Exploring Longevity Initiatives:

Canadian Pensioners Mortality Improvement Rates by Data Source and Income

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Outline

1. Introduction
2. Mortality Study Results: 2005-2007
3. Recent Trends in Mortality
4. Mortality Improvement Rates
5. Impact on Present Value of Annuity, Life Expectancy
6. Conclusion

1. Introduction

- Acknowledgements
- Nature of Mortality Study
- Measurements
- Messages

1.1 Acknowledgements

- Funding
  - Chaire d'actuariat, Laval University
  - Previous work: CIA, SOA
- Data and support
  - Office of the Chief Actuary, Ottawa (CPP)
  - Régie des rentes du Québec, Québec (QPP)
- Collaborators
  - Undergraduate and graduate students
  - Colleagues & CIA Pension Experience Subcommittee members

1.2 Nature of Mortality Study

- Measure Canadian Pensioners mortality
- Current level and trend over time
- With data features:
  - **Canadian**: not U.S.
  - **Recent**: from 1967 to 2007 (*)
  - **Administrative**: not census or survey
  - **Complete and reliable**: CPP & QPP
  - **Individual**: dates, pension paid

1.3 Mortality measures

- Probability of death by age, year: q_x
- Mortality "Improvement" Rate over time: IR_x^t
- Used for: life expectancy, present value of an annuity, etc.
- Mortality measured by **5** variables
  1. Age: 60 to 115 years
  2. Gender: M, F
  3. Data Source: CPP, QPP, CAN=QPP+CPP
  4. **Income Class**:
     1=low, 2=mid, **3=high, 4=2+3**, 5=All
  5. Year or Triennial Period: 1967 to 2007

1.4 Messages

- Recent Trend of Mortality: **steeper decrease than expected**
- Living Longer : **+ and - for whom?**
- Important for pension plans, esp. for highly mature D.B. Plans
- Impact on Life Expectancy, Plan Liabilities & Current Service Cost: **it costs more**
- Mortality varies according to many variables:
  - age, gender**, income, region**
- **Higher income**: lower level of mortality and **higher improvement rates**
- Prudence: No crystal ball !

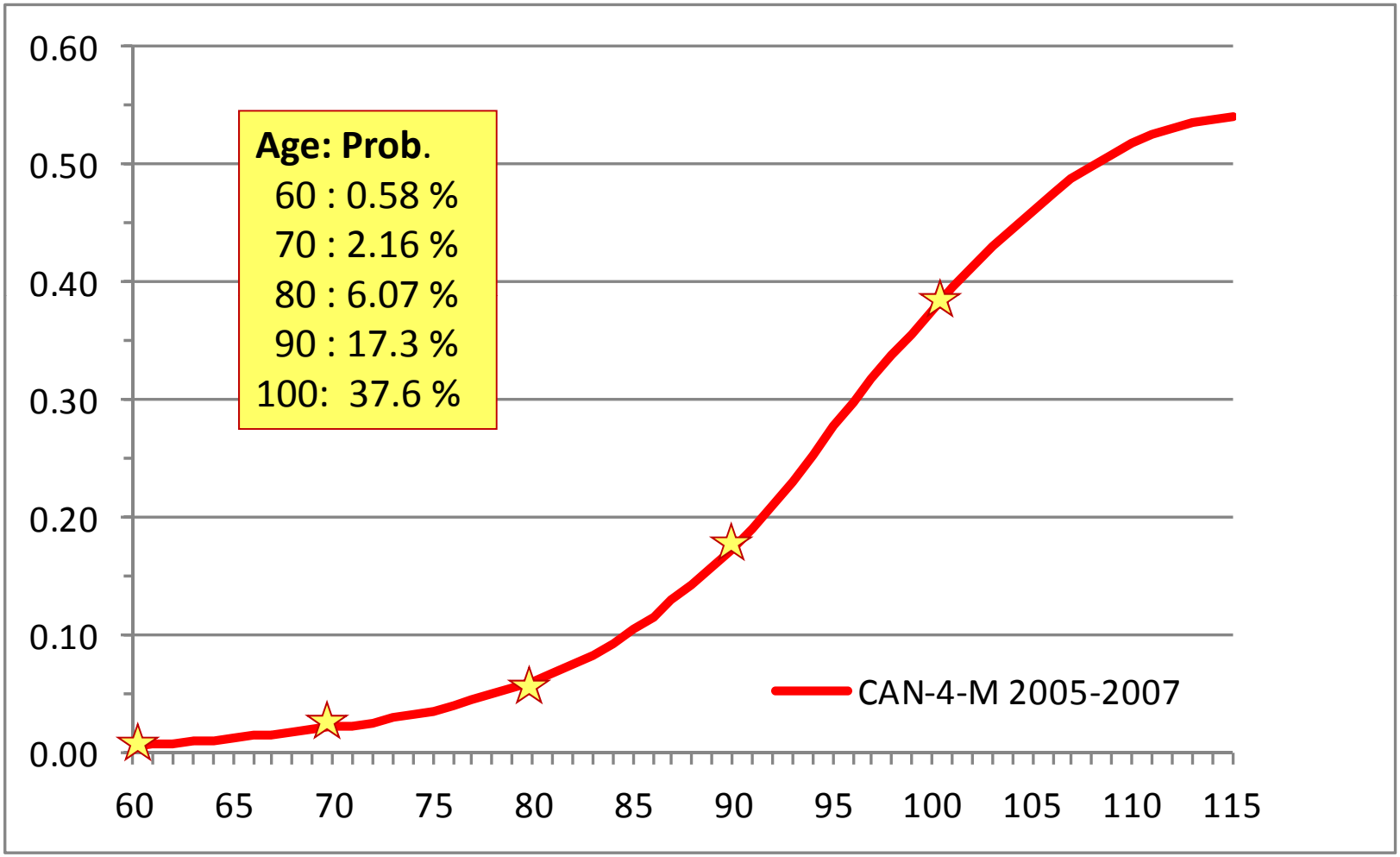
1.5 Recent studies: Canada, USA

- CIA Pension Experience Subcommittee (PES)Draft report: July 2013
- 26th CPP Actuarial Report as at 2012-12-31: December 2013
- QPP Actuarial Report as at 2012-12-31: December 2013
- CIA PES Final Report: February 2013
  - Updated Tables from July 2013 Draft
  - Updated Improvement Scale from Draft
- SOA Report RP-2014 Mortality table and MP-2014 Improvement Scale: February 2013
- **New info not reflected in this presentation**

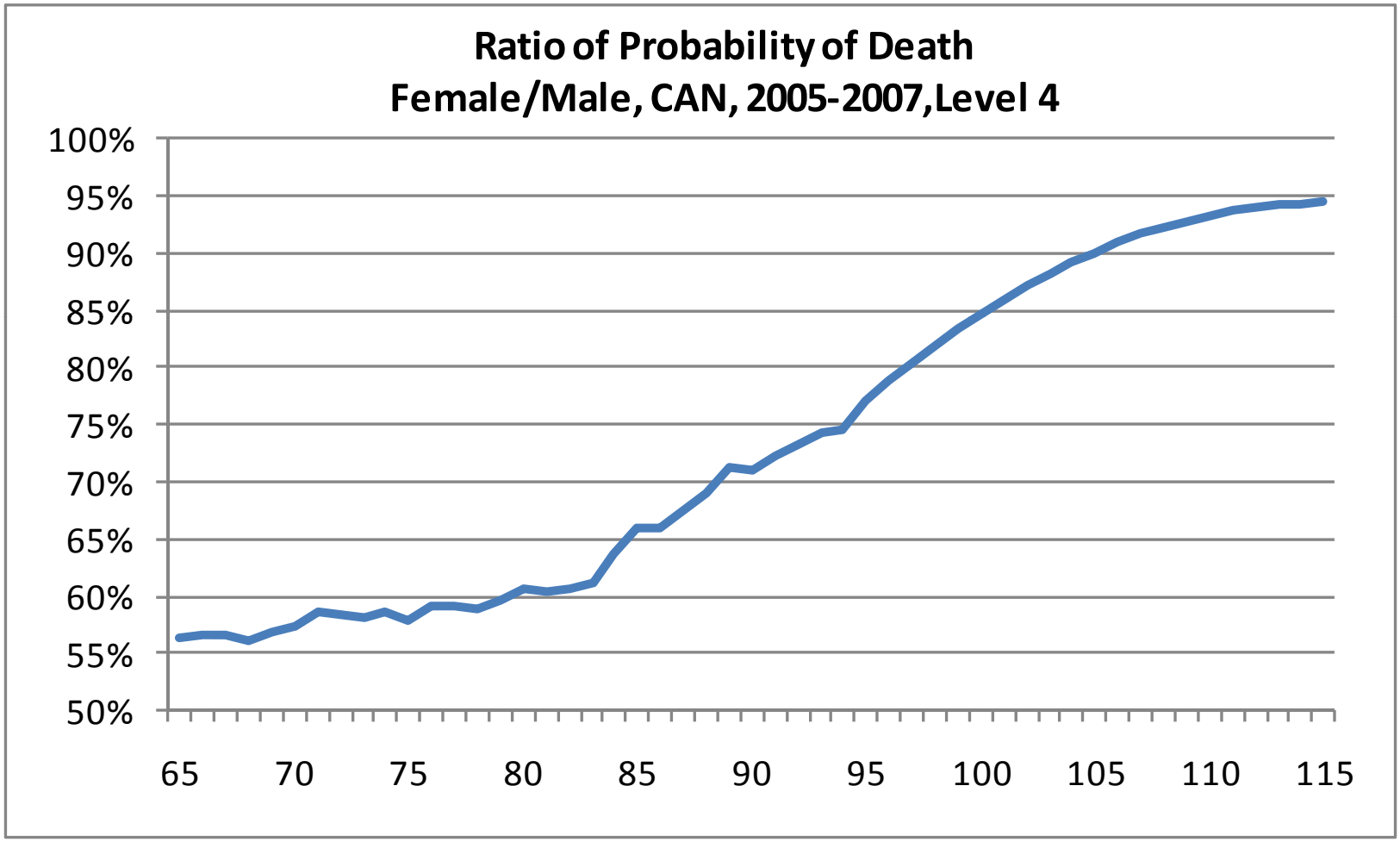
2. Study Results, 2005-2007

- 2005-2007 3-year Period, Canada data source
- Probability of death during the year by...
  - Age: 60 to 115 years
  - Gender: female / male ratio
  - Income Class: ratios
  - Data source: QPP vs CPP
- Available on Canadian Institute of Actuaries' website (http://www.cia-ica.ca/publications): 213003e.pdf, 213003t.pdf, 213012.pdf

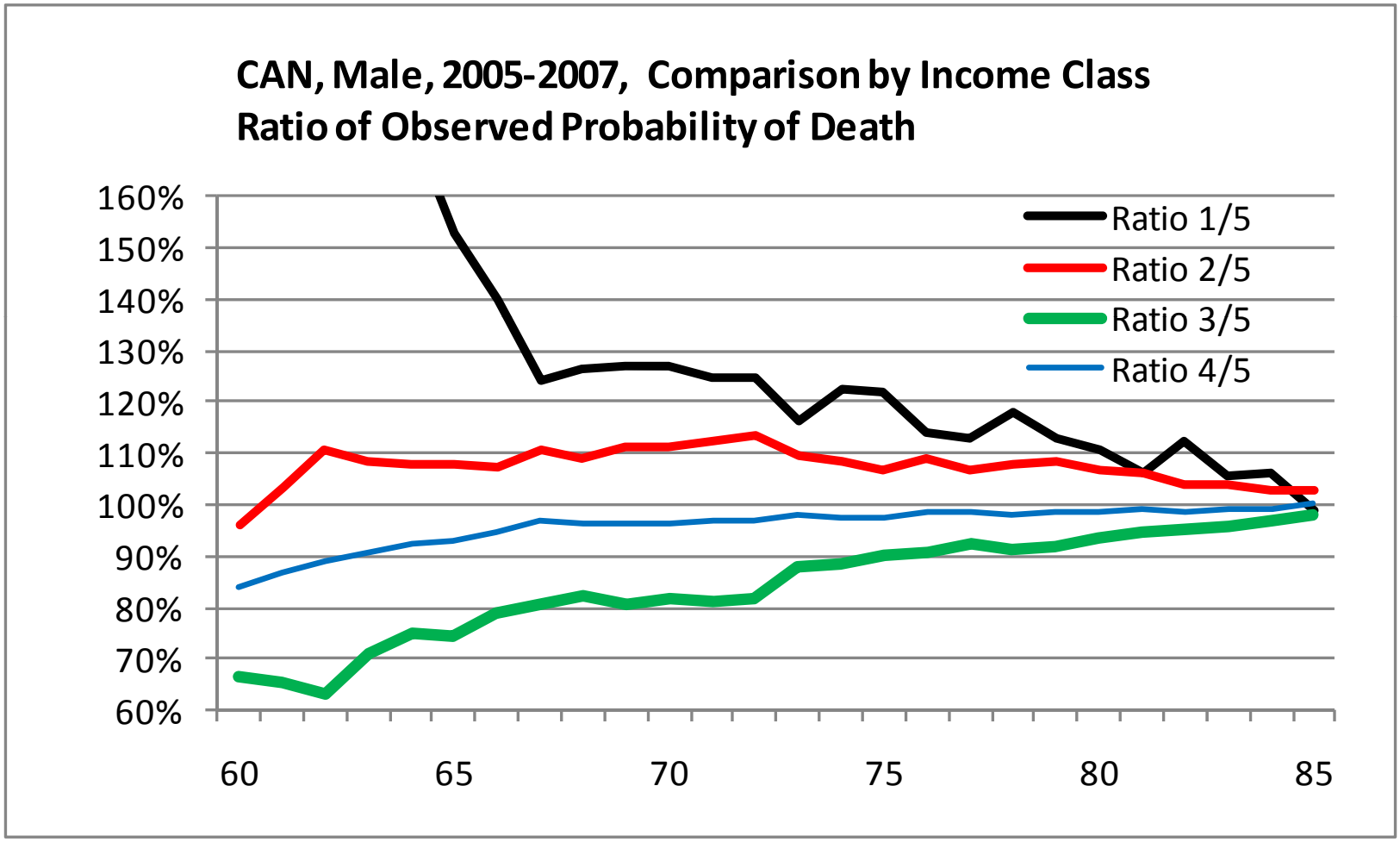
2.1 Mortality by age: CAN-4-M q(x)



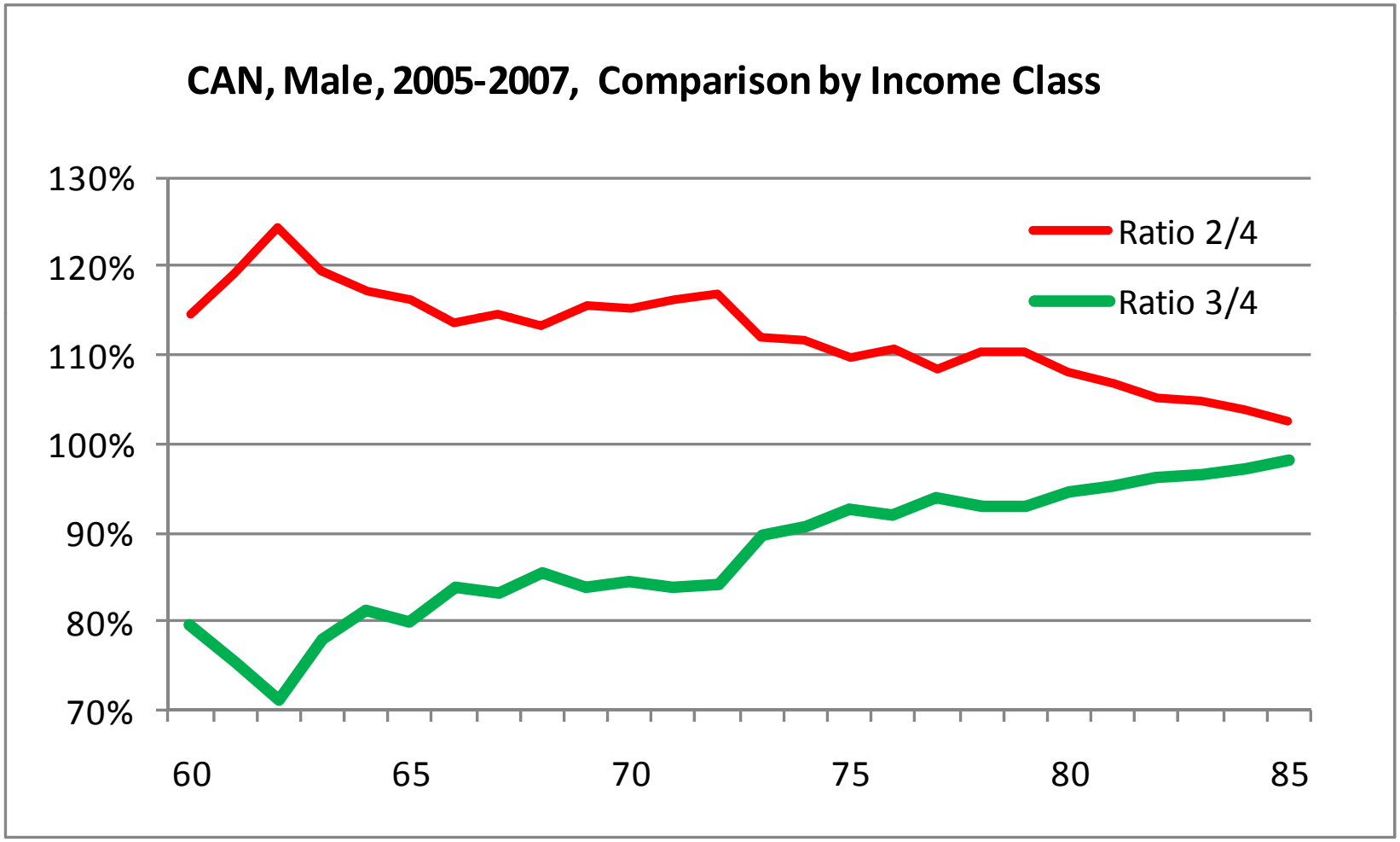
2.2 Mortality by Gender: F/M ratio



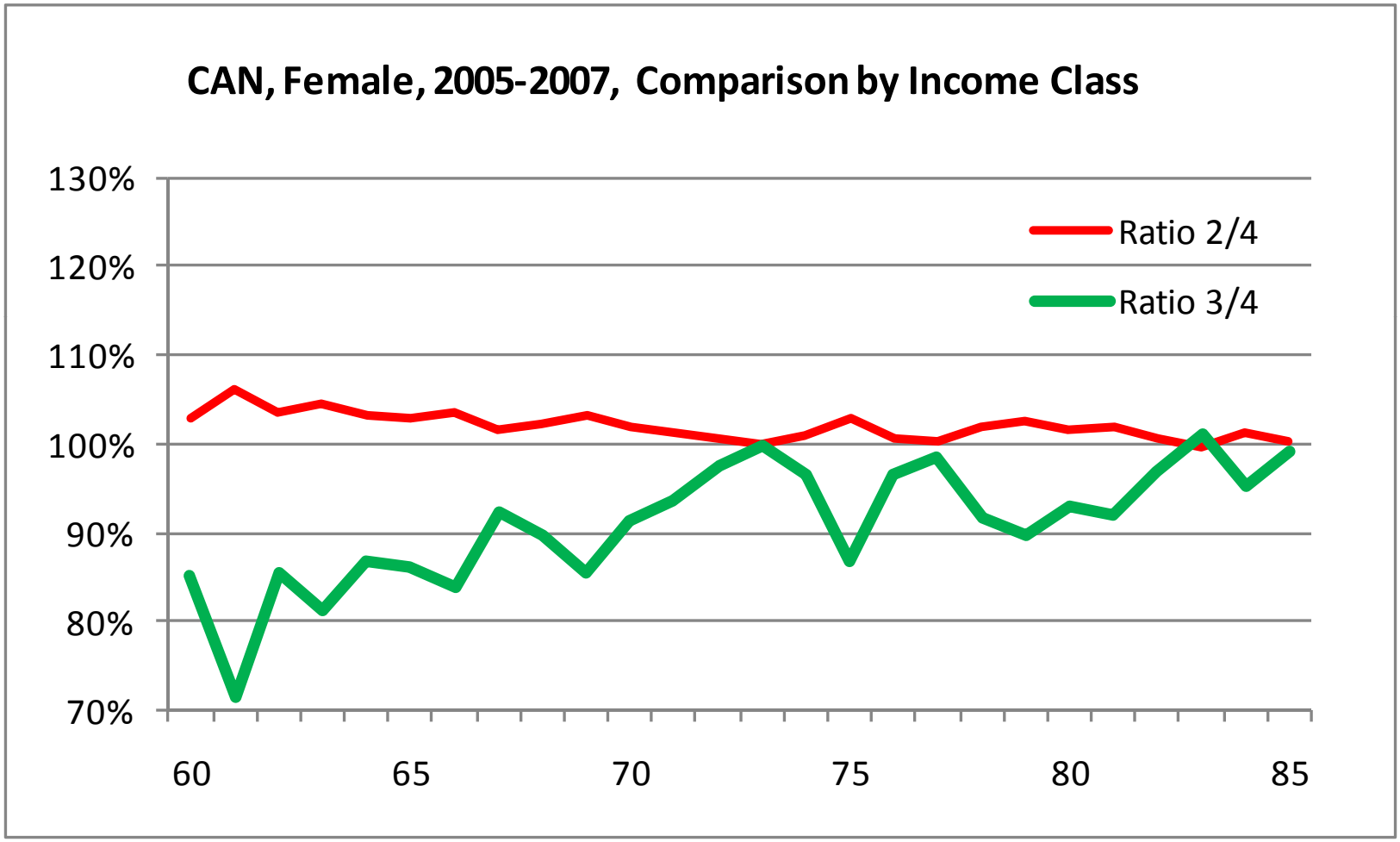
2.3 Mortality by Income Class: 1 to 5, M



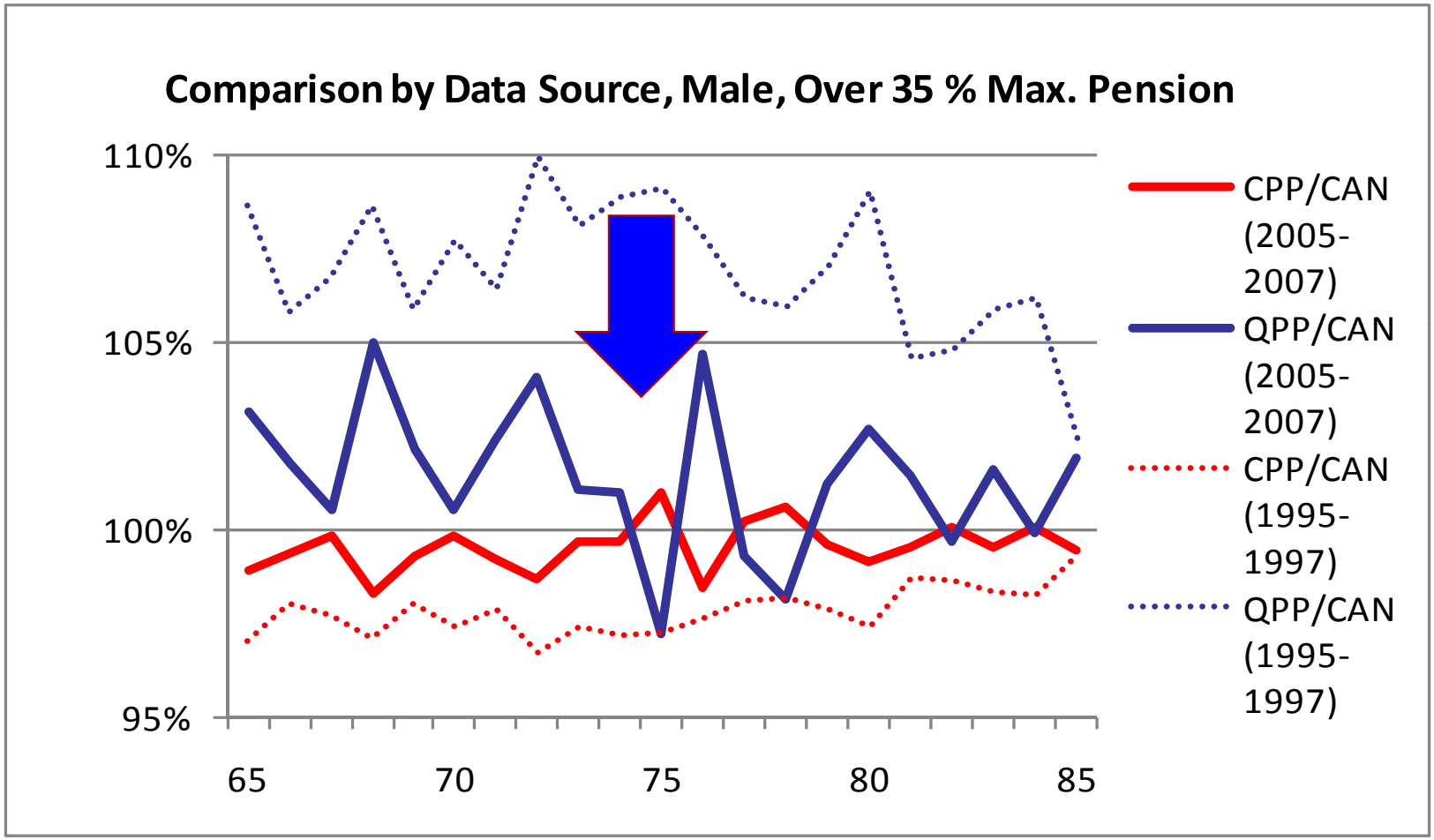
2.4 Mortality by Income: 2-3-4, M



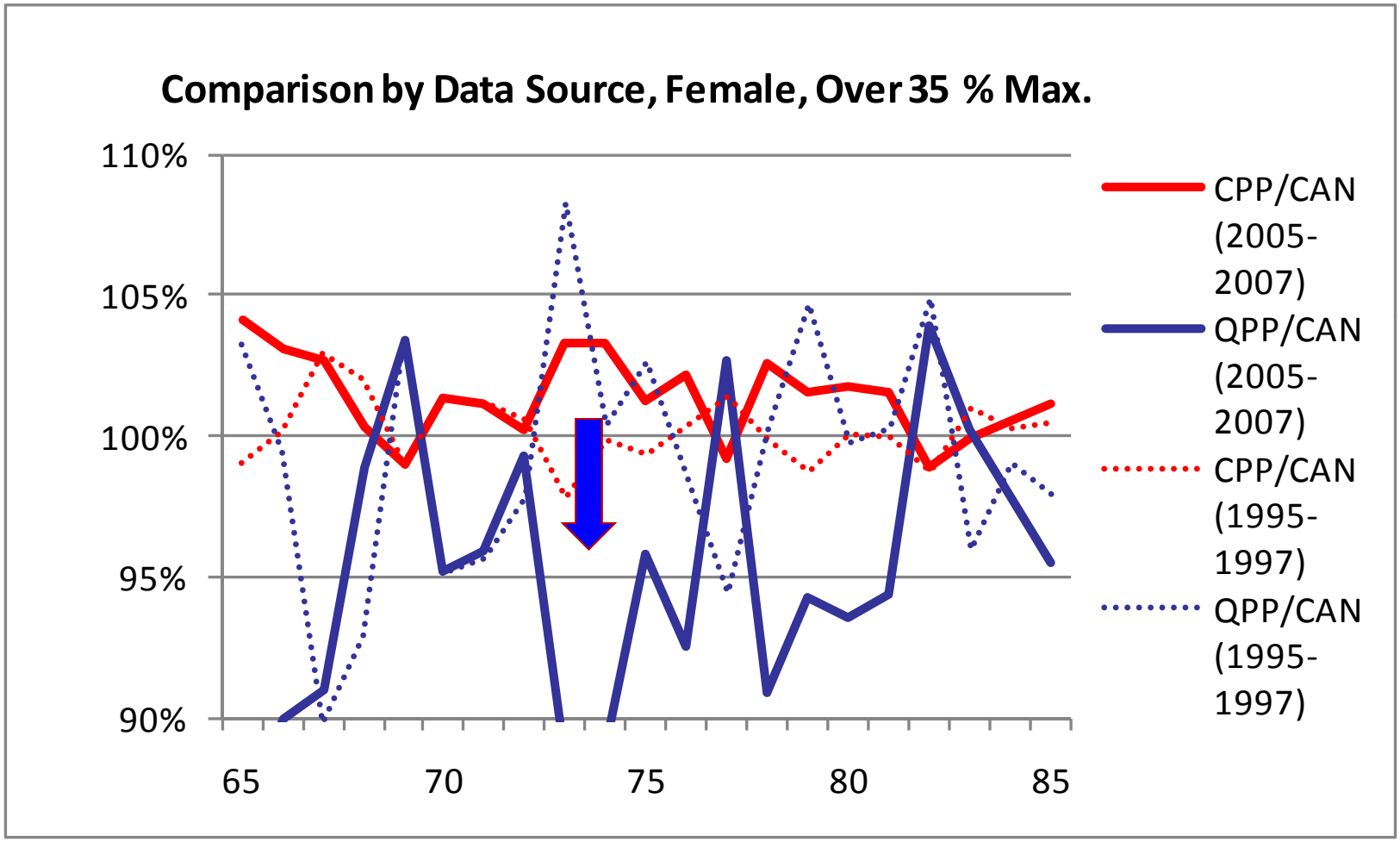
2.5 Mortality by Income: 2-3-4, F



2.6 Mortality by Data Source: M



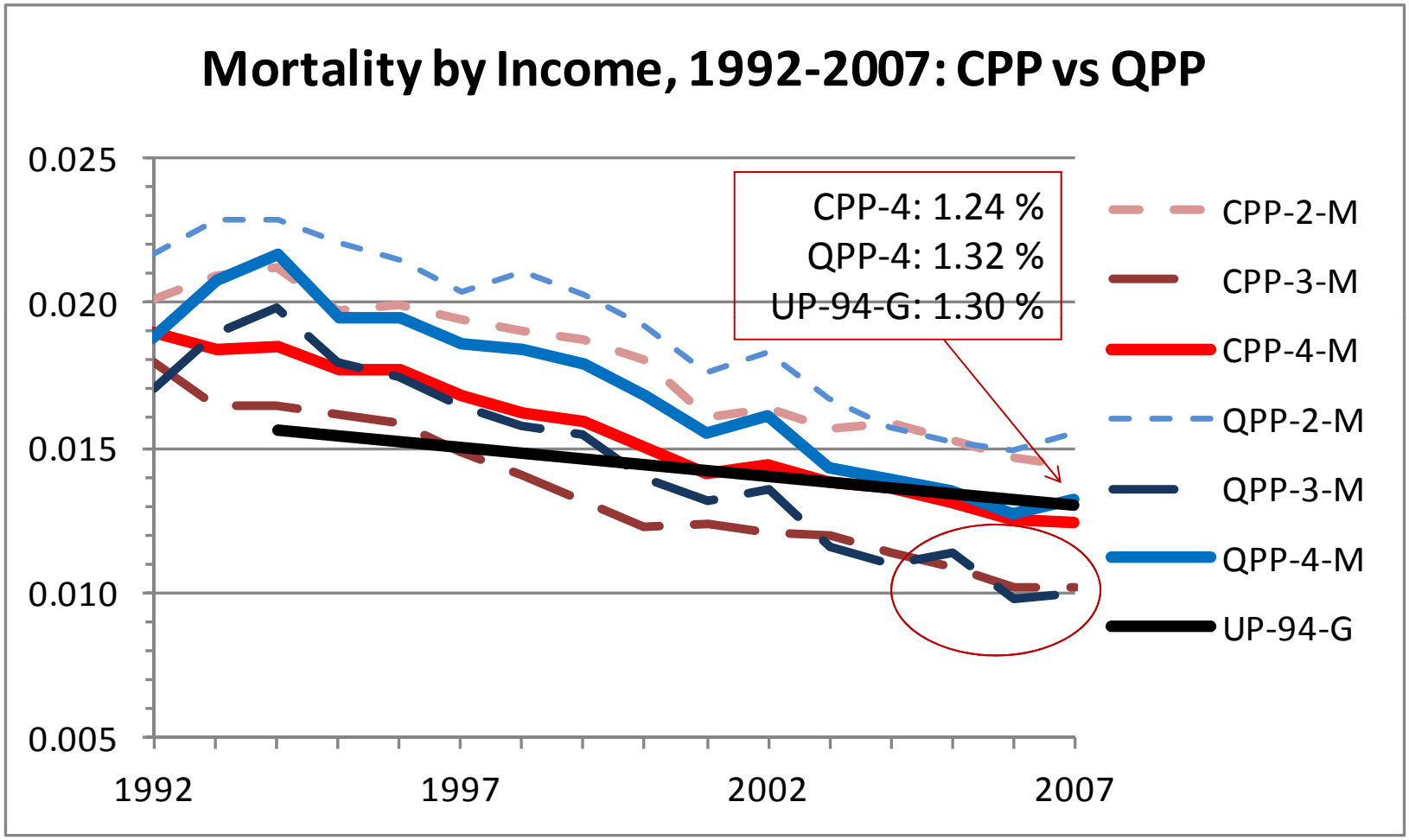
2.7 Mortality by Data Source: F



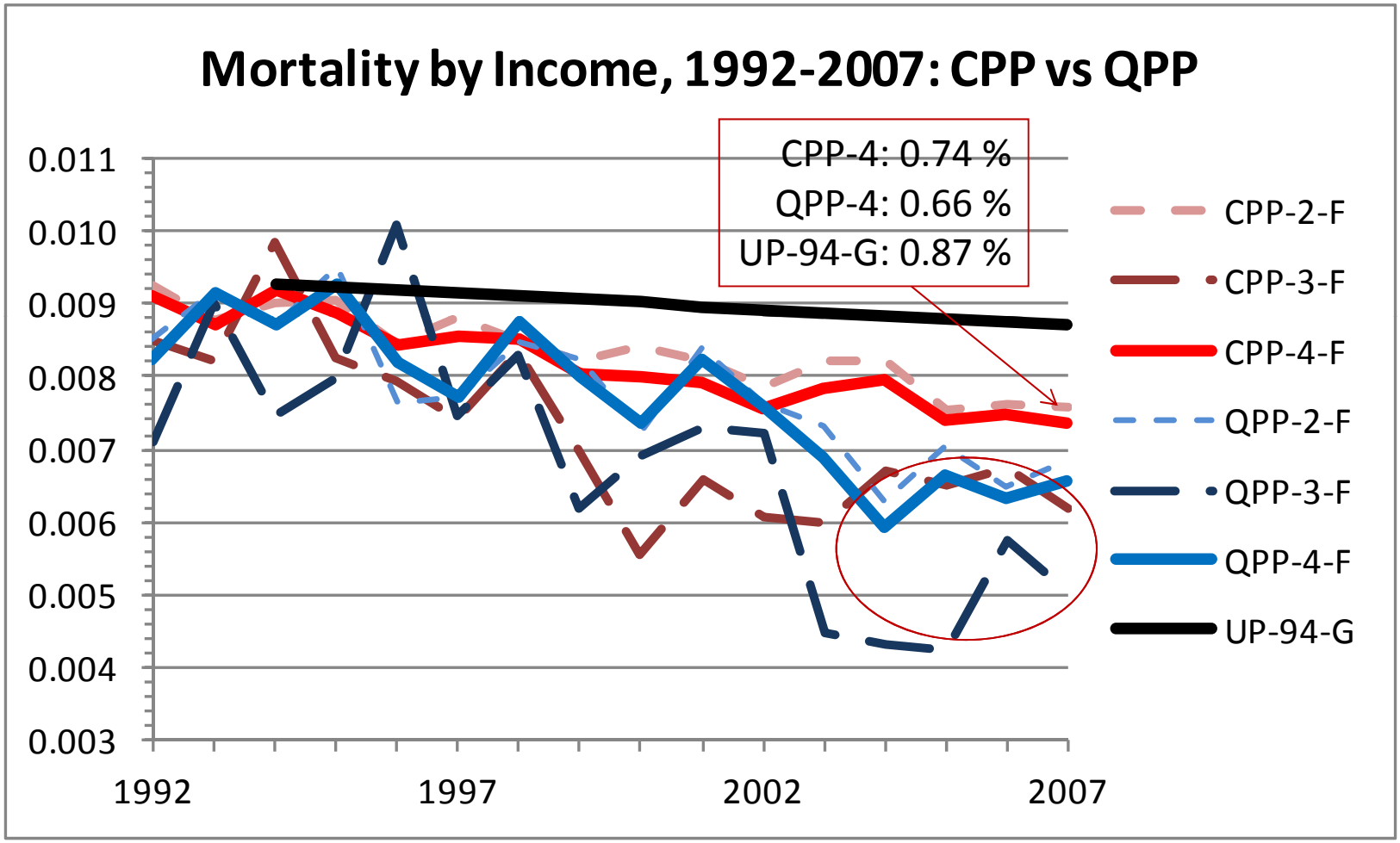
3. Recent Trends in Mortality

- Mortality: q(x) values shown on next slides
- Trend over time: 1992-2007
- By Income Class:
  - 2 (mid), 3 (high), 4 (2 & 3 combined)
- By Data Source: QPP or CPP
- Compared to UP-94 Generational Table (pension plans, current Cdn standard)
- **Steeper mortality evolution than expected**
- Varies by: age, gender, **income, source**

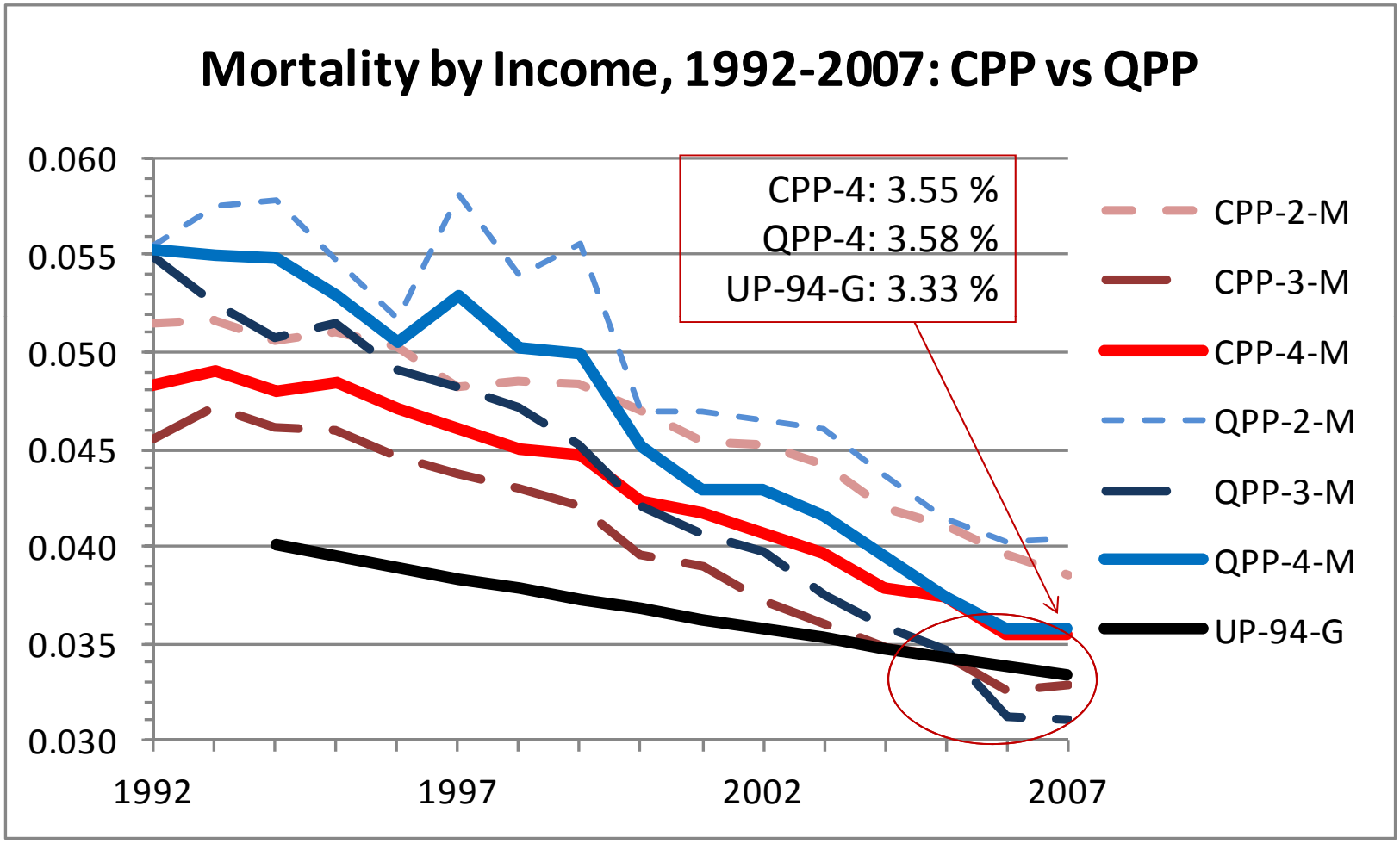
3.1 Evolution, Male, Age 65



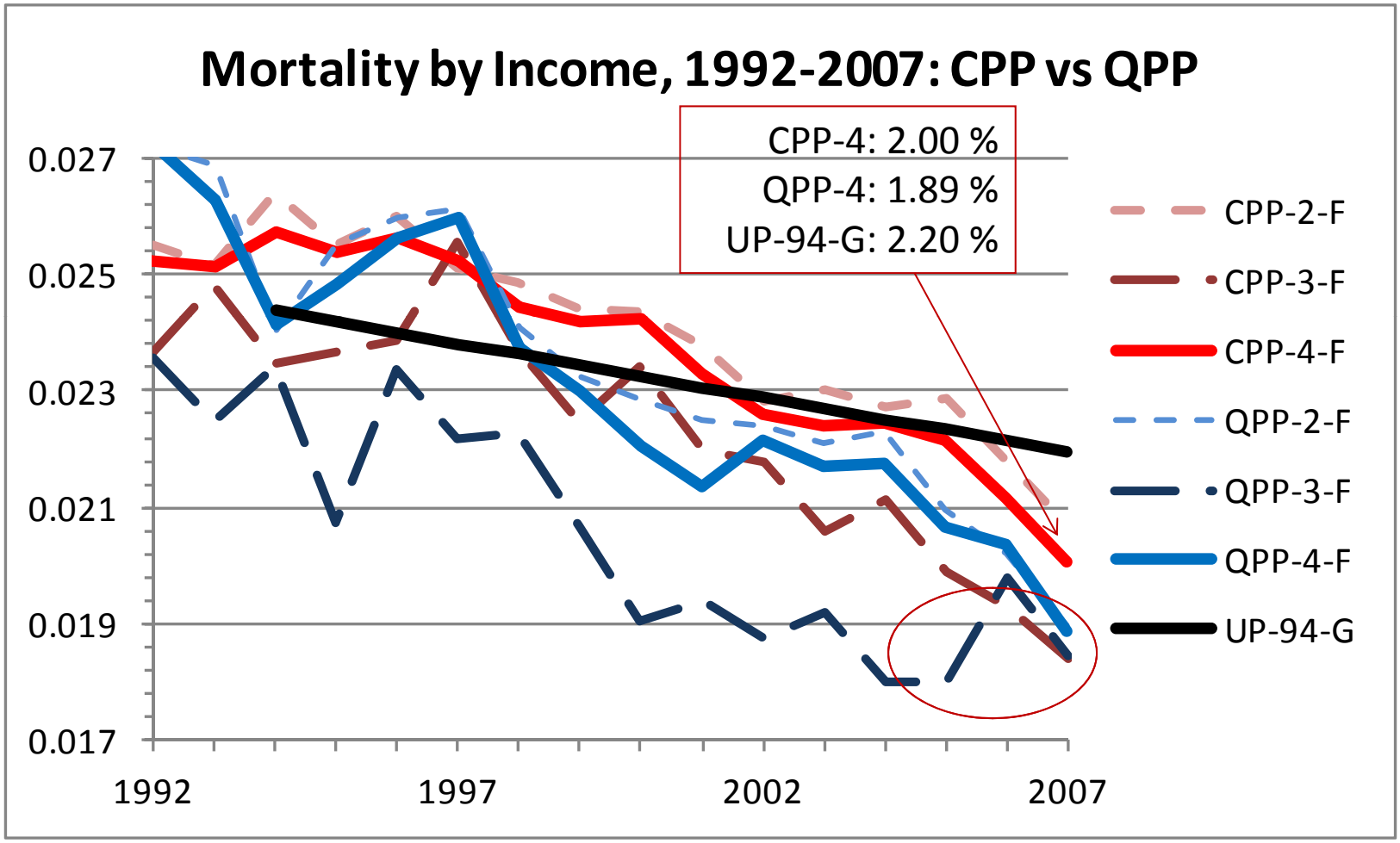
3.2 Evolution, Female, Age 65



3.3 Evolution, Male, Age 75



3.4 Evolution, Female, Age 75



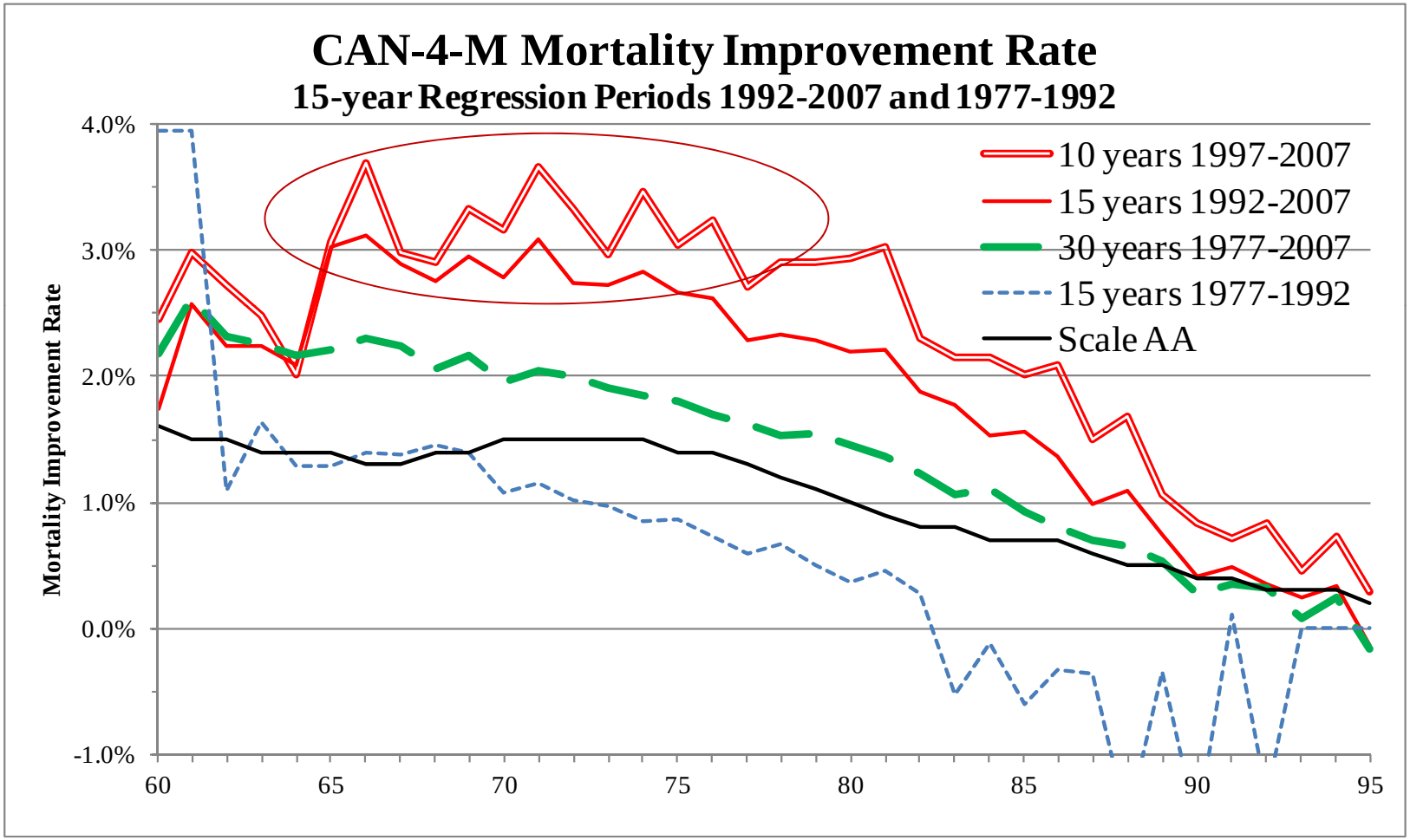
3.5 Remarks

- **Margins** in mortality assumptions: **gone !**
- Females: even more so !
- Steeper slope than expected: higher IR(x)
- Slope at higher income: more pronounced
- **If IR(x) increases faster than expected**
  - → prob. of death q(x) decreases faster
    - → one lives longer
      - → p. v. of life annuity increases
        - → **A pension plan costs more...**

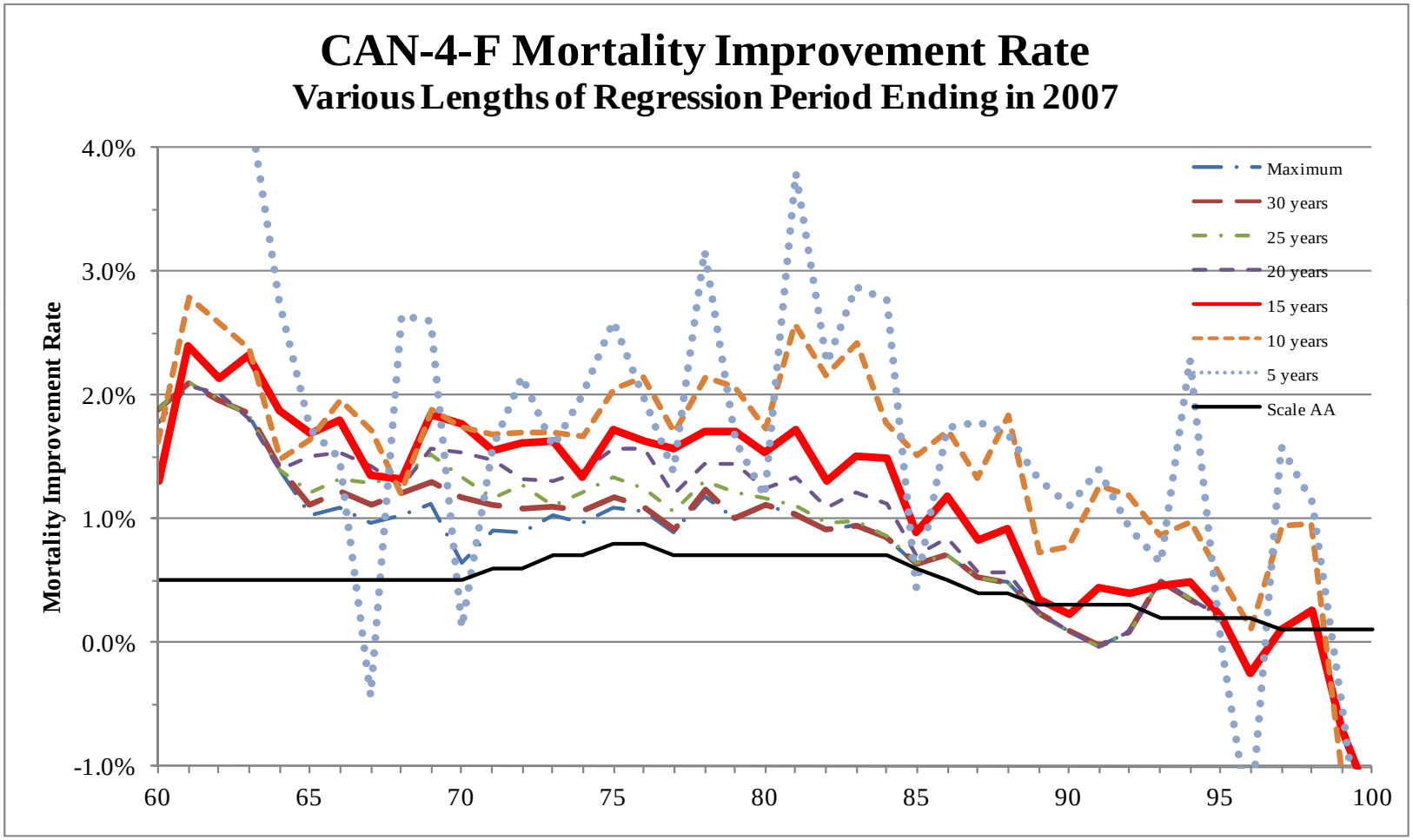
4. Mortality Improvement Rate

- "Slope of mortality curve": IR_x^t
- Average rate varies with length of period and end point
- High values in the past 10-15 years
- Different values by **data source**
- Varies also by **Income Class**

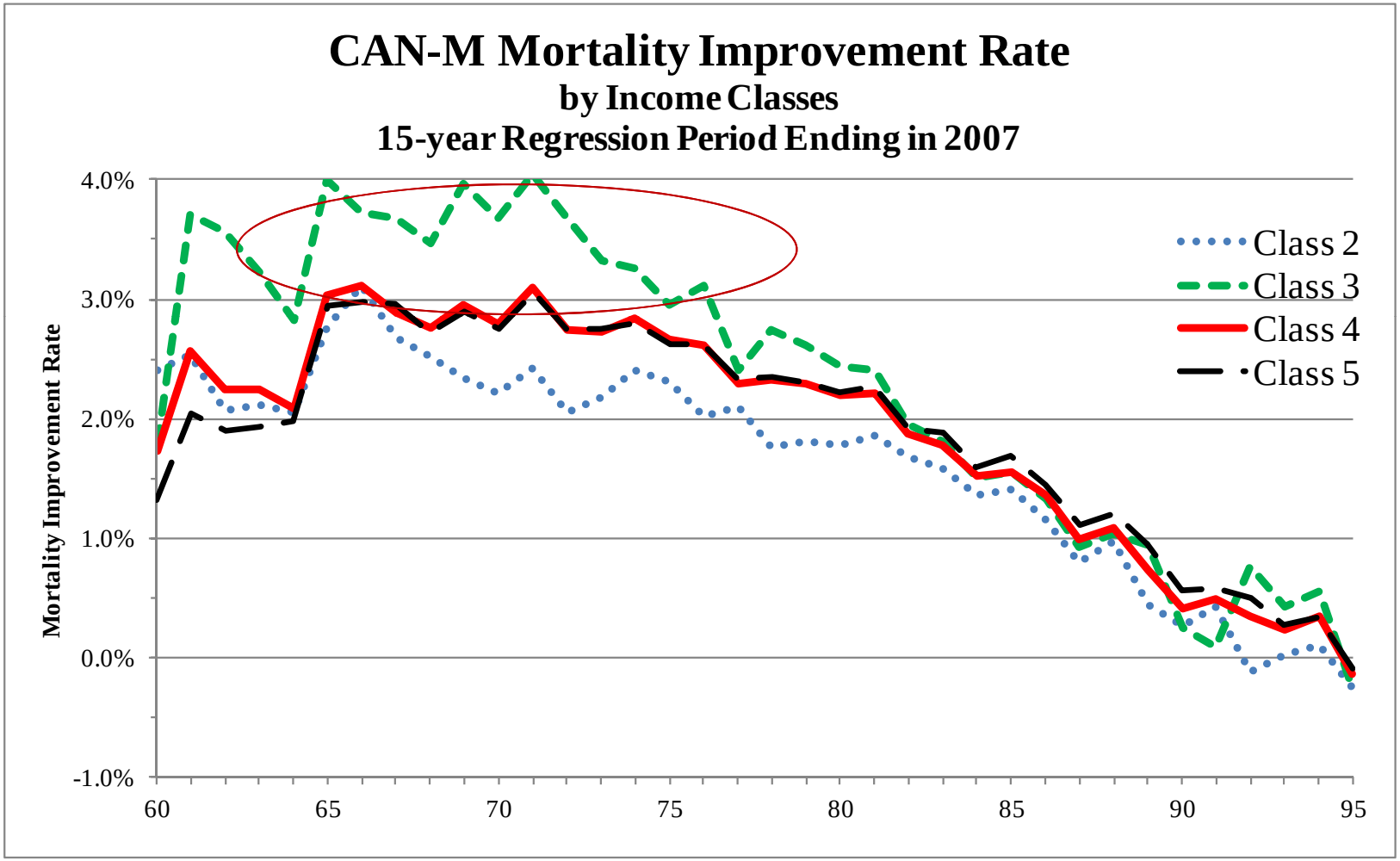
4.1 IR(x) by Length of Period: CAN-4-M



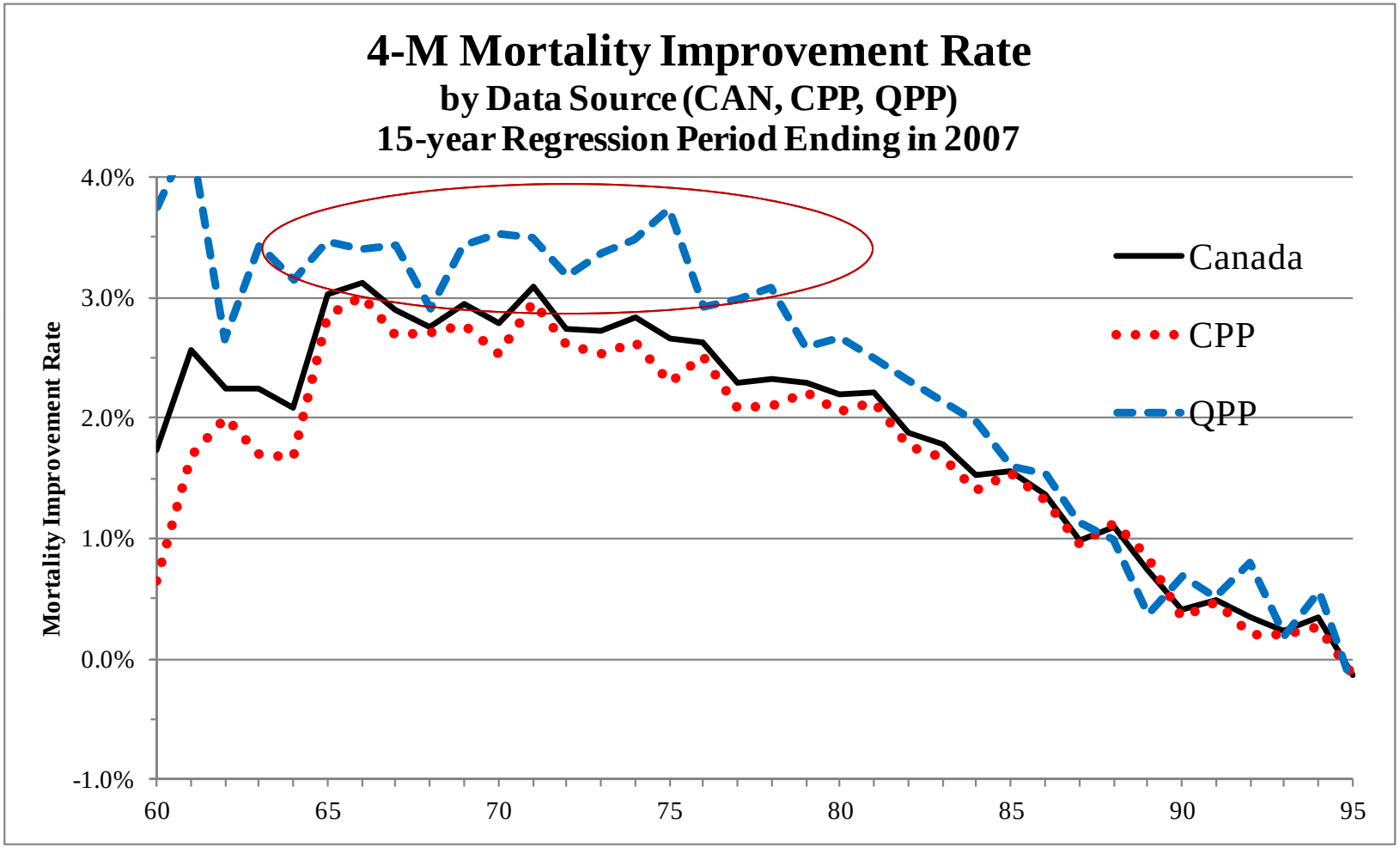
4.2 IR(x) by Length of Period : CAN-4-F



4.3 IR(x) by Income: CAN-2/3/4-M



4.4 IR(x) by Source: CAN/CPP/QPP-M



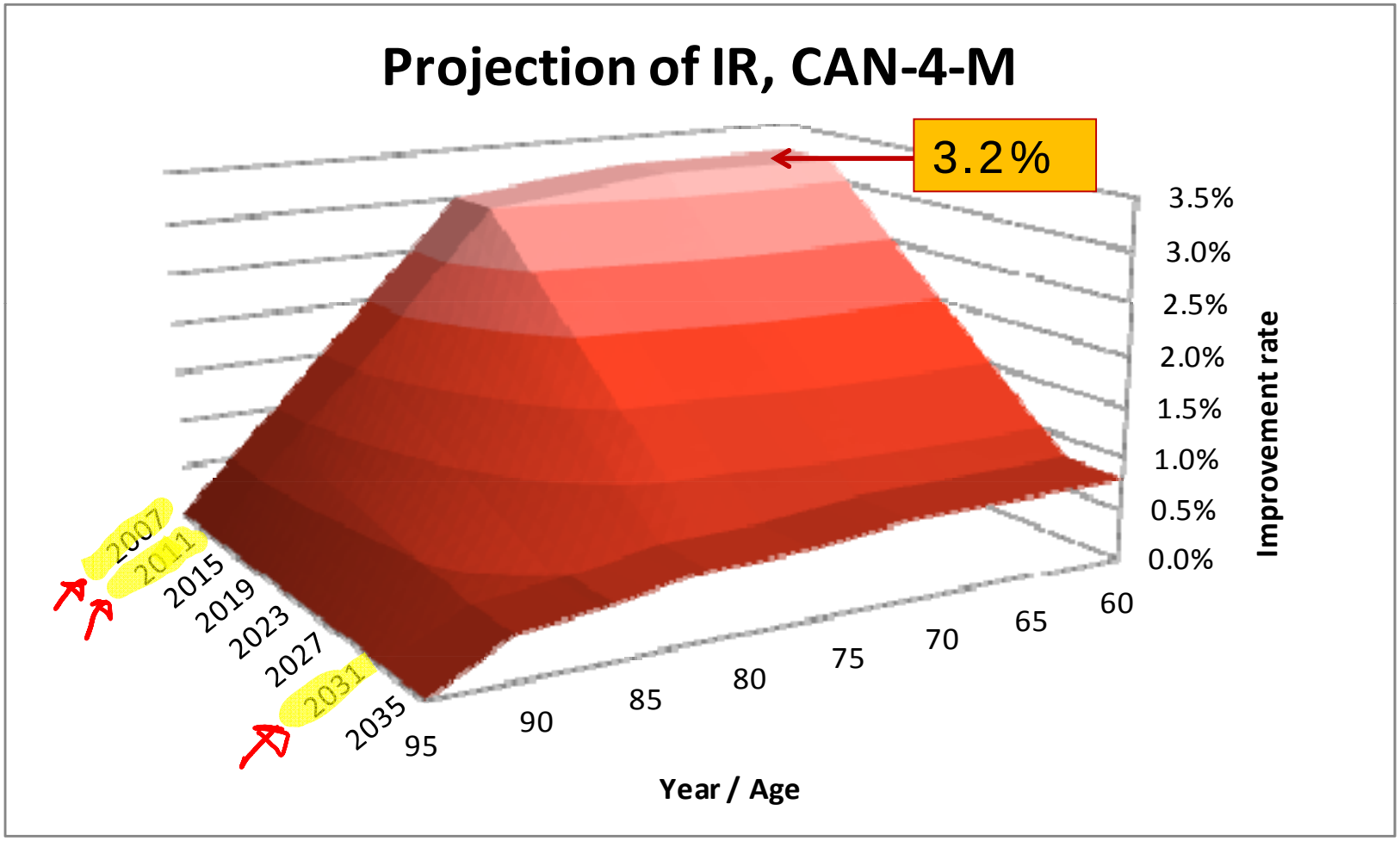
4.5 Improvement Rates: Source & Income

- Procedure described on next slide
- previous 1-D scale: AA scale varies by age and gender
- proposed 2-Dimension scale: by age, gender and calendar year
- Shown in 3 dimensions (3-D):age, year, IR by age & year
- **Heterogeneous variables**: IR scale varies also by income and data source, in addition to age and gender
  - ➡ Increase size of projection scales
- If scales are different, projected q(x) values are different
- Compromise between simplicity and precision ?

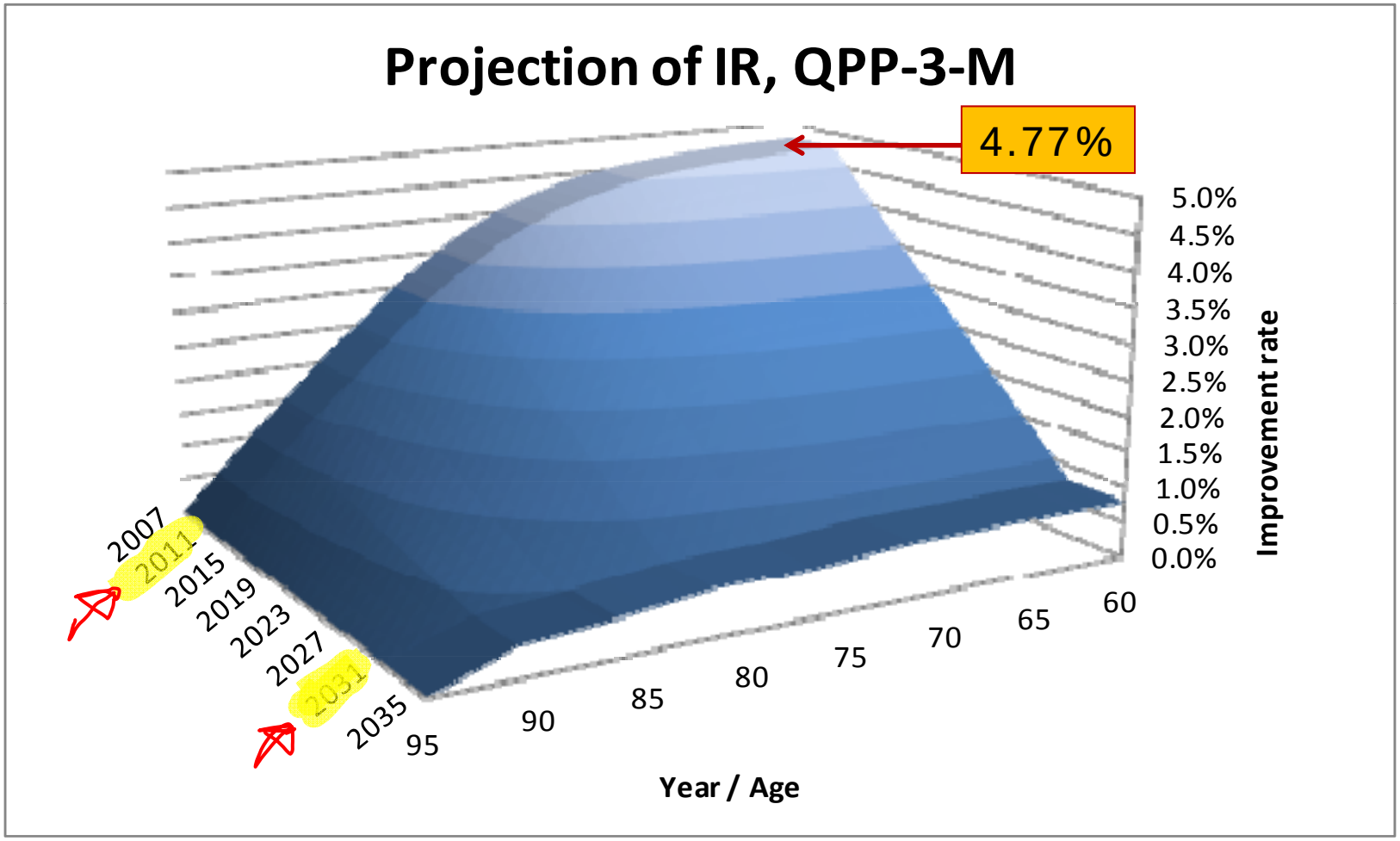
4.6 IR: Source & Income

- Constant Initial Rates 2007-2011: smoothed average experience, **10 years 1997-2007**
- Initial Rates by **age:**
  - Smoothed with cubic B-splines, with weights based on R^2 and variance of IR
  - Linear interpolation from age 90 to 0% at 95
  - Adjustments for some combinations: proportion of Income Class 5 rates
- By **year**: linear interpolation from 2011 to 2031
- Ultimate Rate in 2031: weighted long term rate CPP/QPP (2009-12-31 Actuarial Reports, 2040 Rate):
- Ultimate scale by gender: no income difference assumed (Improvement Rates convergence)

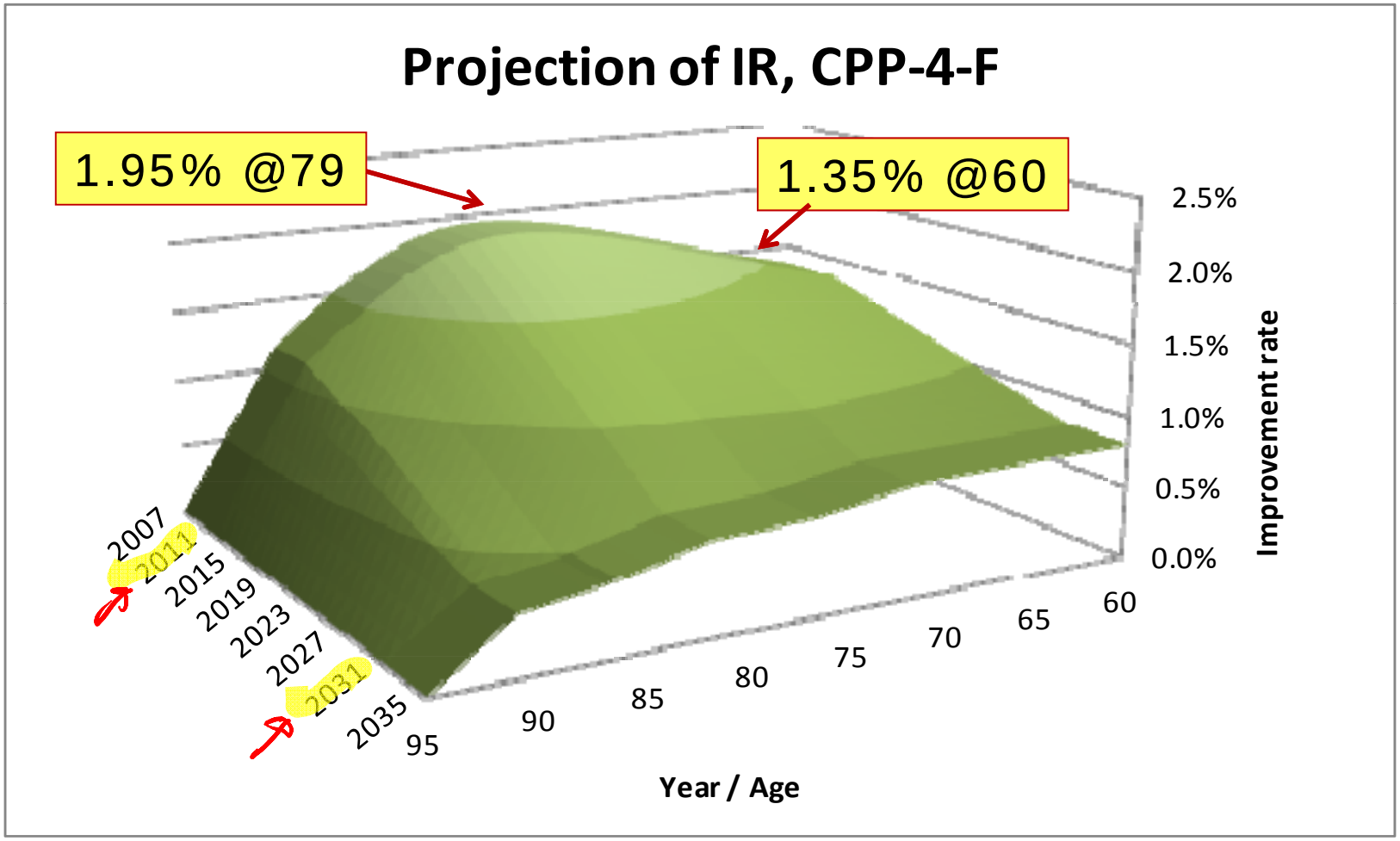
4.7 3-D Examples: CAN-4-M



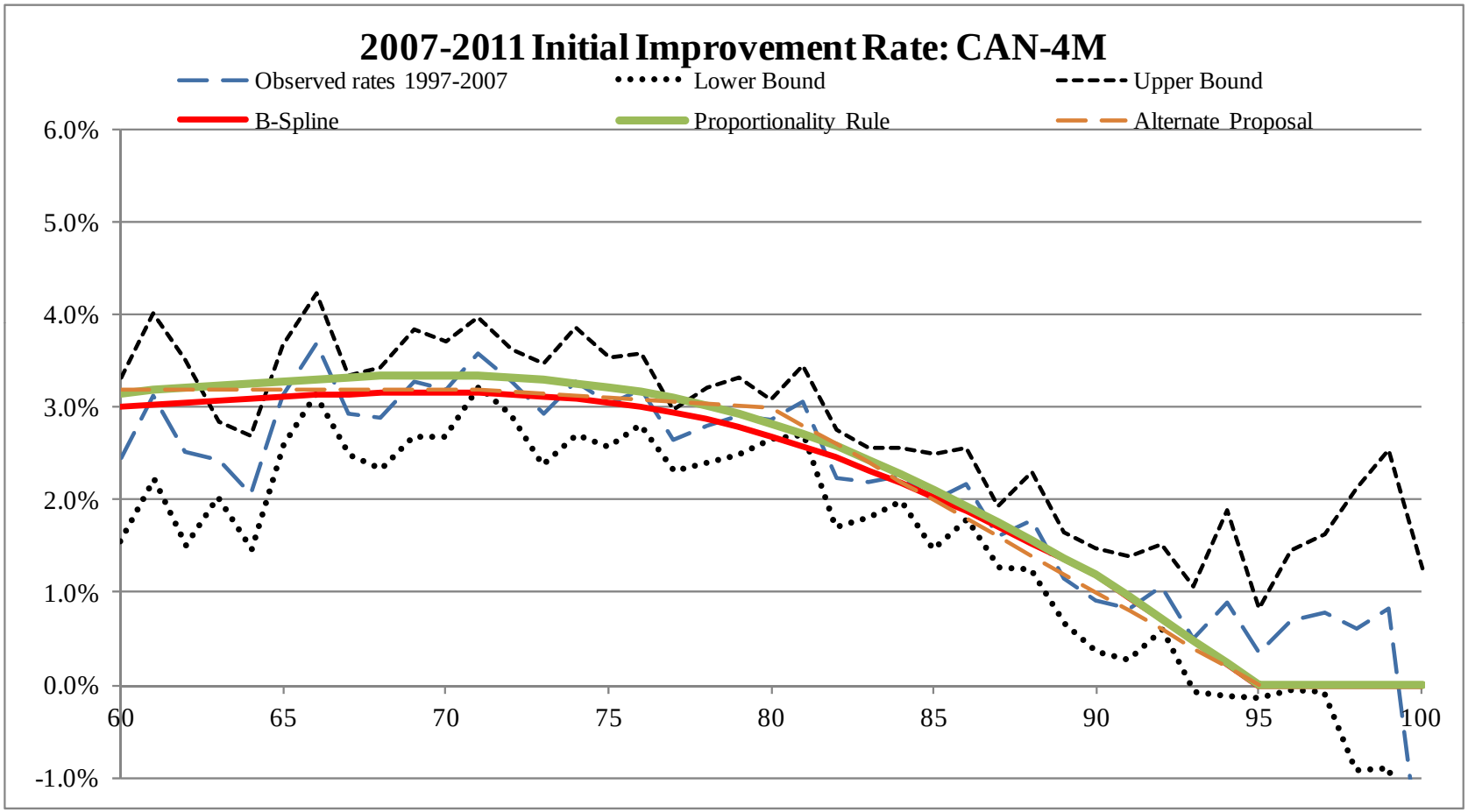
4.8 3-D Examples: QPP-3-M



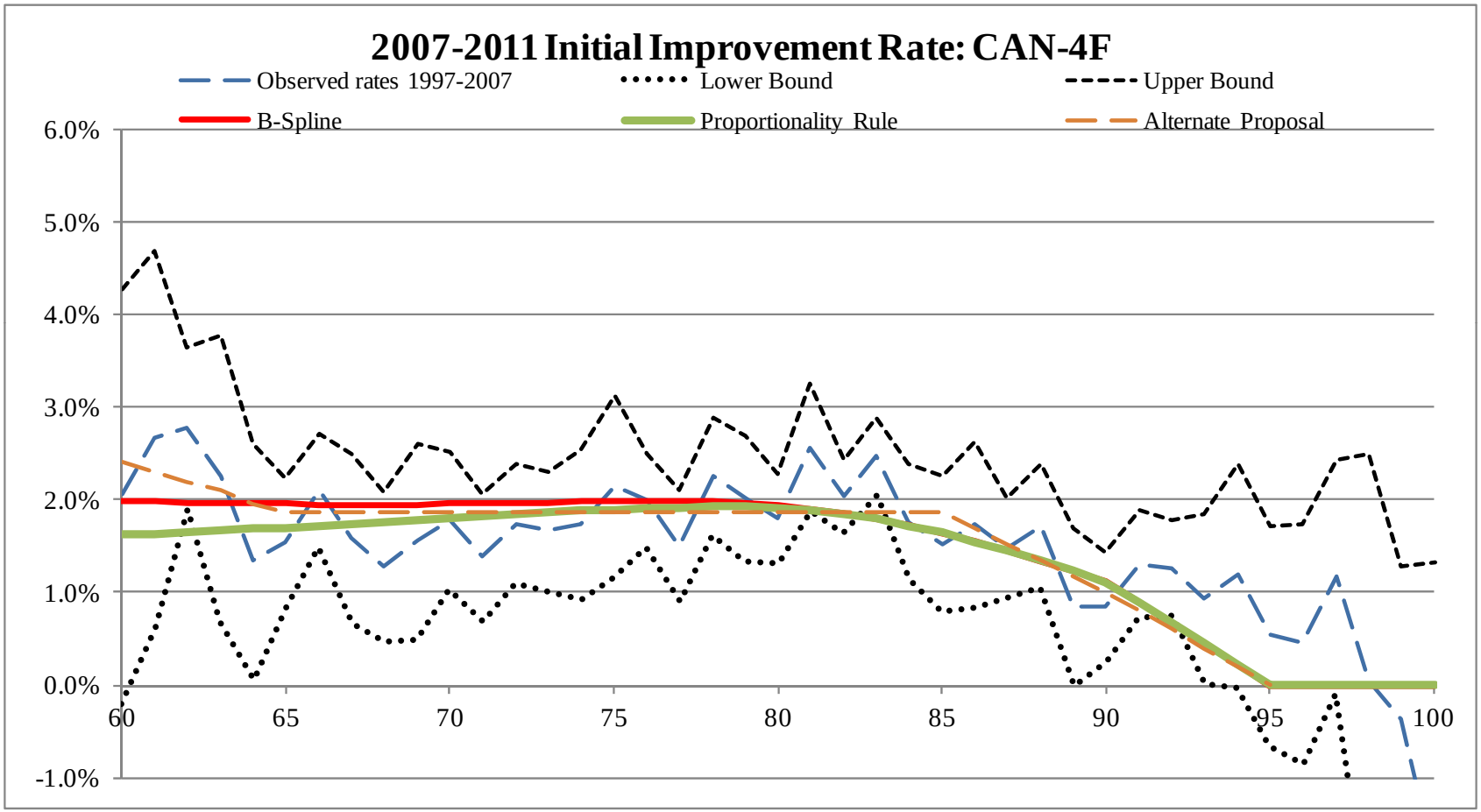
4.8 3-D Examples: CPP-4-F



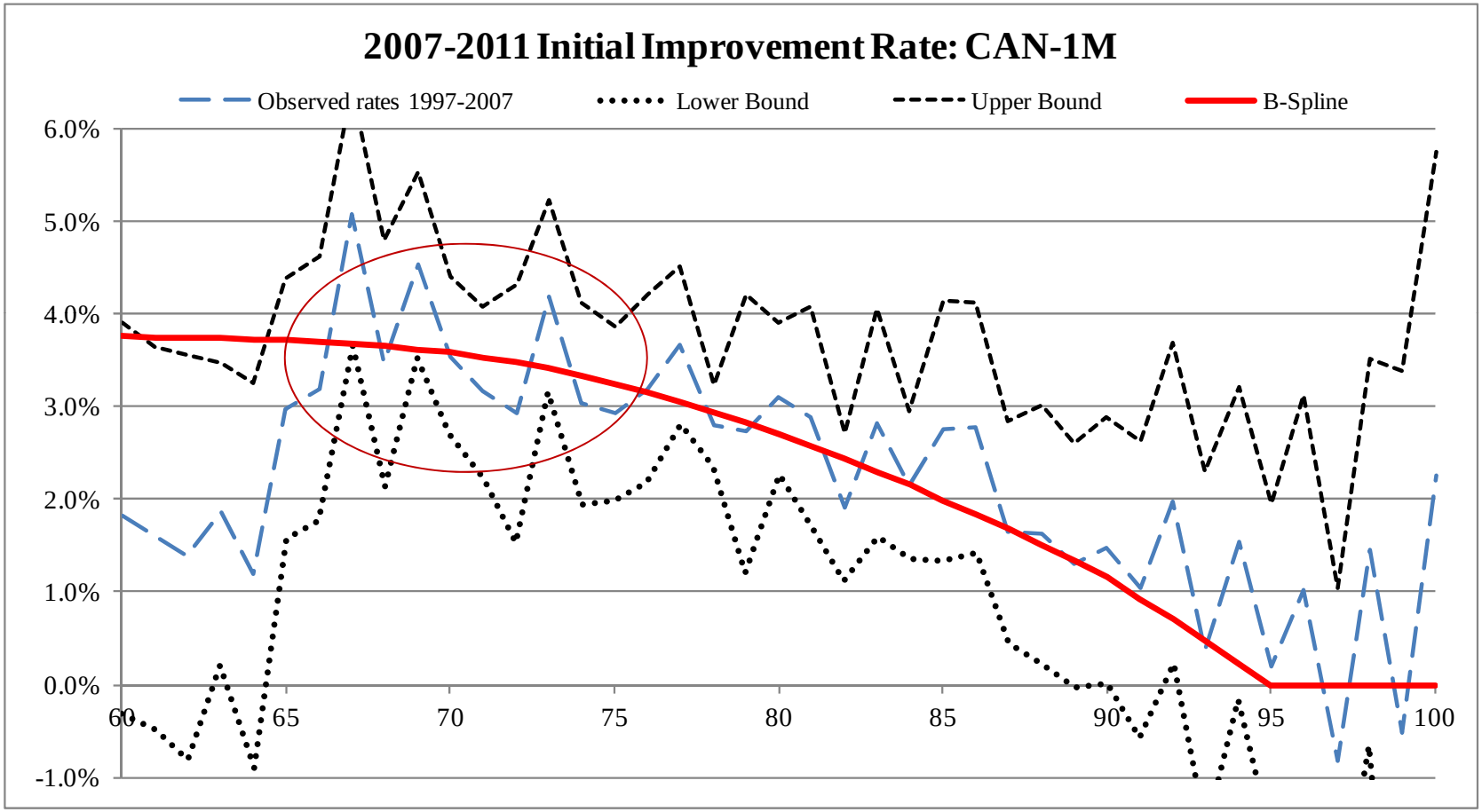
4.10 Initial IR(x) : CAN-4-M



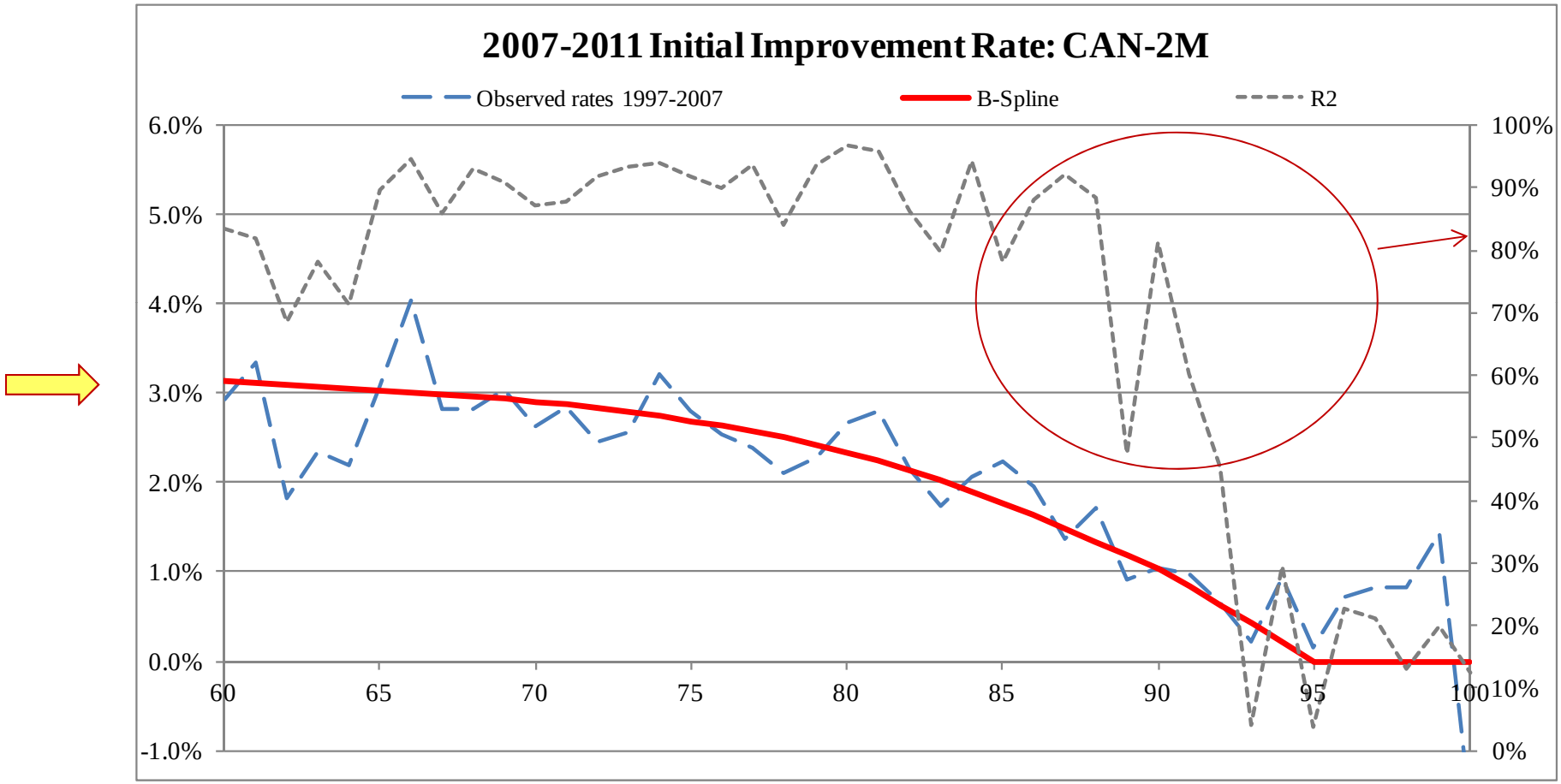
4.11 Initial IR(x) : CAN-4-F



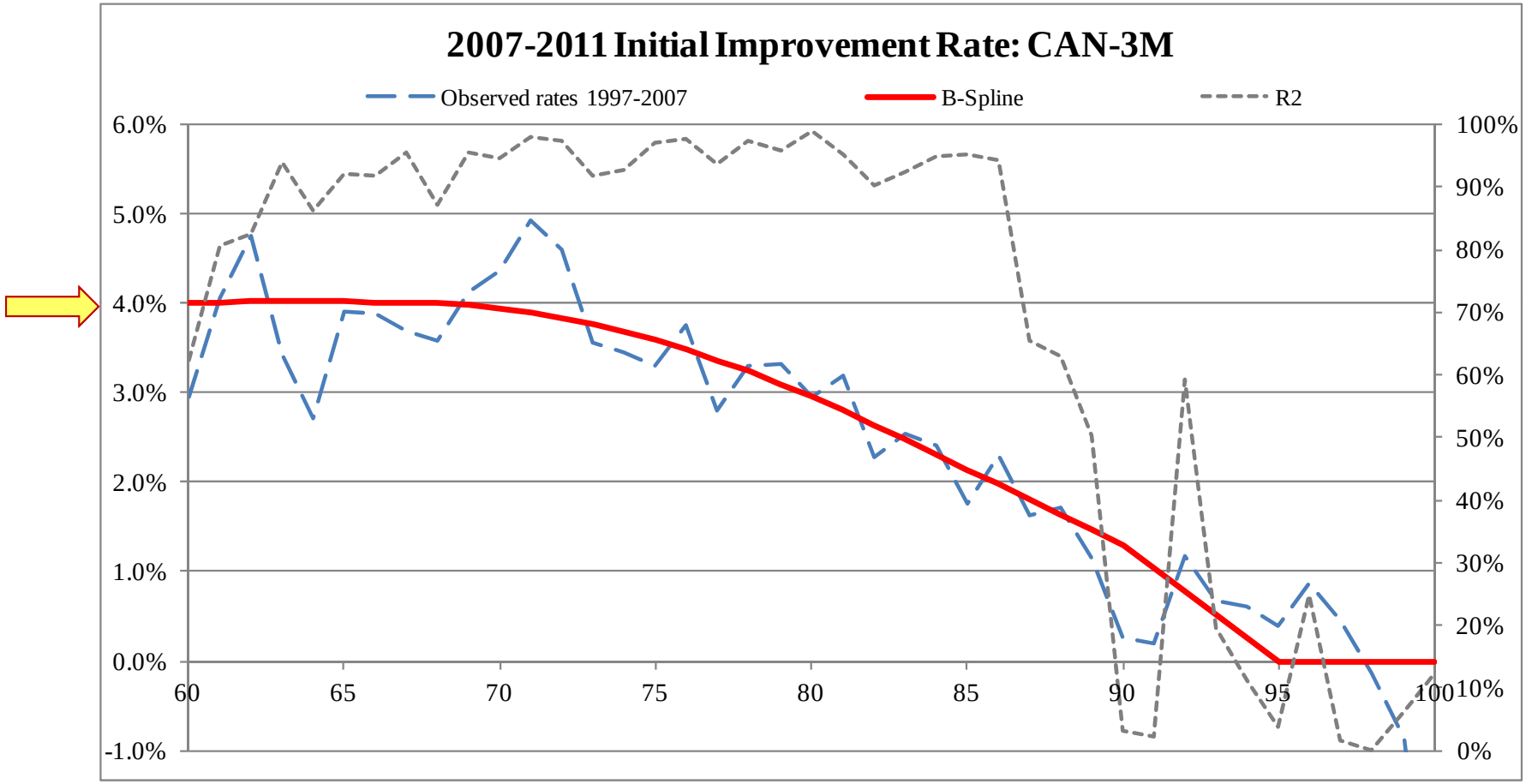
4.12 Initial IR(x) : CAN-1-M



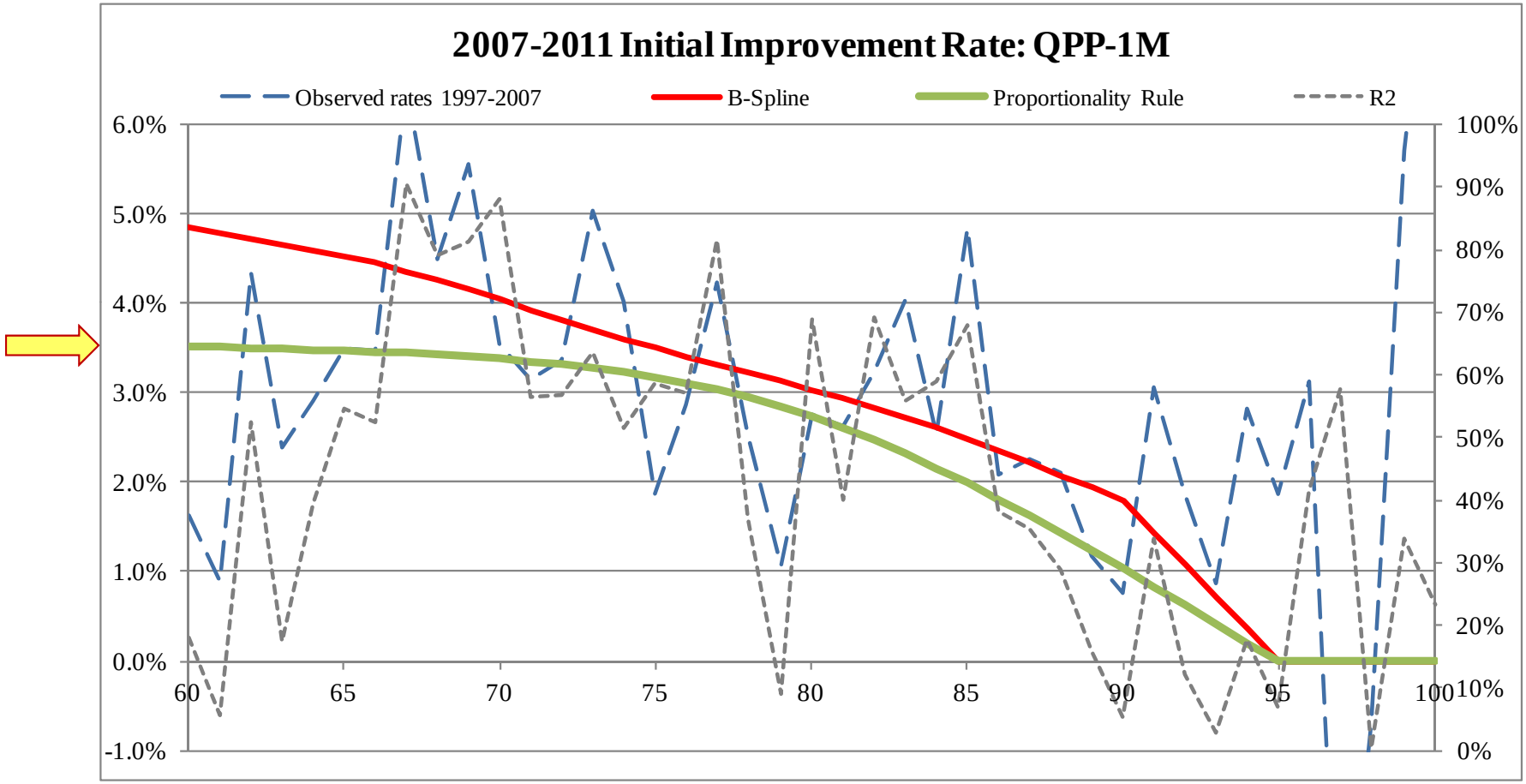
4.13 Initial IR(x) : CAN-2-M



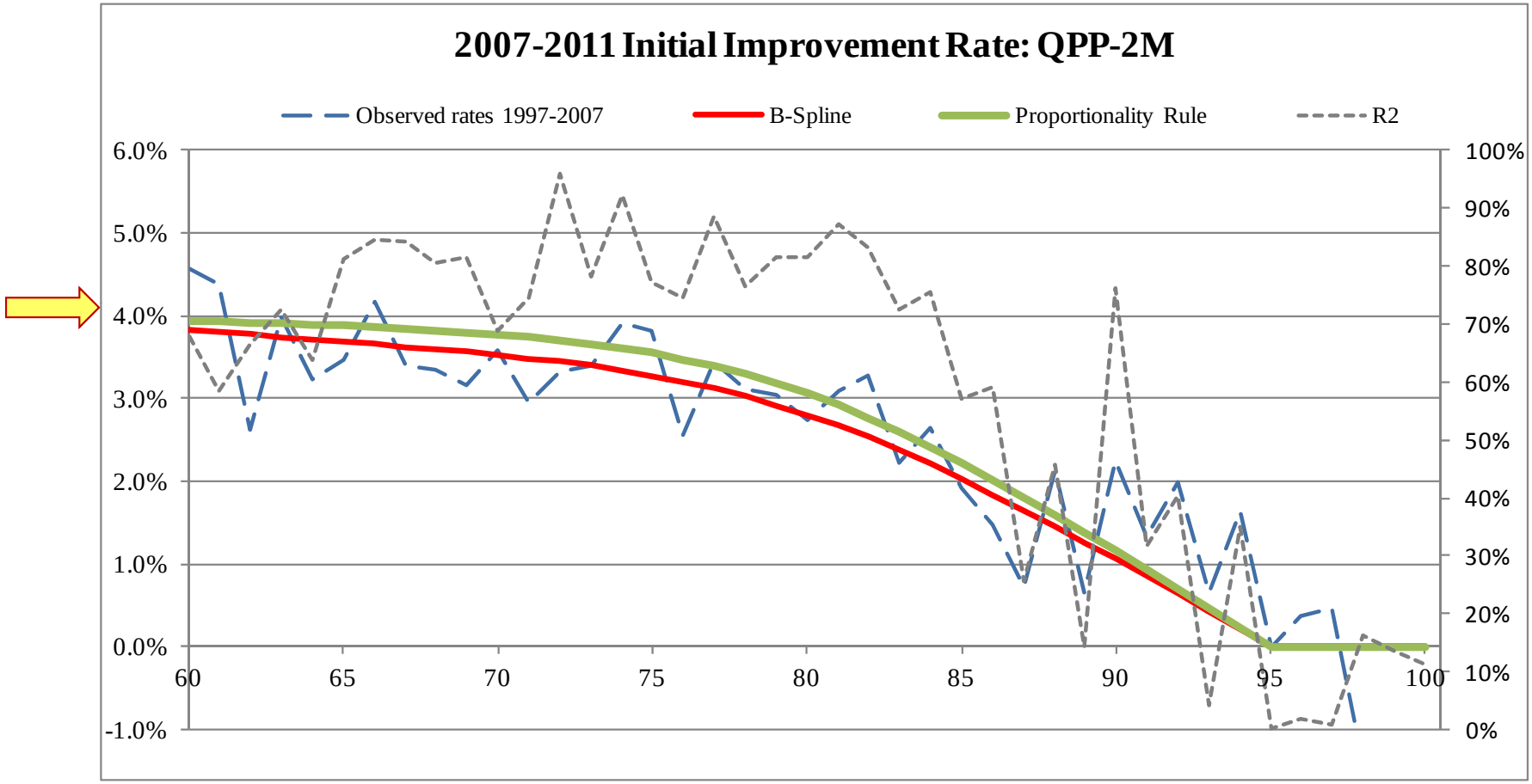
4.14 Initial IR(x) : CAN-3-M



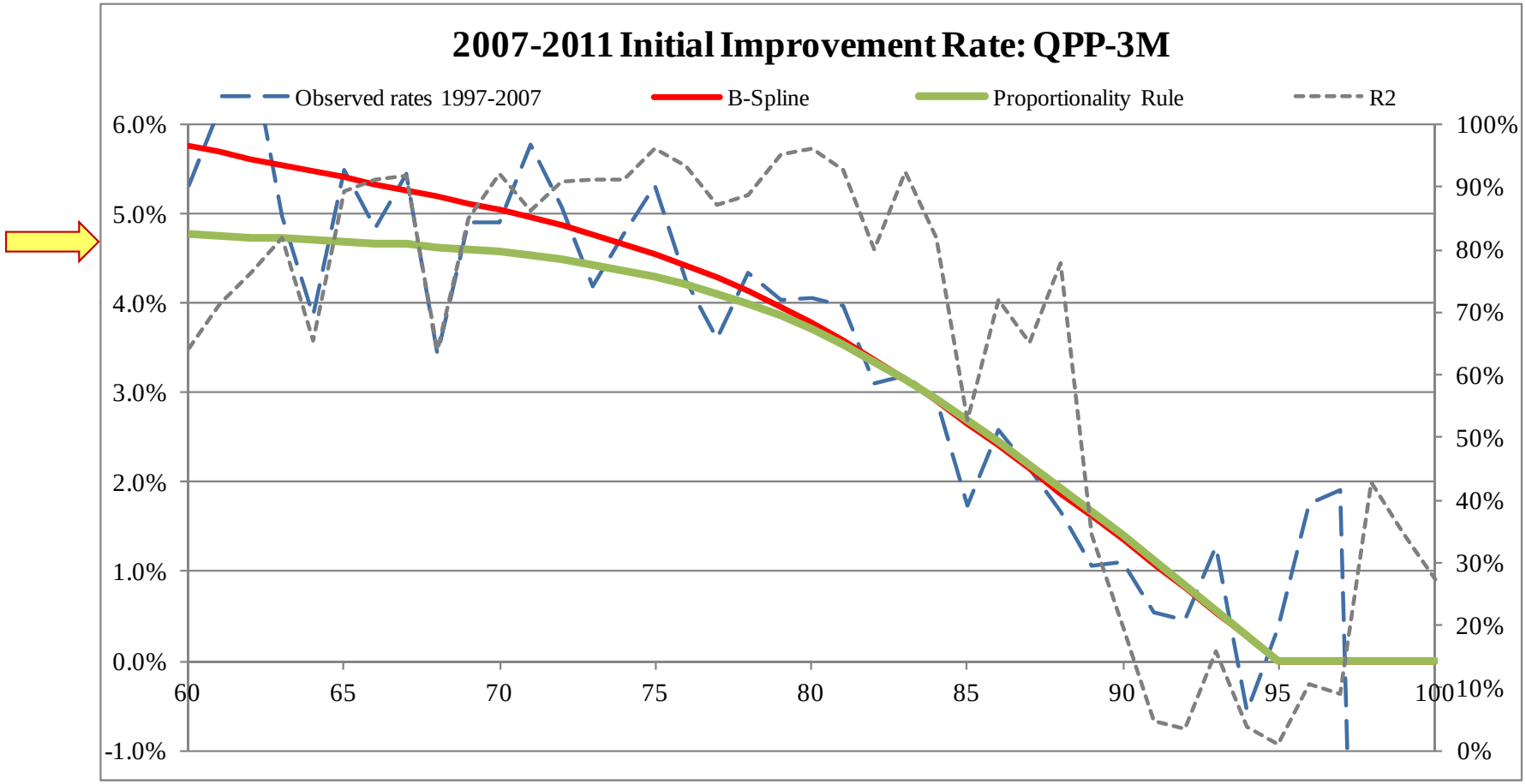
4.15 Initial IR(x) : QPP-1-M



4.16 Initial IR(x) : QPP-2-M



4.17 Initial IR(x) : QPP-3-M



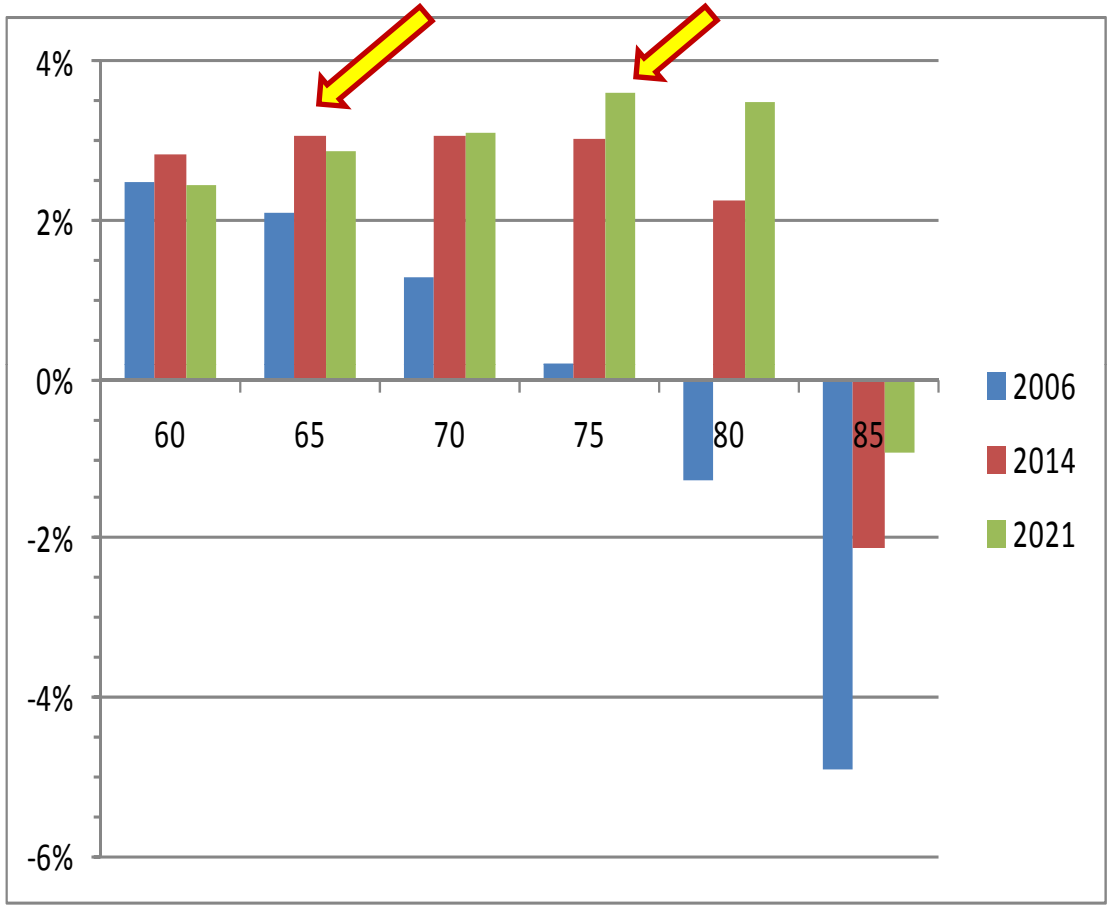
5. Impact on present value of an annuity

$\ddot{a}_x$

- P.V. of life annuity (i=5%)
- Valuation at 2014/1/1 (and 2006, 2021)
- Compared to UP-94 Generational Table
- Mortality level: by Source and Income Class
- Improvement rates: also vary by Data Source and Income Class

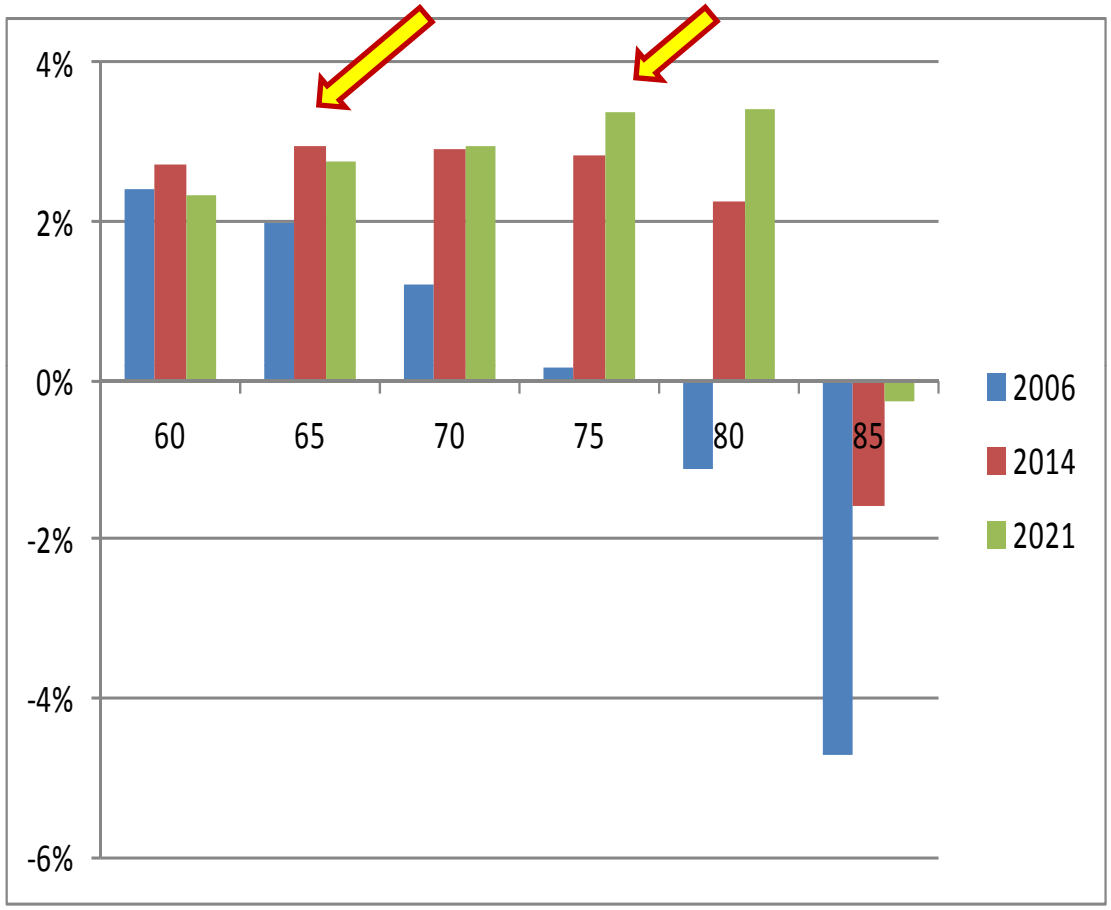
5.1 UP94-G vs. CAN-4-M, with CIA 2013 proposed IR(x) (old)

- % Increase in A.P.V.
- Males
- 2014, Age 65: +**3.1**%
- 2021, Age 75: +**3.6**%
- Similar impact on Actuarial Liabilities and Current Service Cost



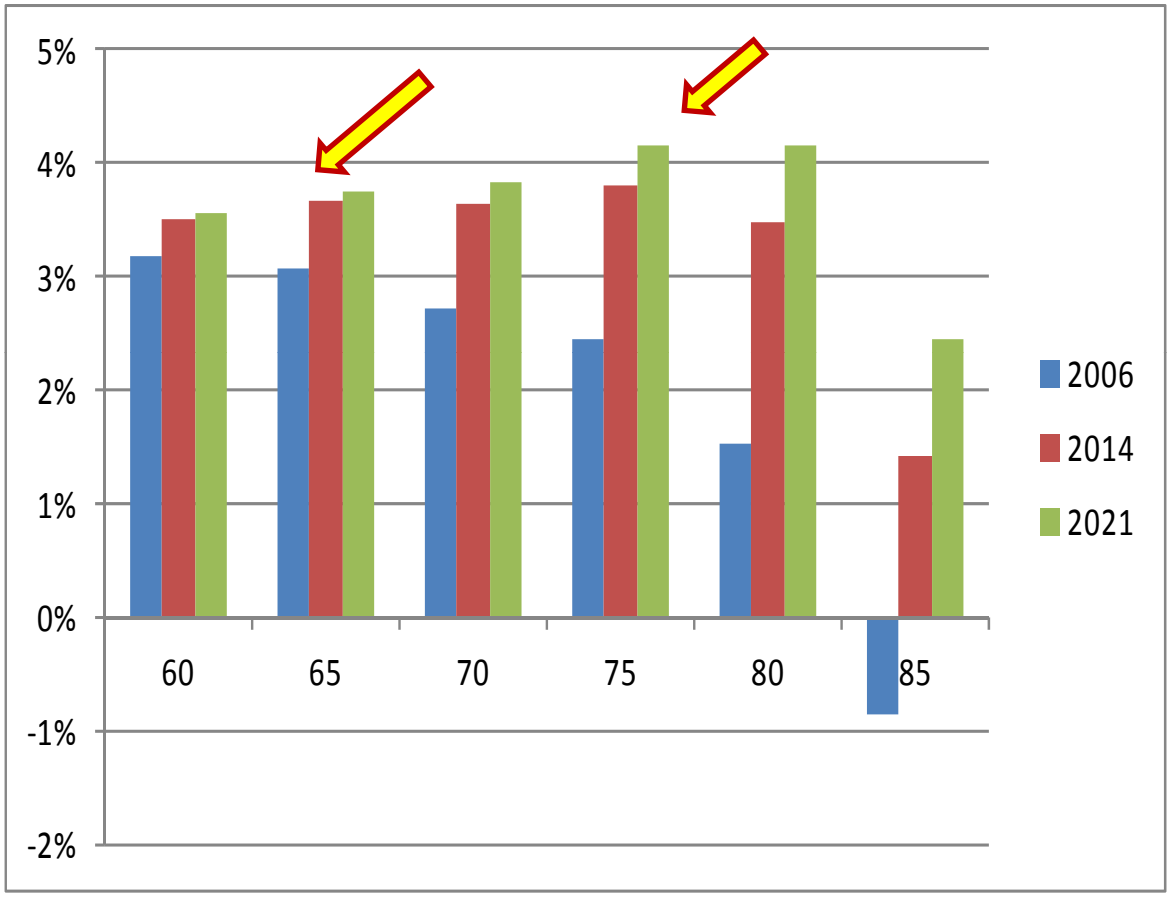
5.2 UP94-G vs. CAN-4-M, with cubic splines IR(x)

- % Increase in A.P.V.
- Males
- 2014, Age 65: +**2.95**%
- 2021, Age 75: +**3.4**%
- Similar impact on Actuarial Liabilities and Current Service Cost



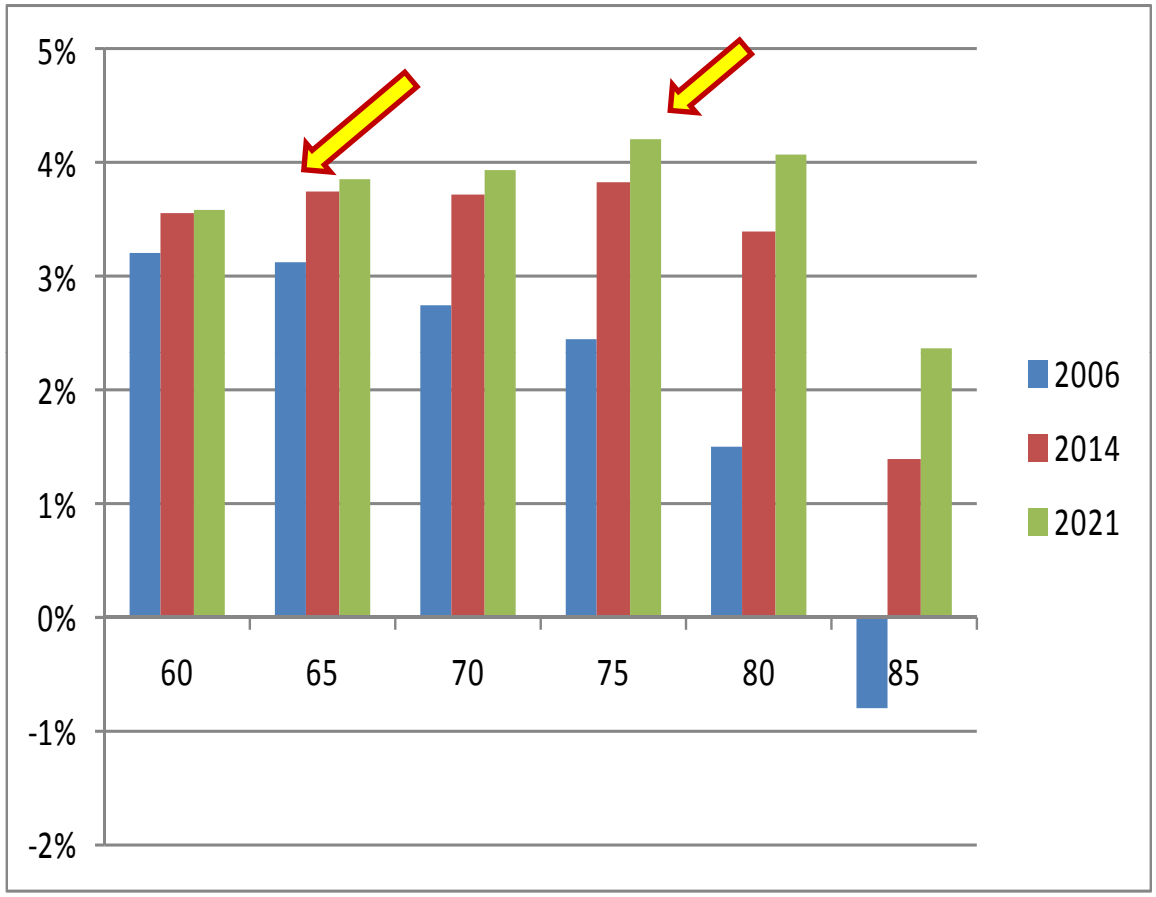
5.3 UP94-G vs. CAN-4-F, with CIA 2013 proposed IR(x) (old)

- % Increase in A.P.V.
- Females
- 2014, Age 65: +**3.7**%
- 2021, Age 75: +**4.1**%
- Similar impact on Actuarial Liabilities and Current Service Cost



5.4 UP94-G vs. CAN-4-F, with cubic splines IR(x)

- % Increase in A.P.V.
- Females
- 2014, Age 65: +**3.75**%
- 2021, Age 75: +**4.2**%
- Similar impact on Actuarial Liabilities and Current Service Cost



5.5 UP94-G vs. CPP: Impact source & Income

Age	CPM-CPP-2-M	CPM-CPP-3-M	CPM-CPP-4-M
60	0.12%	4.99%	2.41%
65	**-0.23%**	**5.52%**	**2.60%**
70	-0.69%	5.50%	2.47%
75	**-0.74%**	**5.09%**	**2.41%**
80	-0.77%	4.26%	1.98%
85	-3.57%	0.07%	-1.57%

5.6 UP94-G vs. QPP: Impact source & Income

Age	CPM-QPP-2-M	CPM-QPP-3-M	CPM-QPP-4-M
60	1.33%	6.76%	4.07%
65	**1.11%**	**7.47%**	**4.30%**
70	0.68%	7.67%	4.31%
75	**0.40%**	**7.48%**	**4.21%**
80	-0.24%	6.10%	3.17%
85	-4.08%	0.82%	-1.69%

6. Conclusion

- Better knowledge of Canadian pensioner mortality
- **Improvement Rates** are not constant
  - High rates in recent history
  - Rates vary with: age, gender, **source**, **income**
  - Unknown: future length of high improvement rates
  - No crystal ball for long term: prudence, sensitivity analysis…
- Actuarial liabilities and costs for pension plans: **significant impact**
- **Monitoring required for mortality trends**

Questions ?

Thank you !

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