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PROCEEDINGS

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FOREWORD

Actuarial science originated in England in 1792 in the early days of life insurance. Because of the technical nature of the business, the first actuaries were mathematicians. Eventually, their numerical growth resulted in the formation of the Institute of Actuaries in England in 1848. Eight years later, in Scotland, the Faculty of Actuaries was formed. In the United States, the Actuarial Society of America was formed in 1889 and the American Institute of Actuaries in 1909. These two American organizations merged in 1949 to become the Society of Actuaries.

In the early years of the 20th Century in the United States, problems requiring actuarial treatment were emerging in sickness, disability, and casualty insurance—particularly in workers compensation, which was introduced in 1911. The differences between the new problems and those of traditional life insurance led to the organization of the the Casualty Actuarial and Statistical Society of America in 1914. Dr. I. M. Rubinow, who was responsible for the Society's formation, became its first president. At the time of its formation, the Casualty Actuarial and Statistical Society of America had 97 charter members of the grade of Fellow. The Society adopted its present name, the Casualty Actuarial Society, on May 14, 1921.

The purpose of the Society is to advance the body of knowledge of actuarial science in applications other than life insurance, to establish and maintain standards of qualification for membership, to promote and maintain high standards of conduct and competence for the members, and to increase the awareness of actuarial science. The Society's activities in support of this purpose include communication with those affected by insurance, presentation and discussion of papers, attendance at seminars and workshops, collection of a library, research, and other means.

Since the problems of workers compensation were the most urgent at the time of the Society's formation, many of the Society's original members played a leading part in developing the scientific basis for that line of insurance. From the beginning, however, the Society has grown constantly, not only in membership, but also in range of interest and in scientific and related contributions to all lines of insurance other than life, including automobile, liability other than automobile, fire, homeowners, commercial multiple peril, and others. These contributions are found principally in original papers prepared by members of the Society and published annually in the *Proceedings of the Casualty Actuarial Society.* The presidential addresses, also published in the *Proceedings,* have called attention to the most pressing actuarial problems, some of them still unsolved, that have faced the industry over the years.

The membership of the Society includes actuaries employed by insurance companies, industry advisory organizations, national brokers, accounting firms, educational institutions, state insurance departments, and the federal government. It also includes independent consultants. The Society has two classes of members, Fellows and Associates. Both classes require successful completion of examinations, held in the spring and fall of each year in various cities of the United States, Canada, Bermuda, and selected overseas sites. In addition, Associateship requires completion of the CAS Course on Professionalism.

The publications of the Society and their respective prices are listed in the Society's *Yearbook*. The *Syllabus of Examinations* outlines the course of study recommended for the examinations. Both the *Yearbook,* at a charge of $40 (U.S.), and the *Syllabus of Examinations,* without charge, may be obtained from the Casualty Actuarial Society, 1100 North Glebe Road, Suite 600, Arlington, Virginia 22201.

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* Term expires at the 1995 Annual Meeting. All members of the Executive Council are Officers. The Vice President-Administration also serves as Secretary and Treasurer.

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NOTICE

Papers submitted to the *Proceedings of the Casualty Actuarial Society* are subject to review by the members of the Committee on Review of Papers and, where appropriate, additional individuals with expertise in the relevant topics. In order to qualify for publication, a paper must be relevant to casualty actuarial science, include original research ideas and/or techniques, or have special educational value, and must not have been previously copyrighted or published or be concurrently considered for publication elsewhere. Specific instructions for preparation and submission of papers are included in the *Yearbook* of the Casualty Actuarial Society.

The Society is not responsible for statements of opinion expressed in the articles, criticisms, and discussions published in these *Proceedings*.

Volume LXXXII, Part 1 No. 156

PROCEEDINGS
May 14, 15, 16, 17, 1995

ADDRESS TO NEW MEMBERS—MAY 15, 1995

DAVID G. HARTMAN

Isn't it appropriate that we are here today in the shadow of Gateway Arch as you new Fellows and new Associates are at the gateway of the rest of your career! What I would like to do today is talk to you in three areas: First, *compliment* you, with both an "i" and an "e"; second, share with you some of the experiences of my *contemporaries*; and third, *challenge* you.

Compliment/Complement

First of all, the compliment. Congratulations to you on a job well done! To Fellows, for making it all the way through the exams; to Associates, for making it at least 70% of the way through. We appreciate very much the stick-to-itiveness that you have demonstrated and the sacrifice that this has meant. Keep at it. Compliments also to spouses who have been so supportive of you as you have taken the exams, as well as to friends, co-workers, and others who have been supportive of you in attaining this particular milestone. You have now entered a profession.

There are four hallmarks to a profession. First, a profession has a core of basic knowledge unique to that profession. Second, a professional continues his or her education. Both of these functions are performed in the actuarial profession by the Casualty Actuarial Society or, for our life, pension and health counterparts, the Society of Actuaries. To complement that, with an "e," is the American Academy of Actuaries, primarily performing two other key parts of professionalism. The third hallmark of a profession is that there are standards. One standard would be a Code of Conduct; others would be the Standards of Practice as promulgated by the Actuarial Standards Board (ASB). The fourth hallmark is discipline, which is performed by the Actuarial Board for Counseling and Discipline (ABCD). They like to emphasize that counseling is the key part of their function. I urge you to complement your CAS membership by becoming a member of the Academy, if you have not already done so.

Contemporaries

Moving on to the area of contemporaries, I thought it would be interesting for you to let me share with you the paths taken by the six of us who became Fellows together at the May 1972 meeting. Unfortunately, one of those, Edward R. Murray, died in 1984. I'd like to give you a thumbnail sketch of the other five of us and hopefully have some of our experiences stimulate thoughts about your own career. To set the stage, I'd like to recall for you a definition of an actuary that past CAS President Fred Kilbourne presented back in 1978. That definition is that "an actuary is that professional who is trained in evaluating the current financial implications of future contingent events."

Walt Stewart and I are, more or less, traditional company actuaries. Walt is vice president and senior actuary of CIGNA Property and Casualty. He has responsibility for research, pricing policy, claims operation support, workers compensation, administration, the actuarial student program, statistical reporting, and part of actuarial systems. Walt has been a representative of his company on a number of industry committees, principally at ISO and the National Council on Compensation Insurance. Some of the research that he has brought forward has been very much the kind of thing that would make him an actuary's actuary.

As indicated in my introduction, I am managing director and senior vice president and chief actuary at the Chubb Group of Insurance Companies. In addition to my many professional activities, I am or have been active in leadership of church, Scouts, United Way, and local hospital groups.

Bob Anker is, and has been for the past three years, president and chief operating officer of Lincoln National Corporation, an insurance holding company including American States Insurance Companies and the Lincoln National Life Insurance Company of which he is chairman and CEO—a casualty actuary serving as president of a life company! Bob worked as a casualty actuary for ten years at Employers Insurance of Wausau prior to joining American States in 1974. As an example of his continuing education, he has earned both the CPCU and the CLU designations. He has served the profession as vice president of development and director of the Casualty Actuarial Society and is currently a director of the American Academy of Actuaries. He has written reviews of papers and frequently served as a panelist on CAS meeting programs. He is a past president of the Midwestern Actuarial Forum. Looking at community service, Bob has served, or is serving, on the boards of 11 civic organizations.

Bob Bergen is chairman of Investment Research Institute, Incorporated, an organization he co-founded in 1981 with another CAS member, Bernie Shaeffer. IRI publishes the Option Advisor and Fund Profit Alert newsletters with over 20,000 subscribers. These newsletters provide investment advice in the stock, option, and mutual fund areas. Bob worked for ISO for ten years and for Great American for seven years prior to forming IRI. Bob has written me saying that his community service encompasses involvement with youth sports, including sponsoring youth baseball teams, consulting on league insurance programs, fundraising, and handling team statistician chores. Bob says that while the financial markets are a natural extension of his interest in economics, statistics, and just plain numbers, the disciplines of the CAS have served him well in many aspects of a growing business. Attention to detail and ability to interpret financial data are valuable in the creation, planning, and analysis of marketing programs. The ability to analyze statistical information for accuracy and relevance is important in many areas, especially for management reports and accounting and financial statements, as well as in research relating to deriving stock and option recommendations for subscribers.

Charlie Rinehart is chairman of the board and chief executive officer of Home Savings of America, which is the largest savings and loan in the United States with $54 billion of assets. Charlie worked for Fireman's Fund for 15 years where he rose to the number two job in the Actuarial Department in his first six years, then managed the Personal Lines Underwriting Department, and then the Commercial Group Department, which did mass merchandising. He was in charge of all field operations before he left in 1983 to become president of Avco Finance. He joined Home Savings in 1989. Charlie tells me that he finds that there are many similarities between his work in property/casualty insurance and consumer finance. The pricing of consumer finance involves predicting default risk by first reviewing historical data of homogeneous groupings and also by reviewing trends in external economic factors, such as home prices and the job market. Both involve setting reserves using operations research and econometric modeling tools. Both involve financial statement analysis. He found the only real adjustment between the two to be what comes first. In insurance, what comes first is the payment of a premium which is set up as an asset, and then liabilities are established for unearned premium reserves and loss reserves. In consumer finance, on the other hand, first money is borrowed establishing a liability, and then assets are established in the way of mortgages.

So all five of us are actuaries in terms of the definition that Fred Kilbourne enunciated, yet our training has taken us into pricing, reserving and financial analysis in property and casualty, life, consumer finance, and investment applications. As you look at your future, I hope you will consider Fred's definition as a broad one encompassing traditional and non-traditional actuarial roles for yourself.

Challenges

Moving on now to the area of challenges as you step through this gateway, let me offer several specific items for your consideration.

First, do your best at what you are doing right now. As the old adage says, if you rest on your laurels, you're wearing them in the wrong place. You have received training as a casualty actuary, and that is something special throughout the world. Nowhere else in the world does any group of actuaries receive such specialized training as you are receiving in the practice of casualty insurance, or what is referred to as general insurance outside the U.S. As you do your best, make sure to add value to the process in which you are involved. Your first priority on the job is to provide your customer with what they need. Charlie Rinehart captured that by saying, "find solutions for the *business* problems." An elegant mathematical model without practical application is unlikely to add value. If you do your current job well, you will be building a solid foundation for the future.

Second, continue your education. For those of you who are new Associates at this meeting, I urge you to finish your Fellowship exams. Never stop growing. I look at myself years ago when I was deciding whether I should be a life actuary or a casualty actuary, and I deliberately chose the casualty field because it was an area where things were always changing. You could never learn all there is to know about the practice of casualty actuarial science. Keep ahead of the curve as you continue your education. The changes in the areas of legal, economic, and technological developments seem to be occurring at an exponential pace. Think of how your training and your skills can be applied to keep pace with, or even stay ahead of, these developments.

Third, maintain the highest ethical standards in what you do. In short, abide by our Code of Conduct. A key characteristic of a professional, or any leader, is integrity. You can work for years building a reputation and then have it dashed forever with one ethical violation. Mistakes can be forgiven, but a lapse in ethical behavior cannot be.

These three challenges I've given you correspond very closely with the first three hallmarks of a profession. First, having and applying a base of knowledge unique to the profession; second, continuing your education; and third, abiding by standards. The fourth challenge I am going to give is not directly related to discipline, which is the fourth hallmark of the profession, but it does require discipline in the way you conduct your life. The advice or the challenge I give to you is to volunteer. Make sure to make time to help others; to give back a part of what you have received. Be of service to both your profession and to your community. You are aware that back in 1989, and also in April of this year, the *Jobs Rated Almanac* rated the job of actuary as number one. As such, we are really blessed. Hopefully, you will be able to share this blessing by volunteering to serve on a CAS or an Academy committee, or to put a face on our profession in your community.

In summary, it is my pleasure to welcome you to the actuarial profession. I challenge you to be seen as a professional. You've earned it; now maintain and enhance it.

MINUTES OF THE 1995 SPRING MEETING

May 14–17, 1995

THE ADAM'S MARK HOTEL, ST. LOUIS, MISSOURI

Sunday, May 14, 1995

The Board of Directors held their regular quarterly meeting from noon to 5:00 p.m.

Registration was held from 4:00 p.m. to 6:00 p.m.

From 5:30 p.m. to 6:30 p.m., there was a special presentation to new Associates and their guests. The session included an introduction to the standards of professional conduct and the CAS committee structure.

A welcome reception for all members and guests was held from 6:30 p.m. to 7:30 p.m.

Monday, May 15, 1995

Registration continued from 7:00 a.m. to 8:00 a.m.

CAS President Allan M. Kaufman opened the meeting at 8:00 a.m. and recognized special guest Hans Bühlmann, Professor of Mathematics, Swiss Federal Institute of Technology and the first Bowles Chair of Actuarial Science at Georgia State University. Professor Bühlmann participated in the general session on Dynamic Financial Analysis.

Mr. Kaufman also recognized past presidents of the CAS who were in attendance at the meeting, including Irene K. Bass (1994), Phillip N. Ben-Zvi (1985), Ronald L. Bornhuetter (1975), Charles A. Bryan (1990), Michael Fusco (1989), David G. Hartman (1987), W. James MacGinnitie (1979), Jerome A. Scheibl (1980), Michael L. Toothman (1991), and Michael A. Walters (1986).

Paul Braithwaite, David Hafling, John Kollar, and Michael Miller announced the 123 new Associates and the 17 new Fellows. The names of these individuals follow.

NEW FELLOWS

Timothy James Cremin
Bradley A. Granger
Craig W. Kliethermes
Mathieu Lamy
Suzanne Martin
Brett Evan Miller
Mark Priven
Eduard J. Pulkstenis
John F. Rathgeber
David M. Savage
Jeffrey Jay Scott
Russell Steingiser
Eileen M. Sweeney
Yuan-Yuan Tang
Thomas C. Toce
John Vincent Van de Water
Peter Gerard Wick

NEW ASSOCIATES

Rimma Abian
Christopher R. Allan
John Porter Alltop
K. Athula P. Alwis
Steven Douglas Armstrong
Martin Scott Arnold
Bruce J. Bergeron
Steven Louis Berman
Corey J. Bilot
Carol Ann Blomstrom
John T. Bonsignore
Douglas J. Bradac
Kevin Michael Brady
Betsy A. Branagan
James L. Bresnahan
Lisa Jenny Brubaker
Elliot R. Burn
Tara Elizabeth Bush
J'ne Elizabeth Byckovski
Sandra L. Cagley
Pamela J. Cagney
Douglas Anthony Carlone
Martin Carrier
Jill Christine Cecchini
Heather Lee Chalfant
Jean-François Chalifoux
Peggy Cheng
Gary C. K. Cheung
Christopher John Claus
William Francis Costa
Christopher George Cunniff
Sean Richard Devlin
Behram Mehelli Dinshaw
William A. Dowell
Kimberly J. Drennan
Pierre Drolet
Stephen C. Dugan
Tammy Lynn Dye
Jeffrey Eddinger
Sven Anders Ericson
James G. Evans
Steven J. Finkelstein
Daniel Joseph Flick
André F. Fontaine
Susan Terese Garnier
Christopher H. Geering
Eric J. Gesick
John Thomas Gleba
John Edmund Green
Steven A. Green
Charles R. Grilliot
Julie Kay Halper
David S. Harris
Betty-Jo Hill
John V. Hinton
Jason N. Hoffman
John Frederick Huddleston
Li Hwan Hwang

Brian L. Ingle
Christian Jobidon
Daniel Keith Johnson
Gail E. Kappeler
Lowell J. Keith
Thomas Paul Kenia
Michael Benjamin Kessler
Jean-Raymond Kingsley
Gary R. Kratzen
Brian Scott Krick
Marc La Palme
Debra K. Larcher
Gregory D. Larcher
Daniel Eugene Lents
Edward A. Lindsay
Richard Borge Lord
Cornwell H. Mah
Anthony Leroy Manzitto
Scott Andrew Martin
Tracey Lynn Matthew
Camley A. Mazloom
Deborah Lynn McCrary
Mike McCutchan
Kelly S. McKeethan
Lynne Sener McWithey
Claus Siegfried Metzner
Paul W. Mills
Anne Hoban Moore
Kenneth Bowers Morgan, Jr.
Kevin T. Murphy
Hiep Trong Nguyen
James L. Nutting
Milary Nadean Olson
Thomas Passante
Nicholas H. Pastor
Claude Penland
William Peter
Geneviève Pineau
Robert Emmett Quane III
Peter Sebastian Rauner
Natalie J. Rekittke
Scott Reynolds
Meredith G. Richardson
John Walter Rollins
Rajesh V. Sahasrabuddhe
Christina Lee Scannell
Marilyn Schafer
Michael Jeffrey Scholl
Mary Kathryn Smith
John B. Sopkowicz
Michael J. Sperduto
Scott D. Spurgat
Scott Timothy Stelljes
Kevin D. Strous
Steven J. Symon
Joy Yukiko Takahashi
David Michael Terné
Daniel A. Tess
Son Trong Tu
Eric Vaith
Cynthia Leigh Vidal
Robert J. Walling III
Steven Boyce White
Elizabeth R. Wiesner
Michael J. Williams

Mr. Kaufman then introduced David G. Hartman, a past president of the Society, who presented the Address to New Members.

Alice H. Gannon, CAS Vice President of Programs and Communications, presented the highlights of the program.

It was announced that no *Proceedings* papers would be presented at this meeting. In response to a CAS call for papers on Dynamic Financial Analysis, it was announced that eight discussion papers would be presented at the meeting, and bound in the *1995*

CAS Discussion Paper Program, titled "Incorporating Risk Factors in Dynamic Financial Analysis".

Mr. Kaufman then began the presentation of awards. He gave some background information about the Charles A. Hachemeister Prize and announced the prize winners, Michel Laparra, Isabelle Lion, and Christian Partrat, all from France. The award will be officially presented at the 1995 CAS Annual Meeting in San Diego, California, in November 1995.

Mr. Kaufman also announced that Larry Lickteig is the recipient of the 1995 Harold W. Schloss Memorial Scholarship Fund. He will be presented with a $500 scholarship.

Patrick J. Grannan spoke to the CAS membership about the activities of the American Academy of Actuaries Committee on Property/Liability Financial Reporting Issues, of which he is the chairperson.

Mr. Kaufman then concluded the business session of the Spring Meeting.

After a refreshment break, Albert J. Beer introduced R. W. Apple, Washington Bureau Chief for the New York Times. Mr. Apple was the keynote speaker and spoke to the CAS membership about the first 100 days of the new Republican Congress.

The first general session was held from 10:45 a.m. to 12:15 p.m.:

"Dynamic Financial Analysis"

Moderator:	David G. Hartman Senior Vice President and Chief Actuary Chubb Group of Insurance Companies
Panelists:	Hans Bühlmann Professor of Mathematics Swiss Federal Institute of Technology Bowles Chair of Actuarial Science Georgia State University

Shane A. Chalke
Chief Executive Officer
CHALKE Incorporated

Weston Hicks
Analyst
Sanford C. Bernstein & Co.

After a luncheon, the afternoon was devoted to concurrent sessions which included a presentation of the discussion papers and panel presentations.

The discussion papers presented were:

1. "Mean-Variance Analysis and the Diversification of Risk"

   Author: Leigh J. Halliwell
   Louisiana Workers' Compensation Corporation

2. "How to Best Use Engineering Risk Analysis Models and Geographic Information Systems to Assess Financial Risk from Hurricanes"

   Authors: Auguste Boissonnade, Ph.D.
   Risk Management Solutions, Inc.

   Peter Ulrich
   Risk Management Solutions, Inc.

3. "Measuring and Managing Catastrophe Risk"

   Authors: Ronald T. Kozlowski
   Tillinghast/Towers Perrin

   Stuart B. Mathewson
   Tillinghast/Towers Perrin

4. "Managing Catastrophe Risk"

   Author: Glenn G. Meyers, Ph.D.
   Insurance Services Office, Inc.

5. "An Approach to Evaluating Asset Allocation Strategies for Property/Casualty Insurance Companies"

   Authors: Manuel Almagro, Jr.
   Tillinghast/Towers Perrin

   Stephen M. Sonlin
   Tillinghast/Towers Perrin

6. "New Products—Uncertainty of Cost, Measurement and Control of Risks, and Implied Profit Margins"

   Author: Owen M. Gleeson
   President
   Financial Analysis and Control Systems

7. "A Decade of Cash Flow Testing—Some Lessons Learned"

   Author: Ralph S. Blanchard III
   Aetna Life & Casualty

   Eduardo P. Marchena
   Aetna Life & Casualty

8. "Forecasting the Future: Stochastic Simulation and Scenario Testing"

   Author: Sholom Feldblum
   Liberty Mutual Insurance Company

The panel presentations covered the following topics:

1. "Underwriting and Ratemaking for Catastrophe Risk"

   Moderator: Robert B. Downer
   Vice President and Actuary
   Farmers Insurance Group

   Panelists: Jonathan White
   Assistant Vice President and Actuary
   Insurance Services Office, Inc.

   Michael A. Walters
   Consulting Actuary
   Tillinghast/Towers Perrin

2. "Driving on the Information Superhighway: Actuaries, Insurance and the Internet"

   Panelists: Richard A. Derrig
   Senior Vice President
   Automobile Insurers Bureau of Massachusetts

   James R. Garven, Ph.D.
   Assistant Professor
   University of Texas Finance Department

3. "A World With GATT"

   Moderator: John C. Narvell
   Senior Consulting Actuary
   Ernst & Young LLP

   Panelists: Carl A. Modecki
   President
   National Association of Insurance Brokers

   Kevin C.W. Mulvey
   Associate Director, Government Affairs
   American International Group

4. "Commercial Package Ratemaking"

   Moderator: Kathleen A. McMonigle
   Director, Commercial Actuarial
   ITT/Hartford

   Panelists: Robert P. Eramo
   Vice President and Chief Actuary
   Johnson & Higgins

   Gary Hoover
   Actuary I
   State Farm Insurance Company

5. "Political Forces and Insurance Costs"

   Moderator: Ronald J. Swanstrom
   Principal
   Coopers & Lybrand, L.L.P.

Panelists: Steven Ahmuty
Partner
Schaub, Ahmuty & Citrin

David Helfrey
Principal
Helfrey, Simon & James, P.C.

6. "Quality Assurance for the Actuarial Work Product"

Moderator: Robert F. Conger
Consulting Actuary
Tillinghast/Towers Perrin

Panelists: Thomas S. Carpenter
Senior Vice President and Chief Actuary
Arbella Mutual Insurance Company

Roy G. Shrum
Vice President and Actuary
United States Fidelity and Guaranty Company

Jane C. Taylor
Senior Vice President
Reliance Insurance Companies

7. "The Impact of Reinsurance on Loss Reserves"

Moderator: Kim E. Piersol
Vice President and Actuary
CNA Insurance Companies

Panelists: Christy H. Gunn
Assistant Vice President and Associate Actuary
CNA Insurance Companies

Donald P. Skordenis
Senior Consultant
Coopers & Lybrand, L.L.P.

Alfred O. Weller
President
Workers' Compensation Reinsurance Bureau

8. "Current Financial Reporting Issues"

Moderator: Patrick J. Grannan
Consulting Actuary
Milliman & Robertson, Inc.

Panelists: Sheldon Rosenberg
Senior Vice President and Chief Actuary
Continental Insurance

Richard Roth, Jr.
Assistant Commissioner
California Department of Insurance

9. "Compilation of State Laws Regarding Statements of Actuarial Opinion on Loss Reserves"

Moderator: Robert J. Finger
Consulting Actuary
Milliman & Robertson, Inc.

Panelists: Elise C. Liebers
Supervising Actuary
New York State Insurance Department

Michael L. Toothman
Consulting Actuary
Arthur Andersen LLP

10. "Actuarial Talent: Supply versus Demand"

Moderator/ Panelist: Stephen P. D'Arcy
Professor, Department of Finance
University of Illinois

Panelists: W. James MacGinnitie
National Director of Actuarial Services
Ernst & Young LLP

David J. Oakden
Consulting Actuary
Tillinghast/Towers Perrin

11. "CAS Examination Committee"

    Moderator: Curtis Gary Dean
    Assistant Vice President and Actuary
    American States Insurance Companies

    Panelists: Michele A. Lombardo
    Examinations and Information Systems Administrator
    Casualty Actuarial Society

    David L. Menning
    Senior Associate Actuary
    State Farm Mutual Automobile Insurance Company

12. "Questions and Answers with the CAS Board of Directors"

    Moderator: Albert J. Beer
    Senior Vice President
    American Re-Insurance Company

    Panelists: Patrick J. Grannan
    Consulting Actuary
    Milliman & Robertson, Inc.

    John M. Purple
    Consulting Actuary
    Arthur Andersen, LLP

    Richard H. Snader
    Vice President, Corporate Actuary
    United Stated Fidelity and Guaranty Company

13. "CAS Actuarial Research Corner"

    Moderator: Richard G. Woll
    Senior Actuary
    Allstate Research and Planning Center

An officers' reception for new Fellows and guests was held from 5:30 p.m. to 6:30 p.m., and the general reception for all members and their guests was held from 6:30 p.m. to 7:30 p.m.

Tuesday, May 16, 1995

Two general sessions were held from 8:30 a.m. to 10:00 a.m. The first was

"Unfair Discrimination in Insurance Underwriting—Fact or Fiction?"

Moderator: Irene K. Bass
Managing Director
William M. Mercer, Inc.

Panelists: Robert W. Klein, Ph.D.
Director of Research
National Association of Insurance Commissioners

Eric F. Gottheim
Senior Vice President and Chief Actuary
The Robert Plan Corporation

Yvonne S. Sparks
Executive Director
Neighborhood Housing Services of St. Louis, Inc.

The other session, presented simultaneously, was

"Technology and Information System"

Moderator: Stephen W. Philbrick
Consulting Actuary
Tillinghast/Towers Perrin

Panelists: David Hollander
Partner
Andersen Consulting

John J. Kollar
Vice President
Insurance Services Office, Inc.

Stephen Jacobs
Partner
Reinhart, Boerner, Van Deuren, Norris, and Reiselbach, S.C.

After a refreshment break, the concurrent sessions were held from 10:30 a.m. to noon.

Various CAS committees met from 1:00 p.m. to 5:00 p.m. In addition, concurrent sessions were held from 1:30 p.m. to 3:00 p.m.

All members and guests enjoyed a buffet dinner at the St. Louis Zoo from 6:30 p.m. to 9:30 p.m.

Wednesday, May 17, 1995

Concurrent sessions were held from 8:30 a.m. to 10:00 a.m.

Following the concurrent sessions, Jay Angoff, Commissioner of Insurance for the State of Missouri, gave a special presentation to members.

From 10:15 a.m. to 11:45 a.m., a general session on Professionalism was held. This general session provided case studies and dramatizations of situations involving professional ethical quandries actuaries may face.

Writer:	David Skurnick Senior Vice President and Actuary F & G Re, Inc.
Director:	Nolan E. Asch Senior Vice President and Actuary SCOR U.S. Corporation
Cast:	Lauren Bloom General Counsel American Academy of Actuaries
	Jerome A. Scheibl Member Actuarial Board for Counseling and Discipline

Margaret W. Tiller
President
Tiller Consulting Group

CAS President Allan M. Kaufman officially adjourned the 1995 CAS Spring Meeting at noon after closing remarks and an announcement of future CAS meetings.

May 1995 Attendees

The 1995 CAS Spring Meeting was attended by 162 Fellows, 130 Associates, and 89 Guests. The names of the Fellows and Associates in attendance follow:

FELLOWS

Manuel Almagro, Jr.
Richard R. Anderson
William R. Van Ark
Nolan E. Asch
Irene K. Bass
Albert J. Beer
Phillip N. Ben-Zvi
James E. Biller
Ralph S. Blanchard III
Ronald L. Bornhuetter
Paul Braithwaite
Randall E. Brubaker
Charles A. Bryan
James E. Buck
Thomas S. Carpenter
Sanders B. Cathcart
Mark M. Cis
Michael A. Coca
Robert F. Conger
Charles F. Cook
Timothy J. Cremin
Robert J. Curry
Stephen P. D'Arcy
Ronald A. Dahlquist
Curtis Gary Dean
Michael C. Dolan
Robert B. Downer
Michael C. Dubin
Judith E. Dukatz
Grover M. Edie
Valere M. Egnasko
Warren S. Ehrlich
Douglas D. Eland
Sholom Feldblum
George Fescos
Robert J. Finger
Nancy G. Flannery
James E. Fletcher
Michael Fusco
Scott F. Galiardo
Alice H. Gannon
Robert W. Gardner
Richard Gauthier
Owen M. Gleeson
Steven F. Goldberg
James F. Golz
Karen Pachyn Gorvett
Linda M. Goss
Eric F. Gottheim
Leon R. Gottlieb
Bradley A. Granger
Patrick J. Grannan
Christy H. Gunn
David N. Hafling
James A. Hall III
Robert C. Hallstrom
David G. Hartman
Roger M. Hayne
Todd J. Hess
Anthony D. Hill
Kathleen A. Hinds
James G. Inkrott
Richard M. Jaeger
Ronald W. Jean
Robert S. Kaplan
Allan M. Kaufman

Anne E. Kelly
Frederick O. Kist
Joel M. Kleinman
Craig W. Kliethermes
John Joseph Kollar
Gary I. Koupf
Ronald T. Kozlowski
Israel Krakowski
Gustave A. Krause
Rodney E. Kreps
Andrew E. Kudera
Paul E. Lacko
Mathieu Lamy
Peter M. Licht
Elise C. Liebers
Robert F. Lowe
Stephen J. Ludwig
Aileen C. Lyle
W. James MacGinnitie
William G. Main
Stuart B. Mathewson
Kathleen A. McMonigle
David L. Menning
Paul A. Mestelle
Robert J. Meyer
Glenn G. Meyers
Robert S. Miccolis
Brett E. Miller
Michael J. Miller
David L. Miller
Brian C. Moore
Phillip S. Moore
Nancy Diane Mueller
Donna S. Munt
James J. Muza
Nancy R. Myers
John C. Narvell
Glen C. Nyce
Terrence M. O'Brien
Paul G. O'Connell
David J. Oakden
Jennifer J. Palo
Curtis M. Parker
Steven C. Peck
Stephen W. Philbrick
Kim E. Piersol
Joseph J. Pratt
Eduard J. Pulkstenis
John M. Purple
John F. Rathgeber
William P. Roland
Sheldon Rosenberg
Richard J. Roth, Jr.
David M. Savage
Jerome A. Scheibl
Brian E. Scott
Jeffery J. Scott
Edward C. Shoop
Roy G. Shrum
David Skurnick
Oakley (Lee) E. Van Slyke
Richard H. Snader
David Spiegler
Lee R. Steeneck
Russell Steingiser
James P. Streff
Stuart B. Suchoff
Christian Svendsgaard
Ronald J. Swanstrom
Susan T. Szkoda
Jane C. Taylor
Catherine Harwood Taylor
Michael T. S. Teng
Patricia A. Teufel
Kevin B. Thompson
Margaret Wilkinson Tiller
Thomas C. Toce
Michael L. Toothman
Gail E. Tverberg
Jean Vaillancourt
John V. Van de Water
William Vasek
Gary G. Venter
Michael A. Walters
Bryan C. Ware
Thomas V. Warthen III
Walter C. Wright III
Alfred O. Weller
Jonathan White
Charles Scott White
Peter G. Wick
Kevin L. Wick
James C. Wilson
Ernest I. Wilson
Susan K. Woerner
Richard G. Woll

ASSOCIATES

Rimma Abian
Christopher R. Allan
Martin S. Arnold
Allan A. Bell
Bruce J Bergeron
Steven L. Berman
Carol A. Blomstrom
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Douglas J. Bradac
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Sandra L. Cagley
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Brian A. Clancy
Christopher J. Claus
William F. Costa
Christopher G. Cunniff
Laura B. Deterding
Sean R. Devlin
Behram M. Dinshaw
Pierre Drolet
Stephen C. Dugan
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Robert P. Eramo
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Gregg Evans
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Susan T. Garnier
Christopher H. Geering
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Leigh Joseph Halliwell
Julie K. Halper
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Jason N. Hoffman
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Daniel J. Johnston
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Brian S. Krick
Chung-Kuo Kuo
Marc LaPalme
Gregory D. Larcher
Debra K. Larcher
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Cornwell H. Mah
Anthony L. Manzitto
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Thomas Passante
Nicholas H. Pastor
Claude Penland IV
Robert C. Phifer
Genevieve Pineau
Robert E. Quane III
Peter S. Rauner
James E. Rech
Natalie J. Rekittke
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John P. Ryan
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BALANCING TRANSACTION COSTS AND RISK LOAD IN RISK SHARING ARRANGEMENTS

CLIVE L. KEATINGE

Abstract

In formulating efficient risk sharing arrangements, it is desirable to minimize both transaction costs and the risk load required by the participating insurers. A simple yet realistic model that explicitly incorporates both transaction costs and risk load is put forth in this paper. It is shown that, under very general conditions, the optimal risk sharing arrangement which results is constructed in layers. Remarkably simple expressions are given for the optimal boundaries between layers as well as each participating insurer's share of each layer. Several examples are included that illustrate the application of the model.

1. INTRODUCTION

This paper addresses the related subjects of optimal risk sharing and premium calculation. "Risk sharing" refers to an arrangement among various entities (in an insurance context, usually insureds, insurers, and reinsurers) to share in the payment of losses. "Premium calculation" refers to the process of figuring charges to add to expected losses to obtain premiums for a particular risk sharing arrangement. These charges take into account both the transaction costs (e.g., commission, brokerage, and overhead) and the risk load associated with a risk sharing arrangement. Optimal risk sharing and premium calculation have been discussed quite frequently in the actuarial literature. The primary feature of this paper that distinguishes it from most other treatments of these subjects is the explicit inclusion of transaction costs as an integral part of the model used to derive results.

The problem discussed in this paper is that of finding the risk sharing arrangement that minimizes the combined premium charged by all of the insurers sharing a particular risk.[1] In the model used to address this problem, we assume that each insurer charges a specified percentage of its own expected losses to account for transaction costs and a specified percentage of the variance of its own losses to account for risk load. These percentages may differ by insurer. In general, we expect insurers that tend to take on small amounts of expected losses for each risk (often reinsurers) to have transaction costs that are a larger percentage of their expected losses than insurers that tend to take on large amounts of expected losses for each risk. Likewise, we expect insurers that tend to take on a very large number of risks (often reinsurers) to have risk loads that are a smaller percentage of the variance of their losses than insurers that take on a small number of risks. More will be said about this later.

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[1] For convenience, throughout this paper, the term "insurer" will be used to refer to any participant in a risk sharing arrangement. However, all the participants in a risk sharing arrangement need not be insurers. An insured may retain a portion of its own losses, a reinsurer may assume losses through a primary insurer, or the risk sharing could be in a noninsurance context. In the case of an insured retaining a portion of its own losses, although premium would not change hands, the insured would incur a cost in maintaining the additional capital and liquidity necessary to absorb the retained losses.

There are certainly other ways one could account for transaction costs in a risk sharing arrangement, and risk load has been a subject of ongoing debate for many years. The purpose of this paper is not to debate the merits of various methods of handling transaction costs and risk load. The model described in this paper is useful because it is simple enough to yield results that are mathematically tractable yet realistic enough to yield results that provide real insight.

2. THE PROBLEM

We begin with the usual formulation of the collective risk model. Let N denote the number of claims produced by a risk (or portfolio of risks) in a given time period. Let $X_1, X_2, X_3, \ldots$ denote the various claim sizes. We assume N, $X_1, X_2, X_3, \ldots$ to be mutually independent random variables and $X_1, X_2, X_3, \ldots$ to be identically distributed. If $S = X_1 + X_2 + \cdots + X_N$, then:

$$\begin{aligned}
\mathrm{E}[S] &= \mathrm{E}[N]\cdot\mathrm{E}[X], \qquad \text{and} \\
\mathrm{Var}[S] &= \mathrm{E}[N]\cdot\mathrm{Var}[X] + \mathrm{Var}[N]\cdot(\mathrm{E}[X])^2 \\
&= \mathrm{E}[N]\cdot\left\{\mathrm{E}[X^2] - (\mathrm{E}[X])^2 + \frac{\mathrm{Var}[N]}{\mathrm{E}[N]}\cdot(\mathrm{E}[X])^2\right\} \\
&= \mathrm{E}[N]\cdot\left\{\mathrm{E}[X^2] + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1\right)\cdot(\mathrm{E}[X])^2\right\}.
\end{aligned}$$

Next, we assume that there are C insurers available to share in the payment of losses. Further, we assume that each insurer pays a predetermined percentage of each claim. These percentages may vary by claim size. Thus, each insurer has associated with it a payment function, $p(x)$, which can vary between 0 and 1, that indicates the percentage of each claim that the insurer will pay.[2] If S_i designates the total losses paid by the ith insurer and

[2]Payment may also be based on the sum of all claims arising from each occurrence. For convenience, the term "claim" will be used throughout this paper.

$p_i(x)$ is the payment function for the ith insurer, then:

$$\mathrm{E}[S_i] = \mathrm{E}[N] \cdot \mathrm{E}[p_i(X) \cdot X], \qquad \text{and}$$

$$\mathrm{Var}[S_i] = \mathrm{E}[N] \cdot \left\{ \mathrm{E}[(p_i(X) \cdot X)^2] + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1 \right) \cdot (\mathrm{E}[p_i(X) \cdot X])^2 \right\}.$$

Let ϕ_i be the percentage of its own expected losses charged by the ith insurer to account for transaction costs, and let ψ_i be the percentage of the variance of its own losses charged by the ith insurer to account for risk load.[3] Then the combined premium charged by all of the insurers sharing the risk is:

$$\begin{aligned} M &= \sum_{i=1}^{C} (\mathrm{E}[S_i] + \phi_i \cdot \mathrm{E}[S_i] + \psi_i \cdot \mathrm{Var}[S_i]) \\ &= \mathrm{E}[S] + \sum_{i=1}^{C} (\phi_i \cdot \mathrm{E}[S_i] + \psi_i \cdot \mathrm{Var}[S_i]). \end{aligned}$$

The problem is to find the payment functions for each of the C insurers that minimize M subject to the constraints that:

$$0 \le p_i(x) \le 1 \qquad \text{and} \qquad \sum_{i=1}^{C} p_i(x) = 1.$$

3. THE SOLUTION

The solution is given here without proof. The proof is provided in the Appendix. First, we assume that the C insurers have been arranged so that the following relation holds:

$$\phi_1 \le \phi_2 \le \cdots \le \phi_C.$$

The solution then involves the familiar concept of layering. The optimal risk sharing arrangement is organized into C layers.

[3] ϕ_i is dimensionless and ψ_i has dimension $\$^{-1}$ (if we are working with dollars). For convenience, $\$^{-1}$ will be omitted throughout this paper.

The first layer (from zero to the first layer boundary) is allocated entirely to the first insurer.

The second layer is allocated to the first two insurers in the following proportions:

$$\text{Insurer 1:} \quad \frac{1/\psi_1}{1/\psi_1 + 1/\psi_2}, \qquad \text{and}$$

$$\text{Insurer 2:} \quad \frac{1/\psi_2}{1/\psi_1 + 1/\psi_2}.$$

Thus, for a claim that penetrates the second (but not the third) layer, the first insurer pays the entire portion of the claim that falls below the first layer boundary and a fraction of the portion above it. The second insurer pays a fraction of the portion of the claim above the first layer boundary.

The third layer is allocated to the first three insurers in the following proportions:

$$\text{Insurer 1:} \quad \frac{1/\psi_1}{1/\psi_1 + 1/\psi_2 + 1/\psi_3},$$

$$\text{Insurer 2:} \quad \frac{1/\psi_2}{1/\psi_1 + 1/\psi_2 + 1/\psi_3}, \qquad \text{and}$$

$$\text{Insurer 3:} \quad \frac{1/\psi_3}{1/\psi_1 + 1/\psi_2 + 1/\psi_3}.$$

One insurer is then added in each successive layer until the top layer has all of the C insurers participating in the following proportions:

$$\text{Insurer } i: \quad \frac{1/\psi_i}{1/\psi_1 + 1/\psi_2 + \cdots + 1/\psi_C}.$$

Thus, for low layers, which contribute much more to expected losses than to variance, only the insurers with the smallest ϕ_is participate. For high layers, where variance is a much more important consideration than expected losses, many insurers participate in order to better reduce the variance. Within a particular layer, the insurers with the smallest ψ_is get the largest shares.[4]

We now address the issue of the location of the layer boundaries. Let the layer boundaries be $l_1 \leq l_2 \leq \cdots \leq l_{C-1}$. Then each l_j is given by the solution of the following equation:

$$l_j + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1\right) \cdot \mathrm{E}[X; l_j] - \sum_{i=1}^{j} \frac{\phi_{j+1} - \phi_i}{2 \cdot \psi_i} = 0$$

where $\mathrm{E}[X; l_j]$ is the expected value of X limited at l_j.[5] The relationship between adjacent l_js can be expressed as follows:

$$(l_j - l_{j-1}) + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1\right) \cdot (\mathrm{E}[X; l_j] - \mathrm{E}[X; l_{j-1}])$$

$$- \frac{\phi_{j+1} - \phi_j}{2} \cdot \sum_{i=1}^{j} \frac{1}{\psi_i} = 0.$$

The first thing to observe about these equations is that the l_js depend on the claim count distribution only through the ratio of the variance to the mean. If this ratio is 1, as it is with the Poisson distribution, the l_js are independent of the claim size distribution. If this ratio is less than 1, the more severe the claim size distribution, the higher the l_js will be. If this ratio is greater than 1, the more severe the claim size distribution, the lower the l_js will be.

The second of the above equations shows that if ϕ_j is associated with the insurer just added in a given layer and ϕ_{j+1} is

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[4] This same type of layering arrangement was derived by Bühlmann and Jewell [1] in the context of a model based on exponential utility functions.

[5] This equation can be easily solved for l_j using Newton's method. Note that the derivative of the left side of the equation with respect to l_j is simply:

$$1 + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1\right) \cdot (1 - F(l_j))$$

where $F(x)$ is the cumulative distribution function of X.

associated with the insurer to be added in the layer above, then the greater the difference between them, the greater the width of the former layer will be. In other words, if the insurer to be added in the layer above charges a much greater percentage of its expected losses than the most expensive of the insurers participating on a given layer, a large increment will be required to reach a point where the reduction in variance provided by the addition of the next insurer is worthwhile. On the other hand, if $\phi_j = \phi_{j+1}$, then the width of the layer will be 0, and both insurers will be added at the same time. In the extreme case where all of the ϕ_is are equal to one another, all of the l_js will be 0, so there effectively will be only one layer, with all C of the insurers participating. This reflects the well-known result that if transaction costs do not depend on how a risk is shared, then a quota share arrangement is optimal.

Another noteworthy aspect of the above equations is that a given l_j is only affected by the ψ_is associated with insurers on layers below it. Thus, the ψ_is associated with insurers to be added in higher layers have no effect on the location of a particular l_j. It is also clear that smaller ψ_is will result in higher l_js. In other words, if insurers do not charge large percentages of the variances of their losses, variance reduction is less of a priority than it would otherwise be, and the points at which insurers are added can be higher.

The optimal risk sharing arrangement described above minimizes the combined premium charged by all of the insurers sharing a risk. In order to calculate each insurer's premium, expressions are needed for $\mathrm{E}[p_i(X)\cdot X]$ and $\mathrm{E}[(p_i(X)\cdot X)^2]$, the first and second moments of each insurer's own claim payment distribution. Since the optimal risk sharing arrangement is constructed in layers, the needed expressions are as follows:

$$\mathrm{E}[p_i(X)\cdot X] = \sum_{j=i}^{C} r_{ij} \int_{l_{j-1}}^{l_j} (1 - F(x))\,dx, \qquad \text{and}$$

$$\mathrm{E}[(p_i(X)\cdot X)^2] = \sum_{j=i}^{C}\int_{l_{j-1}}^{l_j}\left[\sum_{m=i}^{j-1} r_{im}\cdot(l_m - l_{m-1}) + r_{ij}\cdot(x - l_{j-1})\right]^2 f(x)dx,$$

where:

$l_0 = 0$ and $l_C = \infty$,

$f(x)$ = probability density function of X, and

r_{ij} = ith insurer's share of the jth layer as defined above.

If claims are censored by a policy limit, a term must be added to the expression for the second moment to take into account the spike of probability at the policy limit. However, the equation used to calculate the l_js is not affected by a policy limit. Insurers that participate only on layers that fall completely above a policy limit are effectively not needed in the optimal risk sharing arrangement.

4. EXAMPLES

The application of the results presented in the previous section will be illustrated with several examples. The claim size distributions used in the examples are Mixed Paretos.[6] Each distribution is the weighted average of two Paretos, one of which has a relatively thick tail and one of which has a relatively thin tail. The density and distribution functions of the Mixed Pareto are as follows:

$$f(x) = \frac{Q1\cdot B1^{Q1}}{(x+B1)^{Q1+1}}\cdot(1-P) + \frac{Q2\cdot B2^{Q2}}{(x+B2)^{Q2+1}}\cdot P, \qquad \text{and}$$

$$F(x) = 1 - \left(\frac{B1}{x+B1}\right)^{Q1}\cdot(1-P) - \left(\frac{B2}{x+B2}\right)^{Q2}\cdot P.$$

[6]Mixed Pareto distributions are used in the Insurance Services Office increased limits procedure.

TABLE 1

KEY STATISTICS FOR OPTIMAL RISK SHARING TYPICAL GENERAL LIABILITY RISK

$B1$ = 25,000	Layer 1: 0 – 75,677	Policy Limit = 1,000,000
$B2$ = 5,000	Layer 2: 75,677 – 255,814	
$Q1$ = 1.25	Layer 3: 255,814 – 562,307	
$Q2$ = 3.25	Layer 4: 562,307 – 1,000,000	
P = .80		
Var[N]/E[N] = 2		

	Insurer 1	Insurer 2	Insurer 3	Insurer 4	Total	No Risk Sharing
Layer 1 Share	100.0%				100.0%	
Layer 2 Share	45.5	54.5%			100.0	
Layer 3 Share	27.0	32.4	40.6%		100.0	
Layer 4 Share	17.5	21.1	26.3	35.1%	100.0	
Expected Loss	9,814	2,589	1,057	414	13,874	13,874
ϕ Charge	491	259	158	83	991	694
ψ Charge	315	107	38	8	468	1,401
Total Charge	806	366	196	91	1,459	2,095
Percentage	8.2%	14.1%	18.5%	22.0%	10.5%	15.1%

The charges in the examples are calculated assuming that E[N] = 1. Charges for other values of E[N] can be found simply by multiplying the charges shown by E[N].

In each of the examples, we will assume that there are six insurers available to share the risk. The ϕ_is for the six insurers are .05, .10, .15, .20, .25, and .30, and the ψ_is for the six insurers are $.30 \cdot 10^{-6}$, $.25 \cdot 10^{-6}$, $.20 \cdot 10^{-6}$, $.15 \cdot 10^{-6}$, $.10 \cdot 10^{-6}$, and $.05 \cdot 10^{-6}$, respectively. More will be said later about how these values might be estimated.

Table 1 shows the key statistics for the optimal risk sharing arrangement for what might be considered a typical general liability risk with a \$1,000,000 policy limit. Note that only four insurers are required in this case. For comparative purposes, charges are also shown for the case in which there is no risk sharing and In-

TABLE 2

KEY STATISTICS FOR OPTIMAL RISK SHARING LARGE POLICY

$B1 = 25{,}000$	Layer 1: 0 – 75,677	Policy Limit = 10,000,000
$B2 = 5{,}000$	Layer 2: 75,677 – 255,814	
$Q1 = 1.25$	Layer 3: 255,814 – 562,307	
$Q2 = 3.25$	Layer 4: 562,307 – 1,036,058	
$P = .80$	Layer 5: 1,036,058 – 1,760,102	
$\mathrm{Var}[N]/\mathrm{E}[N] = 2$	Layer 6: 1,760,102 – 10,000,000	

	Insurer 1	Insurer 2	Insurer 3	Insurer 4	Insurer 5	Insurer 6	Total	No Risk Sharing
Layer 1 Share	100.0%						100.0%	
Layer 2 Share	45.5	54.5%					100.0	
Layer 3 Share	27.0	32.4	40.6%				100.0	
Layer 4 Share	17.5	21.1	26.3	35.1%			100.0	
Layer 5 Share	11.5	13.8	17.2	23.0	34.5%		100.0	
Layer 6 Share	6.8	8.2	10.2	13.6	20.4	40.8%	100.0	
Expected Loss	10,099	2,932	1,485	986	822	984	17,308	17,308
ϕ Charge	505	293	223	197	206	295	1,719	866
ψ Charge	401	193	124	94	86	109	1,007	8,722
Total Charge	906	486	347	291	292	404	2,726	9,588
Percentage	9.0%	16.6%	23.4%	29.5%	35.5%	41.1%	15.7%	55.4%

surer 1 takes the entire risk. Risk sharing in this example results in a savings of 4.6% of expected losses.

Table 2 shows the statistics for the optimal risk sharing arrangement for a risk identical to that underlying Table 1 except with a policy limit of $10,000,000. In this case, all six insurers are required, and risk sharing results in a savings of 39.7% of expected losses.[7]

[7]This is an illustration of how the absence of risk sharing in a model can result in very large risk loads at high policy limits. Robbin [2] has discussed the need to consider risk sharing when computing risk loads and has presented a simple model of risk sharing (allowing only quota share arrangements) that incorporates transaction costs (attributed to Klinker).

TABLE 3

KEY STATISTICS FOR OPTIMAL RISK SHARING
VARIANCE EQUALS MEAN

$B1$ = 25,000	Layer 1: 0 – 83,333				Policy Limit = 1,000,000	
$B2$ = 5,000	Layer 2: 83,333 – 266,667					
$Q1$ = 1.25	Layer 3: 266,667 – 575,000					
$Q2$ = 3.25	Layer 4: 575,000 – 1,000,000					
P = .80						
Var[N]/E[N] = 1						
	Insurer 1	Insurer 2	Insurer 3	Insurer 4	Total	
Layer 1 Share	100.0%				100.0%	
Layer 2 Share	45.5	54.5%			100.0	
Layer 3 Share	27.0	32.4	40.6%		100.0	
Layer 4 Share	17.5	21.1	26.3	35.1%	100.0	
						No Risk Sharing
Expected Loss	9,978	2,477	1,022	397	13,874	13,874
ϕ Charge	499	248	153	80	980	694
ψ Charge	301	103	36	8	448	1,343
Total Charge	800	351	189	88	1,428	2,037
Percentage	8.0%	14.2%	18.5%	22.2%	10.3%	14.7%

Table 3 shows the statistics for the optimal risk sharing arrangement for a risk identical to that underlying Table 1 except with Var[N]/E[N] equal to 1. As noted in the previous section, in this case, the layer boundaries are independent of the claim size distribution. The results are similar to those shown in Table 1.

Table 4 shows the statistics for the optimal risk sharing arrangement for a risk identical to that underlying Table 1 except with smaller $Q1$ and $Q2$ parameters. This adjustment thickens the tail of the claim size distribution, thus making risk sharing more important. The layer boundaries change very little, but risk sharing results in a savings of 9.7% of expected losses.

TABLE 4

KEY STATISTICS FOR OPTIMAL RISK SHARING SMALLER $Q1$ AND $Q2$ PARAMETERS

$B1$ = 25,000	Layer 1: 0 – 72,930	Policy Limit = 1,000,000
$B2$ = 5,000	Layer 2: 72,930 – 248,026	
$Q1$ = 0.75	Layer 3: 248,026 – 548,936	
$Q2$ = 2.75	Layer 4: 548,936 – 1,000,000	
P = .80		
Var[N]/E[N] = 2		

	Insurer 1	Insurer 2	Insurer 3	Insurer 4	Total	No Risk Sharing
Layer 1 Share	100.0%				100.0%	
Layer 2 Share	45.5	54.5%			100.0	
Layer 3 Share	27.0	32.4	40.6%		100.0	
Layer 4 Share	17.5	21.1	26.3	35.1%	100.0	
Expected Loss	17,352	8,338	4,807	2,397	32,894	32,894
ϕ Charge	868	834	721	479	2,902	1,645
ψ Charge	910	450	199	54	1,613	6,039
Total Charge	1,778	1,284	920	533	4,515	7,684
Percentage	10.2%	15.4%	19.1%	22.2%	13.7%	23.4%

5. AGGREGATION

To this point, we have assumed that risk sharing is done on a claim by claim (or occurrence by occurrence) basis. Each insurer participating on a risk pays a predetermined percentage of each claim, with the percentage depending on the size of the claim. However, the model can also be applied to situations where a number of claims are aggregated together before being allocated to each insurer. If the claims are independent of one another, algorithms are available that may be used to calculate an aggregate distribution from the underlying claim count and claim size distributions, or a simulation technique may be used.

The only change to the model involves the equation for the layer boundaries. If claims are aggregated together over definite time periods, there will be only one "claim" per time period.

Therefore, the variance-to-mean ratio of the claim count distribution must be set at zero, and the equation reduces to:

$$l_j - \mathrm{E}[X; l_j] - \sum_{i=1}^{j} \frac{\phi_{j+1} - \phi_i}{2 \cdot \psi_i} = 0.$$

An advantage of aggregating independent claims together before allocating them to insurers is that claims considered as a group are more predictable than claims considered individually. As a result, more of the expected losses can remain in the lower layers with insurers with lower ϕ_is, thus resulting in a lower combined premium for each risk. The larger the number of claims aggregated, the greater the effect will be.

A lower bound for the combined premium may be easily computed. First, note that the combined charge for transaction costs cannot be lower than the total expected losses multiplied by ϕ_1, which we have assumed to be the smallest of the ϕ_is. Second, as alluded to earlier, if transaction costs are disregarded, a quota share arrangement is optimal, with each of the insurers being allocated relative shares inversely proportional to their ψ_is. Therefore, a lower bound for the combined premium may be obtained by assuming that all of the expected losses are allocated to the lowest layer and all of the variance is allocated to the highest layer. This lower bound is thus:

$$\mathrm{E}[S] + \phi_1 \cdot \mathrm{E}[S] + \sum_{i=1}^{C} \psi_i \cdot \left(\frac{1/\psi_i}{\sum_{k=1}^{C} 1/\psi_k} \right)^2 \cdot \mathrm{Var}[S]$$

$$= \mathrm{E}[S] + \phi_1 \cdot \mathrm{E}[S] + \frac{1}{\sum_{i=1}^{C} 1/\psi_i} \cdot \mathrm{Var}[S].$$

Table 5 shows how this lower bound compares to results without risk sharing and with risk sharing on a claim by claim basis for the risks underlying Tables 1 and 2.

TABLE 5

TOTAL CHARGE AS A PERCENTAGE OF EXPECTED LOSSES

Policy Limit	No Risk Sharing	Claim By Claim	Aggregate Lower Bound
1,000,000	15.1%	10.5%	5.7%
10,000,000	55.4	15.7	8.4

Given that it is possible to lower the combined premium by aggregating claims together before allocating them to each insurer, one might conclude this should always be done. However, this may not always be the best approach. For example, if claims are aggregated together, an insurer participating on a high layer can be affected by a large number of small claims in addition to one large claim, which may not be desirable. In some cases, the overhead associated with aggregate coverage may result in larger transaction costs. The model cannot account for all the practical realities that must be considered. Also, to reduce the combined premium by a significant amount, it may be necessary to aggregate together a very large number of claims.

Finally, it should be noted that many risk sharing contracts exist that aggregate together only the portion of claims in specified layers. For example, in many retrospective rating contracts, losses below a given retention are aggregated together before determining coverage, while the insurer pays the portion of any claim that falls above the retention. As another example, a reinsurer may provide coverage only if the sum of all losses that fall in a given layer exceeds a given aggregate retention, while the ceding insurer retains all losses in this layer below the aggregate retention as well as all claims that fall completely below the layer. The hybrid nature of these contracts makes them difficult to analyze. However, the expression giving a lower bound for the combined premium remains valid.

6. PARAMETER ESTIMATION

This section addresses several points that must be considered if we wish to estimate actual values for the ϕ_is and ψ_is. As shown previously, each l_j is given by the solution of the following equation:

$$l_j + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1\right) \cdot \mathrm{E}[X;l_j] - \sum_{i=1}^{j} \frac{\phi_{j+1} - \phi_i}{2 \cdot \psi_i} = 0.$$

Note that only differences of ϕ_is appear in this equation. If all the ϕ_is were increased by the same amount, the solution to the equation would not change. This reflects the fact that what matters are differences in transaction costs among insurers. If there are some costs (e.g., agents' commissions) that are incurred regardless of how a risk is ultimately shared among insurers, then these costs have no effect on the optimal risk sharing arrangement.

If risk sharing is accomplished through reinsurance, the difference between ϕ_i for a primary insurer and ϕ_i for a reinsurer should reflect the additional transaction costs (e.g., brokerage and overhead) that are incurred as a result of the reinsurance contract. Reinsurers that take on small amounts of expected losses for each risk, such as those that tend to take on high layers, can be expected to have larger ϕ_is than reinsurers that take on large amounts of expected losses for each risk, such as those that tend to take on low layers.

The estimation of ψ_i for an insurer should generally be somehow based on the variability of the insurer's overall results. A simple estimation method is illustrated here. Suppose an insurer estimates that its aggregate loss distribution for the next year (for losses retained) has a mean of \$50,000,000 and a standard deviation of \$5,000,000 (and thus a variance of 25,000,000,000,000 $\$^2$). Suppose further that the insurer decides that it needs half of the standard deviation, or \$2,500,000, as risk load. Then, in order to generate the required amount of risk load, its ψ_i should be calculated as follows:

$$\psi_i = \frac{2{,}500{,}000}{25{,}000{,}000{,}000{,}000} = .10 \cdot 10^{-6}.$$

Since variance is additive for independent risks (or independent blocks of risks), if the insurer uses this ψ_i when calculating the risk load for each of its independent risks (or independent blocks of risks), the required amount of risk load will be generated.

It may be difficult to obtain estimates of ϕ_i and ψ_i for each insurer participating in a risk sharing arrangement. However, if a primary insurer is simply interested in finding the retention below which it should retain 100% of every risk, and if the insurer is willing to assume that $\mathrm{Var}[N]/\mathrm{E}[N]$ is 1, then the equation at the beginning of this section simplifies to:

$$l_1 = \frac{\phi_2 - \phi_1}{2 \cdot \psi_1}.$$

Thus, the insurer needs only an estimate of the additional transaction costs associated with the most inexpensive acceptable reinsurance available and an estimate of its own ψ_i. For example, if $\phi_2 - \phi_1$ is estimated to be .05 and ψ_1 is estimated to be $.10 \cdot 10^{-6}$, then:

$$l_1 = \frac{.05}{2 \cdot .10 \cdot 10^{-6}} = \$250{,}000.$$

The final topic of this section is the effect of trend in claim sizes. When a trend factor T is applied to a claim size distribution, we expect the optimal layer boundaries to be multiplied by T. If we examine the equation at the beginning of this section, we see that this will occur if all of the ψ_is are divided by T. Since the variance of each insurer's losses is multiplied by T^2 when T is applied to a claim size distribution, each insurer's risk load would be multiplied by $(1/T) \cdot T^2 = T$. Since each insurer's expected losses would also be multiplied by T, each insurer's risk load as a percentage of expected losses would remain constant. If nothing else changes, this is the desired result. Thus, whenever a claim size distribution is trended, the ψ_is must be "detrended." The ϕ_is are not affected.

7. THE REINSURANCE MARKET

This section is a brief discussion of a few issues that relate to how the model and its results fit into the actual workings of the reinsurance market, within which most risk sharing among insurers takes place. First, to this point, no mention has been made of allocated loss adjustment expenses (ALAE). If ALAE is included with losses before being allocated to layer, ALAE may be incorporated into the model by using a claim size distribution that is based on the sum of losses and ALAE. If ALAE is allocated to layer in the same proportions as the losses, ALAE is not easily incorporated into the model. However, setting aside any practical considerations, this treatment of ALAE is less efficient from a risk sharing perspective than including ALAE with losses. A clear illustration of this occurs when a ceding insurer incurs a large amount of ALAE in defending a claim on which ultimately no payment is made. In this case, risk sharing does not occur; the ceding insurer pays the entire ALAE amount.

In the examples presented earlier, the insurers with the larger ϕ_is, presumably reinsurers, were also assumed to have the smaller ψ_is. An examination of the model shows that this relationship does not necessarily have to hold. Although large reinsurers may indeed have small ψ_is, there is also room for reinsurers with large ψ_is. They would simply receive smaller shares of the layers on which they participate.

One apparent drawback of the model is that, in order to apply it, we must assume that a set number of insurers are available to participate in a risk sharing arrangement. In reality, numerous insurers and reinsurers may be competing to participate on a particular risk. In the examples presented earlier, we assumed that there was only one insurer with a ϕ_i of .05 available to participate in the risk sharing arrangement. In reality, there may be numerous insurers with ϕ_is of .05 available to participate in the risk sharing arrangement. If the model were strictly applied, all of the insurers would participate, each receiving a relatively small share of the expected losses. However, if this were to occur, it is doubtful that the ϕ_is of these insurers would remain at .05. It is likely that their transaction costs as a percentage of their expected losses would increase.

This illustrates an implicit assumption underlying the model, namely that each insurer's ϕ_i is reasonable given the amount of expected losses taken on by each insurer for a particular risk. Too many insurers participating in a risk sharing arrangement simply drives up the ϕ_is for all of them.[8] At some point, this offsets the reduction in variance achieved by incorporating extra insurers on a risk. If a number of insurers with ϕ_is of .05 were to compete for a particular risk, in reality only one of them would end up participating on the risk. The higher layers would be left to the reinsurers, with larger ϕ_is, that specialize in taking on small amounts of expected losses for each risk.

Thus, for purposes of finding the optimal risk sharing arrangement and its associated premiums, we can assume that a limited number of insurers are available to participate. It would certainly be possible to construct the ϕ_i for each insurer as a function of the expected losses it takes on, instead of as a fixed value. However, the danger in doing this is that the mathematical complications introduced may obscure any additional insight that might be achieved. The allure of the model as it stands is that it captures the essential features of the problem being addressed, yet is still simple enough to yield a tractable solution.

8. CONCLUSION

In formulating risk sharing arrangements, if transaction costs are minimized without accounting for risk load, then the conclusion is that risk sharing should not take place. If risk load is minimized without accounting for transaction costs, then the conclusion is that every risk should be shared pro rata among as many insurers as possible. Clearly, neither conclusion is correct. The model described in this paper provides a workable way to find the risk sharing arrangement that strikes the best balance between the two competing goals of the minimization of transaction costs and the minimization of risk load.

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[8] An alternate point of view is that additional insurers bring with them additional fixed costs instead of larger ϕ_is. Either way, the effect is the same.

REFERENCES

[1] Bühlmann, H. and W. S. Jewell, "Optimal Risk Exchanges," *ASTIN Bulletin* 10, 1979, pp. 243–262.

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APPENDIX

1. PRELIMINARIES

The problem addressed in this appendix is that of finding the set of payment functions $\{p_i(x)\}$ for the C insurers that minimizes:

$$
\begin{aligned}
M &= \mathrm{E}[S] + \sum_{i=1}^{C} (\phi_i \cdot \mathrm{E}[S_i] + \psi_i \cdot \mathrm{Var}[S_i]) \\
&= \mathrm{E}[N] \cdot \Bigg[\mathrm{E}[X] + \sum_{i=1}^{C} \Bigg(\phi_i \cdot \mathrm{E}[p_i(X) \cdot X] \\
&\quad + \psi_i \cdot \left\{ \mathrm{E}[(p_i(X) \cdot X)^2] + \left(\frac{\mathrm{Var}[N]}{\mathrm{E}[N]} - 1 \right) \cdot (\mathrm{E}[p_i(X) \cdot X])^2 \right\} \Bigg) \Bigg],
\end{aligned}
$$

subject to the constraints that:

$$
0 \le p_i(x) \le 1 \qquad \text{and} \qquad \sum_{i=1}^{C} p_i(x) = 1.
$$

There are three basic steps to the proof of the solution, corresponding to the remaining three sections of this appendix. In the first step we show that any set of payment functions minimizing M must satisfy the condition that an insurer which pays a given amount on a claim of a given size pays at least as much on claims of all larger sizes. This implies that the number of insurers participating in the payment of a claim may not decrease (and may very well increase) as the size of the claim increases. In the second step, we use the method of Lagrange multipliers to find a condition that must be satisfied by any set of payment functions minimizing M given that the expected losses allocated to each insurer are fixed at certain amounts. It can then be deduced that the only risk sharing arrangement satisfying both these conditions is a layering arrangement with one insurer added at each successively higher layer. Finally, in the third step we find the layering arrangement minimizing M without restricting the amount of expected losses allocated to each insurer.

Similar reasoning applies regardless of whether the claim size distribution is discrete, continuous, or mixed. However, to make the proof easy to follow, we use a discrete formulation in the first two steps and a continuous formulation in the third step. In the second step, we assume that claims may take on integral values from 1 to ∞ and that each possible value has positive probability. In the third step, we assume that the claim size distribution has a probability density function that is positive everywhere. The assumption of positivity does not restrict the generality of the solution, because any probability or probability density function that vanishes in some places can be approximated by a function that is positive everywhere, yet where the contribution to M from points or intervals that actually have zero probability is arbitrarily small. Thus, with the proviso that the payment functions may take on arbitrary values where the probability or probability density function of the claim size distribution is zero, the solution holds for any claim size distribution with finite mean and variance (which is necessary for the problem to make sense).

2. A FIRST NECESSARY CONDITION

We will now show that if M is at a minimum and x_L and x_R are any two possible claim sizes such that $x_L < x_R$, then $p_i(x_L)x_L \leq p_i(x_R)x_R$ for each of the C insurers. In other words, any set of payment functions minimizing M must satisfy the condition that an insurer which pays a given amount on a claim of a given size pays at least as much on claims of all larger sizes.

Suppose that for some x_L and x_R, $x_L < x_R$ and $p_i(x_L)x_L > p_i(x_R)x_R$ for at least one insurer. Let one of these insurers have index 1 and let $D_1 = p_1(x_L)x_L - p_1(x_R)x_R$. D_is associated with the other insurers may then be selected such that the following conditions are satisfied:

$$D_i = 0, \qquad \text{if} \quad p_i(x_L)x_L \geq p_i(x_R)x_R,$$

$$p_i(x_L)x_L - p_i(x_R)x_R \leq D_i \leq 0, \qquad \text{if} \quad p_i(x_L)x_L < p_i(x_R)x_R,$$

$$\text{and} \qquad D_1 + \sum_{i=2}^{C} D_i = 0.$$

Now let an alternate set of payment functions $\{p_i^*(x)\}$ be defined as follows:

$$p_i^*(x) = p_i(x) - \frac{f(x_R)}{f(x_L)+f(x_R)} \cdot \frac{D_i}{x_L}, \qquad \text{if} \quad x = x_L,$$

$$p_i^*(x) = p_i(x) + \frac{f(x_L)}{f(x_L)+f(x_R)} \cdot \frac{D_i}{x_R}, \qquad \text{if} \quad x = x_R, \qquad \text{and}$$

$$p_i^*(x) = p_i(x), \qquad \text{otherwise,}$$

where $f(x)$ is the probability function of the claim size distribution. Then:

$$\begin{aligned}
&p_i^*(x_L)x_L f(x_L) + p_i^*(x_R)x_R f(x_R) \\
&= \left[p_i(x_L) - \frac{f(x_R)}{f(x_L)+f(x_R)} \cdot \frac{D_i}{x_L}\right] x_L f(x_L) \\
&\quad + \left[p_i(x_R) + \frac{f(x_L)}{f(x_L)+f(x_R)} \cdot \frac{D_i}{x_R}\right] x_R f(x_R) \\
&= p_i(x_L)x_L f(x_L) + p_i(x_R)x_R f(x_R).
\end{aligned}$$

Thus, $\mathrm{E}[p_i^*(X)\cdot X] = \mathrm{E}[p_i(X)\cdot X]$. Also:

$$\begin{aligned}
&(p_i^*(x_L)x_L)^2 f(x_L) + (p_i^*(x_R)x_R)^2 f(x_R) \\
&\quad = \left(\left[p_i(x_L) - \frac{f(x_R)}{f(x_L)+f(x_R)}\cdot\frac{D_i}{x_L}\right]x_L\right)^2 f(x_L) \\
&\quad\quad + \left(\left[p_i(x_R) + \frac{f(x_L)}{f(x_L)+f(x_R)}\cdot\frac{D_i}{x_R}\right]x_R\right)^2 f(x_R) \\
&\quad = (p_i(x_L)x_L)^2 f(x_L) + (p_i(x_R)x_R)^2 f(x_R) \\
&\quad\quad - 2D_i[p_i(x_L)x_L - p_i(x_R)x_R]\cdot\frac{f(x_L)\cdot f(x_R)}{f(x_L)+f(x_R)} \\
&\quad\quad + D_i^2\cdot\frac{f(x_L)\cdot f(x_R)}{f(x_L)+f(x_R)}.
\end{aligned}$$

Since $D_1 = p_1(x_L)x_L - p_1(x_R)x_R$:

$$\begin{aligned}
&(p_1^*(x_L)x_L)^2 f(x_L) + (p_1^*(x_R)x_R)^2 f(x_R) \\
&\quad = (p_1(x_L)x_L)^2 f(x_L) + (p_1(x_R)x_R)^2 f(x_R) \\
&\quad\quad - D_1^2\cdot\frac{f(x_L)\cdot f(x_R)}{f(x_L)+f(x_R)} \\
&\quad < (p_1(x_L)x_L)^2 f(x_L) + (p_1(x_R)x_R)^2 f(x_R).
\end{aligned}$$

For $i \neq 1$, since $p_i(x_L)x_L - p_i(x_R)x_R \le D_i \le 0$:

$$\begin{aligned}
&(p_i^*(x_L)x_L)^2 f(x_L) + (p_i^*(x_R)x_R)^2 f(x_R) \\
&\quad \le (p_i(x_L)x_L)^2 f(x_L) + (p_i(x_R)x_R)^2 f(x_R) \\
&\quad\quad - D_i^2\cdot\frac{f(x_L)\cdot f(x_R)}{f(x_L)+f(x_R)} \\
&\quad \le (p_i(x_L)x_L)^2 f(x_L) + (p_i(x_R)x_R)^2 f(x_R).
\end{aligned}$$

Thus, $\mathrm{E}[(p_1^*(X)\cdot X)^2] < \mathrm{E}[(p_1(X)\cdot X)^2]$ and for $i \neq 1$, $\mathrm{E}[(p_i^*(X)\cdot X)^2] \le \mathrm{E}[(p_i(X)\cdot X)^2]$.

Therefore, the alternate set of payment functions $\{p_i^*(x)\}$ produces a smaller value of M than that produced by the original set of payment functions. Hence, if M is at a minimum, $p_i(x_L)x_L$ may not be greater than $p_i(x_R)x_R$ for any insurer.

3. A SECOND NECESSARY CONDITION

We will now show that the optimal risk sharing arrangement must be constructed in layers, with one insurer added at each successively higher layer.

To ensure that $0 \le p_i(x) \le 1$, let $p_i(x) = z_i^2(x)$. We will then optimize each $z_i(x)$, which for notational convenience will be written as simply z_i. Also for notational convenience, let $v = \mathrm{Var}[N]/\mathrm{E}[N]$. In the long expression for M, we will drop the leading factor $\mathrm{E}[N]$ and the leading term $\mathrm{E}[X]$ in the brackets since neither one will have an effect on the solution. Thus, we are left with the problem of minimizing:

$$M_1 = \sum_{i=1}^{C}(\phi_i \cdot \mathrm{E}[z_i^2 \cdot X] + \psi_i \cdot \{\mathrm{E}[(z_i^2 \cdot X)^2] + (v-1)\cdot(\mathrm{E}[z_i^2 \cdot X])^2\})$$

subject to the constraint that:

$$\sum_{i=1}^{C} z_i^2 = 1.$$

Now let $Z_i = \mathrm{E}[z_i^2 \cdot X]$. For now, we will assume that the Z_is are fixed. Later, we will find optimal values for the Z_is. Thus, we want to minimize:

$$M_1 = \sum_{i=1}^{C}\left(\phi_i \cdot Z_i + \psi_i \cdot \left\{\sum_{x=1}^{\infty}(z_i^4 x^2 f(x)) + (v-1)\cdot Z_i^2\right\}\right)$$

$$= \sum_{i=1}^{C}(\phi_i \cdot Z_i + \psi_i \cdot (v-1)\cdot Z_i^2) + \sum_{i=1}^{C}\sum_{x=1}^{\infty}\psi_i z_i^4 x^2 f(x)$$

subject to the constraints that:

$$\sum_{i=1}^{C} z_i^2 = 1 \qquad \text{and for each } i, \qquad \sum_{x=1}^{\infty} z_i^2 x f(x) = Z_i.$$

To find the z_is minimizing M_1 for any given values of the Z_is, it is sufficient to minimize:

$$M_2 = \sum_{i=1}^{C} \sum_{x=1}^{\infty} \psi_i z_i^4 x^2 f(x)$$

subject to the above constraints. If any of the Z_is are zero, the corresponding z_is must be identically zero. These Z_is are disregarded in what follows. Because of the constraints on the z_is, we must introduce Lagrange multipliers and consider:

$$M_3 = \sum_{i=1}^{C} \sum_{x=1}^{\infty} \psi_i z_i^4 x^2 f(x) + \sum_{x=1}^{\infty} \left(\lambda(x) \sum_{i=1}^{C} z_i^2 \right) + \sum_{i=1}^{C} \left(\mu_i \sum_{x=1}^{\infty} z_i^2 x f(x) \right).$$

A necessary condition for M_2 to be at a constrained minimum is that there exist a function $\lambda(x)$ (i.e., a separate multiplier for each possible claim size) and C constants μ_i such that, for each z_i and each possible claim size:

$$\frac{\partial M_3}{\partial z_i} = 4\psi_i z_i^3 x^2 f(x) + 2\lambda(x) z_i + 2\mu_i z_i x f(x)$$
$$= 2z_i[2\psi_i z_i^2 x^2 f(x) + \lambda(x) + \mu_i x f(x)] = 0.$$

If $z_i \neq 0$, then:

$$\frac{\lambda(x)}{\psi_i} = -2z_i^2 x^2 f(x) - \frac{\mu_i}{\psi_i} x f(x).$$

For a given claim size, we may sum over the insurers for which $z_i \neq 0$ to get:

$$\lambda(x) \sum_{\substack{k=1 \\ z_k \neq 0}}^{C} \frac{1}{\psi_k} = -2x^2 f(x) - \sum_{\substack{k=1 \\ z_k \neq 0}}^{C} \frac{\mu_k}{\psi_k} x f(x).$$

Solving for $\lambda(x)$ and substituting back yields:

$$\frac{\partial M_3}{\partial z_i} = 2 z_i x f(x) \left[2\psi_i z_i^2 x + \frac{-2x - \sum\limits_{k=1, z_k \neq 0}^{C} \mu_k / \psi_k}{\sum\limits_{k=1, z_k \neq 0}^{C} 1/\psi_k} + \mu_i \right] = 0.$$

If $z_i \neq 0$, then:

$$z_i^2 x = \left[\frac{x + \sum\limits_{k=1, z_k \neq 0}^{C} \mu_k / 2\psi_k}{\psi_i \sum\limits_{k=1, z_k \neq 0}^{C} 1/\psi_k} - \frac{\mu_i}{2\psi_i} \right].$$

From the first necessary condition, we know that if M_2 is at a constrained minimum, an insurer that pays a given amount on a claim of a given size must pay at least as much on claims of all larger sizes. Thus, the number of insurers participating in the payment of a claim may not decrease (and may very well increase) as the size of the claim increases. The difference function of $z_i^2 x$ with respect to x within a range of claim sizes with the same participating insurers is:

$$z_i^2 (x+1) - z_i^2 x = \frac{1/\psi_i}{\sum\limits_{k=1, z_k \neq 0}^{C} 1/\psi_k}.$$

Since this expression is not dependent on x, we may conclude that the optimal risk sharing arrangement must be constructed in layers, with one insurer added at each successively higher layer. Each participating insurer's share of a particular layer is then given by:

$$\frac{1/\psi_i}{\sum\limits_{k=1, z_k \neq 0}^{C} 1/\psi_k}.$$

Recall that we have been assuming that $Z_i = \mathrm{E}[z_i^2 \cdot X]$ is fixed for each insurer. Given the Z_is, we now have enough information to determine in which order the insurers are added and the boundaries between the layers without finding explicit values for the μ_is. The highest layer has all of the insurers participating with shares that have been determined above. The highest layer boundary, l_{C-1}, is determined by moving it down from ∞ until the allocation of expected losses for one insurer, given by its Z_i, has been satisfied. That insurer is then dropped from further participation and the next layer boundary down, l_{C-2}, is determined by moving it down from l_{C-1} until the allocation of expected losses for another insurer has been satisfied. This procedure is continued until all the layer boundaries have been determined.

The risk sharing arrangement described above minimizes M given that the expected losses allocated to each insurer are fixed at certain amounts. It remains to find the risk sharing arrangement that minimizes M without any restrictions on the amount of expected losses allocated to each insurer. To do this we must find the optimal set of Z_is. Each possible set of Z_is is associated with a set of layer boundaries, and vice versa. It is more convenient to focus on finding the optimal set of layer boundaries. The optimal set of Z_is will then directly follow.

4. OPTIMAL LAYER BOUNDARIES

Since we know that the optimal risk sharing arrangement is constructed in layers, we may write M_1 as follows:

$$
\begin{aligned}
M_1 = \sum_{i=1}^{C} \Bigg\{ & \phi_i \cdot \sum_{j=i}^{C} \frac{1/\psi_i}{\sum_{k=1}^{j} 1/\psi_k} \int_{l_{j-1}}^{l_j} G(x)\,dx \\
& + \psi_i \cdot (v-1) \cdot \left(\sum_{j=i}^{C} \frac{1/\psi_i}{\sum_{k=1}^{j} 1/\psi_k} \int_{l_{j-1}}^{l_j} G(x)\,dx \right)^2 \\
& + \psi_i \cdot \sum_{j=i}^{C} \int_{l_{j-1}}^{l_j} \left(\sum_{m=i}^{j-1} \frac{1/\psi_i}{\sum_{k=1}^{m} 1/\psi_k} (l_m - l_{m-1}) \right. \\
& \left. + \frac{1/\psi_i}{\sum_{k=1}^{j} 1/\psi_k} (x - l_{j-1}) \right)^2 f(x)\,dx \Bigg\},
\end{aligned}
$$

where $l_0 = 0$, $l_C = \infty$, and $G(x) = 1 - F(x)$ where $F(x)$ is the cumulative distribution function of X. At this point, we do not know in which order the insurers should be added in successively higher layers. The above expression, with insurers indexed according to the order in which they are added, could apply to any ordering of insurers. Differentiating with respect to a particular

l_j yields:

$$\frac{\partial M_1}{\partial l_j} = \sum_{i=1}^{j} \phi_i \cdot \frac{1/\psi_i}{\sum_{k=1}^{j} 1/\psi_k} \cdot G(l_j) - \sum_{i=1}^{j+1} \phi_i \cdot \frac{1/\psi_i}{\sum_{k=1}^{j+1} 1/\psi_k} \cdot G(l_j)$$

$$+ \sum_{i=1}^{j} 2 \cdot \psi_i \cdot (v-1) \cdot \left(\sum_{m=i}^{C} \frac{1/\psi_i}{\sum_{k=1}^{m} 1/\psi_k} \int_{l_{m-1}}^{l_m} G(x)\,dx \right)$$

$$\cdot \frac{1/\psi_i}{\sum_{k=1}^{j} 1/\psi_k} \cdot G(l_j)$$

$$- \sum_{i=1}^{j+1} 2 \cdot \psi_i \cdot (v-1) \cdot \left(\sum_{m=i}^{C} \frac{1/\psi_i}{\sum_{k=1}^{m} 1/\psi_k} \int_{l_{m-1}}^{l_m} G(x)\,dx \right)$$

$$\cdot \frac{1/\psi_i}{\sum_{k=1}^{j+1} 1/\psi_k} \cdot G(l_j)$$

$$+ \sum_{i=1}^{j} \left(2 \cdot \psi_i \cdot \frac{1/\psi_i}{\sum_{k=1}^{j} 1/\psi_k} \cdot G(l_j) \cdot \sum_{m=i}^{j} \frac{1/\psi_i}{\sum_{k=1}^{m} 1/\psi_k} \cdot (l_m - l_{m-1}) \right)$$

$$- \sum_{i=1}^{j+1} \left(2 \cdot \psi_i \cdot \frac{1/\psi_i}{\sum_{k=1}^{j+1} 1/\psi_k} \cdot G(l_j) \cdot \sum_{m=i}^{j} \frac{1/\psi_i}{\sum_{k=1}^{m} 1/\psi_k} \cdot (l_m - l_{m-1}) \right)$$

$$= 2 \cdot G(l_j) \cdot \left[\frac{\sum_{i=1}^{j} (\phi_i / 2\psi_i) + (\nu - 1) \cdot \int_0^{l_j} G(x)dx + l_j}{\sum_{i=1}^{j} 1/\psi_i} - \frac{\sum_{i=1}^{j+1} (\phi_i / 2\psi_i) + (\nu - 1) \cdot \int_0^{l_j} G(x)dx + l_j}{\sum_{i=1}^{j+1} 1/\psi_i} \right]$$

$$= 2 \cdot G(l_j) \cdot \frac{1/\psi_{j+1}}{\left(\sum_{i=1}^{j} 1/\psi_i\right)\left(\sum_{i=1}^{j+1} 1/\psi_i\right)}$$

$$\cdot \left[\sum_{i=1}^{j} \frac{\phi_i}{2\psi_i} - \phi_{j+1} \cdot \sum_{i=1}^{j} \frac{1}{2\psi_i} + (\nu - 1) \cdot \int_0^{l_j} G(x)dx + l_j \right].$$

For M_1 to be meaningful, we must have $0 \leq l_1 \leq l_2 \leq \cdots \leq l_{C-1} \leq \infty$. This will be referred to as the admissible region. The first thing to note is that if any of the l_js are near infinity, M_1 will not be at a minimum, since its derivative with respect to this l_j would be positive, thus indicating that M_1 is increasing as l_j approaches infinity.

For M_1 to be at a minimum, the derivative of M_1 with respect to each l_j in the interior of the admissible region must be zero. We will now determine what conditions must be satisfied by any l_js at the boundary of the admissible region when M_1 is at a minimum. An l_j is at the boundary of the admissible region if it is coincident with another l_j or with zero.

First take the case where two or more l_js are coincident with one another at a nonzero point. Let the point of coincidence be called l_s (s will be the index of the first of the l_js which coincide at l_s). Suppose that n of the l_js coincide at l_s. Then, at a minimum, the derivative of M_1 with respect to l_s must be zero. If this were not so, all n of the l_js that coincide at l_s could be either increased or decreased slightly to yield a smaller value of M_1. The derivative of M_1 with respect to l_s is simply the sum of the derivatives with respect to the n l_js that coincide at l_s:

$$\frac{\partial M_1}{\partial l_s} = 2 \cdot G(l_s) \cdot \left[\frac{\sum_{i=1}^{s} (\phi_i/2\psi_i) + (\nu - 1) \cdot \int_0^{l_s} G(x)dx + l_s}{\sum_{i=1}^{s} 1/\psi_i} - \frac{\sum_{i=1}^{s+n} (\phi_i/2\psi_i) + (\nu - 1) \cdot \int_0^{l_s} G(x)dx + l_s}{\sum_{i=1}^{s+n} 1/\psi_i} \right]$$

$$= 2 \cdot G(l_s) \cdot \frac{\sum_{i=s+1}^{s+n} 1/\psi_i}{\left(\sum_{i=1}^{s} 1/\psi_i\right)\left(\sum_{i=1}^{s+n} 1/\psi_i\right)} \cdot \left[\sum_{i=1}^{s} \frac{\phi_i}{2\psi_i} - \frac{\sum_{i=s+1}^{s+n} \phi_i/\psi_i}{\sum_{i=s+1}^{s+n} 1/\psi_i} \sum_{i=1}^{s} \frac{1}{2\psi_i} + (\nu - 1) \cdot \int_0^{l_s} G(x)dx + l_s \right].$$

Note that the factor in brackets above is identical to the corresponding factor in the expression for the derivative of M_1 with respect to a single l_j except that ϕ_{j+1} is replaced by a weighted average of ϕ_{j+1}s. If the n ϕ_{j+1}s corresponding to the n l_js are not all equal to one another, then at least one of these ϕ_{j+1}s must be smaller than the weighted average. If these insurers are reordered so that an insurer with a ϕ_{j+1} smaller than the weighted average is placed first, then if the derivative with respect to l_s is zero (which implies that the factor in brackets must be zero), the derivative of M_1 with respect to the corresponding l_j will be greater than zero. This implies that if this first l_j of those coincident at l_s is moved down slightly, a smaller value of M_1 will result. Therefore, we conclude that, if M_1 is at a minimum, two or more l_js may not be coincident with one another at a nonzero point unless their corresponding ϕ_{j+1}s are all equal to one another.

We now move to the case where the first n of the l_js coincide at zero. If $\phi_1, \ldots, \phi_{n+1}$ are not all equal to one another, then at least one of these ϕ_{j+1}s must be greater than or equal to all the others, and strictly greater than at least one of the others. If these insurers are reordered so that this insurer is placed last, then the derivative with respect to the corresponding l_j will be less than zero. This implies that if this last l_j of those coincident at zero is moved up slightly, a smaller value of M_1 will result. Therefore, we conclude that if M_1 is at a minimum, the first n l_js may not coincide at zero unless $\phi_1 = \phi_2 = \cdots = \phi_{n+1}$.

The above arguments imply that, if M_1 is at a minimum, the derivative of M_1 with respect to each l_j must be zero. Therefore, for each of the l_js, the following equation must be satisfied:

$$\sum_{i=1}^{j} \frac{\phi_i}{2\psi_i} - \phi_{j+1} \cdot \sum_{i=1}^{j} \frac{1}{2\psi_i} + (v-1) \cdot \int_0^{l_j} G(x)\,dx + l_j$$

$$= l_j + (v-1) \cdot \int_0^{l_j} G(x)\,dx - \sum_{i=1}^{j} \frac{\phi_{j+1} - \phi_i}{2 \cdot \psi_i} = 0.$$

The relationship between adjacent l_js may be expressed as follows:

$$(l_j - l_{j-1}) + (v-1) \cdot \int_{l_{j-1}}^{l_j} G(x)dx - \frac{\phi_{j+1} - \phi_j}{2} \cdot \sum_{i=1}^{j} \frac{1}{\psi_i} = 0.$$

It is clear from this equation that $l_j - l_{j-1}$ will be positive if and only if ϕ_{j+1} is greater than ϕ_j, and that l_j will be equal to l_{j-1} if and only if ϕ_{j+1} is equal to ϕ_j. Thus, to ensure a solution to these equations in the admissible region, the insurers must be added in an order such that their ϕ_js are nondecreasing. Furthermore, since the order in which insurers with identical ϕ_js are added does not affect the solution, there is only one solution, which we conclude must yield the point at which M_1, and hence M, assumes its minimum value.

DISCUSSION OF PAPER PUBLISHED IN VOLUME LXXIV

A NOTE ON THE GAP BETWEEN TARGET AND EXPECTED UNDERWRITING PROFIT MARGINS

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DISCUSSION BY WILLIAM R. GILLAM

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1. INTRODUCTION

Dr. Venezian's paper provides a simple yet powerful result: the traditional actuarial pricing method produces an expected underwriting profit margin that is lower than the target margin. This will not be avoided by an unbiased projection of losses; as long as there is uncertainty in that projection, the results follow.

This uncertainty in the projection of loss costs is *parameter risk*. The loading in rates for *profit and contingencies* should reflect the parameter risk assumed by the insurer, at least in the *contingencies* part. Unfortunately, an appropriate loading for parameter risk is usually not susceptible to an easy statistical measure. Dr. Venezian's theorem leads to a natural method for quantifying that loading. This review uses that method to calculate a contingencies loading for workers compensation rates.

The reviewer is aware of the controversy surrounding Dr. Venezian's result, and has read Sholom Feldblum's review [1] several times. Mr. Feldblum does not refute the statistical theorem

$$\mathrm{E}\left[\frac{1}{X}\right] \geq \frac{1}{\mathrm{E}[X]} \qquad (1)$$

for positive-valued random variable X, but points out that the correct way to combine the loss ratios of several individual policies is not to take a straight average but to aggregate them; i.e., add all the losses for the numerator and all the premiums for the denominator. This is equivalent to a weighted average of loss ratios. If, as in Feldblum's example, the many policy loss ratios encompass the complete distribution of projection errors, there is no projection error left. The variance in loss ratios by policy is irrelevant.

This reviewer would not be so quick to dismiss Venezian's result. The theorem can still be applied to loss ratios that cannot be aggregated. For sake of this discussion, the reviewer has had to decide when a loss ratio must stand on its own. Individual company calendar quarter loss ratios, for instance, do not hold much actuarial relevance. Nevertheless, they seem to generate a fair amount of discussion in financial markets and among carriers. The reviewer has selected a one policy year statewide loss ratio as having enough actuarial and financial relevance to stand on its own. The bureau estimates and files a (pure) premium level change by state each year. In order to realize a certain underwriting return on premium, admitting that the filed loss rates are an estimate, we wish to determine how they should be loaded for profit and contingencies.

Alternatively, the analysis could be done by grouping states or years, which would result in a smaller, but non-zero, load. Larger companies can combine a few states before calculating results, but there are many companies writing in one or two states that cannot afford this luxury: Parameter risk affects the bottom line results.

2. DEVELOPMENT OF ALGEBRA FOR ANALYSIS OF RATE LEVEL UNCERTAINTY

As each renewal date approaches, the actuaries must choose a single estimate of the needed rates in the ensuing year. In workers compensation, the indicated rate change is estimated as a projected ratio of loss to premium at current level, divided by the permissible loss ratio, or PLR. Once a rate change is approved, the actuaries can revise their projected loss ratio to reflect the actual rate change. When the year is complete, and the actual premium is reported, projected losses, or PRJ, are calculated by extending that premium by the revised projected loss ratio.

The emerged actual losses for the year are a random variable ACT, with some unknown expected value TAR so that E[ACT] = TAR. The quantity name TAR is used to evoke Stephen Philbrick's article on credibility [2]. Philbrick likened the estimation of an unknown parameter such as TAR to target shooting. The value of ACT varies around TAR because of the random nature of the process, the process variance. At any time before maturity, the exact value of ACT is unknown and must be estimated by actuaries.

PRJ is also a random variable, the outcome of a stochastic process called ratemaking, based on data subject to errors, formulas subject to assumptions, and debate prejudiced by politics. For purposes of this exposition, we assume the loss projection is unbiased, thus E[PRJ] = E[ACT] = TAR.

We define a random variable X by:

$$X = \frac{\text{PRJ}}{\text{TAR}}.$$

So

$$\text{PRJ} = \text{TAR} \cdot X. \tag{2}$$

X is a positive-valued random variable, with non-zero variance. By its definition, $\text{E}[X] = 1$.

As stated by Dr. Venezian,

$$\mathrm{E}\left[\frac{1}{X}\right] \geq \frac{1}{\mathrm{E}[X]} = 1$$

for any positive valued random variable X with unity mean. Except in some degenerate cases, strict inequality will obtain. (The variable X here is the same as Venezian's $1 + X$.)

Following Venezian's logic, to assure realization of the profit provision, rates should be multiplied by the factor $\mathrm{E}\left[\frac{1}{X}\right]$; or, alternatively, the PLR (in the original filing) should be divided by $\mathrm{E}\left[\frac{1}{X}\right]$. This adjustment should be made after the target profit provision is established using cost of capital and/or other economic evidence.

In practice, the loading would be an element added to the provision for expenses, tax and profit (the complement of the PLR). To develop that loading, define a new target loss ratio, PLR$'$. Then:

$$\begin{aligned} \mathrm{PLR}' &= \frac{\mathrm{PLR}}{\mathrm{E}\left[\frac{1}{X}\right]} \\ &= \frac{\mathrm{PLR}}{1 + \left(\mathrm{E}\left[\frac{1}{X}\right] - 1\right)} \cong (\mathrm{PLR})\left[1 - \left(\mathrm{E}\left[\frac{1}{X}\right] - 1\right)\right] \\ &= \mathrm{PLR} - \mathrm{PLR}\left(\mathrm{E}\left[\frac{1}{X}\right] - 1\right). \end{aligned}$$

The element added to expenses is then $\mathrm{PLR}\left(\mathrm{E}\left[\frac{1}{X}\right] - 1\right)$. It will be largest when the uncertainty in the projected loss costs is greatest; that is, when the *parameter risk* is greatest.

3. ESTIMATION OF THE CONTINGENCY LOADING

To estimate parameters of the distribution of X for workers compensation statewide rate level indications, the reviewer has assembled reported financial data comprising eight policy years' loss ratios for twenty-six states. These loss ratios are developed to ultimate as of the latest evaluation at 12/31/92.

For each state and policy year, there is also a projected loss ratio based on an analysis of rate indications and approvals as described in Section 2. Weighted averages must be taken in cases where rate changes occur at other than January 1.

The general approach is to compare the actual emerged losses by policy year with those projected at the time of rate level approval. The projected losses are the product of a projected loss ratio and earned standard premium. The quotient, projected losses divided by actual losses, will be used as a sample estimate of the random variable X. This requires several assumptions documented below. From the many samples, statistics of the distribution of X are derived.

Exhibit 1 displays two of twenty-six states' data used in this estimation. Calculations progress from left to right, across the page in the usual fashion. The reader should anticipate the eventuality of looking (down) through the pages (through the states) to calculate statistics pertaining to all states in each policy year. The notes below explain each column.

1) Policy years 1984 through 1991 are used.

2) Standard premium shown is as actually earned.

3) Projected Loss Ratio is that actually expected given the rate filing approval.

4) The Projected Loss, PRJ, is a product of Actual Standard Premium (2) and the loss ratio expected after the rate change (3).

5) Incurred Loss is as of the latest evaluation, developed to ultimate. This is a best estimate of ACT. We will be using ACT as an estimate of TAR.

6) The ratio (4) ÷ (5) is the ratio of the *projected* to *actual losses* (which is also a *ratio* of loss ratios to on-level premium). PRJ/ACT is an estimate of the random variable PRJ/TAR = X defined above. The denominator, ACT, is an estimate of the underlying targeted losses, TAR. This estimate is subject to two principal errors—process variance and error in the estimated development to ultimate. The process variance we may safely disregard as small using the following logic:

The emerged losses ACT in Column 5 vary around some true expected value TAR_y (by year y) due to process variance. Ignoring estimation error for a moment, variance of PRJ/ACT will be greater than the variance of PRJ/TAR, but by an insignificant amount. We can estimate the variance of L = ACT/TAR using risk modeling concepts. It has a relatively small variance.

Assuming frequency and severity are independent,

$$\text{Var}[L] = \text{Var}\left(\frac{\text{ACT}}{\text{E[ACT]}}\right) = \frac{\text{E}[y]\text{Var}[z] + \text{Var}[y]\text{E}[z]^2}{\text{E}[y]^2\text{E}[z]^2}, \quad (3)$$

where y is the claim count and z is the severity random variable. So:

$$\begin{aligned}\text{Var}[L] &= \frac{1}{\text{E}[y]}\left[\frac{\text{Var}[z]}{\text{E}[z]^2} + \frac{\text{Var}[y]}{\text{E}[y]}\right] \\ &\cong \frac{1}{\text{E}[y]}[36 + 2],\end{aligned}$$

using reasonably conservative estimates of the variance components. (If these were doubled, it would not change the conclusion that process variance is relatively small.) Then

$$\text{Var}[L] = \frac{38}{100,000} = .0004,$$

where 100,000 is clearly a low estimate of expected claim count in almost any state.

The error in development to ultimate is probably more significant, but is at least of the same nature as error in the original projection. The basic quid pro quo for being unable to unravel this estimation error is that so much of the variance of the projection is eliminated in the next step.

7) Because this contingency loading is not a correction for bias in the projection of losses, the estimates in Column 6 have been normalized by state so that over the eight years in the sample, the average error of the projections is nil; i.e., the ratios average to unity. This effectively ignores a lot of parameter risk exhibited in the data, probably of a much greater magnitude than whatever parameter risk is introduced by the immaturity of the evaluations. Even after this adjustment, a significant amount of error remains, and we will try to estimate its distribution. Elements of Column (7) are sample estimates x_i of the variable X. The average over the eight years, which is now unity, is shown in the last row.

8) We have observed above that the loss projection process is a stochastic process, the result of multiple judgments. Most of these judgments are *factors*—factors for loss development, trend, law evaluations, etc. It is natural to use a lognormal distribution to model the results of such a process. With the goal of fitting a lognormal, we take logarithms $t_i = \ln x_i$ of the sample points x_i in Column 7 and square them. The t_i^2 will be used to estimate the parameter σ^2 of the lognormal distribution.

The ninth row shows the averages of each of the Columns 6, 7, and 8.

Since we are estimating the parameters of a distribution with mean of unity, we can require that $\mu = -\frac{1}{2}\sigma^2$, so that the lognormal mean will be unity. We must then estimate only the parameter σ^2 from the sample. The maximum likelihood estimate S^2 of the parameter σ^2 is given by the following:

$$S^2 = 2\left(\sqrt{1 + \frac{1}{n}\Sigma t_i^2} - 1\right). \tag{4}$$

This leads to by-state evaluations of S^2 in the tenth row. For each state, a contingency loading, $(e^{S^2} - 1) \cdot \text{PLR}$ is shown in the eleventh row. A better estimate of σ^2 is the calculation of S^2 across all the states for each year. This is calculated in the next to last column of Exhibit 2 using the respective elements of Column 7 from each state. The values of S^2 vary from 0.0036 to 0.0548 over the eight years in the study.

The statistic $S^2 = 0.0214$ calculated in the first half of Exhibit 2 uses all 208 ($= 26 \times 8$) estimates of X in the exhibit. For the lognormal distribution of X with parameters $[-\frac{1}{2}\sigma^2, \sigma^2]$, $\mathrm{E}\left[\frac{1}{X}\right] = e^{\sigma^2}$. When $\sigma^2 = 0.0214$, $\mathrm{E}\left[\frac{1}{X}\right] = e^{0.0214} \cong 1.022$. This leads to a contingency loading of $\text{PLR}(1.022 - 1) \cong 1.5\%$, when the permissible loss ratio is 70%.

For the record, the second half of Exhibit 2 calculates a contingency loading when there has been no normalization of projection error. This is about 4%.

When the risk can be spread over more states the loading could be lower. It has also been suggested that the loss ratio should be aggregated over more years, and the loading thus reduced. As long as ratemaking is an inexact science, the loading should be non-zero.

REFERENCES

[1] Feldblum, Sholom, Discussion of Venezian: "A Note on the Gap Between Target and Expected Underwriting Profit Margin," *PCAS* LXXVII, 1990, pp. 42–95.

[2] Philbrick, Stephen W., "An Examination of Credibility Concepts," *PCAS* LXVIII, 1981, pp. 195–219.

EXHIBIT 1
PART 1

CALCULATION OF CONTINGENCY LOADING
STATE A

(1) Policy Year	(2) Standard Premium	(3) Projected Loss Ratio	(4) (2)*(3) Projected Losses	(5) Incurred Losses	(6) (4)/(5) Initial *X* Estimate	(7) (6)/avg(6) Balanced *X* Estimate	(8) $(\ln(7))^2$ MLE Summand
1984	200,278,065	62.3%	124,773,234	175,356,228	0.7115	0.9216	0.0067
1985	256,463,153	61.9%	158,750,692	233,709,184	0.6793	0.8798	0.0164
1986	316,065,139	62.7%	198,200,656	262,386,482	0.7554	0.9784	0.0005
1987	358,210,729	63.8%	228,450,683	285,366,347	0.8006	1.0369	0.0013
1988	389,240,500	64.4%	250,561,895	354,792,510	0.7062	0.9147	0.0079
1989	453,685,090	64.6%	293,272,502	381,609,365	0.7685	0.9954	0.0000
1990	437,795,706	72.9%	318,953,543	400,409,757	0.7966	1.0317	0.0010
1991	420,210,734	74.2%	311,814,224	325,316,985	0.9585	1.2415	0.0468
Unwtd Avg					0.7721	1.0000	0.0101

Maximum Likelihood Estimator (S^2) = 0.0100

PLR= 0.700

Indicated Contingency Loading = 0.71%
$(\exp(S^2)-1)$*PLR

EXHIBIT 1

PART 2

CALCULATION OF CONTINGENCY LOADING
STATE B

(1) Policy Year	(2) Standard Premium	(3) Projected Loss Ratio	(4) (2)*(3) Projected Losses	(5) Incurred Losses	(6) (4)/(5) Initial *X* Estimate	(7) (6)/avg(6) Balanced *X* Estimate	(8) $(\ln(7))^2$ MLE Summand
1984	140,918,339	63.0%	88,827,393	102,565,294	0.8661	0.7438	0.0876
1985	141,994,308	63.5%	90,166,386	100,536,644	0.8969	0.7702	0.0682
1986	136,240,676	62.9%	85,682,919	86,646,787	0.9889	0.8493	0.0267
1987	157,438,852	63.8%	100,415,130	83,836,649	1.1977	1.0286	0.0008
1988	192,055,479	62.7%	120,418,785	78,084,105	1.5422	1.3244	0.0789
1989	224,943,549	62.7%	141,039,605	100,022,404	1.4101	1.2110	0.0366
1990	217,048,436	64.4%	139,779,193	113,539,367	1.2311	1.0573	0.0031
1991	228,893,562	64.5%	147,636,347	124,865,150	1.1824	1.0154	0.0002
Unwtd Avg					1.1644	1.0000	0.0378

Maximum Likelihood Estimator (S^2) = 0.0374

PLR= 0.700

Indicated Contingency Loading = 2.67%
$(\exp(S^2)-1)$*PLR

EXHIBIT 1

PART 3

CALCULATION OF CONTINGENCY LOADING
STATE C

(1) Policy Year	(2) Standard Premium	(3) Projected Loss Ratio	(4) (2)*(3) Projected Losses	(5) Incurred Losses	(6) (4)/(5) Initial X Estimate	(7) (6)/avg(6) Balanced X Estimate	(8) $(\ln(7))^2$ MLE Summand
1984	261,040,400	62.5%	163,150,250	219,855,325	0.7421	0.7623	0.0737
1985	369,646,569	62.4%	230,659,459	234,716,774	0.9827	1.0095	0.0001
1986	462,582,740	61.8%	285,876,133	270,424,555	1.0571	1.0859	0.0068
1987	515,074,069	60.8%	313,409,179	308,069,073	1.0173	1.0450	0.0019
1988	566,185,080	59.6%	337,409,506	357,625,450	0.9435	0.9692	0.0010
1989	606,576,835	61.9%	375,471,061	374,780,756	1.0018	1.0291	0.0008
1990	657,397,693	62.6%	411,530,956	413,304,435	0.9957	1.0228	0.0005
1991	705,333,080	64.1%	452,280,026	431,686,665	1.0477	1.0762	0.0054
Unwtd Avg					0.9735	1.0000	0.0113

Maximum Likelihood Estimator (S^2) = 0.0112

PLR= 0.700

Indicated Contingency Loading = $(\exp(S^2)-1)$*PLR = **0.79%**

EXHIBIT 2

PART 1

CALCULATION OF CONTINGENCY LOADING
X ESTIMATES NORMALIZED OVER POLICY YEARS

PY:	STATE: A	B	C	D	E	F	G	H	I	J	K	L	M	N
1984	0.9216	0.7438	0.7623	0.8869	1.1806	0.7664	1.4200	0.8322	0.9226	0.9722	0.8613	1.1411	0.6027	1.0160
1985	0.8798	0.7702	1.0095	0.9513	0.9815	0.8680	1.2845	0.9056	0.9161	1.0247	0.9098	1.1479	0.5983	0.9881
1986	0.9784	0.8493	1.0859	0.8172	1.0833	0.8730	1.2605	0.9424	0.9955	1.0087	1.0210	1.1354	1.0118	0.8783
1987	1.0369	1.0286	1.0450	0.8849	0.8982	0.8634	0.9954	0.9954	1.0571	0.9676	0.9597	1.0579	1.0574	1.0181
1988	0.9147	1.3244	0.9692	0.9625	0.9313	0.7993	0.8353	1.0103	1.0232	0.9505	1.0292	0.9920	1.1030	1.0210
1989	0.9954	1.2110	1.0291	0.9730	1.0480	1.0232	0.7771	0.9817	0.9701	0.9216	0.9735	0.8123	0.8974	0.9185
1990	1.0317	1.0573	1.0228	1.1688	0.9560	1.4859	0.7071	1.0957	1.0436	1.1045	1.0576	0.8292	1.2197	1.0141
1991	1.2415	1.0154	1.0762	1.3553	0.9211	1.3210	0.7202	1.2365	1.0718	1.0503	1.1879	0.8843	1.5097	1.1460
AVG	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
STAT	0.0100	0.0374	0.0112	0.0238	0.0077	0.0513	0.0692	0.0126	0.0032	0.0030	0.0084	0.0186	0.0921	0.0055
LOAD	0.71%	2.67%	0.79%	1.69%	0.54%	3.69%	5.01%	0.89%	0.22%	0.21%	0.59%	1.31%	6.75%	0.39%

EXHIBIT 2

PART 2

CALCULATION OF CONTINGENCY LOADING
X ESTIMATES NORMALIZED OVER POLICY YEARS

PY:	O	P	Q	R	S	T	U	V	W	X	Y	Z	AVG	STAT	LOAD
1984	0.9809	0.5008	1.1290	0.8613	0.7806	1.0722	0.9866	0.8531	0.8014	1.0465	1.1154	0.8316	0.9227	0.0548	3.95%
1985	1.0587	0.6958	1.0928	0.9824	0.8379	1.0204	1.0191	0.9484	0.8930	1.0676	1.0567	0.9315	0.9554	0.0261	1.85%
1986	1.1376	0.8750	0.9567	1.0829	0.9834	1.0978	1.0655	1.1633	0.9229	1.0762	0.9499	0.9778	1.0088	0.0109	0.77%
1987	1.0165	0.9860	0.9544	1.0698	0.8961	1.0076	0.9961	1.0409	0.9292	0.9866	1.0377	1.0100	0.9922	0.0036	0.25%
1988	0.9948	1.1099	0.8732	0.9456	0.9773	0.9932	0.9468	1.1639	1.0071	0.9506	0.9715	1.0465	0.9941	0.0098	0.69%
1989	0.9289	1.2173	0.9347	1.0622	1.1424	0.8449	0.9907	1.0233	1.1748	0.9290	1.0408	1.0599	0.9954	0.0119	0.84%
1990	0.9104	1.2317	0.9868	0.9622	1.0440	0.9301	0.9480	0.9738	1.0940	1.0094	0.9830	1.0677	1.0360	0.0185	1.31%
1991	0.9722	1.3837	1.0724	1.0336	1.3384	1.0336	1.0472	0.8333	1.1777	0.9342	0.8451	1.0751	1.0955	0.0351	2.50%
AVG	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
STAT	0.0044	0.1008	0.0068	0.0053	0.0261	0.0061	0.0016	0.0137	0.0167	0.0031	0.0062	0.0068		0.0214	
LOAD	0.31%	7.42%	0.48%	0.38%	1.85%	0.43%	0.11%	0.97%	1.18%	0.22%	0.44%	0.48%			1.51%

EXHIBIT 2

PART 3

CALCULATION OF CONTINGENCY LOADING
X ESTIMATES NOT NORMALIZED

PY: \ STATE:	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1984	0.7115	0.8661	0.7421	0.6565	1.2141	0.6309	1.6881	0.7869	0.8411	0.8375	0.7333	0.9617	0.4897	0.8604
1985	0.6793	0.8969	0.9827	0.7042	1.0093	0.7146	1.5270	0.8563	0.8352	0.8828	0.7745	0.9675	0.4862	0.8368
1986	0.7554	0.9889	1.0571	0.6049	1.1141	0.7187	1.4986	0.8911	0.9076	0.8690	0.8692	0.9569	0.8221	0.7438
1987	0.8006	1.1977	1.0173	0.6550	0.9237	0.7108	1.1834	0.9412	0.9638	0.8336	0.8170	0.8916	0.8592	0.8622
1988	0.7062	1.5422	0.9435	0.7124	0.9577	0.6580	0.9931	0.9553	0.9328	0.8189	0.8761	0.8360	0.8962	0.8646
1989	0.7685	1.4101	1.0018	0.7202	1.0777	0.8423	0.9239	0.9283	0.8844	0.7940	0.8288	0.6846	0.7292	0.7778
1990	0.7966	1.2311	0.9957	0.8652	0.9832	1.2233	0.8406	1.0361	0.9515	0.9515	0.9004	0.6989	0.9911	0.8588
1991	0.9585	1.1824	1.0477	1.0032	0.9472	1.0875	0.8562	1.1692	0.9772	0.9048	1.0113	0.7453	1.2267	0.9705
AVG	0.7721	1.1644	0.9735	0.7402	1.0284	0.8233	1.1889	0.9456	0.9117	0.8615	0.8513	0.8428	0.8126	0.8469
STAT	0.0781	0.0545	0.0122	0.1184	0.0083	0.0980	0.0864	0.0164	0.0120	0.0255	0.0354	0.0504	0.1500	0.0338
LOAD	5.69%	3.92%	0.86%	8.80%	0.58%	7.21%	6.32%	1.16%	0.84%	1.81%	2.52%	3.62%	11.33%	2.40%

EXHIBIT 2

PART 4

CALCULATION OF CONTINGENCY LOADING
X ESTIMATES NOT NORMALIZED

STATE:

PY:	O	P	Q	R	S	T	U	V	W	X	Y	Z	AVG	STAT	LOAD
1984	0.7844	0.5219	0.9306	0.7761	0.6743	0.8179	0.7382	0.9271	0.6185	0.8300	0.9338	0.9228	0.8268	0.1048	**7.74%**
1985	0.8466	0.7252	0.9007	0.8851	0.7238	0.7784	0.7625	1.0307	0.6892	0.8467	0.8846	1.0336	0.8562	0.0699	**5.07%**
1986	0.9097	0.9119	0.7885	0.9757	0.8495	0.8375	0.7972	1.2643	0.7122	0.8535	0.7952	1.0850	0.9068	0.0474	**3.40%**
1987	0.8129	1.0276	0.7866	0.9639	0.7741	0.7687	0.7453	1.1313	0.7171	0.7825	0.8687	1.1208	0.8906	0.0416	**2.97%**
1988	0.7955	1.1568	0.7197	0.8520	0.8443	0.7576	0.7084	1.2649	0.7773	0.7540	0.8132	1.1613	0.8961	0.0542	**3.90%**
1989	0.7429	1.2687	0.7704	0.9570	0.9868	0.6445	0.7412	1.1121	0.9067	0.7369	0.8712	1.1762	0.8956	0.0535	**3.85%**
1990	0.7280	1.2837	0.8133	0.8669	0.9019	0.7095	0.7093	1.0584	0.8443	0.8006	0.8229	1.1848	0.9249	0.0372	**2.65%**
1991	0.7775	1.4421	0.8839	0.9313	1.1562	0.7884	0.7835	0.9056	0.9089	0.7410	0.7075	1.1930	0.9733	0.0322	**2.29%**
AVG	0.7997	1.0423	0.8242	0.9010	0.8639	0.7628	0.7482	1.0868	0.7718	0.7931	0.8371	1.1097	0.8963		
STAT	0.0547	0.0988	0.0450	0.0167	0.0509	0.0794	0.0844	0.0195	0.0864	0.0567	0.0386	0.0169		0.0552	
LOAD	**3.93%**	**7.27%**	**3.22%**	**1.18%**	**3.66%**	**5.79%**	**6.17%**	**1.38%**	**6.32%**	**4.08%**	**2.75%**	**1.19%**			3.97%

DISCUSSION OF PAPER PUBLISHED IN VOLUME LXXXI

UNBIASED LOSS DEVELOPMENT FACTORS

DANIEL M. MURPHY

DISCUSSION BY DANIEL F. GOGOL, PH.D.

Daniel Murphy presents some powerful and useful techniques for estimating biases and variances of loss reserve estimators. It is mentioned in the introduction of Murphy's paper that Casualty Actuarial Society literature is inconclusive regarding whether certain loss development techniques are biased or unbiased. It is also stated that the paper provides a model so that these questions, and others, can be answered.

Although the assumptions of Murphy's models enable him to show that the simple average development factor method and the weighted average development factor method are unbiased, actually they both are biased upwards. (The Bornhuetter–Ferguson and Stanard–Bühlmann methods also are biased upwards if they use these factors.) It is only because Murphy's models have unrealistic properties that it is possible to prove that the estimators are unbiased. Murphy is aware of this, as is shown by his discussion of claim count development in Appendix B. He states:

> Take the weighted average development method for example. Clearly there is a positive probability (albeit small) that $x = 0$, so the expected value of the weighted average development link ratio y/x is infinity.

Murphy also indicates that a general, heuristic argument that weighted average development yields biased estimates can be found in Stanard [3]. Stanard's argument for the bias of weighted average development factors [3, Appendix A], is actually only a derivation of an equation which must be satisfied in order for the factors to be unbiased. Stanard states without proof that the equation is not true in general. (It can be seen that the equation is untrue by considering Murphy's above point; i.e., the positive probability that $x = 0$.)

Murphy's statement that the expected value of the weighted average development link ratio is infinity is true; but of course, further analysis is necessary to give some idea of the amount of the bias.

In actual practice, a reserving actuary would obviously not use an infinite link ratio. In many situations the possibility of an infinite weighted average link ratio is remote and it may be judged that any weighted average link ratio greater than some R will be replaced by R in computing weighted average development factors. Suppose also that if the weighted average link ratio is $0/0$, the zeroes will be replaced judgmentally by some y/x.

However, even with this new system, weighted average development factors will be biased upwards if the probability that y/x is $0/0$ or $y/x > R$ is sufficiently small. The proof that will be given could be useful in estimating the amount of the bias.

The case of a single factor for a single accident year will be considered first although the same argument applies to policy years or report years. It will later be shown that the result demonstrated for a single factor applies to weighted or unweighted averages of factors.

Let X and Y be random variables which represent the reported losses for an accident year at evaluations x and y years after the start of the accident year. The factor which, when multiplied by X, produces an unbiased estimate of the mean of Y is $\mathrm{E}(Y)/\mathrm{E}(X)$, since

$$\mathrm{E}((\mathrm{E}(Y)/\mathrm{E}(X))X) = (\mathrm{E}(Y)/\mathrm{E}(X))\mathrm{E}(X) = \mathrm{E}(Y).$$

It is not true in a realistic model that, given a particular value x of X, $(\mathrm{E}(Y)/\mathrm{E}(X))x$ necessarily equals, or is even a good approximation of, $\mathrm{E}(Y \mid X = x)$. For example, it is not true that $\mathrm{E}(Y \mid X = 0) = (\mathrm{E}(Y)/\mathrm{E}(X))(0) = 0$.

The equality $(\mathrm{E}(Y)/\mathrm{E}(X))x = \mathrm{E}(Y \mid X = x)$ is, however, implicitly assumed in Murphy's Model II, which he described as follows: $y = bx + e$, $\mathrm{E}(e) = 0$, $\mathrm{Var}(e)$ is constant across accident years, and the e's are uncorrelated between accident years and are independent of x.

In a realistic model, a prior expectation E_p could be estimated for Y, based on data other than the loss experience of the accident year being considered. $\mathrm{E}(Y \mid X = x)$ can be approximated by a credibility weighting of E_p and the experience indication $(\mathrm{E}(Y)/\mathrm{E}(X))x$. (See [3].) The demonstration that will be given of the upward bias in development factors uses the assumption that, for $x \geq 0$, $\mathrm{E}(Y \mid X = x)$ is equal to a weighting of the form $(1 - Z)E_p + (Z)(\mathrm{E}(Y)/\mathrm{E}(X))x$. However, it can be seen that all the steps of the argument also hold true if the above weighting is a good approximation, as is generally true in actual practice.

It follows from the above assumption that

$$\mathrm{E}(Y \mid X = x) > (\mathrm{E}(Y)/\mathrm{E}(X))x$$

if x is sufficiently less than $\mathrm{E}(X)$. Similarly,

$$\mathrm{E}(Y \mid X = x) < (\mathrm{E}(Y)/\mathrm{E}(X))x$$

if x is sufficiently greater than $\mathrm{E}(X)$. Also, it is clear that $\mathrm{E}(Y \mid X = x)/x$ is a monotonically decreasing function of x.

Let X' and Y' be the random variables which represent the values of X and Y, respectively, after they have been judgmentally changed, as described previously, if $X = 0$. If the probability that $X = 0$ is sufficiently small, then $\mathrm{E}(Y')/\mathrm{E}(X')$ is very close to $\mathrm{E}(Y)/\mathrm{E}(X)$. It will be shown that

$$\mathrm{E}(Y' \mid X') > \mathrm{E}(Y')/\mathrm{E}(X'). \tag{1}$$

Let $f(x)$ be the probability density function of X'. Then

$$\int_0^\infty (\mathrm{E}(Y'/X') \mid X' = x)xf(x)dx = \mathrm{E}(Y').$$

Therefore,

$$\int_0^{\infty} (\mathrm{E}(Y'/X') \mid X' = x)(x/\mathrm{E}(X'))f(x)\,dx = \mathrm{E}(Y')/\mathrm{E}(X'). \tag{2}$$

However,

$$\begin{aligned}\mathrm{E}(Y'/X') &= \int_0^{\infty} (\mathrm{E}(Y'/X') \mid X' = x)f(x)\,dx \\ &> \int_0^{\infty} (\mathrm{E}(Y'/X') \mid X' = x)(x/\mathrm{E}(X'))f(x)\,dx, \end{aligned} \tag{3}$$

as will be shown below. It follows from (2) and (3) that (1) is true.

In the two integrals in the above inequality, the same function of x, i.e., $\mathrm{E}(Y'/X') \mid X' = x$, is multiplied by $f(x)$ and by $(x/\mathrm{E}(X'))f(x)$, respectively.

It was mentioned above that $f(x)$ is the probability density function of X'. The function $(x/\mathrm{E}(X'))f(x)$ is also a probability density function, since

$$\int_0^{\infty} (x/\mathrm{E}(X'))f(x)\,dx = (1/\mathrm{E}(X'))\int_0^{\infty} xf(x)\,dx = 1.$$

Note that:

$$(x/\mathrm{E}(X'))f(x) < f(x) \qquad \text{for} \quad x < \mathrm{E}(X'), \quad \text{and}$$

$$(x/\mathrm{E}(X'))f(x) > f(x) \qquad \text{for} \quad x > \mathrm{E}(X').$$

Thus, the density function $(x/\mathrm{E}(X'))f(x)$ gives less weight than $f(x)$ to values of $\mathrm{E}(Y'/X') \mid X' = x$ for which $x < \mathrm{E}(X')$, and more weight to values of $\mathrm{E}(Y'/X') \mid X' = x$ for which $x > \mathrm{E}(X')$. However, $\mathrm{E}(Y/X) \mid X = x$ is a monotonically decreasing function of x. If X' and Y' are not too different from X and Y, then $\mathrm{E}(Y'/X') \mid X = x$ is close enough to a monotonically decreasing function so that Equation 3 is true. This completes the proof of upward bias for a single factor.

Murphy uses the assumptions that the expected development pattern for each accident year is identical, and that development is independent for each accident year. It follows that the expected value of a simple average of development factors, at the same evaluations, equals the expected value of any individual factor. Therefore, using Murphy's assumptions and the proof above, the simple average of development factors is biased upwards.

It also follows from Murphy's assumptions that weighted average development factors are biased upwards. For a set of accident years, let X_i and Y_i represent the reported losses for accident year i at evaluations x and y years after the start of accident year i. Then the random variable Y/X, where $Y = \sum Y_i$ and $X = \sum X_i$, equals the weighted average development factor. It can easily be verified that the proof of Equation 1 is valid with the previous definitions of X and Y (and the corresponding X' and Y') replaced by these new definitions.

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DISCUSSION OF PAPER PUBLISHED IN VOLUME LXXVII

RISK LOADS FOR INSURERS

SHOLOM FELDBLUM

DISCUSSION BY STEPHEN PHILBRICK

VOLUME LXXVIII

AUTHOR'S REPLY TO DISCUSSION

VOLUME LXXX

DISCUSSION BY TODD BAULT[1]

1. INTRODUCTION

I have been following with great interest this discussion "thread" in the *Proceedings* [1, 2, 3], along with the recent papers of Rodney Kreps [4] (with Daniel Gogol's reply [5]) and Glenn Meyers [6] (with Ira Robbin's reply [7] and Meyers's response [8]). Obviously, this is an important topic for the CAS, as evidenced by the amount of discussion it has generated; and it is of particular interest to me, given my current specialization in rate of return, surplus need, and related areas of financial actuarial practice. The focus of the Feldblum/Philbrick discussion has been five methods of setting risk loads and the relative merits and deficiencies of each. The other papers by Kreps and by Meyers deal with related approaches and issues. I wish to add two observations to the discussion:

[1]The author would like to thank Mr. Randall Holmberg for the training, insight, and encouragement he has provided me over the years, and for the many stimulating discussions we have had, one of which led to this paper.

- All of the methods are more *similar* than different, including the methods discussed by Kreps and Meyers, and if care is taken to use a common set of assumptions, the methods are nearly *equivalent*;
- *None* of these methods, *including* CAPM, resolves several fundamental problems; and any risk loads derived from these methods must still contain a great deal of subjectivity, more than is implied by Feldblum's discussion of CAPM.

I wrote this discussion to question the level of certainty conveyed in Feldblum's initial paper and to keep the topic open. Although Philbrick's comments help in this regard, he does not go far enough. I am concerned that inexperienced actuaries will see betas published in the *Proceedings* and will feel justified in rushing off to use these in setting profit loads, despite Feldblum's warning that his calculations were for illustration only. There are still many unresolved issues regarding the measurement of risk and its application to profit provisions. The research to date is encouraging and highly connected, as we shall see, but there is still much left to do.

2. THE FIVE RISK LOADS—ARE THEY EQUIVALENT?

I start this analysis with the work of Rodney Kreps—his paper already describes most of the connections I want to demonstrate, but they have not been fully integrated. We can use his equations to show that variance, standard deviation, ruin theory, and CAPM describe similar (and nearly equivalent) concepts. Although I could not incorporate utility theory and the reinsurance method with sufficient mathematical rigor, there is reasonable evidence that these latter approaches are also strongly related to the others.

We begin with Kreps's equation for surplus supporting insurance variability of a given portfolio. Kreps assumes this portfolio represents a company's book of business, and Feldblum agrees that this assumption is appropriate for adapting CAPM to insurance. However, I will assume this portfolio is the *industry* portfolio (in the next section, I will support this position—one could use a company portfolio in this analysis and reach the same conclusions). The equation is

$$V = zS - R, \tag{2.1}$$

where V is the surplus, S is the standard deviation of the portfolio, R is the return in dollars, and z is the standard normal percentile value associated with a given probability of ruin (i.e., exceeding needed surplus). Kreps does not show explicitly that a *ruin theory* equation produces this formula; it is

$$\Pr(\boldsymbol{L} + E > \mathrm{E}(\boldsymbol{L}) + E + R + V) < e, \tag{2.2}$$

where $\boldsymbol{L}$ is the random variable for loss (boldface will always be used for random variables), E is expense, and e is the threshold probability of ruin corresponding to the value z. Note that the standard deviation of $\boldsymbol{L}$ is S. Standardizing $\boldsymbol{L}$ to $(\boldsymbol{L} - \mathrm{E}(\boldsymbol{L}))/S$ produces the solution for z, from which (2.1) follows:

$$z = (R + V)/S. \tag{2.3}$$

Kreps then produces the equation for the marginal surplus required for a new risk $\boldsymbol{x}$. We shall assume $\boldsymbol{x}$ is very small in magnitude compared to $\boldsymbol{L}$, for both means and standard deviations. The equation for the marginal surplus is

$$V' - V = z(S' - S) - r, \tag{2.4}$$

where V' and S' are the surplus and standard deviation, respectively, for the portfolio with $\boldsymbol{x}$ added, and r is the return for $\boldsymbol{x}$. Further, Kreps solves for $S' - S$ as

$$S' - S = \sigma(2SC + \sigma)/(S' + S), \tag{2.5}$$

where σ is the standard deviation of $\boldsymbol{x}$, and C is the correlation coefficient of $\boldsymbol{x}$ and $\boldsymbol{L}$.

Gogol, in his discussion of Kreps's paper, noted that this approach is highly "order dependent." That is, Equation 2.5 shows the increase in standard deviation if x is the *last* risk added to the portfolio. If we assume that L is a portfolio of risks identical to x, then x's contribution would be σ if it were the *first* risk in the portfolio, a smaller number than σ (or at least not larger) for the second risk, and so on, despite the fact that the risks are identical. Measuring each risk's surplus requirement based only upon its marginal risk contribution will underestimate the total surplus need of the portfolio. Gogol developed a formula to allocate the total surplus need to all individual risks based upon an average of the risk's standard deviation on a "first-in" and "last-in" basis. (Please see Gogol's paper for more details.) This is an important adjustment for practical implementations of this method, but please note that Gogol's technique is not the only way to do this—another approach will be discussed at the end of this section.

Up to this point, we could call Kreps's method a ruin theory approach, because ruin theory is the basis of his equations. But is this method related to any other approaches? Suppose that x and L are *independent* (rare, but the usual assumption), so that $C = 0$. Then

$$S' - S = \sigma^2/(S' + S) \approx \sigma^2/(2S), \tag{2.6}$$

because σ is small compared to S. Thus, the marginal surplus is a function of the *variance* of the new risk. (Feldblum cites this formula in Footnote 1 of his reply to Philbrick, but does not mention explicitly the independence requirement.) Conversely, if x and L are completely dependent (also rare, but illustrative), then $C = 1$ and

$$S' - S = \sigma(2S + \sigma)/(S' + S) \approx \sigma. \tag{2.7}$$

Again, this is true because σ is small compared to S. Now the marginal surplus is a function of the *standard deviation* of the new risk. So in the most common situation, where x is slightly correlated with L, the marginal surplus will be a linear combination of the variance and standard deviation related to the *covariance*. In my opinion, this makes the whole "variance vs. standard deviation" debate much less interesting, because both are simply special cases of a unifying covariance framework. Actuaries may continue to choose one or the other method on the basis of tractability concerns (and measuring covariance *is* very difficult), but they should be aware of what these decisions imply and whether or not their assumptions are appropriate.

We have two important results so far:

1. The distinction between variance and standard deviation methods is somewhat artificial. Which method to use is a function of the correlation between the new and existing risks, and in most cases, the "correct" answer is a marginal risk approach that incorporates covariance.

2. Marginal risk methods (including variance and standard deviation methods as special cases) are closely related to a ruin theory approach.

Let us examine $S' - S$ further. Define P as the premium associated with the industry portfolio, and let p be the premium associated with the new risk. From Equation 2.2, it should be clear that S/P is the standard deviation for the industry return on premium. Further, $(S' - S)/p$ is the *marginal contribution* to the standard deviation of the return on premium from the new risk. Using Equation 2.5 and some algebraic manipulation, note that

$$\begin{aligned}
[(S' - S)/p]/[S/P] &= [\sigma(2SC + \sigma)/((S' + S) \times p)]/[S/P] \\
&= [(2SC\sigma + \sigma^2)/(p \times 2P)]/[(S/P) \times (S' + S)/2P] \\
&\approx [C \times (\sigma/p) \times (S/P)]/[(S/P) \times (S/P)] \\
&\quad \text{(because } \sigma^2/(pP) \text{ is small)} \\
&\approx \mathrm{cov}(\boldsymbol{x}/p, \boldsymbol{L}/P)/\mathrm{var}(\boldsymbol{L}/P). \qquad (2.8)
\end{aligned}$$

The last part of Equation 2.8 looks remarkably like a CAPM beta. In fact, this *is* the formula for beta proposed by Feldblum, so let us "set" β equal to $[(S' - S)/p]/[S/P]$. This is *not* how beta would be derived in practice, but it serves as a link in the chain of reasoning of this analysis. However, Feldblum might disagree with this characterization, as I have just said, in effect, that the variance in profit equals the variance in loss, and Feldblum produced at least three examples to demonstrate that this is not true. Before proceeding, then, I should justify this simplification.

Two of Feldblum's examples are rather naive descriptions of how to measure the variance of losses, and it is fairly easy to remedy the problems he describes. His first example, retrospective rating, could be fixed by measuring the variance of the insurer's *effective* loss distribution, which is zero in his idealized example. His third example, heterogeneous mix of risks, is fixed by using homogeneous groups, or by adjusting for the heterogeneity in a reasonable fashion.

But Feldblum does indicate some important sources of risk that are not derived from the loss distribution, including inflation, investment, default, and parameter risk. All of these need to be measured, but the method for doing so does *not* require measuring the variance of profits directly. In fact, given the problems with calendar year measures of profitability in insurance (which Feldblum used, although he did acknowledge that problems existed), it may be preferable to measure the variance of profitability in other ways, such as starting with the variance of accident year losses and modeling additional sources of risk as required. (This will be discussed further in the next section.) Thus, as long as x and L reflect these additional sources of risk, it is appropriate to use β as I have defined it. Therefore, I shall assume that x and L are so stated.

Feldblum will probably have one final point of disagreement: Covariance and ruin theory approaches usually do *not* reflect these additional sources of risk, so to claim that x and L consider these factors alters his initial assumptions to represent a situation much more like CAPM, making this an unfair comparison. Further, adjusting loss distributions to reflect these risk sources is non-trivial, and probably non-objective as well. These are both reasonable points, but for most lines of business (after adjusting for special features like retrospective rating), why is the loss distribution *not* a reasonable first approximation for measuring the variance of profits? With the exception of parameter risk, most of the other components have very low variance compared to losses. Parameter variance must be included, but it is not clear that measuring calendar year variance of profits directly is the best way to do this.

Returning to the analysis, consider the following return on equity equation, which is a form of the equation used by Ferrari [9]:

$$R_m = R_f + (P/(zS\beta))R_p, \tag{2.9}$$

where R_m is the target return on equity for risk x (and, in fact, for all risks), R_f is the risk-free rate of return obtained from the supporting surplus, R_p is the return on premium, and $P/(zS\beta)$ is the premium-to-surplus (or *leverage*) ratio appropriate for x. But wait—shouldn't this last statement be a question? *Is* $P/(zS\beta)$ an appropriate leverage ratio for x? The answer is yes, *if* $P/(zS)$ is the appropriate leverage ratio for the industry portfolio. To see this, consider the standard CAPM equation:

$$R_e = R_f + \beta(R_m - R_f), \tag{2.10}$$

where R_m is the return on equity for the industry portfolio. To solve for the return on premium, R_p, needed to produce R_e, according to Feldblum, we subtract the risk-free rate and divide by the portfolio leverage ratio to obtain:

$$R_p = (R_e - R_f)/(P/(zS)) = (R_m - R_f)/(P/(zS\beta)). \tag{2.11}$$

But Equation 2.11 is also equivalent to Equation 2.9 *if* R_m in Equations 2.9 and 2.10 means the same thing. Note that Equations 2.9 and 2.10 are two different approaches to the same question: How do we determine the needed profit load? Under Equation 2.10, the CAPM approach, each risk requires a different rate of return, but a common leverage ratio is used for all lines. Under Equation 2.9, which I will call the *leverage ratio approach*, we target a common rate of return but vary the leverage requirements; in effect, all lines are scaled to the market return.

This last result might seem a little odd—aren't the measures of actual ROE by line of business different under the two approaches? The answer is yes, but this is because the approaches use different leverage ratios. Under CAPM, the industry leverage ratio $P/(zS)$ is used for *all* lines of business, whereas under the leverage ratio approach, the leverage varies by line: $P/(zS\beta)$. If you accept a single leverage ratio, then you must demand differing rates of return on equity based upon the line's beta. But if you adjust the surplus requirements *by* beta, then you can accept an *equal* rate of return on equity across all lines, and this will equal the industry rate. In practice, the distinction is largely academic—regardless of which formula we use, the resulting profit load is the same. Thus, the meanings of R_m in Equations 2.9 and 2.10 are equivalent, and we have our third important result:

3. CAPM and the leverage approach, which are based upon the covariance method, are equivalent for computing insurance profit loads.

We also obtain an additional result, a counterargument to those who suggest that surplus shouldn't be allocated to line of business for pricing purposes. If we allocate surplus in proportion to a line's beta, we obtain a profit load rule that is equivalent to that produced by CAPM. We also normalize the by-line ROEs towards the industry average, allowing the convenience of targeting a single ROE for all lines instead of varying the ROE target by line. You can obtain the same results by *not* allocating surplus, using the industry leverage for all lines and varying the target ROE according to CAPM. I agree with Feldblum that this allocation of surplus has nothing to do with *solvency* considerations, but that it produces a *pricing* rule that makes economic sense. This allocation of surplus differs from Gogol's method in that it is simply a "grossing up" of the marginal surplus requirements so that they balance back to the total.

But now we have a problem. In creating this nice link to CAPM, we seem to have lost our way back to the original ruin theory equation. According to CAPM and the leverage approach, the appropriate surplus for the industry is zS, but Equation 2.1 says this value should be $zS - R$. R is *not* small compared to zS, and there is no adjustment that brings these approaches into line. However, let us recall Philbrick's concern for "the overly simplistic binary division of the world into solvent and insolvent companies. Gradations of insolvency are important...." We could reflect this by adopting a more aggressive ruin constraint: for example, that the sum of loss and expense, *minus profit*, may not exceed premium plus available surplus (i.e., just surviving is not good enough). In this case, the needed surplus would now be zS, as per CAPM and the leverage approach. This is no longer strictly ruin theory, but it is certainly related, and our analysis provides evidence that this is a more "financially sound" approach than pure ruin theory.

That leaves us with the two final approaches, utility theory and the reinsurance method. As Feldblum noted in his paper, neither of these approaches has straightforward equations with which to work, so this part of the analysis will be less rigorous, and more brief!

The reinsurance approach is not really an independent method, but is, as Philbrick pointed out, "a powerful reality check." Presumably, reinsurers are subject to the same market forces as primary insurers, and assuming that marginal risk methods are correct for primary insurers, they should work for reinsurers also. In fact, this was the context in which Kreps presented his findings. Further, the "reality checking" feature should help both primary insurers and reinsurers calibrate their estimates from other approaches and verify that they make sense in the context of the larger market. But this is the extent of this "method's" usefulness—it cannot determine risk loads from scratch, and it is not the only way one can check the market viability of other methods.

Utility theory is a more complicated issue. Feldblum notes correctly that there is no good method for determining exactly what utility function should be used for determining investor preferences (or insurer risk loads). However, CAPM requires *as an assumption* that investors have utility functions of a certain form—specifically, risk-averse functions with known first and second moments [10]. Suppose we consider all of the assumptions required by CAPM *except* for the utility requirement, and furthermore, suppose we *assume* that investors will value risk as per the CAPM formula. The question is: what does this say about investor utility? Clearly, it still implies that investors are risk-averse, because they demand higher returns for taking on more risk. Do we really need to know anything else? CAPM can price the risk loads, so why do we need a corresponding utility method to do the same?

One might argue that we could better price the risk if we knew more specifics about the market utility function, but this seems equivalent to knowing how the market rewards different levels of risk, at least for fairly "well behaved" utility functions. One could certainly conceive of investor utility functions so complex that CAPM no longer applies, but such functions could probably be shown to fit into the framework of something like the arbitrage pricing model (APM), which is a generalization of CAPM [10]. This is not a trivial step—APM is considerably more complex than CAPM, in that it allows investors to use information other than mean and variance statistics to price risk. This strikes me as an important insight—utility theory at least holds out the potential of using more information than just the first two moments of a portfolio's probability distribution to determine investor preferences. The following chart describes this potential shift in approach:

Current Methods		*Future Methods*
moment-based	→	moments plus other data
CAPM	→	APM
simple utility functions	→	complex utility function
simple ruin theory	→	complex ruin theory

As used here, "simple" basically means "tractable and understandable." Most people involved in the field of financial research know that CAPM and related approaches are approximations (hopefully good ones) of a more complex reality. But tractability becomes less of an issue every year as computing power increases and research progresses. Understandability is a more serious issue and may slow progress more than tractability.

I don't want to pursue this direction any further in this paper—the subject would fill a book. As for a verdict on utility theory: 1) for a fairly large class of tractable utility functions, there is consistency with CAPM and related methods, so it seems unimportant that we don't actually have a method to determine what utility functions to use; and 2) even if more complex utility functions might model market preferences more accurately, there are probably other equivalent methods, like APM, that would be used in practice.

In summary, it seems clear that the five approaches have more in common than Feldblum, or even Philbrick, would admit. The key is to carefully state the initial assumptions and eliminate the various shortcuts and approximations that are so often used with these approaches. If actuaries continue to ignore covariance considerations when setting risk loads, for example, then the approaches will not agree, and many of Feldblum's and Philbrick's criticisms will be completely justified.

3. REMAINING PROBLEMS

This analysis seemingly produces a good result, in that we now have a single approach for setting profit loads that is objective, agrees with financial theory, and could be used in practice. However, the conclusion I have reached is that *none* of the five approaches deals with some very important and practical considerations, and without a resolution to these problems, we end up with risk loads that are driven largely by subjective considerations. This conclusion does *not* imply that these methods are unusable—I use a form of the leverage ratio approach in practice—but Feldblum's article might leave one with the impression that CAPM solves more subjectivity problems than it actually does. There are many problems that require further attention, but the following are examples that loom large in my mind.

What is the Industry Leverage Ratio?

This is a very important question that CAPM does not answer and that Feldblum appears to have overlooked. In fact, Feldblum seems to imply in his paper that once you have computed your return-on-premium betas, you need only use the "Kenney Rule" (2-to-1 premium-to-surplus ratio) to convert CAPM return on equity targets to profit loads! The exact leverage value is not important—the point is that Feldblum seems to be saying that $P/(zS)$ (using the above notation) is *known* for the industry, when most certainly it is not. zS is definitely not statutory surplus, nor even GAAP equity, because these accounting measures don't use components that are stated economically (e.g., reserves aren't discounted), and we cannot rely upon any given year-end snapshot of equity to be free of distortions and random fluctuations. Even if we came up with a way to measure S properly (does risk-based capital do this?—I have my doubts), what is the correct value for z? The answer must be something like "whatever the market *says* z should be," but this doesn't help us to *compute* a value for z.

No, there is only one answer to this question at the present time: $P/(zS)$ must be *selected*, giving due consideration to the amount of risk the market and company senior management are willing to bear (as correctly discerned by Kreps). Once this key leverage ratio is selected, the other calculations become possible, and it *is* key because it impacts the profit load for every individual line of business. So the most CAPM can accomplish is to compute profit load *relativities*, which is no better than ISO's approach, old or new. Perhaps this is what Glenn Meyers means when he says that CAPM requires an allocation of surplus. Strictly speaking, CAPM does not require one to know leverage ratios by line, as that is what it computes, but CAPM most certainly *does* require that one know the overall leverage ratio or, equivalently, the leverage for one line of business. It would certainly be worthwhile to try to develop ways to evaluate the choice of overall leverage ratio and its accompanying return on equity (apart from obvious *ad hoc* methods like comparisons to industry figures, or other industries with similar risk characteristics, etc.), but that is a subject worthy of a paper of its own.

Why Industry Leverage Over Company Leverage?

In my analysis, I specifically assumed that the existing large portfolio was the *industry* portfolio, rather than an individual *company* portfolio as specified by Feldblum. This difference in assumption does not affect the conclusions of my analysis *per se*, but it could produce different risk loads. Indeed, Feldblum notes that a "small- or moderate-size insurer needs a slightly larger risk load than that indicated by the industry-wide experience," in order to pick up some of the specific risk. I question this: why would an insured be willing to pay this additional charge? One could argue that a small insurer may be less "solid" than a large insurer because the small insurer is more affected by random fluctuations in experience. The risk of insolvency is higher and thus the small insurer offers a "lower quality product" and thus demands a *lower* premium. This is a simplistic argument with problems of its own, of course, but I have heard it made. Although I agree that an *insurer* may possess additional risks versus other companies, I don't see why an *insured* would pay for this difference.

Why shouldn't "equivalent" lines of business demand equal risk premiums in a competitive market? This question is almost tautological. The answer that "every insurer is different" might be a hard sell to insureds, particularly less-sophisticated insureds (e.g., as in personal lines, where the products are relatively simple risk-transfer mechanisms and are largely interchangeable between companies). A riskier insurer needs to *do something*, probably via reinsurance or a portfolio change, to "steer" its portfolio towards the market optimal portfolio that is less risky. Using a "market equilibrium"-type argument, shouldn't insureds pay only the competitive equilibrium risk charge for all interacting companies, and doesn't this mean that beta should therefore be measured against the market return as opposed to a company's overall return?

Also, do not assume that "market" means the *insurance* market—in view of overall concerns for asset/liability management, why shouldn't we measure risk against the *entire* market? Actually, this is perhaps too big a stretch—in his paper, Feldblum points out some valid reasons why insurance contracts differ from financial instruments. But surely the risk inherent in the investment portfolios varies among insurers. The extent to which the investment portfolio does not interact efficiently with the insurer's underwriting book is another risk for which insureds may not be willing to pay. This line of reasoning starts to touch on areas outside of underwriting risk. For example, insurers are exposed to asset risks that are not directly related to their underwriting risk, such as the risks associated with stocks, real estate, or venture capital. From a stockholder's perspective, these asset risks are important components of an insurer's beta; but, arguably, these forms of investment should pay their own way and should not be charged back to the policyholder in the form of a higher risk load. It would seem that only those risks that arise from the interaction of investment and underwriting that cannot otherwise be diversified away should be included in insurance risk loads. Realistic examples of this seem hard to come by: one could envision a deal to pay an insured a guaranteed rate of interest on the funds held for a large deductible account, and the rate might be higher than current Treasury rates. The insurer would certainly have a right to charge for this, but I suspect that such an arrangement would more likely be struck, with little consideration for an adequate rate, simply to get the account.

There is another reason why the distinction between industry and company risk is important. If one measures risk against a company portfolio only, it is possible that individual transactions could unduly influence the risk calculation. An example would be large assumed reinsurance contracts. Although such considerations are important to the insurer, there is still the question of how much of this cost to pass down to the insured. In his discussion of Kreps's paper, Gogol correctly identified this issue as a problem of "order dependence" (i.e., that the risk load changes depending upon when the risk is written) and developed a formula to correct for this. Similarly, using a larger market base forces the risk measurement of individual contracts closer to the margin, which equalizes risk charges and better satisfies CAPM assumptions.

There are no definitive answers to these questions. The practical effect of these concerns would be to shift an insurer's total risk load up or down, equivalent to changing the overall industry leverage ratio, and in practice this value is selected as noted above. The point is that the CAPM methodology proposed by Feldblum has not resolved these issues, although it is a very good framework within which to further discuss the problems.

How to Compute Covariance?

The fact that CAPM is a theory that applies specifically to financial securities means that assumptions will be needed to adapt the approach to measuring insurer risk. For example, Feldblum states in a footnote that CAPM "has obviated the need for quantifying covariance." This may be true for stocks, but not for insurance profit loads. As stated before, empirical profit information is not the best starting point for this calculation. Feldblum mentioned at least two problems that require attention:

- adjusting for reserve deficiencies and redundancies (i.e., getting to an accident year basis); and
- using discounted cash flow to allocate investment income.

There is a third problem, and it's a big one. To estimate the by-line betas, we need a series of historical operating ratios by line and in total in order to perform the required regression. However, what we want is an estimate of the *current* beta for a line. Doesn't that require our data to be at "current level"? Moreover, "current level" comprises a lot more here than just rates and trends—changes in mix of limits, legal climate, social conditions, and the like are much more important in an analysis of risk than in an analysis of expected cost. Add to this the numerous other calendar year distortions faced by insurance companies, and calendar year data becomes very messy indeed. It isn't clear that the most fruitful approach is to start with calendar year data and to expend a lot of effort cleaning it up. Actuaries simply have more troublesome data problems than do stock analysts in this instance!

The reviewers of this paper brought up a good point. Bringing data to current level has the effect of reducing the variance of historical loss ratios that resulted from shifting conditions, but these shifts reflect legitimate risks to the company and should be included in the cost of capital. I agree with this *to a point*. By bringing data to current level, my hope is to obtain a good measure of *process* risk. However, this procedure does eliminate valid sources of *parameter* risk that somehow must be measured and included. I prefer to separate the two measures and try to obtain a clean estimate of each. Further, some of this perceived risk *cannot* be passed on to insureds—for example, the risk due to a period of deliberate underpricing to gain market share. This is something that a company inflicts upon itself, and we cannot expect future policyholders to accept risk loads computed using past "price volatility."

Rather than a straight CAPM approach with calendar year data, begin instead with a model of current accident year losses, adjusted for all current conditions and including a measure of parameter risk. The advantage of this approach is that models of this form probably already exist for pricing and/or reserving purposes. One problem, of course, is that we must also include a measure of this distribution's covariance to the market. In practice, the only source for such information is the same kind of calendar year industry data used by Feldblum, but such data are very difficult to work with even for this more narrow purpose, and don't produce very "intuitive" results (such as the low beta for surety computed by Feldblum and noted by Philbrick). In most cases, it is necessary to *ignore* the covariance terms and to use instead a simplification that is more practical (e.g., one based upon standard deviation). It is preferable not to do this, but we must realize that this *is* an approximation to the correct answer. Further, we should continue to explore ways to better measure and incorporate covariance.

It boils down to a choice between simplifying assumptions: use CAPM with calendar year data adjusted "top-down" as best you can, or start "bottom-up" with an accident year model and reflect as many sources of risk as possible. I prefer the latter, and I presume Feldblum would advocate the former; but *both* are approximations and need more research.

4. CONCLUSION

Feldblum and the many other contributors to this subject should be congratulated and encouraged to continue the discussion. Most of what they have said has significantly advanced the state of the art in measuring risk loads. My message is directed primarily to those less familiar with these issues, and that message is 1) the show has just begun, and 2) the show to date has largely consisted of variations on a common theme. My concerns are only a sampling of the issues needing resolution—this topic should be fertile ground for inquiry for some time to come.

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AUTHOR'S REPLY TO DISCUSSION

Abstract

The actuarial theory of insurance risk loads has followed a meandering course. Actuaries have approached this subject with different perspectives, contributing important but seemingly unrelated insights. Todd Bault's masterful discussion of "Risk Loads for Insurers" demonstrates the connections between the different approaches, thereby laying a firm foundation for a unified theory.

Bault first shows the consistency among the risk load procedures proposed by Rodney Kreps, Stephen Philbrick, and Sholom Feldblum; he concludes with several issues that warrant further analysis. This reply follows a similar format, beginning with the current applications of risk loads and risk margins, and then addressing three of the issues that Bault raises.

1. RISK LOADS: FROM THEORY TO PRACTICE

"The show has just begun," says Bault, and he foresees an exciting future for this drama. He is correct; indeed, the future has already begun.

Twenty years ago, when Robert Miccolis [4] wrote his seminal paper, "On the Theory of Increased Limits and Excess of Loss Pricing," the subject of risk loads was considered too theoretical for most actuaries. The practicing actuary was busy determining personal automobile or workers compensation rates and relativities. Only a few rating bureau actuaries had the leisure to devise risk adjustments for increased limits factors.

Now even practicing actuaries deal with risk loads in their day to day work.

Economic Reserves

Reserving once consisted simply of determining a point estimate of an undiscounted indication.

Now companies ask, "What is the economic value of the reserve?" or "What is the true net worth of the company?" Robert Butsic [1] has argued that the answers to these questions require the consideration of risk margins in the reserves or risk adjustments to the loss reserve discount rate. Discounting the reserve at a risk-free rate gives a result lower than the true economic value. The American Academy of Actuaries, in Standard of Practice Number 20, "Discounting of Property and Casualty Loss and Loss Adjustment Expense Reserves," Section 5.5, follows Butsic's lead:

> The actuary should be aware that a discounted reserve is an inadequate estimate of economic value unless appropriate risk margins are included.[1]

Quantifying loss reserve risk margins is half the task; the other half is properly reporting them in financial statements. Stephen Philbrick [6] has recently proposed accounting procedures for loss reserve risk margins. If loss reserve discounting becomes accepted accounting practice—as seems likely for property/casualty companies—the treatment of risk margins will become a burning issue.

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[1]Butsic uses a risk adjustment to the discount rate instead of a risk load in the reserves themselves. The AAA Standard of Practice No. 20, Paragraph 5.5.2, considers both methods acceptable: "Explicit margins may be included as an absolute amount and/or through an explicit adjustment to the selected interest rate(s)."

Pricing

When making rates for first-dollar coverage in a line of business characterized by high frequency/low severity losses, such as personal automobile insurance, there is little need for risk loads.[2] In commercial lines, however, alternative products are now emerging in which insurers are providing high-risk layers of coverage. In workers compensation, for instance, deductible credits on large dollar deductible policies accounted for about $5 to $6 billion in 1994.[3] The risk load is the dominant concern in the pricing of large dollar deductible policies, since the risk to the insurer is great yet marketplace competition is severe. The transition to alternative products in the commercial lines of business has been so rapid that pricing actuaries are now scrambling to properly estimate risk loads.

Valuation

The underlying premise of the NAIC's new risk-based capital requirements is that the capital needed by an insurer depends on the risks faced by that insurer. But how might we quantify the "risks faced by an insurer"? The quantification of the variance in the loss estimate, which is the stepping stone for estimating pricing and reserving risk loads, has been extended by Robert Butsic into the quantification of the "expected policyholder deficit" and the implied capital requirements [2]. The requisites for an insurer's "government affairs" actuary were once no more than a good sense of humor and an endless patience for bureaucracy. Now the government affairs actuary must understand asset risks, loss reserve margins, and covariance adjustments (and still retain the humor and the patience).

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[2]See Woll [7], who shows that the process variance on this business—which the risk load is intended to hedge against—is insignificant.

[3]See NCCI [5, p. 2]. In a large dollar deductible policy, the insured reimburses the insurer for losses up to the deductible amount, which generally is $100,000 or more. The insurer provides true excess coverage on losses exceeding the deductible amount. The deductible credit is the difference between the premium for the large dollar deductible coverage and the premium for corresponding first-dollar coverage.

2. THE MARKET AND THE ACTUARY

"What is the industry leverage ratio?" asks Bault. "This is a very important question that....Feldblum appears to have overlooked."

Two years ago, Feldblum and Butsic were discussing this question. One needs a starting point, a rock to stand upon, from which all else can be derived. If one knows the appropriate industry leverage ratio for all lines combined, then one can determine leverage ratios for the individual lines of business.

"Tell me the expected policyholder deficit ratio that the company or the industry is comfortable with," said Butsic, "and I will tell you the proper leverage ratio."

"No," said Feldblum. "Managers and investors are not fluent in our discourse of risk loads, probability of ruin, or policyholder deficits. Yet given free markets, they invest funds where returns are most promising. For pricing purposes, the market is the ultimate arbiter of needed capital, not the actuary. The actuary's task is to understand the raw force of the market, not to turn it back."

In other words, the existing industry leverage ratio for all lines combined is our best estimate of the "proper" leverage ratio. If the leverage ratio is too high, investors will supply more capital. If it is too low, investors will take their capital elsewhere.[4]

Of course, not all insurers are equally subject to investor expectations. The capital structures of many mutual insurance companies can be explained better by agency theory than by modern portfolio theory.[5] Even for stock companies, the judgments of

[4]Of course, pricing is not the only determinant of leverage ratios. Regulators may demand lower leverage ratios for financial solvency purposes. Here the marketplace is at best an imperfect arbiter.

[5]Agency theory seeks to interpret the business strategies of company managers, who are agents of the stockholders or owners. In a mutual insurance company, for instance, will managers use excess surplus to pay policyholder dividends, increase employee salaries, or invest in new business operations?

the capital markets seem inexorably slow. New infusions of capital and the demise of inefficient insurers may stretch out over decades.

There are cogent arguments for both Butsic's and Feldblum's viewpoints. Butsic is skeptical of the acumen of the marketplace, and relies more on actuarial expertise. Feldblum is skeptical of the acumen of actuaries, and relies on the power of the marketplace. Bault comes down on Butsic's side, though without endorsing any specific procedure. But his basic premise is correct: This is a central issue in estimating risk loads.

3. INDUSTRY LEVERAGE VERSUS COMPANY LEVERAGE

"In my analysis," says Bault, "I specifically assumed that the existing large portfolio was the industry portfolio, rather than an individual company portfolio...Although...an insurer may possess additional risks versus other companies, I don't see why an insured would pay for this difference."

Bault is correct. Pricing begins with the market, whether for insurance companies or for other firms. Company-specific analysis tells you only whether the prices achievable in the marketplace are adequate for your company. If the actuary says, "Our firm needs greater returns, so let us raise our premium rates," the firm will succeed only in losing market share.

4. QUANTIFYING THE RISKS

"Some of the risk," says Bault, "cannot be passed on to insureds—for example, a period of deliberate underpricing to gain market share. This is something that a company inflicts upon itself, and I don't see how one can expect future policyholders to accept risk loads computed using past 'price volatility.'"

Do companies deliberately underprice during underwriting cycle downturns, perhaps to consciously inflict pain upon themselves? Actuaries are aware of the premium inadequacies during soft markets. Why don't they just set higher rates?

Oh, the actuaries recommend higher rates, demonstrate the pressing need for rate increases, and warn of the dangers of inadequate premiums. (They are a garrulous lot, these actuaries.) But actuaries can only indicate rates; the marketplace sets the prices.

Individual companies have little choice. Companies that strive to keep rates adequate—when rates plummet about them—end up with adequate rates and no insureds. Underwriting cycles stem from the business strategies of incumbent insurers to maximize long-term profits.[6] Intelligent insurers learn to "ride the cycles," so that they partake in the industry's profits when times are good but minimize the losses when times are bad. Premium fluctuations are an unavoidable risk of insurance operations. Risk loads are needed for them just as they are for random loss fluctuations.

5. CONCLUSION

As Bault points out, risk loads are becoming a staple of actuarial work, yet many issues are still unresolved. Thanks to his discussion, however, it should be easier to tackle the remaining problems.

[6] See Feldblum [3] for a comprehensive analysis of the nature and causes of underwriting cycles.

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DISCUSSION OF PAPER PUBLISHED IN VOLUME LXXII

A SIMULATION TEST OF PREDICTION ERRORS OF LOSS RESERVE ESTIMATION TECHNIQUES

BY JAMES N. STANARD

DISCUSSION BY EDWARD F. PECK

1. INTRODUCTION

This discussion of James Stanard's paper "A Simulation Test of Prediction Errors of Loss Reserve Estimation Techniques" will use his simulation technique to test three loss reserving methods. Two of these methods are discussed in Stanard's paper, and one is relatively new having been presented in the *Proceedings* last year by Daniel Murphy [6]. The three methods are shown to be special cases of a general weighted average approach. In addition, some of the concepts presented by Stanard concerning the expected value of a loss development factor will be analyzed in a little more detail. Please note that the results derived in this discussion are due to the assumptions made within this discussion and may not be applicable to general loss reserving situations.

2. THREE LOSS RESERVE METHODS

To describe these three methods, the following notation will be used: if $X_{i,j}$ represents a random sum of losses from accident year i, measured j years after the beginning of the accident year, then an accident year loss triangle is as shown in Table 1.

An age-to-age average loss development factor from age j to age $j+1$ can be defined as

$$\mathrm{LDF}_j = \sum_i [X_{i,j+1}/X_{i,j}]/n,$$

TABLE 1

ACCIDENT YEAR LOSS TRIANGLE

Accident Year	Age in years 1	2	3	4
1	$X_{1,1}$	$X_{1,2}$	$X_{1,3}$	$X_{1,4}$
2	$X_{2,1}$	$X_{2,2}$	$X_{2,3}$	
3	$X_{3,1}$	$X_{3,2}$		
4	$X_{4,1}$			

where n is the number of accident years which have reached age $j + 1$. This is the usual average of available individual LDFs. This will be called Method I.

Another way to calculate age-to-age factors is to divide the sums:

$$\mathrm{LDF}_j = \sum_i X_{i,j+1} \Big/ \sum_i X_{i,j}.$$

This will be referred to as Method II. Both of these calculations include only those accident years where both $X_{i,j}$ and $X_{i,j+1}$ exist.

Finally, another approach is to define a proportional relationship of losses from one age to the next and find a least squares estimator. If $X_{i,j+1} = p_{i,j}X_{i,j}$, where $p_{i,j}$ is the parameter to be estimated, then an age-to-age factor can be defined as

$$p_j = \mathrm{LDF}_j = \sum_i X_{i,j+1}X_{i,j} \,/\, \sum_i X^2_{i,j}$$

So, this p_j is an estimator of the change in losses from one age to the next, just as the LDFs using the other two methods are. This calculation would again use only those available $X_{i,j}$s. This least squares technique will be called Method III.

3. WEIGHTED AVERAGE APPROACH

Suppose the observed value $X_{i,j}$ is regarded as a "fixed" or controllable value and is used to predict the random value $X_{i,j+1}$. Since $X_{i,j}$ is not considered a random variable it will be written in lowercase as $x_{i,j}$. To estimate $X_{i,j+1}$, it would make sense to use a weighted average of the available $x_{i,j}$s. The weights are given as

$$w_{i,j} = x_{i,j}^t \Big/ \sum_i x_{i,j}^t,$$

where $\sum_i w_{i,j} = 1.0$. An age-to-age link ratio is then given by

$$\mathrm{LDF}_j = \sum_i w_{i,j} X_{i,j+1} / x_{i,j}.$$

The three methods described in Section 2 can be viewed as special cases of this general weighted average. Table 2 relates the methods and weights.

TABLE 2

WEIGHTS USED

Method	"t"	Weight
I	0	$1/n$
II	1	$x_{i,j} / \sum_i x_{i,j}$
III	2	$x_{i,j}^2 / \sum_i x_{i,j}^2$

If the statistics $X_{i,j+1}/x_{i,j}$ are from the same distribution (or different distributions with the same mean), then the weighted averages will be unbiased since the weights sum to one. This may not hold for $X_{i,j+1}/X_{i,j}$, where the denominator is viewed as a random variable, as will be discussed later.

Assuming for the time being that $x_{i,j}$ is fixed, it could be helpful to consider the variance of $X_{i,j+1}$ in deciding which set of weights to use. In some cases, the variance of $X_{i,j+1}$ for a given $x_{i,j}$ may depend on the size of $x_{i,j}$. For example, a "large" value of $x_{i,j}$ could typically be followed by a small variance in $X_{i,j+1}$.

If the $X_{i,j+1}$s are independent and their variances for a given $x_{i,j}$ are given by $s^2_{i,j+1}$, then define the random variable

$$K_j = \sum_i w_{i,j} X_{i,j+1} / x_{i,j}, \qquad \text{and}$$

$$\mathrm{Var}(K_j) = \sum_i w^2_{i,j} / x^2_{i,j} s^2_{i,j+1}. \tag{3.1}$$

If the variance of $X_{i,j+1}$ for a given $x_{i,j}$ depends on the size of $x_{i,j}$, one possible way to relate the two is to consider $s^2_{i,j+1}$ to be proportional to $x^r_{i,j}$:

$$s^2_{i,j+1} \propto x^r_{i,j}. \tag{3.2}$$

Note that $r < 0$ is possible and would imply an inverse relationship between the size of loss and the subsequent variance.

Substituting the right side of Equation 3.2 in Equation 3.1 yields

$$\mathrm{Var}(K_j) \propto \sum_i x^{r-2}_{i,j} w^2_{i,j}. \tag{3.3}$$

The variance of K_j as a function of $x_{i,j}$ is developed here to help choose weights and therefore a reserving method. As Stanard points out, an estimator should be unbiased and have a minimum variance.

It can be shown (see the appendix) that the weight structure that minimizes the variance of K_j is

$$w_{i,j} = x^{2-r}_{i,j} \Big/ \sum_i x^{2-r}_{i,j}.$$

This leads to choosing the usual arithmetic averages (Method I) if $r = 2$, Method II if $r = 1$, and Method III, the least squares estimator, if $r = 0$.

Applying all of this to a loss development triangle, the question is whether the variance of the sum of losses at a particular point in time is dependent on a previous measure of losses. One way to check differing variances at various levels of a predictor variable $x_{i,j}$ is to plot the residuals. Unfortunately, there aren't enough points to look at in most loss reserving situations even if a consistent relationship between accident years is assumed. In some cases, however, one may believe that greater early development of losses commonly reduces the variance of the next period loss level. If this is the case, it would make sense to choose r less than zero.

Exhibit 1 displays the results of applying the Methods I, II, and III using the simulation procedure outlined by Stanard. Recall that Methods I, II, and III correspond to r values of 2, 1, and 0, respectively, depending on the variance assumption. Also tested are weighting schemes where r is set equal to -1 and -2. This would correspond to the case where there is an inverse relationship between the variance and the previous size of loss as discussed above. It is interesting to note that the mean prediction error decreases as r decreases.

These results show that $r = 0$ (Method III) produces the smallest prediction error for the current accident year, but the prediction of previous accident years can be improved by using r less than zero. Given a knowledge of the underlying structure of loss development, as is the case in this simulation model, it would be possible to choose an optimal value of r for the specific structure. In fact, r doesn't have to be restricted to integers; it could take on any real value and even vary by accident year. Finding an optimal r would be nearly impossible with actual loss data due to the lack of sufficient data and changes in underlying reporting patterns. But it could be possible to find a range of r values that would improve estimates.

4. AGE-TO-AGE FACTORS—LOG-NORMAL MODEL

If we regard $x_{i,j}$ more realistically as an observation of a random sum $X_{i,j}$ at time j, followed next period by loss $X_{i,j+1}$, then pairing them, $(X_{i,j}, X_{i,j+1})$, adds another dimension to evaluating their relationship.

Stanard points out in his appendix that, in general,

$$\mathrm{E}[Y/X] \neq \mathrm{E}[Y]/\mathrm{E}[X].$$

In the case of losses emerging and or developing and the notation used here,

$$\mathrm{E}[X_{i,j+1}/X_{i,j}] \neq \mathrm{E}[X_{i,j+1}]/\mathrm{E}[X_{i,j}].$$

So, using the average of development factors to develop ultimate losses could lead to incorrect conclusions.

For ease of presentation, the random variables $X_{i,j}$ and $X_{i,j+1}$ will be represented by X_1 and Y_1, respectively, from here on in this section. Using this notation, the issue is, what is the expected value of the statistic $Z_1 = Y_1/X_1$? To investigate Z_1, the pair of losses (X_1, Y_1) will be modeled as an element of the joint bivariate log-normal distribution where X_1 and Y_1 are possibly related via a correlation coefficient. Other joint distributions may be appropriate, and the choice depends on the characteristics of the data in question. The log-normal leads to very convenient computations, as will be seen.

If and only if X_1 and Y_1 are jointly log-normal, then $X = \ln(X_1)$, and $Y = \ln(Y_1)$ would be joint normal variables. In this case, a loss development factor is given by the statistic

$$\begin{aligned} Z_1 &= Y_1/X_1 \\ &= \exp(Y)/\exp(X) \\ &= \exp(Y - X). \end{aligned}$$

This form is convenient due to the fact that the expected value of Z_1 is easy to find using the moment generating function of the bivariate normal. $M(t_1, t_2)$ will denote the moment generating function of the bivariate normal with the following parameters:

$$\mu_x = \text{mean of } X,$$

$$\mu_y = \text{mean of } Y,$$

$$\sigma_x = \text{standard deviation of } X,$$

$$\sigma_y = \text{standard deviation of } Y, \text{ and}$$

$$\rho = \text{correlation coefficient of } X \text{ and } Y,$$

where $X = \ln(X_1)$ and $Y = \ln(Y_1)$.

$$M(t_1, t_2) = \exp[t_1\mu_x + t_2\mu_y + (t_1^2\sigma_x^2 + 2\rho t_1 t_2 \sigma_x \sigma_y + t_2^2\sigma_y^2)/2].$$

So,

$$\begin{aligned} \mathrm{E}[Z_1] &= \mathrm{E}[Y_1/X_1] = \mathrm{E}[\exp(Y - X)] \\ &= M(-1, 1) \\ &= \exp[\mu_y - \mu_x + (\sigma_x^2 - 2\rho\sigma_x\sigma_y + \sigma_y^2)/2]. \end{aligned}$$

Since

$$\begin{aligned} \mathrm{E}[X_1] &= M(1) \\ &= \exp(\mu_x + \sigma_x^2/2), \end{aligned}$$

and

$$\begin{aligned} \mathrm{E}[Y_1] &= M(1) \\ &= \exp(\mu_y + \sigma_y^2/2), \end{aligned}$$

then

$$\mathrm{E}[Y_1]/\mathrm{E}[X_1] = \exp[\mu_y - \mu_x + (\sigma_y^2 - \sigma_x^2)/2].$$

Getting back to the question of whether $\mathrm{E}[Y_1/X_1] \neq \mathrm{E}[Y_1]/\mathrm{E}[X_1]$, define the ratio

$$d = \mathrm{E}[Y_1/X_1]/[\mathrm{E}[Y_1]/\mathrm{E}[X_1]]$$

$$= \frac{\exp[\mu_y - \mu_x + (\sigma_x^2 - 2\rho\sigma_x\sigma_y + \sigma_y^2)/2]}{\exp[\mu_y - \mu_x + (\sigma_y^2 - \sigma_x^2)/2]}$$

$$= \exp(\sigma_x^2 - \rho\sigma_x\sigma_y).$$

But

$\rho = \sigma_{xy}/(\sigma_x\sigma_y)$ where σ_{xy} is the covariance of X and Y.

So,

$$d = \exp(\sigma_x^2 - \sigma_{xy}).$$

This ratio d is the theoretical ratio of the expected straight average LDFs to the expected weighted average LDFs. Note that d is greater than 1.0 when $\sigma_x^2 > \sigma_{xy}$ and $\mathrm{E}[Y_1/X_1] > \mathrm{E}[Y_1]/\mathrm{E}[X_1]$.

To investigate d, the following simple model of loss development similar to Stanard's is created. Assume:

1. Losses from a Pareto severity:

$$F(x) = 1 - (15{,}000/(15{,}000 + x))^3;$$

2. A normal frequency (mean = 50, variance = 25);

3. An exponential reporting pattern:

$$P(n) = 1 - \exp(0.75n);$$

4. Five "periods" are produced (so if the report time is greater than 5 it is not in the data); and

5. 1,000 samples are produced.

The parameters of the log-normal can be estimated from the sample data using the moments of the transformed variable $\ln(X_1)$. For example,

$$m_x = \sum_i \ln(X_{1i}) \approx \mu_x, \qquad \text{and}$$

$$s_x = \left[\sum_i \ln(X_{1i})^2 - m_x^2\right]^{1/2} \approx \sigma_x.$$

Some statistics of the log transformed sample data by age of development are shown in Table 3. The correlations and covariances are between ages one and two, two and three, etc.

TABLE 3

LOG TRANSFORMED SAMPLE DATA

Age	1	2	3	4	5
Mean	12.12740	12.54222	12.68834	12.74793	12.77808
Variance	0.125657	0.086754	0.071959	0.066450	0.064028
Skew	−0.11204	−0.08357	−0.03813	−0.01074	0.032122
Correlation	0.811968	0.918299	0.970066	0.980749	
Covariance	0.084777	0.072555	0.067079	0.063972	

The next step is to calculate average loss development factors based on the loss data. These would be $\sum_i [Y_{1i}/X_{1i}]$ for straight average (Method I) LDFs and m_y/m_x for weighted average (Method II) LDFs. Four average LDFs are available linking each period:

Age-to-Age	1–2	2–3	3–4	4–5
Straight Average	1.549429	1.165989	1.063784	1.032007
Weighted Average	1.485233	1.149049	1.058583	1.029500

Now, according to the d ratio, the ratio of the straight average to weighted average LDFs from the sample data should be approximately

$$d = \exp(\sigma_x^2 - \sigma_{xy})$$

if the distributions are approximately jointly log-normal. The various values turn out to be:

Age-to-Age	1–2	2–3	3–4	4–5
Ratio	1.043223	1.014742	1.004913	1.002434
d	1.041727	1.014299	1.004891	1.002481

where, for example, Ratio 1–2 is 1.043223 = 1.549429/1.485233 and d for 1–2 is 1.041727 = exp(0.125657 − 0.084777).

Since the theoretical values and the "experimental" values are so close, it is worth the effort to check the distributions of the simulated losses at each period. The Kolmogorov–Smirnov or K–S statistic is helpful in measuring the "closeness" of an empirical distribution to a continuous assumed distribution. The hypothesis H_0 would be that the sampled distributions are normal after the $\ln(X_1)$ transformation. The statistic

$$\text{Max}[|F(x) - F_n(x)|]n^{1/2} > 1.36$$

is significant at the 95% level, where n is the number of data points. A high value indicates a poor fit and rejection of H_0.

For the standardized log transformed data:

Age	1	2	3	4	5
K–S	0.5492	0.4245	0.7075	0.6094	0.5209
Maximum Difference	0.0174	0.0134	0.0224	0.0193	0.0164

The distributions of the standardized log transformed sums of Pareto variables by period are apparently very closely approximated by a standard normal distribution, and the joint log-normal assumption appears to be valid.

The following were calculated using untransformed standardized data from the sample:

Age	1	2	3	4	5
K–S	2.1892	1.6347	1.7544	1.4142	1.6633
Maximum Difference	0.0693	0.0517	0.0555	0.0447	0.0526

These data indicate that a bivariate normal assumption would not be appropriate for this data.

Concluding this section, the answer to the question "What is the expected value of an LDF?" is that it depends on the joint distribution of the losses. The joint log-normal allowed for the determination of expected LDFs in terms of the parameters of the underlying variables. It would be possible to use a similar analysis on actual loss data if reasonable estimates of the distributions of losses by age could be found. Also, this analysis could be extended to the product of LDFs.

5. SUMMARY

Exhibit 1 displays the results of the three loss development methods given in Section 2 using Stanard's simulation routine. Methods II and III are clearly superior in terms of both bias and variance. To the extent that actual loss development patterns are like those simulated, Methods II and III would be preferred over Method I. As noted above, other weighting schemes may produce even better results.

Method I, the straight averaging of LDFs, shows the greatest positive bias. Part of this bias could be explained by the analysis of E[Y/X] in Section 4. An obvious conclusion is that straight average LDFs will overstate projected ultimate losses, at least according to these models. However, if a selection criterion is used, such as excluding the high and low LDFs or judgment based on other information, the straight average LDFs would likely produce better results in terms of average error. The goal of the discussion here is to determine general underlying characteristics of LDFs and age-to-age methods that could possibly have a bearing on decision making.

The idea of correlation between random sums measured at successive points in time could give more insight into the selection of loss development factors and age-to-age factor methods in general. An understanding of how the aggregate distribution of losses changes with time would be a valuable tool.

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EXHIBIT 1

Results of Loss Development Methods

MEAN PREDICTION ERROR

		Accident Year			
Method	*r*	1	2	3	4
I	2	13,627	31,498	83,862	482,307
II	1	13,627	21,887	40,185	121,218
III	0	13,627	16,397	17,110	13,056
	−1	13,627	13,532	5,883	−26,840
	−2	13,627	11,958	67	−44,583

STANDARD DEVIATION OF PREDICTION ERROR

		Accident Year			
Method	*r*	1	2	3	4
I	2	170,234	285,556	391,868	2,406,638
II	1	170,234	278,987	347,260	857,741
III	0	170,234	277,716	345,466	672,590
	−1	170,234	277,909	353,319	613,091
	−2	170,234	278,408	363,256	592,641

APPENDIX

The subscript j will not be used in the appendix for clarity. The goal here is to find w_i such that $\operatorname{Var}(K)$ is minimized. If

$$\operatorname{Var}(K) = h(t) = \sum_i x_i^{r-2} w_i^2,$$

where

$$w_i^2 = x_i^{2t} \Big/ \left(\sum_i x_i^t\right)^2, \quad \text{then}$$

$$h(t) = \sum_i x_i^{2t+r-2} \Big/ \left(\sum_i x_i^t\right)^2 = f(t)/g(t),$$

$$f'(t) = 2\sum_i x_i^{2t+r-2}\ln(x_i),$$

$$g'(t) = 2\sum_i x_i^t \sum_i x_i^t \ln(x_i), \quad \text{and}$$

$$h'(t) = (g'f - f'g)/g^2.$$

Since $g^2 > 0$, we need to find t to set the numerator equal to 0 or $g'f = f'g$. With some factoring this reduces to

$$\sum_i x_i^t \sum_i x_i^{2t+r-2}\ln(x_i) = \sum_i x_i^{2t+r-2} \sum_i x_i^t \ln(x_i).$$

By inspection, $t = 2 - r$ solves this equation.

Using the first derivative test, it will be shown that, as t passes through $2 - r$, the sign of $h'(t)$ changes from negative to positive, indicating that this is a minimum. That is, show

1. If $t < 2 - r$ then

$$\sum_i x_i^t \sum_i x_i^{2t+r-2}\ln(x_i) < \sum_i x_i^{2t+r-2} \sum_i x_i^t \ln(x_i) \quad \text{(A.1)}$$

   and $h'(t)$ is negative.

2. If $t > 2 - r$ then $h'(t)$ is positive.

First, let

$$t < 2 - r.$$

Then

$$2t < 2 - r + t,$$

and

$$2t + r - 2 < t.$$

Also, let

$$x_i > 1.0 \qquad \text{for all} \quad i, \text{ and } x_i \neq x_j \text{ for at least one } (i, j).$$

These two conditions are easily met for the loss data being considered. Since

$$t > 2t + r - 2,$$
$$x_i^t > x_i^{2t+r-2},$$

and

$$\sum_i x_i^t > \sum_i x_i^{2t+r-2}.$$

Equation A.1 is equivalent to the inequality

$$\sum_i x_i^{2t+r-2} \ln(x_i) \Big/ \sum_i x_i^{2t+r-2} < \sum_i x_i^t \ln(x_i) \Big/ \sum_i x_i^t. \tag{A.2}$$

For given x_is, the left side is in the form of a weighted average of $\ln(x_i)$ with weights equal to

$$x_i^{2t+r-2} \Big/ \sum_i x_i^{2t+r-2}, \tag{A.3}$$

and the right side is also a weighted average of $\ln(x_i)$ with weights

$$x_i^t \Big/ \sum_i x_i^t.$$

So, if

$$\sum_i x_i^t \ln(x_i) \Big/ \sum_i (x_i^t) \tag{A.4}$$

is a monotonically increasing function of t, Equation A.2 will be satisfied because $2t + r - 2 < t$.

Taking the first derivative of Equation A.4 with respect to t yields

$$\sum_i x_i^t \ln(x_i)^2 \Big/ \sum_i x_i^t - \left(\sum_i (x_i^t \ln(x_i^t)\right)^2 \Big/ \left(\sum_i x_i^t\right)^2 . \tag{A.5}$$

The form of Equation A.5 is algebraically identical to the variance formula

$$\text{Var} = \text{E}[X^2] - \text{E}[X]^2,$$

where the probabilities are the right side weights and the random variable is $\ln(x_i)$.

According to Mood, Graybill and Boes [4], the Jensen inequality says that if X is a random variable with mean $\text{E}[X]$, and $g(x)$ is a convex function, then $\text{E}[g(x)] \geq g(\text{E}[X])$. It follows that this will hold for Equation A.5. In this case $g(x) = x^2$ is convex, so the derivative in Equation A.5 is greater than or equal to zero. In fact, the only case where the derivative equals zero is when the probability of a given X is concentrated at a single point, or in this case $x_i = x_j$ for all (i, j), which isn't allowed. This implies that the derivative is strictly positive and Equation A.4 is monotonically increasing which, in turn, implies that Equation A.1 and Equation A.2 hold since $2t + r - 2 < t$. This means that $h'(t)$ is negative for $t < 2 - r$, which is what we meant to show.

If we now consider condition 2 from above, the same argument holds for $t > 2 - r$, implying that $h'(t)$ is positive. This shows that $h'(t)$ changes sign from negative to positive, and that $t = 2 - r$ is a minimum.

ADDRESS TO NEW MEMBERS—NOVEMBER 13, 1995

MICHAEL A. WALTERS

When Allan Kaufman asked me to speak at this meeting, I was both surprised and relieved. I was surprised that my turn to give the commencement address to new members had arrived so soon. About ten years ago, we introduced the tradition of having a prior generation past president come back one more time to give such an address at each CAS meeting. With two meetings a year, we now appear to be running out of past presidents. Perhaps we should admit new members only once a year.

I was also happy (and relieved) that I was not elected ten years from now. By then, unless the tradition changes, new presidents-elect will be asked to give a past president's address at the same meeting they are elected president. Even worse, ten years later, one of the new Fellows may have to be chosen at random to give the commencement address as a possible future past president.

Now, thanks to the 100 new Fellows this time, the CAS has allotted only nine minutes for these remarks—nine minutes to congratulate you for your accomplishments and to inspire you to be good CAS corporate citizens in the future. You can do the latter by volunteering for professional activities and by wearing your new credentials with pride and with gratitude toward the CAS.

And you do deserve congratulations for the eight or more years of hard labor spent in passing the exams. No doubt, most of you studied more for the CAS exams than you did collectively for the 40 or so final exams in your eight semesters of college. The good news is that this phase of your life is over. You can now catch up on lost reading or renew some neglected hobbies.

At the same time, don't get too distracted from your professional interests, because the bad news is that you probably have as much continuing education ahead of you as you had basic education to become an actuary.

The fact is that the world of casualty risk will undoubtedly change much more rapidly in the next 25 years than it did over the last quarter of a century, and the changes of the past 25 years occurred at warp speed compared to those of the previous 25. What lies ahead for the actuarial world is a staggering amount of information generated by computers and the obligation to use it, measure it, and make recommendations on how to deal with it.

Actuarial opinions on loss reserves are just the tip of the iceberg. Dynamic financial analysis (DFA) is in its infancy, but the ramifications will be enormous. Today's reserve opinions are really for only a piece of one side of the balance sheet. It will be up to the appointed actuary of the future to articulate and measure the potential variations in future results from plausible risks to the surplus of the entire insurance enterprise. Plus, you will get to use all aspects of your training: pricing, reserving, finance, assets, and valuation.

DFA evolved as the original response of the actuarial profession to the flurry of large insurer insolvencies around 1990. That response was a variation of the British system where regulators required solvency tests performed by appointed actuaries. This appeared to be where Representative John Dingell (D-MI) was headed when he was calling the shots in the U.S. Congress.

But our profession has backed away from that initial trial balloon, and is now pursuing dynamic financial analysis reports as valuable in their own right to all companies. The profession doesn't even need to require them. When DFA reports become routine and cost-efficient, they will effectively be mandated for all insurers through their appointed actuaries. This is because failure to perform DFA tests and communicate problems to senior management would constitute dereliction of duty by the appointed actuary. Thus, dynamic financial analysis may become a reality for all appointed actuaries early in the next century.

There will undoubtedly be new types of insurance and reinsurance, as portfolios of risks will be packaged—like mortgages of the past—into fungible components that can be transferred to nontraditional risk bearers around the world. The actuaries of the future will have to price these transactions and provide valuations for the balance sheets of the new risk bearers.

It sounds like a formidable task, especially because some of these mechanisms haven't been invented yet. But casualty actuaries have staked out their turf in being responsible for keeping score for the future world of non-life financial risk.

How will you maintain your expertise and professionalism to deal with the casualty risks of the future? None of the basic descriptive material has even been written, much less assigned to a syllabus of continuing education. The answer is simple: the same way you succeeded in passing the exams. You demonstrated the ability to get the essence of a problem in a short period of time, to understand complex relationships, to solve the problem, and to articulate it to an audience. These skills, honed by the actuarial exam process, are the key to handling all new actuarial problems confronting you. In fact, the resiliency skills you've demonstrated during this rigorous process are analogous to the ones that made the football teams coached by the legendary Vince Lombardi so successful.

For those who don't remember professional football in the 1960s, one team from a small town in Wisconsin dominated the league. Green Bay was, undoubtedly, the smallest market of any professional team in the history of U.S. sports. Without the large market resources to lavish on players and coaches, the team hired a head coach named Vince Lombardi, whose only previous head coaching experience was at a small high school in New Jersey—St. Cecelia's.

But Lombardi had a system of training—physical and mental—that built a winning tradition. Even those of us who never experienced a professional football preseason can relate to the concept of a rigorous mental training program. Lombardi's players hated the intensity of his training camp and genuinely feared what he would ask them to do next. Nevertheless, it was Lombardi's belief that if you survived his training camp, the regular season would not seem so tough. And, the motivation to win a close game in the fourth quarter was tremendous. No one wanted the pain of those preseason sacrifices to have been in vain, so the efforts expended by his teams in the final quarters were astounding.

Many of you have experienced this in the final month of study before an exam. If you'd already invested three hundred hours of study time, you were not about to slack off in the last few weeks before an exam. That may also explain why the CAS recommends that you keep track of the number of hours you study for each exam. This same attitude of preserving your previous effort will carry over to the next phase of your professional career—not just in motivating you to tackle future challenges, but also in maintaining your professional integrity under difficult circumstances. The presumption is that those who have invested so much time in achieving professional status would not jeopardize their careers by unprofessional conduct. At the same time, there are a few checks and balances to see that you don't forget the basic commitment to quality.

The one negative in the Lombardi training regimen—it is now apparent—was the physical travail that a violent sport like football exacts on one's body. As glamorous as a Super Bowl ring may seem to some, the punishing physical activity probably shortens lives and definitely makes for an arthritic middle age. Of course, none of that affects the career of an actuary. This is duly recognized in the *Jobs Rated Almanac*, which consistently rates actuaries first and NFL linemen close to last in terms of desirable career rankings.

The Vince Lombardi analogy also fails when you consider that no one is yelling at you to make the grade. You are your own coach and have been for at least the last eight years. Also, you're not ending a preseason of training. All of you have been playing regular season games for some time; your training has taken place between games. Nevertheless, you have still put so much into the effort, you are likely to maintain that discipline for long into your careers.

You have come a long way to get here. You have even further to go in the future—so much to contribute to this profession, with your own careers as beneficiaries of that contribution. Good luck in the rest of the games this season and in all future seasons. But, just remember, you can't fire your coach if you don't make the Super Bowl.

PRESIDENTIAL ADDRESS—NOVEMBER 13, 1995

ALLAN M. KAUFMAN

Introduction

In his 1969 CAS Presidential Address, Bill Hazam quoted the earlier CAS President Dudley Pruitt, who wondered why presidents give addresses, and who ever reads them after they have been given. Dudley discovered that presidents give addresses because the Bylaws require it. He further discovered that the addresses are read avidly only by the subsequent presidents.

He was right about presidential reading. In the course of my reading, I discovered that many past presidents have bravely forecast future developments. I also observed that presidential forecasts are no more accurate than loss reserve forecasts. Nonetheless, my remarks will include my forecasts. Future presidents, reading this address, will have their chance to wonder what I was smoking when I prepared these remarks. I can only say that these directions make sense to me at this time.

With that warning in mind, I will discuss two things: the current state of the CAS, and international directions for the CAS.

How Are We Doing—The Numbers

First, I love numbers, so let me give you a few current and projected numbers related to the status of the CAS:

1. We reached almost 2,500 members at this meeting—2,489 to be precise. We will easily double that in the next ten years (2005). Those new members are generally already at work in the profession; so we know the new members' names, not just the numbers.

2. Over the following ten years (2015), we will grow by 50 percent to 100 percent to between 7,500 and 10,000 members.

3. We are over 13 percent of the North American actuarial profession. Twenty years ago we were a bit under 12 percent of that group. In the next twenty years, our share will continue to grow.

4. Worldwide, the CAS is one of the largest actuarial organizations. After the Society of Actuaries (SOA) and the American Academy of Actuaries (AAA), those "mega-organizations," we are roughly the same size as the next set of actuarial organizations; for example, the U.K. Institute and Faculty of Actuaries and the Canadian Institute of Actuaries.

How Are We Doing—Other Considerations

Besides raw numbers, we can observe how we are viewed by some of our important audiences—the business, regulatory, and actuarial communities.

1. We have the respect of the insurance business community. There are jobs for all of us. We are well-compensated relative to many other insurance professionals. The demand for actuaries has seldom been higher. When two New York-based insurance companies effectively discontinued operations and two actuarial departments became unnecessary, there was still essentially no actuarial unemployment.

2. We have the respect of the regulatory community. That is evidenced by reserve opinion requirements, the role played by the actuarial profession in the development of property/casualty risk-based capital, and the fact that any regulatory consideration has been given to Dynamic Financial Analysis (DFA) requirements.

3. Within the actuarial profession, we are viewed as a model for coordination with the AAA and we are sought after as a partner with the SOA.

Recent Demonstrations of Our Strengths

The ability to *maintain* this strong position depends on our capabilities in the areas of research and education, both basic and continuing. Let me point to a few recent demonstrations of those capabilities. First, our DFA research effort has given us a chance to proactively expand the scope of skills available to our members. Second, in the last two years, there has been a major change among insurers in the level of recognition of environmental liability exposures. Roughly four billion dollars have been added this year alone. While there have been many forces at work to produce those changes, I do not think that we are simply flattering ourselves if we acknowledge that the research work of our members and the publication and seminar efforts of the CAS have also contributed to that recognition. Third, in the research area, the use of catastrophe modeling has expanded enormously. While the profession was not the leading force in the emergence of these models, we have and increasingly will become more involved in the application of these tools.

We have been reaching out to academics in our efforts to build our knowledge base. One of the most exciting efforts is the CAS-financed DFA Variables project by Assistant Professor James R. Garvin, Ph.D., of the University of Texas at Austin.

The CAS continues to increase the number of continuing education events, and our members continue to take advantage of those opportunities. In July, we held the first Dynamic Financial Analysis seminar. This seminar is intended to be a regular offering; it is expected to grow from its current "special interest" size of about 150 attendees to a much larger scale, perhaps even the size of the CLRS and Ratemaking Seminars. The 1995 seminar was held in Atlanta—a rather warm location for a July seminar. In 1996, this summertime seminar will move to Montreal, a cooler location.

We continue to explore new topics for classroom-size seminars, and new types of seminars. For example, we held the first participant-led limited attendance seminar on Actuarial and Financial Risk Theory in October in Boston, prior to the Environmental Liability seminar. In that seminar the participants were the teachers. A description of the seminar is in the November 1995 issue of the *Actuarial Review.*

Future Strengths

Looking ahead, there are areas where our skills have not reached the levels that will likely be required in the future. Two of the most important examples are (1) our knowledge of health insurance as it affects casualty coverages, and (2) our understanding of the asset portion of the property/casualty company balance sheet. A newer example relates to an increasing number of efforts to take insurance risk and transform it into capital market risk. It may become more and more difficult to distinguish insurance from investment banking. Finally, we need to export our insurance-related expertise to areas covering similar risks that are not considered insurance. That means corporate risk management in all its varieties. Our members and research committees recognize these weaknesses, and a number of activities are underway to address them.

Society of Actuaries

A few words on the CAS relationship with the SOA are in order at this point.

In many of the cases I just identified, the boundaries between the "casualty" discipline and the actuarial disciplines included in the SOA are undefined and perhaps undefinable. This is a fact of life, which illustrates why our level of coordination with the SOA in the research area will likely increase.

We have a long-standing and successful involvement with the SOA in the basic education process. They are again reviewing their educational structure. They have invited us to assist them in their review, and we have accepted that invitation. They have recently invited CAS involvement in a number of research areas: the *North American Actuarial Journal* and the North American Actuarial Foundation that I mentioned in my "From the President" columns during this year. Those are areas of cooperation that the CAS Board will be assessing in the coming months. There are issues regarding specific suggestions; but, to me, closer coordination with the SOA in the area of research, like our existing close relationship in the area of education, is inevitable and desirable.

While we are always somewhat nervous about cooperation with our large sister organization, our continued strength means to me that we should be proceeding with confidence, not concern.

Our Business Has Become Increasingly International

I want to spend my remaining time discussing another fact of life and its implications for us: our business is increasingly international.

One of my responsibilities as president-elect and president was direct involvement in CAS international relations. In that role, I participated in the creation of the new IFAA, the International Forum of Actuarial Associations. I attended three annual meetings of the U.K. General Insurance Study Group, somewhat like a mini-CAS within the U.K. Institute of Actuaries. Finally, I had the opportunity to go to Japan last year and speak on behalf of the CAS to various actuarial and business groups.

Many of us have also had some international business experience. We have all observed that non-North American companies own many of our employers and clients. In addition, many of our North American-based employers and clients own non-North American insurance operations. While this is not new, the extent of international involvement has changed by an order of magnitude.

In the past two years, two of the largest U.S. reinsurers completed major transactions, creating a global scope for operations that were primarily domestic before that. Other North American companies have been expanding more quietly outside of North America. Similarly, non-North American insurers—some Swiss names come to mind, but the Swiss are not alone—have increased their operations in North America and worldwide.

It is true that the major international insurance and reinsurance companies are now among the largest employers of actuaries worldwide. Those companies have had or will be having international actuarial meetings as they try to take advantage of their new international casualty actuarial capability. When our employers behave internationally, can the CAS activities be far behind?

To establish a strategy, we must understand the international actuarial community. Let me identify some key points. About half of the worldwide actuaries are in North America. Most non-North American actuarial organizations are much smaller than the CAS. No other country has a professional organization that is divided by specialty as the U.S. is divided between the CAS and the SOA, or as the U.S. pension actuarial profession is divided among several organizations. Most countries have no health actuarial discipline. In most countries, the casualty segment of the profession is small or non-existent. Often there is little or no differentiation between life and casualty professionals.

On the other hand, in the U.K., where the actuarial profession is relatively large compared to countries other than the U.S., there is a growing casualty group, referred to as the General Insurance Study Group. This sub-group of the U.K. Institute of Actuaries has about 300 members. Twenty years ago, when that group was formed, there were only 30 members. The U.K. Institute has recognized that different actuarial specialties may have different research and education needs, and it has established "boards" by practice area to allow more specialization in research and education efforts.

As I see it, a casualty discipline has developed in the U.S., Canada, the U.K., and a few other countries where two conditions are met. First, the actuarial community overall is sufficiently large; and, second, the casualty or general insurance market is large enough to support a critical mass of general insurance specialists. These conditions have not yet arisen in many countries. I believe these conditions will increasingly arise, and separate actuarial disciplines will arise accordingly. This does not mean separate organizations, just specialization of activities. This belief is important in my projection of the future CAS international role.

The bulk of the technical general or casualty insurance issues are the same from country to country—much more so than is true of pension or life insurance issues. This observation is also important in my projection of the future CAS international role.

The process of qualifying actuaries varies around the world. Examinations are the standard route of qualification in the English-speaking world and in parts of Asia. On the other hand, a university degree is a common form of professional training in Europe and Mexico. In some countries, the actuarial organization is simply a voluntary association.

The two primary models for examination-based education are the U.K. Institute of Actuaries program, which includes all actuarial disciplines, and the SOA program, which includes all but casualty/general insurance material.

Let me forecast a few trends:

1. Casualty or general insurance specialty groups will develop as required by national marketplaces. These actuaries will recognize the commonality of casualty issues globally, will want access to information and research, and will want to participate with organizations in other countries in ongoing research in the general insurance field. The CAS can fill this need.

2. These actuaries will associate primarily with their national accrediting organizations, especially in countries with existing organizations, so we are not talking about additional CAS members.

3. Emerging countries are looking for an actuarial professional model for their countries. They are likely to choose an examination process to supplement university education. No emerging country is likely to adopt the U.S. model of separate organizations for different specialties. The separation represents an inefficient use of their limited resources and is not responsive to their current market needs. It is worth noting that the SOA program is at a disadvantage relative to the U.K. Institute of Actuaries program, because the SOA program does not include a general insurance segment.

4. The new IFAA will increasingly be a channel of communication among actuarial organizations.

Why does the CAS care? What are our interests? This can be considered from the perspectives of individual members, the CAS as an organization, and our employers. I would list the CAS interests as follows:

1. We want to be sure that the non-North American employers of actuaries recognize the value of CAS membership. That is intended to enhance our value here in the U.S. and Canada.

2. We want to help North American members who wish to practice outside the U.S. and Canada. This applies immediately to nearby countries (Bermuda and Mexico) and longer term to the rest of world. We particularly want to avoid rules that preclude work in any country. I do not expect that there will be large numbers of U.S. expatriate actuaries, but those who do reach out in that way are our emissaries to the rest of the insurance world.

3. We want recognition that general insurance is a specialty of actuarial work that requires specific technical knowledge. With this recognition will come efforts to train actuaries in this specialty. This training will be important to our employers and clients, as they expand worldwide and need local actuarial expertise in their casualty insurance businesses. To provide training means working with non-North American actuarial organizations to help educate actuaries in casualty insurance matters. This is important in establishing the CAS as a brand name with value, rather than as an example of an anomalous specialty behavior of the U.S. actuarial profession.

4. We want to enhance the "image" of actuaries worldwide.

5. International involvement will be professionally interesting and fun.

The important steps, which must be taken to be sure that our interests are recognized, are as follows:

1. We need to maintain our preeminent role in the U.S. and Canadian casualty field. That's obviously what we need to do regardless.

2. We need to continue to develop and strengthen high level contacts between the CAS and non-North American actuarial organizations. We want to communicate to those non-North American organizations that we can work with both the overall organizations and with their casualty insurance specialists, if any. We already have relationships with the U.K. Institute and its General Insurance Study Group. CAS participation in the newly formed IFAA will help make communication with other actuarial organizations more routine.

3. We need to cooperate in research and continuing education with general insurance specialty sub-groups of

non-North American actuarial organizations. This means both (1) inviting non-North American help on issues of North American importance (for example the Loss Reserve Uncertainty Theory of Risk project) and (2) offering to provide CAS assistance to non-North American organizations, through committees or otherwise, on non-North American issues. These activities need to be undertaken in cooperation with the existing national actuarial organizations in those countries. In this respect, we are *not* trying to establish a CAS in other countries.

4. In cooperation with the SOA, we need to integrate casualty material into a complete North American education program suitable for countries that do not have their own education program. This degree of cooperation with our large sister organization in North America requires a high degree of self-confidence about our strengths. I believe that confidence is warranted. Nonetheless, there are some risks in this direction, so I don't suggest it lightly.

Again, I do not picture that we are trying to establish the CAS as the worldwide general insurance organization. I do not picture that hoards of U.S. and Canadian casualty actuaries will spill over the world. I do picture that the CAS will be a recognized and valued brand name around the world, and a role model for generous cooperative participation in the worldwide actuarial and insurance communities.

Summary

What do we need to do to take advantage of the opportunities?

1. Do the best we can here in the U.S. and Canada.
2. Work closely with the other actuarial organizations—in North America and globally—on casualty matters.

The suggested activities will not require much additional CAS effort, since a number of them are already underway. It does require courage to work so closely with the SOA in their international efforts. However, a close working relationship with the SOA in these areas is both necessary and helpful. It does require the willingness to work through other organizations, but that is our tradition here in the U.S., vis-à-vis the AAA.

The resulting cross-fertilization of ideas from around the world will help our own research and continuing education efforts. At the same time, we will establish and reinforce a worldwide CAS brand name that will also serve our members here in the U.S. and Canada.

Good-Byes and Thank Yous

A very traditional part of the Presidential Address is the good-byes and thank yous.

First, I want to thank our Executive Director James H. "Tim" Tinsley. In actuarial fashion, I have a two-by-two matrix of thanks. In one dimension of that matrix, I want first to thank him personally for his help and second to thank him on behalf of the CAS. In the other dimension, the thanks are both to him personally and to the whole CAS office. The office does a marvelous job on our behalf. The CAS office is like Federal Express, the fax machine, and voice mail. Now that it exists, it's hard to understand how things could have ever functioned without it.

Next, I want to thank the current and past Executive Council and Board Members with whom I have served. They helped make this experience personally and professionally rewarding for me.

To my partners and colleagues at Milliman & Robertson, Inc., I want to report that I will finally be getting back to more immediately productive activities, and I want to thank them for taking up enough of the slack during my term of office with the CAS to allow me the time to serve.

Nearly finally, I want to thank my wife Fran who encourages me in all my efforts and without whose love and support nothing I do would be worthwhile.

And, finally, I want to thank you, the membership, for this opportunity to have so much fun while serving you.

MINUTES OF THE 1995 ANNUAL MEETING

November 12–15, 1995

HOTEL DEL CORONADO, SAN DIEGO, CALIFORNIA

Sunday, November 12, 1995

The Board of Directors held their regular quarterly meeting from noon to 5:00 p.m.

Registration was held from 4:00 p.m. to 6:00 p.m.

From 5:30 p.m. to 6:30 p.m., there was a special presentation to new Associates and their guests. The session included an introduction to the standards of professional conduct and the CAS committee structure.

A welcome reception for all members and guests was held from 6:30 p.m. to 7:30 p.m.

Monday, November 13, 1995

Registration continued from 7:00 a.m. to 8:00 a.m.

CAS President Allan M. Kaufman opened the Business Session at 8:00 a.m. and recognized special guests Jack Turnquist, President of the American Academy of Actuaries, Wilson Wyatt, Executive Director of the American Academy of Actuaries, and John O'Connor, Executive Director of the Society of Actuaries.

Paul Braithwaite, David Hafling, and John Kollar announced the 79 new Associates and the 97 new Fellows. The names of these individuals follow.

NEW FELLOWS

Rhonda K. Aikens
Jean-Luc E. Allard
Kerry F. Allison
William M. Atkinson
Karen F. Ayres
Timothy J. Banick
Philip A. Baum
Gary Blumsohn
Donna D. Brasley
Mark E. Burgess
Mark W. Callahan
Kevin J. Cawley
Ralph M. Cellars
Galina M. Center
Francis D. Cerasoli
Laura R. Claude
Mary L. Corbett
David J. Darby
Renee Helou Davis
Marie-Julie Demers
Lisa Nan Dennison
John P. Doucette
Paul E. Ericksen
Dianne L. Estrada
Madelyn C. Faggella
Michael A. Falcone
Denise A. Feder
Mary K. Gise
Olivia Wacker Giuntini
Bradley J. Gleason
Ronald E. Glenn
Marc C. Grandisson
Anne G. Greenwalt
Steven J. Groeschen
William D. Hansen
Christopher L. Harris
Matthew T. Hayden
Suzanne E. Henderson
Anthony Iafrate
Patrick C. Jensen
Janet S. Katz
Tony J. Kellner
Brian Danforth Kemp
Deborah E. Kenyon
Kevin A. Kesby
Michael F. Klein
Terry A. Knull
Adam J. Kreuser
David R. Kunze
Blair W. Laddusaw
Paul B. LeStourgeon
Marc-Andre Lefebvre
Aaron S. Levine
George M. Levine
John J. Lewandowski
Maria Mahon
Barbara S. Mahoney
Lawrence F. Marcus
Robert D. McCarthy
Kathleen A. McMonigle
Stephen J. Mildenhall
Russell E. Moore
Francois Morin
Antoine A. Neghaiwi
John Nissenbaum
Victor A. Njakou
Keith R. Nystrom
Edward F. Peck
Wende A. Pemrick
Mark W. Phillips
Joseph W. Pitts
Denis Poirier
On Cheong Poon
Arlie J. Proctor
Mark S. Quigley
Donald A. Riggins
Bradley H. Rowe
John M. Ruane
James V. Russell
Peter Senak
Rial R. Simons
Keith R. Spalding
Douglas W. Stang
Richard A. Stock
Marianne Teetsel
Cynthia J. Traczyk
Patrick N. Tures
Peter S. Valentine
Charles E. Van Kampen
David B. Van Koevering
Kenneth R. Van Laar, Jr.
Mark D. van Zanden
Trent R. Vaughn
Lisa Marie Walsh
John S. Wright
Claude D. Yoder
Ronald J. Zaleski

NEW ASSOCIATES

Karen L. Barrett
Lisa A. Bjorkman
Barry E. Blodgett
Christopher L. Bowen
Tobias E. Bradley
Michael D. Brannon
Steven A. Briggs
Pamela A. Burt
Michelle L. Busch
Martin Carrier
Victoria J. Carter
Darrel W. Chvoy
Maryellen J. Coggins
Brian C. Cornelison
Claudia M. Barry Cunniff
Angela M. Cuonzo
Malcolm H. Curry
Charles A. Dal Corobbo
Dean P. Dorman
Barry P. Drobes
Mary Ann Duchna-Savrin
Jeffrey Eddinger
William P. Fisanick
Kay L. Frerk
Gary J. Ganci
Thomas P. Gibbons
Stewart H. Gleason
Annette J. Goodreau
Mark A. Gorham
Monica A. Grillo
Brian D. Haney
Adam D. Hartman
Scott J. Hartzler
Daniel F. Henke
Gloria A. Huberman
David D. Hudson
Randall A. Jacobson
Suzanne G. James
Brian J. Janitschke
Philip W. Jeffery
Michael S. Johnson
Philip A. Kane IV
Ira M. Kaplan
Hsien-Ming K. Keh
Timothy P. Kenefick
Robert W. Kirklin
Therese A. Klodnicki
Salvatore T. LaDuca
William J. Lakins
Josee Lambert
Thomas C. Lee
Isabelle Lemay
Charles R. Lenz
James R. Merz
Kathleen C. Odomirok
Dmitry Papush
Charles Pare
Brenda L. Reddick
Dennis L. Rivenburgh
Peter A. Royek
Jason L. Russ
Thomas A. Ryan
Manalur S. Sandilya
Michael C. Schmitz
Craig J. Scukas
Terry M. Seckel
Raleigh R. Skaggs
L. Kevin Smith
Lori A. Snyder
Thomas Struppeck
Yuan Yew Tan
Thomas A. Trocchia
Jennifer S. Vincent
Isabelle T. Wang
Jeffrey D. White
David L. Whitley
Kirby W. Wisian
Mark L. Woods
Floyd M. Yager

Mr. Kaufman then introduced Michael A. Walters, who presented the Address to New Members.

Michael J. Miller then presented the 1995 CAS Matthew Rodermund Service Award to Dale A. Nelson. Nelson became a

Fellow of the CAS in 1965, and has volunteered more than 20 years of service to the Society throughout his career.

A moment of silence was held to mark the passing of three members of the CAS during the past year: Kenneth L. McIntosh (ACAS 1961), James W. Thomas (FCAS 1956), and Robert W. Parlin (FCAS 1960).

Paul Braithwaite, CAS Vice President-Administration, presented highlights of the Administration Report, and the Financial Report.

Alice H. Gannon, CAS Vice President of Programs and Communications, presented the highlights of the program.

David L. Miller, chairperson of the CAS Committee on Review of Papers, announced that one *Proceedings* paper would be presented at this meeting and one discussion of a previously presented *Proceedings* paper would be presented. In addition, three discussions and one author's reply would not be presented, but published in the 1995 edition of the *Proceedings*, Volume LXXXII.

The *Proceedings* paper and discussion presented at this meeting were:

1. "Balancing Transaction Costs and Risk Load in Risk Sharing Arrangements" by Clive L. Keatinge
2. Discussion of "A Note on the Gap Between Target and Expected Underwriting Profit Margins" by Emilio C. Venezian (*PCAS* LXXIV, November, 1987), Discussion by William R. Gillam

The three discussions and one author's reply not presented at this meeting, but to be published in this volume of the *Proceedings*, are

1. Discussion of "Unbiased Loss Development Factors" by Daniel F. Murphy (*PCAS* LXXXI, November 1994), Discussion by Daniel F. Gogol

2. Discussion of "Risk Loads for Insurers" by Sholom Feldblum (*PCAS* LXXVII, November 1990), Discussion by Todd R. Bault
3. Discussion "A Simulation Test of Prediction Errors of Loss Reserve Estimation Techniques" by James Stanard (*PCAS* LXXII, May 1985), Discussion by Edward Peck
4. Author's Reply: "Risk Loads for Insurers" by Sholom Feldblum

David Miller gave a brief summary of the *Proceedings* papers, discussions, and author's reply, and authors in the audience were recognized.

David Miller then presented the 1995 CAS Dorweiler Prize to Roger M. Hayne for his paper "Extended Service Contracts," which was published in the *Proceedings of the Casualty Actuarial Society*, 1994 edition, Volume LXXXI. Miller announced that the Woodward-Fondiller Prize would not be awarded this year.

Mr. Kaufman then concluded the business session of the Annual Meeting.

After a refreshment break, Mr. Kaufman introduced Peter Huber, who gave the Keynote Address. Huber is a lawyer, and writer, who earned a Ph.D. from the Massachusetts Institute of Technology in mechanical engineering and a law degree from Harvard Law School.

The first general session was held from 11:00 a.m. to 12:30 p.m.:

The Property/Casualty Insurance Industry: A New Frontier

Moderator: Mary R. Hennessy
Senior Vice President and Chief Actuary
American Re-Insurance Company

Panelists: J. Christopher Bulger
President
Sedgwick James of California, Inc.

Bradley E. Cooper
Principal
Insurance Partners

Gary K. Ransom
Senior Vice President
Conning & Company

The general session was followed by a luncheon with the Presidential Address by Allan M. Kaufman. The luncheon was held from 12:30 p.m. to 2:00 p.m.

The afternoon was devoted to concurrent sessions, which consisted of various panels and papers.

The panel presentations covered the following topics:

1. Modeling Financial Solvency

Moderator: Oakley E. Van Slyke
President
Oakley E. Van Slyke, Inc.

Panelists: Rodney E. Kreps
Senior Vice President
Sedgwick Payne Company

William R. Van Ark
Actuary
The Wyatt Company

2. CAS Dynamic Financial Analysis Handbook

Moderator: Susan T. Szkoda
Second Vice President and Actuary
The Travelers Insurance Company

Panelists: James K. Christie
President
IAO Actuarial Consulting Services

Roger M. Hayne
Consulting Actuary
Milliman & Robertson, Inc.

Donald K. Rainey
Actuary
Milliman & Robertson, Inc.

Steven T. Morgan
Vice President
American Re-Insurance Company

3. Derivatives and Reinsurance

Moderator: David Koegel
Senior Vice President
Gill & Roeser, Inc.

Panelists: Robert Arvanitis
Senior Vice President
Guy Carpenter & Company, Inc.

Sylvie Bouriaux
Senior Economist
Chicago Board of Trade

Jonathan S. Roberts
Senior Vice President
AIG Risk Management, Inc.

4. Update on Lloyd's

Moderator: Paul A. Jardine
Partner
Coopers & Lybrand, L.L.P.

Panelist: Peter K. Demmerle
Partner
LeBoeuf, Lamb, Greene & MacRae, LLP

5. Auto Insurance Fraud Weapons

Panelists: Daniel J. Johnston
President
Automobile Insurers Bureau of Massachusetts

Michael L. Powell
Regional Vice President–Western Region
National Insurance Crime Bureau

6. Long Range Planning for the CAS

Moderator: Patrick J. Grannan
Consulting Actuary
Milliman & Robertson, Inc.

Panelists: Robert S. Miccolis
Senior Vice President and Actuary
Reliance Reinsurance Corporation

Deborah M. Rosenberg
Assistant Chief Casualty Actuary
New York State Insurance Department

7. Catastrophe Model Output in Ratemaking

Moderator: Christopher S. Carlson
Senior Actuarial Officer
Nationwide Insurance Company

Panelists: Beth E. Fitzgerald
Manager and Senior Associate Actuary
Insurance Services Office, Inc.

Michael A. Walters
Consulting Actuary
Tillinghast – Towers Perrin

Debra L. Werland
Executive Director
United Services Automobile Association

8. Asset/Liability Management

Moderator: Stephen T. Morgan
Vice President
American Re-Insurance Company

Panelist: Bennett W. Golub
Partner
Black Rock Financial Management

9. Health Care Reform

Moderator: John M. Bertko
Principal
Coopers & Lybrand, L.L.P.

Panelists: Louis A. Kent
Vice President and Chief Actuary
Blue Shield of California

Richard D. Schug
Actuary
The Travelers Insurance Company

10. The Cost of Reinsurance in Pricing Insurance Products

Moderator: Israel Krakowski
Actuary
Allstate Insurance Company

Panelists: Jerome E. Tuttle
Senior Vice President and Actuary
Mercantile & General Reinsurance Company

Russell S. Fisher
Vice President
General Reinsurance Company

11. Environmental Liability and Superfund

Moderator: Brian Z. Brown
Consulting Actuary
Milliman & Robertson, Inc.

Panelists: Todd J. Hess
Senior Vice President and Chief Actuary
Underwriters Reinsurance Company

Roger Carrick
Attorney
Preston, Gates & Ellis

12. Introduction to the CAS Examination Committee

Moderator: Richard P. Yocius
Actuary
Allstate Insurance Company

Panelists: David R. Chernick
Senior Actuary
Allstate Insurance Company

Beth E. Fitzgerald
Manager and Senior Associate Actuary
Insurance Services Office, Inc.

David H. Hays
Actuary
State Farm Fire & Casualty Company

Michele A. Lombardo
Examination & Information Systems Administrator
Casualty Actuarial Society

Virginia R. Prevosto
Assistant Vice President and Actuary
Insurance Services Office, Inc.

The officers held a reception for new Fellows and their guests from 5:45 p.m. to 6:30 p.m. There was a general reception for all members from 6:30 p.m. to 7:30 p.m.

Tuesday, November 14, 1995

Two general sessions were held from 8:30 a.m. to 9:30 a.m. They were:

"NAIC and State Legislators"

Moderator: Mavis A. Walters
Executive Vice President
Insurance Services Office, Inc.

Panelists: Steven T. Foster
Insurance Commissioner
Virginia Bureau of Insurance

Phillip L. Schwartz
Vice President and Associate General Counsel
American Insurance Association

Therese M. Vaughan
Insurance Commissioner
Iowa Insurance Department

The Honorable Guy Velella (R-Bronx)
Chairman/Senate Insurance Committee
State of New York

"The Cost of Capital Issues"

Moderator: Michael J. Miller
Consulting Actuary
Miller, Rapp, Herbers, Brubaker & Terry, Inc.

Panelists: Richard A. Derrig
Senior Vice President
Automobile Insurers Bureau of Massachusetts

Steven G. Lehmann
Actuary
State Farm Mutual Automobile Insurance Company

Oakley E. Van Slyke
President
Oakley E. Van Slyke, Inc.

From 10:00 a.m. to 11:30 a.m., several concurrent sessions were held. The panel presentations, in addition to some of the subjects covered on Monday, covered the topics of:

1. Evaluating Workers Compensation Reforms

Moderator: Robert N. Darby, Jr.
Consulting Actuary
Tillinghast – Towers Perrin

Panelists: William J. Miller
Vice President
National Council on Compensation Insurance

Wade T. Overgaard
Associate Actuary
The Travelers Insurance Company

2. California Landscape

Moderator: Richard J. Roth, Jr.
Assistant Commissioner
California Department of Insurance

Panelists: David M. Bellusci
Senior Vice President and Chief Actuary
Workers Compensation Rating Bureau of California

John P. Drennan
Vice President and Actuary
Allstate Insurance Company

3. CAS Actuarial Research Corner

Moderator: Glenn G. Meyers
Assistant Vice President and Actuary
Insurance Services Office, Inc.

4. ASB Standard of Practice—Rate of Return/Profit Provision

Moderator: Mark Whitman
Assistant Vice President and Actuary
Insurance Services Office, Inc.

Panelists: Steven G. Lehmann
Actuary
State Farm Mutual Automobile Insurance Company

Richard G. Woll
Senior Actuary
Allstate Research and Planning Center

The afternoon was reserved for committee meetings and tournaments.

All members and guests enjoyed a buffet dinner, with a special guest appearance by "Marilyn Monroe" at the "Some Like it Hot" reception, held from 6:30 p.m. to 10:00 p.m.

Wednesday, November 15, 1995

From 8:00 a.m. to 9:30 a.m., several concurrent sessions were held and two *Proceedings* papers were presented. In addition to the concurrent sessions repeated from the previous two days, the new concurrent sessions held were:

1. Artificial Intelligence Applications in Reserving

   Moderator: Roger M. Hayne
   Consulting Actuary
   Milliman & Robertson, Inc.

   Panelists: Moses Cheung
   President
   Oxford Group

   Evan Fenton
   Principal
   Deloitte & Touche LLP

   Mark W. Mulvaney
   Consulting Actuary
   Milliman & Robertson, Inc.

2. AAA Casualty Practice Council

   Moderator: David P. Flynn
   Director
   First Quadrant Corporation

   Panelists: Jan A. Lommele
   Principal
   Deloitte & Touche LLP

Paul G. O'Connell
Director
Coopers & Lybrand, L.L.P.

Jean K. Rosales
Assistant Director of Government Information
American Academy of Actuaries

The *Proceedings* papers that were presented were:

1. "Balancing Transaction Costs and Risk Load in Risk Sharing Arrangements"

   Author: Clive L. Keatinge

2. Discussion of "A Note on the Gap Between Target and Expected Underwriting Profit Margins," *PCAS* LXXIV, 1987, by Emilio C. Venezian

   Author: William R. Gillam

Following the concurrent sessions, William W. Palmer, General Counsel, California Department of Insurance, gave a special presentation to the CAS members.

From 10:00 a.m. to 11:30 a.m., the final general session was held.

"Whither Liability Reform?"

Moderator: Michael L. Toothman
Partner
Arthur Andersen LLP

Panelists: Jeffrey Gifford
Pavalon & Gifford, P.C.

Sherman Joyce
President
American Tort Reform Association

Philip D. Miller
Consulting Actuary
Tillinghast – Towers Perrin

After the official passing of the presidential gavel from outgoing CAS President Allan M. Kaufman to new CAS President Albert J. Beer, Mr. Kaufman announced future CAS meetings, gave closing remarks, and officially adjourned the 1995 CAS Annual Meeting at 11:45 a.m.

November 1995 Attendees

The 1995 CAS Annual Meeting was attended by 455 Fellows, 242 Associates, and 293 Guests. The names of the Fellows and Associates in attendance follow:

FELLOWS

Barbara J. Addie
Rhonda K. Aikens
Kristen M. Albright
Terry J. Alfuth
Jean-Luc E. Allard
Kerry F. Allison
Richard R. Anderson
Charles M. Angell
Robert A. Anker
Kenneth Apfel
John G. Aquino
Richard V. Atkinson
William M. Atkinson
Guy A. Avagliano
Karen F. Ayres
Anthony J. Balchunas
Timothy J. Banick
W. Brian Barnes
Todd R. Bault
Edward J. Baum
Philip A. Baum
Gregory S. Beaulieu
Allan R. Becker
Albert J. Beer
Linda L. Bell
David M. Bellusci
William H. Belvin
Phillip N. Ben-Zvi
Regina M. Berens
James R. Berquist
G. Gregory Bertles
Neil A. Bethel
Richard A. Bill
James E. Biller
Richard S. Biondi
Everett G. Bishop
Michael P. Blivess
Gary Blumsohn
LeRoy A. Boison, Jr.
Paul Boisvert, Jr.
Ronald L. Bornhuetter
Wallis A. Boyd, Jr.
Nancy A. Braithwaite
Paul Braithwaite
James F. Brannigan
Donna D. Brasley
Yaakov B. Brauner
Paul J. Brehm
Dale L. Brooks
J. Eric Brosius
Brian Z. Brown
William W. Brown, Jr.
Randall E. Brubaker
Gary S. Bujaucius
Mark E. Burgess
Patrick J. Burns
Mark W. Callahan
Claudette Cantin
Ruy A. Cardoso
Christopher S. Carlson
Lynn R. Carroll
Michael J. Cascio
Martin Cauchon
Michael J. Caulfield
Kevin J. Cawley
Ralph M. Cellars

Galina M. Center
Francis D. Cerasoli
Janet L. Chaffee
Scott K. Charbonneau
David R. Chernick
James K. Christie
Allan Chuck
Gregory J. Ciezadlo
Laura R. Claude
Michael A. Coca
Robert F. Conger
Eugene C. Connell
Mary L. Corbett
Francis X. Corr
Alan M. Crowe
Alan C. Curry
Michael T. Curtis
Daniel J. Czabaj
Ronald A. Dahlquist
David J. Darby
Robert N. Darby, Jr.
Jerome A. Degerness
Daniel Demers
Marie-Julie Demers
Patrick K. Devlin
Mark A. Doepke
Michael C. Dolan
John P. Doucette
John P. Drennan
Diane Symnoski Duda
Richard Q. Easton
Maribeth Ebert
Dale R. Edlefson
Bob D. Effinger, Jr.
Gary J. Egnasko
Valere M. Egnasko
Nancy R. Einck
Thomas J. Ellefson
John W. Ellingrod
James Ely
Jeffrey A. Englander
David Engles
Paul E. Ericksen
Dianne L. Estrada
Glenn A. Evans
Philip A. Evensen
John S. Ewert
Doreen S. Faga
Janet L. Fagan
Madelyn C. Faggella
Michael A. Falcone
Dennis D. Fasking
Denise A. Feder
Mark E. Fiebrink
Russell S. Fisher
Beth E. Fitzgerald
Daniel J. Flaherty
David P. Flynn
Claudia S. Forde
David C. Forker
Barry A. Franklin
Kenneth R. Frohlich
Michael Fusco
Alice H. Gannon
Andrea Gardner
Louis Gariepy
James J. Gebhard
David B. Gelinne
John F. Gibson
Richard N. Gibson
Bonnie S. Gill
William R. Gillam
Mary K. Gise
Olivia Wacker Giuntini
Bradley J. Gleason
Ronald E. Glenn
Steven A. Glicksman
Daniel C. Goddard
Steven F. Goldberg
Charles T. Goldie
Leon R. Gottlieb
Susan M. Gozzo Andrews
Gregory S. Grace
David J. Grady
Marc C. Grandisson
Patrick J. Grannan
Anne G. Greenwalt
Steven J. Groeschen
Linda M. Groh
Carleton R. Grose
Marshall J. Grossack
Denis G. Guenthner
David N. Hafling
James W. Haidu
Allen A. Hall
James A. Hall III
Robert C. Hallstrom
Malcolm R. Handte
William D. Hansen
H. Donald Hanson
Jonathan M. Harbus
Christopher L. Harris
David C. Harrison
David G. Hartman
Matthew T. Hayden
Roger M. Hayne
David H. Hays

Suzanne E. Henderson
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Allan M. Kaufman
Clive L. Keatinge
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John Joseph Kollar
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Israel Krakowski
Gustave A. Krause
Rodney E. Kreps
David J. Kretsch
Adam J. Kreuser
Jane Jasper Krumrie
John R. Kryczka
Jeffrey L. Kucera
Andrew E. Kudera
David R. Kunze
Michael A. LaMonica
Blair W. Laddusaw
D. Scott Lamb
Dean K. Lamb
John A. Lamb
Alan E. Lange
James W. Larkin
Michael D. Larson
Paul W. Lavrey
Paul B. LeStourgeon
Nicholas M. Leccese, Jr.
Robert H. Lee
Marc-Andre Lefebvre
Steven G. Lehmann
Joseph W. Levin
Aaron S. Levine
George M. Levine
Allen Lew
John J. Lewandowski
Stephanie J. Lippl
Barry C. Lipton
Richard W. Lo
Jan A. Lommele
Edward P. Lotkowski
W. James MacGinnitie
Maria Mahon
Barbara S. Mahoney
Lawrence F. Marcus
Joseph O. Marker
Steven D. Marks
Blaine C. Marles
Steven E. Math
Robert W. Matthews
Michael G. McCarter
Robert D. McCarthy
John W. McCutcheon, Jr.
William G. McGovern
Michael F. McManus
Michael A. McMurray
Dennis T. McNeese
Dennis C. Mealy
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Stephen J. Meyer
Glenn G. Meyers
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Joseph W. Pitts
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Richard C. Plunkett
Denis Poirier
On Cheong Poon
Jeffrey H. Post
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Philip O. Presley
Virginia R. Prevosto
Mark Priven
Boris Privman
Arlie J. Proctor
Glenn J. Pruiksma
John M. Purple
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Richard A. Quintano
Kay K. Rahardjo
Donald K. Rainey
Rajagopalan K. Raman
Gary K. Ransom
Jerry W. Rapp
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Richard D. Robinson
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Jeffrey R. Ill
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Manalur S. Sandilya
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Sandra C. Santomenno
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Frederic F. Schnapp
Peter R. Schwanke
Craig J. Scukas
Terry M. Seckel
Ahmad Shadman-Valavi
Theodore R. Shalack
Kerry S. Shubat
Janet K. Silverman
Jeffrey S. Sirkin
Raleigh R. Skaggs, Jr.
Byron W. Smith
Gina L.B. Smith
L. Kevin Smith
David C. Snow
Lori A. Snyder
John A. Stenmark
Michael J. Steward II
Ilene G. Stone
Thomas Struppeck
Joy Y. Takahashi
Craig P. Taylor
Joseph O. Thorne
John P. Thorrick
Thomas A. Trocchia
Robert C. Turner, Jr.
James F. Tygh
Frederick A. Urschel
Therese Vaughan

Jennifer S. Vincent
Jerome F. Vogel
Joseph W. Wallen
Monty J. Washburn
Russell B. Wenitsky
Jeffrey D. White
David L. Whitley
Elizabeth R. Wiesner
Kirby W. Wisian
Robert F. Wolf
Cheng-Sheng P. Wu
Floyd M. Yager
Robert S. Yenke
Vincent F. Yezzi
Barry C. Zurbuchen

REPORT OF THE VICE PRESIDENT–ADMINISTRATION

The objective of this report is to provide a brief summary of CAS activities since the last CAS Annual Meeting.

I will first comment on these activities as they relate to the following purposes of the Casualty Actuarial Society as stated in our Constitution:

1. Advance the body of knowledge of actuarial science in applications other than life insurance;
2. Establish and maintain standards of qualification for membership;
3. Promote and maintain high standards of conduct and competence for the members; and
4. Increase the awareness of actuarial science.

I will then provide a summary of other activities that may not relate to a specific purpose but yet are critical to the ongoing vitality of the CAS. And lastly, I will update you on the current status of our finances and key membership statistics.

In support of Purpose 1, the CAS has devoted significant resources during the past year to initiating research, with specific focus on developing the concept of Dynamic Financial Analysis (DFA). As one indication of the increased pace of activity this year, the CAS currently has eight different prize programs and funded research projects in various stages of progress.

The high priority areas of research during the year included the following projects as assigned to the appropriate committee:

- A funded research project to identify variables used in financial analysis models (DFA Task Force on Variables),
- Publication in September 1995 of the *Handbook on Dynamic Financial Analysis for Property/Casualty Insurance Companies* (Committee on Valuation and Financial Analysis),

- Completion of a draft Statement of Guidance Regarding Management Data and Information (Committee on Management Data and Information).
- Development of a 1996 Call Paper Program on Ratemaking (Committee on Ratemaking).
- Drafting of a proposed exposure draft on Principles of Risk Classification (Committee on Risk Classification).

New papers published in the *Proceedings*, the *Forum*, and the other CAS publications all increase the body of knowledge available to our profession. An issue of the *Forum* released in Fall 1995 included research reports by both CAS and American Academy of Actuaries committees as well as a number of papers from actuaries and academics. The 1994 *Proceedings* included seven new papers on a variety of topics.

Continuing education opportunities help fulfill Purpose 3, and a significant amount of DFA material was offered in this year's programs. Seminars relating to DFA topics included the first special interest seminar devoted specifically to DFA, held in July 1995; the limited attendance seminar on "Principles of Finance in Pricing Property and Casualty Insurance" which was held twice; a new limited attendance seminar on "Managing Asset and Investment Risk;" and the CIA/CAS Seminar for the Appointed Actuary held in September 1995. The CAS Spring Meeting in May featured eight papers presented as part of the discussion paper program on "Incorporating Risk Factors in Dynamic Financial Analysis." In addition to this meeting, the Casualty Loss Reserve Seminar, the June Reinsurance Seminar, the Ratemaking Seminar, and the CAS Annual Meeting all contained sessions on DFA subjects.

The Admissions Committees provide the major support for Purpose 2. They make continuous improvements to the syllabus and exam preparation and grading process, while overseeing the administration of the testing of approximately 6,500 registered candidates. Major initiatives in this area this year included:

- Establishment of an Educational Task Force to identify needed skills for actuaries of the future.
- Adoption of separate Canadian and U.S. revisions of Part 7. These separate exams will include three categories of syllabus material: common core material, common material with different testing emphasis, and nation-specific material. Part 8 has been restructured in the same categories.
- Introduction of a Student Liaison Committee to improve communications between students and admissions committees. In order to facilitate communications, a quarterly *Student Newsletter* is under development, with an inaugural issue planned for distribution in December 1995.

A report by the Travel Time Working Group was completed and presented to the Board of Directors in February 1995. This report, recently published in the CAS *Forum*, represents the culmination of a two-year effort to establish the information necessary for the CAS to monitor travel time through the CAS exam process; ensure that the CAS database contains the requisite information; define the criteria by which travel time should be monitored; and draw preliminary conclusions regarding the impact of exam partitions on travel time, if possible.

Maintaining our high standards is also accomplished through a quality program of continuing education. The CAS provides these opportunities through the publication of actuarial materials and the sponsorship of a number of meetings and seminars. This year's sessions included:

- The Spring and Annual Meetings, held in St. Louis and San Diego;
- The 1995 CAS Seminar on Ratemaking, held in New Orleans, which had 733 registrants;

- The Casualty Loss Reserve Seminar in Chicago, of which the CAS is a co-sponsor with the American Academy of Actuaries, attended by 753;
- The special interest seminar on "Profitability" in April attended by 96;
- The special interest seminar on "Dynamic Financial Analysis" in July in Atlanta, attended by 135;
- The special interest seminar on "Environmental Risks" held in October in Boston, attended by 136;
- The Reinsurance Seminar in June with attendance of 328 in New York City;
- The CIA/CAS Seminar for the Appointed Actuary in Montreal, co-sponsored by the Canadian Institute of Actuaries and the CAS, attended by 290; and
- The previously mentioned limited attendance seminars on DFA topics.

The Continuing Education Committees have explored ways to provide additional opportunities to our membership. This year, we saw continued growth in the use of a relatively new forum: limited attendance seminars with academic instructors. These have been well received.

The CAS Regional Affiliates also provide valuable opportunities for the members to participate in educational forums. In addition, the Regional Affiliates are a resource to help increase the awareness of the profession (Purpose 4) at the local level. Discussions are underway with the leadership of the Regional Affiliates to encourage more communication at the high school level.

The CAS also promoted awareness of the profession through continued financial support of the Forecast 2000 program. This program seeks to align the actuarial profession with crucial public policy issues and increase visibility of actuaries with the general public.

Also related to the fourth purpose, but generally impacting all purposes, are the CAS's international activities. In addition to the ongoing attendance at various international actuarial society meetings by the CAS leadership, the CAS became a charter member of the International Forum of Actuarial Associations.

The CAS Office continues to provide excellent support and to expand its services and capabilities. Significant productivity gains have been realized with their enhanced MIS capabilities, while support for exam administration and the annual budget process have been greatly enhanced. New member services introduced this year include the development of a quarterly continuing education calendar and enhancement of CAS bulletin board capabilities. The CAS Office is also providing an increased level of support to the various committees.

Another resource of the CAS, and an integral part of its fabric and success, is its committees and many volunteers. Member participation on our committees remains high. The annual Committee Chairpersons' Meeting in March was highlighted by group discussions of key CAS issues.

In closing, I will provide a brief status of our membership and financial condition. Our size continued its rapid increase as we added 200 new Associates and 114 new Fellows. Our membership now stands at 2,490.

New members elected to the Board of Directors for next year include Regina M. Berens, Claudette Cantin, David R. Chernick, C. K. "Stan" Khury, and David L. Miller. The membership elected Robert A. Anker to the position of President-Elect, while Albert J. Beer will assume the Presidency.

The Executive Council, with primary responsibility for day-to-day operations, met either by teleconference or in person at least once a month during the year. The Board of Directors elected the following Vice Presidents for the coming year.

Vice President–Administration, Paul Braithwaite
Vice President–Admissions, John J. Kollar
Vice President–Continuing Education, Susan T. Szkoda
Vice President–Programs and Communications,
  Patrick J. Grannan
Vice President–Research and Development, Michael J. Miller

The CPA firm of Feddeman & Company has been engaged to examine the CAS books for fiscal year 1995 and its findings will be reported by the Audit Committee to the Board of Directors in February 1996. The fiscal year ended with unaudited net income of $369,684, which compares favorably to a budgeted amount of $38,506. Members' equity now stands at $1,617,288, subdivided as follows:

Michelbacher Fund	$91,292
Dorweiler Fund	5,115
CAS Trust	3,469
Scholarship Fund	7,319
Rodermund Fund	13,934
CLRS Fund	5,000
ASTIN Fund	4,000
Research Fund	180,665
CAS Surplus	1,306,495
TOTAL MEMBERS' EQUITY	$1,617,288

This represents an increase in equity of $376,620 over the amount reported last year.

For 1995–96, the Board of Directors has approved a budget of approximately $3.2 million. Members' dues for next year will be $260; an increase of $10, while fees for the Invitational Program will increase by $15 to $320.

Respectfully submitted,
Paul Braithwaite
Vice President–Administration
November 13, 1995

FINANCIAL REPORT
FISCAL YEAR ENDED 9/30/95

OPERATING RESULTS BY FUNCTION

FUNCTION	*INCOME*	*EXPENSE*	*DIFFERENCE*
Membership Services	$ 704,013	$ 732,492	$ (28,479)
Seminars	691,780	435,147	256,633
Meetings	481,735	435,788	45,947
Exams	2,067,812	1,926,995 (a)	140,817
Publications	42,345	29,807	12,538
TOTAL	$ 3,987,685	$ 3,560,229	$ 427,456 (b)

NOTES: (a) Includes $1,279,000 of volunteer services for income and expense.
(b) Change in surplus before interfund transfers of $52,000 for research and ASTIN funds.

BALANCE SHEET

ASSETS	*9/30/94*	*9/30/95*	*DIFFERENCE*
Checking Account	$ 366,425	$ 50,260	$ (316,165)
T-Bills/Notes	1,197,008	1,980,044	783,036
Accrued Interest	19,185	54,661	35,476
CLRS Deposit	5,000	5,000	0
Prepaid Expenses	51,694	23,810	(27,884)
Prepaid Insurance	6,628	7,949	1,321
Accounts Receivable	45,000	45,000	0
Computers, Furniture	233,279	259,800	26,521
Less: Accumulated Depreciation	(149,899)	(192,299)	(42,400)
TOTAL ASSETS	$ 1,774,320	$ 2,234,225	$ 459,905

LIABILITIES	*9/30/94*	*9/30/95*	*DIFFERENCE*
Exam Fees Deferred	$ 296,989	$ 315,087	$ 18,098
Annual Meeting Fees Deferred	78,740	38,359	(40,381)
Seminar Fees Deferred	30,854	47,328	16,474
Limited Attendance Workshop Fees Deferred	0	700	700
Accounts Payable and Accrued Expenses	58,333	134,589	76,256
Deferred Rent	45,074	39,002	(6,072)
Accrued Pension	23,661	36,101	12,440
TOTAL LIABILITIES	$ 533,653	$ 611,166	$ 77,514

MEMBERS' EQUITY

Unrestricted	*9/30/94*	*9/30/95*	*DIFFERENCE*
CAS Surplus	$ 936,810	$ 1,312,266	$ 375,456
CLRS Fund	5,000	5,000	0
Michelbacher Fund	87,896	91,292	3,396
Dorweiler Fund	5,823	5,115	(708)
CAS Trust	3,305	3,469	164
Research Fund	178,165	180,665	2,500
ASTIN Fund	2,000	4,000	2,000
Subtotal Unrestricted	1,218,999	1,601,807	382,808
Temporarily Restricted			
Scholarship Fund	7,446	7,318	(128)
Rodermund Fund	14,222	13,934	(288)
Subtotal Restricted	21,668	21,252	(416)
TOTAL EQUITY	$ 1,240,667	$ 1,623,059	$ 382,391

Paul Braithwaite, Vice President–Administration

This is to certify that the assets and accounts shown in the above financial statement have been audited and found to be correct.

CAS Audit Committee: Steven F. Goldberg, Chairperson; Robert F. Conger, Anthony J. Grippa, and William M. Rowland.

1995 EXAMINATIONS—SUCCESSFUL CANDIDATES

Examinations for Parts 3B, 4A, 4B, 5A, 5B, 6, 8, 8C (Canadian), and 10 of the Casualty Actuarial Society were held on May 1, 2, 3, 4, and 5, 1995. Examinations for Parts 3B, 4A, 4B, 5A, 5B, 7, and 9 of the Casualty Actuarial Society were held on November 1, 2, 3, and 6, 1995.

Examinations for Parts 1, 2, 3A, and 3C (SOA courses 100, 110, 120, and 135) are jointly sponsored by the Casualty Actuarial Society and the Society of Actuaries. Parts 1 and 2 were given in February, May, and November of 1995, and Parts 3A and 3C were given in May and November of 1995. Candidates who were successful on these examinations were listed in joint releases of the two societies.

The Casualty Actuarial Society and the Society of Actuaries jointly awarded prizes to the undergraduates ranking the highest on the Part 1 examination.

For the February 1995 Part 1 examination, the $200 first prize winners were Robert J. Aguirre of Rice University and Patrick Beaudoin of the University of Laval. The $100 second prize winners were Sumit K. Daftuar of Harvard University, Erik J. Sandquist of Cornell University, and Jue Wang of Queens College.

For the May 1995 Part 1 examination, the $200 first prize was awarded to Emil B. Kraft of Eastern Washington University. The $100 second prize winners were Fai T. Tong of the University of Chicago; and Hai Lin, Liqiang Ni, Hairong Zhang, and Zhisheng Zhou, all from Fudan University in Shanghai.

For the November 1995 Part 1 examination, the $200 first prize was awarded to Kohji Hirabayashi from the University of Tokyo and Lifeng Wu of Fudan University in Shanghai. The $100 second prize winners were Nicholas Albicelli, State University of New York; Paul Colucci, University of Illinois; Daoyong Lou, Fudan University in Shanghai; and Timothy Mosler, Florida Atlantic University.

The following candidates were admitted as Fellows and Associates at the CAS Spring Meeting in May 1995 as a result of their successful completion of the Society requirements in the November 1994 examinations.

NEW FELLOWS

Timothy J. Cremin
Bradley A. Granger
Craig W. Kliethermes
Mathieu Lamy
Suzanne Martin
Brett E. Miller
Mark Priven
Eduard J. Pulkstenis
John F. Rathgeber
David M. Savage
Jeffery J. Scott
Russell Steingiser
Eileen M. Sweeney
Yuan-Yuan Tang
Thomas C. Toce
John V. Van de Water
Peter G. Wick

NEW ASSOCIATES

Rimma Abian
Christopher R. Allan
John P. Alltop
K. Athula P. Alwis
Steven D. Armstrong
Martin S. Arnold
Bruce J. Bergeron
Steven L. Berman
Corey J. Bilot
Carol A. Blomstrom
John T. Bonsignore
Douglas J. Bradac
Kevin M. Brady
Betsy A. Branagan
James L. Bresnahan
Lisa J. Brubaker
Elliot R. Burn
Tara E. Bush
J'ne E. Byckovski
Sandra L. Cagley
Pamela J. Cagney
Douglas A. Carlone
Jill C. Cecchini
Heather L. Chalfant
Jean-François Chalifoux
Peggy Cheng
Gary C. K. Cheung
Christopher J. Claus
William F. Costa
Christopher G. Cunniff
Sean R. Devlin
Behram M. Dinshaw
William A. Dowell
Kimberly J. Drennan
Pierre Drolet
Stephen C. Dugan
Tammy L. Dye
S. Anders Ericson
James G. Evans
Steven J. Finkelstein
Daniel J. Flick
Andre F. Fontaine
Susan T. Garnier
Christopher H. Geering
Eric J. Gesick
John T. Gleba
John E. Green
Steven A. Green
Charles R. Grilliot
Julie K. Halper
David S. Harris
Betty-Jo Hill
John V. Hinton
Jason N. Hoffman
John F. Huddleston
Li Hwan Hwang
Brian L. Ingle
Christian Jobidon
Daniel K. Johnson
Gail E. Kappeler
Lowell J. Keith
Thomas P. Kenia

Michael B. Kessler
Jean-Raymond Kingsley
Gary R. Kratzen
Brian S. Krick
Marc LaPalme
Debra K. Larcher
Gregory D. Larcher
Daniel E. Lents
Edward A. Lindsay
Richard B. Lord
Cornwell H. Mah
Anthony L. Manzitto
Scott A. Martin
Tracey L. Matthew
Camley A. Mazloom
Deborah L. McCrary
Michael K. McCutchan
Kelly S. McKeethan
Lynne S. McWithey
Claus S. Metzner
Paul W. Mills
Anne H. Moore
Kenneth B. Morgan, Jr.
Kevin T. Murphy
Hiep T. Nguyen
James L. Nutting
Milary N. Olson
Thomas Passante
Nicholas H. Pastor
Claude Penland IV
William Peter
Genevieve Pineau
Robert E. Quane III
Peter S. Rauner
Natalie J. Rekittke
Scott Reynolds
Meredith G. Richardson
John W. Rollins
Rajesh V. Sahasrabuddhe
Christina L. Scannell
Marilyn E. Schafer
Michael J. Scholl
M. Kate Smith
John B. Sopkowicz
Michael J. Sperduto
Scott D. Spurgat
Scott T. Stelljes
Kevin D. Strous
Steven J. Symon
Joy Y. Takahashi
David M. Terne
Daniel A. Tess
Son T. Tu
Eric Vaith
Cynthia L. Vidal
Robert J. Walling III
Steven B. White
Elizabeth R. Wiesner
Michael J. Williams

The following is a list of successful candidates in CAS examinations held in May 1995.

Part 3B

Jason R. Abrams
William J. Albertson
Anthony L. Alfieri
Genevieve L. Allen-Stote
Frank J. Barnes
Wendy A. Barone
Suzanne Barry
Andre Beaulieu
Jennifer L. Beck
Heather L. Bennett
Shelley L. Bitner
Lisa A. Bjorkman
Jonathan E. Blake
Mary Denise Boarman
Mark E. Bohrer
James G. Brady
Christopher S. Bramstedt
Rodney L. Brunk
Paul E. Budde
Lisa K. Buege
Lori L. Burton
Michelle L. Busch
Matthew E. Butler
Kelli R. Caldwell

Todd D. Cheema
Thomas J. Chisholm
Lisa A. Chodaczek
Catherine Choi
Andrew K. Chu
Charles A. Cicci
Lori Anne Cieri
Edward W. Clark
Eric J. Clymer
Costas A. Constantinou
Ellen B. Cooper
Brian C. Cornelison
Crystal Dawn Danner
Elisa J. Davenport
Barry P. Drobes
Mary Ann Duchna-Savrin
Louis Durocher
Elizabeth B. Emory
William H. Erdman
Jui-Chuan Fan
William M. Finn
Noelle C. Fries
John E. Gaines
Sherri L. Galles
Daniel J. Gieske
Moshe D. Goldberg
John P. Gots
Melanie T. Green
Daniel C. Greer
Kay L. Haarmann
Scott J. Hartzler
Jason C. Head
Kandace A. Heiser
Todd D. Hubal
Susan E. Innes
Paul T. Jakubczak
Ann M. Jellison
Rishi Kapur
Kelly Martin Kingston
John R. Klages, Jr.
Thomas G. Kneer
Steven T. Knight
Brian R. Knox
Tanya M. Kovacevich
Kathryn L. Kritz
Todd J. Kuhl
Brendan M. Leonard
Craig A. Levitz
Xiaoying Liang
Darcy Lindley
Bradley W. Lippowiths
Rebecca M. Locks
Aviva Lubin
James P. Lynch
Thomas J. Macintyre
Richard J. Manship
Stephen P. Marsden
Josef E. Martin
Rosemary C. Martin
David M. Maurer
Douglas W. McKenzie
Kirk F. Menanson
Deborah Ann Mergens
Todd A. Michalik
Keith N. Moon
Erica F. Morrone
Sharon E. Murray
Maria Nash
David R. Nix
Jason M. Nonis
Randall H. Nordfors
James L. Norris
Karen A. O'Brien
William T. O'Brien
Barbara B. O'Connor
Roger D. Odle
Chad M. Ott
Bruce J. Packer
Robert A. Painter
Charles Pare
Carolyn Pasquino
Amy A. Pitruzzello
Phillip A. Pitts
Dylan P. Place
Kenneth A. Plebanek
Lisa M. Poulin
David N. Prario
Lewis R. Pulliam
John T. Raeihle
Lynellen M. Ramirez
Christopher Randall
Kiran Rasaretnam
Joe Reschini
Mark P. Riegner
Choya A. Robinson
Jeffrey J. Rozwadowski
Seth A. Ruff
Tracy A. Ryan
Brian C. Ryder
Michelle L. Sands
Christopher P. Sartor
Jason T. Sash
Parr T. Schoolman
Amy V. Shakow
Seth Shenghit
James S. Shoenfelt

Jessie S. Siau
Robin B. Simon
Raleigh R. Skaggs, Jr.
Tracy L. Smith
Jesse D. Sommer
Matthew G. Sorkin
Alan M. Speert
Amy J. Stavros
Laura B. Stein
Michael A. Steinman
T. Matthew Steve
Bret L. Stewart
Jonathan L. Summers
Brian T. Suzuki
Elizabeth S. Tankersley
Jonathan G. Taylor
Huguette Tran
David A. Tritsch
Richard A. Van Dyke
Anil Varma
Jayne L. Walczyk
Henry A. Walsh, Jr.
Matthew M. White
Kaylie Wilson
Robert L. Winder
Joel F. Witt
Elissa C. Wolf
Floyd M. Yager
Yuhong Yang
Steven B. Zielke

Part 4A

Angela H. A'Zary
Ethan D. Allen
Silvia J. Alvarez
Julie A. Anderson
Satya M. Arya
Robert D. Bachler
Gregory K. Bangs
Amy L. Baranek
Emmanuil Bardis
Brian K. Bell
James H. Bennett
Heather A. Bertellotti
Kristen M. Bessette
Brian A. Bingham
Christopher D. Bohn
Mark E. Bohrer
David R. Border
David C. Brueckman
Paul E. Budde
Marian M. Burkart
Christopher J. Burkhalter
Brian P. Bush
Steven M. Byam
Kelli R. Caldwell
Janet P. Cappers
Victoria J. Carter
John Celidonio
Yvonne W. Y. Cheng
Aleksandr Chernyavskiy
Julia F. Chu
Brian K. Ciferri
Kevin M. Cleary
Jeffrey J. Clinch
Nancy J. Collings
Hugo Corbeil
Jeffrey A. Courchene
Hall D. Crowder
Claudia M. Barry Cunniff
Jonathan S. Curlee
Amy L. DeHart
Kevin F. Downs
Michael E. Doyle
Emilie Drouin
Tammi B. Dulberger
Gregory L. Dunn
Louis Christian Dupuis
Ruchira Dutta
James R. Elicker
Brian Elliott
Juan Espadas
Brian A. Evans
Carolyn M. Falkenstern
Horng-Jiun Fann
Benedick Fidlow
Karen L. Field
Sherri L. Galles
Natalya Gelman
Gary J. Goldsmith
Andrew S. Golfin, Jr.
Natasha C. Gonzalez
Michael J. Grandpre
Martin Halek
Alex A. Hammett
David L. Handschke
Aaron G. Haning

Michelle L. Harnick
Eric C. Hassel
Deborah L. Herman
William N. Herr, Jr.
Cynthia J. Heyer
Peter B. Hindman
Grace Ho
Bradford K. Hoagland
Amy L. Hoffman
Heidi L. Hower
Joseph M. Izzo
Christopher D. Jacks
Karen L. Jiron
Burt D. Jones
Dennis J. Keegan
Jean Y. Kim
Kristie L. Klekotka
Matthew R. Kuczwaj
James D. Kunce
Brian D. Kurth
Julie-Linda LaForce
Isabelle LaPalme
Douglas H. Lacoss
Martine Laflamme
Robert G. Landau
Brian P. LePage
Chanseo Lee
Sue Jean Lee
Brendan M. Leonard
Eric F. Liland
Chia-Lin C. Liu
James R. Lyter
David D. Magee
Alexander P. Maizys
Rajnish Malhotra
Ratsamy Manoroth
Stephen J. McAnena
Lawrence J. McTaggart III
Mea Theodore Mea
Martin Menard
Deborah Ann Mergens
Troy C. Milbrandt
Richard G. Millilo
Ashish Modhera
John Monroe
David P. Moore
Lynn S. Moore
Matthew K. Moran
Lambert Morvan
Michael J. Moss
Malongo Mukenge
RoseMina Munjee
Susan K. Nichols
John E. Noble
Yanic Nolet
Lauree J. Nuccio
Jill E. O'Dell
Ann Marie O'Grady
Roger D. Odle
Chad M. Ott
Rebecca W. Palmer
Kelly A. Paluzzi
David J. Persik
Dylan P. Place
Jennifer K. Price
Eileen A. Prunty
Marie-Josee Racine
Marc Raphael
Amir Rasheed
Jennifer L. Reisig
Neil W. Reiss
Michael T. Reitz
Nigel K. Riley
Delia E. Roberts
Kathleen F. Robinson
Efrain Rodriguez
Jennifer L. Rupprecht
Thomas A. Ryan
Joseph J. Sacala
Gary F. Scherer
Jeffery W. Scholl
John R. Scudella
Kelvin B. Sederburg
Ernest C. Segal
Craig S. Sharf
Seth Shenghit
Rebecca L. Simons
Kristen L. Sparks
Michael W. Starke
Jonathan C. Stavros
Roxann P. Swenson
Christopher C. Swetonic
Michelle M. Syrotynski
Charles A. Thayer
Christopher S. Throckmorton
Craig Tien
Morris Tien
Andy K. Tran
Michael C. Tranfaglia
Laura J. Vargas
Lidia E. Villasenor
Nathan K. Voorhis
Tom C. Wang
Christopher B. Wei

Joseph C. Wenc
Shannon A. Whalen
Patricia C. White
Dean M. Winters
Wendy L. Witmer
John Wong
Yuhong Yang
Kathermina Lily Yuen

Part 4B

Cyriaque A. Adou
Sajjad Ahmad
Giuseppina Alacchi
Ethan D. Allen
Jennifer E. Alper
Scott J. Altstadt
Khurram Amin
John K. Anderson
Maria L. Andrade
Choon-Hong Ang
Amy P. Angell
Marc D. Archambault
Jennifer D. Arnett
Craig V. Avitabile
Patrick Barbeau
Chad Barber
Emmanuil Bardis
John A. Barnett
Dana Barre
Patrick Beaulieu
John A. Beck
Julie Belanger
Jody J. Bembenek
James H. Bennett
Gregory A. Berman
Zahir Bhanji
Sarah J. Billings
Nicole P. Bitros
Cindy M. Bloemer
Michael J. Bluzer
Efren A. Boglio
Genevieve Boileau
Anouk Boucher
Bernardo Bracero, Jr.
Rebecca S. Bredehoeft
Ian R. Brereton
Steven A. Briggs
Mike A. Brisebois
David V. Bruce
Christopher J. Burkhalter
Jennifer A. Burns
Hayden Burrus
Aleksandr A. Bushel
Jason Cafaro
James M. Campbell
Nathalie Cardinal
Sandra L. Carlson
Patrick J. Causgrove
Jennie Chang
Pei Yi Chao
Hung-Wen M. Chen
Lung Chen
Yi-Ju Chen
Chung-Wen Cheng
Adam K. Cheung
Sheng-Ching Chung
Brian K. Ciferri
Derek W. Clayton
Christopher P. Coelho
Steven A. Cohen
Brian M. Collender
Richard Jason Cook
Peter J. Cooper
Brian P. Corrigan
Matthew A. Cowell
Spencer L. Coyle
Jonathan S. Curlee
Dawne L. Davenport
Anne M. DelMastro
Shannon S. Demaree
Stephanie Pelham Demeo
Tim P. Deno
Patrick Desrosiers
Kelly D. Dickens
Mark C. Dickey
Marco Dickner
Dean P. Dorman
Paul N. Doss
Richard J. G. Dragon
Joanne Adele Dufault
Gregory L. Dunn
Stephanie M. Dupuis
Denis Durand
Marianne E. Dwyer
Cindy Dye
Elaine V. Eagle
Scott W. Edblom
Henry J. Elliot

Tanya E. Eng
Jonathan Palmer Evans
Chieh Fan
Thomas W. Feltz
Yanjie Feng
Stephen M. Finley
Kristine M. Firminhac
Steven A. First
Jeffery A. Fitch
Stephen F. Flick
Michael Alexander Fortier
Antony G. Friel
Timothy J. Friers
Noelle C. Fries
Brian Frost
Martine Gagnon
David E. Gansberg
Michael A. Garcia
Genevieve Garon
Claudine Gauthier
Gregory Evan Gilbert
Jean-François Girard
Ingrid H. Gokstorp
Alla Golovanevskaya
Natasha C. Gonzalez
Philippe Gosselin
Nicolette A. M. Goulbourne
Stephanie A. Gould
Mathieu Guay
Lawrence A. Guenther
Veronika Hackenjos
David B. Hackworth
Brian D. Haney
Elaine J. Harbus
Michael S. Harrington
Sven Hauptfeld
Michael J. Hawksworth
Jason B. Heissler
Christopher Heppner
Sonia Heroux
Peter B. Hindman
Scott M. Hippen
Jill K. Hoffman
Robert G. Holdom
Susan E. Holland
Allen J. Hope
Ya-Chun Huang
Julie Hubert
Naomi M. Hudetz
Jui-Ruei Hung
Wan M. Idris
Jamshaid Islam
Stephen A. James
Edward Jhu
James JL. Jiang
Michael S. Johnson
Theodore A. Jones
Jeremy M. Jump
Vasilios Kakavetsis
James M. Kelly
Michael J. Kenney
Dean W. Kepraios
Cameron D. Kimbrough
Kristie L. Klekotka
James D. Kunce
Joanne Kurys
Zoe M.Y. Kwok
Martin Labarre
Marie-Eve Lachance
Douglas H. Lacoss
Kelly Bryant Lambert
Isabelle Lauziere
Gilles Lavoie
Dennis H. Lawton
Richard G. LeRose
Dominique Lebel
Chang Lee
Norman Shane Leib
Hubert Lemire
Craig A. Levitz
Yueh-Ying Liao
Ken S. Lim
Lincoln Y.D. Lin
Shiu-Shiung Lin
Jen-Kai Liu
Xin Liu
Anita M. Lo
Tze T. Lo
Kendrick Lombardo
Alison C. Marek
David Laurent Marleau
Clarke E. Marrin
Lori J. Mattusch
Daniel E. Mayost
Jarilyn A. McCartney
Peter B. McCloud
Ian J. McCracken
Lorol Megan McCrossan
Mark Z. McGill III
Douglas W. McKenzie
Mea Theodore Mea
Anmol Mehra
Jean-François Michaud

Eric J. Mikulaninec
Lisa S. Miolo
Teresa M. Moll
David P. Moore
Isabelle Moreau
Michael J. Morell
Robert Morency
David K. Morton
Jonathan M. Moss
Peter J. Mulcahey
Paul R. Myers
Claude Nadeau
Jennifer Y. Nei
Kari A. Nicholson
Nina Hemraj Noorali
Eduard A. Nunes
Avital Ohayon
Adeniyi C. Olaiya
Sheri L. Oleshko
Cameron J. Olig
Christopher E. Olson
David A. Ostrowski
Apryle L. Oswald
Gilbert Ouellet
Stella X. Pan
Jerome Z. Pansera
Erika D. Parker
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Sanford E. Penn
Jennifer L. Pepin
Isabelle Perron
Christopher J. Pezalla
Mary G. Phipps
Richard M. Pilotte
Jan L. Pitts
Jordan J. Pitz
Luc Pomerleau
Jonathan W. Porter
Marshall E. Posner
Jennifer K. Price
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M. Joseph P. Raaymakers
Scott Rastin
Leslie E. Reed
Kenneth S. Reeves
Sylvain Renaud
Douglas L. Robbins
Kathleen F. Robinson
Ronald J. Robinson
Efrain Rodriguez
Nathan W. Root
Richard A. Rosengarten
Carrie C. Round
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Jennifer L. Rupprecht
Mark T. Rutherford
Frederick D. Ryan
Joanne M. Ryan
Mark B. A. Samlalsingh
Eric G. Sandberg
Myrene Constance Santos
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David W. Scheible
Gary F. Scherer
Rick D. Schnurr
Robin M. Seifert
Lyle S. Semchyshyn
Michael W. Shackleford
Gregory C. Shane
Hsiao-Chien Shen
Aviva Shneider
John W. Slipp
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Eugenea Y. Sohn
Jonathan Zhan Shan Song
Hak Hong Soo
George Dennis Sparks
Michael W. Starke
Robert T. Stevenson
Chris Stiefeling
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Su-Mei Wang
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Ka Yee Yeung
Christine Seung H. Yu
Hung-Chih Yu
Shan-Pi Yu
Fu-Yang Yuan
Kathermina Lily Yuen
Carina Zagury
Richard L. Zarnik
Xu Zhang
Yan Zhu
Michele L. Ziegler

Part 5A

Bijoy Anand
Paul D. Anderson
Mario G. Arguello
Afrouz Assadian
Michael J. Bednarick
Michael J. Belfatti
Mariano R. Blanco
Kofi Boaitey
Raju Bohra
Hobart F. Bond III
Patrice Brassard
Ron Brusky
Hayden Burrus
Brian R. Coleman
Kimberly S. Coles
Margaret E. Conroy
Sharon R. Corrigan
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Kenneth R. Dipierro
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Stefvan S. Drezek
Sophie Dulude
Mark Kelly Edmunds
Jane Eichmann
Sarah J. Fore
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Robert C. Fox
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Susan I. Gildea
Olga Golod
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David J. Gronski
Jacqueline L. Gronski
Scott T. Hallworth
Brian T. Hanrahan
Gregory Hansen
Scott E. Haskell
Eric C. Hassel
Cynthia J. Heyer
Margaret M. Hook
Allen J. Hope
Rebecca R. Hunt
Mangyu Hur
Jean-Claude J. Jacob
Patrice Jean
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Chad C. Karls
Hsien-Ming K. Keh
Jill E. Kirby
Therese A. Klodnicki
Richard S. Krivo
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Dar-Jen D. Kuo
Jin-Mei J. Lai
William J. Lakins
Peter Latshaw
Michael L. Laufer
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Doris Lee

Robin R. Lee
Thomas C. Lee
Charles Letourneau
Xiaoyin Li
Smith W. McKee
Stephanie J. Michalik
Catherine E. Moody
Jennifer A. Moseley
Roosevelt C. Mosley
Ethan Mowry
John V. Mulhall
Thomas E. Newgarden
Chris M. Norman
Lowell D. Olson
David A. Ostrowski
Donna M. Pinetti
Dylan P. Place
Mary K. Plassmeyer
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Jacqueline M. Ramberger
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Andrew S. Ribaudo
Marie R. Ricciuti
Rebecca J. Richard
Sophie Robichaud
Richard A. Rosengarten
Mark B. A. Samlalsingh
Rachel Samoil
Timothy D. Schutz
Michele Segreti
David G. Shafer
Linda R. Shahmoon
David J. Shaloiko
Kelli D. Shepard-El
Rebecca L. Simons
Donna L. Sleeth
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Alan M. Speert
Carol A. Stevenson
Thomas Struppeck
Mark Sturm
Adam M. Swartz
Christopher C. Swetonic
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Hung K. Tang
Ming Tang
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Matthew L. Uhoda
David W. Warren
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Part 5B

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Andrew S. Becker
Michael J. Belfatti
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Kofi Boaitey
Hobart F. Bond III
Travis L. Brank
Glen R. Bratty
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Ron Brusky
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Allison F. Carp
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Sharon C. Carroll
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Nathalie Charbonneau
Stephen M. Couzens
Michael J. Curcio
Mary Katherine T. Dardis
Mark A. Davenport
Willie L. Davis
Patricia A. Deo-Campo Vuong
Jonathan M. Deutsch
Anthony M. Di Lapi
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Kenneth R. Dipierro
Louis Durocher
Anthony D. Edwards
Jane Eichmann.
Juan Espadas
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William P. Fisanick
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Serge Gagne
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Jacqueline L. Gronski
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Guo Harrison
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Mangyu Hur
Jamison J. Ihrke
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Yin Lawn
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James P. Leise
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Thomas D. Martin
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Roosevelt C. Mosley
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Matthew L. Sather
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Michael F. Schrah
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Meyer Shields
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Miroslaw Wieczorek
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Michael G. Young

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Thomas P. Gibbons
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James W. Gillette
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Mark A. Gorham
Matthew L. Gossell
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Monica A. Grillo
M. Harlan Grove
Greg M. Haft
John A. Hagglund
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Jodi J. Healy
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Daniel F. Henke
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Thomas E. Hettinger
Glenn S. Hochler
Daniel L. Hogan, Jr.
Dave R. Holmes
Brett Horoff
Cheng-Chi Huang
Gloria A. Huberman
David D. Hudson
Thomas D. Isensee
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Suzanne G. James
Christopher Jamroz
Brian J. Janitschke
Walter L. Jedziniak
Philip W. Jeffery
Philip A. Kane IV

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Omar A. Kitchlew
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Elina L. Koganski
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Kirk L. Kutch
Andre L'Esperance
Salvatore T. LaDuca
Steven M. Lacke
Jocelyn Laflamme
Jean-Sebastien Lagarde
Josee Lambert
Guy Lecours
Kevin A. Lee
Isabelle Lemay
Charles R. Lenz
Steven J. Lesser
Jennifer M. Levine
John N. Levy
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Hsin-Hui G. Lin
Christina Link
Robb W. Luck
Tai-Kuan Ly
William R. Maag
Jason N. Masch
Bonnie C. Maxie
Laura A. Maxwell
James R. Merz
Alison M. Milford
David Molyneux
Lisa J. Moorey
Janice C. Moskowitz
Matthew S. Mrozek
Karen E. Myers
Vinay Nadkarni
Lowell D. Nelson
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Mihaela L. O'Leary
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Luba Pesis
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Michael W. Phillips
Mitchell S. Pollack
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Patricia A. Pyle
Daniel D. Rath
Raymond J. Reimer
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Jeremy Roberts
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Sandra L. Ross
Joseph F. Rosta
Peter A. Royek
Chet James Rublewski
Jason L. Russ
Julie C. Russell
Romel G. Salam
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Manalur S. Sandilya
Cindy R. Schauer
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Michael C. Schmitz
Ia F. Scholdstrom
Craig J. Scukas
Terry M. Seckel
Kevin H. Shang
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Bret C. Shroyer
Katherine R. S. Smith
L. Kevin Smith
Lori A. Snyder
Linda M. Sowter
Caroline B. Spain
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William G. Stanfield
Christopher M. Steinbach
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Deborah L. Stone
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C. Steven Swalley
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Kellie A. Thibodeau
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W. Mont Timmins
Philippe Trahan
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Jennifer S. Vincent
Mary Elizabeth Waak
Edward H. Wagner
Benjamin A. Walden
Isabelle T. Wang
Petra L. Wegerich
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Vanessa C. Whitlam-Jones
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Jennifer N. Williams
Jerelyn S. Williams
Laura M. Williams
Trevar K. Withers
Brandon L. Wolf
Terry C. Wolfe
Kah-Leng Wong
Stephen K. Woodard
Mark L. Woods
Perry K. Wooley
Rick A. Workman
Robin Zinger

Part 8

Shawna S. Ackerman
Steven D. Armstrong
Timothy W. Atwill
Herbert S. Bibbero
Gary Blumsohn
George P. Bradley
Donna D. Brasley
Margaret A. Brinkmann
Ward M. Brooks
Elliot R. Burn
Mark W. Callahan
Ralph M. Cellars
Heather L. Chalfant
Dennis K. Chan
Laura R. Claude
Pamela A. Conlin
William F. Costa
Kirsten J. Costello
Christopher G. Cunniff
Joyce A. Dallessio
Jean A. DeSantis
Behram M. Dinshaw
Andrew J. Doll
Norman E. Donelson
John P. Doucette
Peter F. Drogan
Bernard Dupont
Tammy L. Dye
Paul E. Ericksen
James G. Evans
Karen M. Fenrich
John R. Ferrara
Kirsten A. Frantom
Jean-Pierre Gagnon
Eric J. Gesick
John E. Green
Steven A. Green
Lynne M. Halliwell
Alessandrea C. Handley
Elizabeth E. L. Hansen
Bradley A. Hanson
Robert L. Harnatkiewicz
Barton W. Hedges
Suzanne E. Henderson
Betty-Jo Hill
Amy J. Himmelberger
Wayne Hommes
Marie-Josee Huard
Thomas A. Huberty
Anthony Iafrate
Joseph W. Janzen
F. Judy Jao
Christian Jobidon
Daniel K. Johnson
Kurt J. Johnson
Rebecca A. Kennedy
Joan M. Klucarich
Richard F. Kohan
Mary D. Kroggel
Howard A. Kunst
Andre L'Esperance
Matthew G. Lange
Steven W. Larson
Lee C. Lloyd
Cara M. Low
James M. MacPhee
James M. Maher
Maria Mahon
Stephen N. Maratea

Lawrence F. Marcus
Meredith J. Martin
Dee Dee Mays
Charles L. McGuire III
Kelly S. McKeethan
Daniel J. Merk
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Scott M. Miller
Camille Diane Minogue
Mark J. Moitoso
Robert J. Moser
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Mary Beth O'Keefe
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Ajay Pahwa
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William Peter
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Gregory Riemer
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Tracey S. Ritter
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Michael B. Schenk
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Gerson Smith
Carl J. Sornson
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Marianne Teetsel
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Marie-Josee Huard
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Sean W. Russell
Katie Suljak
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Part 10

Elise M. Ahearn
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Jean-Luc E. Allard
Kerry F. Allison
William M. Atkinson
Karen F. Ayres
Robert S. Ballmer II
Timothy J. Banick
Philip A. Baum
Tracy L. Brooks-Szegda
Mark E. Burgess
Douglas A. Carlone
Daniel G. Carr
Kevin J. Cawley
Galina M. Center
Francis D. Cerasoli
Gary C. K. Cheung

Laura R. Claude
Jo Ellen Cockley
Frank S. Conde
Mary L. Corbett
Catherine Cresswell
David J. Darby
Renee Helou Davis
Dawn M. DeSousa
Marie-Julie Demers
Lisa Nan Dennison
Robert G. Downs
David L. Drury
Jeffrey Eddinger
Martin A. Epstein
Dianne L. Estrada
Madelyn C. Faggella
Michael A. Falcone
Denise A. Feder
Daniel J. Flick
Mary K. Gise
Nicholas P. Giuntini
Olivia Wacker Giuntini
Bradley J. Gleason
Ronald E. Glenn
Marc C. Grandisson
Anne G. Greenwalt
Steven J. Groeschen
William D. Hansen
Christopher L. Harris
Matthew T. Hayden
Patrick C. Jensen
Charles N. Kasmer
Janet S. Katz
Tony J. Kellner
Brian Danforth Kemp
Deborah E. Kenyon

Kevin A. Kesby
Ann L. Kiefer
Michael F. Klein
Terry A. Knull
Gary R. Kratzer
Adam J. Kreuser
David R. Kunze
Mylene J. Labelle
Blair W. Laddusaw
Robert J. Larson
Paul B. LeStourgeon
John P. Lebens
Marc-Andre Lefebvre
Aaron S. Levine
George M. Levine
John J. Lewandowski
Barbara S. Mahoney
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Leslie R. Marlo
Kelly J. Mathson
Robert D. McCarthy
Michael K. McCutchan
David W. McLaughry
Kathleen A. McMonigle
Robert F. Megens
Stephen J. Mildenhall
Madan L. Mittal
Russell E. Moore
François Morin
Giovanni A. Muzzarelli
Antoine A. Neghaiwi
Victor A. Njakou
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Marc Freeman Oberholtzer

Thomas Passante
Abha B. Patel
Edward F. Peck
Wende A. Pemrick
Anne Marlene Petrides
Mark W. Phillips
Joseph W. Pitts
Denis Poirier
On Cheong Poon
Arlie J. Proctor
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Donald A. Riggins
Douglas S. Rivenburgh
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Jay Andrew Rosen
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James V. Russell
Melodee J. Saunders
Christina L. Scannell
Peter R. Schwanke
Peter Senak
Rial R. Simons
Keith R. Spalding
Douglas W. Stang
Richard A. Stock
Collin J. Suttie
Jeanne E. Swanson
Cynthia J. Traczyk
Patrick N. Tures
Peter S. Valentine
Charles E. Van Kampen
David B. Van Koevering
Kenneth R. Van Laar, Jr.

Mark D. van Zanden	Lisa Marie Walsh	Claude D. Yoder
Trent R. Vaughn	John S. Wright	Ronald J. Zaleski
Joseph W. Wallen	Cheng-Sheng P. Wu	Barry C. Zurbuchen

The following candidates were admitted as Fellows and Associates at the CAS Annual Meeting in November 1995 as a result of their successful completion of the Society requirements in the May 1995 examinations.

NEW FELLOWS

Rhonda K. Aikens	Michael A. Falcone	Paul B. LeStourgeon
Jean-Luc E. Allard	Denise A. Feder	Marc-Andre Lefebvre
Kerry F. Allison	Mary K. Gise	Aaron S. Levine
William M. Atkinson	Olivia Wacker Giuntini	George M. Levine
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Timothy J. Banick	Ronald E. Glenn	Maria Mahon
Philip A. Baum	Marc C. Grandisson	Barbara S. Mahoney
Gary Blumsohn	Anne G. Greenwalt	Lawrence F. Marcus
Donna D. Brasley	Steven J. Groeschen	Robert D. McCarthy
Mark E. Burgess	William D. Hansen	Kathleen A. McMonigle
Mark W. Callahan	Christopher L. Harris	Stephen J. Mildenhall
Kevin J. Cawley	Matthew T. Hayden	Russell E. Moore
Ralph M. Cellars	Suzanne E. Henderson	François Morin
Galina M. Center	Anthony Iafrate	Antoine A. Neghaiwi
Francis D. Cerasoli	Patrick C. Jensen	John Nissenbaum
Laura R. Claude'	Janet S. Katz	Victor A. Njakou
Mary L. Corbett	Tony J. Kellner	Keith R. Nystrom
David J. Darby	Brian Danforth Kemp	Edward F. Peck
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Marie-Julie Demers	Kevin A. Kesby	Mark W. Phillips
Lisa Nan Dennison	Michael F. Klein	Joseph W. Pitts
John P. Doucette	Terry A. Knull	Denis Poirier
Paul E. Ericksen	Adam J. Kreuser	On Cheong Poon
Dianne L. Estrada	David R. Kunze	Arlie J. Proctor
Madelyn C. Faggella	Blair W. Laddusaw	

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Donald A. Riggins
Bradley H. Rowe
John M. Ruane
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Peter Senak
Rial R. Simons
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Douglas W. Stang
Richard A. Stock
Marianne Teetsel
Cynthia J. Traczyk
Patrick N. Tures
Peter S. Valentine
Charles E. Van Kampen
David B. Van Koevering
Kenneth R. Van Laar, Jr.
Mark D. van Zanden
Trent R. Vaughn
Lisa Marie Walsh
John S. Wright
Claude D. Yoder
Ronald J. Zaleski

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Christopher L. Bowen
Tobias E. Bradley II
Michael D. Brannon
Steven A. Briggs
Pamela A. Burt
Michelle L. Busch
Martin Carrier
Victoria J. Carter
Darrel William Chvoy
Maryellen J. Coggins
Brian C. Cornelison
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Claudia M. Barry Cunniff
Malcolm H. Curry
Charles A. Dal Corobbo
Dean P. Dorman
Barry P. Drobes
Mary Ann Duchna-Savrin
Jeffrey Eddinger
William P. Fisanick
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Philip A. Kane IV
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Mark L. Woods
Floyd M. Yager

The following is the list of successful candidates in examinations held in November 1994.

Part 3B

Angela H. A'Zary
Jennifer A. Ahner
Sharyn A. Alfers
Keith P. Allen
Mario G. Arguello
David S. Atkinson
Edward H. Balderstone
Emmanuil Bardis
David B. Bassi
Edward L. Bautista
Chad M. Beehler
Ellen A. Berning
Eric D. Besman
John T. Binder
Kofi Boaitey
Josee Bolduc
Michael J. Bradley
Glen R. Bratty
Robert J. Brunson
Debra L. Burlingame
Mary L. Cahill
Hong Chen
Ja-Lin Chen
Yvonne W. Y. Cheng
Jonas O. Cho
Seung-Eun Susan Choi
Louise Chung-Chum-Lam
Ronald V. Clementi
Robert G. Cober
Steven A. Cohen
Larry Kevin Conlee
Hall D. Crowder
Maura K. Curran
Kristin J. Dale
Robert P. Daniel
Loren R. Danielson
Timothy A. Davis
Andrea L. Della Rocco
Alain P. DesChatelets
Paul N. Doss
Julie A. Ekdom
Alana C. Farrell
Kathleen M. Farrell
Solomon C. Feinberg
Sean P. Forbes
Sarah J. Fore
Joseph B. Galbraith
Anne M. Garside
Leslie A. George
Graham S. Gersdorff
Cary W. Ginter
Joseph E. Goldman
Alla Golovanevskaya
Philippe Gosselin
Stephanie A. Gould
Christopher J. Grasso
Amanda Gress
Diane Grieshop
Curtis A. Grosse
Kimberly Baker Hand
David L. Handschke
Chad A. Henemyer
Laurent Holleville
Wayne Hommes
Hsienwu Hsu
Steven M. Jokerst
Richard B. Jones
Theodore A. Jones
Daniel R. Kamen
Michael A. Kaplan
Alexander Kastan
Brandon D. Keller
John B. Kelly
Joseph P. Kirley

Joseph E. Kirsits
Jocelyn Laflamme
Jean-Sebastien Lagace
Valerie Lavoie
Yin Lawn
Chanseo Lee
Chiouray Lin
Hsin-Hui G. Lin
Steven R. Lindley
Chia-Lin C. Liu
Jeffrey Y. Liu
James W. Mann
Annmay M. Manrique
David E. Marra
Sarah P. Mathes
Daniel E. Mayost
William B. McAlister
Timothy J. McCarthy
Wayne H. McClary
Robert B. McCleish IV
Melissa L. McDonough
Joanne M. Missry
Rodney S. Morris
Malongo Mukenge
Seth W. Myers
Lauree J. Nuccio
Michael G. Owen
Patrick M. Padalik
Susan M. Pahl
M. Charles Parsons
Michael T. Patterson
Michael A. Pauletti
Sylvain Perrier
Julie Perron
Jordan J. Pitz
Paul M. Pleva
Troy J. Pritchett
Patrice Raby
Suzanne M. Rasch
Sylvain Renaud
Andrew S. Ribaudo
Benjamin L. Richards
Josephine T. Richardson
Rhamonda J. Riggins
Nigel K. Riley
Jeremy Roberts
Ronald J. Robinson
Maureen E. Roma
Benjamin G. Rosenblum
Adam J. Rosowicz
Hanie A. Rowin
Frances G. Sarrel
Dianne R. Schwitzgebel
John R. Scudella
Steven G. Searle
Linda R. Shahmoon
Vladimir Shander
Dawn M. Shannon
Aviva Shneider
Matthew R. Sondag
John H. Soutar
Harold L. Spangler, Jr.
Kenneth W. Stam
David K. Steinhilber
Donald Swofford
Nitin Talwalkar
Robert M. Thomas II
Laura L. Thorne
Nicole C. Tillyer
Philippe Trahan
Ronald J. Trahan
Andy K. Tran
Salvatore M. Tucci
Alice M. Underwood
Danielle T. Van Zwet
Kyle J. Vrieze
Ya-Feng Wang
Jiang Weidong Wayne
Brian D. White
Christopher S. Wohletz
Karen N. Wolf
Mihoko Yamazoe
Sharon M. Yao
Mark K. Yasuda
Kristen K. Yates
Jil L. York
Kenneth Scott Young
Tanya Y. Young

Part 4A

Jason R. Abrams
Cheryl R. Agina
Amy P. Angell
David S. Atkinson
Jane L. Attenweiler
Kim M. Basco
Patrick Beaulieu
Stephane Beaulieu
Tony F. Bloemer
Mary Denise Boarman
Bernardo Bracero, Jr.
Matthew E. Butler
Lisa A. Cabral
Allison F. Carp
Richard J. Castillo
David U. Cho
Andrew K. Chu
Larry Kevin Conlee
M. Elizabeth Cunningham
John E. Daniel
Loren R. Danielson
Conrad K. Davids
Mari A. Davidson
Jean-François Desrochers
Ryan M. Diehl
Derek D. Dunnagan
Robert E. Farnam
Alexander Fernandez, Jr.
Brenda L. Finlen
Sylvain Fortier
Martine Gagnon
Kathy H. Garrigan
Edward R. Garza
Etienne Gingras
Stacey C. Gotham
Amy L. Grbcich
Paul E. Green
Chantal Guillemette
Brian T. Hanrahan
Michael S. Harrington
James A. Heer
James D. Heidt
Christopher R. Heim
Chad A. Henemyer
Stephen J. Higgins, Jr.
Kurt D. Hines
Margaret M. Hook
Francis J. Houghton, Jr.
Candace Yolande Howell
Jodie M. Hyland-Agan
Michael S. Jarmusik
Kelly A. Jensen
Eric D. Johnson
Bryon R. Jones
Brandon D. Keller
Jeff D. Kimble
Steven T. Knight
Robert A. Kranz
Ignace Y. Kuchazik
Richard A. Kutz
Richard V. LaGuarina
François Lacroix
Anh Tu Le
Ramona C. Lee
Jennifer M. Levine
Hsi-yen Lu
Robb W. Luck
Kenneth W. Macko
James W. Mann
David E. Marra
Rosemary C. Martin
Thomas D. Martin
Julie Martineau
Ross H. Michehl
Matthew Mignault
Rose L. Miller
David Molyneux
Bilal Musharraf
Seth W. Myers
David E. Nicpon
Gregory P. Nini
Jason M. Nonis
Nancy E. O'Dell-Warren
Randall W. Oja
Gilbert Ouellet
Christopher K. Perry
Kevin T. Peterson
Christopher J. Pezalla
Richard M. Pilotte
Jordan J. Pitz
Kenneth A. Plebanek
Judy L. Pool
Penelope A. Quiram
Kara L. Raiguel
Sylvain Renaud
Jennifer E. Rice

Benjamin G. Rosenblum
Tracy A. Ryan
Elizabeth A. Sander
Michelle L. Sands
Keith D. Saucier
Raymond G. Scannapieco
Stuart A. Schweidel
Terri L. Schwomeyer
Ronald L. Smith
John H. Soutar
Alan M. Speert
Gary A. Sudbeck
Beth M. Sweeney
Jonathan G. Taylor
Eric D. Telhiard
Christian A. Thielman
Laura L. Thorne
Diane R. Thurston
John D. Trauffer
Philip Tso
Brian K. Turner
Matthew L. Uhoda
Susan B. Van Horn
Danielle T. Van Zwet
Robert M. VanBrackle
Karl C. Von Brockdorff
Keith A. Walsh
Julie S. Wang
Wade T. Warriner
Jiang Weidong Wayne
Kelly M. Weber
Scott Werfel
Carolyn White
Arthur S. Whitson
Amy M. Wixon
Scott M. Woomer
Christine Seung H. Yu
Richard L. Zarnik
Yin Zhang

Part 4B

A. Scott Alexander
Marc N. Altschull
Gwendolyn Lilly Anderson
Carl X. Ashenbrenner
Jonathan Balsam
Daniel Bar-Yaacov
Polina Basanskaya
Marc C. Bastien
Michael J. Belfatti
Brian K. Bell
Nicolas P. Bergeron
Kristen M. Bessette
Timothy R. Bishop
Timothy S. Bleick
Joseph D. Bogdan
Mark E. Bohrer
Thomas G. Bowyer
Erica P. Brown
Peter J. Brown
Paul E. Budde
Susan K. Bulmer
Marian M. Burkart
John C. Burkett
Lisa A. Cabral
Brian A. Cameron
Janet P. Cappers
Peggy Chan
Jenny N. Chang
Peggy Chang
Shu-Ching Chang
Christopher J. Chaplain
Martin Charron
Hui-Chun Chen
Aleksandr Chernyavskiy
Chia-Ling Chou
Jason T. Clarke
Kevin M. Cleary
Jeffrey J. Clinch
Melissa Clines
DiAnne D. Clous
Robert B. Collins
James A. Conley
Pamela A. Connors
Susan D. Cooper
Hugo Corbeil
Matthew D. Corwin
Julie Cousineau
Mari A. Davidson
Robert E. Davis
Annie Derome
Martin Desautels
John T. Devereux
John D. Diffor
Elana L. Doron

Stephanie V. Dupuis
Tomasz Duski
Chakib Erquizi
Carl R. Fagenbaum
Dana M. Feldman
Gina C. Ferst
Benedick Fidlow
Julia M. Ford
Debbie H. Fu
Rosemary D. Gabriel
Joanne Galinsky
James M. Gallagher
Robert F. Geer
Natalya Gelman
Geoffrey W. Gerow
Barry A. Gertschen
Isabelle Gingras
Sanjay Godhwani
Chris D. Goodwin
Glenda J. Granowski
Melanie T. Green
Robert A. Grocock
Chantal Guillemette
Jack F. Gulick
Brian N. Gustafson
Daniel M. Harris
Guo Harrison
Mark A. Hartman
Philip S. Haynes
Kevin B. Held
Chad A. Henemyer
David J. Hennings
Daniel L. Hermetz
William N. Herr, Jr.
Brent L. Hoeppner
Joseph H. Hohman
Kevin L. Holmes
Eric J. Hornick
David Houle
Derek J. Houle
Jeff S. Howatt
Kuo-Lung Huang
Rebecca R. Hunt
Caleb E. Huntington
Su-Fen Hwang
Philip M. Imm
Kristin K. Ives
Christopher D. Jacks
Joseph W. Janzen
Karen L. Jiron
Carolyn M. Jolly
Burt D. Jones
Michael J. Kallan
Jason E. Kehrberg
Brandon D. Keller
Douglas H. Kemppainen
James R. Kennedy
Jean Y. Kim
Anne Marie Klein
David R. Kotick
Christopher Kremer
Rachna Kumar
Ting Kwok
Reuben N. Labendz
Hugues Laquerre
John W. Law
John J. Leonard
Thomas E. Leonard
Peggy Leung
Tu-Yi R. Li
Larry J. Lickteig
Jeffrey A. Lookkong
Robert A. Macagnano
Lawrence P. Macdonald
Michael S. Manno
David E. Marra
Emmanuel Matte
Kirk F. Menanson
Troy C. Milbrandt
Kathleen C. Miller
Eric Morin
Ronald T. Nelson
Leo H. L. Ng
Questor K. H. Ng
Mindy Y. Nguyen
Yanic Nolet
Jason M. Nonis
Darci L. Noonan
James L. Norris
Randall W. Oja
Serge A. Ouellette
Robin V. Padwa
Pamela S. Pan
Cosimo Pantaleo
Tom Peng
Charles V. Petrizzi
Dylan P. Place
Jonathan P. Polon
Michael Porcelli
Devika Prashad
Yuan Qin
Moshe D. Radinsky
Kara L. Raiguel
Christopher Randall
Ronald S. Rees
Mario Richard

Mark P. Riegner
Mark E. Robinson
Jaime J. Rosario
Kemp D. Ross
Robert R. Ross
Celine Rouillard
Scott A. Rushing
Joseph J. Sacala
Kim Schaefer
Christine E. Schindler
Jeffery W. Scholl
Karl E. Schwehr
Paul S. Serafini
Craig S. Sharf
Boris Shekhter
Junning Shi
Mohammad Faisal Siddiqi
Heather A. Smith
Meade G. Smith
Matthew R. Sondag
Shoaib Soofi
Jay M. South
Michele L. Spale
Alan M. Speert
Andrew D. Sponsler
Mark R. Strona
Justin B. Struby
Jonathan L. Summers
Karrie L. Swanson
Edward T. Sweeney
Christopher C. Swetonic
Jonathan G. Taylor
Andy K. Tran
Michael C. Tranfaglia
David L. Treble
Steven J. Tutewohl
Mark Tynkov
Alice M. Underwood
Rahul Vaidyanath
Carlos M. Vazquez
Leslie A. Vernon
Richard Viesta
Jon S. Walters
Janet L. Wang
Tom C. Wang
Jiang Weidong Wayne
Patricia C. White
Toby A. White
Wendy L. Witmer
Joel F. Witt
Scott J. Witt
John Wong
Ken Hoong Wong
Whitman Wai Man Wu
Milton F. Yee
Shuang M. Yu
Yin Zhang
Xiaojing Zhao
Vadim Zinkovsky

Part 5A

Carl X. Ashenbrenner
Kevin J. Bakken
Emmanuil Bardis
James V. Barilaro
James H. Bennett
Jonathan E. Blake
David R. Border
Thomas S. Botsko
Thomas G. Bowyer
Paul E. Budde
Julie Burdick
Hugh E. Burgess
John C. Burkett
Christopher J. Burkhalter
Donia N. Burris
Aleksandr A. Bushel
Matthew R. Carrier
Milissa D. Carter
Bernadette M. Chvoy
Brian K. Ciferri
Sandra Creaney
Andrew S. Dahl
Mujtaba H. Datoo
Jill A. Davis
Timothy A. Davis
Harin A. De Silva
Brian H. Deephouse
Patricia A. Deo-Campo Vuong
Sharon D. Devanna
Timothy M. DiLellio
Cynthia Durbin
Rachel Dutil
Ruchira Dutta
Greg J. Engl

Kristine M. Esposito
Jonathan Palmer Evans
Patrick V. Fasciano
Karen L. Field
Chauncey E. Fleetwood
Sean P. Forbes
Hugo Fortin
Mark A. Fretwurst
John E. Gaines
Barbara B. Glasbrenner
Andrew S. Golfin, Jr.
Lori A. Gordon
Jay C. Gotelaere
Elaine J. Harbus
Christopher R. Heim
Kevin B. Held
Daniel J. Henderson
Peter B. Hindman
Luke D. Hodge
Brett Horoff
C. M. Ali Ishaq
Joseph W. Janzen
Kathleen M. Johnson
Jeremy M. Jump
Linda I. Kierenia
Gary G. Kilb
Jean Y. Kim
Kelly Martin Kingston
Russell G. Kirsch
Paul W. Kollner
Robin M. LaPrete
W. Scott Lennox
Serge M. Lobanov
Richard P. Lonardo
Jason K. Machtinger
Daniel Patrick Maguire
John T. Maher
Jason A. Martin
Victor Mata
Daniel E. Mayost
Stephen J. McAnena
George J. McCloskey
Michele L. McKay
Michael B. McKnight
Allison M. McManus
Sarah K. McNair-Grove
Eric Millaire-Morin
Paul D. Miotke
David Molyneux
Christopher J. Monsour
David P. Moore
Kari S. Nelson
Michael D. Neubauer
Kevin J. Olsen
Richard D. Olsen
David J. Otto
Robert A. Painter
Alan M. Pakula
Harry T. Pearce
Robert B. Penwick
Jeffrey J. Pfluger
Richard M. Pilotte
Jennifer K. Price
Frank S. Rau
Marn Rivelle
Delia E. Roberts
Nathan W. Root
Robert R. Ross
Janelle P. Rotondi
Tracy A. Ryan
Brian C. Ryder
Christy B. Schreck
Darrel W. Senior
Bipin J. Shah
James S. Shoenfelt
Bret C. Shroyer
Brian T. Suzuki
Elizabeth S. Tankersley
Varsha A. Tantri
Hugh T. Thai
Jennifer L. Throm
Sadhana Tiwari
Beth S. Tropp
Dennis R. Unver
Michael O. Van Dusen
Claude A. Wagner
Edward H. Wagner
Helen R. Wargel
Kevin E. Weathers
Dean A. Westpfahl
Patricia C. White
Kendall P. Williams
Gretchen L. Wolfer
Michael G. Young

Part 5B

Joseph J. Allard
Ethan D. Allen
Gwendolyn Lilly Anderson
Satya M. Arya
Robert D. Bachler
Amy L. Baranek
John M. Barish
Michael W. Barlow
Victoria A. Beltz Schnitzer
Mario Bivetti
Jennifer L. Blackmore
Mariano R. Blanco
Daniel R. Boerboom
Raju Bohra
David R. Border
Julie Burdick
Christopher J. Burkhalter
Ann Marie L. Cariglia
Scott A. Chaussee
Jamie Chow
Brian K. Ciferri
Philip A. Clancey, Jr.
Jeffrey A. Clements
Eric J. Clymer
Sean O. Cooper
Richard S. Crandall
Jonathan S. Curlee
Gregory E. Daggett
Andrew S. Dahl
David F. Dahl
Harin A. De Silva
David A. DeNicola
Brian H. Deephouse
John C. Dougherty
Kevin F. Downs
John A. Duffy
Rachel Dutil
Jeffrey A. Dvinoff
Thomas J. Dwyer
Kevin M. Dyke
Richard Engelhuber
Kristine M. Esposito
Ellen E. Evans
Alana C. Farrell
Lawrence K. Fink
Ronnie S. Fowler
Robert C. Fox
Timothy J. Friers
Noelle C. Fries
Martine Gagnon
John E. Gaines
Sherri L. Galles
Barry A. Gertschen
Olga Golod
Natasha C. Gonzalez
David B. Hackworth
Barry R. Haines
Eric C. Hassel
Cynthia J. Heyer
Amy L. Hicks
Peter B. Hindman
Allen J. Hope
Marie-Josee Huard
Elizabeth J. Hudson
Rebecca R. Hunt
C. M. Ali Ishaq
Gregory O. Jaynes
William R. Johnson
Robert C. Kane
Panayotis N. Karambelas
Douglas H. Kemppainen
Omar A. Kitchlew
Wendy A. Knopf
David Kodama
Tanya M. Kovacevich
Kathryn L. Kritz
Rocky S. Latronica
Peter Latshaw
Doris Lee
Xiaoyin Li
Xiaoying Liang
Timothy D. Logie
Vahan A. Mahdasian
Meredith J. Martin
Laura A. Maxwell
Patrick A. McGoldrick
Kirk F. Menanson
Jill M. Merchant
Katherine F. Messerschmidt
Paul D. Miotke
Christopher J. Monsour
Jennifer A. Moseley
Ethan Mowry
Thomas E. Newgarden
Susan K. Nichols

Brett M. Nunes
Kimberly A. Oaks
Helen S. Oliveto
Richard D. Olsen
Michael A. Onofrietti
Grace A. Orsolino
Chad M. Ott
David J. Otto
M. Charles Parsons
Wendy W. Peng
John M. Pergrossi
Kraig P. Peterson
Jennifer K. Price
Brentley J. Radeloff
William D. Rader, Jr.
Jacqueline M. Ramberger
William J. Raymond
Teresa M. Reis
Mario Richard
Rebecca J. Richard
Nathan W. Root
Richard A. Rosengarten
Frederick D. Ryan
Ryan D. Schave
Michael Shane
Bintao Shi
Aviva Shneider
Rebecca L. Simons
Christopher S. Strohl
Gary A. Sudbeck
Elizabeth A. Sullivan
Adam M. Swartz
Nitin Talwalkar
Harlan H. Thacker
Joel A. Vaag
Janet K. Vollmert
Nathan K. Voorhis
Claude A. Wagner
Edward H. Wagner
Josephine M. Waldman
Vanessa C. Whitlam-Jones
Kendall P. Williams
Tamara M. Winton
Jeffrey F. Woodcock
Jodi L. Wrede
Jimmy L. Wright
Ruth Zea

Part 7

Jeffrey R. Adcock
John Scott Alexander
Nathan J. Babcock
Keith M. Barnes
Kimberly M. Barnett
Paul C. Barone
Elizabeth F. Bassett
Michael J. Bednarick
Michael J. Belfatti
Bruce E. Binnig
Lesley R. Bosniack
Edmund L. Bouchie
Kimberly Bowen
Charles Brindamour
Linda M. Brockmeier
Lisa A. Brown
Louis M. Brown
Robert F. Brown
Kirsten R. Brumley
Ron Brusky
Alan Burns
Joseph G. Cerreta
Hsiu-Mei Chang
Henry H. Chen
Stephen D. Clapp
Michelle Codere
William B. Cody
Sally M. Cohen
David G. Cook
Sheri L. Daubenmier
Jeffrey W. Davis
Raymond V. DeJaco
Dawn M. DeSousa
John D. Deacon
John C. Dougherty
Christopher S. Downey
Peter F. Drogan
David L. Drury
Louis Durocher
Dawn E. Elzinga
Ellen E. Evans
Sylvain Fauchon
Sholom Feldblum
Vicki A. Fendley
John D. Ferraro
Kristine M. Firminhac
Mary E. Fleischli
Sy Foguel

Jeffrey M. Forden
Christian Fournier
Walter H. Fransen
Bethany L. Fredericks
Jean-Pierre Gagnon
David E. Gansberg
Kathy H. Garrigan
Lynn A. Gehant
James W. Gillette
Moshe D. Goldberg
Karl Goring
Jeffrey S. Goy
Mari L. Gray
Daniel C. Greer
Christopher G. Gross
Nasser Hadidi
Greg M. Haft
John A. Hagglund
Lynne M. Halliwell
Scott T. Hallworth
Alessandrea C. Handley
Gerald D. Hanlon
Michael B. Hawley
Jodi J. Healy
David E. Heppen
Ronald J. Herrig
Thomas E. Hettinger
Cynthia J. Heyer
Luke D. Hodge
Daniel L. Hogan, Jr.
Melissa K. Houck
Linda M. Howell
Jane W. Hughes
Mangyu Hur
Brian E. Johnson
James B. Kahn
John P. Kannon
Chad C. Karls
Anthony N. Katz
Mary C. Kellstrom
James M. Kelly
John H. Kim
Martin T. King
Diane L. Kinner
Brandelyn C. Klenner
Elina L. Koganski
Terri C. Kremenski
Kirk L. Kutch
Andre L'Esperance
Steven M. Lacke
Timothy J. Landick
Steven W. Larson
Thomas V. Le
Bradley R. Leblond
Guy Lecours
Betty F. Lee
James P. Leise
Steven J. Lesser
Philip Lew
Christina Link
Lee C. Lloyd
Cara M. Low
Robb W. Luck
Kyra D. Lynn
William R. Maag
Joseph A. Malsky
Betsy F. Maniloff
Joseph Marracello
Bonnie C. Maxie
Claudia A. McCarthy
Patrice McCaulley
Douglas W. McKenzie
Scott A. McPhee
Jennifer Middough
Michael J. Miller
Stephen A. Moffett
Catherine E. Moody
Lisa J. Moorey
Roosevelt C. Mosley
Matthew S. Mrozek
Karen E. Myers
Donna M. Nadeau
Vinay Nadkarni
Helen P. Neglia
Catherine A. Neufeld
James D. O'Malley
Kevin J. Olsen
David J. Otto
Ajay Pahwa
Erica Partosoedarso
Lisa M. Pawlowski
Jeremy P. Pecora
Tracie L. Pencak
Judy D. Perr
Daniel B. Perry
Luba Pesis
John S. Peters
Michael C. Petersen
Michael W. Phillips
David J. Pochettino
Mitchell S. Pollack
Dale S. Porfilio
Anthony E. Ptasznik
David S. Pugel
Ni Qin-Feng
Kiran Rasaretnam
Raymond J. Reimer

Ellen K. Rein
Andrew S. Ribaudo
Cynthia L. Rice
Melissa K. Ripper
Christopher R. Ritter
Dave H. Rodriguez
Sandra L. Ross
Jean-Denis Roy
Chet James Rublewski
David L. Ruhm
Douglas A. Rupp
Joanne E. Russell
Shama S. Sabade
Romel G. Salam
Cindy R. Schauer
Timothy D. Schutz
Michele Segreti
Jonathan N. Shampo
Michael Shane
Kevin H. Shang
Scott A. Shapiro
Jill C. Sidney
Jeffery J. Smith
Kendra Barnes South
Caroline B. Spain
Theodore S. Spitalnick
William G. Stanfield
Christopher M. Steinbach
Carol A. Stevenson
Curt A. Stewart
Lori E. Stoeberl
Deborah L. Stone
Brian K. Sullivan
Roman Svirsky
Michael J. Tempesta
Mark L. Thompson
Jennifer M. Tornquist
Philippe Trahan
Amy Beth Treciokas
Joseph D. Tritz
Kai L. Tse
Laura M. Turner
Mary Elizabeth Waak
Benjamin A. Walden
Denise R. Webb
Erica L. Weida
Robert G. Weinberg
Mark S. Wenger
Carol B. Werner
Miroslaw Wieczorek
Jennifer N. Williams
Robin D. Williams
Bonnie S. Wittman
Brandon L. Wolf
Barbara A. Wolinski
Kah-Leng Wong
Rick A. Workman
Michele N. Yeagley

Part 9

John P. Alltop
Scott C. Anderson
Steven D. Armstrong
Richard J. Babel
Andrea C. Bautista
Douglas S. Benedict
Cynthia A. Bentley
Steven L. Berman
Eric D. Besman
Barry E. Blodgett
Carol A. Blomstrom
Erik R. Bouvin
George P. Bradley
Margaret A. Brinkmann
Lisa J. Brubaker
Pamela J. Cagney
Anthony E. Cappelletti
Douglas A. Carlone
Michael E. Carpenter
Daniel G. Carr
Jill C. Cecchini
Julie S. Chadowski
Heather L. Chalfant
Jean-François Chalifoux
Gary C. K. Cheung
Kuei-Hsia R. Chu
Rita E. Ciccariello
Christopher J. Claus
Kay A. Cleary
Jo Ellen Cockley
Thomas P. Conway
Brian C. Cornelison
William F. Costa
Jose R. Couret
Kenneth M. Creighton
Angela M. Cuonzo
Charles A. Dal Corobbo

Jean A. DeSantis
Behram M. Dinshaw
Tammy L. Dye
Jeffrey Eddinger
David M. Elkins
James G. Evans
John R. Ferrara
Carole M. Ferrero
Ginda Kaplan Fisher
Daniel J. Flick
Kay L. Frerk
Margaret Wendy Germani
Annette J. Goodreau
Elizabeth E. L. Hansen
David S. Harris
Lise A. Hasegawa
Barton W. Hedges
Noel M. Hehr
Betty-Jo Hill
Amy J. Himmelberger
Thomas A. Huberty
Jeffrey R. Hughes
Christian Jobidon
Kurt J. Johnson
James W. Jonske
Ira M. Kaplan
Charles N. Kasmer
Lowell J. Keith
Steven A. Kelner
Rebecca A. Kennedy
Michael B. Kessler
Ann L. Kiefer
Joseph P. Kilroy
Joan M. Klucarich
Gary R. Kratzer
Brian S. Krick
Edward M. Kuss
Cheung S. Kwan
Salvatore T. LaDuca
Mylene J. Labelle
Josee Lambert
Matthew G. Lange
Debra K. Larcher
Thomas C. Lee
Julie Lemieux-Roy
Deanne C. Lenhardt
Roland D. Letourneau
Richard S. Light
Shu C. Lin
James M. MacPhee
Donald E. Manis
Kelly J. Mathson
Camley A. Mazloom
Heather L. McIntosh
Kelly S. McKeethan
David W. McLaughry
Jeffrey A. Mehalic
Brian James Melas
Claus S. Metzner
Scott M. Miller
Mark J. Moitoso
Kenneth B. Morgan, Jr.
Raymond D. Muller
Turhan E. Murguz
Giovanni A. Muzzarelli
Aaron West Newhoff
Hiep T. Nguyen
Marc Freeman Oberholtzer
Richard A. Olsen
Milary N. Olson
Charles Pare
Thomas Passante
Nicholas H. Pastor
Miriam E. Perkins
Mark A. Piske
Gregory J. Poirier
Yves Provencher
Regina M. Puglisi
Cathy A. Puleo
Karen L. Queen
Kathleen Mary Quinn
Yves Raymond
Natalie J. Rekittke
Ellen J. Respler
Scott Reynolds
Meredith G. Richardson
Christine R. Ross
Jason L. Russ
Thomas A. Ryan
Rajesh V. Sahasrabuddhe
Manalur S. Sandilya
Linda M. K. Saunders
Christina L. Scannell
Christine E. Schindler
Michael C. Schmitz
Michael J. Scholl
Arthur J. Schwartz
Craig J. Scukas
Robert D. Share
Raleigh R. Skaggs, Jr.
M. Kate Smith
Lori A. Snyder
Jay M. South
Klayton N. Southwood

Kevin D. Strous
Thomas Struppeck
Jeanne E. Swanson
Rae M. Taylor
Daniel A. Tess
Dom M. Tobey
Theresa A. Turnacioglu
Robert W. Van Epps
Jennifer S. Vincent
Kimberley A. Ward
Michael J. Williams
Kirby W. Wisian
Rita M. Zona
Barry C. Zurbuchen

NEW FELLOWS ADMITTED MAY 1995

Front row, from left: Brett E. Miller, Thomas C. Toce, **CAS President Allan M. Kaufman,** Mathieu Lamy, Bradley A. Granger, Peter G. Wick. **Second row:** John V. Van de Water, John F. Rathgeber, David M. Savage, Eduard J. Pulkstenis, Craig W. Kliethermes, Jeffery J. Scott, Russell Steingiser, Timothy J. Cremin. **New Fellows Admitted in May 1995 who are not pictured:** Suzanne Martin, Mark Priven, Eileen M. Sweeney, and Yuan-Yuan Tang.

New Associates Admitted May 1995

Front row, from left: Scott A. Martin, Daniel K. Johnson, Anthony L. Manzitto, Gail E. Kappeler, **CAS President Allan M. Kaufman**, Deborah L. McCrary, Anne H. Moore, Camley A. Mazloom, Kelly S. McKeethan. **Second row:** Jean-Raymond Kingsley, John E. Green, Cornwell H. Mah, Susan T. Garnier, Charles R. Grilliot, Christopher H. Geering, Julie K. Halper, John V. Hinton, Debra K. Larcher, Gregory D. Larcher, Eric J. Gesick, Brian S. Krick. **Third row:** Christian Jobidon, Steven A. Green, Kenneth B. Morgan, Jr., Marc LaPalme, Jason N. Hoffman, Kevin T. Murphy, David S. Harris, Michael K. McCutchan, Betty-Jo Hill, Lowell J. Keith, Thomas P. Kenia, Daniel E. Lents.

NEW ASSOCIATES ADMITTED MAY 1995

Front row, from left: Lisa J. Brubaker, Pamela J. Cagney, J'ne E. Byckovski, Peggy Cheng, **CAS President Allan M. Kaufman**, Steven L. Berman, Christopher G. Cunniff, Sandra L. Cagley, Martin S. Arnold, Rimma Abian. **Second row:** Heather L. Chalfant, Jill C. Cecchini, Douglas A. Carlone, Tammy L. Dye, William F. Costa, Behram M. Dinshaw, Christopher J. Claus, Kevin M. Brady, Douglas J. Bradac, Carol A. Blomstrom, Stephen C. Dugan. **Third row:** James L. Bresnahan, Jean-Francois Chalifoux, Pierre Drolet, Christopher R. Allan, Sean R. Devlin, Elliott R. Burn, Steven J. Finkelstein, James G. Evans, John T. Gleba, Bruce J. Bergeron, S. Anders Ericson, Gary C.K. Cheung, Andre F. Fontaine.

First row, from left: John W. Rollins, Meredith G. Richardson, Milary N. Olson, Natalie J. Rekittke, **CAS President Allan M. Kaufman**, David M. Terne, Cynthia L. Vidal, Christina L. Scannell, Steven J. Symon, Peter S. Rauner. **Second row:** Robert J. Walling III, James L. Nutting, Claude Penland IV, Robert E. Quane III, Genevieve Pineau, Thomas Passante, Michael J. Williams, M. Kate Smith, Hiep T. Nguyen. **Third row:** John B. Sopkowicz, Nicholas H. Pastor, Michael J. Scholl, Steven B. White, Michael J. Sperduto, Eric Vaith, Brian L. Ingle, Daniel A. Tess, Scott Reynolds.

New Associates Admitted in May 1995 who are not pictured: John P. Alltop, K. Athula P. Alwis, Steven D. Armstrong, Corey J. Bilot, Carol A. Blomstrom, John T. Bonsignore, Betsy A. Branagan, Tara E. Bush, William A. Dowell, Jr., Kimberly J. Drennan, Daniel J. Flick, John F. Huddleston, Li Hwan Hwang, Michael B. Kessler, Gary R. Kratzer, Edward A. Lindsay, Richard B. Lord, Tracey L. Matthew, Lynne S. McWithey, Claus S. Metzner, Paul W. Mills, William Peter, Rajesh V. Sahasrabuddhe, Marilyn E. Schafer, Scott D. Spurgat, Scott T. Stelljes, Kevin D. Strous, Joy Y. Takahashi, Son T. Tu, Elizabeth R. Wiesner.

NEW FELLOWS ADMITTED NOVEMBER 1995

Front row, from left: John J. Lewandowski, Kerry F. Allison, Dianne L. Estrada, Philip A. Baum, **CAS President Allan M. Kaufman**, Marie-Julie Demers, George M. Levine, Karen F. Ayres, Suzanne E. Henderson, Madelyn C. Faggella. **Second row:** Christopher L. Harris, Donna D. Brasley, John M. Ruane, Ronald E. Glenn, Marc C. Grandisson, Anthony Iafrate, Trent R. Vaughn, John S. Wright. **Third row:** Janet S. Katz, Richard A. Stock, James V. Russell, Denis Poirier, David B. Van Koevering, Antoine A. Neghaiwi. **Fourth row:** Charels E. Van Kampen, Adam J. Kreuser, Timothy J. Banick, Marc-Andre Lefebvre, Stephen J. Mildenhall, David R. Kunze, Laura R. Claude, Olivia Wacker Giuntini. **Fifth row:** Patrick N. Tures, Brian Danforth Kemp, Matthew T. Hayden, Michael A. Falcone, Deborah E. Kenyon, Bradley J. Gleason. **Sixth row:** Blair W. Laddusaw, Donald A. Riggins, Rhonda K. Aikens, Terry A. Knull, Mark W. Callahan, Russell E. Moore, Gary Blumsohn, John P. Doucette. **Seventh row:** Aaron S. Levine, David J. Darby, Peter S. Valentine, On Cheong Poon, Mark S. Quigley, Joseph W. Pitts, Tony J. Kellner. **Eighth row:** Denise A. Feder, Bradley H. Rowe, Steven J. Groeschen, William D. Hansen, Victor A. Njakou, Douglas W. Stang, Francois Morin. **Ninth row:** Kenneth Van Laar, Anne G. Greenwalt, Francis D. Cerasoli, Lawrence F. Marcus, Mary K. Gise, Arlie J. Proctor, Mark W. Phillips, Paul E. Ericksen. **Tenth row:** Keith R. Nystrom, Ronald J. Zaleski, Mark E. Burgess, Mary L. Corbett, Maria Mahon, Michael F. Klein. **Eleventh row:** Rial R. Simons, Kevin J. Cawley, Barbara S. Mahoney. **Twelfth row:** Keith R. Spalding, Jean-Luc E. Allard, Peter Senak, Claude D. Yoder, Robert D. McCarthy. **Last row:** Paul B. LeStourgeon, William M. Atkinson, John Nissenbaum, Galina M. Center.

New Fellows Admitted in November 1995 who are not pictured: Ralph M. Cellars, Renee Helou Davis, Lisa Nan Dennison, Patrick C. Jensen, Kevin Kesby, Kathleen A. McMonigle, Edward F. Peck, Wende A. Pemrick, Marianne Teetsel, Cynthia J. Traczyk, Lisa Marie Walsh, Mark D. van Zanden.

NEW ASSOCIATES ADMITTED NOVEMBER 1995

Front row, from left: Karen L. Barrett, Kathleen C. Odomirok, Victoria J. Carter, Josee Lambert, **CAS President Allan M. Kaufman**, Tobias E. Bradley, Michelle L. Busch, Angela M. Cuonzo, Annette J. Goodreau. **Second row:** Michael D. Brannon, Hsien-Ming K. Keh, Thomas A. Trocchia, Claudia M. Barry Cunniff, Isabelle Lemay, Therese A. Klodnicki, Ira M. Kaplan, Barry P. Drobes. **Third row:** Michael C. Schmitz, Jennifer S. Vincent, Gloria A. Huberman, Floyd M. Yager, James R. Merz, Kay L. Frerk, Thomas C. Lee. **Fourth row:** Stewart H. Gleason, Raleigh R. Skaggs, Manalur S. Sandilya, Lisa A. Bjorkman, Peter A. Royek, Charles A. Dal Corobbo, Terry M. Seckel. **Fifth row:** Scott J. Hartzler, Malcolm H. Curry, Robert W. Kirklin, Philip A. Kane, IV, Randall A. Jacobson, Philip Jeffery, Thomas A. Ryan. **Sixth row:** Daniel F. Henke, Lori A. Snyder, Brenda L. Reddick, Steven A. Briggs, Dmitry Papush, Thomas P. Gibbons, Mark A. Gorham, David D. Hudson. **Seventh row:** Timothy P. Kenefick, William P. Fisanick, Barry E. Blodgett, Maryellen J. Coggins, Jason L. Russ, Charles R. Lenz, Jeffrey Eddinger. **Eighth row:** Jeffrey D. White, William J. Lakins, David L. Whitley, L. Kevin Smith, Charles Pare, Brian C. Cornelison. **Ninth row:** Monica A. Grillo, Craig J. Scukas, Thomas Struppeck, Kirby W. Wisian, Brian J. Janitschke. **Last row:** Darrel W. Chvoy, Gary J. Ganci, Dennis L. Rivenburgh, Salvatore T. LaDuca, Adam D. Hartman, Christopher L. Bowen.

New Associates Admitted in November 1995 who are not pictured: Pamela A. Burt, Martin Carrier, Dean P. Dorman, Mary Ann Duchna-Savrin, Brian D. Haney, Suzanne G. James, Michael S. Johnson, Yuan Yew Tan, Isabelle T. Wang, Mark L. Woods.

OBITUARIES

William J. Hazam
Laura J. Manley
Kenneth L. McIntosh
Robert W. Parlin
James W. Thomas

WILLIAM J. HAZAM
1915–1995

William J. Hazam, a past president of the CAS, died December 29, 1995, at his home in Winter Park, Florida.

Hazam was born in Norwich, Connecticut, on February 14, 1915. He earned a bachelor's degree from Columbia University in 1936, and a master's degree in mathematics from the University of Michigan in 1938.

He was a commissioned officer for the U.S. Navy and served in World War II as an aerologist. (In the U.S. Navy, the position of "aerologist" was equivalent to those of "meteorologist" or "weather officer," terms for similar positions that were used by other branches of the U. S. military.) According to Hazam's long-time friend and colleague, Richard L. Johe, one of the stories that Hazam enjoyed repeating related to a World War II experience "when he correctly predicted a typhoon, thereby providing sufficient warning to enable our Pacific fleet to scatter and ride out a dangerous storm. His forecast put him on the Admiral's staff of favored officers for the rest of the war."

Immediately after World War II, Hazam spent some time in Sweden where he starred in a Swedish cowboy movie. In that movie, his famous one line was, "I tink I go home now," spoken with a forced Swedish twang.

While studying for the CAS Examinations from 1947 to 1950, Hazam served as meteorologist for the American Overseas Airlines. He became an Associate of the Society in 1949, and a Fellow the following year.

Hazam began his actuarial career in 1950 at American Mutual Liability Insurance Company where he worked for 26 years. His boss was Harold J. Ginsburgh, also a former president of the CAS. The two worked closely for many years at American Mutual and shared the same "knowledge, sincerity, and intellectual traits," Mr. Johe remembered. Johe explained that he, Messrs. Hazam and Ginsburgh, and others, worked "during an older, confrontational time in the history of the Stock and Mutual companies; thus, many of Hazam's contributions to our industry will not be found in the binders of the *PCAS*, but rather in the dusty files of minutes of long-forgotten industry committee meetings during which industry issues and endless meetings demanded much of our energy and attention, leaving little time for writing actuarial papers."

Hazam continually demonstrated his dedication to the property/casualty actuarial profession by serving as general chairperson of the CAS Education and Examination Committee for four years, and serving 18 years on various CAS committees, usually in leadership positions. Those committees include the Committee on Programs, the Constitution Committee, Committee on Professional Conduct, the Nominating Committee, the Committee on Levels of Certification, and the Textbook Committee. Hazam served as vice president of the Society in 1967, and as CAS president in 1968. It was under Hazam's leadership as president that Article II of the CAS Constitution was changed to include the words "to promote and maintain high standards of conduct and competence for the members."

In 1977, he moved to Virginia Beach to become president of Physicians Underwriting Company, Inc. He was there only a year before going back to New England to become an independent consulting actuary in South Windsor, Connecticut. In 1985, he retired to Reading, Massachusetts, and moved to central Florida in 1988 to spend his remaining years in retirement.

Johe remembered Hazam as a "man whose confidence I respected and treasured." Thomas Murrin, also a past president of the CAS and a long-time friend of Hazam, said that "Bill was a great guy, always friendly, pleasant, and gentle—and able to see the humor in business situations."

He is survived by his wife, Elaine; three sons, Stephen, John, and Bruce; daughters Margaret Volpe and Linda Williams; one sister, Ann Hutchinson; and five grandchildren.

LAURA J. MANLEY
1957–1995

Laura J. Manley, an Associate of the Society since 1990, died November 14, 1995, at her home in Abington, Massachusetts, after a long illness.

Manley was born March 9, 1957, in Palmer, Massachusetts. She graduated in 1980 from Northeastern University with a bachelor's degree in mathematics, and began her actuarial career at Commercial Union Insurance Company in Boston. During her 10 years with Commercial Union, Manley participated in the actuarial rotation program and worked in personal lines pricing, corporate actuarial financial analysis, and reserving and commercial auto pricing. In 1992, she began working as an associate actuary for the Automobile Insurers Bureau of Massachusetts in Boston where she contributed to all aspects of the private passenger rate filing process and developed a legislative pricing model for Massachusetts automobile insurance. Even while dealing with a critical illness, Manley remained steadfastly committed to her work and her continued development as an actuary.

"Laura was an inspiration here at the Automobile Insurers Bureau of Massachusetts, and she will be greatly missed," said Daniel J. Johnston, President of the Bureau. At the time of her application for membership in the Casualty Actuarial Society, James E. Fletcher of Commercial Union recommended Manley to the Society because of her "high ethical standards." David L. Miller, chief actuary at Commercial Union, said that Manley "displayed competence and integrity in all areas." Members of the CAS Office staff remember Manley as a smiling and cheerful meeting participant who visited the registration desk at CAS meetings and seminars.

Manley enjoyed traveling, skiing, and gardening. She was also active in neighborhood functions and youth programs in the town where she lived. Friends and family of Manley have established the Laura J. Manley Math and Science Scholarship Fund for seniors graduating from her town's high school. Contributions can be made in care of the North Abington Cooperative Bank, North Abington, Massachusetts.

She is survived by her husband, Andy MacKenzie, parents, four brothers, a sister, and several nieces and nephews.

KENNETH L. McINTOSH
1995

Kenneth L. McIntosh, an Associate of the Society since 1961, died on January 22, 1995.

At the time he became an Associate, McIntosh was the manager for the Louisiana Rating and Fire Prevention Bureau in New Orleans. While working there, McIntosh wrote a *Proceedings* paper, "Mathematical Limits to the Judgment Factor in Fire Schedule Rating." In 1965, McIntosh won the CAS Woodward-Fondiller Prize for his *Proceedings* paper, "A Mathematical Approach to Fire Classification Rates." He also served for four years on the CAS Committee on Mathematical Theory of Risk.

In 1968, McIntosh moved to Little Rock, Arkansas, to become a property/casualty actuary at the Arkansas Insurance Department. While working in Little Rock, McIntosh presented discussions of two Proceedings papers: "The Minimum Absolute Deviation Trend Line," and "The Credibility of the Pure Premium."

In 1980, McIntosh moved to Atlanta to become property/casualty actuary at the Georgia Insurance Department. He retired in 1984 and remained in Atlanta until his death.

ROBERT W. PARLIN
1927–1995

Parlin was born January 15, 1927, in Yunchun, Fukien, China, where his father was a missionary. After his family returned to the United States, Parlin received a degree from the University of Minnesota, and served in the United States Navy for two years.

At the time he became an Associate of the CAS in 1960, Parlin was working as an actuary for Mutual Service Insurance Companies in St. Paul, Minnesota. When he became a Fellow of the Society in 1962, he left the actuarial field to become a research associate at the University of Minnesota, College of Medical Science, Laboratory of Physiological Hygiene Research. Parlin spent five years there focusing on epidemiological research in coronary heart disease, and published a paper entitled "Death Rates among Physically Active and Sedentary Employees of the Railroad Industry," with five other scientists. That paper appeared in the *American Journal of Public Health* in 1966.

In 1968, Parlin returned to the property/casualty insurance field and moved to Adickesalle, Germany, to become an actuary for Neckura Insurance. He remained in Germany until 1984, when he moved to Herrliberg, Switzerland, just outside of Zurich. He remained there until his death on August 26, 1995.

He is survived by his wife, Marianne; a son, David; and a daughter, Cathy.

JAMES W. THOMAS
1921–1995

James W. Thomas, a Fellow of the CAS since 1956, died March 26, 1995, in Wethersfield, Connecticut.

Thomas was born March 13, 1921, in LeMars, Iowa. He graduated from the University of Iowa in Iowa City, and served for four years as a meteorologist with the 9th Army Air Corps during World War II.

At the time of his Fellowship, Thomas was working at the Travelers Insurance Company as an assistant actuary. In 1969, he was promoted to associate actuary. According to his wife, M. Jane (Armour) Thomas, he enjoyed the many friends he made while working more than 40 years for Travelers during its "heyday."

During his years at Travelers, Thomas also served on various CAS committees, including three years on the CAS Finance Committee.

In 1988, Thomas retired to Wethersfield, Connecticut, where he remained until his death.

Thomas is survived by his wife, Jane, and two daughters, Jo Ellen Thomas and Janet Hartmann. He was predeceased by a son, John.

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