

## LIFE INSURANCE

## THE MOUNTING PRESSURES ON FINANCIAL MODELING

Pressures on a variety of fronts are spurring life insurers to develop ever more sophisticated financial models to meet future needs. Technology and modeling techniques need to be continually updated to meet the demand.

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Over the last 20 years, life insurers have made great strides in risk management, capital optimization, product development and other important aspects of their business with the help of significant enhancements in financial modeling. However, as models have improved, pressures mount to come up with even more sophisticated models. Today's products are increasingly complex, and financial reporting demands to measure risk are growing. As a result, models viewed as highly sophisticated just a few years ago are now inadequate to meet today's needs.

To assess today's modeling needs, it is useful to review how far modeling techniques have come. In various parts of the world, financial modeling has aided the transformation of many basic industry practices, as shown in *Exhibit 1*.

In general, these developments add complexity to current models, which typically have up to five basic aspects:

- time, typically segmented into annual, quarterly or monthly steps
- portfolio detail, ranging from a very few representative model points to individual policies
- product/risk features and assumptions
- scenarios, ranging from a single "most likely" scenario to stochastic (e.g., Monte Carlo simulation)

**EXHIBIT 1**  
**Industry practices are transforming to more detailed models**

BASIC FUNCTION	TRADITIONAL METHODS	NEW METHODS
Loss	Commutation functions	Projected cash flows
Calculations	Annual	Monthly
Investments	Simple yields	Model asset and cash flows
Modeling complexities	Broad brush	Precise by product features
Projections	Expected averages	Distributions
Analysis of risk	Group basis	Separate by risk

■ value calculations, taking into account economic or regulatory factors, such as reserves or the cost of guarantees, at specific future points in time.

Detail added to each of these areas places great stress on the ability to create and run the models using a reasonable expenditure of resources and time.

### FACTORS BEHIND THE MODELING BOOM

The trend toward more sophisticated models has been driven by a number of factors. First and foremost is that such models have been "enabled" by the vast increase in the power and memory of computers.

Other important forces have also been at work, some of which strain the capabilities of even the fastest computers.

Another factor is the long-term trend toward increased competition. The thinner margins that have resulted, along with increasing scrutiny of capital efficiency, demand a better understanding of profit drivers, of capital needs in different parts of the business and of the risks the business faces. This in turn creates a need for more precise instruments to measure these elements.



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The continued movement toward insurance products with more guarantees, whether they are long-term guarantees of mortality premiums for life products or guarantees of minimum performance on equity-based products such as variable annuities, is another factor influencing model requirements. This complexity of product design, and the risks inherent in these guarantees, has placed great demands on models.

Life insurers also face growing pressure for better information and line-of-business controls from multiple fronts — externally from regulators, rating agencies and analysts, and internally from boards of directors and company management. Insurance regulators are themselves under pressure to align insurance reporting and regulatory analysis with processes common in the banking and other financial services industries. Recent work by the International Association of Insurance Supervisors on global solvency standards will lead to greater reliance on internal company models to determine individualized capital requirements. Solvency II work in Europe is heading in the same direction.

Taken together, these evolving demands have prompted an ongoing quest to model “reality” as accurately as possible. The challenge for financial modeling practitioners is determining how to keep up.

### **EXAMPLE OF GROWING COMPLEXITY: MODELING OF VARIABLE ANNUITIES**

Variable annuities sold in the U.S., which can include guarantees for minimum death benefits, annuitization benefits, withdrawal benefits and accumulation benefits, are a good example of how industry demands are evolving. The guarantees involve modeling not only investment returns, but also significant policyholder options with respect to lapses, resets and other aspects that can impact an insurer's ultimate costs. Companies need to have a full understanding of the implications of these guarantees, even though the modeling complexities are far greater than ever.

In fact, the modeling boundaries for variable annuities continue to be stretched. Several years ago, companies with these guarantees would have either reinsured the risk or retained it, and performed some fairly simple stochastic modeling of the expected results. More recently, many companies have been hedging the risk with the purchase of financial instruments. This process of dynamic hedging involves continued measurement of the risks in the liabilities and balancing these risks with offsetting financial instruments, and modeling is needed for the measurements. Because no hedging is perfect, modeling is also needed to measure the residual risks, as well as to project how earnings will emerge under statutory and GAAP financial statements.

A financial model of dynamic hedging has to project the cost and effect of financial options. Determining the financial options to be purchased in the future requires completion of a separate set of calculations at multiple future points in time.

Another example of how modeling boundaries are being pushed for variable annuities stems from the regulatory trend to use stochastic modeling to determine required reserves and capital. For variable annuities with guarantees, stochastic modeling-based required capital (C-3 Phase II) is in place for year-end 2005, and regulations are being developed to require a similar process for reserves (see *Update*, September 2005, “Preparing for C-3 Phase II RBC — From Development to Implementation”).

For the calculation of C-3 Phase II capital at time zero with dynamic hedging, or for pricing models without hedging that seek a projection of capital, the modeling is two dimensional, requiring nested stochastic calculations. This is also referred to as “stochastic on stochastic.” For nested stochastic models, computer run time and memory overload become even more significant issues.



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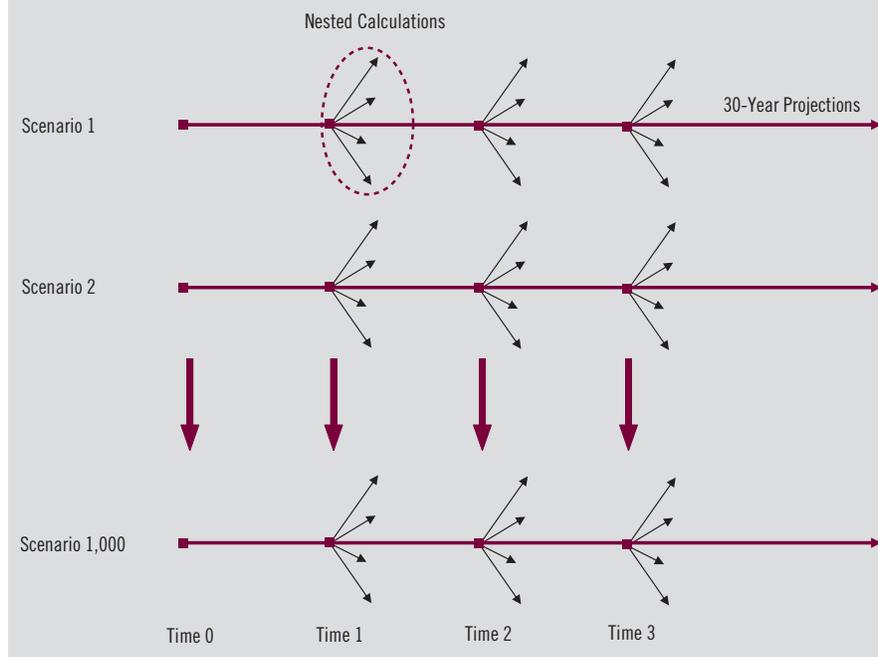
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*Exhibit 2* displays the concept of two-dimensional nested stochastic modeling. Along each base scenario (horizontal lines), the projection stops at each node (i.e., predetermined time step) to perform a set of nested calculations in order to assess the impact before continuing on with the base projection.

When calculating C-3 Phase II capital at time zero while also taking into consideration current and future hedging, nested calculations across a set of risk-neutral scenarios must be performed, so that the model can compute new positions in hedge assets and reflect the purchase or sale of hedge assets before continuing on to the next node or time step (i.e., one month or less in the case of dynamic hedging). For pricing models without future hedging that seek a projection of capital at each node, capital must be determined by performing nested calculations across a range of C-3 Phase II compliant scenarios before continuing on to the next node. In the latter example, nodes are defined as explicit capital recalculation points (e.g., at the end of each projection year).

For pricing models that have both future hedging and a projection of future capital amounts, the computation is a three-dimensional nested stochastic exercise (also referred to as “stochastic within nested stochastic calculations” or “stochastic on stochastic on stochastic”). While implementation of this type of projection is not impossible, run time and memory issues using today’s technology make it impractical, unless simplifying modifications are made.

## EXHIBIT 2 Two-dimensional nested stochastic model



## TECHNOLOGICAL ADVANCES SUPPORT NEWER MODELS

The challenges that companies face continue to mount, and the tools and expertise needed to respond must evolve rapidly to provide timely solutions. The example above for U.S. variable annuities is indicative of the financial modeling challenges faced in other countries and other product lines. Driven by these demands and using the ever-faster computers that are available, modeling software providers are adapting their products to meet these demands. The changes include:

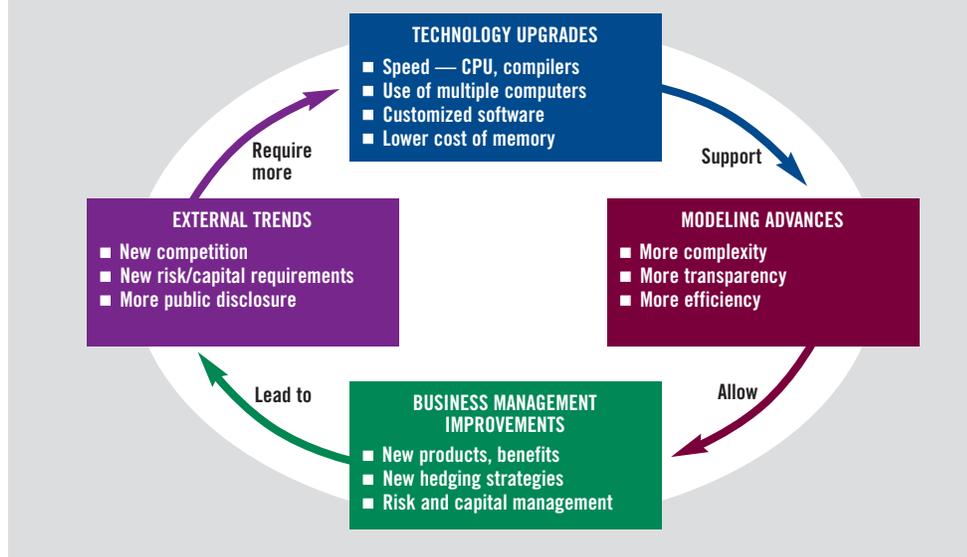
- Utilizing new compilers that produce faster code.

- Spreading projection runs across multiple computers. This may be provided as part of the product or through links to third-party “grid computing” products from specialist providers such as Platform Computing and DataSynapse.

- Customizing models for different purposes and specific companies rather than using a one-size-fits-all approach. For example, models are available to calculate hedging positions for a specific company. These models are often “tuned,” or optimized, using tools such as code profilers to replace inefficient code.

- Minimizing the need for models to read and write information to disk. The increasing availability and affordability of memory on PCs is making this easier to achieve.

**EXHIBIT 3**  
**Modeling spurs continuous improvement cycle**



### ADVANCES IN MODELING ALLOW IMPROVED ANALYSIS

As models become more complex, they need to be kept under control. Considerations include the following:

- Modeling software needs to be auditable, transparent and adaptable. Companies will be completing complex analyses that will assist in decisions worth potentially millions of dollars. With auditable and transparent software, companies can gain comfort that their analyses are correct.

- Companies are continually inventing and incorporating unique new features into their products. Adaptable software is required to accommodate unique benefits and product design.

- Stochastic projections may be performed using a model to represent the many liability contracts. An appropriate set of model points, based on optimized grouping rules, is the key to significantly reducing run time and memory consumption. Grouping rules should take into consideration a wide variety of dimensions, such as issue age, sex, type of benefit, net amount of risk and mix of funds. Care must be taken to ensure that results produced using the model points are a reasonable representation of results produced using seriatim data or model points with more individual product detail.

- Representative scenarios can be introduced into a model, potentially reducing a large number of scenarios to a manageable subset and reducing run time by a proportionate amount. For example, 50 scenarios could be identified that reasonably represent the larger set of 1,000, using an appropriate methodology to focus on the

tail results in question, and applying different appropriate weights to the different scenarios.

Advancements in financial projection models have led to concerns over consistency and control within the corporation. Some companies have mandated movement toward one corporate model (see *Emphasis* 2004/3, “Evolving Corporate Financial Models” by Jack L. Gibson and Hubert Mueller). There are significant challenges to a single corporate model approach when some of the modeling uses require extensive stochastic calculations. This implies that separate but consistent models may need to be developed for different purposes.

### BETTER RESULTS, GROWING DEMANDS

Recent advances in technology and models have not satisfied growing demands for more precise and clearer information, and it is unlikely to ever fully satisfy these demands. This is because we are continuously striving to model reality, and an insurance company is not a closed system. There are many dimensions to the business and an infinite number of internal and external factors influencing management decision making.

As shown in *Exhibit 3*, advances in modeling allow for advances in the management of business, and also spur the development of new products and strategies that take advantage of the advanced capabilities. As companies gain the ability to better model their risk profile, they gain the ability to improve their risk and capital management, and can develop more efficient (more profitable) business strategies.

As competitors follow the leaders, leading-edge capabilities in modeling will become industry standards. Regulators and rating agencies will take note of these changes and set higher modeling standards, and investors will want evidence that companies have their risks adequately modeled.

Together, these forces will spur continued improvement of financial modeling. In order to survive in today’s competitive environment, companies need to ensure that their models keep up in terms of necessary enhancements.

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