

PENSION SECTION NEWS

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Members of Pension Section Council are available to explain the Retirement 20/20 initiative to your local actuarial club or any other interested group. If you'd like to arrange for a presentation - either in person or via Web cast - please contact Ann Gineo at agineo@segalco.com. Ann is a member of Pension Section Council and leader of the Retirement 20/20 Communication and Outreach subgroup.

should be of interest to pension actuaries everywhere. [Full article>>](#)

THE GOOD, THE BAD AND THE UGLY OF PENSION ACCOUNTING
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Find out more about the CERA credential here. [Full article>>](#)



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CHAIRPERSON'S CORNER

Sandi Kruszewski, ASA

There is currently a significant debate within the United States pension actuarial community with regard to public sector pension plans. How should liabilities be measured? What are the appropriate assumptions underlying this measurement? How should this information be disclosed?

In keeping with the SOA's mission to provide and promote education and research for its members, the PSC is working to address this situation objectively and academically. We hope our efforts will help address the present and often tense discussions. The Society of Actuaries has a history of introducing ideas from outside our profession to its members and the Council feels that this kind of outreach is necessary in this situation.

In February, we co-sponsored a roundtable discussion with the American Academy of Actuaries regarding disclosure for public sector plans. This discussion was fruitful and set the stage for the next steps in this process.

We are currently sponsoring a Call for Papers which will examine the actuarial, non-actuarial and academic viewpoints of various aspects of public plan finance. Our goal is to create a library of well-researched, articulate papers to keep the debate at the appropriate level: respectful, intelligent and fact-based. To ensure that this process will be reasonable and robust, we need to explore as many facets of this issue as possible. Additionally, we need to be aware of the perspective financial professionals and academicians can bring to our discussion.

We anticipate that these papers will be presented in a symposium at the 2009 Spring Employee Benefits meeting, which the SOA jointly sponsors with the Conference of Consulting Actuaries. This meeting is tentatively scheduled for June 2009. We strongly encourage anyone who is interested to submit an abstract by Oct. 15, 2008.

Keep in mind that this is a process; it may not end soon and the only way that it will be successful and satisfying to all parties is if we all participate.

It would be ideal if we could resolve this debate within our profession; that way we have more opportunity to influence the outcome. If we appear disunited, the "solution" may be imposed upon us by those who do not have our understanding of the issues involved. I believe that this would not be an optimal outcome. I welcome your participation.

Sandi Kruszewski is the Pension Section Council Chair for 2008. She is a consulting actuary based near Seattle, Wash. She can be reached at sandbrd@comcast.net.

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EDITOR'S COLUMN

Art Assantes, FSA

The Pension Section Communication Team is pleased to give you an update on the "Name the *Pension Section News*" contest. In the May 2008 issue of the *Pension Section News*, we asked the section subscribers to vote on five possible names of which *Pension Section News* was one of the choices. When the votes were tabulated none of the selections had more than 50 percent of the votes cast. Instead of picking the name that garnered the most votes, we decided to hold a "run-off" election between the two names that received the highest number of votes. The two names that received the highest votes were *Pension Section News* and *Pension Perspectives*. Please look at this issue's poll and vote your choice for our newsletter's name.

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PERSPECTIVES FROM THE FUTURE OF PUBLIC EMPLOYEE RETIREMENT SYSTEMS CONFERENCE

Anna Rappaport, FSA

This May, I attended the annual research conference of the Pension Research Council, and as usual, it was a lively and interesting discussion. The activities and publications of the Council bring together diverse perspectives including those of economists, actuaries, attorneys, plan sponsors, representatives of labor and government. This is a forum where academic researchers and practitioners come together to exchange ideas and learn from each other. I am proud to serve on the Advisory Board of the Council, and feel that over the years, I have learned a lot from this association and have made connections with many people who I have had the chance to learn from and exchange views with. This article will focus on the 2008 conference and what I and some of the actuaries attending it took away from the conference.

At this year's conference, the diverse and lively group of actuaries, academics, financial experts, regulators, and plan sponsors discussed the challenges facing public retirement systems in the United States and around the world. Several actuaries were on the program as paper writers and discussants, and more were in attendance. The presentations are available on the Pension Research Council Web site, [here](#), and the papers will be available as working papers and later in a conference volume. Thanks are due to conference organizers Olivia Mitchell and Gary Anderson for assembling the paper writers, presenters and participants.

Big Picture Perspectives

The conference included papers on a wide range of topics. Steve McElhaney, the author of a conference paper, and an actuary from Mercer specializing in public plans offered the following perspectives:

One thing that impressed me about the conference was that the participants came from so many different fields and had many different perspectives on issues regarding public employee retirement systems. Regardless whether one agreed with a presenter's opinion, it was clear that these opinions were well developed and researched. The primary area where disagreement occurred concerned the measurement of pension liabilities. There were convincing arguments made for continuing to use traditional actuarial measures, and arguments just as convincing on the other side from those who believe that the public sector should move to a financial economics approach.

Several of the papers presented were non-controversial and included valuable information and data. One particularly valuable paper outlined best practices for public sector defined

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contribution plans ("Defined Contribution Pension Plans in the Public Sector: A Best Practice Benchmark Analysis," by Roderick B. Crane, Michael Heller, and Paul Yakoboski from TIAA-CREF). Since it appears likely that public sector employers will be moving more towards defined contribution plans, a resource such as this one will be much appreciated.

-Steve McElhaney

The program traced the history of public sector pensions and retiree health programs, compared public with private sector pay and benefits, and offered perspectives on public policy concerns regarding accounting and management in public employee plans in the United States, focusing on ways to properly measure liabilities and how to make the plans more cost effective. It was clear that some of the topics discussed were very controversial. The discussion also focused on both defined contribution versus defined benefit plans in the public sector, and offered best practices for defined contribution plans. An international focus was included with a discussion of reforms in the German, the Japanese, and the Canadian public employee plans.

I liked many of the papers. I was particularly interested in some of the papers that included research and ideas that were entirely new to me. For example, Brad M. Barber of UC Davis, presented a paper on "Pension Fund Activism: The Double Edged Sword." Barber focuses on the effectiveness and implications of social and shareholder activism, and has studied the returns of CalPERS. He says "Using simple empirical methods, I estimate the gains to the high profile activism of CalPERS focus list firms over the period 1992 to 2007." His conclusions tell us that "Institutional activism is a two edged sword. When prudently applied, shareholder activism can provide effective monitoring of publicly traded corporations. When abused, portfolio managers can pursue social activities to advance their personal agendas at the expense of those whose money they manage." I encourage actuaries to look at the working papers for new insights.

Controversy and Discussion about the Appropriate Ways to Measure Assets and Liabilities

One of the interesting aspects of the discussion was the clear difference in perspectives on whether market values should be used to determine pension liabilities in the public sector, and if so for what purpose. The papers and discussions showed different perspectives on this topic. In his discussion, Robert North, chief actuary for the New York City Retirement System, explained that they disclose market values in their actuarial reports, and believes that it is helpful to all concerned. Jeremy Gold and Gordon Latter, co-authored a paper and provided their case for "Marking Public Plan Liabilities to Market."

The actuarial profession has recognized that this a major issue, and it sponsored a symposium on this topic earlier this year and on Sept. 4, 2008, the Public Interest Committee of the American Academy of Actuaries conducted a public forum on this topic. The purpose of the forum was to hear the views of stakeholders in the debate over the disclosure of the market value of assets and liabilities in public pension plans.

In May, the Academy Board of Directors asked the Public Interest Committee to determine whether a Board statement advocating such disclosures in public pension plans would be in the public interest. The daylong public forum was part of the information-gathering process toward making that determination.

Paul Angelo, an actuary from the Segal Company specializing in public plans, was a speaker assigned to discuss the papers focusing on financial issues, and he provided a perspective on the conference and what he learned. I asked Paul the question: What single comment or insight from the Wharton Conference captured your attention or advanced your understanding? He provided me a very thoughtful response:

There were two, one immediate and encouraging, one more long simmering and illuminating. I'll start with the second one.

I was invited as a discussant of the "new developments" papers and I knew that the main focus for me would be on the controversy surrounding applying the extension of market value liability (MVL) measures from corporate plans to public sector plans. Also since this was Wharton, I anticipated I would be in a minority position as one critical of applying corporate financial economics (FE) methods and measures to public plans. That certainly was the case, but there was also the opportunity to hear from FE proponents—economists—outside the usual actuarial FE circuit.

One of those economists was David Wilcox, deputy director, Division of Research and Statistics, Federal Reserve Board, at the Federal Reserve. In terms of financial economics, David is very well respected, a formidable, compelling and articulate proponent of market valuation of pension promises. I spent some time after my session talking with him and one of his colleagues, Columbia economist Steve Zeldes.

One thing I learned from our side talk was that these two economists were much less familiar with pension cost accrual methods than I expected. Level cost entry age normal vs. back loaded unit credit all seemed pretty new to them. I found that significant since one of the main objections to MVL for public plans is the unit credit accrual pattern, which I argue is simply not "decision useful" (to use the GASB term) for a public plan.

But their focus was almost entirely on the discount rate, and the fact that—from a market perspective—the more sure a promise is, the lower the discount rate, and so the higher the value assigned by the market. I noted how counterintuitive that is from a funding perspective, where if you have a flaky funding source you would charge them more, not less.

Eventually for me this distilled into a basic distinction between market pricing and funding, the fact that in those two measurements the discount rate behaves in the opposite direction. In market pricing, the discount rate is the cost to the borrower, so the less dependable borrower (think junk bonds) gets a higher rate, and so pays a higher cost. In funding, the discount rate anticipates investment earnings, which is an offset to cost (ultimately contributions equal benefit payments plus expenses minus investment income). So a higher discount rate actually anticipates a lower cost to the plan sponsor (or "borrower" in the FE identification of pensions with debt). That is one reason why, when it comes to discount rates, pensions and debt are not identical. And that, ultimately, is what I learned from Wharton.

And how did I happen to have such illuminating discussions with these two economists, my academic adversaries? I owe that to David Wilcox. Earlier in the day, during the Q&A after my presentation, David observed to the audience that my understanding of a pension liability, while no doubt carefully considered, was utterly foreign to him. We somehow see the pension liability completely differently. He likened discussions between financial economists and pension actuaries to talking to someone with whom you do not share a common language. At first you talk slowly, then slowly and loudly, and eventually frustration and impatience take over.

And then he said something that I have not heard in all the FE/MVL discussions going on in the actuarial community. He said, with a sincerity and sense of invitation that I cannot really describe, that what he would like to do is come to understand how we can see things the way we do, a way that is so different from the way he sees them.

So I took him up on his offer and in the process of trying to make my position more understandable to him, gained a better understanding of it myself. Now I owe it to David—and myself—to cycle back to him and see if I can help him, as he put it, understand how to see things my way!

-Paul Angelo

Thinking About Risk in New Ways

Chris Bone, long-time leader in thinking about emerging paradigms for risk, an independent consulting actuary and former member of the Pension Research Council Advisory Board answered my questions by focusing us on perspectives from Germany:

As anticipated, there was a lively exchange of views on the topic of whether, when and how to determine market value of liabilities for public sector pension plans. Sessions, and discussions between the sessions, featured comments about not only the difference in perspectives, but also about the difficulties of transition from one perspective to the other.

But this conference also presented new ways of looking at issues of public sector finance that integrate actuarial and economic techniques and with potential new perspectives for application to asset allocation, public sector employer risk, surplus ownership, etc. In particular my attention was caught by the presentation by Raimond Maurer (see Maurer, Mitchell and Rogalla, "Reforming German Civil Servant Pensions: Funding Policy, Investment Strategy, and Intertemporal Risk Budgeting") This looked at first to be a typical stochastic asset allocation study but presented some new ideas in how to measure risk and rewards of different asset allocations.

In the study, the authors looked at a 50 year projection of the civil servant pension plan for the German state of Hesse. Applying the somewhat arbitrary constraint that the plan would be terminated in 50 years with no reversion of any surplus assets they derived a deterministic plan valuation of the liabilities, contribution rates needed to fund the liabilities, etc. They then proceed to look at asset allocation methodologies

that minimize risk. This may at first sound rather typical of such studies today, but several items of interest jump out. First is the discussion of risk minimization and, in particular, of the risk to be minimized. Rather than minimizing risk of asset fluctuation (the classic asset allocation model that minimizes variance of asset returns) or asset/liability mismatch (minimizing underfunding risk), the authors focus on minimizing the conditional value at risk of the present value of future pension contributions (including penalty contributions assessed on underfunding). In other words, the authors' model looks at minimizing the value of future contributions should worst case (five percent) conditions prevail. Whether the authors' choice of risks to minimize is correct is perhaps less important than the perspective it affords of opening up a dialogue about measuring acceptable levels of risk to a more comprehensive and more intuitive basis. It can be difficult to get plan sponsors to agree that they should minimize asset return variance—since most sponsors believe that only downside risk matters—they are perfectly happy to accept upside variation. But by beginning to look at conditional downside risks we start a discussion that can be translated into terms accessible by our public clients.

Also of interest is the paper's finding that so long as the 50 year constraint on termination applies with no surplus reversion, the optimal asset allocation is dominated by bonds. But when surplus reversion is allowed, optimal asset allocation is radically different, dominated by equities and looking quite similar to the asset allocation prevalent among U.S. public sector plans today. Of course, if the plan were not assumed to terminate at year 50, the ability to finance future pension accruals might be of similar value to a reversion.

There were many other papers of interest, but in many ways the above paper captures many of the values this symposium offers—with a vibrant exchange of views among economists, actuaries, demographers, plan sponsors and others interested in pension policy today and in the future.

-Chris Bone

Insights Helpful in the DB-DC Debate

The patterns of benefits in the public and private sectors in the United States (and in other countries) are quite different. DB is much more common in the public sector. Several of the papers and discussions offered interesting insights.

Beth Almeida of the National Institute on Retirement Security has done a research study on reasons public plans convert from DB to DC or consider it seriously. This study suggests that an important factor is when the legislature and governor are both Republican. There are also key lobbying interest groups and she argues that economics is not the driver in most of these cases. This is a fascinating study and well worth looking at and analyzing seriously. It uses different methodologies than actuaries and economists commonly use. If the findings could be applied on a widespread basis, it would be very important to understand them.

Ed Husted provided a new look at the administrative costs of DB and DC systems in the public sector, and his research shows very positive results

for DB plans.

Keith Brainard of NASRA offered us insights into developments and variations in plan design.

And there was a lot more.

Great Networking Opportunities and New Collaborations

William (Flick) Forna, an actuary from Aon specializing in public plans, was a speaker assigned to discuss the papers focusing on reform paths for public plans. He provided a perspective on the conference and what he learned. I asked Flick the question: What single comment or insight from the Wharton Conference captured your attention or advanced your understanding? Flick said:

What made the conference so valuable was the collection of brilliant thought leaders that I either came to know or got to know and understand better. It was a pleasure to have in depth discussions with my old friends Jon Forman, Keith Brainard, Rod Crane and Paul Angelo, plus new thinkers such as David Wilcox, Parry Young and Stephen Zeldes.

But the most fruitful discussion was when I sat down to dinner across the table from Beth Almeida, an economist and the director of the new organization "National Institute on Retirement Security." We began to discuss her and my presentation and discovered that we have many of the same views.

We began to collaborate on a paper on the financial advantages of defined benefit plans, which NIRS will release later this year. Beth and I presented our work in July at the National Conference of State Legislators and it was well received.

I'm hopeful that our work will add to the pension body of knowledge.

- Flick Forna

Thinking About the Future—Some More Ideas

I want to add my overall comments. I thought the Future of Public Employee Retirement Systems conference was outstanding. I liked the papers and mix of people.

There was a lot to be said about the success of public sector DB plans that was hidden in the papers, but these comments were not well integrated into a summary. My take is that we have heard a lot about DB failures but we rarely hear about successes.

Some key points about public sector DB plans:

- Many people are getting benefits.
- These plans offer strong support for the employment deal.
- They offer more cost effective delivery of benefits than DC plans.

Unfortunately, the press lives on reporting about failures and unusual events and not on reporting about the things that happen every day and not about reporting on successes. If we lived in Europe and followed the press, we might well think that American cities were full of murders and fires and never have any idea about the beauty, nice things or great places to live in many locations.

Some of my top observations are as follows:

Moves and attempted moves to DC—the role of interest groups and ideology seemed very important to me in understanding what has happened, what might be expected and what actions make sense. I do not usually focus on this topic. I want to learn more about how ideology factors in driving decisions for change and would like to see more research on this topic.

Labor deal and the role of pensions—I heard a little about this at the conference, and I think it is central to the importance of the plans. One of the big questions to me is whether long term employment will continue to be very popular in public employment. I wish this had been discussed more.

Changes in retirement ages—the keynote speaker said this issue was off the table in the discussions about Social Security, but I see this as a critical issue going forward. This issue needs to be on the table in pension discussions, and particularly in regard to public employee plans.

Evolving plan designs—the introduction of some hybrid features in public plans is very interesting.

Comparative costs of DB and DC—there are lots of different ways to think about this, including the cost of a dollar of retirement benefit delivered. It is important to also understand what goes to administrative expenses.

Conclusion

There was a lot to think about at this conference, including some that is beyond what we traditionally think about as actuaries. Thanks to the Pension Research Council for a provocative discussion. Many actuaries already are affiliated with the Pension Research Council or closely follow its work. I encourage more to do so, and I encourage all actuaries to participate in multi-disciplinary efforts.

Note about the Pension Research Council—For more than 50 years, the Pension Research Council of the Wharton School of the University of Pennsylvania has been committed to generating debate on key policy issues affecting pensions and other employee benefits. The Council sponsors interdisciplinary research on the entire range of private pension and social security programs, as well as related benefit plans in the United States and around the world. Actuaries serving as Advisory Board members and participating in events have made many valuable connections. Individuals can get copies of publications and news by e-mail. Membership is open to organizations as Senior Partners or Institutional members. <http://www.pensionresearchcouncil.org/membership/>

Anna Rappaport, FSA, MAAA is chair of the Society of Actuaries Committee on Post-Retirement Needs and Risks, and a Past-President of the Society of Actuaries. She has worked more than 10 years to build relationships between actuaries and other professionals who are interested in pensions. She can be reached at anna@annarappaport.com.

Contributing to the article were Paul Angelo, FSA, MAAA, EA (of the Segal Company in San Francisco, Calif.), Chris Bone, FSA, MAAA, EA (of Edth Limited, LLC in Flemington, N.J.), William (Flick) Fornia, FSA, MAAA, EA (of Aon Consulting in Denver, Colo.), and Steve McElhaney, FSA, MAAA,

EA (of Mercer in Richmond, Va.).

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SPRINGBOARD FOR DISCUSSION

Basil Xavier, ASA

Basil Xavier, ASA 1981, worked in Los Angeles for his entire career, mostly with Mercer or its predecessor organizations. He was a thoughtful actuary who made several contributions to the *Pension Section News* including the following article that appeared in June of 1990. He died in 2003.

An essay on the measurement of the reasonableness of each individual non-economic actuarial assumption.

OBRA 1987 mandated that the test of 'reasonableness' must now be applied to each individual actuarial assumption, rather than to the assumptions in the aggregate.

The stage appears to be set whereby our actuarial assumptions will be under closer scrutiny and challenged. As actuaries it behooves us to discuss what "reasonableness" means before some artificial standard is foisted on us.

Despite the fact that non-economic assumptions are usually developed by considering the experience of the actual *number* of participants decrementing under the various assumptions, there appears to be a tendency to want to consider actuarial gain and loss as a measure of deviation of expected from the actual for each individual assumption using the analysis of gain and loss by source.

There have been several classic papers on analysis of gain and loss by source (notably Throwbridge, Dreher, Lynch and Anderson). Each of these papers breaks down the total gain and loss by source, but there is enough difference in the methodology so that the allocation by source is unique depending on the paper involved.

Aside from this variance, however, there is another critical factor to consider that is fundamental to all methods of gain and loss analysis by source that should invalidate this method as a quantitative measure of the "reasonableness" of each individual noneconomic actuarial assumption.

In a multiple decrement situation, a participant is expected to decrement fractionally in all decrements. Let's clarify this statement by means of an example. Suppose at age x the mortality rate is 0.1, the withdrawal rate is 0.2 and the retirement rate is 0.5. This means that during the year of age x we expect 1/10 of the participants to die, 1/5 of the participants to withdraw from the plan and 1/2 of the participants to retire. The real world however, is not as creative, and decrementing has to be by whole numbers, or not at all. In other words, there is a fundamental difference between our mathematical model and the real world.

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Before we proceed further, let us define the following terms that will assist in this discussion:



Now, let us quote Dreher: "the actuarial gain equals (a) excess of net actual release of liability over the release predicted by the valuation basis, plus (b) the excess of expected disbursements over actual disbursements."

Using the symbols we have defined, Dieher's definition can be succinctly written as follows:



Having laid the groundwork let us return to our participant age x . Let us assume that he actually dies during the year of age x . The gain attributable to the death decrement is



This shows that the gain allocated to the death decrement depends on the total expected release of liability; in other words, it is dependent on all the other decrement assumptions as well as the death decrement assumption. Also, all the benefits of the plan, not only the death benefits, contribute to the gain attributable to the death decrement.

Analogous analyses can be developed assuming the participant withdraws,

retires, or survives to age $x+1$. It should be pointed out that even if we define G^d as



and reassign the balance of the gain to the respective other decrements, we cannot escape the fact that the rates in a multiple decrement situation are *dependent* variables, that is  of the form , where the  are dependent on the other actuarial assumptions in the multiple decrements table. Changing any of the other decrements would change .

A quote from Anderson's paper may be revealing. He says that "it is important to realize that the designation of some portion of equation (39) 'the equation of Total Gain' as 'gain from mortality' or the like is fairly arbitrary...."

So, what good is an analysis of gain and loss by source? It is designed to allocate the total gain to the various decrements in order to obtain a valuable insight into the causes of the gain, even though the allocation of some portions of the gain may be fairly arbitrary due to the nature of dependent variables.

When assumptions can be considered reasonable in the aggregate this arbitrary allocation does not present a problem.

Using analysis of gain and loss by source as quantitative measure of the deviation of expected from actual for each individual actuarial assumption in isolation is a dubious proposition at best. The notion of each individual assumption being "reasonable" in its own right while operating in a multidecrement environment is intriguing. A more precise definition of what "individually reasonable" really means must be forthcoming before we can attempt to apply a quantitative measure.

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LIVING TO 100 AND BEYOND: A RETIREMENT ISSUE

Steve Siegel, ASA

Introduction

Late last year, in the weeks leading up to the 2008 Living to 100 and Beyond Symposium, I casually mentioned my pending trip to Orlando to attend the symposium to a number of my friends. Besides their feigned expressions of sympathy for my brief reprieve from the brutal Chicago winter cold, I was startled by an almost universal reaction. It seems everyone had a story about a grandparent, uncle, aunt, cousin, or in-law either in their late 90s or even past the century mark. Indeed, each new anecdote I heard seemed more fascinating than the previous one, describing lives not only still filled with favorite activities but even a few late life romance stories thrown into the mix.

Listening to these stories made me question in my actuarial thinking mode whether I might have simply been talking to an unrepresentative sample. Were these anecdotes truly indicative of where life expectancy is headed? Or, do I just happen to be traveling in a circle of friends with a particularly good gene pool? These nagging questions further whipped up my anticipation for the symposium and the opportunity to once again interact with some of the leading thinkers in this area. After spending three beautiful days in Orlando, I am pleased to report that the 2008 symposium not only did not disappoint, but, without a doubt, has continued to build on the success of the previous symposia in the series.

As with the two previous symposia, the 2008 symposium gathered together a diverse range of professionals, scientists and academics, in an interactive, multidisciplinary forum for three days of highly engaging sessions. As a matter of fact, the strength of this year's program and the organizational leadership provided by the SOA, led Event Co-Chair Bob Johansen to remark, "...the symposium has achieved a position of international prestige among not only actuaries, but also demographers, gerontologists, government offices and others concerned with increasing longevity, its implications for the future and possible solutions." And to further confirm Johansen's observation, the symposium organizers were gratified to receive overwhelmingly positive feedback from the attendees.

Significant Issues for the Elderly and for Retirement Systems

While the success of the symposium is a cause for celebration, many of the sessions over the three day event conveyed a more serious tone and highlighted growing challenges for the elderly in the face of increasing longevity. Of particular interest to retirement actuaries, such challenges clearly have direct impact on the retirement systems of North America and across the globe. Among the issues discussed, highlights from research by

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the Society of Actuaries and other sources revealed that many workers and retirees do not plan long term, and there are significant gaps in knowledge on planning for post-retirement risks as well as on the risks themselves. Furthermore, the research highlighted that the less than optimal strategy of reducing spending remains the favored method of dealing with post-retirement risk, rather than through financial protection products. At the same time—as pension professionals are well aware—employers have reduced their commitment to traditional pensions that provide lifetime income, forcing individuals to become increasingly responsible for managing their own retirement funds and making them last longer. Taken together, this information points to a need for products that can help retirees cope with impending risks that come along with greater longevity and increased individual financial responsibility. Among these needs and risks are:

- Guaranteeing sufficient investment returns on retirement assets
- Converting retirement assets into guaranteed lifetime income
- Funding the costs of long-term care
- Supplementing Medicare coverage
- Protecting a surviving spouse through provision of regular and sufficient income
- Converting home equity into retirement income through products such as reverse mortgages
- Managing retirement assets in the event of diminishing mental and physical capabilities through Alzheimer's and other health conditions.

The Future of Survival

Besides discussions of the financial impact to the elderly as a result of increased longevity and extended periods of retirement, a primary objective of the Living to 100 series is to showcase the latest in thinking on the science of aging. The 2008 symposium led off with a spellbinding presentation by Dr. Cynthia Kenyon on her work with the *C. elegans* worm and the consequences of dietary restrictions on longevity. Through genetic manipulation, the normal two week lifespan of the worm has been extended to four weeks or as Bruce Schobel, SOA President, aptly put it in his introduction of Kenyon, "Four weeks has become the new two weeks." Kenyon also raised a number of social and economic implications that would need to be addressed if such dramatic extension of longevity could be applied to humans.

While Kenyon's work focused on genetic manipulation as a way of impacting longevity, Dr. Leonard Hayflick, in a later session at the symposium, provided an alternative viewpoint on how this type of manipulation may affect the aging process in humans and its ultimate applicability—or, more accurately, inapplicability. Related to this, Hayflick further discussed a number of theories on the distinction between the biology of aging, the aging process and age related diseases. Kenyon and Hayflick's differing perspectives on the biological questions related to aging reinforced to attendees the complexity of the issues as well as the diversity of opinion in the scientific community— clearly, this was one of the major takeaways of the symposium. Further discussion by the organizing committee after the symposium highlighted the need to understand and think about the range of different opinions on aging, and the related challenges in deciding how retirement practice actuaries can make use of this information for more accurate funding methodologies, valuation techniques, system design, and contractual provisions.

Measuring and Projecting Improved Survival

The challenges of measuring high age mortality and the difficulty in securing reliable data to do so were important motivators for the first Living to 100 Symposium. These challenges persist.

In this regard, Dr. Jean-Marie Robine, a demographer and gerontologist who is probably best known as the co-validator of the oldest verified supercentenarian of all time, discussed the concept of the compression of mortality and morbidity. This phenomenon can be observed when the shape of recent mortality and morbidity curves are compared to curves from a hundred years ago. When viewed side by side, it appears that the curves have moved towards a rectangular pattern over time. This movement or apparent compression is sometimes referred to as “squaring of the curve.” The implication of this trend is that increasing numbers of persons born in the same year are living similar lifespans, further implying the potential for a fixed maximum lifespan. Robine concluded that there is probably a limit to the ultimate amount of this compression, and further conjectured on alternative patterns of mortality that may emerge. In either case, questions remain as to whether or not a fixed maximum lifespan exists when viewed from the lens of mortality trends.

To truly gauge mortality trends, it is vital to measure mortality levels on a precise and consistent basis. Given the fundamental importance that measurement represents for all aspects of the study of longevity, the symposium included presentations from several of the world's leading thinkers in this area. Included among the topics discussed in the sessions on mortality measurement were data validation techniques and integrity checks. As in many other disciplines, data is the fundamental building block and foundation for new breakthroughs.

The measurement of mortality also bears directly on the projection of future mortality levels. The need for mortality level projections that are thoughtfully developed cannot be overstated for many of society's key financial security systems. For instance, government social security systems around the world depend on solid mortality projections for planning purposes to ensure long-term fiscal soundness. In recognition of this, an enlightening session was held at the symposium with prominent actuaries from social security governmental agencies in the United States, United Kingdom and Canada, presenting their most recent mortality projections and methodologies. It was readily apparent from this session that these countries are contending with many of the same longevity issues that may ultimately challenge the long-term solvency of their public programs.

Interesting Material for Retirement Actuaries

Over 30 papers were presented at the symposium in addition to several panel discussions. While all papers are worth taking the time to read, the list below highlights papers and session material that may be of special interest to readers with a retirement systems background:

- Leonard Hayflick's "Entropy Explains Aging, Genetic Determinism Explains Longevity, and Undefined Terminology Explains Misunderstanding Both" which discusses the theory of aging.
- Papers presented in the session titled "Social Insurance Perspectives and Implications." These papers describe Social Security mortality projections for the United States, Canada and the United Kingdom.
- Papers discussed in the session titled "Longevity Risk Pricing."
- Eric Stallard's "Estimates of the Incidence, Prevalence, Intensity and Cost of Chronic Disability among the Elderly" provides an insightful view into expected periods of retirement in various states

of health.

- “Living to 100 and Beyond in Canada with Dignity” by Doug Andrews discusses issues of improving the lives of the elderly.
- Brian Burnell’s “Retirement and Retirement Ages in Canada Revisited” explores the changing concept of retirement.
- “Micro Pension Plan: Indian Perspective” by Prakash Bhattacharya describes pension issues that are a by-product of the economy in India.
- “Economic Sustainability of Retirement Pensions in Mexico: Is There a Link with the Mexican-Origin Population in the United States?” by Roberto Ham-Chande
- Anna Rappaport’s “Living to 100—A Woman’s Issue” focuses on longevity issues of special relevance to women.
- Mike Cowell’s “Health, Wealth and Wisdom—Living Long, Living Well” enlightens readers with an actuarial perspective on health and aging.
- Material from the session “Implications of Longer Life Spans: What Does this All Mean to Us?” which describes the impact of increased longevity on a variety of financial systems and stakeholders.
- Beverly Orth’s “Evaluation of Approaches to Reducing Women’s Longevity Risk” focuses on several alternatives for providing lifetime income.

Accessing the Information

Complete versions of the papers and material described above as well as others produced for the symposium are available in an online monograph on the SOA’s Web site at www.soa.org/livingto100monographs. Readers may also be interested in viewing the monographs from the 2005 and 2002 events, also available on the SOA’s Web site.

Related Material on Post-retirement Risk Research

Those interested in the research presented at the Living to 100 Symposium on the risks of aging and its implications may wish to read further about related work the Society of Actuaries has completed. A substantial number of research studies have been conducted to gauge what the public knows about post-retirement risks and how they expect to manage these risks, as well as a number of other aspects relating to these risks. The findings from this research reveal gaps in the public’s knowledge of these risks and present opportunities for improvement through products and education. The research can be found on the SOA Web page at <http://www.soa.org/research/pension/research-post-retirement-needs-and-risks.aspx>. The Web page includes findings from a series of surveys conducted in 2001, 2003, 2005 and 2007 on awareness of post-retirement risks as well as results from several focus groups organized to study how the public expects to manage assets post-retirement. Many of the findings from studies appearing on this Web page were presented at the symposium and these studies provide a worthy supplement to the Living to 100 material.

Final Acknowledgement and Thanks

The symposium organizers, through me, wish to thank the Pension Section for being one of the event co-sponsors. It was truly gratifying to see retirement actuaries attending the event and providing important contributions to its success. In this regard, the organizers would value any comments or suggestions for making future Living to 100 events as worthwhile as possible for retirement actuaries and others. Please feel free to contact me with your thoughts.

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ONTARIO'S EXPERT COMMISSION ON PENSIONS

Faisal Siddiqi, FSA

Because of how Canada's constitution divides responsibilities between the federal government and the provinces, most pension plans must be "registered" (a registered plan in Canada is akin to a qualified plan in the United States) in one of the 10 provinces and overseen by that province's regulator. For these same constitutional reasons, the pension plans of companies in the transportation, communications, and financial sectors are regulated by the federal government. In contrast to the United States where all pension plans are governed by ERISA, Canada has eleven different pension jurisdictions.

The Financial Services Commission of Ontario (FSCO) is responsible for overseeing more pension plans than any other Canadian regulator (almost 7,400 registered plans out of a total of over 15,000 in Canada, 2.15 million plan members out of a Canadian total of 6.7 million).

Background

In the fall of 2006, the Government of Ontario established the Expert Commission on Pensions to examine the legislation governing Ontario-registered pension plans.

Why is such a review being done? There are many reasons. Significant changes to the Ontario Pension Benefits Act (PBA) were made back in 1987. Since then, many changes have taken place in terms of plan design, pension coverage and workforce mobility. Also, the pace of mergers, acquisitions and corporate downsizing has increased. There was a perception that the PBA had become outdated and was not able to adapt to these changes. Some specific developments of concern include the growth of defined contribution plans, the need for a regulatory framework that better deals with the needs of multi-employer pension plans, the impact of long-standing uncertainty regarding the ownership of surplus assets—both in ongoing pension plans and on wind-up—on DB plans, and the need to codify many of the administrative practices of FSCO.

The mandate of the Commission is to review the viability, security and sustainability of the pension system in Ontario. A panel of experts was selected to assist the Chair of the Commission in conducting the review and preparing a report to the Minister of Finance. A series of guiding principles were established to provide a framework within which the review would be conducted. The Commission was asked to observe the following principles:

- The importance of maintaining and encouraging the system of defined benefit pension plans in Ontario.
- The importance of maintaining the affordability of defined benefit pension plans for members and plan sponsors.

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- The importance of pension plans to a competitive economy.
- The need to safeguard the security of pension benefits.
- The need to balance the rights of employers, plan members and pensioners.
- The impact of demographics and changing nature of the workforce on the provision of occupational pensions.

The scope of the Commission's review is quite broad and the Commission's report can be expected to make recommendations for regulatory change in the following areas:

- Pension plan funding.
- Treatment of pension plan surplus (the framework in Ontario is very different from the reversion rules in the United States).
- The existence and operation of the Pension Benefits Guarantee Fund (similar in concept to the Pension Benefit Guaranty Corporation in the United States).
- Pension plan wind-ups.
- Pension plan splits and mergers.
- Pension plans and their inter-relationship with attraction and retention of a qualified workforce.

The Commission is expected to provide its final report to Ontario's Minister of Finance in the fall of 2008.

The Commission—Chair, Advisory Panel and Senior Staff

In choosing the Chair of the Commission, the Government of Ontario wanted to select an individual who would be unbiased and open to input from all stakeholders. The government also wanted the Chair to have familiarity with this type of an assignment and credibility in the eyes of the interested parties. University Professor Emeritus Harry Arthurs was chosen. He is a former Dean of Osgoode Hall Law School and a former President of York University. He recently served as a Commissioner charged with reviewing the federal labor-standards legislation.

After the Chair was selected, a panel of experts in pension issues had to be assembled to assist the Chair in this complicated endeavor. Typically, such a panel would consist of pension lawyers, pension actuaries, and other technical experts in this field. An Advisory Panel consisting of the following four individuals was created:

- Bob Baldwin is an Ottawa-based consultant who specializes in pensions, aging society and labor market issues. He is a senior associate with Infrometrica Limited and adjunct research professor in the School of Public Policy at Carleton University. He served as the pension specialist for the Canadian Labour Congress for twenty-eight years.
- Kathryn Bush is a lawyer who works primarily with plan sponsors. She is a partner in the Pension and Employee Benefits Group of Blake, Cassels & Graydon LLP. She is also a former vice chair of FSCO.
- Murray Gold is another lawyer, one whose practice involves considerable work for organized labor. He is a Partner in the Toronto office of Koskie Minsky LLP. He practices in pensions, benefits, insolvency law.
- Ian Markham is an actuary. He is director of pension innovation, Canada for Watson Wyatt Worldwide. He specializes in providing strategic advice related to the full spectrum of retirement consulting services.

Five senior staff members were appointed to assist the Chair and Advisory

Panel. One of these is an actuary, Rob Brown, who acted as director of research. Rob is a professor at the University of Waterloo, and a former president of both the Society of Actuaries and the Canadian Institute of Actuaries.

Public Meetings and Research Papers

In February of 2007, the Commission issued a consultation paper entitled "Reviewing Ontario's Pension System: What Are the Issues?" The purpose of the consultation paper was to seek input from interested stakeholders and to help focus submissions to respond to the scope of the Commission's mandate. The consultation paper asked stakeholders to share their views on issues related to Ontario's regulatory pension framework. A period of public consultation occurred in the fall of 2007. Stakeholders could make written submissions, and/or they could appear in front of the Commission at one of a series of hearings which took place in five different cities.

In all, 78 presenters filed formal briefs and appeared at one of the hearings. Presenters included representatives of employees and retirees, public sector plan sponsors, private sector plan sponsors, employee benefits consulting firms, and professional organizations including the Canadian Institute of Actuaries. The Commission also received informal submissions from 45 individuals who either walked in to a hearing or made informal submissions online.

Themes and recommendations arising from the submissions generally fell into one of the following categories:

- Amend the PBA to encourage and promote the coverage of Ontario workers in defined benefit pension plans.
- Amend the PBA to improve understanding of plan sponsors' and members' rights and responsibilities and to remove the lack of clarity in many issues that arise with respect to the operation of pension plans in Ontario such as funding, mergers and acquisitions, asset transfers, plan wind-ups, investment rules, rules for DC arrangements, treatment of plan expenses, etc.
- Amend the PBA to permit alternate funding approaches for defined benefit pension plans (for example, the creation of "superfunds," use of letters of credit to secure solvency/wind-up deficiencies, elimination of funding where unnecessary).
- Treatment of the asymmetry of risk in pension plans from both plan sponsors' and plan participants' points of view to clarify responsibility for plan funding and ownership of surpluses.
- Harmonize pension legislation with legislation of other Canadian jurisdictions.
- Improve pension plan governance.

Issues relating to pension plans in Ontario, as elsewhere, can be contentious and many stakeholders have opposing views. Because of this, the Commission also asked several independent parties to conduct research to consider and analyze the claims made by various parties with respect to pension plan funding, use of surpluses, plan conversions, plan wind-ups, and pension plan splits and mergers.

Between February and April of 2007, the Commission initiated 17 studies. Researchers were asked to analyze topics such as:

- Pension coverage and the funding of plans.
- Factors affecting trends in pension plans in Ontario.
- Funding regimes in a comparative context.
- Insurance against pension plan failure.

FSCO's regulatory practices.

- Multi-employer pension plans, and.
- Pension plans and the labor force.

Status of the Commission and Its Final Report

In January of 2008, the Chair of the Commission submitted an interim report to the Minister of Finance. The report provided background, outlined the Commission's approach, explained the process followed to collect submissions, and provided an update on how meetings with the various interested parties went. Also in January 2008, Executive Summaries of all 17 research papers were posted to the Commission's Web site.

The final report of the Commission is expected before the end of 2008.

All of the formal briefs, as well as the summaries of the research papers, can be found at www.pensionreview.on.ca. The complete research papers are available on request from info@pensionreview.on.ca.

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THE GOOD, THE BAD AND THE UGLY OF PENSION ACCOUNTING

Dimityr Mindlin, ASA

Pension Accounting and the "Economic Mainstream"

There has never been a shortage of criticism of pension accounting (throughout this article, the term "pension accounting" should be understood in a broad sense that includes both conventional accounting and funding sides). There has always been a concern that a particular pension accounting figure is either opaque, or deceptive, or impractical, or all of the above plus some other transgressions. Consequently, pension accounting rules and conventions have been frequently "reformed" and augmented. Every major development in this area has been accompanied by seemingly convincing arguments that "this time we got it right," only to be declared inadequate later. Meanwhile, the funding and financial reporting regulations have been increasingly perceived as too burdensome and unfriendly to plan sponsors. This perception has made a significant contribution to the general negative attitude toward defined benefit plans we are witnessing now.

Another powerful surge of criticism of pension accounting is currently in full swing. These days, it is common for the leading national and industry periodicals to publish articles highly critical of pension actuaries and other practitioners in the pension industry. The criticism is increasingly directed toward the actuaries working for public pension plans. A recent article in the *New York Times* is a good example of this trend.¹ Among other disapproving statements about practitioners in the pension system, the author makes the following declaration:

"Most of all, public pension actuaries use old methods that have fallen far out of sync with the economic mainstream."

The problem is not the calculations actuaries perform—few have accused actuaries of using incorrect math. The problem is the *assumptions* actuaries make to produce the results that are allegedly "far out of sync" with the self-proclaimed "economic mainstream."

The main culprit is usually the assumption for the future investment returns. Most pension actuaries utilize a deterministic rate of return. The assumed rate of return is typically used in a "riskless" manner, even though the rate may contain a sizable risk premium. The results of such calculations are described as "vulnerable to distortion, misunderstanding and abuse" in the article. The riskless rates obtainable in the marketplace are currently much lower, which makes conventional actuarial figures also vulnerable to the charges of "misinformation." Greg Abbott, the Texas attorney general, is perfectly clear about this matter. Abbot states in the *New York Times* article, "Actuarial assumptions based on misinformation are a recipe for disaster

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So, what exactly is this “economic mainstream” that is supposedly impervious to the charges of “misinformation?” Without a doubt, it refers to “marked-to-market” pension accounting. These days, the practices that do not comply with the “marked-to-market” mindset are denounced. The practitioners who do not support “marked-to-market” conventions routinely face the accusations of being insufficiently educated as well as guilty of the demise of DB plans.²

The intense scrutiny conventional actuarial practices have endured lately is well-deserved. Indisputably, these practices must be improved. I do not believe, however, that “marked-to-market” paradigm alone presents a credible alternative. The harsh criticism actuaries and other practitioners have experienced lately comes largely from *the desire to apply conventional accounting concepts beyond the scope of their applicability*.

The purpose of this article is to demonstrate that the virtues of “marked-to-market” pension accounting are greatly exaggerated for both public and private pension plans. I demonstrate that the “marked-to-market” paradigm, as applied to pensions, is based on a questionable economic foundation and may produce plenty of “misinformation” of its own. I take a short journey to the foundations of the concepts of present value and discounting, analyze the principles behind the “marked-to-market” mindset, describe the aspects of this mindset that make sense and the ones that do not, and sketch a better way to measure pension plans.

A Sensible Aspect of Pension Accounting

When one has to “account” for a pension plan, it is not unreasonable to attempt to value the benefits already granted to the plan participants. The price of a group annuity contract with a highly rated insurance company that pays all these benefits is a good candidate for a fair value of the promised benefits calculated for the accounting purposes. As an economic concept, the cost of plan termination (settlement) deserves consideration and represents a sensible aspect of “marked-to-market” pension accounting.

At the same time, conventional actuarial reports do not concentrate exclusively on the cost of termination. Public plans, for example, do not necessarily report the cost of termination, and more than a few authors want to challenge this premise. Furthermore, some authors claim that “marked-to-market” pension accounting has much more substance than the cost of termination.³ Some assert that the “marked-to-market” paradigm comes from one of the core principles of financial economics—the law of one price.

The Law of One Price

Here is the essence of “marked-to-market” pension accounting as applied specifically to public plans.

“The most basic concept in the field of finance is that of the present value of a future payment, whereby the future payment is discounted at a rate that reflects the risk associated with the payment. Public pension payments are risk-free for all intents and purposes. Accordingly, a theoretically correct discount rate is the yield of long-term U.S. Treasury bonds.”⁴

We have hypothetically matching payments of different nature—bonds and pensions. The law of one price states that two financial instruments that generate identical cash flows (in terms of timing, magnitude and likelihood) and tradable in an efficient market must have the same price. Otherwise, there would be an arbitrage opportunity, which cannot exist in an efficient

market. Therefore, the price of the bond portfolio is the only “theoretically correct” valuation of the pension commitment.

Or that is what the proponents of “marked-to-market” pension accounting want everyone to believe. This logic does not work because the following two important conditions are not satisfied. First, the law of one price requires *both* financial instruments to be tradable, and pension benefits are not tradable (at least, not yet). The tradability requirement for both instruments is not a mere technicality that can be easily dismissed. The ability to take advantage of the arbitrage opportunity created by the “mispricing” is the foundation of the law of one price.

Second, the two payments must be perfectly, and not hypothetically, matched. Matching bonds may exist for some pension payment and may not exist for some others—even “long-term U.S. Treasury bonds” are not long enough. Furthermore, while public pension payments are risk-free in a sense that they will certainly be paid, they are not risk-free in a sense that their timing and magnitude are far from certain. In particular, since *public pension plans are on-going*, their benefits may depend on the wage inflation in a particular region and/or occupation (at least, to some extent), but U.S. Treasury bonds are not diverse enough to provide a perfect hedge for this type of risk for all plans.

Overall, the law of one price is inapplicable. The theory according to which “a theoretically correct discount rate is the yield of long-term U.S. Treasury bonds” contains a major flaw.

Essentially, to value a pension plan as the hypothetical matching bond portfolio is a choice, not a necessity. In reality, different valuations of a particular pension plan do not necessarily create arbitrage opportunities. To value the pension commitment and the matching bond portfolio similarly may be a very sensible choice, but the driving force behind this choice is the usefulness of this valuation, not a flawed economic theory and an illusory arbitrage opportunity that a “mispricing” may create. In other words, calculations must be useful for something. Forcing actuaries to produce calculations for the sole purpose of satisfying a flawed economic theory is not a good idea.

The Basics of Present Value and Discounting

Clearly, the debate about the proper place for “marked-to-market” pension accounting has created a lot of confusion, at least partially due to the fact that the fundamental concepts of “present value” and “discounting” have been often misunderstood and misrepresented in the debate. In order to clarify these issues, let’s get back to the basics.

Think of portfolio P and its starting market value PV (stands for “Present Value”). After a period of time, the market value of portfolio P is equal to FV (stands for “Future Value”). To measure the asset value change, we define investment return R_P as the ratio of the investment gain over the present value:



(1)

This definition establishes a relationship between PV , FV , and R_P . If we need to calculate future value FV when present value PV and investment return R_P are known, simple transformations of definition (1) produce the following equation:



(2)

The distribution of return R_P is usually analyzed using a set of forward-looking capital market assumptions that include expected returns, risks, and correlations between various asset classes. Given present value PV , any portfolio generates future value FV calculated using (2).

Pension plans, however, face a different challenge. For a pension plan, future values—the promised benefits—are relatively predictable. In contrast, present values—e.g. the present value of future contributions—are much more volatile. The plan's main challenge is to determine the optimal asset allocation, contribution and benefit policies *at the present*. Therefore, the problem is to calculate present values given future values.

To do so for a given portfolio P , a simple transformation of equation (2) produces the following equation for present value PV :



(3)

Formula (3) represents the concept of *discounting procedure*—given portfolio P , it produces the asset value PV required to be invested in this portfolio at the present in order to accumulate future value FV . It must be emphasized that return R_P in (3) is generated by the actual portfolio P , as *there is no discounting without investing*. Any discounting procedure assumes that the assets are actually invested in a portfolio that generates the returns used in the procedure. Given future value FV , any portfolio generates present value PV calculated using (3).

It is essential to distinguish discounting *procedures* and discount *rates*. A discount *rate* is used when return R_P is certain, or risk-free. A discounting *procedure* is used when return R_P is not necessarily certain. As a result of a discounting procedure generated by a portfolio of risky assets, the present value of a cash flow may be uncertain and, as such, have a substantial volatility. Since most pension plans fund their commitments via investing in risky assets, present values of their pension commitments are uncertain. It should be mentioned that uncertain present values belong to the mainstream of actuarial science.⁵

Let's revisit the statement "a theoretically correct discount rate is the yield of long-term U.S. Treasury bonds" from Ennis [2007] quoted in the previous section. It is clear now that the statement contains little substance. When it is stated "the future payment is discounted at a *rate*," then it is effectively *assumed* that the return is risk-free. The statement essentially declares that if the return is risk-free, then it is generated by the U.S. Treasury bonds. Actuaries of all persuasions must be glad we got this thing straight, although it is not clear how this knowledge may affect their practices.

The Fallacy of "Marked-To-Market" Pension Accounting

In light of the concepts of present value and discounting we just discussed, let's look at "marked-to-market" pension accounting in action and consider the following example. A pension plan has made a commitment to make one payment of \$100 in a year from now. If one-year zero-coupon Treasury bond yields 3 percent, then the cost of "termination" (settlement) is equal to \$97.09 in a perfectly "marked-to-market" accounting report. We assume that the plan has \$97.09 *invested in stocks*. The plan has enough money to buy the matching bond, and it is common to call this plan "fully funded."⁶

However, the fact that the money and the matching bond are readily available does not mean that the plan has actually purchased the matching bond. The report shows that the plan assets are sufficient to buy the matching bond and absolutely ignores the fact that the actual portfolio has nothing to do with the matching bond. *This report completely conceals the riskiness of the plan's existing portfolio and, therefore, is manifestly deceptive.*

Now, let's consider the existing portfolio (100 percent stocks), assuming that stocks return R has geometric mean 8.00 percent and standard deviation 16.00 percent. As discussed in the prior section, the *required assets (RA)* associated with the plan's stock portfolio and the commitment to pay \$100 in a year is



The mean and the standard deviation of RA are 93.58 and 13.72 correspondingly.⁷ The existing asset value \$97.09 is equal to the 63th percentile of RA , so there is only a 63 percent chance that the plan will have enough money to pay the promised \$100 and a 37 percent chance that it will not. Does this plan look "fully-funded" to anyone? Will anyone stand up and say "misinformation?"

If the only "theoretically correct" discounting procedure is discounting by "the yield of long-term U.S. Treasury bonds," then the only "theoretically correct" policy portfolio is "long-term U.S. Treasury bonds," as other portfolios would generate other discounting procedures. One may plausibly argue that it makes little sense to fund the plan's short-term financial commitment via investing in stocks and the matching bond is a better investment solution. But this is an asset allocation preference, not a theoretical economic concept. As a theoretical concept, the necessity of discounting by "the yield of long-term U.S. Treasury bonds" is unsubstantiated.

The biggest deficiency of this concept, however, is not its theoretical flaws, but the severe restrictions it imposes on the risk management tools available to the plan's stakeholders. Using the discounting procedure that utilizes the full range of returns generated by the plan's actual portfolio (instead of "the yield of long-term U.S. Treasury bonds"), the plan's stakeholders can determine that the plan has just a 63 percent chance to fulfill its promise. Moreover, they may want to reduce the riskiness of the plan and, using a similar discounting procedure, determine that investing 20 percent of the plan's assets in a broad index of fixed income instruments and leaving the remaining 80 percent in stocks would increase this chance to 69 percent.⁸

Looking at the "marked-to-market" accounting statement alone, the plan's stakeholders have no way of knowing all of that. The inability to measure and manage the plan's riskiness clearly illuminates the fallacy of "marked-to-market" accounting.

What we have here is the inherently *uncertain* cost of funding and, on the other hand, accounting conventions that require *certain* values to be reported. The ambition to find accounting entries that fully and transparently describe the uncertain cost of pension funding is little more than wishful thinking.

The Cure May Be Worse Than the Disease

For decades, actuaries have used a single discount rate to calculate present

values of pension commitments. The single discount rate is somewhat close to the portfolio's geometric expected return, and, therefore, may include the risk premium. This practice is no longer required for corporate plans; for public plans, this practice is widely used.

The problem with this practice is it implies that there exists a portfolio that delivers risk premium without risk, which makes little sense. Many critics, however, understand that criticism without a viable alternative is a non-starter. Consequently, many offer "marked-to-market" pension accounting as the alternative.

The trouble is the cure may very well be worse than the disease. It is true that the conventional practice assumes an imaginary investment in a portfolio that delivers the risk premium without risk. But "marked-to-market" accounting also assumes an imaginary investment in an imaginary bond portfolio. The conventional practice completely ignores the riskiness of the existing portfolio, but "marked-to-market" accounting does exactly the same.

At the same time, the conventional practice—as inadequate as it is—has certain advantages over "marked-to-market" accounting. The conventional practice is based on the assumption that the objective of the stakeholders of a pension plan is to *fund* the plan. In contrast, "marked-to-market" accounting is based on the assumption that the objective is to *price* the plan, which may be helpful only for the purpose of plan termination. The conventional practice has some relationship, however imperfect, with the plan's actual portfolio. In contrast, "marked-to-market" accounting has nothing to do with the plan's actual portfolio. The conventional practice at least attempts to deal with the cost of running the plan—it contains some estimates, however imperfect, of the present value of future contributions. In contrast, "marked-to-market" accounting has nothing to do with the cost of running the plan.

In reality, the cost of running a pension plan is inherently uncertain. It depends, among other things, on the plan's policy portfolio and future investment returns. While we can measure and manage the uncertainty of cost, there is no single value that perfectly and transparently describes this uncertainty. The future is not transparent. There is nothing anyone can do about it.

I believe the most promising way to help pension plan managers to run their plans efficiently is to apply powerful risk management methodologies to *uncertain present values of pension commitments* generated by various portfolios under consideration. This subject, however, is outside of the scope of this paper.⁹

Conclusion

Here is the crux of the matter. The proponents of "marked-to-market" pension accounting are correct to say if you can't account for risk, don't use the risk premium. Since conventional accounting concepts don't deal with risk, the risk premium can't be used in a conventional accounting framework. But the rest of us do not have to limit ourselves to the Potemkin villages of conventional accounting. The risk premium along with other expectations of capital markets can and should be incorporated into the calculations of present values of pension commitments.

The "marked-to-market" straitjacket is a choice, not a necessity. Without it, the information available to the decision makers of the plan is much more comprehensive, as was discussed in prior sections. It includes, but is not limited to, the cost of termination, risk measurements of the existing policy portfolio and alternative portfolios. Ultimately, I believe the marketplace of ideas will sort everything out.

Meanwhile, the proponents of the “marked-to-market” pension accounting demand to incorporate “marked-to-market” values in actuarial valuation reports (even for public plans). In today’s environment of low tolerance to any perceived lack of disclosure, they may very well get their wishes granted. If it happens, these “marked-to-market” values—as inapplicable, stale, vague, “vulnerable to distortion, misunderstanding and abuse” and, most of all, unhelpful to most plans as they are—will be disclosed in every valuation report.

In this case, everyone who wishes the DB system well should demand that the nature of this “disclosure” is unmistakably disclosed. The “marked-to-market” figure should not have the term “liability” attached to it in any way. In the spirit of transparency, it must be clearly labeled as what I believe it really is: *the cost of termination*—a figure of questionable utility for a majority of plans published several months after the moment this figure might have been meaningful.

Let’s not kid ourselves, however, about what this disclosure will have accomplished: we will have another deficient methodology to follow. Moving in that direction, we won’t be getting closer to giving pension plan managers the valuable risk management tools they need.

When the actuarial valuation report (released sometime in June, if we are very lucky) reveals the cost of termination as of *January 1*, it will be up to the proponents of “marked-to-market” pension accounting to educate the plan’s decision makers why the cost of imaginary plan termination is vital and no other measurement is needed. It may be a good idea to remind them that time is of the essence, as the decision makers still have to take care of another important responsibility—to manage the plan, thank you very much.

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Endnotes

¹ See “Actuaries Scrutinized on Pensions,” by Mary Williams Walsh, *The New York Times*, May 21, 2008, http://www.nytimes.com/2008/05/21/business/21pension.html?_r=1&oref=slogin

² For example, see “Who Killed DB Plans? All the Usual Suspects,” by Douglas A. Love, *Pensions & Investments*, Dec. 11, 2006.

³ For example, see SOA-AAA, [2006] (p.4): “If company assets or liabilities

are valued at anything other than fair market value, arbitrage is introduced into that asset/liability valuation.”

⁴ See Ennis [2007], p. 39.

⁵ For example, see Bowers [1997], chapters 4 and 5, or Kellison [1991], chapter 10.

⁶ For example, see Ennis [2007], p. 40: “a fully funded plan to be one for which the market value of assets equals the ABO. If assets exceed the ABO, the plan has a surplus. If assets fall short of the ABO—for whatever reason—the plan has a funding deficit.”

⁷ Throughout this paper, I assume that all portfolio returns are distributed lognormally.

⁸ We assume the index return has geometric mean 5.00 percent, standard deviation 5.00 percent, and correlation with stocks 0.3.

⁹ For initial steps in this direction, see Mindlin [2008].

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BOOK CORNER: **PENSION DUMPING**, BY FRAN
HAWTHORNE
Tom Sablak, FSA

If pension plans have traditionally been considered to involve “sacrosanct promises” made by employers to employees, and if pension laws have been designed over the years to prevent the termination of underfunded defined benefit plans, then why does the PBGC run deficits measured in billions of dollars? Have bankruptcy laws actually made it relatively easy for organizations and industries to “dump” their underfunded plans onto the PBGC? And why has the PBGC—and ultimately retirees—been virtually powerless to stop this practice?

In *Pension Dumping: The Reasons, the Wreckage, the Stakes for Wall Street* (Bloomberg Press, 2008), Fran Hawthorne offers answers to these important questions. As a senior editor and senior writer at *Fortune* and *Institutional Investor*, Hawthorne has covered the pension industry for over twenty years, and her book guides us through the myriad of ERISA rules, PBGC regulations, bankruptcy laws, and investor expectations that have failed to prevent, and have perhaps even have contributed to, many high-profile plan terminations.

In the first section, “The Reasons,” Hawthorne suggests that underfunded pension plans are often not the primary reason that companies file for bankruptcy, but rather that distress plan terminations are sometimes the convenient course of action for companies that find themselves in bankruptcy court. She then examines the shortcomings of ERISA and bankruptcy law in the second section titled “The Laws,” arguing that the goal of bankruptcy proceedings, more often than not, is to help companies emerge from Chapter 11 and not to protect pensions. As a result, the PBGC, created by ERISA, is simply just another creditor in the bankruptcy process. While the PBGC’s standing in bankruptcy proceedings may not come as a surprise to pension actuaries who have followed the headlines over the years, Hawthorne’s account of the fate of pension plans in bankruptcy court is certainly worth reading.

According to Hawthorne, Wall Street and so-called “vulture investors” have also played a significant role in encouraging pension dumping, and she devotes the third section of her book to “The Investors.” In this section, through interviews and other research, she shows how those who invest in distressed companies are keenly aware that pensions can be dumped and are often only too happy to take advantage of this option. In the final section, titled “The Future,” Hawthorne argues that, since the Pension Protection Act does not contain provisions that could put an end to the practice of pension dumping, the best hope for reversing the trend may be to revisit bankruptcy law.

The Pension Section of the Society of Actuaries is thrilled to welcome Fran

Members of Pension Section Council are available to explain the Retirement 20/20 initiative to your local actuarial club or any other interested group. If you'd like to arrange for a presentation - either in person or via Web cast - please contact Ann Gineo at agineo@segalco.com. Ann is a member of Pension Section Council and leader of the Retirement 20/20 Communication and Outreach subgroup.

Hawthorne as a guest speaker at the 2008 SOA Annual Meeting & Exhibit in Orlando, Fla. Please join us for a breakout session titled "Pension Dumping—Who Wins and Who Loses When Pension Promises Are Broken" (Wednesday, October 22 at 10:45 a.m.), where Fran will be on hand to discuss (and autograph) her book and share her insights on the practice of pension dumping.

Tom Sablak, FSA, FCA, MAAA is chair of the Pension Section Continuing Education Team. He's a consulting actuary with the Cassidy Retirement Group in Concord, Mass. He can be reached at tom@cassidyretirement.com.

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PENSION FINANCE RESOURCES

Richard Herchenroether, FSA

The Pension Protection Act may currently be the most urgent topic of study for U.S. pension actuaries, but most meetings and conferences also have sessions with "Financial Economics" or "Pension Finance" as part of their titles. And, the FE/PF topic is at the center of considerable debate in both American and Canadian actuarial circles at present. The study of finance underpins economic analysis taught in business schools. For many non-actuaries, these financial tools have long been the basis for the analysis of pension liabilities. Actuaries were not unaware of this—you may recall the 600-page text published by The Actuarial Foundation in 1998.

One charge of the Joint AAA/SOA Pension Finance Task Force (originally known as the Joint AAA/SOA Task Force on Financial Economics and the Actuarial Model) is to promote educational opportunities for actuaries so that we may integrate finance into our work. The Task Force has created a library of material on the SOA Web site containing well over 100 papers, essays, articles, and newsletters. Various points of view are represented. Authors include academics, economists, and investment professionals, as well as actuaries. A description of what is available on-line follows, along with a few reasons why you might find the material (and the resource) useful.

Where to Find the Pension Finance Resources

The direct link to the home page of this resource is <http://www.soa.org/professional-interests/pension/research-thinking-ahead/pen-finance-resources.aspx> or type "pension finance" in the Quick Search block and one or more of the first few items listed should be a link to the Pension Finance Resources home page.

There are several things going on at Pension Finance Resources:

- There is a link to the Pension Actuary's Guide to Financial Economics and also an Excel worksheet that illustrates the tax arbitrage problem described in the Guide. The guide was created by the task force to give an overview of financial concepts that are applied to measure pension benefit liabilities. If you decide that you wish to purchase a print copy of the Guide, they can be ordered for only \$15 [here](#).
- The links to "Key Points" and "Changes Needed to Actuarial Practice" open to pages with individual articles that helped bring the finance topic to the attention of the wider pension actuarial community.
- At the bottom of the home page under the heading "Further

Members of Pension Section Council are available to explain the Retirement 20/20 initiative to your local actuarial club or any other interested group. If you'd like to arrange for a presentation - either in person or via Web cast - please contact Ann Gineo at agineo@segalco.com. Ann is a member of Pension Section Council and leader of the Retirement 20/20 Communication and Outreach subgroup.

Research" are several links leading to broad topical categories.

But, the newest resource featured is the list of readings of a somewhat ad hoc and eclectic nature, collected as a spin-off from the work of the task force. Members of the task force often circulate readings as they debate diverse points of view. Other readings are drawn from academic papers written by economists and financial analysts. The literary quality of these papers may be uneven, but all of them—as implicitly suggested by their inclusion in the first place—contain relevant insights and add to the growing body of knowledge around this relatively nascent topic. As with any library, the choice of which items to pull from the shelf depends on individual interests and needs.

Let me suggest two ways that I have found most useful for reviewing this list:

1. A click on the title "Joint Academy/Society of Actuaries Pension Finance Task Force Library," brings you to a page with a short list of topics. Click on a topic and the title/authors are listed. Occasionally, the links will take you to external Web pages (due to copyright considerations), and some articles are listed under (or linked to) more than one topic. Keep in mind that the topical assignment to each reading—and even the list of topics itself—is often a matter of subjective judgment.
2. The alternative is a link to open an Excel file named "Pension Finance Knowledge Sharing Index." This option is repeated on the topic-oriented pages as well. Several advantages of this approach come to mind. You can search for key words, authors or subject; the file includes abstracts for each listing; and you can download the Excel file for further investigation off-line. The links to the readings are embedded within the Excel file so you are all set to access documents at your leisure.

The readings range in scope from the seminal 1958 academic paper by Modigliani and Miller (or M&M for short) to a newspaper interview with Herbert Simon. The irony is that while Miller's current publisher is the University of Chicago, a leader (if not the leader) in the realm of finance, all three of the above authors/academicians were teaching at Pittsburgh's Carnegie Tech (now Carnegie-Mellon) in the 1950s. These "M&M propositions" are generally recognized as the kicking-off point for the new area of study that came to be known as financial economics. Simon's concurrent idea of "bounded rationality" grew into behavioral economics. All three eventually earned Nobel prizes in economics.

Why Spend Time on Finance?

The recent trends in law, accounting (U.S., Canadian and global), Actuarial Standards of Practice, and Wall Street/Bay Street analysis have all been affected by the business school finance model. Starting in the mid-1970s, investment bankers took the lead in the application of financial analysis to pension liabilities. Meanwhile, the attention of pension actuaries continued to be focused on ERISA and SFAS 87 (prior to 132/158), and CICA rules in Canada. Since both pension funding and financial accounting were rooted in traditional actuarial methods prior to the ascendancy of finance to its current prominence, we actuaries too easily ignored the growing influence of the finance view outside our ranks. Over time, there developed a schism between the adherents of these two approaches.

The 2003 publication of "Reinventing Pension Actuarial Science" by Bader

and Gold precipitated an awareness of the schism. Their paper was the one that began to provoke a broader discussion among pension actuaries, although others had been writing on the usefulness of finance concepts for years. This new awareness led to the Great Controversy Symposium, imbedded within the June 2003 SOA meeting in Vancouver, where more than 20 papers were presented and discussed.

“Reinventing” implies replacing traditional actuarial methods with financial concepts and methods. The U.K. actuary, John Shuttleworth, clearly agrees. His Staple Inn essay was republished in the October 2002 *Risks and Rewards* newsletter. In it, he describes the shift, saying “... for many actuaries, reinventing their knowledge base will be pleurably therapeutic, even cathartic.” He asks not to be viewed as inflammatory, but his writing is colorful and active. The online version can be found [here](#).

Dimitry Mindlin presents an evolutionary view of the blending of finance with traditional actuarial methods in his paper “Reaffirming Pension Actuarial Science,” originally published in the April 2005 *Pension Forum* (Vol. 16, No. 2). The online version can be found [here](#).

A large part of the controversy is exemplified by these positions. Are traditional actuarial methods outmoded, to be replaced with modern financial analysis as taught in business schools? Or is a blending—an evolution—the path to the future? Each position has supporters. Suffice it to say that the use of financial economics tools and methods for valuing assets and liabilities is predominant among non-actuaries. This fact alone requires pension actuaries to understand the finance point of view.

The focus placed on “mark to market” liability measurement by the new Pension Protection Act in the United States is based, however imperfectly, on finance. The accounting community is, albeit slowly, shifting toward the same market-based measurements. Our own standards of practice are also being affected. The “money” people, such as CFOs, with whom we consult with increasing frequency have been schooled on financial economics.

For example, large plan clients frequently ask for expected benefit disbursements year by year, often for the next 30 to 50 or more years. This data is then used to feed an investment consultant’s model of plan assets and liabilities. When the opportunity arises, you can be more influential in the discussion if you are able to articulate your ideas in the language used by the finance folks and their investment consultant.

Conclusion

My hope is that in one way or another I have planted a seed of interest in the coming together of modern finance and traditional actuarial science. The crossroads was built, for those of us based in the United States, when ERISA granted pension participants a claim on the assets of corporate pension plan sponsors. That, to adopt a frequently-used adage, changes everything.

Additions will be made to our list of readings from time to time. I would be happy to receive suggestions of articles that you have found useful. If not obvious, information on copyright ownership would help the SOA staff in securing necessary permissions.

Richard Herchenroether, FSA, FCA, EA, MAAA, is a consulting actuary in Pittsburgh, Pa. Any opinions expressed or implied are his own and not necessarily those of other members of the Joint AAA/SOA Task Force on

Pension Finance. He can be reached at richard.herchenroether@gte.net.

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VALUING LIABILITIES AND LUMP SUMS UNDER PPA

Howard J. Small, ASA

The Pension Protection Act (PPA) introduced a significant modification in the way pension liabilities and annuity payments, in general, are to be valued.

Very succinctly, PPA follows the contemporary idea that the present value of an annuity is the discounted value of a cash flow stream. As such, a present value can, in theory, be equated with a series of zero coupon bonds, each of which has a maturity date and face amount that corresponds to each expected cash flow payment. For example, the present value of \$10,000 payable at age 65 to an active person currently age 61 is completely determined by the yield-to-maturity of a 4-year zero coupon bond and the probability that a 61-year-old will survive to age 65. Similarly, \$10,000 payable at age 66 to the same 61-year-old would be based on the yield-to-maturity of a 5-year zero coupon bond and the probability of surviving to age 66. While it's permissible for valuation purposes to discount each future cash payment by the interest rate corresponding to a yield-to-maturity bond curve, PPA simplified the number of interest rates to three segment rates. The first segment rate applies to cash flows payable within the first five years of the determination date. The second segment rate applies to cash flows payable during the 15-year period that extends from five to twenty years from the determination date. The third segment rate applies to cash flows payable from twenty years and beyond with respect to the determination date.

Returning to our 61-year old active participant who is expected to retire at age 65, there is statistical data supporting the fact that actively working people are generally healthier and have lower mortality than those who are retired. PPA captured this notion by stipulating two mortality tables: an annuitant mortality table which applies to an individual when benefits go into pay status and a non-annuitant mortality table which applies for the period preceding payment status. In the previous paragraph, the expected second payment of \$10,000 at age 66 would be computed as the probability of surviving four years to age 65 using non-annuitant mortality and one year to age 66 using annuitant mortality. (In accordance with IRS Revenue Ruling 2007-67, the mortality rates for payment forms subject to §417(e) (i.e., lump sums) are based on the combined annuitant and non-annuitant tables rather than on separate tables which generally will be required for minimum funding.)

In general, as we all learned at one time, the annuity with annual payments of \$10,000 can be formulated as:



where r_t equals the first segment rate when $t = 4$; the second segment rate for



; and, the third segment rate for



, and

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 is derived using non-annuitant mortality prior to age 65, and annuitant mortality, thereafter.

It may be a matter of opinion, but this actuary concluded that with three interest rates and two mortality tables, it's easier to value the summation directly than to develop three sets of commutation functions in order to first compute and then sum the present value of payments for each of the three segment periods.

The summation formula denoted above can be expanded to reflect monthly payments. Before we completely abandon commutation functions, note that the present value of a 1-year temporary annuity can be approximated by:



If you consider an annuity as the discounted value of a series of 1-year temporary annuities the present value summation can be rewritten as



But wait. There's more...

Not only is it straightforward to evaluate the above summation formula by tabulating each component term in a column of a spreadsheet, but this first principles approach can be extended very nicely. For starters, there's no reason to be restricted to an annual payment of \$1 payable monthly. Have you ever had to evaluate a temporary annuity where the number of payments is not a multiple of 12? Sure, you can do a linear interpolation between two temporary annuities. A better solution is to develop a general formula for a temporary annuity where the payment period is less than one year:



The reasonableness of  is easily verified. Setting $n = 1$ results in



. Setting $n = 12$, results in the familiar



. Now we have complete flexibility in choosing any

number of months in the payment period. Tabulating a column of  means you can specify the age where payments begin and the point where payments end. In other words,



where:  is computed using the appropriate segment rate;

 is computed using non-annuitant mortality prior to the payment period and annuitant mortality, thereafter; and



is derived using annuitant mortality.

But wait. There's more...

In the original example, suppose that instead of being exact age 61, the participant were age 61 and 3 months, and we had to compute the present value of a \$10,000 annual accrued benefit where the normal retirement age is 65. While it's possible to interpolate between annuity values, the PPA segmented interest rates and mortality table structure pose a knotty problem. The second and third segment interest rates

begin at ages x and y , respectively. The breakpoint age between non-annuitant mortality and annuitant mortality is exact age 65. Given what we have learned, what's the best way to solve the problem? Answer: Interpolate the mortality

rates. In other words, x is really y and, in general, x . ² Once the mortality rates are adjusted, the segmented interest rates coincide with the ages. But for one other adjustment discussed below, the annuity factor is derived the same way as it would for an exact age calculation. No further interpolation is required.

Having defined the beginning of 1-year time intervals to correspond with ages x etc., age 65 is no longer an exact age with reference to the revised age intervals. Age 65 is nine months into the 1-year interval that began at age

x . Moreover; from age 65 to age y there are only three monthly payments. There may be other alternatives, but one prudent solution is to define

x in terms of the annuitant mortality at age 65, then discount it back to the beginning of the year with nine months of interest and non-annuitant mortality.

Accordingly, if we define the term x as

x

where x is based on non-annuitant mortality, we can further generalize the basic PV summation formula:

x

where x equals 1 for all years, except in the year where the first payment is in not at the beginning of a year.

Conclusion

Years ago, when I started in the field, my manager was an actuary who was an engineer by training. I was humored by the fact that he did not have an electric calculator on his desk (yes, electric not electronic). He worked with a slide rule. He was comfortable with it, and it served him well right up until his retirement.

Commutation functions have been in the actuarial literature for about 200 years. They have served us well by simplifying to a division of x , what would have been a completely unworkable calculation without the aid of a computer. Life was simple when we had one interest rate and one mortality table. We now have multiple interest rates combined with non-annuitant and annuitant generational mortality tables. Just

as my first manager was comfortable with his slide rule, actuaries are comfortable with commutation functions. It may take a while, but eventually we all will have to part with our old ways. I actually framed my high school slide rule several years ago. I might have to consider doing the same with my copy of Wallace Jordan's *Life Contingencies*.

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Notes

¹ The present value of a n-payment temporary annuity of \$1 per annum payable monthly equals

Let $\ddot{a}_{\overline{n}|i}$ and approximate $\ddot{a}_{\overline{n}|i}$ with a linear function over the range $i \in [0, 0.10]$. Note, $\ddot{a}_{\overline{n}|0} = n$ and $\ddot{a}_{\overline{n}|0.10} = \ddot{a}_{\overline{n}|0.10}$. Hence, the slope of the line over the range $i \in [0, 0.10]$ is $\frac{\ddot{a}_{\overline{n}|0.10} - n}{0.10}$. Consequently,

$\ddot{a}_{\overline{n}|i} \approx n + \frac{\ddot{a}_{\overline{n}|0.10} - n}{0.10}i$. So, the summation can be approximated as:

$$\sum_{k=1}^n \frac{1}{(1+i)^k} \approx \sum_{k=1}^n \left(n + \frac{\ddot{a}_{\overline{n}|0.10} - n}{0.10}i \right)^k$$

² (Interpolating Mortality Rates)

Except for early ages, the mortality curve is concave. Consequently, a linear interpolation between any two points will result in a line segment that is above the mortality curve.

A geometric interpolation, *i.e.*, $\frac{q_x + q_y}{2}$ results in an interpolated rate that is equal to or less than a linearly interpolated rate:

$\frac{q_x + q_y}{2} \leq \frac{q_x(1-q_y) + q_y(1-q_x)}{2}$. The conclusion, therefore, is that a geometrically interpolated rate "fits" closer to the underlying mortality curve.

³ (Proposed formula to evaluate $\ddot{a}_{\overline{n}|i}$)

Let $\ddot{a}_{\overline{n}|i}$.

Note, $\ddot{a}_{\overline{n}|0} = n$ and $\ddot{a}_{\overline{n}|0.10} = \ddot{a}_{\overline{n}|0.10}$.

Since $\ddot{a}_{\overline{n}|i}$ is a decreasing function of i ,



As a further note, upon expanding the expression , we have



Within the brackets, the sum of the third and subsequent terms is negative.

Consequently,  for . Therefore, consistent with the observation in NOTE 2, the proposed formula results in a larger  than would be derived using a UDD assumption.

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