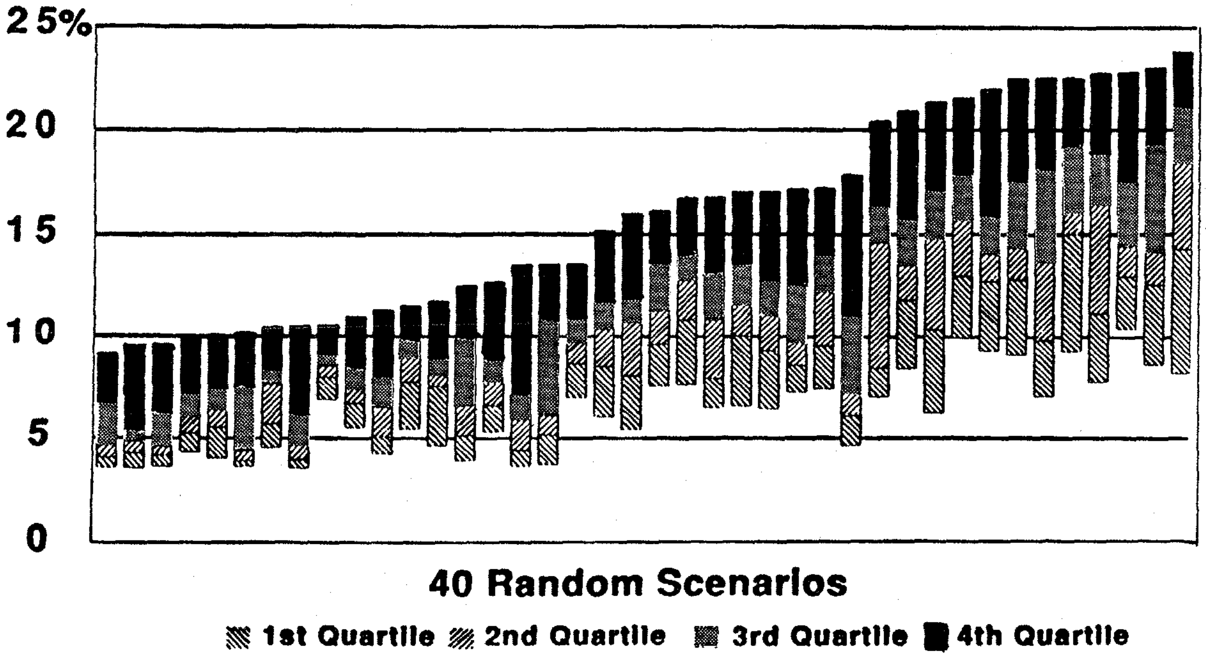
GRAPH 7

ACCUMULATED SURPLUS COMPARISON



GRAPH 8

SCENARIO INTEREST RATES



Graph 9 shows the output distribution for accumulated surplus, based on a set of 4,000 log normal scenarios. You can see that enough scenarios were run to produce a very smooth distribution curve. (Preliminary research indicates that this curve does not fit any of the generally used mathematical distributions, which perhaps suggests that simple rules of thumb for C-3 risk will not be forthcoming.) I think that this graph has a lot of impact in telling the story of how stochastic modeling permits one to analyze the probability distribution for key financial performance statistics.

Note that the real information contained in 4,000 data points is easily presented on one piece of paper using this graph. Were we to have run 4,000,000 scenarios instead, the answer would still fit on one piece of paper. What would change is the statistical credibility of the results.

Oversampling is to be avoided as an unnecessary expense! The number of scenarios needed for reliable results depends on the underlying business purpose to be served. If one wants to test reserve adequacy at the 90% level, approximately 200 log normal scenarios appear sufficient, based on preliminary research into this question.

Graph 10 shows how undersampling can produce unreliable information. The cumulative distribution for ending surplus has been plotted using the data from two different sets of scenario runs. The first run is based on 40 scenarios, the second on 1,000. Undersampling can lead to erroneous conclusions such as the starting reserve will assure adequacy 40% of the time, when in fact it will be adequate only 30% of the time. This kind of error is material, because over-reserving is expensive just as underreserving can be very costly!

Another dimension of investment risk is default risk or C-1 risk. Scenario testing, for the effects on profit and solvency of default rate volatility, can be a useful aid to management and regulators. Some research has been published on the distribution of default rates, and more work is in progress.

Graph 11 shows how the graphic presentation of output from default rate scenarios could be used to compare business strategies, in a manner completely analogous to the approach to interest rate scenarios discussed in detail above. The use of default rate scenarios is particularly important in addressing questions of asset quality, whether for studying reserve adequacy or for comparing investment strategies or pricing (credited rate) strategies.

Graph 12 shows how one can enhance the management strategy-making process by thinking in terms of an efficient frontier for total return on equity. Just as in the efficient frontier for total return on assets, measurements of risk and return for each available strategy are critical to the process. The technique of stochastic scenario modeling is one way to drive this decision-making process.

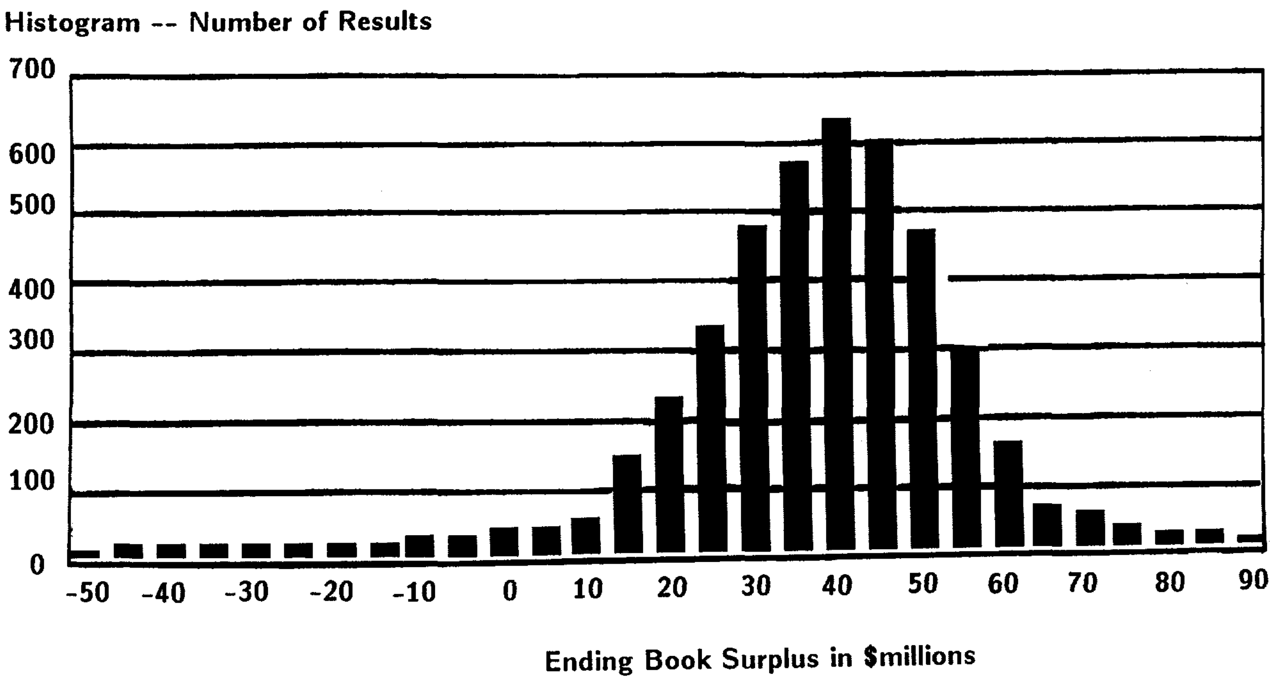
MR. SHELDON EPSTEIN:

INTRODUCTION

The actuarial profession has developed methodology that can be used to determine the appropriateness of an investment strategy for insurance liabilities classified as the simulation approach. An alternative approach that can be used to develop an investment strategy for insurance liabilities is to determine how an insurance liability will react to various investment risk factors. Then an investment portfolio can be constructed so that it mimics the liability behavior as closely as possible. This approach will therefore determine the risk-neutral or

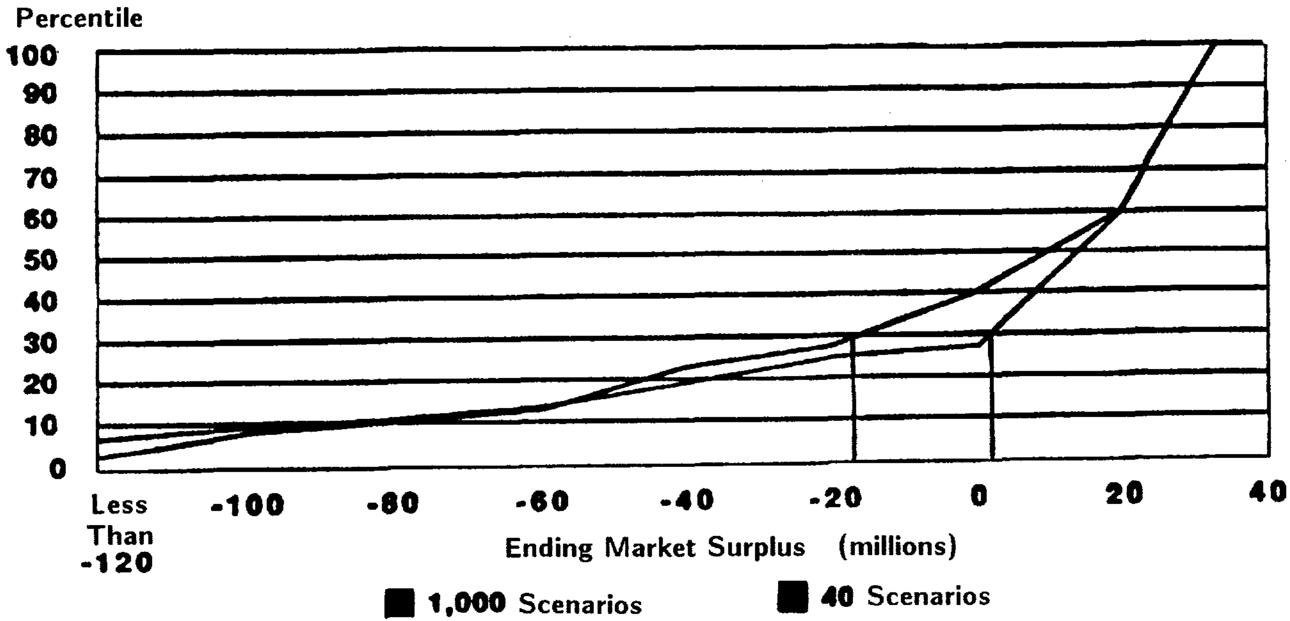
GRAPH 9

4,000 SCENARIOS



GRAPH 10

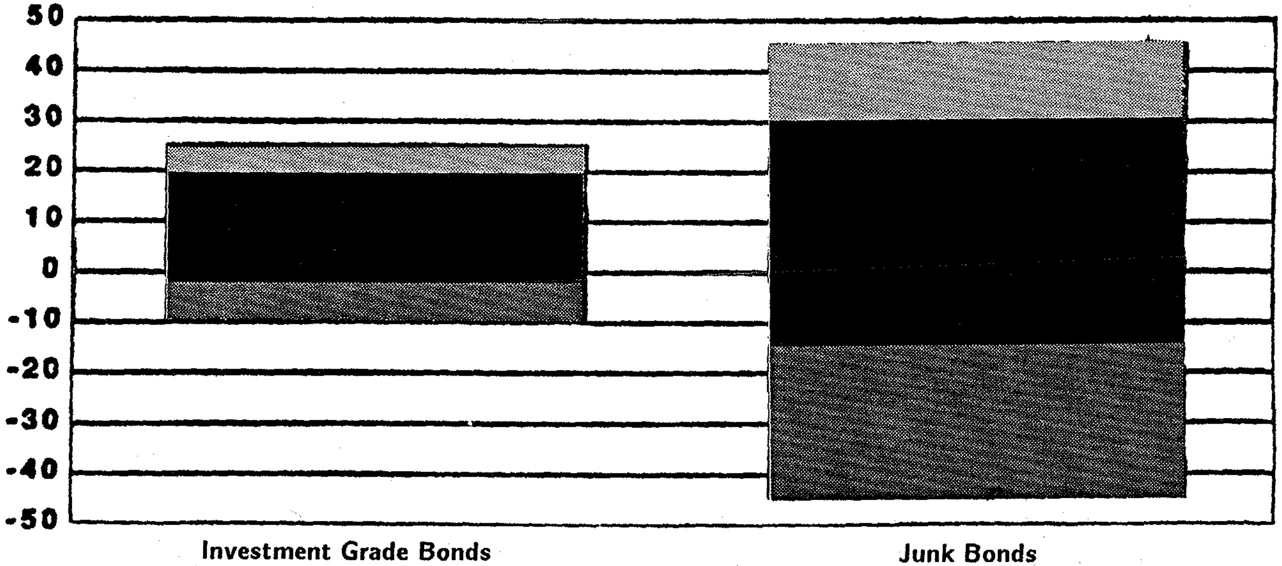
CUMULATIVE RESULTS
1,000 vs. 40 Scenarios



GRAPH 11

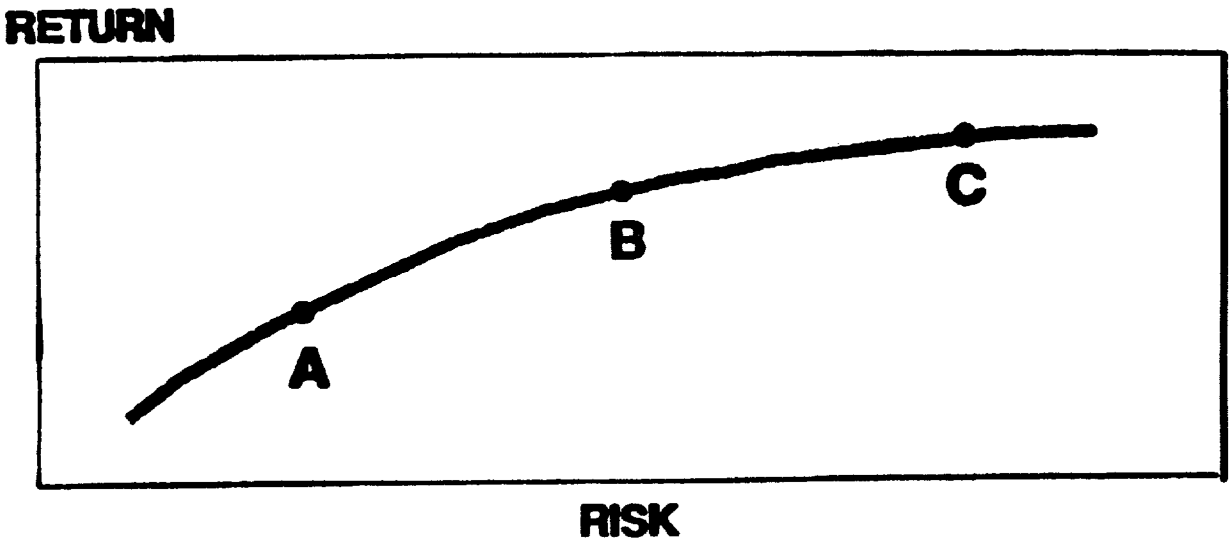
SPDA SAMPLE SIMULATIONS STUDY

Ending Surplus ($ millions)



GRAPH 12

STRATEGY "EFFICIENT FRONTIER"



immunizing investment strategy. The technology necessary for this approach is built on the actuarial simulation methodology but augments it with financial pricing theory. The mechanics are somewhat involved but they yield results that are intuitively appealing for both the investment manager and the actuary.

My talk will focus on the conceptual framework needed to evaluate the suitability of an investment strategy with respect to insurance liabilities. The basic structure of a risk-based approach to developing an investment strategy is fairly straightforward:

1. Define the Investment Risks: This involves identifying those variables in the economic environment which can have an impact on assets, liabilities or both.

2. Determine the Risk-Neutral Strategy: This step is probably the most complicated from a computational point of view. The basic approach is to determine how each of the investment risks impacts the liabilities. The risk-neutral investment strategy will be the one which mimics the liability behavior.

3. Quantify the Risk-Reward Parameters: This step is required so as to be able to determine the extent that it will be feasible to deviate from the risk-neutral strategy. Such constraints as competition, investment supply, statutory valuation rules and management's risk aversion must all be considered.

4. Set Selection Criteria for the Securities: This is the last step prior to implementation. The preceding steps provide most of the rules for inclusion and exclusion of assets in the portfolio as well as for necessary restructuring of existing portfolios. Still, these rules need to be carefully defined to ensure that the degree of risk assumed is compatible with overall risk constraints.

DEFINE INVESTMENT RISKS

Most insurance products, especially the current generation of interest-sensitive products, have investment needs that are tied to interest rates. Therefore, I will limit my discussion to the world of fixed income securities. This does not mean that there is not a place for equities in an investment strategy for insurance liabilities, but that the inclusion of equities will result in a deviation from the risk-neutral investment strategy.

There are many more investment risks associated with fixed income securities than the four that I will focus on; however, it should be kept in mind that for practical purposes it is appropriate to focus on those risks which are of financial significance. I feel that the four risks listed below are the ones which have the most significance.

- Secular/Cyclical Interest Rate Movements
- Spread Movements
- Credit Risk
- Volatility Risk

Recent research by the actuarial profession has emphasized secular/cyclical interest rate movements. Credit risk has been handled through a credit risk charge. I am going to describe how these other risks are important and how an investment strategy can be developed which will immunize the financial results from each of these risks.

1. Secular/Cyclical Interest Rate Movements

The basic idea behind secular/cyclical interest rate movements is that they affect all fixed income securities. These movements are based on broad economic factors such as inflation, recession, currency demands, etc. The driving force behind this risk is environmental -- a change in interest rates will generally be reflected by newly issued insurance products, by the behavior of policyholders towards their existing policies, and in the value of existing assets. The net result of these types of changes is that both the rate the insurance company earns and the rate it credits to policyholders will be affected.

The cash flows that arise from an insurance product are generally a function of broader economic levels of interest rates, since competitor insurance companies will generally be subject to the same factors. Therefore, if interest rates rise it is likely that competitors will be offering new products with higher current credited rates.

Similarly, the cash flows that arise from the various supporting assets will be a function of the same broad economic levels of interest rates. Mortgages and mortgage-backed securities (MBS) are exposed to prepayment risk since the home owner can refinance at lower rates when interest rates fall. Callable bonds might be called if the issuing corporation's cost of new funds becomes lower than under its current financing arrangements.

The focus of the actuarial community has been on the risk of secular/cyclical interest rate movements under the umbrella of C-3 risk. As I mentioned earlier, the trend has been to perform simulation analysis of various interest rate scenarios. At Morgan Stanley we have developed an approach that effectively immunizes an asset/liability portfolio against this risk. The recent Morgan Stanley publication -- *Immunizing Insurance Liabilities: The Case of the SPDA* demonstrates the high degree of immunization which is attainable. The basis of this approach will be described shortly as the approach can handle almost any of the risk factors.

2. Spread Movements

We define spread as the excess yield from a security over the yield from a comparable maturity risk-free security. Usually the risk-free yield is derived from U.S. government securities such as bills, notes and bonds. The determination of the spread of a noncallable bond is fairly easy since the spread is exactly equal to the excess of the bond's yield over the yield on a similar maturity U.S. treasury bond. For interest-sensitive securities like MBS, callable/putable bonds, and all other securities which implicitly or explicitly include options, option-adjusted yields have to be used to properly determine the spread. Optionpricing models provide the technology for determining option-adjusted yields.

The level of a security's spread results mainly from two factors. Firstly, the overall range for the spread is defined by the security's underlying credit risk. This is why it is generally acceptable to treat the credit risk as a deduction to the gross yield, as long as the portfolio is adequately diversified. The second factor which determines the level of a security's spread is the supply and demand for the security. In fact, supply and demand account for the majority of spread movements. An investment strategy has to address the risk that spreads can and do change.

An example of spread risk exists in the market for MBS. MBS are usually issued by government agencies or government-sponsored agencies like Government National Mortgage Association (GNMA), Federal National Mortgage Association (FNMA), and Federal Home Loan Mortgage Corporation (FHLMC). While most MBS are not explicitly guaranteed by the government, the agency's creditworthiness can be considered as high grade. Therefore, the spread requirements on these securities as a result of credit concerns should be minimal and fairly stable. However, fairly large and variable spreads exist on these securities as a direct result of the supply and demand for these securities relative to risk-free securities. Similar supply and demand dynamics drive the spreads in the various sectors of the corporate bond market, regardless of whether the underlying creditworthiness of an issuer has changed.

From a liability point of view, spread risk can be separated from secular/cyclical or general interest rate movement risk by realizing that a change in spreads will usually affect the interest rate that an insurance company earns. However, a change in asset spreads usually does not affect the credited rates on inforce insurance products. Thus an increase/decrease in spreads will tend to make liabilities cheaper/dearer more so than a similar change in general interest rates.

3. Credit Risk

Credit risk is the risk that the entity which is liable for the obligations under a security will not be able to meet those obligations as they fall due. Credit risk is generally reflected in the spread that a security yields over risk-free rates. As I mentioned earlier, credit risk is only one parameter in the determination of spread.

Perhaps the most effective way to handle this risk is to develop analytical abilities with respect to the creditworthiness of an organization. As long as the portfolio is fairly well diversified, this risk can be represented in an investment strategy by deducting an appropriate amount from each security's gross option-adjusted yield when determining the acceptability of a security. However, if the portfolio is not well diversified, it may be necessary to use more sophisticated approaches, such as the simulation approach developed by Joe Buff to study C-1 risk.

4. Volatility Risk

Volatility is a measure of the average relative movement in interest rates. It is usually measured as a percentage of the current level of interest rates; therefore, a volatility of 20% means that interest rates will have average relative movements of either plus or minus 20% of the current rate.

Interest sensitivity would not be an issue to actuaries if interest rate volatility did not exist. Intuitively we know that since there are many possible future interest rate paths, that volatility is nonzero.

Changing volatility alone will not affect the price of noninterest-sensitive cash flows, such as noncallable bonds or annuity certains. The reason is that expected interest rates do not change just because volatility changes, and since the cash flows of these securities are fixed, their expected values (market values) also do not change.

It is important to understand that interest-sensitive securities, like callable bonds or Universal Life, are affected by volatility since the degree to which cash flows will change is proportional to the level of volatility. An example of this would be a put option on a U.S. Treasury bond that has a strike price of $95. This option allows the holder to sell a $100 par amount bond for $95 during the option's exercise period. If the bond is currently selling for $100 the option will only have value if there is potential for interest rates to change. If volatility is nonexistent the price of the option would in fact be zero since the option could never be exercised.

A statistical interpretation of volatility is that it is the standard deviation (expressed on an annualized basis) of a continuously changing interest rate such as the one-year T-bill yield. If the current one-year T-bill yield is 10% and volatility is 20%, then there is a 66% chance that the one-year T-bill yield will be between 8.2% and 12.2%; there is a 95% chance that the one-year T-bill yield will be between 6.7% and 14.9%; and there is a 99% chance that the one-year T-bill yield will be between 5.5% and 18.2%.

To illustrate the effect of different levels of volatility on an interest-sensitive cash flow stream, I valued a callable bond using various volatility assumptions. The bond studied had 10% coupons, matured in 10 years, was call protected for 5 years and was callable at 105. The values for this bond were calculated assuming that an investor would want to earn 125 basis points over the U.S. Treasury yield curve on April 15, 1988. The results of the valuation are as follows.

As volatility increases (Exhibit 1), the price of the bond decreases for a given spread over U.S. Treasury yields. The reason is that the call option becomes more valuable as volatility increases and the investor requires an additional premium in terms of a lower price for granting this option to the issuer. Most securities that an insurance company typically invests in exhibit the kind of behavior where volatility and price are inversely related.

It is possible, and in fact it usually is the case, that an interest-sensitive insurance product will exhibit the opposite type of volatility/price behavior. As an example I modeled an SPDA that required an investment spread of 125 basis points over U.S. Treasury yields. The required gross premium varied directly with the level of volatility as follows for an initial $100 account value.

The main reason that the value of the SPDA increased with volatility is that the surrender option that the policyholder has is more valuable than the way the insurance company chooses to reset the credited rate (Exhibit 2). Since the surrender option value is directly proportional to the level of volatility, the overall liability value increased with higher volatility. It does not have to be this way, but as I mentioned earlier most insurance products that we have studied exhibit this behavior. It is clear that if volatility changes there is a potential risk to an insurer who has assets and liabilities that do not respond to the volatility changes in the same manner.

DETERMINE THE RISK-NEUTRAL STRATEGY

The basic problem that must be solved when establishing a risk-neutral investment strategy is that the risk-neutral investment strategy must ensure there is

EXHIBIT 1

Volatility Risk

Example 1

Bond:	**10-year maturity** **5 years of call protection** **10% coupons**
Valuation Date:	**April 15, 1988**
Option-Adjusted Spread:	**125 bp**

Volatility	Price
0%	$101.17
15	100.00
30	97.99

EXHIBIT 2

Volatility Risk

Example 2

SPDA:	**3-year guarantee** **Credit 5-year U.S. Treasury - 75 bp** **Surrender Charge 8%/7/.../0**
Valuation Date:	**April 15, 1988**
Option-Adjusted Spread:	**125 bp**

Volatility	Required Gross Premium
0%	$ 96.62
15	100.00
30	107.43

sufficient asset value at all times to satisfy the liabilities when they fall due or are liquidated. One way to satisfy this requirement is the risk-neutral strategy can be achieved when the market value of the assets tracks the movement in the market value of the liabilities when any of the risk factors change.

The problem of establishing a risk-neutral strategy can therefore be reduced to measuring the sensitivities of market values due to changes in various risk factors, and then matching the average sensitivities of the assets and the liabilities. The basic formula for measuring price-sensitivity indices for a change in any risk factor is:

$$Dx = \frac{\pm 100 \times \delta MV \;/MV}{\delta Rx}$$

where δRx represents the standardized change in x-th risk factor (such as 100 bp for the risk of interest rates, or 5% for the risk of volatility).

The price-sensitivity index to changes in interest rates is usually defined as:

$$Di = \frac{-100 \times \delta MV}{\delta i} \;/MV$$

For noninterest-sensitive cash flows this index is equal to Macaulay's duration which is the cash flow-weighted average time to payment. For interest-sensitive cash flows this index has to be determined by actually calculating the market value of the cash flows for different changes in interest rates. Option-pricing techniques allow the calculation of market values in various interest rate environments that are all financially consistent with the current market value. The recent Morgan Stanley publication that I mentioned earlier illustrates how option-pricing techniques are used to calculate secular/cyclical interest rate durations in order to determine immunizing investment strategies for an SPDA.

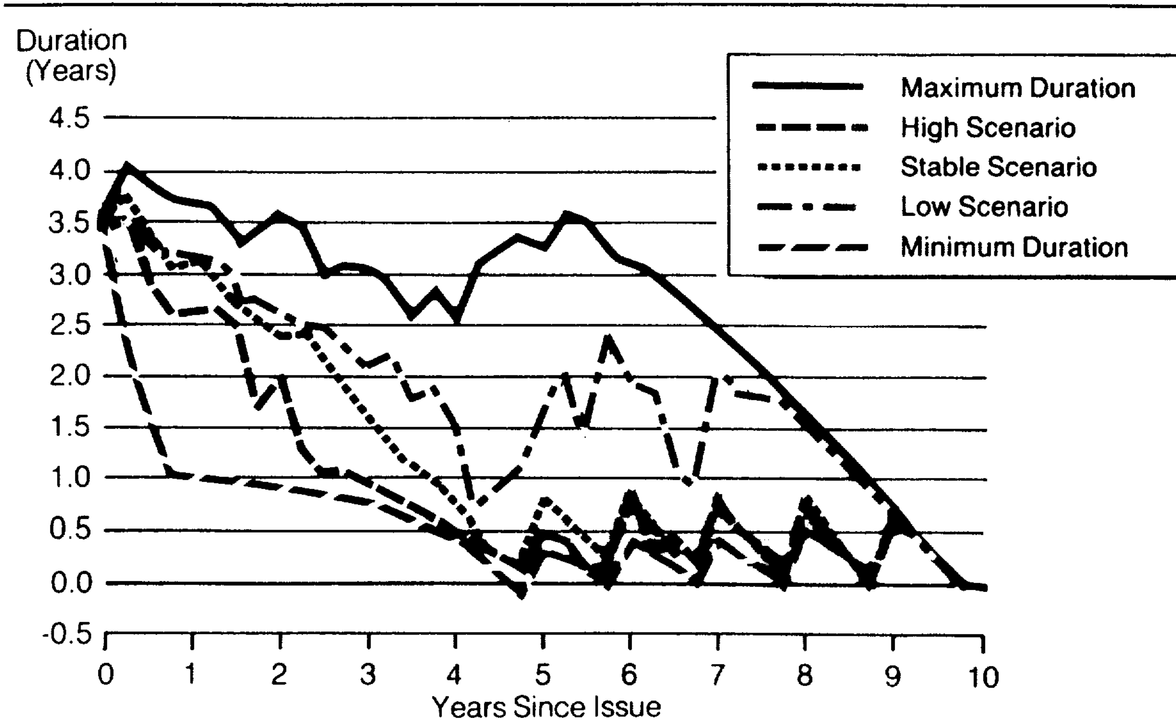
In that paper we demonstrated that an investment strategy which involved matching option-adjusted durations of the assets and the liabilities with quarterly rebalancing can effectively immunize an insurance company's surplus against changes in interest rates. We tested the duration-matching strategy for an SPDA which had a five-year initial rate guarantee and annual resets thereafter. The specific assumptions for the study are contained in the paper, but it suffices to say that the product was designed to be considerably interest sensitive.

We basically simulated the SPDA and the investment strategy along 100 different interest rate paths. After each quarter we had to apply the option-pricing model to the SPDA in order to determine the correct duration and market value. This effectively involved generating 300 interest rate paths emanating from each point on each of the 100 simulation paths. This paper effectively demonstrates the difference between Macaulay duration and the real duration -- the price sensitivity to interest rates. Graph 13 shows durations along three representative interest rate paths as well as the maximum and minimum durations along all paths.

The Macaulay duration of this SPDA was 6.3 years. This differed considerably from the initial option-adjusted duration of 3.5 years. The option-adjusted duration varies considerably from path to path but definitely tends to follow a sawtoothed pattern that has new "teeth" emerging whenever the credited rate resets. The height of the teeth also corresponds to the length of time remaining

GRAPH 13

SPDA Duration



in the guarantee period. This should be fairly intuitive since if an interest rate is guaranteed for one year, the obvious investment to back the guarantee also has a one-year duration. The duration deviates from the length remaining in the guarantee mainly on account of the minimum interest rate guarantee, which lengthens duration in low interest rate scenarios, and on account of competitive new money rates making the surrender charges less of a barrier in high interest rate scenarios.

Graph 14 shows the present value of the final surplus that would emerge under various investment strategies when the portfolio is initially composed of just enough asset market value to cover the liability market value. It is obvious that the duration matching strategy provides significantly more immunization than the other investment strategies. You should also keep in mind that the duration matching strategy does not require a simulation of many different investment strategies to focus in on the risk-neutral strategy.

PRICE-SENSITIVITY CHARACTERISTICS

I will be referring to the price-sensitivity indices as durations even though they generally are not related to the average time of payment of a stream of cash flows since most people associate duration with price sensitivity. I will now discuss some of the characteristics of the various duration measures.

1. Secular/Cyclical Interest Rate Movements

As we saw earlier, the interest rate duration of insurance products is related to the length of the interest rate guarantee period. However, the duration is modified by exterior factors which tend to implicitly change the guarantee period, such as minimum interest rate guarantees and interest-sensitive lapses. Similar characteristics apply to interest-sensitive asset cash flows since both mortgage prepayments and call provisions can effectively shorten the length of time that a certain yield is earned.

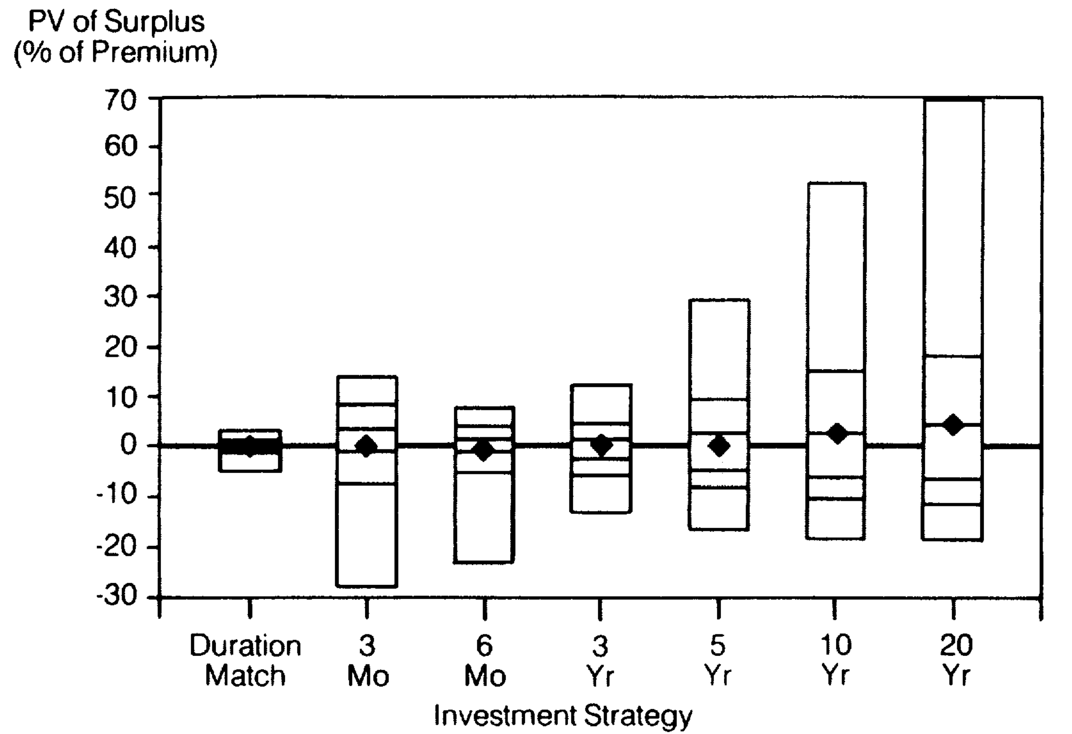
A more subtle measure of how market values change when interest rates change is convexity. Convexity can be thought of as the way that durations change when interest rates change, and in a mathematical sense, convexity is a second-order measure whereas the price sensitivities that I have described are first-order measures. Convexity is harder to match than duration since the numbers tend to be less stable and of higher magnitudes than duration measures. Therefore, to counterbalance convexity mismatches, a portfolio manager will have to rebalance his portfolio more often to keep durations matched.

Duration drift is the term that describes how durations change over time. It is also a second-order measure of price movements that tends to be difficult to match. Therefore, it is also necessary to periodically rebalance a portfolio even if interest rates do not change. Fortunately, it is possible to achieve a considerable degree of immunization by just matching durations as long as there is a set regimen of periodic rebalancings. We always get asked about the cost of rebalancing. The answer is that rebalancing can be relatively inexpensive when new cash flow from either new sales or investment income is used to achieve duration targets, however, there will be times that this may not be possible and the cost of rebalancing should be reflected in the credited rates.

GRAPH 14

Simulation of SPDA Liability

Present Value of Surplus



2. Spread Movements

Spread duration can be related to Macaulay duration, even if the interest rate duration is not. Spread duration will approach Macaulay duration when a change in spread does not affect the level of the underlying cash flows. Good examples of this are MBS in which mortgage prepayments and therefore cash flows are affected by changes in Treasury rates but not in the spread of MBS over Treasury rates. Spread duration is calculated for an insurance product by assuming that the spread change on the assets is not passed through to policyholders unless other competitors can achieve similar spread changes.

3. Volatility Movements

Volatility duration measures the sensitivity of cash flows to changes in volatility. All noninterest-sensitive cash flows have volatility durations of zero. Callable bonds and MBS have positive volatility duration since their prices tends to fall as volatility rises. The reason for this is that the present value of the imbedded put and call options increases with the increase in volatility and the investor will therefore want to pay less for a security granting such options.

Unfortunately, most interest-sensitive insurance products have negative volatility durations; that is, their value increases as volatility increases because a significant portion of the value consists of volatility-sensitive features like minimum interest guarantees and book value cash surrender values. The only feature of an insurance product that has positive volatility duration is the insurance company's option to reset interest rates. Unfortunately, most products we study do not maximize the value of this option and therefore the overall product will have a negative volatility duration.

QUANTIFY THE RISK-REWARD PARAMETERS

In order to establish a set of rules for an investment strategy, it is necessary to quantify the extent of the risks and the possible rewards that might accrue by assuming risks. A company that is risk adverse would choose to immunize itself against all of the investment risks, which would entail matching all of the price-sensitivity indices between the assets and the liabilities. A company that is interested in taking moderate risks in return for greater potential reward needs to know the distribution of possible results when it mismatches any or all of the price-sensitivity indices.

For all but the most risk-adverse insurance company there is a potentially subjective element in determining the risk of not immunizing. The reason subjectivity exists is that either explicitly or implicitly the company has to determine the distribution of possible results for a particular risk factor. In most cases there will not be objective data available for quantifying the distribution. Therefore, opinions will have to substitute for facts. In any event, a convenient way to summarize these results is in terms of confidence intervals.

A confidence interval is a statement about the probability that a result will lie between two extremes. A confidence interval for spread might be that there is a 99% chance that the spread-over Treasuries on a certain bond will be between 25 and 75 basis points at any given time. If the bond's spread-over Treasuries was currently 50 basis points, and if the degree of mismatch between asset and liability spread durations was four years, the confidence interval could then be translated to a 99% chance that the market value of the surplus would change from between -1% of the liability market value to +1% of the liability market value. If the current surplus is 2% of the current liability market value the range of possible surplus results might be deemed unacceptable.

From the above example, it is apparent that an insurance company should explicitly define the maximum surplus loss it will bear on account of assuming the various investment risks. When the company has determined confidence intervals for the various risk factors it can determine whether and to what extent deviating from a risk-neutral strategy makes sense. The degree of risk taking might involve trade-offs between the various risk factors.

For example, a company that requires a larger spread-over Treasuries than an immunizing strategy might provide, may want to take a general interest rate duration mismatch. The strategy would be to invest in assets which have longer durations than the liabilities, assuming a positively sloped yield curve. The degree of mismatch the company takes may depend on the size of the market value loss from the duration mismatch that could occur versus the market value loss that would be incurred by not earning enough spread in an immunized state. It should be clear that by analyzing investment risks in terms of price sensitivity and by quantifying possible outcomes in a probabilistic sense, that the riskreward decisions become relatively straightforward.

SET SELECTION CRITERIA FOR SECURITIES

At this stage the insurance company has completed the following steps: determined the investment risks that affect its liabilities; determined the risk-neutral investment strategy for its particular blend of liabilities; and determined confidence intervals for the various investment factors and specified the degree of loss that it is willing to absorb on account of risk-taking.

It is therefore fairly obvious that all of the above steps taken as a whole provide rules for the inclusion or exclusion of various assets in the investment portfolio. These rules are easy to apply if they are phrased in terms of price-sensitivity indices and tolerances for mismatches.

The purpose of investing money generated by insurance liabilities is to maximize return within the above risk constraints. Therefore, the final selection criterion for an asset is whether or not it provides sufficient value (or yield) to the insurance company. This implies that when a choice must be made between two securities which meet all of the risk criteria, then the correct choice is the security which provides the highest yield. If it is not possible to find any assets which provide sufficient value while meeting all of the other selection criteria, it may be necessary to change the nature of the liabilities in terms of insurance plan design. It therefore seems reasonable to incorporate the determination of investment needs as part of the product design process.

CONCLUSION

I have outlined the development of an investment strategy for insurance liabilities in terms of price-sensitivity indices and risk-reward constraints. The investment manager can become more effective if these criteria are explicitly defined, for he can then go about the task of finding and managing assets which best meet the needs of the insurance product and hence the insurance company.

MR. ERIC D. WERNER, JR.:

INTRODUCTION

I want to describe how one particular life insurance organization, Capital Holding, goes about developing our investment strategies and our asset/liability management policies. I believe our story is a unique one due to the product and asset innovation we have developed over the last several years. It is also a story not anywhere near the final chapter. There is much left to learn and do in this area.

First, a few words about Capital Holding. We are a New York Stock Exchange traded insurance holding company engaged in a broad range of insurance and related financial services businesses. Growth in the last few years has been impressive with assets now totaling $10 billion. We operate through a number of insurance, product management, and bank subsidiaries. In total, we have 10,000 employees to support these efforts.

Recently we reorganized into three major business units -- the Agency Group, the Direct Response Insurance Group, and the Accumulation and Investment Group.

The Agency Group markets traditional life and health products aimed at low- to middle-income households. Business is sold through a 3,500-person agency force. Insurance subsidiaries include Commonwealth Life and Peoples Security Life.

The Direct Response Insurance Group is mainly focused on the sales of health, life and some P/C insurance products. All are marketed via direct response methods: TV, 800 numbers, mail, inserts, etc. Insurance subsidiaries include Worldwide Insurance (P/C) and National Home Life.

The Accumulation and Investment Group has evolved from what we call the accumulation or asset/liability management business. It represents the results of two distinct entrepreneurial efforts -- one in the Agency Group and one in the Direct Response Insurance Group -- to build businesses totally unrelated to traditional bases. More on the reason for the formation of the Accumulation/ Investments Group later.

Out of the Agency Group a thriving institutional accumulation business has been built around a unique form of Guaranteed Interest Contract (GIC). These funding arrangements, sold to institutional sources of funds, are a dominant force in the 401(k) and Thrift Plan marketplace, representing perhaps $150 billion of funds for the insurance industry.

The unique version that Capital Holding developed was a floating rate version that required a lot of new thinking among actuaries, marketers, and investment professionals because of the cutting edge investment strategies needed to support the particular nature of these liabilities. This line grew so fast that a separate product management subsidiary, Capital Initiatives Corporation, was formed two years ago to focus on this and other institutional money management opportunities.

At about the same time, in the Direct Response Insurance Group, a retail version of this floating rate product was developed and packaged as an SPDA sold through stockbrokers, financial planners, and more recently, savings and loans and banks.

Both these businesses have grown tremendously over the last five years to where they now constitute a $5 billion business or 50% of Capital Holding.

Interestingly enough, there is no single insurance entity around which this business is managed. Instead, the original business managers of each of these accumulation product lines had to convince the then existing management of our three major insurance subsidiaries (CLICO, PSI, NHL) to use their paper to write the products even though an entirely different management group was responsible for product development, pricing, marketing, and administration.

It speaks to the entrepreneurial nature of Capital Holding that these businesses have grown to a point where they are now a major part of the company. It also points to the trust and cooperation needed to run a business like this.

When these various accumulation businesses were in their infancy, it was quickly recognized that support for this accumulation business cut across several organizational lines. Adding to the complexity was the matrix management form of organization at Capital Holding.

As a response to this, and to ensure that these budding new businesses received the proper level of support and control, an asset/liability management committee was formed to provide overall strategic management for the business. This committee consists of the senior members of the two product line management organizations, corporate financial, and investments. The committee, in turn, reports to the Chairman and CEO.

Even though we did not know it at the time, this Asset/Liability Management Committee proved to be a competitive advantage in the accumulation business. Why was that?

First, a camaraderie developed among key management groups that gave each area a distinct stake in wanting the business to succeed.

Second, throwing together different disciplines (marketing, investments, financial) created an innovative environment where new ideas could be tested, probed, and strengthened since each area had a chance to examine products and investment strategies in their infancy.

Third, incentive plans were redesigned to ensure that everyone had a consistent motivation for the business. Not surprising, the major measure for everyone has been profitability, and this fact alone allowed each area to come to the table with the same motivation and concerns of the other areas.

Fourth, not one member of the committee had a formal sales or marketing background. Even the product line managers on the committee were actuaries who now had marketing responsibilities. Profitability, not sales, was (and is) the overriding concern of each member of the committee. Our chief financial officer is as concerned about sales as our product line managers, and they in turn are just as concerned about profit margins as our chief actuary.

Fifth, the setup required a high degree of trust and cooperation among disciplines. The fact that we were developing cutting edge products and investment strategies created significant excitement; the challenge of being in on something new proved contagious. The commonality of incentive plan features also helped.

This committee meets monthly and is supported by an extensive set of financials produced for each meeting detailing items such as sales results, new investments, monthly profitability measured on both a reported and economic basis (where all capital gains and losses, whether realized or unrealized, are counted), and certain liquidity ratios that are maintained as a safety cushion.

Detailed minutes of each meeting are distributed to a fairly broad audience to ensure that the entire organization is knowledgeable about the current state of the business, as well as where it is headed.

Why does the accumulation business need to be so carefully managed? That is a basic question whose answer depends on the nature of asset/liability management in the insurance industry.

Historically, the insurance industry has sold products of long duration (e.g., whole life) and backed them up with assets of long duration (corporate bonds, private placements, mortgages, etc.). Everything was carried at book and over a given interest rate cycle, things worked pretty well. A lot of this changed as the GIC business and later the SPDA business began to explode and asset/liability management became much more critical. The volatility of the financial markets in the 1980s has made this even more true.

Because of competitive pressures and the historical long-term nature of insurance products, most insurance companies have struggled in the 1980s with the conflicting needs of (1) crediting competitive interest rates consistent with the long-term end of the maturity curve, and (2) improving the match of assets and liabilities where the liabilities are increasingly of a shorter duration.

Companies in general have responded to this conflict by mismatching assets and liabilities in three areas:

(1) Duration -- As the yield curve steepens, substantial yield pick up can be obtained by investing in long-term bonds.

(2) Quality or Credit -- Some insurers have made heavy use of junk bonds.

(3) Tax -- There used to be quite a few tax plays (e.g. tax-exempt industrial revenue bonds), but these have been largely legislated away by a succession of so-called "tax reform" acts.

The point is that the insurance industry has become much more leveraged due to the growth of the various accumulation businesses. This has made true underlying economic profits much more volatile. Without a sound, very intensely managed asset/liability management process, a company is running a large risk that unexpected economic events could undermine its solvency.

All of these concerns culminated last year in Capital Holding's management reexamining the accumulation business. The result was the formation of the Accumulation/Investments Group. I believe we are the only insurance company to have combined our product line management with our investment operation and viewed the business as an integrated whole. We define the business of the Accumulation/Investments Group as asset/liability management. Our objective is to manage our accumulation business line in such a manner as to produce an attractive spread within certain risk tolerances. Our experience has been that when the business is viewed as an integrated asset/liability business, ideas for products can come from investment people and ideas for investments can come from product people. This is because the assets and liabilities are viewed as simply different sides of the same coin.

All of the above organizational and strategic considerations have resulted in an asset/liability management business which is somewhat unique and has the following characteristics.

The First is Diversification By Product -- This is an essential feature in order to reduce overall profit volatility. Some of our products are tied to long-term interest rates, others to short-term, still others are fixed rate. Further product diversification efforts are directed at products linked to noninterest rate indexes (such as the Standard & Poor's [S&P] 500), and product balancing (the process of creating a mix of liabilities so that some become more profitable and others less so in a given interest rate environment).

Second is Diversification By Distribution Channel -- A big fear of any company in the asset/liability business is a "run on the bank" (or perhaps I should say a run on the insurance company). This can occur for a variety of reasons. However, experience has shown that retail deposits tend to be more stable than wholesale or institutional deposits (contrast Bank of America's huge retail base which has not seriously eroded despite severe problems at the bank with Continental Illinois, where large institutional CD holders quickly withdrew their funds when trouble occurred).

On the other hand, institutional fund gathering (such as, through GICs) requires a lot less effort and expense than retail fund gathering (for example, SPDAs sold by stockbrokers or agents).

We believe a balanced approach is best and, therefore, actively market through both institutional and retail channels. We also diversified globally when we set up an office in Hong Kong to market GICs to Far Eastern financial institutions. We are the only insurance company marketing GICs internationally.

Third is Managed, Controlled Growth -- We are just as concerned with not exceeding our annual sales objectives as we are in meeting them. Because of the unique investment strategies we have developed to support this business, we can only put so much new business on the books and still do a prudent job of managing it. We may well say "no" to more new business than practically any other insurer. It's not a matter of liking to be negative, it's simply our way of ensuring that we'll be in business for the long term.

Fourth, we are Active Investment Portfolio Managers -- Traditionally, most insurance companies have been "buy and hold" investors. Our management style is very active as the portfolio managers reposition investments to take advantage of undervalued sectors, execute arbitrage, adjust duration, or maneuver for the optimal tax position. In all, our fixed income staff executed more than 5,400 trades in 1987 and repositioned almost $8 billion of securities.

The fifth is the Willingness To Try New Investment Ideas -- Over the past several years, we have worked closely with a number of major Wall Street firms (including that of my esteemed colleagues here from Morgan Stanley). As you know, Wall Street has come out with new investment instruments almost weekly. We have developed a reputation with major Wall Street firms as a firm that is willing to try new investment ideas and will act quickly and decisively while the opportunity exists. What this means is that we are frequently one of the first institutions approached about a new idea. This in general leads to our being able to take advantage of these new instruments when the pricing is the most favorable.

And finally, we are active in the use of Derivative Instruments Such as Futures and Options -- We are blessed with not being licensed in New York. As a result, we used futures and options to hedge our portfolio long before New York State relaxed its restrictions on these instruments. In fact, we find in general a much more cooperative and open regulatory environment in the three states of domicile for our three major insurance subsidiaries (Kentucky, North Carolina, and Missouri).

Our investment process is an extremely dynamic one. The amount of money under management at Capital Holding has grown rapidly from under $3 billion in 1983 to more than $8 billion today. At the same time the complexity of our business and volatility of the market have also multiplied.

Indeed, the complexity of our business and the dynamics of the market demand that all of our investment people be aware of the context of their assignments within the larger Capital Holding mission, i.e., how what they do matches with the liabilities. This means our people must be good analysts, have excellent grounding in economic and investment theory, maintain broad market perspective to recognize relative value, and work well under pressure. Our people are organized to serve the investment portfolios. The investment portfolios themselves are managed on a segmented basis by liability type. Our segmented portfolios include the following: (1) the General account for our traditional life insurance business; (2) the Long-Term Accumulation account for SPDA, single-premium life, universal life, and long-term GIC liabilities; (3) Life Annuity for immediate annuities, pension buyouts and structured settlements; (4) The short-term Accumulation account for short-term GICs; and (5) the property casualty portfolios.

Assets are allocated to these accounts based on the characteristics of the liabilities such as the following: (1) need for liquidity; (2) duration of the liability; (3) tax positions; (4) surplus allocation; (5) disintermediation risk; and (6) other product features such as whether they offer a fixed or floating interest rate.

Once asset allocation policy is established, actual day-to-day asset allocation versus the policy is a function of relative value, and economic and environmental perspectives. Asset allocation is not a static process.

Our investment staff is supported by the latest in market and management information and analysis systems, including Bloomberg, Telerate, Technical Data, Bond Scholar, and Knight Ridder systems and direct lines to broker-dealer trading businesses.

We have been very progressive and innovative in utilizing state-of-the-art investment media such as futures and options, as well as less well-known vehicles for asset/liability balancing use, such as London Interbank Offered Rate perpetuals, collateralized mortgage obligations, reverse perls, yield curve notes, lower floaters, interest rate swaps, and interest only pieces and principal only pieces.

I suspect that some of you may not have heard of many of these instruments and my point isn't to throw a lot of technical terms at you, but to highlight that not only has our volume grown, and our business become more complex, but the instruments we have to work with have also become more complicated.

We think the Capital Holding investment organization is recognized in the industry and among the broker dealer community as being among the most responsive and innovative in the business. We take pride in this reputation and believe that the people we have in place will allow us to build further on that reputation.

CONCLUSION

I hope I have given you a flavor of the asset/liability and investment management process as practiced by Capital Holding. Our business is an exciting and changing one -- one that requires a high degree of entrepreneurial spirit, creativity and nimbleness in order to succeed.

MR. WALTER N. MILLER: I have a question that I wish each of the panelists would take a crack at. October 19, has that caused any significant differences in either your operations or your techniques or methodologies that you use? If so, what?

MR. EPSTEIN: Well, as far as we're concerned, October 19 on the fixed-income side highlighted the fact that volatility was a major risk for fixed-income assets and for fixed-income liabilities. That's one of the driving forces behind looking at price sensitivities with respect to different risks. I think, from that point of view, it made us open our eyes to other risks besides general interest rate movements, but it hasn't really affected the basic models or the way we look at things.

MR. WERNER: From Capital Holding's viewpoint, it did have a significant impact on us, although we were well postured prior to that event. One of the things that we've been concerned about for the last year or so is the length of the recovery. We had been looking for some significant risk on the downside from an economic standpoint, so before the crash we were focusing on higher quality in our portfolio. We were also focusing on increased liquidity measures. We had a junk bond portfolio, probably our best performing portfolio for the last three years. But we were about 40% in cash at the time of the crash, so we performed very well in that.

We bought more of those securities after the crash and then liquidated that entire portfolio in January and February. We are not very comfortable with a lot of credit risk at the moment.

MR. BUFF: Well I think one thing that's fair to say is that for Tillinghast's Worldwide operations as part of Towers Perrin, the most immediate impact on us was not in the United States, but in countries like the U.K. and Australia that have 50% or more of their assets invested in equities. What we have seen in the United States is increased interest in having a capability to include common stock and equity real estate investments in cash flow projections.

We are at work on such a technique. We've had the idea for the last year. We are expecting, perhaps within the next 12 months or sooner, although that's not a promise, to introduce an enhancement to our proprietary software package that would include equity investments. We expect that insurance companies will have a bit more interest in looking at that than they have in the past, as a result of October 19.

MR. MARK WILLIAM GRIFFIN: I would like to add a word. From the perspective of the broker/dealer community, there is now less capital devoted to making markets in fixed-income securities than there was before October 19. That will tend to widen bid/ask spreads which will increase rebalancing costs. Obviously the crash has had a big effect on us and it will therefore have an effect on our clients, many of whom are insurance companies.

MR. IRWIN T. VANDERHOOF: A couple of points with a little question for Joe. You mentioned that you were doing some sort of study of the relationship between defaults and interest rates or inflation. I looked for it and I couldn't find anything that was convincing. I think it should be there, but I couldn't find it. Were you able to find something convincing in the data that shows a relationship is there?

MR. BUFF: We are doing a study of studies to see what might already have been done, so we don't reinvent the wheel. We may conclude, as you did, that there is no convincing relationship that has already been quantified. If that is our conclusion, I think what we're prepared to do is apply a certain amount of intuitive common sense so that we would end up with a scenario process that would permit both high and low default rates with the same level of interest rates.

There's no direct correlation because, in the last couple of decades, we've had periods that were recessionary where interest rates were low and default rates were high. And the early 1970s were called a period of stagflation because default rates were high and interest rates were high. So, just as the slope of the yield curve inverts, the slope of that relationship, as it were, ought to invert from time to time in the model. The one thing about the beta distribution as it's documented in the work that you published and presented in Montreal last year is that there is no direct random walk process from one year to the next. Each year you could have a number from the beta distribution that would be the default rate for that year. We just have a feeling that there ought to be an underlying relationship from one year to the next. What it is, we're not yet sure.

MR. VANDERHOOF: Just for your information, I tried to use a Box Jenkins formula to relate one year to the previous year. I couldn't make anything work. I believe that the default rates should go down during periods of higher inflation, but I wasn't able to find it. I believe default rates should go up when interest rates and inflation go down, but I can't really document it.

MR. BUFF: It's interesting.

MR. VANDERHOOF: If you find one method that you can make work, please let me know because I haven't been able to find one myself.

MR. BUFF: I will.

MR. VANDERHOOF: I wanted to compliment the panel on a very fine presentation. I think they all did magnificent jobs. Two other quick points. One is that I would like to emphasize that getting a big enough spread, getting enough profit margin, is something that's easy for us to forget when we talk about how we're going to match the duration and match the scenarios. My experience is that every time you try to do a rebalancing or every time you try to rethink the portfolio strategy, there's a loss, not just in direct transaction cost, but there's some kind of a loss in the operation. Maybe it's because you don't find out you're out of balance until three weeks or three months or something after the event took place. So you're always operating a little bit in the red. I somehow never remember these things functioning so that they give you an additional profit. That may be selective memory. You only remember the things that burned you. You never remember touching the stove when it was moderately warm or cool.

But I worry that we get so tied up in the technicalities that we forget the whole thing is profit. If you have a big enough profit margin, you may be able to get away with some errors on the other side. And it may make up for some errors when the valuation was wrong or the asset inventory data were incorrect and all the rest of it.

The last point I'd like to make is something that troubles me and I don't know if any of you have an answer for it. In looking at default rates, I fit a beta distribution to them. I have 17 years of data. Now the beta distribution is a continuous distribution, like your log normals. You can compute an infinite number of paths based upon logs, but there isn't an infinite amount of data underlying it.

Now I don't know what you do about it, but I think we are ending up by getting out a lot more than we put in. And that leads me to the conclusion we have to be very cautious about how much reliance we place on it. A couple of people have mentioned October 19. Aaron Tenenbein's article in the November *Actuary* I think is still pertinent on that subject.

MS. MARY JO NAPOLI: I'd like to ask Mr. Epstein and Mr. Buff corresponding questions. Suppose I have the time only to investigate and analyze and use one of your techniques, the option-pricing theory technique or the scenario technique. Mr. Buff, what dangers am I facing by using only the option-pricing technique and not scenarios? And Mr. Epstein, what dangers am I facing by using only the scenario approach?

MR. EPSTEIN: Well, basically I think there is a danger if you use only the option-pricing approach. Number one is that you won't be able to satisfy things like Regulation 126 without doing some type of scenario analysis.

MS. NAPOLI: My company is not a New York company.

MR. EPSTEIN: Okay, if you're not a New York company then the other problem might be GAAP and Stat constraints for your particular company. The economic values of risks of immunizing do not always flow through directly to the statements in the way you would like them to. For example, if you sell off some of your assets and the market value has changed, you'll represent that change in your statement, but you won't show the change in the market value of the liability in the statement. That may be an unacceptable result from a statement point of view. So that's a constraint that limits the use of duration matching to its fullest degree. What would be ideal would be a market value accounting approach. But given that you can't do that, you need some type of simulation mechanism to layer on top of the option-pricing mechanism to make sure that these other constraints are satisfied.

MR. BUFF: Well, the first point I would like to make about Regulation 126 is it's true that it only covers companies that are licensed or admitted reinsurers in New York State. However, the issue really is not statutory compliance. Regulation 126 came out of asset/liability management and not the other way around.

The real issue is determining whether or not your reserves are adequate, however your senior management defines adequate. Regulation 126 is at best a minimal approach in one state where the regulators are asking companies that do valuation filings in that state to do a little bit more to demonstrate whether or not there is adequacy. However, I think every insurance company in the United States and probably in the world ought to be asking itself whether its reserves are adequate, as well as asking lots of other related questions.

In fact, I would suggest that you would certainly not want to show your most critical asset/liability analyses to regulators or anybody outside your company. That would be for the very important reason that the best information that you could develop, I think, would be extremely valuable proprietary information. I doubt that you would want to reveal this to your competitors or regulators or any outsiders. I guess the question that you asked me is what are the possible risks of using scenario testing alone and I have to admit all the time that Sheldon was talking I was trying to come up with a good answer. I'm going to really have to wing it and probably do the worst job of fielding a question from the audience since I've been giving these presentations for, I guess, three and a half years now. I suppose if you select the wrong assumptions, whatever that means, you could be led to conclusions that are not the right conclusions, whatever right actually means.

I think that argues in favor of doing sensitivity testing about things like the lapse rate function, for instance, for interest-sensitive products. Another possible problem might be that you believe that the availability of scenario testing relieves senior management of the responsibility to understand the business problems, because it certainly does not, and I guess related to that is the risk that one might believe that scenario testing technology or, in fact, any technology is going to relieve the company's management team from the responsibility of understanding what it's really trying to accomplish in the short term and in the long term. So you should not expect more from a model than the model can really deliver. And I think that is probably the biggest risk in knowing about and having access to and relying on any of the modeling that we've discussed. The approach of utility theory is, I guess, an alternative to what Sheldon or I have discussed. It doesn't relieve you of the need to think very hard and have a lot of ongoing discussion about where your company should be going; where it is going; what to do to get it to go from where it seems to be to where it should be going.