Seeing Beyond Risk Canadian Institute of Actuaries Institut canadien des actuaires Voir au-delà du risque

Draft Report for Comments

Canadian Pensioners Mortality

Pension Experience Subcommittee –

Research Committee

July 2013

Document 213059

Ce document est disponible en français

Seeing Beyond Risk Canadian Institute of Actuaries Institut canadien des actuaires Voir au-delà du risque

Memorandum

To: All Fellows, Affiliates, Associates, and Correspondents of the Canadian Institute of Actuaries

From: Marc-André Melançon, Chair
Member Services Council

Dave Dickson, Chair
Research Committee

A. Kim Young, Chair
Pension Experience Subcommittee

Date: July 31, 2013

Subject: **Draft Report: Canadian Pensioners Mortality – July 2013**

The attached document contains proposed Canadian pensioners mortality tables and improvement scales based on experience studies conducted by the Canadian Institute of Actuaries (CIA). There are a number of documents and tables referenced in this document that are available online; links are provided at the applicable reference points.

The report is being presented to the membership in the form of a draft report to obtain feedback on the content of the report and on the proposed tables and scales.

The primary objective of these studies was to build base mortality tables and mortality improvement scales that may be used for actuarial valuations for funding and/or financial reporting purposes for a broad range of Canadian pension plans. Furthermore, it was expected that such tables and scales may be considered for use under actuarial standards of practice for the determination of pension commuted values and the division of pension benefits on marriage breakdown.

Parties wishing to comment on the draft report should direct those comments to Kim Young at kim.young@sunlife.com **by September 30, 2013**. A copy should also be sent to CIA resident actuary Chris Fievoli at chris.fievoli@cia-ica.ca.

MAM, DD, AKY

INTRODUCTION

In 2008, the Research Committee of the Canadian Institute of Actuaries (CIA) formed the Pension Experience Subcommittee to:

- Review the pensioner mortality experience in Canada; and
- Develop and maintain a Canadian pension mortality table and improvement scale.

To this end, the Institute commissioned two concurrent experience studies. One study, the CPP/QPP Study, reviewed the experience of pensioners under the Canada Pension Plan, under the Québec Pension Plan, and in combination. For the purpose of developing mortality tables, the CPP/QPP Study reviewed the mortality experience of all persons receiving a retirement pension from the CPP and QPP for the calendar years 2005, 2006, and 2007 (central year 2006). The complete results of this study are provided in a report prepared by Louis Adam, FCIA, FSA, entitled "The Canadian Pensioners Mortality Table, Information on mortality for the triennial period ending December 31, 2007 with data as at December 31, 2008" (the CPP/QPP Phase II Report), which can be found here.

The CPP/QPP Study also reviewed the trends of mortality experience since 1967, the first year that pensions became payable under these programs. Results of this study are provided in the report, also prepared by Louis Adam, entitled "The Canadian Pensioners Mortality Table, Historical Trends in Mortality Improvement and a Proposed Projection Model based on CPP/QPP data as at December 31, 2007" (the CPP/QPP Phase III Report), which can be found here.

The second study, the RPP Study, reviewed the experience of a number of Canadian registered pension plans, including both public sector and private sector plans. The results of this study are provided within this report.

The primary objective of these studies was to build base mortality tables and mortality improvement scales that may be used for actuarial valuations for funding and/or financial reporting purposes for a broad range of Canadian pension plans. Furthermore, it was expected that such tables and scales may be considered for use under actuarial standards of practice for the determination of pension commuted values and the division of pension benefits on marriage breakdown.

This report presents a set of proposed mortality tables based primarily on the experience observed from the RPP Study and proposed mortality improvement scales based primarily on the experience observed from the CPP/QPP Study. The report presents gender-specific mortality tables based on the overall RPP Study data and separate tables based on public and private sector data. In addition, proposed size adjustment factors that reflect mortality differences observed by pension income level are provided. The report presents both a two-dimensional mortality improvement scale and a transitional one-dimensional scale that approximates in the near term the financial effect of the two-dimensional scale.

The subcommittee notes that the proposed tables should be used with due regard for plan-specific experience and circumstances. In many cases, adjustments to the published base table may be appropriate in specific circumstances.

The Institute thanks the 19 administrators/record-keepers (contributors) for contributing data and providing ongoing clarification to the subcommittee. The Institute appreciates the considerable effort expended by the contributors.

The Institute also thanks those members and non-members of the Institute who have dedicated significant time to this work as current and past participants of the subcommittee. In particular, the Institute thanks Louis Adam, Bob Howard, and MIB Solutions for the data compilation and analyses prepared on behalf of the Institute.

The members of the Pension Experience Subcommittee as at June 2013 are: A. Kim Young (Chair), Louis Adam, Michael Banks, Gavin Benjamin, Assia Billig, Paul Burnell, Bob Howard, Hrvoje Lakota, Scott McManus, and Catherine Robertson.

1 PROPOSED MORTALITY TABLES AND MORTALITY IMPROVEMENT SCALES

1.1 Proposed Mortality Tables

1.1.1 Introduction

In the RPP Study, the mortality experience for calendar years 1999 to 2008 of a subset of Canadian public sector and private sector registered pension plans was reviewed. Based on the results of the RPP Study, the following base male and female mortality tables for the year 2014 are provided:

- RPP 2014 Mortality Table (CPM-RPP2014)—developed from the combined experience exhibited under the public and private sector plans included in the RPP Study;
- RPP 2014 Public Sector Mortality Table (CPM-RPP2014Publ)—based on the separate experience exhibited under the public sector plans included in the RPP Study; and
- RPP 2014 Private Sector Mortality Table (CPM-RPP2014Priv)—based on the separate experience exhibited under the private sector plans included in the RPP Study.

Each of the above tables includes a set of size adjustment factors to reflect the experience exhibited at different pension income levels.

The table name abbreviations have been chosen to be consistent with the naming convention adopted in the CPP/QPP Phase II Report, where "CPM" refers to Canadian Pensioners Mortality. The tables and size adjustment factors can be found here.

1.1.2 Application

It is expected that practitioners will adopt a table and adjustment factors that are most reasonable and appropriate in the circumstances of the particular plan under review. Further details on the development of the mortality tables and adjustment factors presented with this report are provided in section 2.

1.1.2.1 Mortality Tables

The subcommittee believes that the private sector data reviewed in the RPP Study included limited or no representation from the "Finance, insurance and real estate" or from "Information and cultural" industries (Statistics Canada classifications). It is expected that both of these industries would likely exhibit mortality rates closer to those of the public sector than the private sector, as reflected in the RPP study.

The subcommittee notes that the combined RPP 2014 Mortality Table represents the experience of all registered pension plans included in the RPP Study and suggests that it could be considered suitable for use under actuarial standards of practice for the

determination of pension commuted values and for the division of pension benefits on marriage breakdown.

1.1.2.2 Size Adjustment Factors

The RPP Study, and the CPP/QPP Study, identified significant experience variation by size of pension. Accordingly the subcommittee developed size adjustment factors that can be used with the base mortality tables. The subcommittee believes that it is best practice to modify the base tables to reflect actual, credible experience of the pension plan under review. However, if sufficient experience is not available, using the size adjustment factors would normally be appropriate where the average size of pensions under the particular plans is significantly larger or smaller than the average size of pensions reflected in the RPP Study data. Note that the range limits for each pension size band are as at 2014 and may require adjustment when the table is applied in subsequent years. One potential adjustment that may be appropriate is to adjust the limits to reflect changes in Average Weekly Earnings (AWE).

For reference, the average pension sizes reflected in the RPP study adjusted with AWE to 2014 are shown in table 7 provided in section 2.1.5.

The subcommittee believes that the best practice approach when applying size adjustment factors would be to group pensioner data by pension size band at the valuation date and use a separate mortality table for each band. However, a satisfactory approximation may be to determine a single size adjustment factor for each gender using the average size adjustment factor weighted by pension amount.

Table 1 illustrates the calculations using the size adjustment factors as proposed. The example is based on fictional data. For simplicity, all pensioners are assumed to be males age 70. The discount rate is 4%, and the calculations are performed as at January 1, 2014. [Note: in the tables provided in this report, sums may not add exactly due to the rounding of interim amounts.]

Table 1. Example of calculating pension values with size adjustments

Band	Monthly Pension Range	Number of Members	Total Monthly Pension	Monthly Average Pension	Size Adjust. Factor	Annuity Factor	Value
3	1000-1499	100	110,000	1,100	1.2535	11.630	15,352,098
4	1500-1999	70	115,500	1,650	1.2108	11.744	16,276,824
5	2000-2499	40	88,000	2,200	1.1532	11.903	12,569,173
8	3500-3999	25	93,750	3,750	0.9770	12.438	13,992,323
	Total	235	407,250	1,733			58,190,418
	Weighted	235	407,250	1,733	1.1560	11.895	58,128,588
	Look up	235	407,250	1,733	1.2108	11.744	57,391,659

The example assumes that pension records are first summarized into bands with increments of $500 per month. The sixth column shows values from the proposed size adjustment table. The annuity factor in the seventh column is the present value of a monthly annuity-due of $1 per annum for a male age 70. The last column is the product of 12, the monthly pension and the annuity factor.

The subcommittee believes that an acceptable alternative is suggested by the row marked "Weighted". The size adjustment factor is the weighted average of the four size adjustment factors shown in the first part of the table. That is, the fourth and sixth columns are multiplied together and the sum is divided by the sum of the fourth column. The resulting value of the pensions is close to that of the exact calculation. Further testing on more realistic datasets found the "weighted" method did not deviate from the "exact" by more than 0.15%. There may be some downward bias because in all tests "weighted" was lower, but not significantly so. The subcommittee considers the "weighted" method to be a satisfactory approximation.

The last row of table 1, marked "Look up", shows a method that, although intuitive, will rarely be satisfactory. In this case the average pension, which is $1,733, is noted to fall in the size adjustment factor band 4. Therefore, the table is adjusted using the band 4 size adjustment factor. (Note that the annuity factor is the same as on the second row of the first part of the table, 11.744.) The "look up" method is not recommended.

Because the size adjustment factors do not have a linear relationship with size, it is not enough to consider the average size of pension within a pension plan. The distribution by size adjustment band is also important. Accordingly it is not necessarily correct to assume that the value of a pension plan with an average size similar to that of the underlying data will be the same with and without size adjustments; see chart 9 in section 4.2 below.

Since the size adjustment factors are designed to apply directly to the valuation of pensions in pay, actuaries will need to consider whether it is appropriate to incorporate a comparable average size adjustment into the valuation of active members for a particular plan.

1.2 Proposed Mortality Improvement Scales

1.2.1 Introduction

The CPP/QPP Study reviewed the trends of mortality experience since 1967, the first year that pensions became payable under those programs. Based on the results of the CPP/QPP Study, the following male and female improvement scales are provided:

- CPM Improvement Scale A (CPM-A)—improvement rates by age that decrease in a linear fashion for years 2014–2030 and ultimate rates applicable for all years after 2030; and
- CPM Improvement Scale A1-2014 (CPM-A1D2014)—improvement rates by age only designed to approximate the CPM Improvement Scale A for pension valuations in 2014 and 2015.

These improvement scales can be found online here.

1.2.2 Application

The subcommittee recommends that practitioners consider adopting the proposed two-dimensional mortality improvement scale, CPM Mortality Improvement Scale A. However, the subcommittee recognizes that few pension valuation systems are currently designed to accommodate a two-dimensional scale.

Based on these considerations, the subcommittee also developed a transitional, one-dimensional (age only), gender-specific mortality improvement scale, CPM Improvement Scale A1-2014, that

approximates in the near term the financial effect of the two-dimensional scale, assuming both sets of rates are applied on a generational basis.

For each age, the mortality improvement rates developed for the one-dimensional scale take into account the evolution of improvement rates anticipated over the next several decades. The two-dimensional scale assumes a slowdown in mortality improvement during years 2014 to 2030. As such, it may be inappropriate to apply the one-dimensional scale for the purpose of actuarial valuations after 2016 since it may result in an overstatement of actuarial liabilities.

It would be valid to use the CPM Mortality Improvement Scale A for valuations where the base table has been adjusted for mortality improvement or experience to 1999 or a later year. The CPM Mortality Improvement Scale A would then be applied from that particular year. However, the one-dimensional CPM Improvement Scale A1-2014 is only suitable for use with a table that has been adjusted for mortality improvement or experience to 2014.

To clarify the use of the two-dimensional improvement scale developed under this study, consider the following example:

Table 2. Example of using 2-dimensional improvement scale

Subset of CPM Improvement Scale				Subset of CPM-RPP2014	
Male	2014	2015	2016	Age	Male
80	0.02649	0.02532	0.02415	80	0.03678
81	0.02478	0.02371	0.02264	81	0.04186
82	0.02308	0.02210	0.02113	82	0.04783

Suppose it is desired to calculate the probability at the start of 2015 for a male then age 80 to survive for two years. In the notation below, "I" represents the improvement rate and a superscript is the year for the mortality rate or improvement rate, where the base year is 2014.

$${}_2p_{80}^{2015} = p_{80}^{2015}p_{81}^{2016} = (1 - q_{80}^{base}(1 - I_{80}^{2015}))\,(1 - q_{81}^{base}(1 - I_{81}^{2015})\,(1 - I_{81}^{2016}))$$

= [1-0.03678*(1-0.02532)]*[1-0.04186*(1-0.02371)*(1-0.02264)]

= 0.92564

Notation for mortality rates and improvement rates by year does not appear to be standardized within the profession. We use the following definitions, which incidentally were also used by the Society of Actuaries in connection with the two-dimensional Scale BB.

q_x^y means the probability that a person, age *x* nearest birthday at the beginning of calendar year *y*, will die before reaching the end of the calendar year. Note that both *x* and *y* are defined at the beginning of the one-year period.

I_x^y means the improvement rate in mortality for persons aged *x* nearest birthday at the start of calendar year *y*-1 to those aged *x* at the start of calendar year *y*. In this case *x* is constant through the one-year period, and *y* is defined at the end of the period.

$$q_x^y = q_x^{y-1}(1 - I_x^y)$$

2 DEVELOPMENT OF MORTALITY TABLES AND SIZE ADJUSTMENT FACTORS

2.1 Data—RPP Study

2.1.1 Data Gathering

The Institute commissioned MIB Solutions to gather data from Canadian pension plan contributors on lives covered by their pension plans. The call for data went out in November 2009, and data were collected during 2010. Nineteen contributors submitted data for calendar years 1999 to 2008, from both the public and private sectors, for active lives, for pensioners and for beneficiaries after the death of pensioners. Not all contributors provided data for all years and one contributor subsequently withdrew from the study.

The data collection and validation processes are described in the MIB Solutions report, which can be found online here.

MIB Solutions provided Bob Howard, a member of the Institute and the subcommittee, with seriatim records derived from the data submitted. In particular, to protect confidentiality, member identification numbers were removed, company and plan names were replaced by codes, and dates of birth and death were replaced by age and year of death. Codes were added to indicate the status as active, pensioner or beneficiary, whether excluded, and whether unresolved. A record is marked unresolved if there was exposure for that life in some years but not in later years and no death was reported.

To ensure that the data transmitted to and assembled by Bob Howard remained consistent with that provided by MIB Solutions, the MIB Solutions report includes a table of ungraduated mortality rates based on preliminary public sector pensioner data. A comparison of those rates to similarly calculated rates prepared by Mr. Howard confirmed for the subcommittee that he and MIB Solutions were using the data in an appropriate and consistent manner. All further analyses and tables constructed for the RPP Study were prepared by Mr. Howard.

2.1.2 Data Selection and Modification

Not all data submitted by contributors were of uniformly high quality. Individual records were excluded if they had been flagged by MIB Solutions as excluded. If a record was marked as unresolved, all records for that life were excluded.

Not all contributors provided sign-off to MIB Solutions indicating their agreement that the data were sufficiently accurate. Subsequent to receiving the data from MIB Solutions, the subcommittee approached three contributors who had not signed off. One of these withdrew its data because a summary of its data was not consistent with its internal mortality study. The other two contributors provided sign-off.

The RPP Study used data only if the relevant contributor signed off. In the end, the data from 11 contributors were used for the RPP Study.

It was necessary to exclude some contributor-years of data. All records for a contributor were rejected for a particular year if any of the following criteria was met:

- Unresolved records exceeded 10% of the number of deaths in the year;
- The actual/expected ratio based on annualized pension was an outlier by more than three standard deviations; or

- The number of deaths in the year was less than 20.

For one contributor, which submitted data for all 10 years, there were so many unresolved records for the first five years of data that the subcommittee initially rejected those years of data. After examining a sample of 20 unresolved records for pensioners, it was found that all had died and 19 of them had died in the last year that the pensioner had been included in the data (but marked as alive). Therefore, for this contributor only, all unresolved records were treated as deaths in the last year reported alive and all 10 years of data were included.

It was concluded that the active life data were not sufficiently reliable for the purpose of constructing a table. Salaries were available for such a small proportion of the data that the salary information was not usable. A non-zero salary on death records was rare. The actual to expected death ratios by number of lives were very low at the younger ages and very high at the older ages, so much so that the accuracy of the active death records was in question. Furthermore, it was the subcommittee's view that the mortality rates for active lives are typically less relevant in the context of pension valuations.

The subcommittee also concluded that the beneficiary data should not be used in table construction. It would be appropriate to include beneficiary data only if the study could also include experience for these lives prior to the death of the member, but such experience was not available.

In contrast to the RPP Study, the Institute's Individual Annuitant Mortality Study tracks both lives from the outset of a joint and survivor annuity. That experience shows that mortality is lighter than for single lives while both are alive, but substantially higher after the first death. A test on that data showed that the present value of a joint and survivor annuity would be essentially the same whether calculated based on single life mortality throughout or on "joint both alive" mortality until the first death and on "joint survivor" thereafter. These observations gave the subcommittee confidence in relying on the member pensioner data only to give a satisfactory result. The subcommittee concluded that including the beneficiary data would bias mortality rates upward.

All pensioner records with a monthly income of less than $10 were excluded. A surprisingly large number of records included pensions with very low or zero income. It is not clear how there can be a pension with a zero monthly benefit; those records were considered to be unreliable. If the income is very small, there is less incentive for the contributor to seek information on the pensioner, and a death is more likely to go unreported.

The monthly income for any one record was capped at $10,000; any excess is ignored. There are a few records with very large pension amounts. Without capping the monthly income, these very large records could have too strong an influence on the experience measured by income, and their presence at the least increases the variability of the experience.

There are codes to indicate the form of benefit (e.g., life only, joint and survivor, etc.). It would have been desirable to study experience separately for each type. However, so many contributors reported the form as "unknown" that distinction by form of payment was abandoned.

Similarly, workforce characteristic (e.g., salaried, hourly, union, etc.) was reported as "unknown" so frequently that this code is ignored for table construction.

It is also important to note, based on the location of contributors participating in the RPP Study, that pensioners included are primarily located in the provinces of British Columbia, Nova Scotia and Ontario.

2.1.3 Incurred But Not Reported (IBNR)

It is probable that the data submitted misses some deaths that have occurred but were not yet reported at the time the data were submitted, referred to as incurred but not reported (IBNR) deaths. Since the most recent data are certain to have more IBNR deaths than the data for earlier years, it is important to adjust for IBNR before trying to infer the extent of improvement in mortality. This adjustment, although important, is highly subjective. The subcommittee has no pension-related information on which IBNR factors can be determined. The subcommittee used the IBNR factors of the Institute's Individual Annuitant Mortality Study as a starting point. However, it must be noted that the IBNR factors vary considerably by company, gender, duration, and form of benefit.

Since data were contributed in 2010 with 2008 as the last year of experience, it made sense to start with a factor consistent with the second duration. The subcommittee decided to adjust for IBNR by multiplying deaths in the period 2004–2008 by 1.002, 1.004, 1.008, 1.012, and 1.02, respectively; deaths for years 1999 to 2003 were taken as complete.

2.1.4 Public Sector versus Private Sector Data

The subcommittee was initially concerned that the data had a markedly higher proportion of public sector members than the proportion of public sector registered pension plan membership in Canada. The subcommittee compared our data with that of CANSIM 280-0016, which shows the number of members included in defined benefit plans split by gender and public/private sector. In addition, the subcommittee believes that the private sector data have almost no representation from "Finance, insurance and real estate" and from "Information and cultural" industries, both of which the subcommittee believed can be expected to exhibit mortality rates closer to those of the public sector than the remainder of the private sector. Therefore, for comparison purposes the subcommittee adjusted the CANSIM 280-0016 data to reflect these two industry groupings as public rather than private sector using data from CANSIM 280-0011, which provides data on defined benefit pension plan membership by gender and North American Industry Classification System categories.

After the data selection and modification described in section 2.1.2, the proportions of public sector versus private sector membership for the study data and Canadian pension plan membership were closer than initially expected. To match the proportions implied by the CANSIM data, one would need to weight the private sector data by 114% for males and 111% for females. Considering that the CANSIM data reviewed relates to current pension plan members rather than pensioners, the subcommittee concluded that the proportions from the RPP study data were close enough to the proportions from the CANSIM data to justify using the data for a composite table without applying additional weighting to the private sector data.

2.1.5 Data Summaries

Table 3 shows the data for pensioners as submitted by participating contributors and a summary for each deduction: for not signed off, excluded (as flagged by MIB), unresolved (records missing with no death reported), rejected (contributor-year of data meets one of the three criteria mentioned above related to questionable data), for small incomes (under $10 per month) and for excess incomes (over $10,000 per month). "Included" refers to the data used in the RPP Study. Data for the public and private sectors are shown separately.

In all tables, "count" means the number of life-years included, and "pension" is the sum of the annualized pensions over those same life-years.

Table 3. Summary of data for Pensioners

Public Sector				
	Exposed		Deaths	
	Count	Pension	Count	Pension
Submitted	5,152,184	107,173,848,575	99,299	1,400,807,796
Not signed off	2,060,368	39,524,681,937	38,176	464,961,117
Excluded	9,213	82,473,466	200	699,909
Unresolved	4,061	86,896,439	0	0
Rejected	389,127	6,907,378,095	5,997	27,889,458
Small	4,858	91,312	142	1,510
Excess	0	0	0	0
Included	2,684,556	60,572,327,326	54,784	907,255,803
Private Sector				
	Exposed		Deaths	
	Count	Pension	Count	Pension
Submitted	1,111,753	10,182,244,855	58,875	359,704,629
Not signed off	101,815	976,491,938	2,653	17,231,322
Excluded	158	653,914	289	1,235,865
Unresolved	5	12	0	0
Rejected	0	0	0	0
Small	90,538	4,201,957	7,160	347,927
Excess	0	7,113,552	0	127,146
Included	919,237	9,193,783,482	48,774	340,762,369
Total Included	3,603,793	69,766,110,808	103,558	1,248,018,172

Table 4 shows the data included in the RPP Study for each year of experience. The average year of experience, weighted by income exposed, is 2004.38.

Table 4. Data by year for Pensioners

Public Sector				
	Exposed		Deaths	
Year	Count	Pension	Count	Pension
1999	165,692	3,347,669,395	3,713	52,647,662
2000	175,702	3,681,953,478	3,853	57,544,931
2001	186,443	4,081,910,146	3,786	59,480,166
2002	211,040	4,842,741,328	4,347	73,981,647
2003	224,464	5,259,922,839	4,289	72,910,072
2004	316,632	6,923,599,845	6,312	102,134,734
2005	330,716	7,389,891,130	6,795	110,404,228
2006	344,318	7,879,329,714	7,001	118,701,848
2007	357,680	8,327,830,024	7,241	124,803,514
2008	371,869	8,837,479,427	7,448	134,647,001
Public	2,684,556	60,572,327,326	54,784	907,255,803
Private Sector				
	Exposed		Deaths	
Year	Count	Pension	Count	Pension
1999	71,603	656,878,935	3,661	23,931,876
2000	70,812	664,747,000	3,464	23,613,072
2001	69,191	690,526,229	3,405	23,484,348
2002	67,273	704,584,338	3,322	25,654,980
2003	108,106	903,059,324	4,989	31,397,052
2004	105,677	914,634,897	5,897	38,221,098
2005	102,228	917,412,733	5,795	37,456,365
2006	109,966	1,198,588,542	6,204	44,509,651
2007	107,647	1,245,180,211	6,009	45,649,648
2008	106,734	1,298,171,273	6,027	46,844,279
Private	919,237	9,193,783,482	48,774	340,762,369
Total	3,603,793	69,766,110,808	103,558	1,248,018,172

Tables 5 and 6 show the data included in the RPP Study by gender. The actual to expected ratios, particularly by pension, show that UP-94 mortality rates projected with Scale AA to 2004 (UP94@2004) are significantly higher than experienced at most ages. Perhaps more significant is the fact that the slope of the experience is materially different from the slope of UP94@2004.

Table 5. Experience by quinquennial age groups for Male pensioners

Male	Exposed		Deaths		A/E on UP94@2004	
Ages	Count	Pension	Count	Pension	Count	Pension
50-54	29,746	1,030,004,756	166	3,790,036	176.2%	115.1%
55-59	212,664	7,620,906,420	1,045	30,788,358	92.1%	75.7%
60-64	300,124	9,966,329,872	2,375	66,168,769	82.8%	70.1%
65-69	328,010	7,386,420,787	4,577	86,272,644	82.5%	69.6%
70-74	317,488	5,727,082,951	7,796	118,613,577	92.6%	78.8%
75-79	291,626	4,324,456,891	12,638	163,883,284	100.6%	88.7%
80-84	211,803	2,636,662,327	15,603	173,088,151	100.3%	90.0%
85-89	107,907	1,130,218,697	13,019	128,496,678	105.4%	99.9%
90-94	33,802	321,508,686	6,799	60,348,999	111.3%	104.0%
95-99	5,682	49,708,780	1,629	13,991,351	106.6%	104.7%
100-104	570	4,872,768	181	1,646,678	88.5%	94.0%
All ages	1,843,025	40,258,370,696	65,894	848,136,491	99.2%	85.5%

Table 6. Experience by quinquennial age groups for Female pensioners

Female	Exposed		Deaths		A/E on UP94@2004	
Ages	Count	Pension	Count	Pension	Count	Pension
50-54	39,400	1,171,175,324	184	3,872,681	253.7%	177.7%
55-59	257,983	6,982,552,668	850	21,232,829	104.0%	96.4%
60-64	360,837	8,243,945,014	1,630	33,358,000	74.6%	67.8%
65-69	341,290	5,002,875,842	2,676	38,896,252	72.4%	72.2%
70-74	257,595	3,155,748,038	3,571	39,772,937	82.6%	75.6%
75-79	203,671	2,099,494,320	5,096	46,630,436	88.3%	79.0%
80-84	152,114	1,380,000,830	7,065	59,004,240	94.8%	87.4%
85-89	91,143	840,489,987	7,771	67,478,433	100.5%	94.3%
90-94	39,148	397,552,978	5,945	57,477,672	105.9%	100.4%
95-99	9,909	109,074,053	2,336	25,045,033	106.6%	103.8%
100-104	1,174	12,968,929	400	4,527,055	106.8%	109.8%
All ages	1,760,768	29,507,740,111	37,663	399,881,681	93.5%	86.2%

Table 7 shows the average monthly pension for both sectors combined and each separately. The first two columns are the average size as indicated in the data submitted. The last two columns adjust each year's amounts by Average Weekly Earnings (AWE) to 2014. Note that the average size for public sector is substantially higher than for private sector, and the average for males is higher than for females, especially in the private sector.

Table 7. Average monthly pension

	As submitted		Adjusted to 2014 by AWE	
	Male	Female	Male	Female
Combined	1,820	1,397	2,373	1,821
Public	2,348	1,540	3,058	2,007
Private	982	324	1,286	423

2.2 Table Construction Methodology—RPP Study

Bob Howard calculated the mortality tables presented in this report using a method that he developed in consultation with the subcommittee. The description of the methods, the justification for the choices of parameters, and the tables are provided in his report to the subcommittee, which is available online here.

In summary, the male and female rates in the RPP 2014 Mortality Table were constructed as follows:

- Mortality rates, weighted by amount of pension, experienced over ages 55 to 100 were determined based on the data provided by contributors, subject to the adjustments outlined in section 2.1.
- Reported deaths were adjusted to 2014 using the CPM Mortality Improvement Scale A.
- The experience demonstrated variations in mortality not only by gender, but also by employment sector (public versus private) and by pension income level. Private sector mortality rates are higher than for the public sector and mortality rates improve with high pension incomes. However, the distribution of mortality rates across sector and pension income bands was not consistent across ages.
- Mortality rates were therefore adjusted to fit a standard population so that rates for each sector-band-age were combined in such a way that varying distributions by sector-band for each age will have no effect on the observed results.
- The modified data at each age were added across all sectors and bands then graduated using the Whittaker-Henderson method.
- Mortality rates at ages below 54 were based on the ultimate, non-smoker individual Canadian life insurance mortality rates from the recently-published CIA 97–04 table, with rates from ages 54–60 obtained by fitting a 5^{th} order polynomial to the rates already obtained for ages 51, 52, 53, 61, 62, and 63.
- Mortality rates at ages over 102 were obtained from the paper delivered by Bob Howard at the 2011 Living to 100 Symposium. Similar to the foregoing, male rates from age 95 (98 for females) to age 102 were obtained by fitting a 4^{th} order polynomial to ages 92, 93, 94, 103, and 104 (95, 96, 97, 103, and 104 for females).

2.3 Size Adjustment Factors—RPP Study

It is always preferable to use recent, credible experience from the pension plan being reviewed to adjust a standard table. However, if the pension plan is too small or too new to have useful experience, it may be appropriate to adjust the proposed table using size adjustment factors.

It is evident from both the CPP/QPP Study and the RPP Study that mortality rates vary significantly with size of pension (other factors being equal). Size adjustment factors were derived that reflect the difference in the RPP Study experience by income band (for males and females separately) as described in Section 1.1.2.2.

2.4 Sector-Specific Mortality Tables—RPP Study

The main RPP 2014 Mortality Table is based on the combined public and private sector data and uses 2014 as a base year. Rates are provided for males and females for ages 18 to 115.

The subcommittee also produced secondary tables that were developed separately from the public sector data and from the private sector data. The male rates were developed directly from the RPP Study data with adjustments for low and high ages.

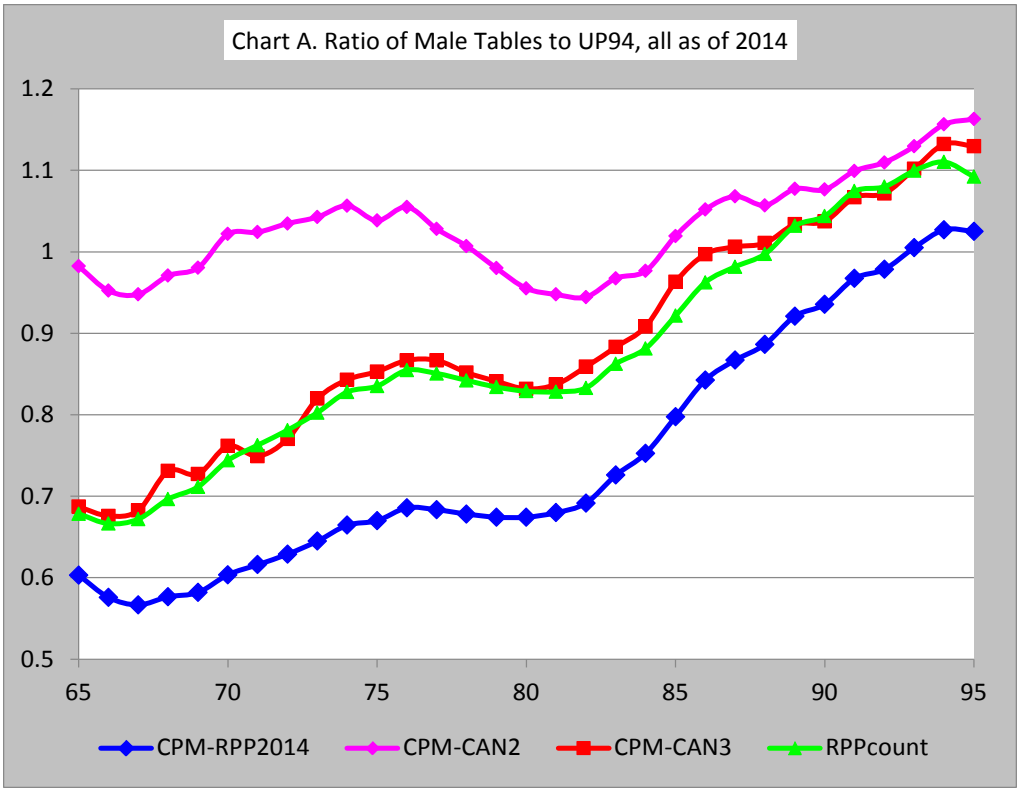
There were insufficient data for private sector females to support the direct construction of a table. However, sector-specific female tables were developed by using an appropriate multiple of the RPP 2014 Mortality Table for females.

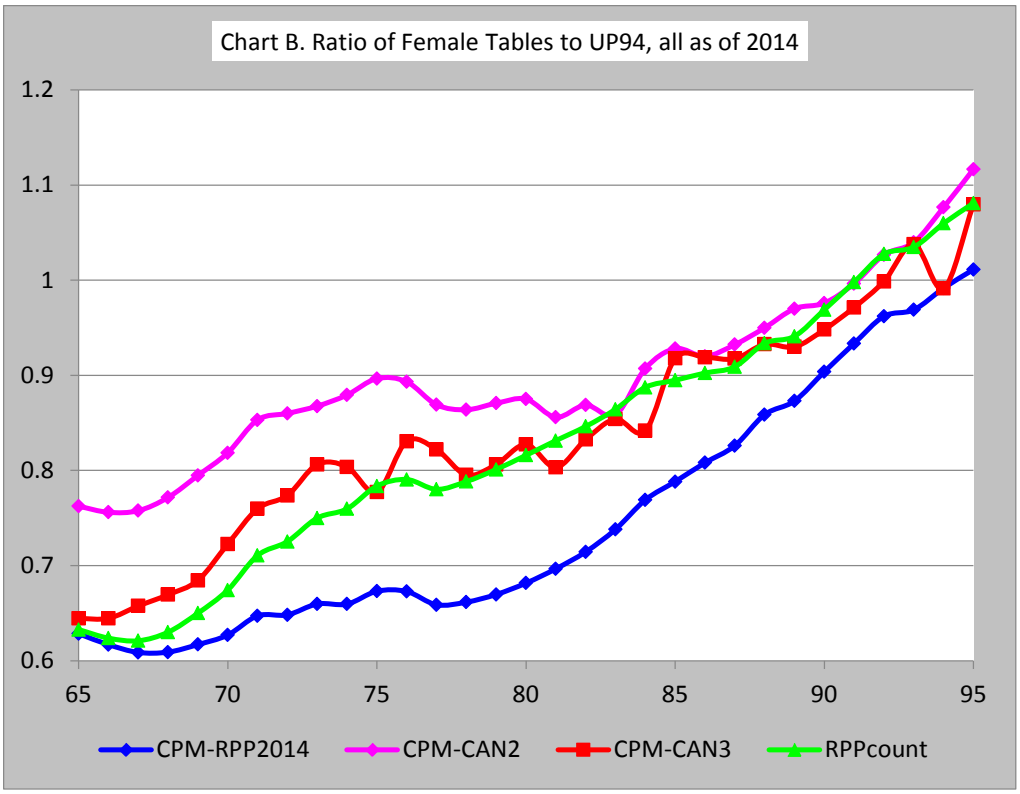
The size adjustment factors provided with the RPP 2014 Mortality Table are modified to produce sector-specific size adjustment factors by applying a common factor so that the ratio of actual deaths to expected with size adjustment for ages 65–90 is 1.0.

2.5 Comparison to UP94—RPP and CPP/QPP Studies

Charts A and B, for males and females respectively, show the ratio of mortality rates under various tables as at 2014 relative to UP94 projected to 2014 with Scale AA (UP94@2014). The tables included are:

1. CPM-RPP2014, the proposed RPP 2014 Mortality Table for combined public sector and private sector data.
2. CPM-CAN2, a table from Louis Adam's CPP/QPP Phase II Report, based on the combined CPP and QPP experience by number of deaths and pensioners exposed for those having pensions in the range of 35–94% of the maximum values. This table is projected to 2014 on the proposed CPM Improvement Scale A.
3. CPM-CAN3, as above but for pensions in the range of 95–100% of the maximum.
4. RPPcount, a table constructed similarly to RPP 2014 Mortality Table but based on experience by number of pensioners rather than on the amount of pensions. [Note: this table was developed for illustrative purposes only and is not recommended for use.]





Charts A and B indicate that the tables developed using RPP data, measured by amounts, are significantly lower than UP94@2014 and lower than the tables developed under the CPP/QPP Study.

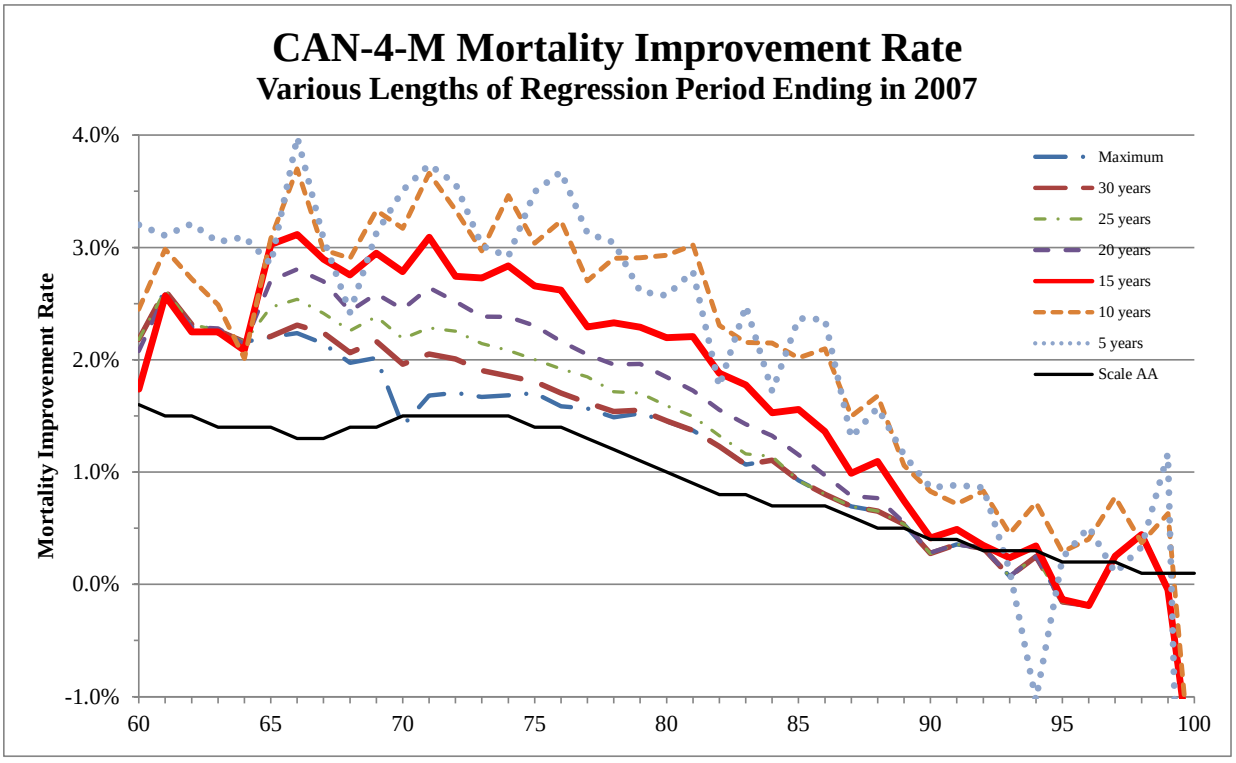
It is noteworthy that the RPP table by count is very similar to the Class 3 table developed under the CPP/QPP Study. Recall the latter was developed using data for pensioners for whom pension amounts were above 94% of the CPP/QPP maximum pensions. This observation reinforces the importance of developing mortality tables based on pension amounts. The use of the RPP Study results, by amount, is necessary to capture the effect of the range of income for RPP pensioners beyond maximum CPP/QPP benefit levels.

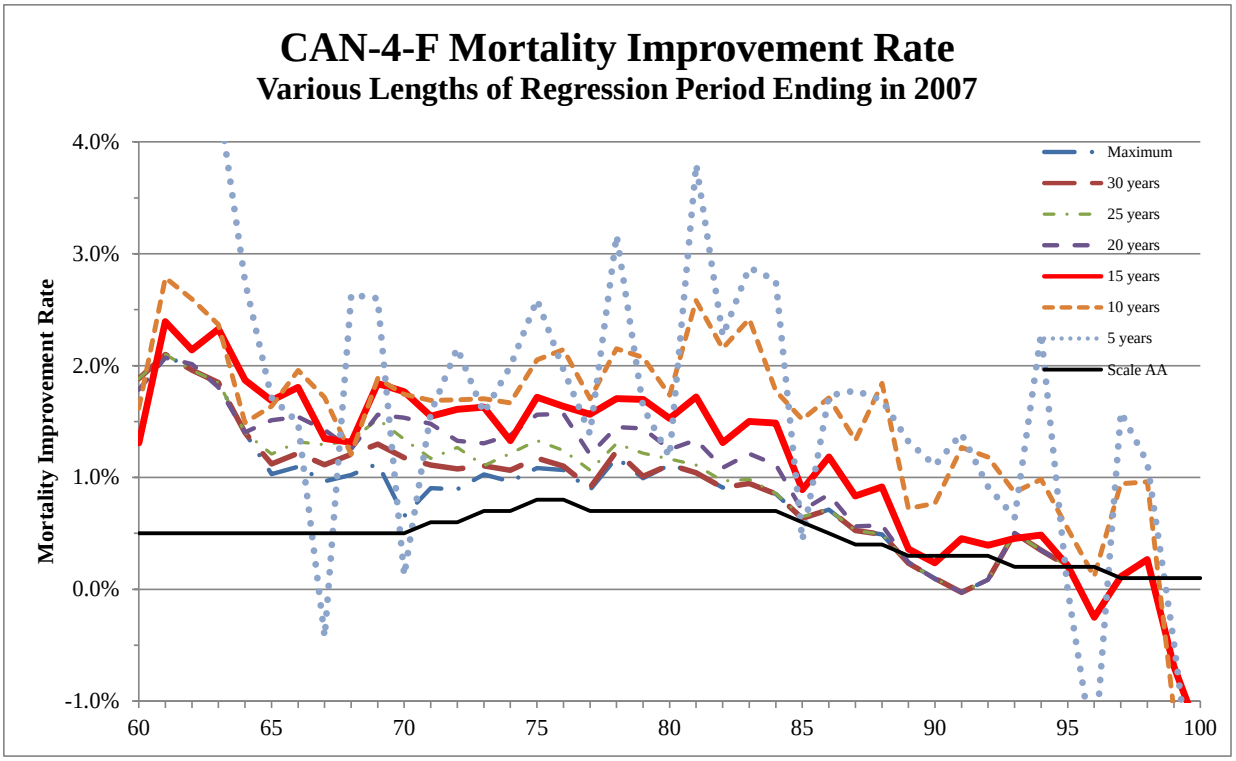
3 DEVELOPMENT OF MORTALITY IMPROVEMENT SCALES

3.1 Introduction

Assumptions in respect of future mortality improvement rates are subject to a high level of uncertainty. In addition, mortality improvement rates are affected by various socio-economic factors—e.g., income, level of education, and place of residence—and extensive data and analyses are required in order to develop scales that would reflect at least some of these factors. The RPP Study has insufficient experience, over too limited a time frame, for use in the development of mortality improvement scales. On the other hand the CPP/QPP Study provides substantive data on recent rates of improvement in the mortality of CPP/QPP pensioners. The subcommittee believes that the proposed mortality improvement scales based on the results of the CPP/QPP Phase III Report with some refinements will serve as a reasonable approximation of future mortality improvement rates of Canadian pensioners in registered pension plans.

The following charts, taken from the CPP/QPP Phase III Report, show experienced CPP/QPP mortality improvement rates for various periods ending in 2007 with Scale AA improvement rates added for reference. The data reflected in these charts are based on combined CPP and QPP data for pensions in the range of 35–100% of the maximum values. Scale AA, published by the Society of Actuaries with the UP94, is currently widely used for registered pension plan valuation purposes and is prescribed for use in the pension commuted value standards.





It can be seen that the CPP/QPP experienced improvement rates are substantially higher than Scale AA and higher for shorter, and thus more recent, periods than over longer periods.

There is broad consensus that continuation of recently-experienced rates of improvement indefinitely into the future is unlikely. Social security actuaries in various countries, including Canada, have developed ultimate improvement rate assumptions well below recently-experienced rates. There is no reliable methodology to forecast the ultimate level of mortality improvement rates or the time frame as to when such ultimate rates will be reached. As proposed in the CPP/QPP Phase III Report, the subcommittee is of the view that reference to the ultimate assumptions adopted by the CPP and QPP actuaries in their December 31, 2009, valuation reports is appropriate.

3.2 Improvement Scales

The proposed gender-specific improvement scales are as follows:

- Short-term rates applicable to years 2000–2011 equal to smoothed 10-Year experience based on the CPP/QPP income class 4 (35% of maximum pension and above) from the CPP/QPP Study for ages 65 and higher.
- Short-term rates for years 2000–2011 for ages up to age 50 are a blend of the CPP and QPP assumptions, as disclosed in the most recent actuarial reports. Note that mortality experience data are not available for CPP/QPP at these ages.
- Short-term rates for years 2000–2011 for ages 51–64 are a linear interpolation between the above rates for ages 50 and 65.
- Ultimate rates applicable for years 2031 and beyond are based on blended CPP and QPP actuarial assumptions (the “long-term scale” proposed in the CPP/QPP Phase III Report).

- Rates for years 2012 to 2030 are derived by linear interpolation between the short-term rates and the ultimate rates.

The choice of years used above is arbitrary. The year 2031 coincides with the ultimate assumption used by CPP. The year 2000 was needed for the construction of CPM-RPP2014. The year 2011 corresponds to the last year in the CPP assumption before rates began to decrease.

3.3 Transitional One-Dimensional Mortality Improvement Scale

The subcommittee believes strongly that a two-dimensional improvement scale fits the experience data better than any one-dimensional scale could and can better reflect reasonable expectations regarding the evolution of the improvement in mortality rates in future years. However, the subcommittee also recognizes that not all practitioners will have immediate access to software that can handle a two-dimensional improvement scale. Therefore, as a transitional measure, the subcommittee has developed a one-dimensional improvement scale that reasonably approximates the results of the two-dimensional scale for calculation dates that are before 2016.

The development of the one dimensional improvement scale is documented in the memo to the subcommittee from Bob Howard, which can be accessed online here.

4 FINANCIAL IMPLICATIONS

4.1 Overview

The UP-94 Mortality Table, adjusted for mortality improvement Scale AA, has been widely used for pension plan valuations and is prescribed for use in the pension commuted value standards of practice. The results of the RPP and CPP/QPP Studies indicate that the overall level of recent mortality experience is significantly lower than that anticipated by UP-94 with Scale AA and exhibits a different shape by age. The CPP/QPP Study also shows that mortality improvement rates experienced in recent years have been substantially higher than indicated by Scale AA.

The experience illustrated by both the CPP/QPP Study and RPP Study indicates that adoption of tables and scales reflecting Canadian mortality experience is warranted.

4.2 Numerical Illustrations

The adoption of the proposed tables will result in an increase in recognized costs for Canadian pension plans and their sponsors to the extent that the mortality tables and improvement scales used in recent valuations have not reflected recent experience.

Tables 8 through 13 below compare the present value of annuities on various tables. Tables 8 through 10 show monthly annuities-due and tables 11 through 13 show monthly annuities deferred to age 65. The calculations are done at 4% interest as at January 1, 2014. Each table indicates what base table and improvement scale were used in the calculation.

Table 8 shows the impact of changing from UP-94 with Scale AA to the proposed basis. Note that the increase is generally larger because of changing from UP-94 to CPM-RPP2014 than changing from Scale AA to the CPM Improvement Scale A.

Table 8. Monthly life annuities at 4% in 2014 without size adjustment					
Table	UP-94	CPM-RPP2014		CPM-RPP2014	
Scale	AA	AA		CPM-A	
	Annuity	Annuity	Incr	Annuity	Incr
M55	16.68	17.53	5.1%	17.63	5.7%
M65	13.06	14.20	8.7%	14.36	9.9%
M75	9.09	10.03	10.3%	10.17	11.8%
M85	5.38	5.68	5.6%	5.71	6.1%
F55	17.41	18.17	4.4%	18.30	5.1%
F65	14.10	15.05	6.7%	15.18	7.7%
F75	10.28	11.11	8.1%	11.23	9.2%
F85	6.25	6.61	5.8%	6.65	6.3%

Table 9 show the impact of the size adjustments. (The average size of the pensions in the RPP dataset is approximately $2,400 per month when adjusted to 2014.) Clearly the size adjustments are material, but more for males than females. Of course, in practice the actuary will adjust for recent, credible experience rather than simply for size. The size adjustment factors are useful when no such experience is available.

Table 9. Monthly life annuities on CPM-RPP2014 with CPM-A at 4% in 2014 with size adjustment for the indicated monthly pension							
Pension	Not Adjusted	$1,200		$2,400		$3,600	
	Annuity	Annuity	Incr	Annuity	Incr	Annuity	Incr
M55	17.63	17.08	-3.1%	17.29	-1.9%	17.68	0.3%
M65	14.36	13.68	-4.7%	13.93	-3.0%	14.43	0.5%
M75	10.17	9.41	-7.5%	9.69	-4.7%	10.25	0.8%
M85	5.71	5.01	-12.1%	5.26	-7.7%	5.78	1.3%
F55	18.30	18.11	-1.0%	18.28	-0.1%	18.36	0.3%
F65	15.18	14.95	-1.6%	15.16	-0.2%	15.26	0.5%
F75	11.23	10.95	-2.5%	11.20	-0.3%	11.32	0.8%
F85	6.65	6.37	-4.1%	6.62	-0.5%	6.74	1.4%

As previously noted in section 1.1.2.1 above, because the size adjustment factors do not have a linear relationship with size, it is not enough to consider the average size of pension within a pension plan.

Table 10 compares the sector-distinct tables with the combined table. The calculations are done assuming the same size annuity to make the comparison more appropriate than by using the tables without adjustment. It is clear that whether to use the combined table or a sector-distinct table is a material choice.

Table 10. Monthly life annuities at 4% in 2014 with size adjustment factor for $2400 per month					
Table	CPM-RPP2014	CPM-RPP2014Publ		CPM-RPP2014Priv	
Scale	CPM-A	CPM-A		CPM-A	
	Annuity	Annuity	Incr	Annuity	Incr
M55	17.29	17.35	0.4%	17.02	-1.5%
M65	13.93	14.01	0.6%	13.62	-2.2%
M75	9.69	9.73	0.4%	9.53	-1.6%
M85	5.26	5.22	-0.8%	5.38	2.2%
F55	18.28	18.28	0.0%	18.03	-1.4%
F65	15.16	15.17	0.1%	14.84	-2.1%
F75	11.20	11.21	0.1%	10.85	-3.1%
F85	6.62	6.62	0.1%	6.32	-4.4%

Tables 11 through 13 are analogous to tables 8 through 10 but for deferred annuities. The conclusions reached are essentially the same as mentioned for the tables above.

Table 11. Monthly life annuities deferred to age 65 at 4% in 2014 without size adjustment					
Table	UP-94	CPM-RPP2014		CPM-RPP2014	
Scale	AA	AA		CPM-A	
	Annuity	Annuity	Incr	Annuity	Incr
M25	2.82	3.01	6.8%	2.96	5.2%
M35	4.07	4.39	7.7%	4.35	6.9%
M45	5.88	6.39	8.6%	6.40	8.8%
M55	8.57	9.38	9.5%	9.48	10.6%
F25	2.93	3.13	7.0%	3.17	8.2%
F35	4.28	4.59	7.3%	4.65	8.6%
F45	6.27	6.75	7.6%	6.83	9.0%
F55	9.25	9.98	7.8%	10.10	9.1%

Table 12. Monthly life annuities on CPM-RPP2014 with CPM-A deferred to age 65 at 4% in 2014 with size adjustment for the indicated monthly pension							
Pension	Not Adjusted	$1,200		$2,400		$3,600	
	Annuity	Annuity	Incr	Annuity	Incr	Annuity	Incr
M25	2.96	2.80	-5.4%	2.86	-3.4%	2.98	0.5%
M35	4.35	4.12	-5.5%	4.21	-3.4%	4.38	0.5%
M45	6.40	6.05	-5.5%	6.18	-3.5%	6.44	0.6%
M55	9.48	8.96	-5.4%	9.16	-3.4%	9.53	0.5%
F25	3.17	3.11	-1.7%	3.16	-0.2%	3.18	0.5%
F35	4.65	4.57	-1.7%	4.64	-0.2%	4.67	0.6%
F45	6.83	6.71	-1.7%	6.82	-0.2%	6.87	0.6%
F55	10.10	9.92	-1.7%	10.08	-0.2%	10.15	0.6%

Table 13. Monthly life annuities deferred to age 65 at 4% in 2014 with size adjustment factor for $2400 per month					
Table	CPM-RPP2014	CPM-RPP2014Publ		CPM-RPP2014Priv	
Scale	CPM-A	CPM-A		CPM-A	
	Annuity	Annuity	Incr	Annuity	Incr
M25	2.86	2.88	0.6%	2.80	-2.3%
M35	4.21	4.23	0.6%	4.10	-2.4%
M45	6.18	6.22	0.6%	6.02	-2.6%
M55	9.16	9.22	0.7%	8.91	-2.7%
F25	3.16	3.16	0.1%	3.09	-2.2%
F35	4.64	4.64	0.1%	4.53	-2.3%
F45	6.82	6.83	0.1%	6.66	-2.4%
F55	10.08	10.08	0.1%	9.84	-2.3%