

**Report on**

**Modeling of Economic Series Coordinated  
with Interest Rate Scenarios**

**Research Sponsored by the**

**Casualty Actuarial Society**

**and the**

**Society of Actuaries**

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**July, 2004**

## Section 1: Introduction and Overview

### Introduction

In May, 2001, the Casualty Actuarial Society (CAS) and the Society of Actuaries (SOA) jointly issued a request for proposals on the research topic “Modeling of Economic Series Coordinated with Interest Rate Scenarios.” The objectives of this request were to develop a research relationship with selected persons to investigate this topic; produce a literature review of work previously done in the area of economic scenario modeling; determine appropriate data sources and methodologies to enhance economic modeling efforts relevant to the actuarial profession; and produce a working model of economic series, coordinated with interest rates, that could be made public and used by actuaries via the CAS / SOA websites to project future economic scenarios. Categories of economic series to be modeled included interest rates, equity price levels, inflation rates, unemployment rates, and real estate price levels.

This topic is of considerable value and importance to the actuarial profession and the broader insurance community, for several reasons. For example, a key aspect of the *dynamic financial analysis* (DFA) process, which continues to be an area of substantial development and interest in the actuarial community, is the generation of economic and financial scenarios. These scenarios provide an economic context for the evaluation of an insurer’s alternative operating decisions and their potential impact, across a variety of possible future economic conditions, on future corporate value. In other words, such stochastic simulation efforts are predicated upon the ability to probabilistically express possible future economic and financial environments. In addition, an integrated scenario generation capability is critical to recognizing the interdependencies between the various economic and financial series – e.g., consistently modeling the relationships between, say, equity returns and interest rate movements.

Similarly, the generation of scenarios is important for *regulatory, rating agency, and internal management tests* of an insurer’s potential future operating conditions. An example is *cash flow testing*; by testing across scenarios, an insurer’s cash position and liquidity can be evaluated over a variety of alternative future economic and financial environments.

This document represents the report, produced by the three researchers selected by the CAS / SOA, which summarizes this research and the development of a scenario generation model available for public use. Full descriptions of the project, the research methodology, analytical implications, and the model itself – a spreadsheet-based stochastic simulation model – are provided in this report.

### Overview

This report includes the following sections and attachments:

Section 1:	Introduction and Overview
Section 2:	Excerpts from Original CAS / SOA Request for Proposals
Section 3:	Excerpts from Proposal of Selected Researchers

Section 4:	Literature Review
Section 5:	Descriptions of Data and Approach
Section 6:	Discussions of Issues
Section 7:	Results of Model Simulations
Section 8:	Conclusions and Acknowledgements
Appendix A:	User's Guide to Model
Appendix B:	Presentations on This Research (including four files containing three presentations and a published paper)
Appendix C:	Simulated Financial Scenario Data
Appendix D:	The Financial Scenario Model

Most of the Section and Appendix titles should be self-explanatory. Brief comments on just a few of these components are provided here.

The *Literature Review* (Section 4) includes brief descriptions of a variety of articles – covering the areas of actuarial science (both life and casualty), finance, and economics – that we believe are relevant, to varying degrees, to this research. (For articles appearing in CAS or SOA publications, hyperlinks to the articles are included.) We appreciate a number of article suggestions made by members of the CAS and SOA oversight committees. Research on the development of financial scenarios, and the analysis of financial and economic time series, is a continually evolving and growing area. We recommend that efforts be made, at least periodically if not continually (e.g., by a formal charge to appropriate CAS / SOA research committees, or by engagement of other interested persons), to provide an ongoing search for and review of relevant new work in the area, in order that the results from this project might be enhanced and updated.

*Discussions of Issues* (Section 6) describes and comments upon some of the specific issues encountered during the course of this research. In some cases, these issues involved decisions which we as researchers were confronted with; our thought processes and the rationales for selected approaches are included. Often, these issues were either provoked or reinforced by questions or comments from members of the sponsoring actuarial committees. Again, this input was greatly appreciated and valued throughout the project.

*Presentations on Research* (Appendix B) includes a schedule of presentations which one or more of the researchers have made, or are planning to make, to actuarial, academic, or other organizations regarding this research. Where a presentation has been made, presentation materials, if available, are included. Copies of future presentations will also be provided, on an ongoing basis, to the CAS / SOA, if desired by those organizations.

*Simulated Financial Scenario Data* (Appendix C) is a spreadsheet database of hundreds of scenarios (i.e., simulation paths) of financial and economic variables, generated as output from the Financial Scenario Model. The intent of this data is to provide an alternative to requiring the @Risk simulation package (an add-on to Excel) in order to run the model. This data can be used directly, in lieu of actually running the model; the “pre-simulated” scenario paths can be used as an input to a DFA or other analytical effort.

*The Financial Scenario Model* (Appendix D) is an Excel spreadsheet-based program, designed to be run, as mentioned above, through the @Risk simulation add-on. The model includes default values of appropriate parameters – however, these can be changed by the user for purposes of updating for new or additional data, sensitivity testing of parameter values, etc.