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ASSET/LIABILITY MANAGEMENT (ALM): AN INTERNATIONAL PERSPECTIVE

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Looking at developments in Europe and North America, and considering both the property and casualty and life insurance perspectives, this will be a wide-ranging session, covering features such as:

- The historical development of ALM
- Practical barriers to implementing ALM theory
- New approaches to efficient frontiers
- Asset/liability surplus management
- Evaluation of capital markets (economic forecasting, model yield curves, and economic-simulation models)
- Stochastic optimization
- Sensitivity testing of critical assumptions
- Performance measurement

MR. ANTHONY DARDIS: We are going to be discussing one of the hottest topics in the actuarial world, asset/liability management. The panel consists of two of the most respected exponents of ALM in the U.S. I am going to give a few introductory remarks, just to set the scene. Then Denny Carr, of the ARM Financial Group, will give a historical view, and take a look into the future, at least for the U.S. Finally, we'll have a presentation from John Sweeney, the chief investment officer of the USF&G Investment Management Group. John is going to say something about one or two specific modeling techniques, and he will be referring to his practical experience in Europe as well as the U.S.

As a brief introduction, I am going to put forward a few ideas just to set the scene. My comments will be structured around five headings.

1. How far should ALM models go?
2. A preliminary look at ALM theory
3. Efficient frontiers
4. Asset/liability surplus management
5. ALM models in practice

HOW FAR SHOULD ALM MODELS GO?

ALM models can be extremely broadly based. They can be just concerned with the fundamental investment policy decisions as to what investment categories should be held and in what proportions. Alternatively, you could have a very specific ALM model. Some models might go as far as to select specific stocks or shares. So you

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can see that the scope for application of ALM models and its implication for the investment process can be considerable.

A PRELIMINARY LOOK AT ALM THEORY

Asset/liability management theory has been around for many years. Redington's theory of immunization, which incredibly is now over 40 years old, is an excellent example of an asset/liability management model. And as a practical model to date, it has had very little competition. The notion of equating the mean term of assets with the mean term of liabilities has been used for many years by a number of insurance companies worldwide. More recently, the notion of convexity has given immunization a new lease on life.

EFFICIENT FRONTIERS

The ideas underlying some of the most advanced ALM theories of today were also established over 40 years ago with the concepts of risk-reward trade-offs and efficient frontiers. At the time, the financial world simply was not ready for the concept of efficient frontiers, or rather, the computer power available at the time just had not reached the stage where the ideas could be put into practice. The efficient frontier model is an example of a very broadly based asset/liability model. Actually, you could use the concept to make specific stock or bond decisions, but I think this would be extremely dangerous, due to the diminishing credibility of data involved in predicting the price movement of individual assets. In any case, the efficient frontier can be turned into a true asset/liability model by redefining risk so it incorporates the nature of the liabilities as well as the nature of the assets. For example, we could define risk in terms of exposure to insolvency, rather than simply asset volatility.

ASSET/LIABILITY SURPLUS MANAGEMENT

Developing from the idea of basing risk on exposure to insolvency, a new concept has begun to appear in the asset/liability management literature in the U.S., this being the idea of asset/liability surplus management (ALSM). ALSM is about asset/liability management which focuses on the National Association of Insurance Commissioners (NAIC) risk-based capital (RBC) standards. An ALSM model would then assess how well the required minimum surplus levels are likely to hold up using the potential investment strategies up for consideration.

ALM MODELS IN PRACTICE

To wrap up this brief introduction, I want to mention an example of a practical ALM model. I do not propose to go into a great amount of detail regarding the model here, which was used in the development of a universal-life product. However, I would like to mention some of the important features of the model that made it an extremely useful tool for us.

The company concerned was worried about marketing a universal-life product where it had no protection against having to credit very high interest rates in times of falling asset values. Because of this concern, the company was looking at incorporating a market-value adjustment. We found that the only way to really test whether this product could stand up without a market-value adjustment was to perform a full cash-flow test using an asset/liability management model. This involved modeling the relationship between yields on the particular asset classes up for consideration and the

yield curve for Treasuries. We used 40 stochastically generated scenarios to make the cash-flow projections for each investment strategy being considered.

There are two particular points I would like to mention regarding this product development project. First, we did not make any attempt at all to dictate anything to the fund managers. The job of suggesting possible portfolios was left entirely to the fund managers, and then it was left to the actuaries to assess whether the suggested investment strategies would work within the proposed product design. Second, reward had nothing to do with returns on assets, per se, but rather, represented the profitability benchmark that was most interesting to senior management. Also, risk was implicitly defined in terms of whether the reward would be able to hold up reasonably, even in the worst-case scenarios.

This wraps up my introductory comments, let us now move on to the main part of our session. Our first speaker is Denny Carr. Denny is currently vice president in charge of product development and asset/liability management for the ARM Financial Group. He is a member of the Investment Section Council. He previously worked in the accumulation products group at Capital Holding, and prior to that, he was a consultant with Tillinghast.

MR. DENNIS L. CARR: My topic is asset/liability management in the U.S., with an emphasis on the past. I have been involved in the asset/liability management practice area for over ten years. ALM began, in its current form, in the late 1970s or early 1980s. There are many valuable lessons we can learn from history, and my purpose is to share some of those with you through some personal experiences and stories.

The ALM began in the late 1970s and early 1980s. The first defining event was the interest rate spike. Around the late 1970s and early 1980s short-term interest rates approached 20% and long-term rates were 15%. We had very high double-digit interest rates. At that time, we also started a product revolution. We saw the advent of money market accounts in the U.S., which, prior to that time, really did not exist for anyone other than individual investors. Also, there was the advent and the growth of universal life. It quickly gained popularity relative to traditional whole-life-type forms. Finally, annuities started a growth spurt at that time. There had been annuity products prior to this growth spurt, but they took on a different form at this time. The central theme is that all of the products, including what went on in the insurance industry, took on more of an investment element. With high interest rates, the returns available on various products became of utmost interest to everyone.

During this time, we started a replacement trend. This involved universal-life products replacing traditional products. This trend began much sooner than it was recognized. Agents would replace existing whole-life contracts, but rather than lapsing them and having that show up as a negative, they would convert them to reduced paid up insurance and switch their premium to the new modern universal-life-type contracts, which were touting double-digit returns. We had many reports that showed statutory earnings and published earnings, but they really did not pick up on what was going on. Real cash flow was not growing as much as the sales figures showed. The lesson is to monitor cash flows because accounting conventions can sometimes hide what is really happening.

This also started the era of shrinking margins. It became very competitive. Many of the pricing elements were stripped out and laid bare to the public in the universal life type contracts, so price competition increased.

We also became more aware of the exercise of policyholder options. This was not just through surrenders of annuities but also through options that we thought were safe, such as policy-loan provisions in ordinary life policies with fixed interest rates of 5% or 6%. I remember Sylvia Porter, the financial columnist, writing about borrowing against your life insurance at 5% or 6% fixed interest and investing in a money-market account at 15% interest. Insurance companies experienced a cash-flow squeeze as money flowed out through the policy-loan feature. There were some company failures at this time; Baldwin United was one of the most prominent. Other companies suffered lesser degrees of financial stress.

As we experienced the interest rate spike of the late 1970s and early 1980s, the mix of business in the insurance industry was not so annuity-weighted. However, many companies had annuity business, and as interest rates spiked up, there was much pressure on that business. During the interest rate spike, I was chief actuary for a medium-sized stock company. Our chief executive officer, concerned about the level of surrenders, moved his office to the annuity service area, and talked to annuity policyholders on the telephone. That is one of my memories of the interest rate spike.

Through the 1970s, we had invested most of the annuity money in long-term bonds and mortgages. Interest rates had been rather calm. As interest rates made their way into the teens, we agonized over what to do. We could afford to raise our rates maybe 50 or 100 basis points, but new money rates were up 500 basis points. It was a helpless feeling. There had to be a better way to manage the annuity business. Fortunately, for myself and for the company, our annuity exposure was not very large, and we managed to weather the storm.

In 1983, I joined Tillinghast and entered the glamorous world of consulting. I have labeled the mid-1980s as the "reaction period." Several things happened in reaction to the problem of the interest rate spike. First, we saw the advent of the valuation actuary. Prior to this time, a valuation basically looked at the liability side only. Reserves were based on statutory prescribed minimums and methodologies that gave a "conservative reserve level." The asset side was not really considered unless surplus levels were tenuous. In general, we tended to be liability focused on the valuation side. The valuation actuary concept involved looking at both the assets and liabilities to determine an appropriate reserve level. Development of new methodologies and systems also flourished in this era. At Tillinghast, I decided that ALM was a topic of the future, and it would be a good place to specialize. I started working on systems that allowed you to consider how both the assets and liabilities behaved as interest rates changed. Prior to that time, most of the actuarial pricing models strictly looked at the liability side. For the asset side the models presumed a given interest rate level, and left it at that. The new methodologies and systems were designed to take a fuller look at the asset side and the interaction that occurred between assets and liabilities.

In 1985, the first symposium for the valuation actuary was held. I was a speaker at the first symposium, and I am going to take you through an illustration that I used in that presentation. The purpose of this illustration is to point out the need to work interactively in ALM. This illustrative company is named Mismatch Life Insurance Company. The chief marketing officer is Sal A. Lot. The hero of the story is the Chief Actuary, Ernie D. Spread. Our third character is Max M. Yield, the chief investment officer.

Our story involves a meeting of the interest-rate-setting committee at Mismatch Life Insurance Company. They are getting together to set interest rates on their annuity products. As usual, Sal, being the bashful type, is the first to speak up. Sal says, "We've been selling at a good pace, but we need to keep that momentum up. Our chief competitor, XYZ Life, is crediting 6.5% on its annuities. The bottom line is, we need to increase our new money crediting rate to 6.35%." Ernie speaks up next and says, "I priced this product and we need 150 basis points to make money. If 6.35% is the credited rate, we need to earn 8.25% on our investments." At that time, all eyes turned to Max, the chief investment officer. He says, "There are many ways to get 8.25%. You can take credit risk or you can extend your duration and go into longer maturities." Everyone agrees to credit 6.75%, and the meeting adjourns. This story was very real ten years ago, and it is still reflective of the asset/liability management used by many companies. How much progress have we made in ALM over the last ten years?

As we moved into the late 1980s we experience the "credit risk crunch." We had problems with junk bonds and with commercial mortgages that were defined as bad asset classes. People started to measure the percentage of bad asset classes to total surplus. There were failures of significant companies such as Executive Life and Mutual Benefit. In the guaranteed investment contract (GIC) marketplace, there was a big slowdown in business. The "G" in GIC denotes a guarantee, but many started to doubt the soundness of that guarantee. There was increased focus on credit ratings. We were forced to deal with rating agencies such as Standard & Poor's, Moody, and Duff and Phelps. In general, we had a credit downgrade for the life insurance industry.

My last point is beyond interest rate risk. The credit crunch was an event risk in the credit markets. Even if you had the latest and greatest interest-rate-risk model, it did not envision this type of event risk. The warning is to be careful for these "other risks." When you think you understand everything that can happen, something new happens.

The final era, which also started in the late 1980s and carried over to the early 1990s, is the bull market in bonds. From 1988-93, yield rates on ten-year Treasury bonds have declined by over 350 basis points. I have several observations about this trend. First, individual annuities generally became quite profitable as credited rates were cut more quickly than investment earnings declined. Spread earnings increased on in-force business. Second, not all companies were able to widen their spread. The yield on their asset portfolio went down equally as fast as credited rates. This was due to convexity risk. As interest rates went down, mortgage instruments and corporate bonds were called and prepaid. Companies received cash to reinvest just when they least wanted it, with interest rates low and heading lower. Finally, we ran

into the interest rate guarantees. Conservative rates of 4% or 5% became less conservative as rates plunged.

Over the past 10-15 years, annuity reserves have grown significantly. To illustrate that fact, let me quote some statistics from the American Council of Life Insurance (ACLI) fact book. For the past 15 years, individual annuity reserves have grown at a compound annual growth rate of between 20% and 25%. Group annuity reserves also exhibited impressive growth rates through the mid-1980s. I think the slowdown over the past five years has been due to the credit crunch in which we saw people moving away from GICs as the guarantee became more suspect.

Another way of measuring the growth of annuity reserves is to look at the changing balance sheet of life insurance companies. ACLI statistics show that annuity reserves as a percentage of total life insurance reserves grew from 27% to 67% over the last 20 years. Any way you look at it there has been big growth in annuity products.

Over the past ten years, I have worked on asset/liability models that take into account interest rate risk, and I have heard many technical presentations about such models. But, when it comes down to really implementing ALM, there are several other issues involved such as organizational structure, incentives and communication. The technology can take you only as far as your people do.

One of the first things we need to ask ourselves is what business are we really in? As an industry, we have two-thirds of our reserves in annuities. The annuity business is fundamentally different than the life insurance business. In the annuity business the key management variable is the interest rate spread and the volatility of that spread, which requires ALM. For life insurance, the key management variable is the expense risk, which includes both distribution costs and other expenses.

Another key issue is, are we organized to manage the annuity business most appropriately? Let me illustrate with a couple of examples from my career. After I left Tillinghast, I joined Capital Holding around 1988. At that point in time, Capital Holding decided to combine its accumulation products and its entire investment area, and form a separate business group. The purpose of that business group was to manage the interest spread, and its focus and incentive programs were designed accordingly. While this created a great deal of alignment, you still had to deal with diverse interests. Over the years, I have had the chance to work with many investment professionals. I have learned that we come from vastly different worlds in many ways. For example, for most investment people, a long time is one hour. For actuaries, 30-year projections are not uncommon. Terminology and training can create barriers to communication. So, even though you put the right organization and incentives in place, more communication is needed.

Last September I joined the ARM Financial Group. This new venture will concentrate strictly in the accumulation business. We own a couple of life insurance companies, but our goal is to work in and focus on the accumulation business. We consider ourselves to be spread managers and have created incentives for everybody in our company to manage the spread.

That is enough about the past. What are some of the issues that we are dealing with in ALM? The first one is RBC. We have seen trends where companies are steering away from the asset classes that have a big capital allocation attributed to them.

The valuation actuary is now operational. We have appointed actuaries signing statements and doing cash-flow testing.

Are we ready if interest rates spike up again? I attended a session on this topic. If rates go up and stay up for a while, we will see lower earnings from the accumulation business. This could be the beginning of our next era—Interest Rate Spike, Part II.

In closing, I would like to make some comments about the future of ALM. First, if interest rates rise and they stay up for a year or so, life insurance company earnings will suffer. With two-thirds of our reserves in annuities, and the spreads tightening on those reserves, some earnings pain is inevitable. If rates go up significantly we may experience some company failures. One of the things I have noticed about ALM is the real gain comes from some pain. Many times it was the failures that caused the next wave of development and the next wave of knowledge.

Organizational structure will continue to evolve. People will recognize that the accumulation business is fundamentally different from the life insurance business. Accumulation products will continue to grow, based on the demographics of the baby boomers.

Advances in technology will provide opportunities for us. As I was involved over the years in developing models, it seemed that we were able to build more and more things into the models based on new chips from Intel that allowed us to run two or three times faster. Even though we were asking the models to do more, we could do more in less time because of the technology. I expect technology to continue to advance. Let me issue a warning about technology. With high-powered personal computers, it is easy to develop information overload. You need to be careful of that. You need to make sure you understand what is going on in your asset/liability models.

Over the years, I have noticed a great deal of progress in asset/liability management in the insurance industry. From my perspective, though, I think it is a situation where the glass is still only half full. I see many improvements are yet to be made through new technology or through people management. We will continue to face new and challenging environments. I am looking forward to moving the science of ALM forward in response to the challenges that lie ahead.

MR. DARDIS: John Sweeney is the chairman of Falcon Asset Management, and chief investment officer of the USF&G Corporation. John has over 20 years of economic, financial, and investment experience throughout the U.S., Europe, Australia, Canada, and Latin America. He is a frequent lecturer on investment and financial issues, and has authored, or coauthored, over 40 published articles and papers. John has been quoted and interviewed by such publications as *The Wall Street Journal, Barron's, A.M. Best,* and *Pension World.*

MR. JOHN C. SWEENEY: I will be providing an overview of the investment process employed by USF&G in the form of a case study of the evolution of the investment and ALM functions at USF&G's property and casualty company.

A prerequisite for the ALM process is the understanding and approval of senior management, product-line heads, and actuarial and investment personnel. At USF&G, the entire investment department has a basic understanding of all business segments with respect to major differences, business characteristics, organizational structure, and business plans and strategies. Our investment policy statement and guidelines are not only written in a corporate context, but also consider each major business segment.

There are five crucial steps involved in developing the asset allocation/asset/liability process that we call the asset/liability management efficient frontier (ALMEF).

1. We need an "economic" evaluation of the balance sheet, an assessment of the market values of assets and liabilities and a determination of capital requirements.
2. We must have an evaluation of the capital markets and determination of equilibrium economic assumptions utilizing a stochastic economic simulation model.
3. Obtain optimization of the assets and liabilities (surplus optimization) utilizing a nonlinear optimization model that employs a multiperiod stochastic diffusion process to generate the asset/liability efficient frontier.
4. We need sensitivity testing for key factors such as inflation, renewal assumptions, loss-ratio variability, and capital-market equilibrium factors.
5. The final step is the development of a performance measurement system to evaluate actual performance versus the chosen optimal portfolio. The process loops back to step one at various stages and is reevaluated on an ongoing basis.

A senior ALM committee has overall ALM decision-making responsibility and approves policy, sets guidelines and constraints, and evaluates performance. In addition, lower-level working committees coordinate efforts, ensure open communication, determine asset allocation and investment strategy, and contribute to product design and pricing on a business segment basis. The lower level committees' primary functions involve analysis, formulation and recommendation of policy and strategy.

This presentation will address only the ALMEF process, although both the aforementioned prerequisite and ongoing issues are critical to the success of the ALM process. Chart 1 is a flow chart depicting the ALMEF process.

ECONOMIC EVALUATION OF THE BALANCE SHEET

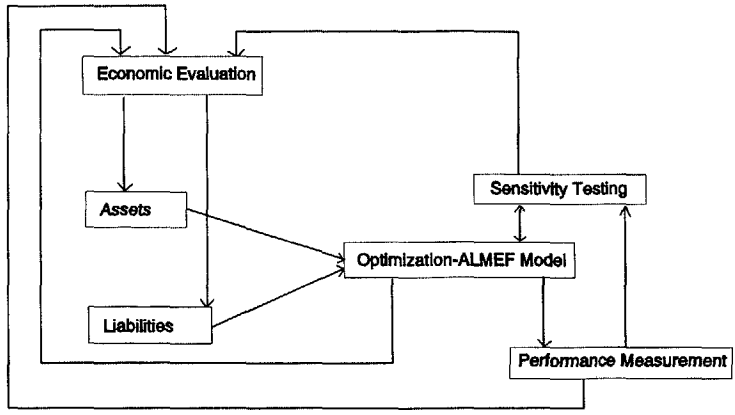
The first and most critical step of the asset/liability process is the evaluation of the balance sheet.

Asset Evaluation

Most companies view their balance sheet from a statutory or published perspective (i.e., on a book-value basis). However this evaluation must be conducted on a market-value basis. In the long run, a market-value basis will provide the best

economic benefit. Most companies' assets consist of marketable securities. Therefore, a conversion to market-value basis is relatively simple with the exception of investments such as private placements and real estate.

CHART 1
ASSET/LIABILITY MANAGEMENT EFFICIENT FRONTIER



The ALMEF model uses asset indices as proxies for asset classes. A thorough analysis and understanding of the key characteristics of major asset classes is necessary to ensure that the proxies serve as reasonable representation of actual portfolios. Our fixed income and analytical model allows us to evaluate the effective or option-adjusted duration and the four factor duration (parallel, nonparallel, quality spread and pass-through spread). We then compare key characteristics and return profiles under various scenarios to proxy indices thus ensuring that our proxy indices serve as reasonable comparisons to our actual holdings. To approximate the effect of taxes, the tax-exempt proxy needs to be adjusted according to an anticipated tax profile. Although many other classes can be modified, some asset classes we employed are listed below.

- Fixed Income
  - U.S. Government—Short
  - U.S. Government—Intermediate
  - U.S. Government—Long
  - U.S. Corporates—1-5 years
  - U.S. Corporates—5-10 years
  - U.S. Corporates—more than 10 years
  - Mortgage Backed
  - Short Term
  - High Yield
- Equities
- Equity Real Estate

Liability Evaluation

Perhaps the most difficult aspect of the ALMEF process is the liability evaluation. The duration measure used for property and casualty liabilities is a modified duration, which is often referred to in terms of sensitivity to interest rate change. No single liability duration methodology is necessarily correct; therefore, each company should resolve the following issues based on its viewpoint and business situation.

1. Is "liquidation" duration or "ongoing" duration more appropriate? Stated differently, should one examine only the existing balance sheet or consider the company as a going concern.
2. How is "ongoing" duration derived?
3. How sensitive are the renewal assumptions?
4. What is/are the appropriate discount rate(s)?

At USF&G we employ the concept of "ongoing duration," which is based on the going-concern theory, defined as the effective liability duration given the payout profile of existing reserves and new and renewal business. (Liquidation duration considers the payout pattern of existing liabilities only). We execute the analysis at a detailed level, by numerous lines of business, and consolidate the results by primary business segment. USF&G's changing business mix makes it essential to develop investment strategy based on a forward or ongoing evaluation of the liabilities. The calculation of ongoing duration requires the support and cooperation of both reserving and pricing actuaries, business-segment heads, and senior management.

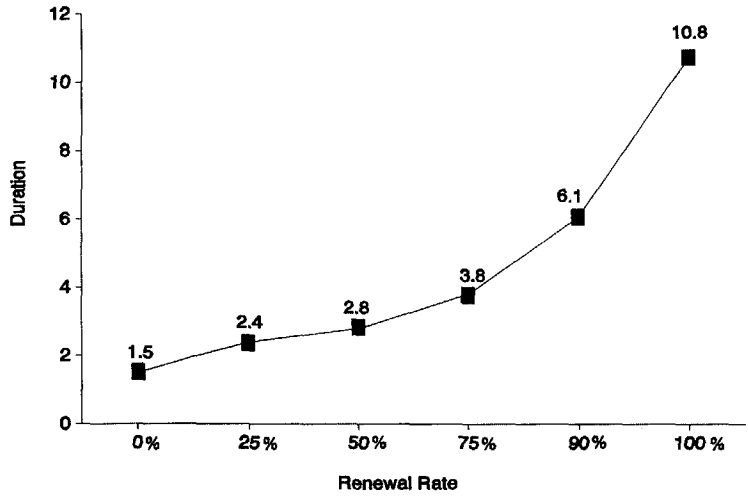
When using the ongoing duration methodology, a decision must be made about factoring in renewals only, new business, or a blend of both. Table 1 illustrates the range of liability durations depending on the methodology employed. Obviously the methodology employed will significantly affect the liability cash flows, the duration, and hence the asset allocation decision.

TABLE 1
LIABILITY DURATIONS—PERSONAL LINES

Method	Duration
Liquidation duration	1.5
Include renewal only	4.4
Include new business for three years, then renewals only	5.1
Include new business indefinitely	10.8

Additionally, the liability duration is extremely sensitive to the renewal assumption(s). Chart 2 illustrates the change in personal lines' duration as a function of the change in the renewal rate. A 0% renewal rate is equivalent to the liquidation duration.

CHART 2
PERSONAL LINES—RENEWAL-RATE SENSITIVITY



Renewal rate is critical in determining the appropriate duration of liabilities. Note that the relationship is not linear. Because this duration is a combination of expected payments on existing reserves and expected payments on new and renewal business, the duration will not be the same for any two companies.

After agreeing on a duration methodology and obtaining current (calendar year) and future (accident year) payout patterns, the next hurdle in liability evaluation is the determination of a discount rate(s). Is a pre- or after-tax discount rate more appropriate? Does one discount by a single Treasury rate for all product lines, such as implied Treasury rates as a function for each product line's liquidation duration, or a series of discount rates as a function of the spot Treasury curve? The discount method chosen can have a significant effect on the durations and market values for longer-tailed lines. An example of the duration impact is given in Table 2 for the longer-tailed workers' compensation line compared to the shorter-tailed fire line.

TABLE 2
DURATION—DISCOUNT RATE SENSITIVITY

Discount Rate	4%	7%	10%
Worker's compensation duration	8.7	6.7	5.3
Fire duration	1.2	1.1	1.0

Because the model we employ explicitly factors in the actual liability cash flows to derive the asset allocation, different discounting methodologies will result only in a different starting surplus (market value of current assets less market value of existing

reserves plus capital) and will not materially impact the asset allocation. To maintain simplicity and consistency in our optimization model, we chose the implied normalized treasury rate based on the overall liabilities' average liquidation duration.

Capital

The final phase of developing a market-value-based balance sheet is determining the appropriate capital to allocate to each business segment. At USF&G, we tied in the ALMEF model to our capital allocation model. The capital allocation model derives required assets and minimum RBC, based on NAIC requirements, for each business segment. Our capital allocation and ALMEF process utilize a consistent framework and the same key inputs (payout pattern, business plan, discount rate, market value basis). One can argue that more or less capital could be allocated to different lines of business. However, using the minimum RBC for each line not only provides a consistent framework, but also allows us to evaluate the effect of increasing the growth rate for various lines and the resulting impact on capital.

Resolution of the asset, liability, and capital issues allows one to develop a market-value-based balance sheet. Market-value analysis is utilized not only for balance-sheet evaluation, but also to segment the assets by business unit. At USF&G, we have segmented our property and casualty company into five categories. Segmentation allows us to explicitly differentiate between business segments. Actual allocation of existing assets has proven to be a tedious and painful procedure but should ultimately lead to a more rational investment process for each business segment. Business segment heads are involved in the ALM process through our working committee structure. The long-term development of investment portfolios will be driven by the distinct liability profiles of each line of business. Two crucial requirements for segmentation are accurate cash-flow information by segment and an investment accounting system that supports segmentation.

EVALUATION OF THE CAPITAL MARKETS—ECONOMIC SIMULATION

Accurate evaluation of the capital markets requires both historical data and the corporate viewpoint concerning future expectations. Capital markets' analysis involves specifying both the current environment and the long-term equilibrium assumptions for key economic and capital market factors (inflation, interest rates, and asset classes). The model employed at USF&G is a stochastic economic stimulation model that allows one to customize asset class assumptions. Asset classes are defined relative to core classes (fixed-income, equity, and cash) to maintain consistency. Additionally, fixed-income categories are defined as a function of their anticipated yield (spread to relative Treasury), duration, convexity, and default or volatility risk. The model also allows one to select the desired time horizon and to analyze the results in nominal, real or income-based returns.

The stochastic economic simulation model has several advantages over traditional lognormal models. Lognormal models provide an extension of the single period mean/variance models pioneered by Dr. Harry Markowitz, thus allowing multiperiod simulations. They assume asset returns will follow a lognormal distribution. (A logarithmic curve is similar to the shape of traditional efficient frontier curves. Because a logarithmic curve is the inverse of an exponential curve, it follows that the curve increases at a decreasing rate). To accomplish this multiperiod extension of the Markowitz model, several key assumptions are required. First, in order to allow for

multiperiod simulation, the assumption is made that year-to-year returns are independent. Second, equilibrium assumptions must remain constant (constant return and variability assumptions). These assumptions oversimplify actual market and asset-class relationships. Both stocks and bonds have been shown to have varying amounts of serial correlation and to exhibit mean reversion to capital market factors, which implies year-to-year returns are not independent. Additionally, lognormal models require equilibrium assumptions that reflect a set of constant return expectations and constant variability, precluding the use of initial market conditions.

Our model's principal advantage over a mean/variance or lognormal model is the ability to reflect the dynamic processes inherent in the economy through the utilization of stochastic differential equations which allow for changes in inflation and interest rates in order to project the future behavior of assets for more than one period. The model starts with the user-specified generation of current and equilibrium economic variables (interest rates and inflation). Capital market factors are generated consistent with the economic variables. The model then develops a range of up to 500 scenarios or possible outcomes. The stochastic economic simulation has five benefits and two considerations relative to a lognormal model. The benefits are that it:

1. Provides a more realistic return generation as opposed to the assumed independence of year-to-year returns generated from a lognormal model,
2. Ensures stable interest rate distributions while explicitly dealing with the concept of mean reversion,
3. Allows both initial and equilibrium economic assumptions,
4. Develops capital market and economic returns on a consistent basis, and
5. Provides the means for a link between assets and liabilities.

These considerations are:

1. Complexity—there are more assumptions to consider and explain.
2. There is no standard approach to generating interest and inflation models.

We believe the benefits far outweigh the complexities, and the model provides a much better assessment of assets' behavior with respect to liabilities under changing economic environments.

STOCHASTIC OPTIMIZATION

There are many methodologies for performing optimization. Traditional mean/variance models require the input of means, variances and correlations. Quadratic programs can then be used to solve for the efficient frontier.

The model employed at USF&G is a multiperiod nonlinear optimization model that utilizes the simulation results obtained from the above-referenced economic simulation model. The model considers both assets and liabilities, resulting in a surplus optimization that maximizes final surplus with respect to the standard deviation of surplus. The principal advantage over the mean/variance or lognormal model is the ability to handle multiperiod optimization problems dealing with dynamically changing distributions that cannot be solved by the use of quadratic algorithms. Additionally, liability cash flows are modeled with respect to simulated interest rates and inflation to ensure consistency of assets and liabilities. The model allows for multiple asset class

constraints that can consider acceptable ranges for duration, risky assets, and income requirements. The optimization model then analyzes up to 500 scenarios or possible outcomes to determine the asset allocation that maximizes the specified reward objective with respect to a particular level of risk. This process is then repeated for all possible risk levels resulting in the formation of an efficient frontier. The model allows for optimization based on return on assets or surplus. At USF&G, we optimize based on maximizing surplus subject to a minimum income requirement.

SENSITIVITY TESTING

The fourth step in our ALMEF process is to test the key input factors such as renewal rates, inflation and interest rate sensitivity of future premiums and liability payouts, changes in capital market equilibrium assumptions, and variability of loss ratios. Sensitivity testing will highlight the major factors affecting each business segment and the degree to which those factors affect each segment. Each factor needs to be tested independently, and relevant factors should be tested in tandem. Sensitivity testing allows one to asses the individual as well as collective impact of modifying key factors by business segment.

The result is an investment strategy that considers not only the existing balance sheet, but also future business, renewals and sensitivity to key asset/liability factors, as well as capital market factors leading to a range of optimal asset allocations. For example, the illustration in Table 3 shows the impact on duration and portfolio mix from changing the renewal rate for personal lines from 75% to 90%. Suppose that the ALM Efficient Frontier produced the following asset allocations for the same risk level (i.e., standard deviation of surplus):

TABLE 3
IMPACT OF RENEWAL RATE CHANGE ON DURATION AND PORTFOLIO MIX

Asset Allocation	Renewal Rate/Duration	
	75%/3.8	90%/6.1
1–5 year corporates	25%	20%
5–10 year corporates	45%	30%
10+ year corporate	30%	50%
Total	100%	100%

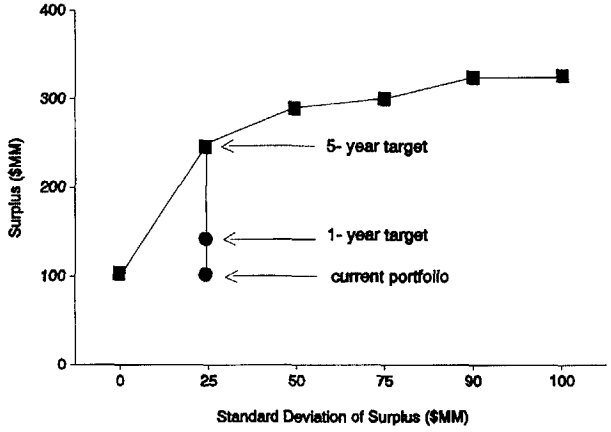
By selecting a constant risk level, one effectively creates the target asset allocation ranges for each business segment. This method provides a rationale for an investment policy statement. The testing also provides a range of durations and a means to assess risk for each business segment. Sensitivity testing is a critical process in terms of ascertaining both the behavior of a liability and its effect on asset mix, and also of developing a profile by business segment for the investment policy statement.

PERFORMANCE MEASUREMENT

No process is complete unless there is a mechanism to asses results. The final step in our ALMEF process is performance measurement. As mentioned above, sensitivity testing allows us to derive optimal asset allocation ranges. Based on these ranges and the current portfolio mix, we select a short-term and long-term allocation. In

theory, one would wish to move to the optimal portfolio immediately. However, income requirements and regulatory constraints make that impractical. An illustration is provided in Chart 3.

CHART 3
HOW QUICKLY CAN WE GET TO THE OPTIMAL PORTFOLIO?



Asset Mix	Current	1-Year Target	5-Year Target
1-5 Year Corporates	25%	20%	20%
5-10 Year Corporates	45	40	30
10+ Year Corporates	30	40	50
	100	100	100

Since the asset allocations are driven by the liability cash flows and sensitivities under 100 (the model allows up to 500 simulations) stochastic economic scenarios, the optimal target mixes derived in the ALMEF model serve as liability proxies. In the above illustration, the one-year target optimal allocation for personal lines comprises 20% in one- to-five-year corporates, 40% in five- to-ten-year corporates, and 40% in over-ten-year corporates; the weighted average return of the three respective indices is used as the one-year target proxy for personal lines. One would then assess the actual portfolio performance compared with these synthetic liability indices, which are measured by utilizing readily available market return data. The model produces not only total return, but also income estimates; therefore we measure investment performance on an income basis as well.

SUMMARY AND CONCLUSIONS

In summary, the ALMEF process at USF&G serves as a guideline or framework for better investment decision making. The five-step ALMEF process consists of:

1. Economic evaluation of the balance sheet,
2. Evaluation of capital markets employing a stochastic economic simulation model,
3. ALM optimization utilizing a multitime period, nonlinear optimization model,
4. Sensitivity testing, and
5. Performance measurement.

The process requires a coordinated effort among numerous departments, extensive and ongoing communication, senior management's support, and appropriate systems capabilities. The result is a prospective investment policy and strategy that considers not only the liability profile for the existing balance sheet, but also how the balance sheet will look going forward. At USF&G, we have taken what many companies may approach intuitively and quantified and implemented the process to not only assess asset/liability characteristics and sensitivities, but more importantly to determine optimal investment strategies which maximize surplus and ultimately improve shareholder wealth.

MR. MICHAEL LOMBARDI: I was intrigued by your presentations. All of you discussed how risk and return has now been redefined as more appropriate to insurance companies, that being in terms of surplus and the standard deviation of surplus rather than total yield and standard deviation of yield. It seems to me that you could extend this further, in that you could have a model that projects financial results in general, and you can do stochastic runs so that you could, for example, let the product line manager, or maybe the chief executive officer of a subsidiary company, use this to determine the best asset allocation. You could customize the definition of return and risk, such that, for example, return could be the size of the assets of that company, five years from now, and the risk might be that the company has to earn a return on equity of at least 5% every year. Maybe by the end of the fifth year, it would have to have an overall return of equity of at least 15% or more. I was wondering if any of the panel has seen developments in this area.

MR. SWEENEY: You make a good point, Mike, in that if you have assets and liabilities, you can define risk and reward many different ways. I think Joe Buff has done some of the better work in this area. He uses exactly the illustration you just laid out in presentations he has made. And the answer is yes, in a couple of the different projects that I was affiliated with, we did use surplus and standard deviation of surplus. This is our management tool now, and this is the way we communicate with management on ALM. But risk can sometimes be defined in terms of expenses, asset growth, or whatever. There are any number of possibilities, as long as you have a good financial model, and you can optimize to that. So, yes, I have seen it, and I think Joe has better illustrations than I do, because we do focus on surplus, for the most part.

MR. DARDIS: The example that I discussed in my introduction was specific to a universal-life product tested using asset/liability management techniques, and utilizing some of the new definitions of risk and reward we have been discussing. So here is a good example of how "customized" ALM can be used to choose appropriate assets specific to a single product line, rather than confining the ALM process to the broader investment policy for the company as a whole.

MR. OAKLEY E. VAN SLYKE: Much of my work has to do with advising companies about strategic planning, and it seems like we have more success when we look at the extreme side of what can go wrong. I am surprised to see that, when comparing surplus to risk, you are using the standard deviation of that change in surplus. I would have thought you should use the variance, because the standard deviation plays down the really bad news. And it was shown, more than 20 years ago, that if you have a risk transfer marketplace, it will be clear if you use variance loads or

something similar, and it will not be clear if you use standard deviations. So there seems to be something theoretically wrong with standard deviations.

MR. SWEENEY: I would not say standard deviations are theoretically wrong; they just use a different approach. And again, we use them because senior management understands them. Variance is a technical issue that really is a personal decision, and not related to what is the best. Standard deviation is something we just happened to be able to use to communicate with our management. Semivariance is probably the best way to go about it. The computation might be very difficult. We have the methodology to do it. We have not been able to explain it to the management yet. So, again, what you use for risk and reward really ought to be a function of what you can explain to your management. This whole process, if it resolves itself into an unintelligible mass of data or jargon, just will not work. You must be able to talk to management about it, and standard deviation is what we use to communicate with management.

MR. DARDIS: Many of these new definitions of risk actually have nothing at all to do with standard deviation. Rather, the standard deviation or the variance is implied in the definition of the returns. Some of these new definitions do look at risk from a different angle.

MR. RALPH S. BLANCHARD, III: This question relates to the idea of using open-ended durations for the property and casualty business in trying to come up with a liability flow. That gets me very nervous, because I know, for term life or for other things, the price is set, so if people renew, you know what price they will renew at. On the other hand, for property and casualty business, the price is reset every year. Many times, people feel that reflects the interest rate environment at that point in time. So, how do you adjust for the fact that, in an open-ended procedure, you do not know what the premium flow will be? Because that could vary to reflect the current market rate.

MR. SWEENEY: We look at three or five-year strategic plans. In our particular model on the liability model side we are interest-rate- and inflation-sensitive. The prices are inflation sensitive as well, and this is all modeled out stochastically. On an ongoing basis, if we have a fairly decent renewal assumption, it gives us the bulk of what we need to forecast out the liability flows. We may not be right but we should not be too terribly wrong one way or the other just by making those assumptions, especially as you are only dealing with a five-year time frame.

MR. BLANCHARD: I have not seen one five-year plan that I thought was worth the paper it was written on for property and casualty business.

MR. SWEENEY: I will not take issue with that one. Bill Panning, the head of ALM at ITT Hartford, has done a considerable amount of work in this area. I have heard him talk on two occasions and apparently they are adopting a similar approach to what we are using. I do not take issue with your five-year plan observation, but you do have to plan! And I think that really the crux of the plan is the renewal assumption.