

### **Section 3: Excerpts from Proposal of Selected Researchers**

#### **Our Understanding of the Problem**

The Casualty Actuarial Society (CAS) and the Society of Actuaries (SOA) are soliciting proposals for research involving the modeling of economic series. This research is important for generating reasonable future economic and financial scenarios, and has critical implications for dynamic financial analysis and cash flow testing. One essential aspect of this research involves the interdependencies between the various economic and financial series, especially, but not exclusively, the interrelationships between the different series and interest rates. In terms of work products, this research would involve surveying and reviewing the relevant literature, presenting an economic scenario generator model, and preparing documentation and one or more papers describing the model and research findings.

#### **Our Proposal to Perform This Research**

This project would be a logical extension of the substantial financial and actuarial work and research performed, and being performed, by the three researchers submitting this proposal. We propose the following research plan to address this important and challenging project.

- 1) ***Literature review.*** A comprehensive survey and review of the relevant literature. This review will include a summary of the procedures and findings documented in many significant articles, in each of the following categories:
  - a) Actuarial
  - b) Financial
  - c) Other (e.g., economic, econometric, and/or statistical)
- 2) ***Development and presentation of an economic scenario generator model.*** This includes several items:
  - a) *Development of a model to represent economic and financial series.* Specific series include:
    - i) Term structure of interest rates. A model for the term structure will include values for *short-*, *medium-*, and *long-term rates*, and will reflect the *shape of the yield curve*. The interest rate model will be a central part of the overall economic scenario generator model, since most other economic and financial series are related to interest rates in some fashion.
    - ii) Inflation. An important interdependency in the model will involve the relationship between interest rates and inflation. A variety of different inflation rates will be modeled, including *general*, *medical*, *wage*, and insurance-specific (*line of business*) inflation rates.
    - iii) Stock market levels. Based on historical data and patterns, this series can be split into several possible sub-series, for example *large* versus *small cap* stocks.
    - iv) Real estate price levels.
    - v) Unemployment rates.
    - vi) Economic growth rates.

- b) *Parameter estimation.* Statistical analyses of relevant historical data will serve to parameterize the model. Interdependencies between variables will be identified through regression-type equations or other means.
  - c) *Provision for extreme conditions.* There will be a provision for the representation of extreme financial and economic conditions. This provision might involve the selection of appropriate parameter values, or other means (e.g., through a stochastic jump process).
- 3) ***Creation of software which allows users to model economic and financial series.*** This software will follow the model developed above, and will be made available to the sponsoring organizations for general use and comment.
  - 4) ***Documentation.*** A comprehensive report describing the literature review, the model, and the parameterization will be written. This report will also include a description of how the parameter estimation can be updated, and a brief discussion of the implications of the model for specific areas of actuarial interest, such as dynamic financial analysis, asset-liability management, risk-based capital, and insurance pricing. In addition, slide presentations summarizing this research will be provided for posting on the sponsoring organizations' websites.
  - 5) ***Additional articles.*** The researchers will write a paper discussing this research, with the intention of publishing it in the *CAS Proceedings*. In addition, other articles may be written, possibly for publications such as the *North American Actuarial Journal*, the *Journal of Actuarial Practice*, or the *Journal of Risk and Insurance*.

One of the key aspects of this research involves a model of interest rates. A large number of models of the stochastic term structure of interest rates have been developed, ranging from relatively simple to extremely complex. The models tend to fall into one of two types: equilibrium models that are derived from proposed relationships between supply and demand for funds, and no-arbitrage models that use the current term structure as a starting point and generate changes from the current values. Some term structure models use only one stochastic variable, usually the short-term interest rate, whereas others have two, three, or more stochastic variables, which can include such factors as the long-term interest rate, the volatility factor, and the mean reversion speed. The general consensus is that no single model is best for all applications and the more complex the model, the more sensitive it is to parameter misspecification. Thus, the results of this research may generate more than one interest rate model. Descriptions of these models would include discussion of the strengths and weaknesses of each model and which models would be most appropriate for particular situations. This approach would allow practitioners with different needs and different levels of comfort with term structure models to select the appropriate model for each application.

### **Sample Reference List**

The following sources represent a sample of the works which may be referenced during this project. Many of these sources will form the basis of the literature survey.

Ahlgrim, Kevin C., Stephen P. D'Arcy and Richard W. Gorvett, 1999, Parameterizing Interest Rate Models, *Casualty Actuarial Society Forum*, Summer 1-50.

- Act-Sahalia, Yacine, 1999, Do Interest Rates Really Follow Continuous-Time Markov Diffusions? University of Chicago Working Paper.
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- D'Arcy, Stephen P. and Richard W. Gorvett, 2001, Measuring the Interest Rate Sensitivity of Loss Reserves, *Proceedings of the Casualty Actuarial Society* 88.
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- Heath, D. , R. Jarrow and A. Morton, 1992, Bond Pricing and the Term Structure of Interest Rates: A New Methodology, *Econometrica*, 60: 77-105.
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- Hull, John C., 2000, *Options, Futures, and Other Derivatives* Fourth Edition (Upper Saddle River, NJ: Prentice Hall).
- Hull, John C, and Allen White, 1990, "Pricing Interest Rate Derivative Securities," *Review of Financial Studies*, 3:573-592
- Litterman, Robert and Jos9 Scheinkman, 1991, Common Factors Affecting Bond Returns, *Journal of Fixed Income* 3:54-61.
- Masterson, Norton, 1968, "Economic Factors in Liability and Property Insurance Claims Costs," *Best's Insurance News* (October), pp. 12-18; subsequent updates published periodically in *Best's Review*
- Reitano, Robert R., 1996, Non-parallel yield curve shifts and stochastic immunization, *Journal of Portfolio Management*, Winter 1996, p. 71.
- Santomero, Anthony and David F. Babbel, 1997, Financial Risk Management: An Analysis of the Process, *Journal of Risk and Insurance* 64:231-270.
- Staking, Kim and David Babbel, 1995, The Relation Between Capital Structure, Interest Rate Sensitivity, and Market Value in the Property-Liability Insurance Industry, *Journal of Risk and Insurance*, 62:690-718.

Tilley, James A., 1988, *The Application of Modern Techniques to the Investment of Insurance and Pension Funds* (New York: Morgan Stanley & Co.)

Vasicek, O, 1977, An Equilibrium Characterization of the Term Structure, *Journal of Financial Economics*. 5: 177

### **Researchers and Qualifications**

The three researchers submitting this proposal are, we believe, uniquely qualified to perform this research. All three are designated actuaries (two are members of the Casualty Actuarial Society, and one is a member of the Society of Actuaries), each has a Ph.D. in Finance with a significant research background in areas relevant to this project, and – importantly – each has considerable experience as a practicing actuary. This latter characteristic refers to full-time, real-world experience, not merely occasional consulting engagements, and is important to the researchers' understanding of the applications of this project to real-world actuarial considerations. In addition, several prior papers written by these researchers have been awarded prizes by the CAS.

Some of the highlights of work and research performed by the researchers include:

- Development of a public-access dynamic financial analysis model
- Research on historical interest rate movements and stochastic interest rate models
- Research on the interrelationships of interest rates with inflation and other economic variables
- Applications of DFA models to insurance companies
- Considerable teaching, seminar, and presentation experience on the implications of financial issues for life and property-liability insurance

Brief descriptions of each researcher follow, in alphabetical order. Complete resumes of each researcher accompany this proposal.

**Kevin Ahlgrim, ASA, MAAA, Ph.D.**, is an assistant professor in the Department of Finance and Quantitative Methods at Bradley University. He received a BS in actuarial science, and an MS and a Ph.D. in finance, all from the University of Illinois at Urbana-Champaign. Prior to entering academia, he worked as an actuary at CIGNA Corporation and Aon Consulting. Kevin has done extensive research using several interest rate models. His specific research interests lie in the application of fixed income techniques to insurance. Specifically, his dissertation analyzed the impact of different term structure models on the dynamic financial analysis of insurance companies, including both property-liability and life companies. Kevin has also examined other applications of term structure models including pricing Eurodollar futures options and investigating biases of specific models.

**Stephen P. D'Arcy, FCAS, MAAA, Ph.D.**, is a Professor of Finance and the John C. Brogan Faculty Scholar in Risk Management and Insurance at the University of Illinois at Urbana-Champaign. He is a Past-President of the American Risk and Insurance Association and a member of the Board of Directors of the Casualty Actuarial Society. He received his B.A. in applied mathematics from Harvard College and his Ph.D. in finance from the University of Illinois. The courses he teaches include an introduction to insurance, property-liability insurance, casualty actuarial mathematics, advanced corporate finance, employee benefits and

financial risk management of insurance enterprises. He teaches a seminar on finance and an on-line course on financial risk management for the Casualty Actuarial Society. Prior to his academic career, he worked as an actuarial student at Aetna Insurance Company and as Actuary at CUMIS Insurance Society. He served on the Governor's Task Force on Medical Malpractice in Illinois. His research interests include dynamic financial analysis, financial pricing models for property-liability insurers, catastrophe insurance futures, pension funding and regulation.

**Richard W. Gorvett, FCAS, MAAA, ARM, Ph.D.**, is an actuarial science professor at the University of Illinois at Urbana-Champaign. He received a BS in mathematics from the University of Illinois at Chicago, an MBA in finance, econometrics, and statistics from the University of Chicago, and a Ph.D. in finance from the University of Illinois at Urbana-Champaign. Prior to entering academia, he worked as a practicing actuary for Allstate, CNA, Tillinghast, and Ernst & Young. He has taught insurance, finance, financial risk management, and actuarial science courses at both the undergraduate and graduate levels. His research activity centers around dynamic financial analysis, insurance securitization, and the application of financial theory to property-liability insurance.

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To update the above personnel descriptions as of July, 2003:

- Mr. Ahlgrim was at Bradley University through the Summer of 2003; effective Fall 2003, he is a finance professor at Illinois State University.
- Mr. Gorvett went to Zurich North America in the Summer of 2001, most recently as Senior Vice President and Director of Internal Audit & Risk Management; effective Fall 2003, he returns to the University of Illinois at Urbana-Champaign as an actuarial science professor.