16th International Conference of Social Security Actuaries and Statisticians

Social Security Financing

Notes for a presentation by
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International Actuarial Association
on

Making Survival Sustainable

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Distinguished speakers, honored guests, and dear colleagues,

I am privileged and honoured to be given this opportunity to speak on behalf of the International Actuarial Association – the IAA – in my capacity as its Secretary General. On behalf of the IAA, I would like to express my sincere appreciation to everyone who has contributed to making this 16th International Conference a great success.

Although the IAA is incorporated under Swiss Law as a not-for-profit, non-political and non-governmental organization, its Head Office is in Ottawa and the Secretariat located less than one km from this hotel. ISSA is one of our 4 institutional members the other 3 being the International Association of Insurance Supervisors (IAIS), the International Accounting Standards Board (IASB), and the International Organization of Pension Supervisors (IOPS). There are currently 62 full member associations and 23 Associate members regrouping over 45 000 actuaries around the world.

The IAA Vision statement reads:

> *"The actuarial profession is recognized worldwide as a major player in the decision-making process within the financial services industry, in the area of social protection and in the management of risk, contributing to the well-being of society as a whole."*

In compliance with the objective of contributing to "*the well-being of society as a whole"* the IAA regularly produces briefs in response to requests from the IASB, IAIS, IOPS, and the OECD to assist in adapting the regulatory framework to a rapidly changing environment.

The IAA response to the GFC

One of the main themes of this Conference is *"Financial crisis and its impact on long term sustainability of pension plans"*. This is also one of the greatest challenges the actuarial profession is now facing given the ongoing global financial crisis which was unique enough to deserve its own acronym: GFC.

Given this objective, the IAA could not remain silent about the GFC. On February 10, 2009, the IAA published a paper entitled *"Dealing with Predictable Irrationality – Actuarial Ideas to Strengthen Global Financial Risk Management"* to communicate the actuarial profession's response to the crisis. The following four recommendations are reflected in the proposals adopted by the G20 in April:

- Introduction of more counter-cyclical regulatory arrangements
- Creation of Country Chief Risk Supervisor role
- Wider use of comprehensive risk management concepts in banks and non-regulated sectors
- Improved use of ERM & risk governance

The February paper was more focused on the banking sector, but a follow-up paper entitled *The Global Financial Crisis – What Next?* issued in July focuses on the consequences for the pension and the insurance sectors. Two issues raised in this paper are relevant for this Conference:

- -Does it imply a need for mandatory scenario / stochastic testing in reports on funding policies for pension plans to ensure that risk levels are consistent with target risk appetites?
- -In the longer term, the GFC also re-opens the question of whether the progressive conversion of Defined Benefit schemes to Defined Contribution pension and saving arrangements in recent years has contributed to increased systemic risk by transferring risks to individuals and removing the source of some buffers in the system

The IAA and the longevity risks

But while we can hope that the GFC will someday become a bad memory, increasing longevity is likely to be a continuing risk for pension and social security programs. Mortality has always been a concern for actuaries and documentation about estimates for the value of a life annuity goes back to the Roman Empire. Modern mortality tables go back to the founding of *The Equitable Insurance Company* in the UK in 1762 and of *La Compagnie Royale d'assurances* in France chartered by Louis XVI in 1787. About a century later, *The Institute of Actuaries*, the oldest actuarial body, was founded in London on July 8, 1848.

Fortunately for risk managers, there is no positive correlation between mortality and the volatility of the economy: economic conditions do not directly affect life expectancy – that is, more or less people do not die if interest rates are high or low or the stock market is bullish or bearish. Thus, despite the attention given to the GFC, mortality remains a key concern for actuaries, as it should be for the society as a whole, given its pervasive impact on many socio-economic issues. The IAA has identified many socio-economic aspects that are affected by changes in mortality rates including:

- The costs of old age income support in social security systems;
- The proportion of resources absorbed by government sponsored and private health arrangements;
- The financial position of defined benefit pension funds;
- The probability that assets will be sufficient for retirement needs for members of defined contribution funds;
- The solvency requirements of life insurers;
- Pricing of long term mortality related financial products;
- Work place practices relating to the employment of older workers;

- The growth of certain industries (such as aged care services) and the need for infrastructure (such as accessibility to transport).

Longevity is not Public Enemy #1

Increasing longevity should not be seen as Public Enemy #1 as it is positive for individuals and for the society as a whole, but as many other changes it entails risks. The challenge is to reap the benefits and manage the risks properly. For that it is necessary to better understand the causes and driving forces of what proves to be a complex phenomenon. It is in the public interest that individuals, the civil society and governments be better informed about the policy options not only to manage the risks but also to promote longevity and thus likely reduce health expenses while improving the economic capacity of the country and the well-being of the people.

The decrease in fertility combined with the increase in longevity is causing the well known phenomenon of demographic aging whereby the dependency ratio increases to a point the sustainability of programs is at risk. This is obviously an issue of public policy where the actuarial profession can help define the options, one of which is increasing the labor force by pushing up the retirement age so as to maintain a proper balance between the period of economic activity and the period of retirement. In most countries this has proven to be a difficult political decision and more clarity as to the causes and the factors affecting longevity can be more persuasive. Maybe an easier alternative would be a more comprehensive change in lifestyle towards a 4-day week but a significantly postponed retirement age?

While there have been numerous studies of mortality and many tables published in different countries for different purposes over the last centuries, in the last few decades there has been a paradigm shift that, with the support of modern powerful computers, has led to projections of mortality improvements and stochastic estimates of the probability of variations. The shift includes more and more emphasis on the risk of surviving too long rather than on the risk of dying too soon which was the key threat to the solvency of life insurance companies. The new challenge is "*Making survival sustainable*" for retirement programs and for pension and annuity products.

Correlation with age, sex and level of income

Deeper knowledge of the drivers of mortality indicates that in addition to age and sex, level of income is an important indicator which has led to analysis of the cross-subsidy implicit in the pooling of mortality within social security programs that cover the whole population. This cross-subsidy can be limited by capping the income taken into account. This is also an important issue of social policy where a better understanding of the factors affecting longevity may lead to better equity and serve the public interest.

The IAA Mortality Task Force

Planning requires knowledge and understanding about rates of mortality and, in the same spirit of addressing strategic challenges that the world must face, in January 2008 the IAA set up a Task Force on Mortality(MTF). The areas under active study by the IAA MTF include:

- **Collection of global mortality tables:** We aim to provide a central point of reference to enable simple web-based access to these websites or tables.

- **Mortality trends**: We aim to provide references to the documentation of such trends and to projection methodologies. What could be said about the uncertainty of projections of future mortality trends?

- **Pandemics**: A pandemic is an outbreak of infectious disease on an international, regional or global scale. How is the impact of a possible future pandemic taken into account in financial calculations?

- **Uncertainty**: The values in mortality tables, both present day and at future dates, are best estimates. How can uncertainty be factored into the calculations made by actuaries and others?

- **Social and demographic stratification**: Rates of mortality vary according to a person's social and demographic profile. How are financial institutions dealing with questions relating to social difference in mortality rates?

- **Analysis by cause of death**: Social changes, medical breakthroughs and increased awareness of basic healthy lifestyle behaviour have resulted in enormous shifts in the causes of death.

- **Projection and Graduation techniques**: There are three broad approaches for forecasting future levels of mortality once the "raw" data has been "graduated" that is smoothed to produce a table:
    - Expectation based on expert opinion,
    - Extrapolation methods.
    - Explanatory methods are based on structured or causal epidemiological models

- **Data availability**: In a number of countries there are reliable data bases for births, deaths and the size of the population. However, in many countries, data is very scarce, since data is lacking or of low quality, or since the country is too small. In these countries, special techniques must be used to construct mortality tables. What insights can the actuarial profession offer, internationally?

- **Mortality related financial products:** The traditional product supporting financial institutions in hedging their mortality risk has been reinsurance but there has also been

a development of other types of mortality related financial solutions and products such as longevity bonds.

Optimizing the IAA contribution

As an association of actuarial associations, the IAA applies a principle of subsidiarity which means that it relies as much as possible on its member associations and focuses on activities that require international co-ordination. Much research has already been done, in particular by the large actuarial associations that are members of the IAA. So the mandate of the MTF implies co-ordination and collection of information which we illustrate below by examples from the UK and North American associations

The MTF expects to be presenting a first report six month from now on the occasion of the next International Congresses of Actuaries hosted by the Actuarial Society of South Africa in Cape Town. There will also be sessions on Micro Insurance, which poses a particular challenge since mortality projections need to take into account the level of income. The 28th ICA was held in Paris in 2006 and I would like to encourage all of you to attend the 29th ICA next March . The 30th ICA will take place in Washington, DC, in the spring of 2014 during the cherry blossom season.

From the UK: Scoping of Mortality Research

In September 2008, in the UK a Mortality Research Steering Group presented its report on the Scoping of Mortality Research[1]. Key themes identified from recommended literature included:

- the role of medicine in mortality reduction;
- the role of lifestyle and environment in mortality reduction, including smoking, socio-economic conditions and obesity;
- causes of death contributing to mortality reduction, in particular coronary heart disease;
- reduction attributable to differing age groups;
- the relationship of active life expectancy to total gains in life expectancy;
- evidence of cohort effects on mortality improvement; and
- future trends in mortality developments.

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Gaps identified in recommended literature are:

- a lack of recommendations from social policy;
- few papers recommended on the role of lifestyle and behavioral factors on mortality;
- few papers recommended on causes of death other than coronary heart disease; and
- few papers recommended on potential threats to future mortality improvement.

From North America: Longevity Risks Quantification and Management

In November 2008, the Society of Actuaries published a comprehensive document entitled *"Longevity Risk Quantification and Management: A Review of Relevant Literature"*[2]. This report is a review of available papers, publications, articles, and presentations on the topic of longevity risk. It is

[1] © Institutes of Actuaries and Faculty of Actuaries; Dr Catriona Macdonald

[2] © 2008 Society of Actuaries; Thomas Crawford, FIA, FSA,MAAA; Richard de Haan, , FIA, FSA,MAAA; Chad Runchey, FSA,MAAA; Ernst & Young LLP

intended to be a resource for actuaries and other professionals interested in learning more about this area. Appendix A contains the papers that were referred to and reviewed for the body of this report. Appendix B contains references to other relevant papers that may be of interest to the readers. All together there are 110 papers listed in the Appendices.

A key finding is that

> *"Almost every nation throughout the world is seeing the life expectancy of their population increase due to factors including better diet, increased access to adequate amounts of food and basic healthcare, and advances in medicine. With concurrent declines in fertility rates, many countries are witnessing a demographic shift towards a 'graying' population, where the number of people in retirement is rapidly catching up with the number of people in the workforce. All across the globe this is putting strains on existing retirement systems, and leading to a shift in the risk from employers and plan sponsors to individuals."*

Like the UK study, the SoA paper identifies gaps in the current literature and research. This report did not include a literature review of the many medical and social factors that may be driving increases in life expectancy. There is significant research available on these topics, and a similar literature review would be useful to those readers interested in understanding the causes and drivers of life expectancy.

A particular gap is with regards to stochastic projections; the academic research conducted to date typically does a good job of pointing out areas where the analysis could be extended:

- More detailed analysis of continuous stochastic mortality models that could be used for pricing mortality derivatives.
- Modeling of longevity bonds with multiple cohorts of lives.
- Further analysis around calibration of the initial mortality term structure.
- Discussion around using different volatility structures as an alternative to Brownian motion.

Mortality/Longevity risks

The IAA identifies four components of mortality/longevity risk and two categories:

Systemic	*Specific*
Level	Volatility
Trend	Catastrophe

Systematic risk refers to having the incorrect base assumptions (level and trend), and specific risk refers to volatility around the base assumptions (volatility and catastrophe). Specific risk reduces as the number of lives covered increases; however, systematic risk cannot be diversified. The impact of systematic risk to pension plans and insurers is estimated to be significant and is increasing.

Projection of Systemic risk

Statistics on increasing longevity often refers to the life expectancy at birth. In countries that have a high infant mortality, this can greatly distort comparisons as the gain results mostly from reduced mortality at young ages. For pension and social security, what is more significant is longevity at higher ages. The following table illustrates the increase of life expectancy at age 60 in the UK. It can be seen that, in the first 40 years, males gained only 1 year, but in the next 40 years it accelerated to 3 years and the same gain is expected over the following 40 years. It should be noted that the differential between males and females has increased from 1 year to 4 years; an increase has also been reported in other countries. Part of the gain can be attributed to the elimination of infectious diseases which have almost disappeared in the UK as a cause of death, but remain important in many developing countries, thus creating room for similar improvements.

Expectation of life at age 60 (UK)[3]

	1911	**1951**	**1991**	**2031**
Males	14	15	18	23
Females	15	18	22	26

A review of the experience indicates that progress has been sustained and generally underestimated. Institutions that make guarantees based on the lifetime of individuals are thus exposed to increased longevity risks. Those institutions include governments that are often the ultimate guarantor of civil service pension plans that they sponsor as well as social security programs, in addition to private insurers and private pension plans.

Sovereign risks rating

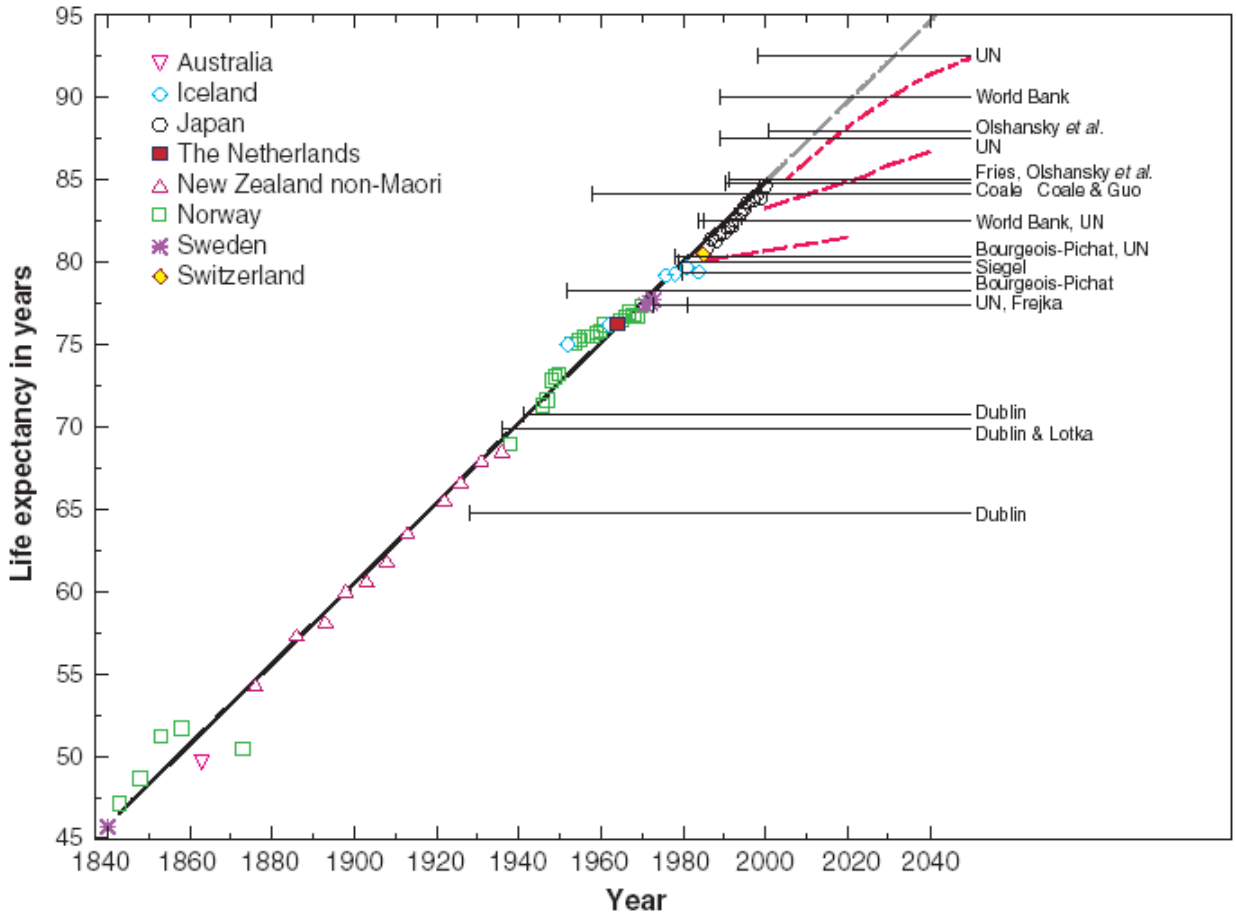
Rating agencies are paying greater attention to longevity risks of insurers and sponsors of occupational plans. In my opinion, it is a question of time before ratings of sovereign risks start to reflect the longevity risks that the governments are supporting which are often a large burden compared to the GDP.

Female Life Expectancy

The following chart displays the life expectancy at birth for females from 1840 projected through 2040. The solid line is fitted from data points which represent mortality studies from a number of countries. The dashed lines illustrate the projected life expectancy as produced by several research papers. As evident in the chart, life expectancy has steadily increased for all of the countries studied, and while past projections have predicted a slowdown in the increases in life expectancy, the fitted line illustrates continuing increases in life expectancy at birth of three months per year from 1840 to 2000.[4]

[3] Source: 1911 to 1991 – ONS
2031 – mid-1998 based Government Actuary's Department population projections

[4] Source: Oeppen J, et al. Science 2002; 296: 1029-31



Historical perspective

While medical advances are a factor, lifestyle is recognized as an important contributor to longevity as are public health initiatives like access to clean water, promotion of better eating habits and simple practices like hands washing. The following summary shows that life style and public health measures have been factors and that future improvements are not dependent on new medical discovery but on the wider implementation of the knowledge that we already have:

<1650: Pestilence & Famine

-Infectious diseases kill young population and pregnant women

-Life expectancy: 20 to 40

1650- 1920: Receding Pandemics

-Cause of death shift from infectious to chronic diseases

-Public health measures (Sanitation), living habits, higher incomes move up life expectancy to 50

1920- 2000: Degenerative diseases of affluence

-Death from heart disease, strokes, cancer

-Medical progress and better care push up life expectancy above 70

2000+: Delayed degenerative diseases

-Accessibility to public and private health care, advances in public health and medical technology, better life styles, control of risk factors (blood pressure, high cholesterol) reduce heart diseases and strokes

-Increase in survival above at 65+ results in higher proportion of elderly

There is still uncertainty as to the extent of future increases in longevity and one can speculate about fantastic discoveries that would dramatically reduce deaths caused by cardio-vascular diseases or cancer but wide gains are possible from the knowledge we already have for example eliminating deaths from infectious diseases. There is enough experience accumulated to help project the effect of eliminating a specific cause of death or changes in life style. We have data on preventable or avoidable causes of death and actuarial studies can help governments estimate the cost/benefit ratio of various initiatives including public education.

Even though the Law of large numbers remains a cornerstone of insurance and annuity calculations, more refinements have been introduced that recognize factors other than age and sex as proxies for estimating mortality for a particular group of individuals.The authors of the SoA study noted that, while most of the trends indicate future life expectancy is increasing, there are schools of thought that argue a potential reversal of recent trends[5]. Pandemics are seen as a bigger threat in a more interconnected world. The widely differing views on future mortality trends indicate that there is a great deal of uncertainty regarding mortality improvement, leading to an ever greater need for action by the industry [and governments] to understand the fundamental drivers of longevity risk. But as pointed out in the same study *"One thing is certain, life expectancy today is greater than at any point in history."*

Are we "deniers"?

It took many years of denials before effectively recognizing the negative effects of smoking and for public policy to react to the findings. Insurance companies were more prompt to offer non-smoking discounts! Even though there is uncertainty as to the extent of long term longevity increases that justifies differences of opinion and for example the debate on the squaring of the survival curve, there is enough evidence to justify applying the "precautionary principle". Although I do not perceive an active challenge to the projection of mortality improvements by a large group of "deniers"[6] as is the case for *Global Warming* there is nevertheless a widespread

[5] See for example Obesity: preventing and managing the global Epidemic. WHO, 1998. See also "Toxic" by William Reymond, Flammarion 2007.

[6]. This term was first coined as "a deliberate reference to the ``Holocaust deniers`` who defend the Nazi regime by claiming that Jews and their allies faked the Holocost." It did not get much traction against people denying the

passivity. For some clients and users of actuarial reports, including governments, long term mortality improvements are another *"inconvenient truth"* and the resulting cost increases deemed speculative. Arguments are made from an accounting point of view that this is creating a contingency reserve for something that may not happen but nothing prevents reporting on a static basis if necessary. In many, maybe in most countries, retirement ages have not yet reflected increased longevity denying the challenge of a shrinking work force supporting a growing proportion of retirees.

Using the knowledge

Even within the actuarial profession we are slow in fully recognizing the reality of the consequences on the future costs of pension and social security systems. Mortality tables are upgraded to more current mortality and not to deny mortality improvements, the table is projected to some year in the near future but further improvements are left for the next actuarial report or the next actuary. Thus instead of deniers maybe we have non-believers! Closing your eyes is an ostrich reaction that endangers sustainability since it may lead sponsors to make promises that will prove unaffordable.

For example a more prudent approach would be to incorporate a best estimate of future mortality improvements and build in the design a dynamic Normal Retirement Age that would track longevity improvements; should the longevity increases slow down it would be an easy political decision to post-pone a scheduled increased in the NRA. For other assumptions the best practice is to have greater margins the farther we are in the future; for mortality it is usual to reduce the rate of improvement in the future!

Projection by cohorts: year of birth versus calendar mortality

Recognizing long term mortality improvements means projecting mortality by cohort that is on the basis of the year of birth rather than the calendar year. The extract shows only the first few columns and lines are shown but the calculations reflect probabilities to the end of the table at age 119. As mortality tables are derived from past experience and it takes a few year to collect the data and construct a cureent table may very well reflect expected mortality for 2002 but let's assume there is no denial that mortality improvements did occur through 2009 and thus the table incorporates a projection of mortality that makes it a best estimate for 2009.

Let's consider a member that retires at 65 in 2009 and thus was born in 1944. In 2009 the mortality expected for calendar year 2009 are the rates shown in the column headed 2009. At age 66 that member should experience the mortality expected for year 2010, that is the calculation should be based not on the next line but on the next line in the next column incorporating one more year of projection. The same will apply for 2011 and subsequent years so the calculation should proceed along the diagonal that will reach the end of the table at age 119 in 2063, thus many hidden columns to the right. The expected sum of future payments of 1

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effect of smoking but it has been revived in relation with the debate on "Global warming". See "The Deniers" by Lawrence Solomon, 2008 published by Richard Vigilante Books ISBN 978-0-9800763-1-8

unit per year for life is 18,250 if calculated using the rates in the column headed 2009. If the calculation proceeds along the diagonal corresponding to YoB 1944 which is bolded, the sum becomes 21,125, that is 15,8%% more than the factor based on 2009 mortality. By the time age 70 is reached in 2014 the difference is still 14,8% and the two will converge gradually towards age 119 in 2063. If the improvements were decreasing linearly to ½% in 2084 the 2009 differential would be 13,8%.

Comparison of Pay-outs on calendar and on cohort basis

Calendar year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Attained age	65	66	67	68	69	70
	Expected sum of future payments of 1/yr for life					
With then calendar year mortality	18,250	17,647	17,052	16,469	15,899	15,346
With mortality for Year of Birth 1944	**21,125**	**20,394**	**19,674**	**18,969**	**18,281**	**17,614**
	Mortality rates with improvements 2%/yr					
65	**0,013195**					
66	0,014522	**0,014232**				
67	0,016175	0,015852	**0,015534**			
68	0,018154	0,017791	0,017435	**0,017086**		
69	0,020457	0,020048	0,019647	0,019254	**0,018869**	
70	0,023086	0,022624	0,022172	0,021728	0,021294	**0,020868**
71	0,026040	0,025519	0,025009	0,024509	0,024018	0,023538
72	0,029319	0,028733	0,028158	0,027595	0,027043	0,026502
73	0,032923	0,032265	0,031619	0,030987	0,030367	0,029760
74	0,036853	0,036116	0,035394	0,034686	0,033992	0,033312
75	0,041108	0,040286	0,039480	0,038691	0,037917	0,037158
76	0,045688	0,044774	0,043879	0,043001	0,042141	0,041298
77	0,050594	0,049582	0,048590	0,047619	0,046666	0,045733
78	0,055825	0,054709	0,053614	0,052542	0,051491	0,050461
79	0,061380	0,060152	0,058949	0,057770	0,056615	0,055483
80	0,067262	0,065917	0,064598	0,063306	0,062040	0,060800

Not denying long term mortality improvements means replacing the vertical series of static rates for each calendar year by a diagonal series sloping down to the right that anticipates future improvements year by year until the end of the survival period of each year of birth cohort. Not only this approach provides a more accurate estimate of future costs but it allocates them to the correct calendar year. Thus reconciling gains and losses in successive actuarial valuations will automatically provide a warning if the experience diverges from the projection and if the projection factors need to be revised up or down. It is thus a better

practice than creating a buffer by using rates for a future calendar year to average the mortality, thus generating gains for a few years and then losses.

Stochastic projections

Even cohort projections are not making full use of the available information and of the potential of new fast computer that feature large memories and can process calculations at the speed of light or close to it! A best actuarial estimate based on the mean gives us only one picture of what the future may hold; that is what actuaries call a deterministic approach. But the analysis of past mortality experience gives us information about the variability of mortality rates which is mitigated by the Law of large numbers but not eliminated. The stochastic simulation can be applied as well to factors other than mortality to capture the contribution to volatility of factors such as retirement age, marital status, interest returns, prices differential, etc...

A stochastic approach entails a large number of simulations giving us information about the distribution of expected results around the mean so readers can see what is the probability that results will diverge from the mean by how much. This is often expressed as a confidence interval indicating results will be within ±5% of the mean 95% of the time, or the probability of results being more than 10% above the best estimate is 4% or 1 year out of 25.

Illustration from the Canada Pension Plan

What is described above may not be a common practice but I submit it is both a best practice and doable. I am fortunate to be able to point out to an application implemented locally in Ottawa to demonstrate the feasibility of applying techniques that can help better quantify the longevity risk and measure its volatility. The reports are publicly available on OSFI's web site[7].The first extract compares calendar based projections and cohort based projections.

If you go to the web site to see the complete set of tables look also for Table 20 CPP Retirement Beneficiaries Life Expectancies which illustrate an analysis of longevity by level of income.

[7] http://www.osfi-bsif.gc.ca/app/DocRepository: Actuarial Study no 7 Canada Pension Plan Mortality Study, July 2008. , Office of the Chief Actuary

Table 10 Life Expectancies for Canada less Québec, without improvements after the year shown*

	Males				Females			
Age	2005	2010	2050	2075	2005	2010	2050	2075
0	78.2	79.2	83.0	84.6	82.7	83.2	86.0	87.5
10	68.7	69.7	73.4	74.9	73.2	73.7	76.3	77.8
20	58.9	59.9	63.5	65.0	63.3	63.8	66.4	67.8
30	49.3	50.3	53.7	55.2	53.5	54.0	56.6	57.9
40	39.8	40.7	44.0	45.4	43.8	44.2	46.7	48.1
50	30.5	31.4	34.5	35.9	34.3	34.7	37.1	38.4
60	21.9	22.7	25.5	26.8	25.3	25.6	27.8	29.1
65	18.0	18.7	21.3	22.4	21.1	21.4	23.4	24.6
70	14.4	14.9	17.2	18.3	17.1	17.4	19.2	20.2
75	11.1	11.5	13.4	14.4	13.4	13.6	15.2	16.1
80	8.3	8.6	10.1	10.8	10.1	10.2	11.5	12.3
90	4.3	4.4	5.0	5.4	5.2	5.2	5.8	6.2
100	2.0	2.0	2.3	2.6	2.5	2.5	2.8	3.1

* These are calendar year life expectancies based on the mortality rates of the given attained year.

Table 11 Life Expectancies for Canada less Québec, with improvements**

	Males				Females			
Age	2005	2010	2050	2075	2005	2010	2050	2075
0	84.4	84.8	87.4	88.8	87.5	87.9	90.2	91.5
10	74.2	74.6	77.1	78.6	77.4	77.7	80.0	81.3
20	63.7	64.1	66.7	68.1	66.9	67.2	69.5	70.9
30	53.4	53.8	56.3	57.8	56.5	56.8	59.1	60.5
40	43.1	43.5	46.0	47.5	46.1	46.5	48.8	50.1
50	33.1	33.5	36.0	37.4	36.0	36.3	38.6	39.9
60	23.6	24.1	26.4	27.7	26.4	26.7	28.8	30.1
65	19.3	19.8	22.0	23.2	21.9	22.2	24.2	25.4
70	15.2	15.7	17.7	18.8	17.6	17.9	19.7	20.8
75	11.6	12.0	13.8	14.7	13.7	14.0	15.6	16.5
80	8.6	8.8	10.3	11.1	10.2	10.4	11.7	12.6
90	4.3	4.4	5.0	5.4	5.2	5.2	5.9	6.3
100	2.0	2.1	2.4	2.6	2.5	2.5	2.8	3.1

** These are cohort life expectancies that take into account future improvements in mortality and therefore differ from calendar year life expectancies, which are based on the mortality rates of the given attained year.

A last extract[8] illustrates the use of stochastic modelling to determine the parameters to be used estimate the importance of variations corresponding to a confidence interval comprising 95% of the results.

[8] 23rd Annual Report for the Canada Pension Plan, October 2007, Office of the Chief Actuary

results.

Table 24 Individual Sensitivity Test Assumptions

	Canada	Low-Cost	Best-Estimate	High-Cost
1	Total fertility rate	2.1	1.6	1.1
2	Mortality: Canadian life expectancy at age 65 in 2050	Males 17.8 Females 18.6	Males 21.9 Females 24.2	Males 25.1 Females 27.9
3	Net migration rate	0.59%	0.54%	0.48%
4	Participation rate (aged 15-69)*	81% (2030)	74% (2030)	71% (2030)
	Unemployment rate*	4.3%	6.3%	8.3%
5	Rate of increase in prices	3.4%	2.5%	1.3%
6	Real-wage differential	1.9%	1.3%	0.5%
7	Real rates of return	5.7%	4.2%	2.7%
8	Retirement rates for cohort at age 60*	Males 20% Females 25%	Males 40% Females 45%	Males 60% Females 65%
9	CPP disability incidence rates (per 1,000 eligible)	Males 2.45 Females 3.05	Males 3.1 Females 3.5	Males 3.75 Females 3.95

* For this test a deterministic instead of a stochastic approach was used to derive the high- and low-cost estimates.

The use of the stochastic method to determine the range is described as follows for the fertility rate:

> *"The best-estimate assumption is that the total fertility rate for Canada will increase slightly from its 2005 level of 1.53 to an ultimate level of 1.60 in 2010. Based on fertility experience of the last 65 years (1941 to 2005), a stochastic approach was used to generate the low- and high-cost scenarios over the 75-year projection period. It was projected that the average total fertility rate throughout the 75-year projection period will be in the range 1.1 to 2.1 with 95% probability."*

These reports demonstrate the feasibility of applying known best practices and should allow you to appreciate the added value from an information and communication point of view. With some effort of imagination you could also appreciate the added value of policy options that would be supported by projections that are more explicit in terms of confidence interval, sensitivity and level of uncertainty. However it is also necessary to appreciate the level of effort as stated in the report:

> *"For each assumption, a minimum of 1,000 outcomes are generated for each year in the projection period. Next, a 95% confidence interval is calculated for each*

> *assumption to determine with 95% probability, the range of possible outcomes. The upper and lower values of this 95% confidence interval are used as the low-cost and high-cost assumptions for these individual sensitivity tests. These stochastically-generated values represent the range of the average outcome for the indicated variable over the entire 75-year projection period."*

The report was reviewed by a Panel of experts[9] that commented favorably on the report while suggesting further improvements in the implementation of the stochastic approach concluding as follows:

> *"The hypothetical ideal would be to use an integrated model where all parameters are stochastically generated in an integrated fashion (e.g., if inflation rises, other economic and even non-economic parameters are varied stochastically in a consistent and plausible fashion). Given the complexity of the CPP model, and indeed of the reality it represents, this ideal is probably not attainable, even for a modest subset of the assumptions".*

In other words, perfection is a journey, not a destination but actuarial science will benefit from efforts that will be deployed by the Office of the Chief Actuary in Canada to further refine the stochastic methods used to measure the remaining uncertainty in his valuations of the CPP.

Conclusion: yes we can make survival sustainable!

The risks arising from systemic and specific factors that drive the increase in longevity are many and their interactions complex. However there is an increased awareness of the importance of better information and analysis for managing in the public interest both the factors that drive longevity and the risks

Indeed despite the risks it entails for pension and social security programs, increasing longevity is a positive development for the society as a whole. Therefore actuarial research generates double returns: better risk management and better management of the resources to be devoted to improving mortality.

A second set of good news is that as research yields more information about the key factors, tools and methodologies are available to quantify the risks. The actuarial profession is poised to help decision makers and the civil society with policy options to optimize the allocation of resources to achieve sustainability.

[9] Review of The Twenty-Third Actuarial Report on The Canada Pension Plan, conducted by the CPP Actuarial Review Panel, March 19, 2008;
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