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Multimedia Presentation of 32nd Actuarial Research Conference

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Instructor: ARNOLD F. SHAPIRO

Summary: The instructor summarizes the research topics presented at the actuarial research conference held at the University of Calgary during August 1997. This session is a nontechnical presentation of research results using a multimedia approach. The purpose of the presentation is to provide a brief introduction to each of the topics presented so that actuaries may obtain more detailed information on the talks they find of personal interest.

Mr. Arnold F. Shapiro: This session covers the material presented at the 32nd Actuarial Research Conference. I'd like the presenters to give you a sense of what they did and then I'll fill in some areas. The topics, generally speaking, include finance, modeling, some discussion of what's going on at the Society, actuarial instruction, retirement issues, and statistical methods.

What I thought I would do is give you a sense of what each one was doing and then bring up their overviews. The proceedings from the 32nd Actuarial Research Conference include a CD-ROM that gives a three-minute overview of what each presenter talked about.

All right, since statistics is common to actuaries, let's start with that topic. Louie Doray was interested in distance estimators, so he compared them with maximum likelihood estimators. Vladimir Kalashnikov is probably a new face to many of you. Vladimir, who is from Russia, received a Committee on Knowledge Extension Research (CKER) grant and investigated boundaries on ruin limits. Cecil Nesbitt started teaching in 1938 at the University of Michigan, and continues to give a talk

each year. You don't have to be a mathematician to appreciate how long he has been doing this. Esther Portnoy often talks about graduation, but this year her focus was infant mortality and she has some interesting things to say about that. Hoque Sharif took some of the things that Goovarts (a founder of Insurance: Mathematics and Economics) had done and cut out some of the redundant mathematics in the proofs. Given the caliber of Goovarts' work, this is a fair accomplishment. There is the interesting presentation of Emiliano Valdez, a student at the University of Wisconsin, who discussed copulas.

The first overview will be by Louis Doray, who will discuss "Estimators of the Regression Parameters of the Zeta Distribution."

Mr. Louis G. Doray: I reanalyzed the data set presented by Hillary Seal in the *Scandinavian Actuarial Journal* in 1947. In that paper, Seal presents the number of people having multiple insurance contracts with an insurance organization. In Table 1, f_i represents the number of people having i insurance policies grouped by ten year intervals from age 15–75.

TABLE 1

Observed frequencies by age group for Seal's data

i	f_i	f_{ij}	(15,25)	(25,35)	(35,45)	(45,55)	(55,65)	(65,75)
1	1695		94	342	590	433	177	59
2	207		6	34	66	59	30	12
3	46		-	5	16	11	6	8
4	22		-	3	8	7	2	2
5	9		-	0	0	3	4	2
6	8		-	2	3	3	0	-
7	4		-	-	2	2	0	-
8	3		-	-	1	1	1	-
9	1		-	-	1	0	0	-
10	1		-	-	0	1	0	-
11	2		-	-	2	0	0	-
12	0		-	-	-	0	0	-
13	1		-	-	-	1	0	-
14	0		-	-	-	-	0	-
15	0		-	-	-	-	0	-
16	0		-	-	-	-	0	-
17	0		-	-	-	-	0	-
18	1		-	-	-	-	1	-
$n = 2000$		w_j	100	386	689	521	221	83
		x_j^c	20	30	40	50	60	70
$\hat{\kappa} = 1.29$		$\hat{n}_j$	1.06	1.16	1.27	1.32	1.40	1.51

What we notice from this table is that the average number of insurance contracts per person increases from 1.06 for 15-25 year-olds, to 1.51 for 65-75 year-olds.

I also estimated the value of the parameters calculated with both methods—maximum likelihood and quadratic distance estimation—as well as the estimated variance-covariance matrix of the parameters. The quadratic distance estimator was obtained in only three seconds after four iterations, while the maximum likelihood took more than one hour to calculate.

Mr. Shapiro: In this example, the superiority of the quadratic distance estimator over the maximum likelihood estimator is quite stunning. If some of you would like to pursue this further, you can find the method discussed in Hogg and Klugman's *Loss Distributions*.

The next speaker is Vladimir Kalashnikov, whose topic is "Bounding and Asymptotic Behavior of Ruin Probabilities in Collective Risk Theory."

Mr. Vladimir Kalashnikov: The basic goals of my research are to develop new constructive probabilistic methods, derive bounds of ruin probabilities, and solve other related problems.

Mr. Shapiro: Let me just give you some background of what he did. He's into ruin theory and so you start with some surplus and premium structure and you trace the trend in the process until you ultimately get to ruin. What makes Kalashnikov's approach interesting is the portion of the curve where he attacks the problem. Most of the solutions that we see have to do with limiting cases, so everyone is working in the tails of the distribution. In practice, it is the earlier part of the curve that is the most relevant, and that is the part he is concentrating on.

Mr. Kalashnikov: The next goal is to provide numerical calculations justifying these methods and to investigate nonstandard risk processes. During the research we obtained the following results: two-sided bounds of ruin probabilities in the cases of small and large claims; continuity estimates of ruin probabilities with respect to some parameters of risk processes and estimates of asymptotic formulas for the initial capital securing a prescribed risk level; some recurrent formulas for calculating the ruin probability in nontraditional risk models, provided the analysis of a risk model under inflationary conditions and some bounds of ruin probability of the case where only two moments of claim size distribution are known.

Mr. Shapiro: In a nutshell, he analyzed a lot of published papers and then produced better boundary conditions.

The next presenter is Cecil Nesbitt, whose talk was titled "An Unfinished Thesis from the 1950's."

Mr. Cecil Nesbitt: Robert W. Butcher did a remarkable job of actuarial theory and computations on what was known and used in the 1950s. Much development has occurred since then, however. Thus, it may be inappropriate and difficult to reconstruct the thesis now.

Mr. Shapiro: I'm not sure how many of you are familiar with the Butcher family. Marjorie Butcher, Bob's wife, who taught at Trinity college, is also an actuary. Apparently Bob did this thesis under Cecil during the 1950s, and Cecil's question was whether anyone would pursue some of his ideas.

Our next presenter is Esther Portnoy, whose topic was "Recent Trends in Race-Specific Mortality Rates."

Ms. Esther Portnoy: Everybody knows that mortality rates for African Americans are greater than those of whites of similar age, so people are frequently surprised to discover that the crude mortality rate, deaths per 100,000 population, is in fact lower for blacks. This is an example where the population average is misleading.

As actuaries, we have a responsibility to contribute to the public debate on such controversial topics with statistics that are both accurate and carefully interpreted.

My paper concentrates on infant mortality, in particular, why is the infant mortality rate for blacks two times what it is for whites? Don't blame teen births. Black teenagers are, in fact, somewhat less likely than older black mothers to have babies of very low birth weight, the factor most clearly linked with excess deaths among black infants. Moreover, black teenagers are less likely to smoke than older black mothers or white mothers in any age group. The real reasons for the excess black infant mortality rate is certainly complex, and we must do much more analysis, especially of economic data.

Mr. Shapiro: How many of you knew that the crude mortality rate is lower for blacks? I didn't.

The title of the next presenter's talk is "Stepwise Recursions for a Class of Compound LaGrangian Distributions." As I mentioned previously, Sharif has taken some very good articles and condensed the mathematics in them.

Mr. Hoque Sharif: The motivation of this work came from the paper written by Goovarts and Kass in 1991. Their work was published in the ASTIN Bulletin. What they did was derive a recursive relation for the compound generalized Poisson distribution. In fact, they developed four sequences of numbers to get the final numbers. When I noticed that result, I simplified it and I used only two sequences

of numbers to get a final sequence of numbers recursively. My result was published in the *Scandinavian Actuarial Journal Bulletin (San Bulletin)*.

In 1993, Kling and Goovarts published a paper that contained recursive calculations for compound generalized distributions. They left a big algebraic mess in their paper. I cleaned up that mess and my work on that paper was published in the *SAA Bulletin* in 1994.

Mr. Shapiro: Gordon Willmot (University of Waterloo) was his thesis advisor, and Willmot, on one occasion, suggested that there's probably a family here, and the LaGrange family is probably what Sharif ought to be looking at. That was the impetus for this inquiry. Let's move on to the methodology.

Mr. Sharif: In my paper, I used probability generating functions and took them to belong to the (a,b) family introduced by Panjer. In the (a,b) family the probability generating function always follows a differential equation. In the LaGrange transformation, if you take the log of it, you can easily construct a differential equation.

Mr. Shapiro: The next overview is by Emiliano Valdez , whose topic is "Understanding Relationships Using Copulas." How many people have run across copulas before? The idea behind his presentation is that there is a copula function of the marginal distribution of a multivariate distribution that is equal to the multi-variate distribution. An important consequence of this is that this provides a straightforward way to do simulations without having to use multi-variate distributions.

Emiliano A. Valdez: Copulas are good because they're useful for estimating multi- variate distribution. Copulas are essentially functions that link the univariate marginals to their full distribution function. Now the reason they came about was because of a result from Sklar in 1959 that said if you have a random factor, say X_1 to X_p, with marginals, F_1 to F_p, then you can always find a function C C is called the copula, which will map the marginal distributions into the multi variate distribution.

Mr. Shapiro: Let's turn now to retirement issues. Our first presenter is Rob Brown, who poses the question, "Is Social Security Regressive?"

Mr. Robert L. Brown: The motivation for this paper was the review of some recent literature that shows a very high correlation between income and life expectancy. Basically, wealthy people live longer. Now that has implications for Social Security. Because wealthy people live longer, they benefit more from the retirement income security benefits of any Social Security system, and were contributions to be set as a

percentage of earnings, then it could be argued that wealthy participants in Social Security do better. Their ratio of benefits to contributions is higher than the ratio of benefits to contributions for poorer workers. So, is Social Security regressive?

There are at least three beginning counter-arguments to this thesis. First, Social Security systems pay benefits other than just retirement income security benefits, such as disability benefits, orphans benefits, survivors benefits, and death benefits. These tend to provide greater benefits to poorer workers than wealthier workers, often because of the benefit formula, but also because of the probability of different workers getting these benefits. Second, governments pay more than just retirement income security from earnings-related schemes. They also usually have some social assistance programs. In the U.S., this would be the supplemental security income (SSI), and in Canada it would be the guaranteed income supplement (GIS). These benefit poor workers more than wealthy workers. Third, in both Canada and the U.S., Social Security benefits are taxable at least partially, and those tax formulae are progressive.

Mr. Shapiro: So there we have the tradeoff. If the basic and supplemental benefits are higher for the lower socioeconomic group but the higher socioeconomic group lives longer, is Social Security regressive? Rob has been at Waterloo for the past 25 years, and has just recently gone back to school to pick up a Ph.D. in gerontology from Simon Fraser University. I believe that this issue was a major part of Rob's Ph.D. dissertation. Let's go to his conclusion.

Mr. Brown: At the end of the day we can definitively say that in North America Social Security is not regressive.

Mr. Shapiro: Our next presenter, Zaki Khorasanee, is the editor of the Institute of Actuaries' newsletter *The Actuary*. He presents an innovative solution to the problem experienced by participants in a DC plan who retire during an adverse market.

Mr. Zaki Khorasanee: My proposal is for a defined-contribution plan in which investment gains and investment losses are spread forward to either increase or reduce the allocation to the active participant.

Pension plans have traditionally been either defined benefit or defined contribution. A defined-benefit plan gives a predictable benefit for the participant, usually as a fraction of salary close to retirement, but an unpredictable cost for the plan sponsor. Defined-contribution plans are just the opposite. You have predictable cost for the plan sponsor, but an unpredictable benefit for the participants. Is there a way of compromising between these two extremes? I believe there is.

The reason why defined-benefit and defined-contribution plans are different is because investment returns are unpredictable variables. If investment returns were uniform there would be no difference. In a defined-contribution plan, the value of the accrued benefits of the active participants are immediately adjusted to absorb the investment gains and investment losses.

Mr. Shapiro: The solution that Zaki proposes is an interesting one. When there is an allocation to the employees, that allocation will, in effect, be given back into a fund that the employer has control of, and there will be an accumulation like there is under a cash-balance plan, although he doesn't call it that. When the individuals get to retirement, the funds at that time will be compared with this hypothetical fund. If it's larger, the excess will remain in the fund for the benefit of other participants. If the fund is less than the hypothetical fund, a portion of the then-current employer contribution would be used to supplement bad investment results. Thus, there is a smoothing effect, similar to the one in defined-benefit plans. Let's go now to his analysis of the model.

Mr. Khorasanee: I've done simulations to compare the benefit outgo of a variable accrual plan with the traditional money purchase, defined-contribution plan. The comparisons show that compared with a money purchase plan, the participants of a variable accrual plan have more secure benefits.

Mr. Shapiro: That is really an interesting idea. Of course, he's from England so he doesn't have some of our problems. The co-author of this paper is looking into whether this might be appropriate for the U.S.

Our next presenter, Jacques Carriere, is concerned with the problem of developing relevant salary scales. The title of his talk is "New Salary Functions for Pension Valuations."

Mr. Jacques F. Carriere: We looked at the prediction of salaries based on the parametric regression-based method. Traditionally, actuaries have done pension evaluations by using the two classical methods: the current average method (CAM), and the increased ratio method (IRM). This talk presents a third method that uses current methods of statistics. Essentially, if it is a parametric regression function.

Mr. Shapiro: You can see where Jacques is headed. He looked at what practitioners are doing and came to the conclusion that it's not very sophisticated. He undertook to build a regression model that would do the job. Now he did build the model and test it on a couple of companies, although he lamented the fact that he only had a few years of data, but that's a different issue.

Carriere focuses on the salary for the k-th individual at age $x+t$, where x is when they started the analysis, and t is time. He envisions the current salary as involving an inflation factor and a merit and seniority factor. Then, since this is a regression model, he has an error term, taking the log results in a nice regression equation.

The next speaker is Anna Rappaport, our leader, whose topic is "Challenges of an Aging Society."

Ms. Anna M. Rappaport: Within the Society of Actuaries, I hope that we will focus on retirement planning and do a research project to focus on the retirement planning framework.

I want to talk to you about the challenges of an aging society. I feel that these issues are very important to all of us as our population is aging. We have a number of concerns. The elderly population is heavily female and females overall are much less well off. That was discussed by Rob Brown. Many need assistance with many of the activities of daily living and with other activities such as shopping, transportation, and bill paying. Parallel issues exist in many countries and while in the U.S. we have disagreement about the policy direction and reluctance to make tough decisions, we are trying to cope with these issues as we think through all of our social programs.

What are some of our problems? Our social programs are too costly and there is not enough individual savings at this stage. Employers have chosen to limit their role and are not going to spend more for benefits. We have no rational system overall, to provide assistance with either long-term care or the other intermediate steps of care. We need to think about and focus on the spectrum of care needs of the elderly and reinvent the systems for both delivery and financing of this type of assistance.

Mr. Shapiro: I don't know if you've heard any of Anna's recent talks, but this is a hot button for her now, so she's putting together a task force to look at this issue.

Ms. Rappaport: What does this mean to actuaries? What are the challenges to us? I recommend first that we focus on the spectrum of needs, that we develop information and make it available to all the different types of stakeholders. As individuals, we take an active role in participating in public debates. I would like to see us get to the stage where, in these public debates, people on all sides feel it is important to have actuaries help them understand the issues and the data.

Mr. Shapiro: If you haven't already heard Anna speak to these issues, you will.

The next overview is from Bruce Jones who discussed "A Model for Analyzing the Impact of Selective Lapsation on Mortality."

Mr. Bruce M. Jones: Selective lapstation can be described as a greater tendency for good risks to let their life insurance policies lapse than poor risks. This results in a poorer group of persisting policyholders and later duration mortality is, therefore, worse.

Mr. Shapiro: The approach that he's using here is probably a little bit different than what you have seen. He uses frailty theory, which is similar to the approach that Gompertz used when he came up with his mortality law. In this instance, it is the propensity to leave the population that is the issue.

Mr. Jones: This should be reflected in pricing products with atypical expected lapses. In attempting to model selective lapsation, I've recognized two important ideas. One is the heterogeneity of insured lives at the time of policy issue, and the other is the deterioration in health that may occur after issue. Heterogeneity has been allowed for by using an unobservable risk level parameter and deterioration is reflected by assuming that insured lives are either in a healthy state or in an impaired state. This leads to some rather interesting results.

Mr. Shapiro: Those of you who are familiar with Jones' Continuing Care Retirement Community (CCRC) study will not be surprised to learn that this study also incorporates a continuous-time stochastic process that is characterized in terms of transition intensity functions.

How many of you feel comfortable with utility theory? Is this something that you have looked at before? Let's turn now to Jenny Young's talk on "Equilibrium in Competitive Insurance Markets Under Adverse Selection and Yaari's Dual Theory of Risk." Both Jenny and Mary Kelly deal with a similar issue, but I am showing Jenny first because she provides background material.

Ms. Virginia R. Young: Our first paper in this area, which inspired this one, dealt with the same problem, only it assumed that insureds maximized expected utility. What we found out was that if the insureds pool for the equilibrium, then they always got less than full coverage. Another artifact of expected utility theory is that the equilibrium insurance would be nonlinear and usually highly nonlinear. These are things we just don't see in the marketplace. On the contrary, we often see that people are willing to pool with higher risks and get full coverage, or something very close to full coverage. We never see nonlinear insurance contracts because they are always piece-wise linear. For example, they have deductibles, co-insurance, and maximum limits, which means that they are piece-wise linear. These things can

be explained under Yarri's dual theory of risk. The explanation is that utility theory distorts wealth before calculating expected value, but Yarri's theory distorts probabilities. Yarri's theory actually says that people are risk averse with respect to probabilities and not wealth, and they calculate expectation that way.

Mr. Shapiro: You probably remember the Rothschild and Stiglitz separating equilibrium involving high risks and low risks. Because of the nature of utility curves, you get a separation where the low risk will not get full coverage but the high risk will. In contrast, Yarri's theorem uses expectations rather than utility. So you get a straight line rather than a curvature. Because of that you can get a pooling equilibrium where everybody gets full coverage. The idea has been around for a while but economists generally have not embraced it.

Mary Kelly's presentation, "Multiple Period Rothschild-Stiglitz Insurance Contracts," also addresses the separating theorem, and it argues that people are better off if they buy pooling contracts.

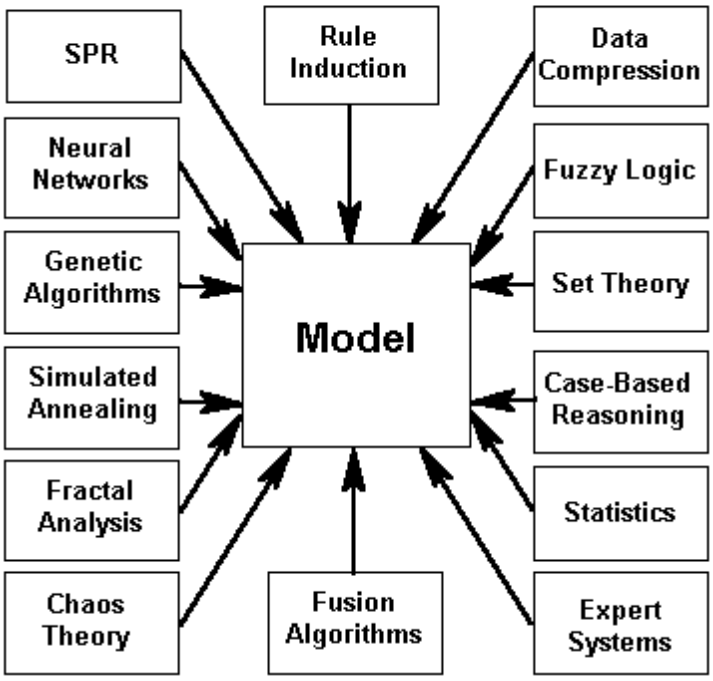
Ms. Mary Kelly: When you think of buying property and casualty insurance, such as auto insurance, you realize that the cost of such contracts are usually contingent upon events such as past accident history. If you look at the insurance literature, traditional models would say that consumers reveal their risk type by their choice of contracts that they make over time. This would indicate that in the real world the amount of the deductible that we choose for this period should influence the sort of contract that we get next period. We all know this is not what we see. The reason this paper was written was to ask the question, why is there this discrepancy?

What is shown in the paper is that low-risk consumers will maximize their expected utility by buying pooling contracts every period over the full lifetime of the model. What this means in reality is that people will not buy these separating contracts, even if they exist, basically because they are better off buying pooling contracts.

Mr. Shapiro: The next presentation, "Technologies Used in Modeling," is mine. The impetus for the presentation was the modeling conference at Georgia State University last December. I attended the conference and became concerned when I realized that I knew very little about many of the current models that were discussed. It was clear that I had some catching up to do and for motivation I committed myself to presenting a talk on the subject at the actuarial research conference.

The topics I discussed are summarized in Chart 1.

CHART 1
TECHNOLOGIES USED IN MODELING

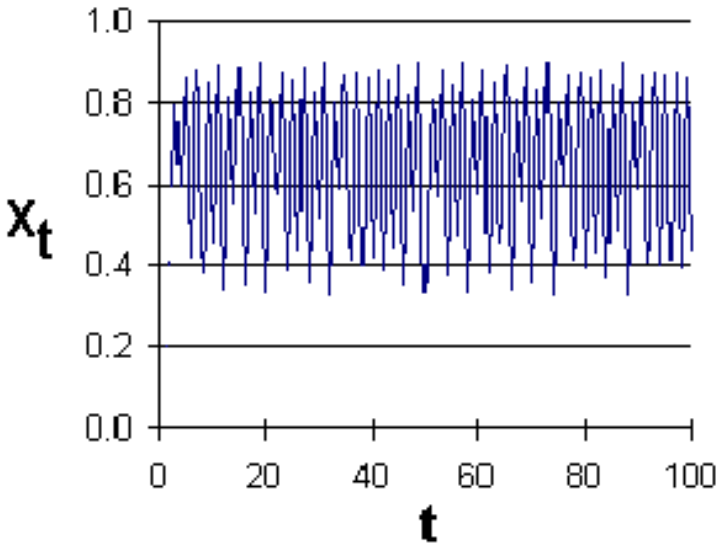


We do not have time to run through all of these, but one discussion that might be of interest to you has to do with chaos theory. The essential message of chaos theory is that normal equations can produce random-looking results; conversely, there may be order in random-looking data. These features of chaos theory are captured in the trend of the logistic equation:

$$x_{t+1} = x_t\, w\, (1- x_t),\ 0 < x < 1,$$

as w varies between 2 and 4, where t is the number of iterations. When $w = 2$ in this nonlinear difference equation, x_t quickly settles down to a stable value. However, as shown in Chart 2, when $w = 3.6$, the system loses all stability and the number of solutions is infinite. The result is chaos.

CHART 2
THE TRANSITION TO CHAOS



Continuing with modeling, the next presenter, Margie Rosenberg, will talk about "A Flexible Model for Time-Dependent Data." Margie's focus is a model that allows paradigm shifts, in the sense that there might be a sudden shift in the mean or variance of the model.

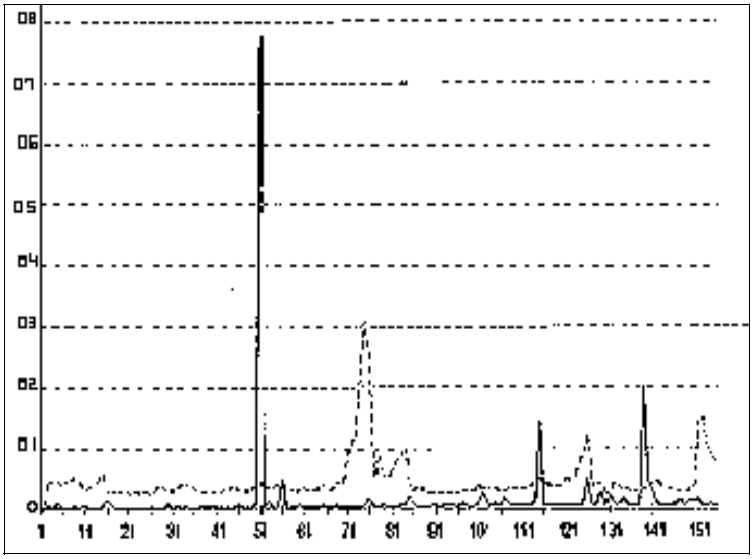
Ms. Marjorie A. Rosenberg: The model and estimation approach that we use to estimate a time series is applied to Social Security macroeconomic data. This is what we call time-dependent data. It's a Bayesian method, and it uses autoregressive terms only, not the moving average terms. It's easy to understand and explain to other people, and the nice thing about the model is that it incorporates the possibilities that the process would shift in the levels or shift in the variance.

One example would be to use simulated data where you know the answer so that you can see how the model works. In Chart 3, I simulated an AR1 process and there's a shift in the level at time 51 and a shift in the variance at time 76.

Chart 3 shows the process itself in both states, and then it also shows prediction intervals from the 2.5% to the 97.5%. So from the top to the bottom you can see an interval of 95%. Chart 4 shows the probability that the process has shifted in the means or that it has shifted in the variance. The dotted line shows that it shifted in

the variance. Each of the dotted lines or the grid lines going across show the probability of an increase of 10%. You can get a feel for how much the process is changed in either level or variance. Chart 4 shows that at time 51 there's a sharp spike, which indicates that the process has changed in the levels at that time. At time 76, there's also a change in the variance, although the probability of that is about 30%. Further on in the process, there's some noise that there could be some shift in the means, but that's due just to the process itself. There was some noise in the data themselves, it's a random process, and it just shows that the data can change with time even though the process itself hasn't changed.

CHART 3
A R1 PROCESS

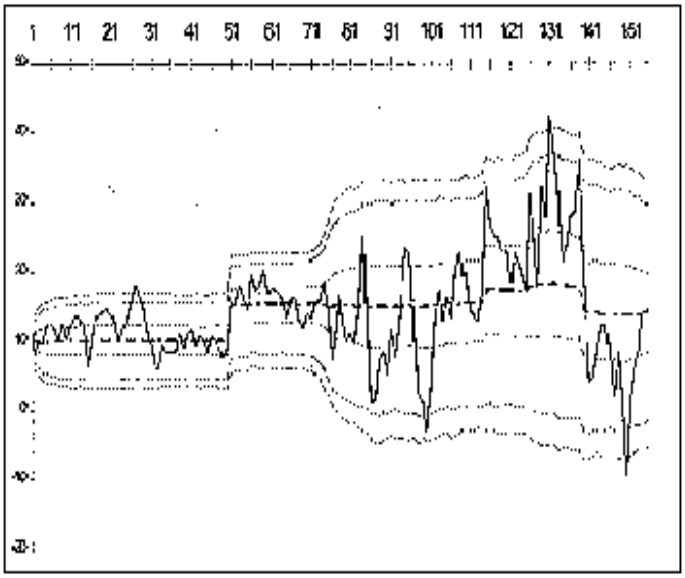


Mr. Shapiro: Let's turn now to the finance presentations in Chart 4. Sarah Christiansen has been focusing on representative scenarios for the last couple of years. She is involved with simulation and is concerned with the problem of replacing a large number of trials, 1,000, with a smaller representative group of say 50. Her presentation this year dealt with some of the issues she found when implementing the procedure.

After Sarah we have Sam Cox who will address catastrophic risk. Then we have Rick Gorvett who will examine dynamic financial analysis from a casualty perspective. The next presenter will be Lijia Guo, who is concerned with the fact that volatility is not very stable. Following her, we will turn to the economic scenario generators of Mark Tenney and Steve Craighead. We will end this portion with an overview by a new researcher from Waterloo, Julia Wirch, who will discuss value-at-risk.

Let's see what they have to say, starting with Sarah's talk on "Stability of Representative Pricing Scenarios."

CHART 4
TIME 51



Ms. Sarah L. M. Christiansen: I work in the scenario generating area, and I create scenarios that are used for pricing. The SPDA area had noticed that there was some inconsistency that resulted from starting from similar yield curves and a resulting crediting rate when they were comparing the use of the scenario methodology versus their own methodology. They came to us and asked if they should fix the seed for the random number generator. Since that would create a very deterministic method for creating scenarios, we thought that there might be some other options.

One of the three questions that came up was, could it be the number of scenarios we started with? We started with 1,000 to cut to 50. Could it be the representative process itself, or might it actually be that we had a problem with the seed? In the representative process when we were creating our candidate list and, and when we were doing it for cash-flow testing, we were matching extremes and got a candidate list of about 200. They were replacing this with a mean plus or minus two standard deviations instead and coming up with 12 candidates.

Mr. Shapiro: Sarah's experience just emphasizes how important it is to continually monitor this type of implementation. It is hard to imagine that anyone using a stochastic process would want to use a degenerate seed, until you realize that you

are dealing here with someone who is trying to establish order. Here are Sarah's conclusions.

Ms. Christiansen: We found out that the groups of 10,000 were very stable, the groups of 1,000 were adequately stable and that by switching from the method that we were currently using to the method that used all of the alternative choices, we cut the range error and the mean of the seven-year rate over the first ten years, (which was the key area for pricing) from 41.9 basis points down to 2.5. We hope that will do the trick for them.

From the Floor: Where will her article be published?

Mr. Shapiro: Most of the presenters will have their article published in the proceedings of the Actuarial Research Conference, which will be coming out at the beginning of 1998. I'm sure that if you contacted her, she'd be more than willing to provide you with a draft.

Our next overview is from Sam Cox, whose topic is "Catastrophe Risk Bonds."

Mr. Samuel H. Cox: We'll show how catastrophic risk is sold in financial markets, and we'll discuss several recent deals, including the USAA bond issue this spring and the Swiss insurance company Winterthur's, bond issue last winter.

Mr. Shapiro: Some of you probably are aware that Morgan Stanley proposed such an issue to the California Earthquake Authority, based on one of Jim Tilley's models, but it was not adopted. Winterthur, though, was windstorm associated with auto. Sam did a survey of what was done and then tried to come up with a financial model.

Mr. Cox: The idea that we discussed for transferring catastrophic risk in financial markets can be used to transfer other types of insurable risk. There are Swiss life insurance companies using the same technology to prepare bonds that will have coupons indexed by a life portfolio.

Mr. Shapiro: Let's turn now to Rick Gorvett's talk on "The Dynamic Financial Analysis of Property-Liability Insurance Companies."

Mr. Richard W. Gorvett: This is a big issue right now for property/liability insurers. It has been a big issue for life insurers for a long time, but property/casualty companies have been a little slower to pick up the modeling of dynamic financial analysis, largely because the durations of their assets and liabilities are smaller. But

it has become a big issue largely because of the increased volatility in interest rates over the years.

There are basically two approaches in my presentation toward dynamic financial analysis modeling. One is the conventional approach in which each stochastic process of the insurance company, both asset and liability, both underwriting and investment, are treated as stochastic and are simulated thousands of times. It produces an outcome whereby the riskiness of the insurance company can be measured by the proportion of unacceptable outcomes. It depends on how you want to define unacceptable in relation to the riskiness of the insurance company.

The second alternative approach is more financially sophisticated, involving the use of contingent claim analysis and equivalent martingale measures. This allows for a mixture of continuous time and discrete financial processes. There have been a number of advances, starting with the Black-Scholes Model, for example, which shows that the value of a contingent claim is not necessarily a function of the riskiness of the environment in which the asset exists. In fact, you can sometimes determine the value of a contingent claim in a risk neutral framework and that simplifies the process quite a bit because you don't have to determine real life asset returns, which is often a difficult thing to measure.

Those are the two approaches I discuss in my presentation. There are trade-offs with each one as with anything in terms of the simplicity and the flexibility of the models. I think they are both approaches that should be followed in the future and should be followed up on in the future. There are going to be applications to solvency testing, sensitivity analysis, determination of optimal corporate management operating policy, and so forth. I think there are a lot of important things that will come out of the future of dynamic financial analysis.

Mr. Shapiro: It's kind of interesting to listen to the way this person presents the case. He's at the University of Illinois and works with Steven D'Arcy. I don't know if you run across Steven D'Arcy, but he writes quite a bit in finance. At any rate, they are both in the finance department and although they're both casualty actuaries, they teach very few actuarial courses, which is really quite interesting. Much of their research is not actuarial per se. It may be that there's some kind of implicit trend. Esther Portnoy manages the actuarial program there.

Our next overview is from Lijia Guo, who will speak on "The Mollification Analysis of Stochastic Volatilities." As with many of her talks, her analysis begins with the general diffusion process.

Ms. Lijia Guo: One of the most important problems in finance is the valuation of financial securities written on underlying assets whose prices are subject to uncertainty. Such uncertainty typically encompasses one or more parameters including volatility. The successful application of hedging and other trading activities will depend critically on how the parameters are quantified.

This paper presented techniques to estimate unknown stochastic volatilities by solving the inverse problem associated with the parabolic partial differential equation which describes the price movement of securities. The model can be used in very general settings.

Mr. Shapiro: Let's turn now to Mark Tenney's overview of his presentation "Economic Scenario Generator for Insurance and Pension Rational Decision Making Under Uncertainty."

Mr. Mark Tenney: The main points of this work have been to try to understand the relationship of the stock market to the bond market. My paper was written with Steve Craighead of Nationwide, and over the course of the last year, Steve and I have worked on extending my interest rate model, the double mean reverting process (DMRP), to incorporate the equity market, dividend yields, and inflation. Steve has done a great deal of work extending the research of Dave Becker to look at stylized facts on interest rates, and we've extended those to stylized facts on the relationship of the bond market to the stock market. Steve has also done a great deal of work using generalized method of moments to extend the estimation of the DMRP from some of my previous work to a much better fitting of it and a more comprehensive analysis of history.

Mr. Shapiro: The pair of them are doing some fine work. Mark, who owns the Mathematical Finance Company, has developed this DMRP and between the two of them, they have applied it to such things as asset/liability management and equity-indexed annuities.

The final overview in finance is by Julia Wirch, who presented the paper, "Value-at-Risk for Risk Portfolios."

Ms. Julia Lynn Wirch: When computing value-at-risk, it is very important to be wary of just one number. Value-at-risk, a percentile type risk measure, was thought to be sub-additive, allowing for a reduction in risk due to hedging or diversification practices. However, it can be shown to be super-additives and thus the value-at-risk calculation can be manipulated by dividing the portfolio into subportfolios.

Mr. Shapiro: Just so we are all on the same page, when we talk about the additivity of the risk measure of a portfolio, we defined it to be additive if the risk measure is equal to the sum of its parts. It is subadditive if the risk measure is less than or equal to the sum of its parts, and it is super-additive if the risk measure is greater than the sum of its parts. In this last case, when you put everything together you will be worse off. Julia has identified some instances where this can happen.

Let's turn to Elias Shiu's overview of his presentation "Annuity Coefficients Explained."

Mr. Elias Shiu: The purpose of my talk is to explain some formulas in Chapter five of the textbook, *Actuarial Mathematics*. These are the formulas that relate the value of the life annuities payable, *m*, times a year to the one that pays once a year. The key idea is to look at the expected cash flows that are not paid by the insurance company in the year of death of the annuitant.

Mr. Shapiro: Let me make sure everyone understands the issue here. In chapter five of Bowers *et. al*. we find the factors $\alpha(m)$ and $\beta(m)$. What Elias addresses is how you would interpret these things. For example, he shows that $\beta(m)$ can be interpreted as the amount not paid in the year of death.

Geoffrey Crofts discussed "A Karup-King Formula with Unequal Intervals."

Mr. Geoffrey Crofts: The formula is derived by finding four different third degree polynomials. What we need is a third-degree formula that is associated with four points, U_a, U_b, U_c and U_d. It passes through the two middle points and has a slope at U_b that's the same as the slope of the second degree polynomial passing through U_a, U_b, and U_c. There is a similar slope at U_c for the polynomial passing through the last three points.

Mr. Shapiro: We are running out of time so I will have to touch quickly on some of the remaining presenters. Here is an overview of a talk by Jed Frees where he focused on "Designing Effective Graphs."

Mr. Edward W. (Jed) Frees: We hope that this paper provides a review of the current practice.

Mr. Shapiro: Jed Frees and Bob Miller, at the University of Wisconsin, are looking at the characteristics of graphs—what's good about graphs and what's bad about graphs. Jed chats about that and comments on abuses.

Mr. Frees: Actuaries are extremely concerned with communication. One of the things that separates them as managers of risk systems, that they deal with quantitative ideas, and they have to communicate complex quantitative ideas to business managers. Communicating these ideas graphically is a very important thing. Computers enable us to create good, effective graphs.

Mr. Shapiro: Then Matt Hassett presented the talk "Data Analysis for the 'Safest Annuity Rule' Project: Implications for Actuarial Education."

Mr. Matthew J. Hassett: Projects of this type would be extremely valuable experiences for actuarial students.

Mr. Shapiro: His story is that he was doing the data analysis for the Safest Annuity Rule project, and he found that he had to get a team together to do that. He believes that students ought to know what that type of project entails.

From the Floor: Can we go to Warren Luckner?

Mr. Shapiro: Yes, of course. The title of Warren's presentation was "Work of the SOA; Research Effectiveness Task Force."

Mr. Warren R. Luckner: The objective of this session was to provide the status of the work of the task force and to obtain input to further that work. The obvious first question is why was the task force appointed? The general response is that research is important to the mission of the SOA. A more specific concern was the level of research spending versus tangible results of the research. The charge to the task force was to design and conduct a review and evaluation of the effectiveness of research project activities, as opposed to an ongoing experience study.

The task force consists of six board members, including Norm Crowder, who is chair of the task force. The main activities of the task force have been a survey and a peer review of recent research productivity. There have been many survey objectives. The main objective includes obtaining input regarding the value and the awareness of research productivity, obtaining ideas about additional research activities and further directions, and obtaining opinions about the relation to the academic community and how that can be improved.

The research survey was fairly extensive. We had three forms in order to try to make it more manageable. We distributed 5,000 copies, and 600 of them have been returned to date. We anticipate, since the deadline just passed, that we'll probably get 650–700 responses. The task force, other board members, and a couple of other individuals, reviewed the documentation for 29 research activities.

The results have not been completely received, but we anticipate that the results will be of value to the task force and also have provided information to reviewers.

We would like to prepare a preliminary report for the Board of Governors at the September meeting and a more extensive report with perhaps some preliminary results in October 1997. A final report should be ready for the January 1998 board meeting.

During my session we broke out into three small groups to obtain input. Three questions that we asked the groups to address were: in what research areas is the SOA doing well? In what areas is it not doing so well, and what are the suggestions for improvement? We reconvened to provide a report which will also be forwarded to the task force. Highlights of the report include what the SOA is doing well: CKER and Ph.D. grants, *The North American Actuarial Journal,* other academic initiatives that will encourage the participation by the academics in the activities of the SOA, and the actuarial research conference. Where we have not been doing so well is providing the link between the academic community and the industry actuaries. Suggestions for improvement include trying to create a list of academics who are interested in working on business problems, and business actuaries who are interested in working with academics on those problems, and providing a matching service, much as the SOA does with jobs. Another important suggestion was that we provide more emphasis on support of supply driven research; that is, research that is driven by what researchers are interested in.