Canadian Institute of Actuaries / Institut canadien des actuaires

Study

Canadian Individual Annuitant Mortality Experience Policy Years 2002–2003 to 2011–2012

Annuitant Experience Subcommittee of the Research Committee

February 2016

Document 216021

Ce document est disponible en français

Memorandum

To:	All Fellows, Affiliates, Associates, and Correspondents of the Canadian Institute of Actuaries
From:	Taylor Wasko, Chair Annuitant Experience Subcommittee
Date:	February 23, 2016
Subject:	**Canadian Individual Annuitant Mortality Experience – Policy Years 2002–2003 through 2011–2012**

The attached document contains summary results for the Canadian Individual Annuitant Mortality Experience for Policy Years 2002–2003 through 2011–2012. There are a number of tables referred to in *Appendix 2: Additional Data for Study* that will be available online here.

1740-360 Albert, Ottawa, ON K1R 7X7 ☽ 613-236-8196 🖷 613-233-4552
head.office@cia-ica.ca / siege.social@cia-ica.ca **cia-ica.ca**

Table of Contents

1. Introduction

This study updates the 2001–2002 through 2010–2011 study published in 2014; the information presented here does not require knowledge of the prior study. Six companies contributed to this study. We acknowledge the assistance of these companies in compiling the data.

Unlike the last study, the results in this report do not include incurred but not reported (IBNR) factors. Please see the comments on this topic in appendix 1.

Joint policies were first included in the 1996–1997 study. They were excluded in prior years because of concerns about the reliability of the data. Because IBNR factors are significantly larger for joint policies than for single policies, the data for single policies are considered more reliable. As in the past, the mortality experience of joint life policies (both alive) is lower than single life policies.

The mix of the business has changed slightly over the 10-year period. In general, the proportion of Registered Retirement Savings Plan (RRSP) business has decreased, while the Non-Registered-Unknown Tax Code (NR-UTC) business has increased. The Registered Pension Plan (RPP) business is small in proportion to the other two blocks. Please see 3. Description of the Data (figure 2) for details.

NR-UTC policies exhibit different characteristics from RRSP policies. NR-UTC policies tend to have higher average income and lower mortality ratios (see table 6A); they appear to exhibit more selection. The details are in the following pages.

Since subgroups of the data exhibit different characteristics, the reader should use the aggregate mortality ratios carefully. Simpson's paradox suggests that mortality improvement in aggregate is suspect when subgroups exhibit different mortality and mortality improvement.

We have attempted to isolate the experience of back-to-back annuities. The data, although sparse, indicate there is much lower mortality for this block of business. (See 4. Observations, table 10A.)

2. Description of the Study

This study considers the experience of Canadian individual annuities. Most of the policies studied are in payout status, but in some cases, experience is included during the deferred period, provided the policy has no cash value and the policy cannot be changed.

Policy Year/Calendar Year Basis

Three companies contributed data on a calendar year basis, while three contributed on a policy year basis. The study runs between successive policy anniversaries. The "year of experience", as the year under study is known, is referred to by the calendar year in which the policy year ends.

The anniversary is based on the "determination date". This is the day on which the income was determined; it may not be changed, as there is a final disposition of funds on that date. Usually the determination date will be the same as the issue date. In the case of an accumulation type of annuity, the determination date would most likely be the date when the policy changes from accumulation status to payout status.

Select Period

The study uses a 10-year select period. Since there are no published annuitant mortality tables with the 10-year select period, the expected mortality for both the select and ultimate periods is calculated using an aggregate table: the 1983 Individual Annuity Mortality (IAM) Basic Table, *Transactions of the Society of Actuaries*, Volume XXXIII.

Standard Deviations

This study includes standard deviations of the mortality ratios based on number of lives and income. ("Mortality ratio" means the ratio of the actual mortality to the expected mortality.) The standard deviation measures the degree of confidence that may be placed in the ratios observed. The formulae used to estimate the standard deviations of actual/expected (A/E) are as follows:

Standard Deviation of Number of Lives = $\frac{\sqrt{\sum deaths}}{E}$

Standard Deviation of Income = $\frac{\sqrt{\sum K^2 \times deaths}}{E}$

where,

- summation is over each individual;
- the expected sums, both denoted above by *E*, are based on expected experience (1983 IAM Basic Table); and
- *K* represents the annualized income of the annuity.

Single and Joint Policies

Data are segregated by single life policies, joint policies in which both annuitants are alive at the beginning of the study year, and joint policies for which only one annuitant is still alive at the beginning of the year. We have concluded that there are real, measurable differences in mortality by group.

Data Breakdowns Studied

We study RRSP policies, RPP policies, and NR-UTC policies separately.

We also study experience separately by refund and non-refund. A refund policy is one that provides for the possibility of some payment after the death of the annuitant. The most common refund provision is a continuation of payments for a minimum specified number of years.

We also include a study of single life data by annualized income by sex and by tax type (RRSP, RPP, and NR-UTC).

There are four main income groups: $0–$999; $1,000–$4,999; $5,000–$9,999, and $10,000 and over. We have also provided a further breakdown of the $10,000 and over category, although it should be used with caution due to small sample sizes.

Age-Nearest Birthday

All results are computed on the basis of age-nearest birthday. None of the companies are currently submitting data on an age-last birthday basis.

3. Description of the Data

Unless indicated otherwise, this report uses single life data only.

Exposure by Sex

For the single life data, males account for 44% of the exposure by number of policies, 47% of the exposure by income, and 48% of the number of deaths.

Exposure by Refund/Non-Refund

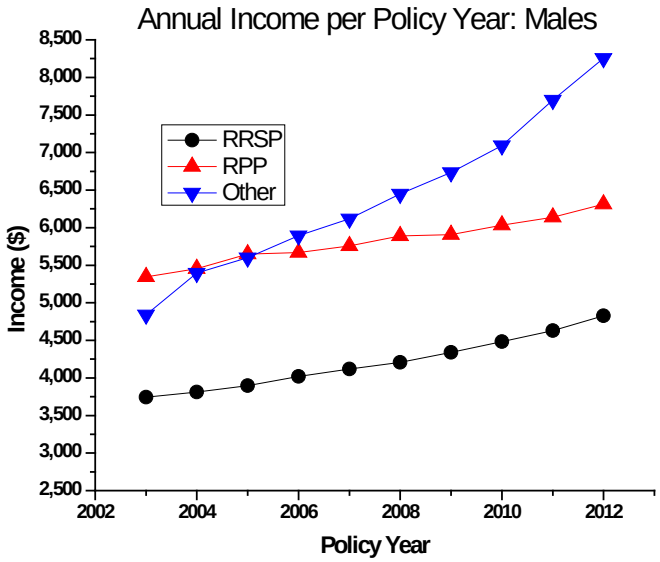
There is less exposure for non-refund policies than for refund policies. Refund business is 74% and 72% of the exposure by policy for male and female single life policies, respectively. Refund business is 69% and 68% of the exposure by income for male and female single life policies, respectively.

Changes in Average Annual Income by Tax Type and Sex

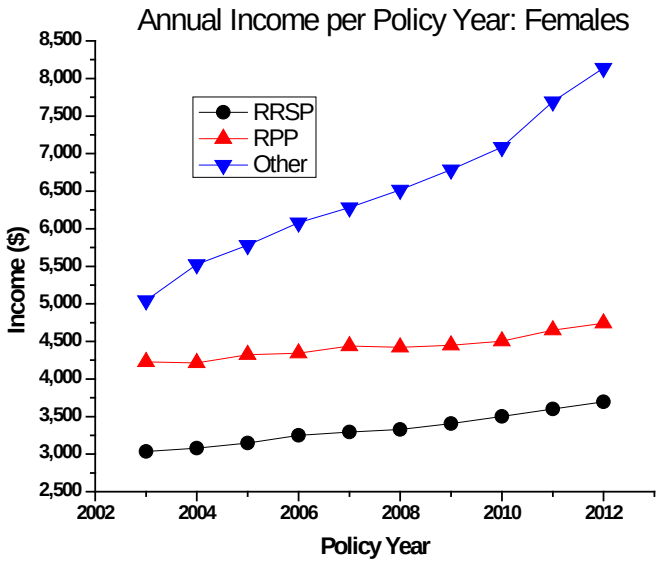
For males, the average annual income per policy for all policies has been growing, with NR-UTC policies increasing the fastest. The same is true for females. These observations are shown in figure 1 below.

Figure 1. Annual Income per Policy Year

A. Males



B. Females

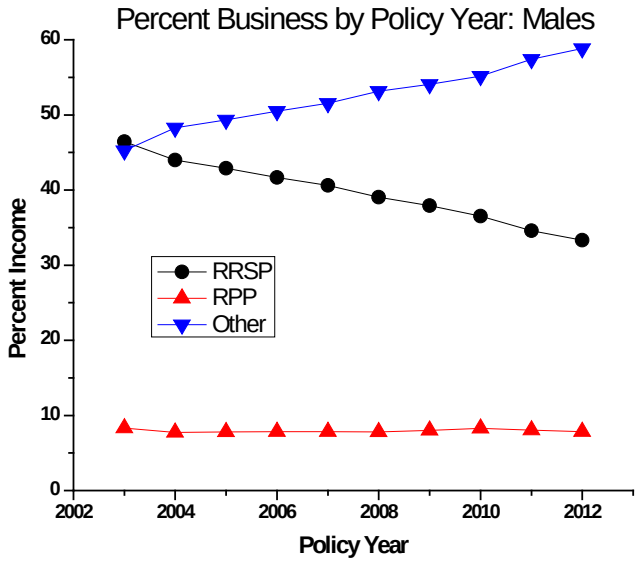


Changes in Business Mix

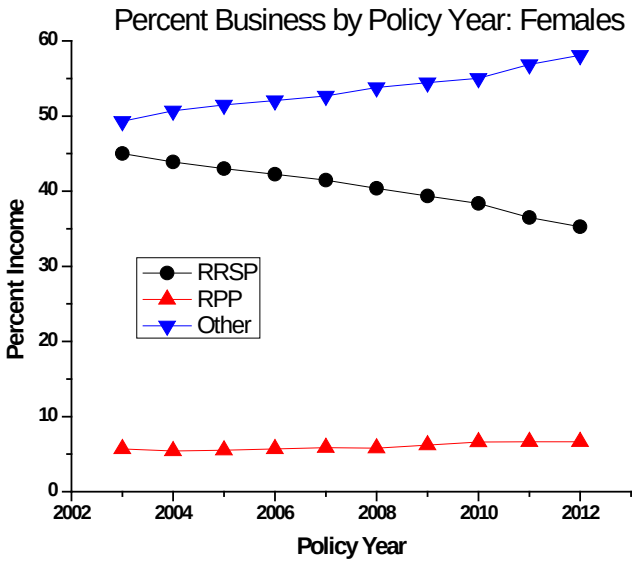
Over time, the NR-UTC portion of the business has increased, while the RRSP portion has decreased, as seen in figure 2 below.

Figure 2. Business Mix by Policy Year

A. Males



B. Females



4. Observations

General Observations

The following tables give overviews of the data by year of experience. The totals in the # Exposed columns for the individual study years represent the data included in this year's report. The totals will not be consistent with previous years' reports, as some of the previous data have been updated to include late-reported deaths and the collection of companies participating has changed. Note that these are counts of deaths reported, unadjusted for IBNR.

During the study period, the A/E ratios by number of policies are greater than the A/E ratios by annualized income for single life data. For joint life data, the A/E ratios for joint survivors are greater than the A/E ratios for joint life (both annuitants alive) by number of policies and by annualized income.

Table 1. Single Life Data

Study Year	# Exposed	# Deaths	A/E by Number	A/E by Income
2003	167,522	9,911	95.2	87.1
2004	182,618	11,339	96.4	84.4
2005	178,789	11,564	96.3	85.1
2006	180,830	11,492	91.1	82.1
2007	171,813	11,468	91.7	84.7
2008	161,761	11,117	90.7	81.2
2009	154,286	11,092	91.5	78.6
2010	147,821	10,425	87.4	77.4
2011	141,245	10,255	87.9	76.2
2012	134,153	9,997	88.1	82.4
Total	1,620,837	108,660	91.6	81.6

Table 2. Joint Life Data (Both Annuitants Alive at Beginning of Study Year)

Study Year	# Exposed	# Deaths	A/E by Number	A/E by Income
2003	102,885	4,308	84.8	86.0
2004	109,938	4,578	80.3	78.6
2005	108,318	4,609	79.1	80.4
2006	104,389	4,590	78.0	74.7
2007	97,150	4,452	78.3	72.2
2008	90,325	4,222	77.1	73.4
2009	85,283	4,149	77.7	76.1
2010	81,392	3,889	74.9	71.1
2011	77,100	3,600	72.2	66.0
2012	72,904	3,203	66.8	67.5
Total	929,684	41,600	77.1	74.4

Table 3. Joint Survivor Data (Only One Annuitant Alive at Beginning of Study Year)

Study Year	# Exposed	# Deaths	A/E by Number	A/E by Income
2003	34,487	2,106	94.2	93.6
2004	38,760	2,709	101.1	97.3
2005	40,916	3,107	103.4	97.8
2006	42,463	3,080	93.2	87.9
2007	43,846	3,479	96.1	93.4
2008	45,413	3,829	96.8	97.6
2009	45,406	4,098	98.2	99.4
2010	45,137	4,218	97.1	95.9
2011	44,397	4,286	96.0	93.1
2012	43,259	4,174	92.1	88.3
Total	424,084	35,086	96.6	94.3

Male/Female Observations

Table 4A summarizes aggregate male and female mortality ratios for single life data only. The mortality ratios for males are greater than those for females by number of policies. However, the differences between the overall male and female A/E ratios by annualized income varies by study year. IBNR adjustments have not been made to the data tabulated. If IBNR adjustments were included, the ratios in the last three years would be increased.

Table 4A. Aggregate Experience for Males and Females, Single Life

Study Year	A/E by Number		A/E by Income	
	Male	Female	Male	Female
2003	99.2	90.8	89.0	84.8
2004	98.1	94.6	86.2	82.4
2005	97.4	95.1	85.6	84.5
2006	92.6	89.7	80.1	84.2
2007	92.5	91.0	82.5	86.9
2008	91.4	90.0	79.3	83.1
2009	95.5	88.3	81.7	75.6
2010	90.2	85.1	76.4	78.3
2011	89.6	86.5	72.9	79.3
2012	90.8	86.1	82.8	82.0
Total	93.8	89.6	81.4	81.9

As shown in tables 4B and 4C below, there is a distinct difference in mortality experience between RRSP and NR-UTC business for both males and females. We note again that the ratios in recent years would be slightly increased by an IBNR adjustment. Mortality ratios are generally higher for RRSP than for NR-UTC policies. For males, the mortality improvement is higher for NR-UTC business than for RRSP.

Table 4B. Male Experience, Single Life

Study Year	A/E by Number		A/E by Income	
	RRSP	NR-UTC	RRSP	NR-UTC
2003	100.5	97.4	93.3	84.9
2004	99.4	95.3	94.0	77.5
2005	101.7	90.2	97.0	73.2
2006	96.3	85.5	89.7	66.7
2007	96.4	84.6	91.6	71.1
2008	93.3	88.0	84.1	71.1
2009	99.3	88.6	90.4	71.9
2010	95.9	80.6	87.8	62.2
2011	95.9	79.6	88.0	58.3
2012	95.8	84.3	90.6	76.1
Total	97.6	87.3	90.6	70.5

Table 4C. Female Experience, Single Life

Study Year	A/E by Number		A/E by Income	
	RRSP	NR-UTC	RRSP	NR-UTC
2003	90.7	91.5	93.5	76.3
2004	95.5	92.0	88.1	76.5
2005	96.3	92.8	94.2	74.4
2006	89.2	90.8	87.1	81.3
2007	90.3	91.2	86.4	85.5
2008	90.8	87.7	84.3	82.2
2009	89.0	85.4	85.1	64.8
2010	85.4	83.8	83.5	73.8
2011	88.5	81.9	86.1	72.1
2012	86.1	86.6	84.7	79.3
Total	90.1	88.2	86.9	76.6

Figure 3 shows the trends over time of mortality ratios measured by income. The circles in the plots represent the ratios of actual to expected deaths. The dashes represent 95% confidence intervals. The trend line shown is an exponential regression line of the ratios of actual to expected deaths.

An exponential trend line is more appropriate than a linear regression line for determining the rate of improvement implied by the data. When the mortality ratios are similar to each other, there is little difference between the two methods, but as the mortality ratios vary more, the exponential improvement rate more reasonably models the dependence. (For example, the trend line cannot go negative.)

The exponential trend line is represented by the following formula, where *"a",* or more precisely e^a, measures the proportional annual range in mortality:

$$Y = b \times e^{ax}$$

The *P*-values give the probabilities that the apparent trends are due to chance. *P*-values less than 0.05 are commonly considered significant.

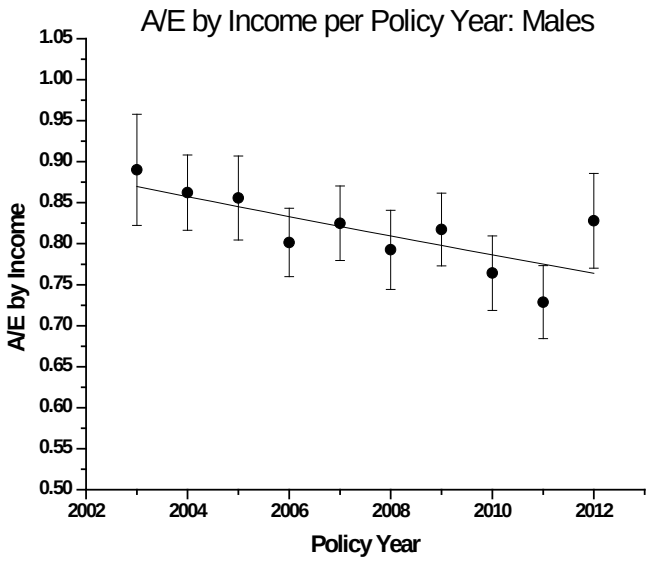
All of the summaries below show a general decrease in mortality ratios over time. In some cases, the sample size is large enough, and the variability over time small enough, that the measured trend is statistically significant.

Figures 3A-C show the trends of male mortality ratios by income by policy year. Figure 3A shows all male data, while figures 3B and 3C show RRSP-only and NR-UTC-only business, respectively.

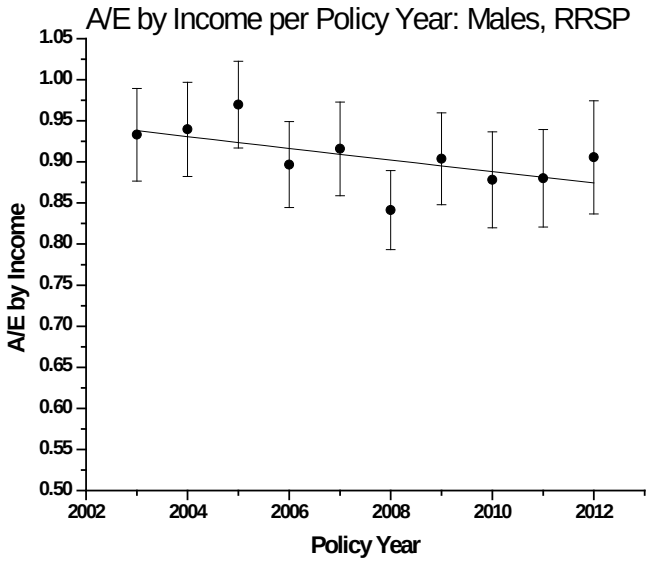
The *"a"* factors are negative, indicating improvement in mortality. The *"a"* factor for the RRSP business indicates a lesser improvement in mortality, while the improvement rate for NR-UTC business is greater. Of figures 3A–C, only the *P*-value for figure 3A is statistically significant.

Figure 3. A/E by Income per Policy Year

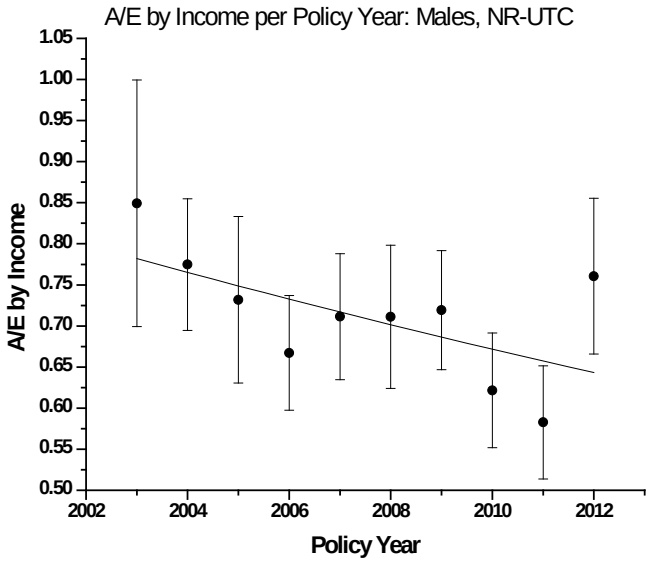
A. Males (a = -0.0144; P = 0.0149)



B. Males, RRSP (a = -0.0078; P = 0.0725)

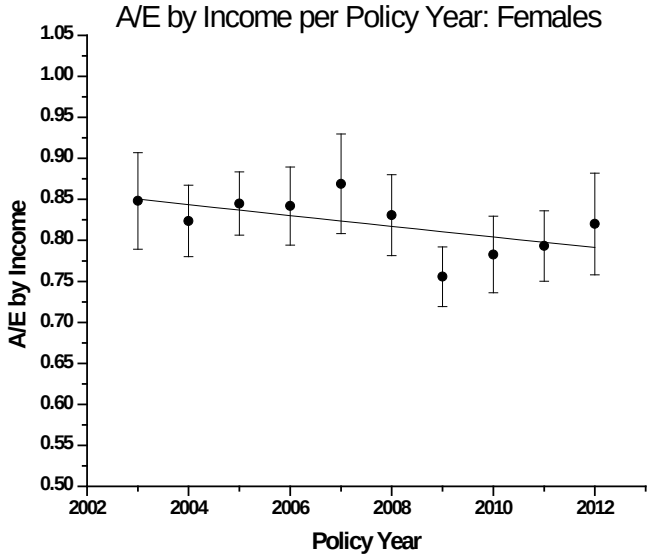


C. Males, NR-UTC (a = -0.0217; P = 0.0640)

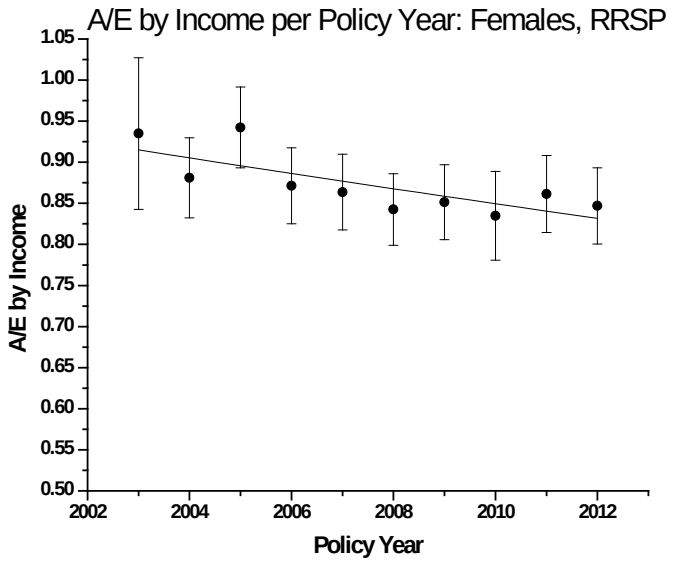


Figures 3D–F show A/E results for female single life policies. Again, the *"a"* factors are negative, indicating improvement in mortality ratios in all three cases. Only the *P*-value for figure 3E (RRSP) is significant, suggesting that the improvement is not due to chance for that portion of business.

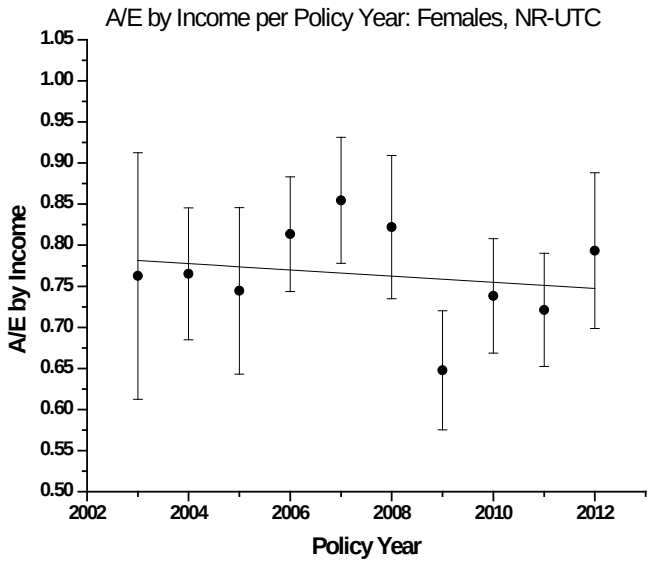
D. Females (a = -0.0080; P = 0.0852)



E. Females, RRSP (a = -0.0106; P = 0.0095)



F. Females, NR-UTC (a = -0.0050; P = 0.5958)



Income Study Observations (Single Life Data Only)

The study by amount of income confirms the previous observations about the relationship between income and mortality ratios. Mortality ratios are lower for larger policy incomes for both males and females.

The pattern of decrease in mortality ratios with increase in policy size is observed in all categories. By splitting the male/female $10,000+ band into sub-bands, we observe that the decreasing trend continues (table 5C). Actuaries dealing with valuation or pricing of annuities with very high income should be careful in selecting mortality assumptions. (Note also that as income has been growing over time, the A/E ratios at higher incomes are more heavily influenced by recent data, i.e., the years most affected by IBNR.)

Tables 5A–E provide overviews of results by income level.

Table 5A. Overall Results by Income Level, 2002-2012

Income	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	371,480	222,037,358	29,265	16,915,301	96.5	95.5	0.6	0.6
$1,000–$4,999	837,395	1,999,456,535	57,533	134,110,118	92.3	91.9	0.4	0.4
$5,000–$9,999	244,754	1,696,601,650	14,135	97,421,135	87.3	87.3	0.7	0.7
$10,000+	167,209	3,945,103,115	7,727	154,020,829	78.7	70.7	0.9	1.2
Total	1,620,837	7,863,198,659	108,660	402,467,383	91.6	81.6	0.3	0.6

Table 5B. Overall Results by Income Level with Male/Female Split, 2002-2012

Income	Males				Females			
	A/E		S.D		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	98.3	97.4	0.8	0.9	94.9	93.8	0.8	0.8
$1,000–$4,999	95.5	94.9	0.6	0.6	89.7	89.4	0.5	0.6
$5,000–$9,999	88.7	88.6	1.1	1.1	86.0	86.0	1.0	1.0
$10,000+	79.4	69.5	1.2	1.5	77.9	72.2	1.3	1.8
Total	93.8	81.4	0.4	0.8	89.6	81.9	0.4	0.8

Table 5C. Overall Results by High Income Level with Male/Female Split, 2002-2012

Income	Males				Females			
	A/E		S.D		A/E		S.D.	
	#	$	#	$	#	$	#	$
$10,000–$19,999	83.8	83.4	1.5	1.6	80.1	79.9	1.5	1.6
$20,000–$49,999	72.3	71.3	2.3	2.3	72.6	71.6	2.6	2.6
$50,000+	59.9	46.8	4.6	4.1	69.6	57.9	5.8	6.2

Table 5D. Overall Results for RRSP with Male/Female Split, 2002-2012

Income	Males				Females			
	A/E		S.D		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	103.4	103.0	1.2	1.3	95.2	93.6	1.0	1.1
$1,000–$4,999	98.2	97.1	0.7	0.8	89.5	89.6	0.6	0.7
$5,000–$9,999	92.1	91.8	1.4	1.4	85.5	85.6	1.4	1.4
$10,000+	84.8	81.8	1.9	2.2	80.4	81.8	2.2	2.8
Total	97.6	90.6	0.6	0.9	90.1	86.9	0.5	0.8

Table 5E. Overall Results for NR-UTC Policies with Male/Female Split, 2002-2012

Income	Males				Females			
	A/E		S.D		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	91.7	90.5	1.2	1.3	94.7	93.6	1.3	1.5
$1,000–$4,999	89.3	89.1	1.0	1.1	89.2	88.8	0.9	1.0
$5,000–$9,999	82.4	82.7	1.8	1.8	85.3	85.2	1.5	1.6
$10,000+	72.9	60.5	1.7	2.1	76.0	68.1	1.6	2.3
Total	87.3	70.5	0.6	1.4	88.2	76.6	0.6	1.4

Tax Observations

Since this study reports results for individual life policies rather than group policies, there is a relatively small amount of RPP business compared to RRSP and NR-UTC business. One would expect A/E ratios to be the highest for RPP and lowest for NR-UTC policies, because RPP annuitants have no option other than to annuitize. Tables 6A–B below show summaries of single life data by tax type. Although the A/E relationship is as expected by number of policies, the A/E ratios by income are almost the same for RRSP and RPP; this can be explained by the variation in the data, as shown by the standard deviation of the estimates.

Table 6A. Overall Results by Tax Type, 2002-2012

Tax Type	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
RRSP	862,136	3,151,418,843	64,918	205,830,395	93.5	88.8	0.4	0.6
RPP	107,015	544,140,360	5,461	22,953,255	97.4	89.1	1.3	2.3
NR-UTC	651,686	4,167,639,455	38,281	173,683,733	87.8	73.7	0.4	1.0
Total	1,620,837	7,863,198,659	108,660	402,467,383	91.6	81.6	0.3	0.6

It is possible that what we are seeing is a result of heterogeneity in the data. Notice that the average annual income for RRSP is $3,655, for RPP is $5,085, and for NR-UTC is $6,395. Since experience improves with increasing size, it is possible that the difference due to tax type is really due to policy size. We observe some variation in the male and female ratios by tax type. The A/E by income difference between RRSP and NR-UTC is larger for males than for females.

Table 6B. Results by Tax Type for Males and Females, 2002-2012

Tax Type	Males				Females			
	A/E #	A/E $	S.D. #	S.D. $	A/E #	A/E $	S.D. #	S.D. $
RRSP	97.6	90.6	0.6	0.9	90.1	86.9	0.5	0.8
RPP	99.4	88.2	1.8	3.0	94.8	90.8	2.0	3.5
NR-UTC	87.3	70.5	0.6	1.4	88.2	76.6	0.6	1.4
Total	93.8	81.4	0.4	0.8	89.6	81.9	0.4	0.8

Select/Ultimate Observations

Tables 7A–B give overviews of the select and ultimate single life mortality ratios in this study. When we look at the overall study results, we can make the following observations:

- There is self-selection;
- The self-selection is mainly present during a select period of approximately 10 years; and
- Within the first 10 years following the policy issuance, self-selection is greatest in the early years, and steadily declines over time.

Table 7A. Overall Ultimate – Select Mortality Experience (10-year Select Period), 2002-2012

Duration	Mortality Ratios				Ultimate minus Select			
	A/E		S.D		A/E		S.D.	
	#	$	#	$	#	$	#	$
1	48.2	32.9	2.5	2.8	45.2	55.8	2.5	2.8
2	57.5	43.5	2.6	4.1	35.9	45.2	2.6	4.1
3	66.6	57.5	2.7	5.1	26.8	31.2	2.7	5.1
4	73.4	55.4	2.8	4.0	20.0	33.3	2.8	4.0
5	76.4	64.7	2.7	4.6	17.0	23.9	2.7	4.6
6	73.4	62.6	2.5	4.7	20.1	26.1	2.5	4.7
7	81.4	56.2	2.5	3.1	12.1	32.4	2.5	3.2
8	79.9	66.4	2.3	6.0	13.5	22.2	2.4	6.1
9	82.2	66.0	2.2	5.2	11.2	22.7	2.3	5.2
10	84.8	72.4	2.2	3.6	8.7	16.2	2.2	3.6
Ultimate	93.4	88.7	0.3	0.6	--	--	--	--
Total	91.6	81.6	0.3	0.6	--	--	--	--

Table 7B. Overall Ultimate – Select Mortality Experience (25-year Select Period), 2002-2012

Duration	Mortality Ratios				Ultimate minus Select			
	A/E		S.D		A/E		S.D.	
	#	$	#	$	#	$	#	$
1–5	62.2	47.6	1.3	2.0	35.5	44.2	1.4	2.3
6–10	79.1	63.2	1.1	2.2	18.6	28.6	1.2	2.4
11–15	87.0	80.0	0.9	1.9	10.7	11.9	1.0	2.1
16–20	89.3	86.2	0.6	1.1	8.4	5.7	0.8	1.5
21–25	93.0	91.2	0.5	0.9	4.7	0.6	0.7	1.3
Ultimate	97.7	91.8	0.5	1.0	--	--	--	--
Total	91.6	81.6	0.3	0.6	--	--	--	--

Further splitting by income band shows a clear relationship between self-selection and income band. This supports the notion that individuals investing a larger amount of money in annuity products are better informed of their health, and/or have invested so that they can maintain good health, thus increasing the impact of self-selection. Table 7C uses a select period of 10 years. The difference between the A/E ratios for the select and the ultimate periods has been used as a measurement of self-selection.

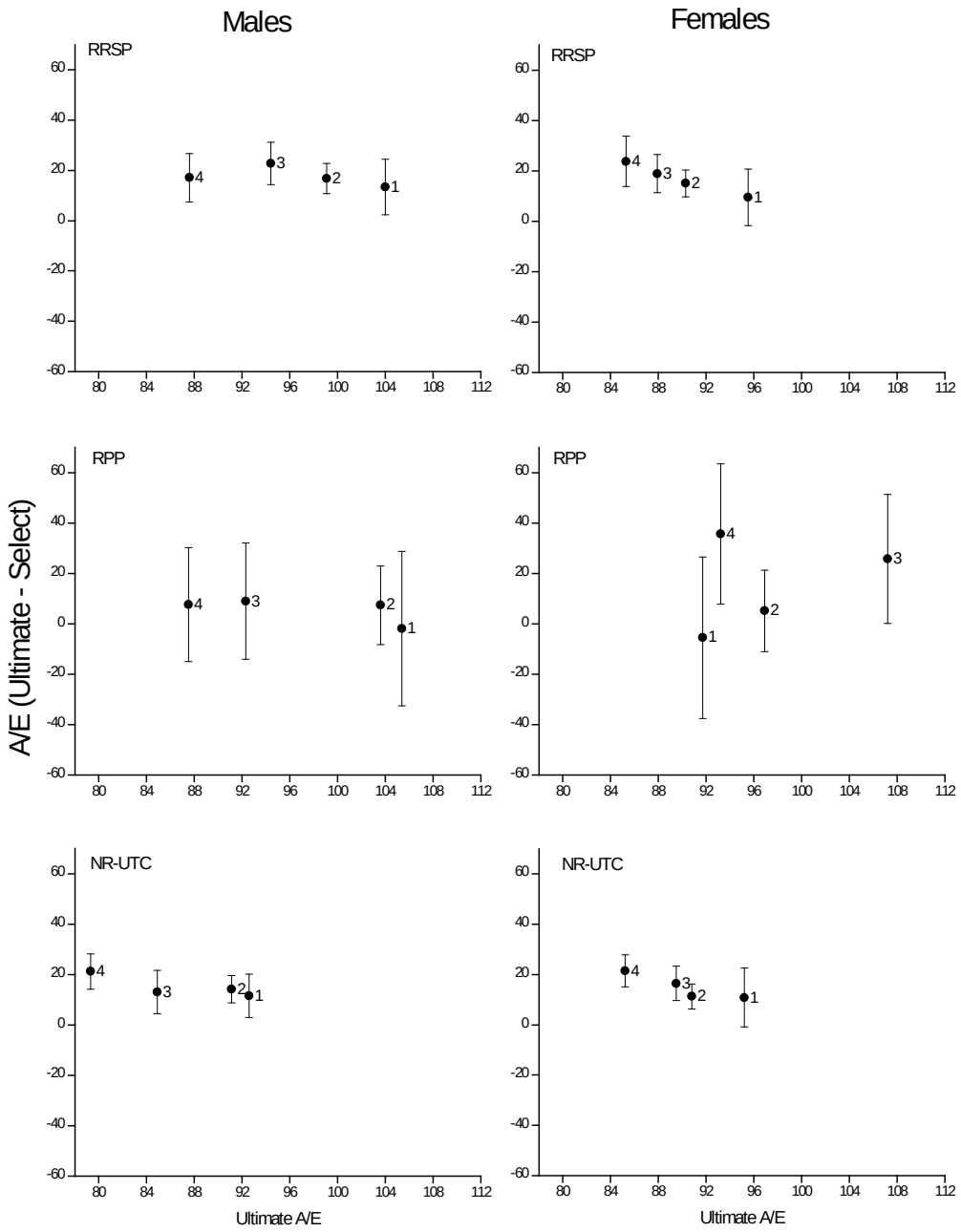
Table 7C. Ultimate – Select Mortality Experience by Income Band (10-year Select Period), 2002-2012

Income	Ultimate minus Select			
	A/E		S.D	
	#	$	#	$
$0-$999	10.9	10.8	2.5	2.7
$1,000-$4,999	14.0	14.5	1.3	1.4
$5,000-$9,999	18.0	18.0	1.9	1.9
$10,000+	21.5	30.7	1.9	2.4
Total	18.5	30.4	0.8	1.5

The above tables indicate that experience, as measured by A/E, depends in important ways on duration, sex, tax type, and income.

The difference in A/E (Ultimate – Select) appears to depend on the Ultimate A/E. Policy groups with low Ultimate A/E tend to have even greater differences in A/E (Ultimate – Select). The following displays are based on grouping single life policies by sex, income, and tax type.

Figure 4A. A/E by Number of Policies (Ultimate – Select) as a function of Ultimate A/E Plots are shown for males, females, three tax types, and four income bands. Income band: 1 = $0–$999; 2 = $1,000–$4,999; 3 = $5,000–$9,999; 4 = $10,000+. We show 95% confidence intervals.



The above displays focus on the difference in A/E (Ultimate – Select). Note, however, that the Ultimate A/E varies greatly by sex, tax type, and income. This is clearly evident for NR-UTC policies in which the Ultimate A/E for males with large income policies is unusually low (79.3% for number of policies; 73.4% for income). Other patterns are significant. From this we conclude that the selection effect measured by the difference A/E (Ultimate – Select) depends on the Ultimate A/E.

Figure 4B. A/E by Annualized Income (Ultimate – Select) as a function of Ultimate A/E Plots are shown for males, females, three tax types, and four income bands. Income band: 1 = $0–$999; 2 = $1,000–$4,999; 3 = $5,000–$9,999; 4 = $10,000+. We show 95% confidence intervals.

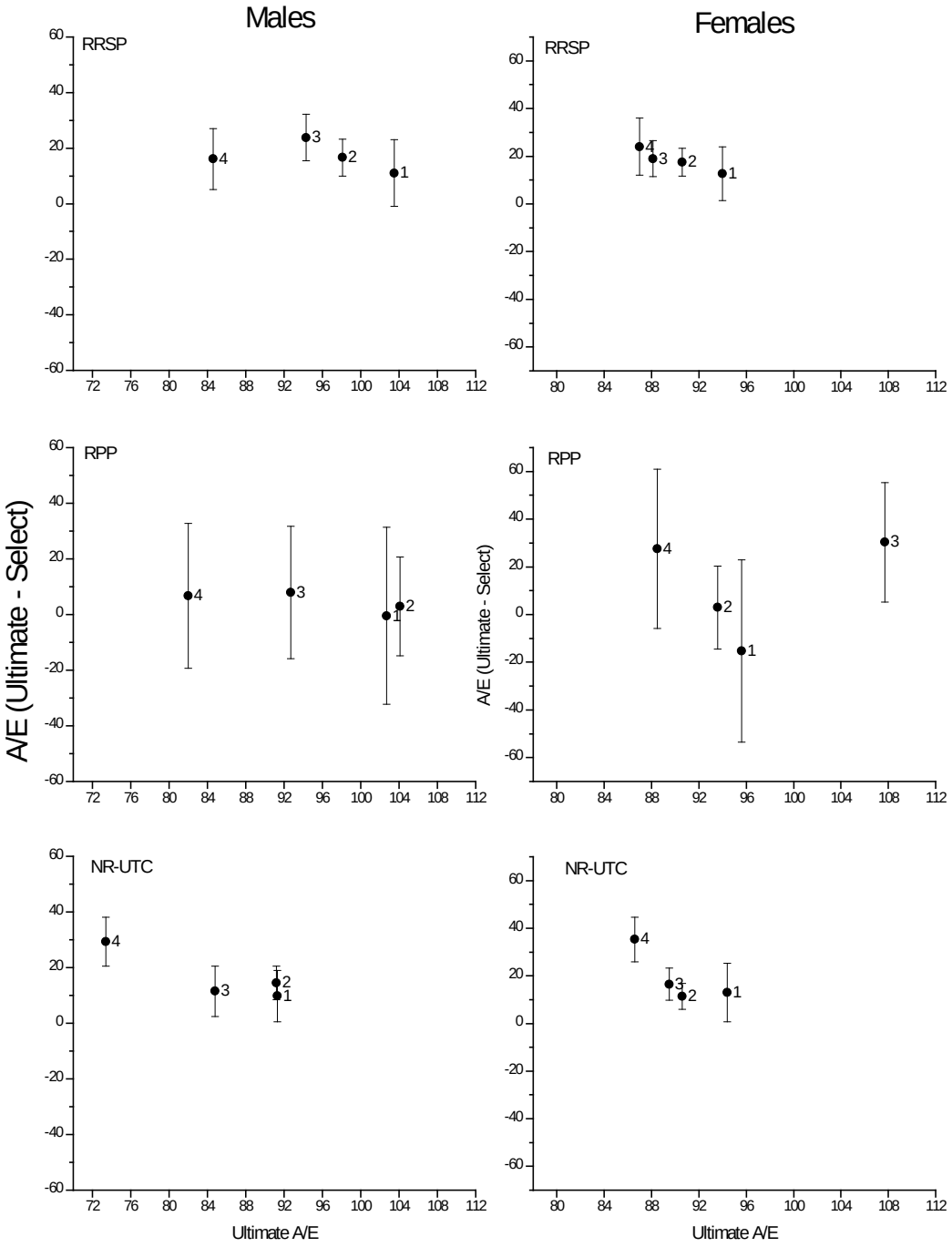


Table 8 below presents the A/E ratios for all groups of policies.

Table 8. A/E Ratios for Males and Females with Four Income Bands and Three Tax Types (Income Bands as for figure 4), 2002-2012

			A/E						S.D. of Difference	
			Select		Ultimate		Ultimate – Select			
Sex	**Income Band**	**Tax Type**	**By #**	**By $**	**By #**	**By $**	**By #**	**By $**	**By #**	**By $**
Males	1	RRSP	90.5	92.4	104.0	103.5	13.4	11.0	5.5	6.0
Males	1	RPP	107.3	103.2	105.4	102.7	-1.9	-0.5	15.3	15.9
Males	1	NR-UTC	81.1	81.5	92.6	91.3	11.5	9.8	4.3	4.6
Males	2	RRSP	82.4	81.5	99.1	98.1	16.8	16.6	3.0	3.3
Males	2	RPP	96.2	101.2	103.6	104.1	7.4	2.9	7.8	8.9
Males	2	NR-UTC	76.9	76.6	91.1	91.2	14.2	14.5	2.7	3.0
Males	3	RRSP	71.6	70.5	94.4	94.3	22.8	23.8	4.2	4.2
Males	3	RPP	83.2	84.7	92.3	92.7	9.0	8.0	11.5	11.9
Males	3	NR-UTC	71.9	73.3	84.9	84.8	13.0	11.5	4.3	4.5
Males	4	RRSP	70.6	68.5	87.6	84.6	17.1	16.1	4.8	5.5
Males	4	RPP	79.9	75.3	87.5	82.0	7.6	6.7	11.3	13.0
Males	4	NR-UTC	58.2	44.1	79.3	73.4	21.2	29.3	3.5	4.4
Females	1	RRSP	86.1	81.3	95.5	94.0	9.4	12.7	5.6	5.6
Females	1	RPP	97.2	110.9	91.7	95.6	-5.5	-15.3	16.0	19.1
Females	1	NR-UTC	84.2	81.4	95.2	94.4	10.9	13.0	5.9	6.1
Females	2	RRSP	75.3	73.2	90.3	90.6	15.0	17.5	2.7	2.9
Females	2	RPP	91.8	90.5	96.9	93.6	5.1	3.0	8.1	8.7
Females	2	NR-UTC	79.5	79.1	90.8	90.6	11.3	11.4	2.5	2.7
Females	3	RRSP	69.0	69.1	87.9	88.1	18.9	19.0	3.8	3.8
Females	3	RPP	81.5	77.4	107.2	107.7	25.7	30.3	12.8	12.5
Females	3	NR-UTC	73.0	73.0	89.5	89.5	16.5	16.5	3.4	3.4
Females	4	RRSP	61.6	63.0	85.3	87.0	23.7	24.0	5.0	6.0
Females	4	RPP	57.6	60.9	93.2	88.5	35.6	27.6	13.9	16.7
Female	4	NR-UTC	63.6	51.4	85.2	86.6	21.5	35.3	3.2	4.7

Non-Refund/Refund Observations

There are several difficulties when comparing refund and non-refund business:

- There is much less non-refund business than refund business, although the percentage of non-refund business has been increasing in the last few study years;
- Refund business is far from homogeneous: both life five-year certain and life certain to age 90 qualify as refund; and
- Some companies have difficulties classifying refund business correctly after the certain period has expired.

Table 9 shows both mortality ratios and standard deviations for single life policies. As can be seen by the standard deviations for the non-refund ratios, there is a greater degree of uncertainty with these results.

Despite this uncertainty and the above concerns, we can make some interesting observations. For single life policies (both male and female), the non-refund mortality ratios are lower than the refund mortality ratios when measured by annualized income. That does not seem to be the case for females when measured by number of policies, although males do follow this trend.

Some of the non-refund mortality ratios by income are lower for NR-UTC policies and for the three highest income bands. These results certainly warrant caution in pricing non-refund annuities.

One possible explanation for the difference observed based on refund status is that the annuitants may have additional information on their health status, such as under back-to-back policies, and they then choose the appropriate type of annuity. Thus, one would expect that annuitants who choose non-refund policies believe that they have good health status and are willing to receive a higher annuity income at the risk of receiving nothing at time of death.

Table 9. Mortality Experience by Refund Type, 2002-2012

Experience	Refund	Exposed		Deaths		A/E		S.D.	
		#	$	#	$	#	$	#	$
Total	No	435,468	2,506,134,303	35,262	145,473,531	91.9	75.9	0.5	1.0
Total	Yes	1,185,369	5,357,064,356	73,398	256,993,852	91.4	85.3	0.3	0.6
Males	No	181,820	1,153,809,439	15,602	69,777,409	92.8	74.9	0.7	1.5
Males	Yes	526,184	2,535,547,900	36,765	131,759,184	94.3	85.2	0.5	0.8
Females	No	253,648	1,352,324,864	19,660	75,696,122	91.3	76.8	0.7	1.4
Females	Yes	659,186	2,821,516,456	36,633	125,234,668	88.7	85.3	0.5	0.9
RRSP	No	215,913	790,745,789	20,121	62,577,618	94.7	89.4	0.7	1.2
RRSP	Yes	646,223	2,360,673,054	44,797	143,252,777	93.0	88.6	0.4	0.7
RPP	No	29,922	155,148,685	2,029	8,944,311	97.9	93.5	2.2	4.1
RPP	Yes	77,094	388,991,675	3,432	14,008,944	97.1	86.5	1.7	2.7
NR-UTC	No	189,633	1,560,239,829	13,112	73,951,602	87.2	65.9	0.8	1.6
NR-UTC	Yes	462,053	2,607,399,626	25,169	99,732,131	88.1	80.8	0.6	1.2
$0–$999	No	103,277	58,708,831	10,180	5,548,364	98.5	97.5	1.0	1.1
$1,000–	No	212,652	513,069,101	17,546	41,118,725	93.8	92.6	0.7	0.8
$5,000–	No	65,140	450,139,701	4,574	31,650,058	87.2	87.5	1.3	1.3
$10,000–	No	33,812	458,780,656	2,013	27,407,617	76.8	76.7	1.7	1.7
$20,000–	No	15,996	457,858,032	763	21,616,606	66.2	65.2	2.4	2.4
$50,000+	No	4,591	567,577,982	186	18,132,161	62.9	49.6	4.6	4.4
$0–$999	Yes	268,203	163,328,527	19,085	11,366,937	95.5	94.6	0.7	0.7
$1,000–	Yes	624,742	1,486,387,434	39,987	92,991,393	91.7	91.6	0.5	0.5
$5,000–	Yes	179,614	1,246,461,949	9,561	65,771,077	87.4	87.2	0.9	0.9
$10,000–	Yes	77,675	1,044,096,291	3,611	47,964,997	85.2	84.9	1.4	1.4
$20,000–	Yes	29,203	833,601,710	1,025	28,453,348	77.8	77.0	2.4	2.5
$50,000+	Yes	5,933	583,188,445	129	10,446,100	65.4	55.0	5.8	5.9
Select (10)	No	63,665	949,050,124	1,789	22,422,327	64.0	45.2	1.5	2.4
Select (10)	Yes	281,406	1,864,718,426	7,144	44,348,093	78.3	68.4	0.9	1.7
Ultimate	No	371,803	1,557,084,179	33,473	123,051,204	94.1	86.6	0.5	1.1
Ultimate	Yes	903,963	3,492,345,930	66,254	212,645,759	93.1	89.9	0.4	0.6

Back-to-Back Policy Observations

The subcommittee isolated the experience of back-to-back annuities. In this study, we assume that the non-refund and NR-UTC policies with higher income bands are back-to-back annuities. Table 10A compares the non-refund and NR-UTC policies by income bands.

Although the data for non-refund and NR-UTC policies are sparse, they indicate that single life policies have monotonically decreasing mortality ratios when measured by number of deaths or by income (except for $50,000+ when measured by number of deaths).

However, the results for joint life policies (both alive and survivor) do not follow the same pattern and are also less informative due to smaller sample sizes.

Table 10A. Single, Non-Refund and NR-UTC Experience Only, 2002-2012

Experience	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	47,362	25,556,734	4,040	2,044,109	95.5	94.9	1.5	1.7
$1,000–$4,999	76,625	186,507,323	5,376	12,763,298	92.0	91.0	1.3	1.4
$5,000–$9,999	30,157	210,563,218	1,909	13,401,188	82.3	82.5	1.9	1.9
$10,000–	19,701	270,925,669	1,127	15,716,632	73.2	73.6	2.2	2.2
$20,000–	11,650	335,759,127	504	14,235,071	59.5	58.0	2.7	2.7
$50,000+	4,138	530,927,759	156	15,791,304	59.8	46.7	4.8	4.5
Total	189,633	1,560,239,829	13,112	73,951,602	87.2	65.9	0.8	1.6

Table 10B. Joint (Both Alive), Non-Refund and NR-UTC Experience Only, 2002-2012

Experience	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	6,941	4,242,546	366	218,797	80.7	80.1	4.2	4.5
$1,000–$4,999	24,986	59,611,116	1,116	2,748,348	82.7	83.2	2.5	2.7
$5,000–$9,999	7,911	55,544,422	389	2,699,649	82.0	81.5	4.2	4.2
$10,000–	4,797	66,543,593	171	2,308,544	63.1	62.1	4.8	4.8
$20,000–	2,094	60,946,067	76	2,160,442	64.9	64.9	7.4	7.7
$50,000+	777	112,561,014	21	4,797,574	51.2	77.2	11.2	27.5
Total	47,506	359,448,758	2,139	14,933,354	79.0	74.1	1.7	8.6

Table 10C. Joint (One Survivor), Non-Refund and NR-UTC Experience Only, 2002-2012

Experience	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	5,083	3,040,938	536	308,851	99.8	99.0	4.3	4.7
$1,000–$4,999	12,250	28,987,301	1,114	2,628,990	96.2	95.2	2.9	3.1
$5,000–$9,999	3,212	22,173,666	300	2,032,064	95.8	95.1	5.5	5.6
$10,000–	1,560	20,617,243	135	1,744,417	92.8	91.5	8.0	8.0
$20,000–	610	16,601,481	50	1,253,324	83.6	77.7	11.8	11.2
$50,000+	89	7,550,044	9	1,548,583	88.9	194.8	29.6	129.3
Total	22,803	98,970,673	2,144	9,516,229	96.4	99.9	2.1	11.2

By splitting the back-to-back business by male and female, we observe that the mortality ratios show the same pattern. (See tables 10D and 10E.)

Table 10D. Single, Male, Non-Refund and NR-UTC Experience Only, 2002-2012

Experience	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	24,098	13,859,867	1,809	985,357	93.3	91.0	2.2	2.4
$1,000–$4,999	32,751	76,426,888	2,272	5,230,342	89.6	88.4	1.9	2.1
$5,000–$9,999	12,147	85,334,276	761	5,473,506	78.0	79.2	2.8	2.9
$10,000–	8,037	111,161,399	488	6,858,821	73.2	73.7	3.3	3.4
$20,000–	5,384	155,497,817	244	6,997,440	57.9	56.8	3.7	3.8
$50,000+	2,071	276,409,701	84	8,598,298	61.5	46.4	6.7	5.9
Total	84,488	718,689,949	5,658	34,143,764	84.8	63.1	1.1	2.3

Table 10E. Single, Female, Non-Refund and NR-UTC Experience Only, 2002-2012

Experience	Exposed		Deaths		A/E		S.D.	
	#	$	#	$	#	$	#	$
$0–$999	23,264	11,696,867	2,231	1,058,752	97.4	98.7	2.1	2.4
$1,000–$4,999	43,874	110,080,435	3,104	7,532,956	94.0	93.0	1.7	1.8
$5,000–$9,999	18,010	125,228,942	1,148	7,927,682	85.5	85.0	2.5	2.6
$10,000–	11,664	159,764,271	639	8,857,811	73.2	73.4	2.9	3.0
$20,000–	6,266	180,261,309	260	7,237,631	61.1	59.3	3.8	3.8
$50,000+	2,067	254,518,058	72	7,193,006	57.8	47.0	6.8	7.0
Total	105,146	841,549,881	7,454	39,807,838	89.2	68.5	1.0	2.2

Joint and Survivor Policy Observations

Figure 5A illustrates the male aggregate mortality ratios by income for single life, joint life (both alive), and joint survivor policies. The data clearly indicate significantly higher ratios for joint survivor policies than for joint life policies (both alive) or single life policies. Ratios for joint (both alive) and single policies do not show a marked difference.

Figure 5. A/E by Income per Policy Year for Three Policy Plans

A. Males

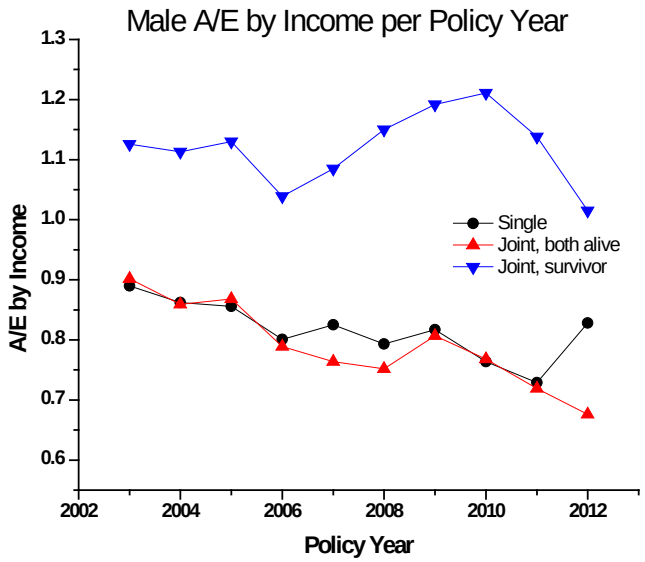
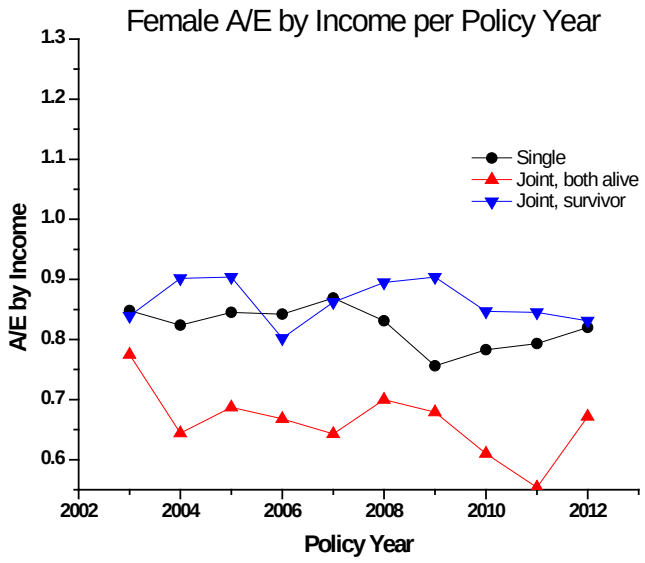


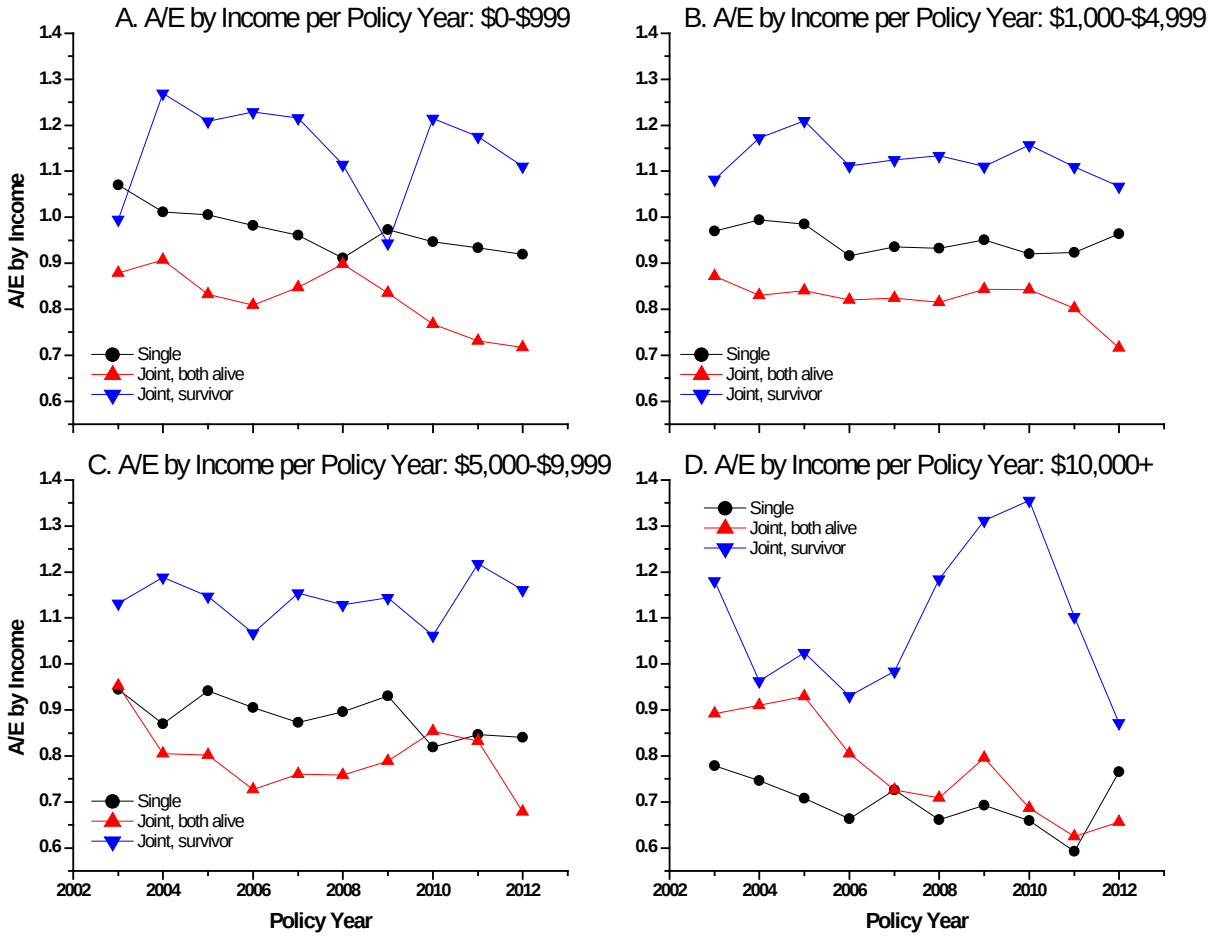
Figure 5B illustrates the corresponding aggregate mortality ratios for female lives. In this case, the data also indicate a relatively higher mortality for joint survivor policies compared with joint, both alive. For males, joint, both alive and single mortality are similar, with joint survivor mortality much higher; for females, joint survivor mortality is somewhat higher than single mortality, but both are clearly higher than joint, both alive.

B. Females



Figures 6A–D illustrate the aggregate mortality ratios for males, for each of the four income bands, for single life, joint life (both alive), and joint survivor policies. The joint (both alive) policies have lower A/E ratios than single and survivor policies at lower income levels, but they appear to be converging with the single plan at the highest income band; joint survivor A/E ratios are highest for all income bands.

Figure 6A–D. Males—A/E by Income per Policy Year for Three Policy Plans and Four Income Bands



Similarly, figures 6E–H illustrate the aggregate mortality ratios for females. The joint (both alive) policies have lower A/E ratios than single and survivor policies at all income levels. Unlike the males, joint survivor A/E ratios are indistinguishable from the single A/E ratios, except perhaps at the highest income band.

Figure 6E–H. Females—A/E by Income per Policy Year for Three Policy Plans and Four Income Bands

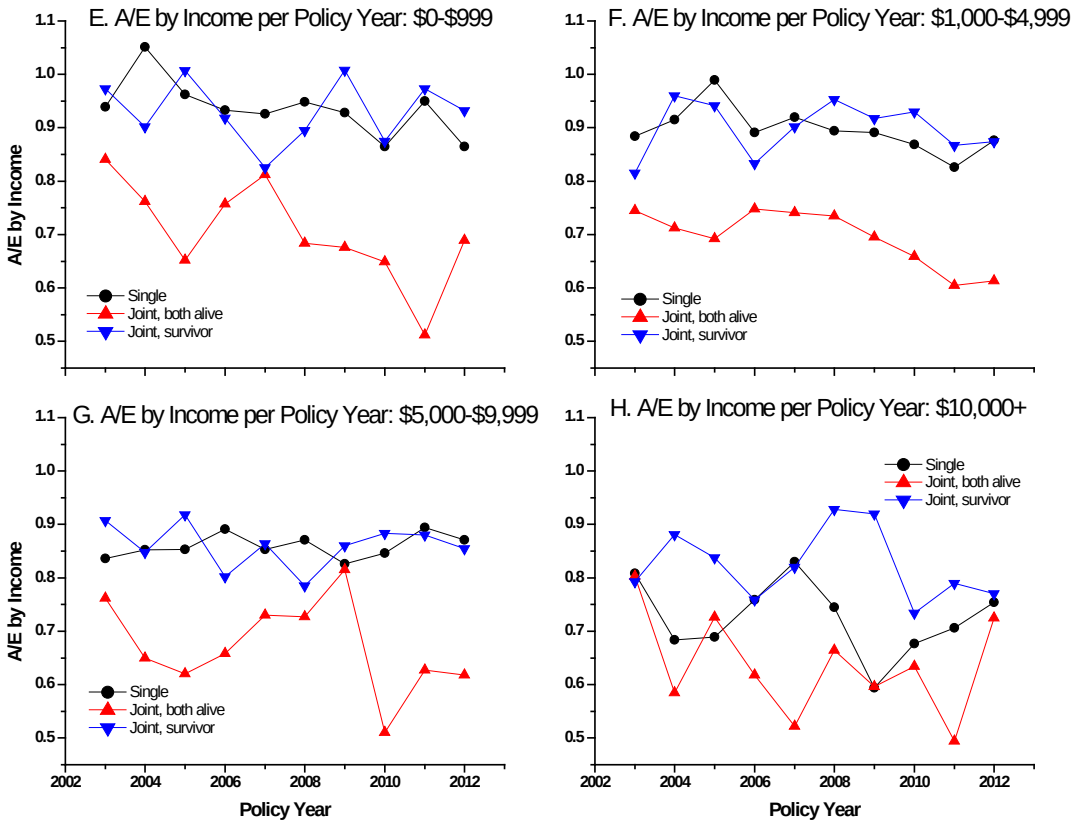
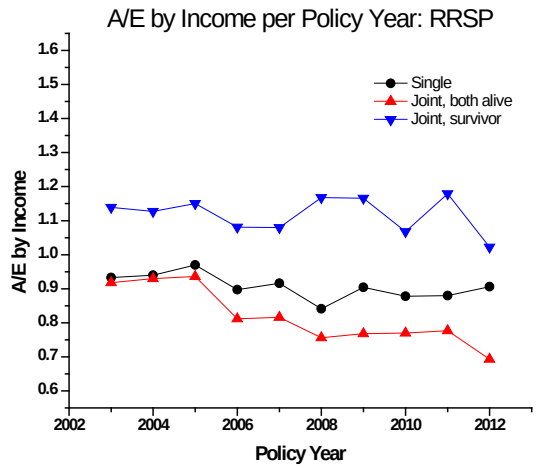
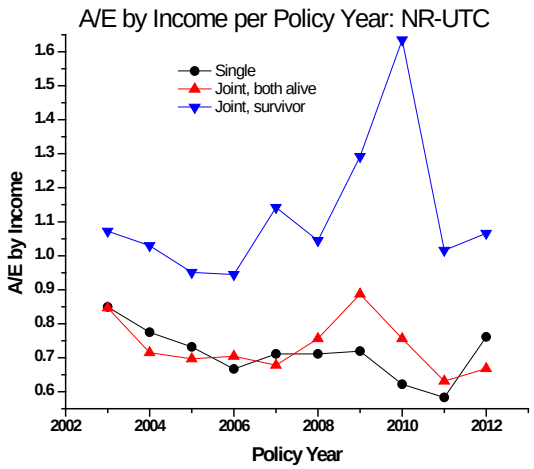


Figure 7 illustrates the ratios by tax status. For males, the mortality ratio is much higher for joint survivors than for joint (both alive) or single life policies.

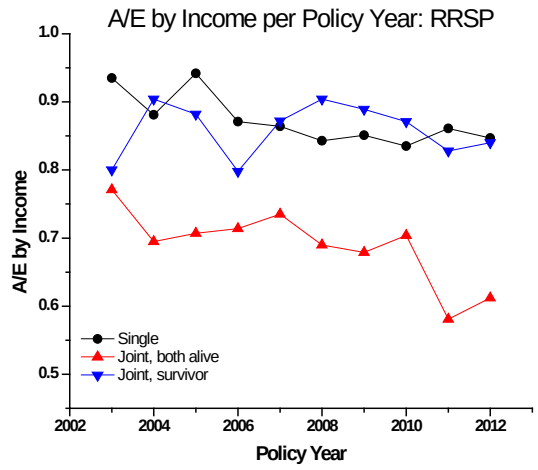
Figure 7. A/E by Income per Policy Year for Three Policy Plans and Two Tax Types

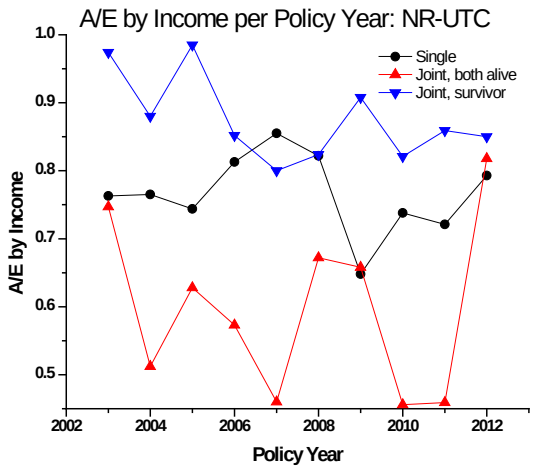
A. Males





B. Females





In the past, joint life policies (both alive) exhibited a lower mortality experience compared to single life policies. This seems true for RRSP, but less so for NR-UTC policies.

5. Contributing Companies

Table 11 shows, for each of the contributing companies, the proportion of deaths on single life policies submitted for 2002–2012.

Table 11. Contributions of Companies

Company	2002-2011	2011-2012
Canada Life	20.0%	17.6%
Co-operators	1.1%	1.9%
Industrial	6.7%	6.6%
Manulife	28.6%	28.0%
Standard Life	9.7%	10.8%
SunLife	33.9%	35.1%

6. Subcommittee Members

At the time the study was prepared, the members of the Annuitant Experience Subcommittee of the Research Committee were: Diana Pisanu (Chair), Taylor Wasko, Lynn Allen, Catherine Bégin, Peter Snyder, and Diane Lachance.

This report was prepared by Barbara Thomson and David Andrews of Thomson Data Analysis, Toronto, ON.

Month 2016

Appendix 1: IBNR (Incurred But Not Reported)

The incidence of late-reported deaths varies by company, year, plan, and sex. Estimating IBNR rates for the current year based on previous data cannot be done precisely. However, the data do provide some indication of these rates.

For each company and each year of submission, we computed the number of deaths for that year and each succeeding submission year. We then computed the percent of total deaths for each year and each company for the year of submission and for the first, second, third, etc. years following.

The deaths that were reported with lags of one, two, and three years were summed separately. The deaths reported in the year of submission were summed for the years 2003–2011, 2003–2010, and 2003–2009, as those were the ranges of years that could have had deaths reported with lags one, two, and three. For example, only deaths that occurred in 2003–2010 could have been reported by 2012 with a lag of two years.

The percentages were computed by dividing the second set of totals by the first. These are the percentages of deaths that are reported with lags of one, two, and three years. For example, the percent of deaths reported with a lag of two years was the sum of all the deaths reported with a lag of two policy years divided by the sum of the deaths reported for the years 2003–2010. Note that the years in the above discussion refer to policy years.

Table A1 presents the summary results by plan and sex.

Table A1. Percentages of Deaths Reported Late for Males, Females, and Three Plans

Plan	Sex	% 1-year lag	% 2-year lag	% 3-year lag
Single	Male	2.0	0.5	0.4
Single	Female	2.2	0.5	0.5
Joint	Male	3.8	1.9	1.1
Joint	Female	8.9	5.4	4.2
Survivor	Male	2.3	1.7	1.2
Survivor	Female	2.4	1.0	0.8

The table suggests that deaths for single policies are under-reported for lags one, two, and three by approximately 2.0%, 0.5%, and 0.5%, respectively. These values suggest the following IBNR multipliers of A/E: 1.005, 1.010 [1 + 0.005 + 0.005], and 1.030 [1 + 0.005 + 0.005 + 0.020], for the years 2010, 2011, and 2012, respectively, since these years are missing reported deaths lagged by three years, two plus three years, and one plus two plus three years, respectively. This modest adjustment is often smaller than the standard deviation of the individual results.

These rates may be useful in the interpretation of trends over years as the experience in the most recent three years is slightly underreported.

Appendix 2: Additional Data for Study

This study includes more detailed tables summarizing the data. Table A2 is a table of contents for the combined 10 years of experience 2002–2012. Note that table 8 includes summaries by policy year.

Table A2. Table of Contents for Detailed Tables Available from the CIA Website

Canadian Annuity Experience	
Between Policy Anniversaries in 2002 and 2012	
Expected SOA Mortality Tables from 1983	
Index of Tables	
TABLE 1.1	TOTAL EXPERIENCE—SINGLE LIFE
TABLE 1.2	MALE EXPERIENCE—SINGLE LIFE
TABLE 1.3	FEMALE EXPERIENCE—SINGLE LIFE
TABLE 2.1	TOTAL EXPERIENCE—SINGLE LIFE—RRSP
TABLE 2.2	TOTAL EXPERIENCE—SINGLE LIFE—RPP
TABLE 2.3	TOTAL EXPERIENCE—SINGLE LIFE—NEITHER RRSP NOR RPP
TABLE 2.4	MALE EXPERIENCE—SINGLE LIFE—RRSP
TABLE 2.5	MALE EXPERIENCE—SINGLE LIFE—RPP
TABLE 2.6	MALE EXPERIENCE—SINGLE LIFE—NEITHER RRSP NOR RPP
TABLE 2.7	FEMALE EXPERIENCE—SINGLE LIFE—RRSP
TABLE 2.8	FEMALE EXPERIENCE—SINGLE LIFE—RPP
TABLE 2.9	FEMALE EXPERIENCE—SINGLE LIFE—NEITHER RRSP NOR RPP
TABLE 3.1	TOTAL EXPERIENCE—SINGLE LIFE—NO REFUND
TABLE 3.2	TOTAL EXPERIENCE—SINGLE LIFE—REFUND
TABLE 3.3	MALE EXPERIENCE—SINGLE LIFE—NO REFUND
TABLE 3.4	MALE EXPERIENCE—SINGLE LIFE—REFUND
TABLE 3.5	FEMALE EXPERIENCE—SINGLE LIFE—NO REFUND
TABLE 3.6	FEMALE EXPERIENCE—SINGLE LIFE—REFUND
TABLE 4.1	TOTAL EXPERIENCE—JOINT, BOTH ALIVE
TABLE 4.2	TOTAL EXPERIENCE—JOINT, ONE SURVIVING
TABLE 4.3	MALE EXPERIENCE—JOINT, BOTH ALIVE
TABLE 4.4	MALE EXPERIENCE—JOINT, ONE SURVIVING
TABLE 4.5	FEMALE EXPERIENCE—JOINT, BOTH ALIVE
TABLE 4.6	FEMALE EXPERIENCE—JOINT, ONE SURVIVING
TABLE 5.1	TOTAL EXPERIENCE—SINGLE LIFE—< $1,000
TABLE 5.2	TOTAL EXPERIENCE—SINGLE LIFE—$1,000-$4,999
TABLE 5.3	TOTAL EXPERIENCE—SINGLE LIFE—$5,000-$9,999
TABLE 5.4	TOTAL EXPERIENCE—SINGLE LIFE—$10,000+
TABLE 5.5	MALE EXPERIENCE—SINGLE LIFE—< $1,000