The Canadian Pensioners Mortality Table: some results on mortality level and trends

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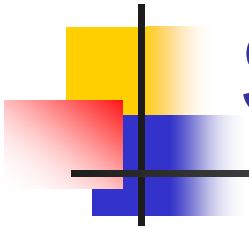
Presentation Outline

1. Introduction: context
2. Data Used and Methodology
3. Mortality Level: 2005-2007
4. Comparisons
5. Short-term Projection Scale
6. Materiality: Impact on Present Values
7. Conclusion: Next Steps



Section 1

Introduction: context

Purpose of this Research

- Measure mortality levels and trends
- For Canadian pensioners
- With complete and reliable data
- Goal: reference table for Canadian pension plans
- Potential use: actuarial valuation, individual commuted value calculations

Context

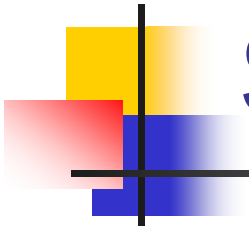
- Previous work
- CIA Commission on Pension Plan Mortality Experience
- 2009 CIA Research grant
- **Acknowledgements**: CIA
  - Chaire d'actuariat, SOA, Régie des rentes du Québec, Office of the Chief Actuary

Project Phases

- Phase 1: Data collection and validation. 2009/07
- Phase 2: Preparation of report on mortality level for the triennial period 2005-2007. 2009/12- 2010/06 (ongoing)
- Phase 3: Mortality trend over time and other comparisons. Fall 2010

Previous Presentations

- *Régie des rentes du Québec* : 2009-11 Perspectives 2009-2030 Seminar
- Presentation (in French) on these results, mortality level and trends
- Goal: help establishing actuarial assumptions for QPP actuarial valuation
- CIA Annual Meeting, Vancouver, 2010-06



Section 2

Data used and methodology

Data Source

- 100 % Canadian
- 1967-2008 Period
- All individual pensions actually paid
- Retirement pensions only
- Quebec Pension Plan (source: Régie des rentes du Québec)
- Canada Pension Plan (source: Office of the Chief Actuary)

Originality

- Not a survey
- Not only members of currently existing plans (coverage ratio)
- Actual pensions paid, not census data
- Data includes dates and amount paid: precision and consistency over time

Relevance

- Measure of mortality based on a reliable source of high-quality data
- Common characteristic of pensioners: worked in Canada and earned pension entitlement
- Covered, or could have been covered, by a private pension

Quality of Data

- High: Pensions actually paid
- Administration: monthly pension $
- Individual records: all pensions
- Excellent collaboration with CPP/QPP
- Validation done by the researcher and CPP/QPP actuaries
- 2008 data excluded (under-reporting)

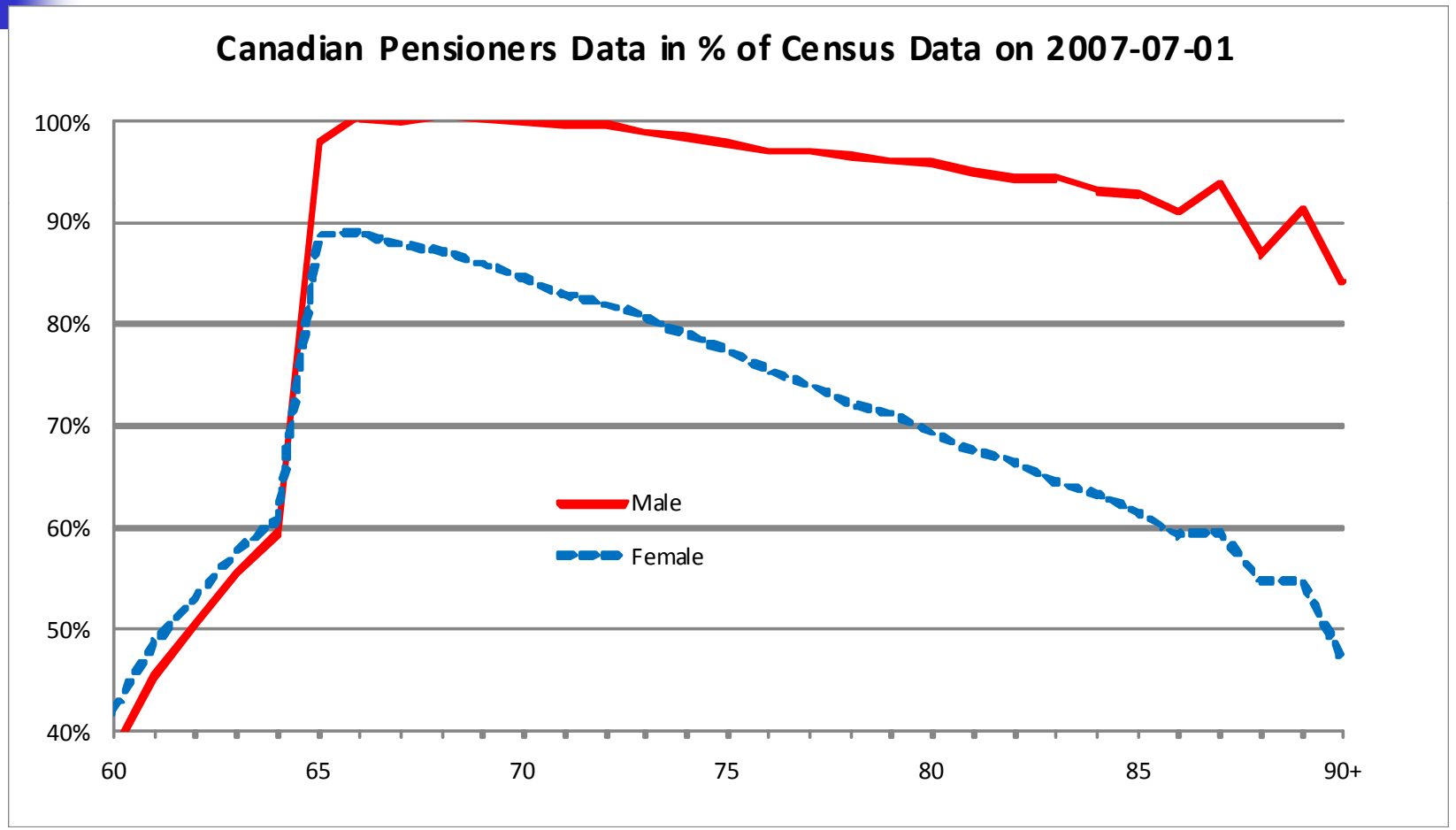
Nature of Data

- Dates: birth, retirement, death (year and month, not the day)
- Age, Calendar year/period
- Confidentiality: no S.I.N.
- $ of initial pension: Income level
- Consistent calculation of death and exposure over time

Volume of Data

- 7.85 M individual records (1967-2008)
  - CPP: 5.82 M QPP: 2.03 M
  - Male: 4.47 M Female: 3.38 M
- Including 3.03 M deaths
  - Male : 2,08 M, Female : 0,95 M
- Alive as at July 1, 2007: 4.61 M
  - Male : 2.30 M, Female : 2.31 M
- **A lot of data** ! (in numbers and %)

Coverage by Age and Sex



Classification Variables: 1

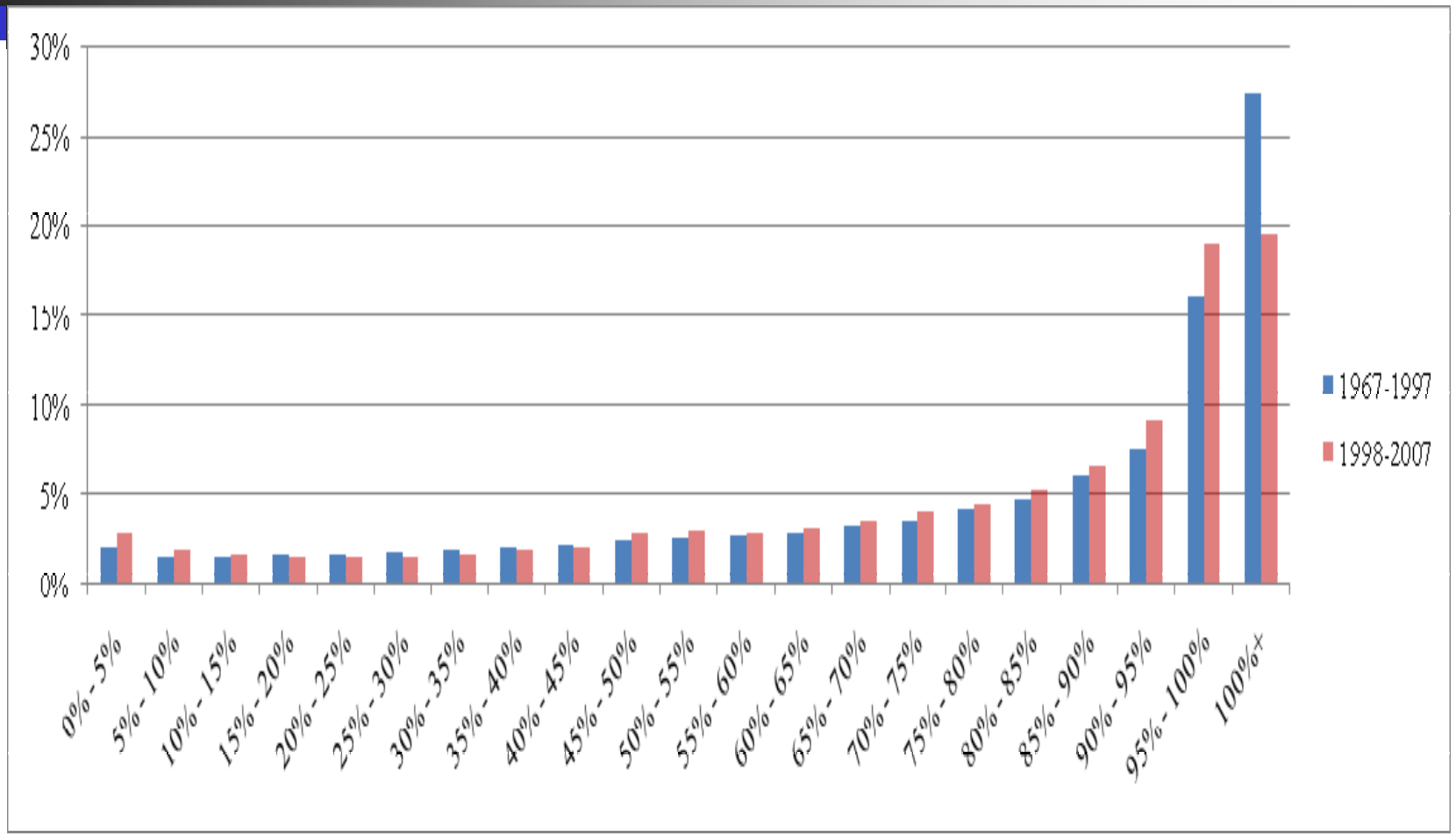
- **Source** : CPP, QPP, CAN=Canada
- **Sex**: Male, Female
- **Age**
  - Age **at last birthday**: integer
  - Precision: 1/24th of a year
  - Adjustment for the day (middle of the month)
  - From 60 to 111 in 2007 (born in 1896 or later)

Classification Variables: 2

- **Calendar year / 3-year period**
  - 1967 to 2007
  - 1990-1992 to 2005-2007
- **Income Level and Income Class**
  - Pension $ translated into % of maximum pension
  - % at beginning of retirement= function (YMPE *)
  - Adjustment according to retirement date: source, early or late retirement, phasing-in formula

* YMPE = C/QPP Yearly Maximum Pensionable Earnings → $ 39,100 in 2002, $ 43,700 in 2007

Data by Income Level (5%-interval): CAN, Male



Classification Variables: 3

- 5 income classes
  - 1: **<** 35 % maximum pension
  - 2: 35-94 % max. pension
  - 3: **>** 95 % max. pension (high income)
  - **4: > 35 %** max. pension **= 2 + 3**
  - **5: All income= 1 + 2 + 3**
- **Class 4: low pensions excluded**

Data Limitations

- Volume varies by year: 1967, 1970, 1990...
- Year 2008 : under-reporting of CPP deaths
- Retirees only: impact on data coverage for female
- No data below age 60
- Early retirement: data from age 60 to 64 since 1984 (QPP)/ 1987 (CPP)
- Maximum Age related to (Year – 1896)
  - 1967: ages 68 to 71
  - 2000: ages 60 to 104

  1970: ages 65 to 74,

  2007: ages 60 to 111

Measured Values

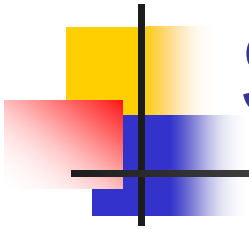
- Death
- Exposure
- Central death rate
- Observed probability of death
- For each cell
  - Source/Age/Sex/Income Class/Year
- Graduated rate calculation (smoothing)

Exposure by Class, CAN 2005-2007

Class	Male (000 Life-Years)	Male (%)	Female (000 Life-Years)	Female (%)
1	707	**11**	2,868	**43**
2	2,852	**43**	3,051	**46**
3	3,071	**46**	694	**11**
4	5,923	**89**	3,745	**57**
5	**6,630**	**100**	**6,613**	**100**

Deaths by Class, CAN, 2005-2007

Class	Male (#)	Male (%)	Female (#)	Female (%)
1	31,567	**12**	85,175	**47**
2	111,084	**43**	77,596	**43**
3	117,952	**45**	17,783	**10**
4	229,036	**88**	95,379	**53**
5	**260,603**	**100**	**180,554**	**100**



Section 3

Mortality Level: 2005-2007

Deaths for CAN, Male, Age 70, Class 4 (>35 % Max. Pension)

Income Class	CPP 2005	CPP 2006	CPP 2007	QPP 2005	QPP 2006	QPP 2007	CAN 2005-2007
1 (< 35 %)	251.50	266.00	241.00	106.00	98.50	96.50	1 059.50
2 (35-94%)	830.50	892.50	886.00	333.00	292.50	301.50	3 536.00
3 (>95%)	678.50	639.00	646.00	216.50	195.50	193.00	2 568.50
4 (>35%)	1 509.00	1 531.50	1 532.00	549.50	488.00	494.50	**6 104.50**
5 (all)	1 760.50	1 797.50	1 773.00	655.50	586.50	591.00	7 164.00

Exposure: CAN, 4, M, Age 70

Income Class	CPP 2005	CPP 2006	CPP 2007	QPP 2005	QPP 2006	QPP 2007	CAN 2005-2007
1 (< 35 %)	8 755.60	9 125.35	9 627.51	2 783.92	2 891.44	3 038.97	36 322.79
2 (35-94%)	33 572.65	34 415.65	34 404.01	11 674.07	12 004.36	12 306.19	138 376.944
3 (>95%)	34 312.29	35 105.43	34 995.06	11 036.42	11 063.15	10 749.68	137 262.028
4 (>35%)	**67 884.94**	**69 521.08**	**69 399.07**	**22 710.49**	**23 067.51**	**23 055.88**	**275 638.972**
5 (all)	76 640.54	78 646.43	79 026.58	25 494.40	25 958.96	26 094.85	311 861.76

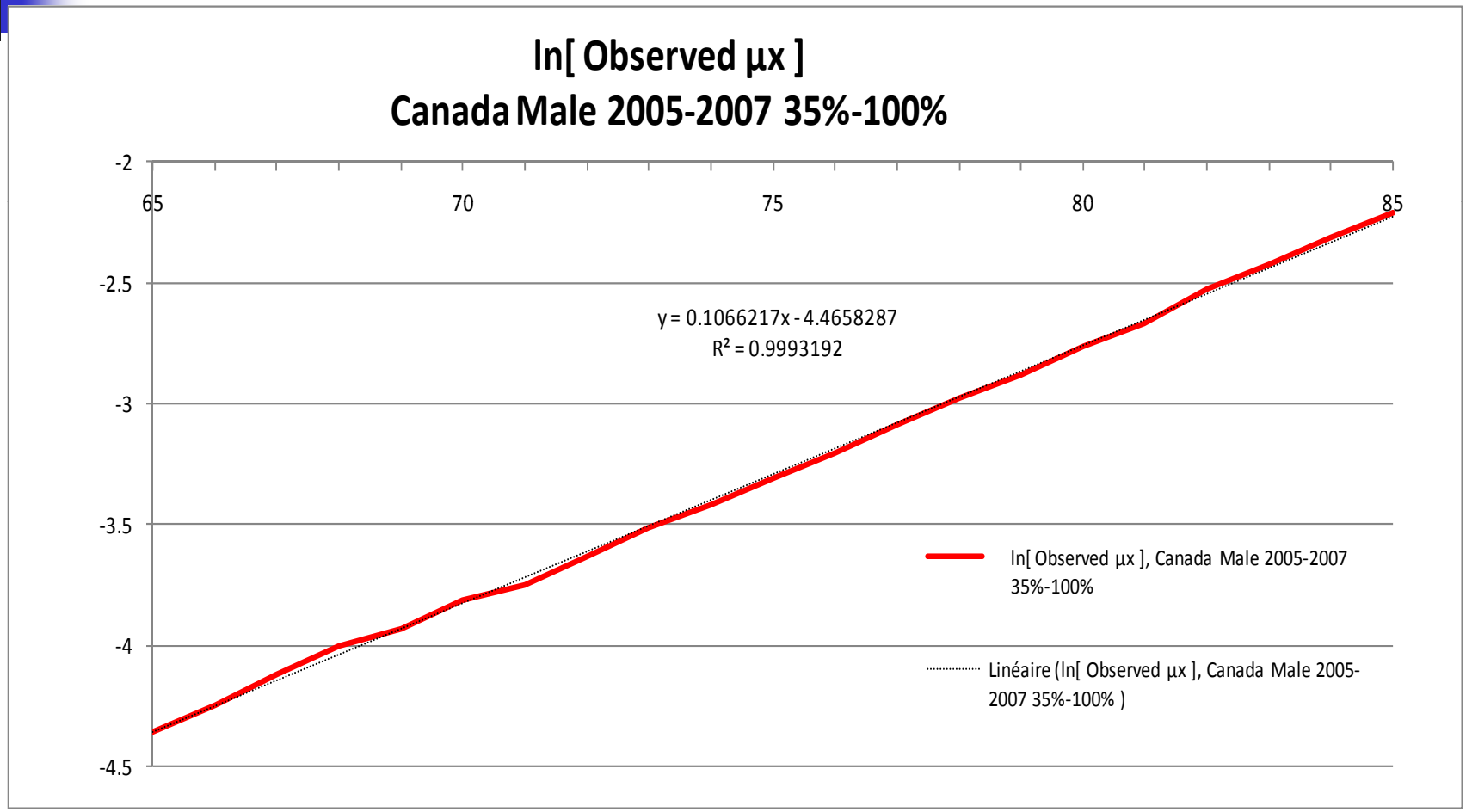
Calculations: CAN, 4, M, Age 70

- Deaths : 6,104.50
- Exposure : 275,638.972
- Central Rate $\hat{\mu}_{70}$: 0.022147
- Probability of Death $\hat{q}_{70}$: **0.021903**
- Standard Deviation of $\hat{\mu}_{70}$: 0.0002835
- Standard Deviation of $\hat{q}_{70}$: **0.000277**
- Coefficient of Variation: 1.27 %

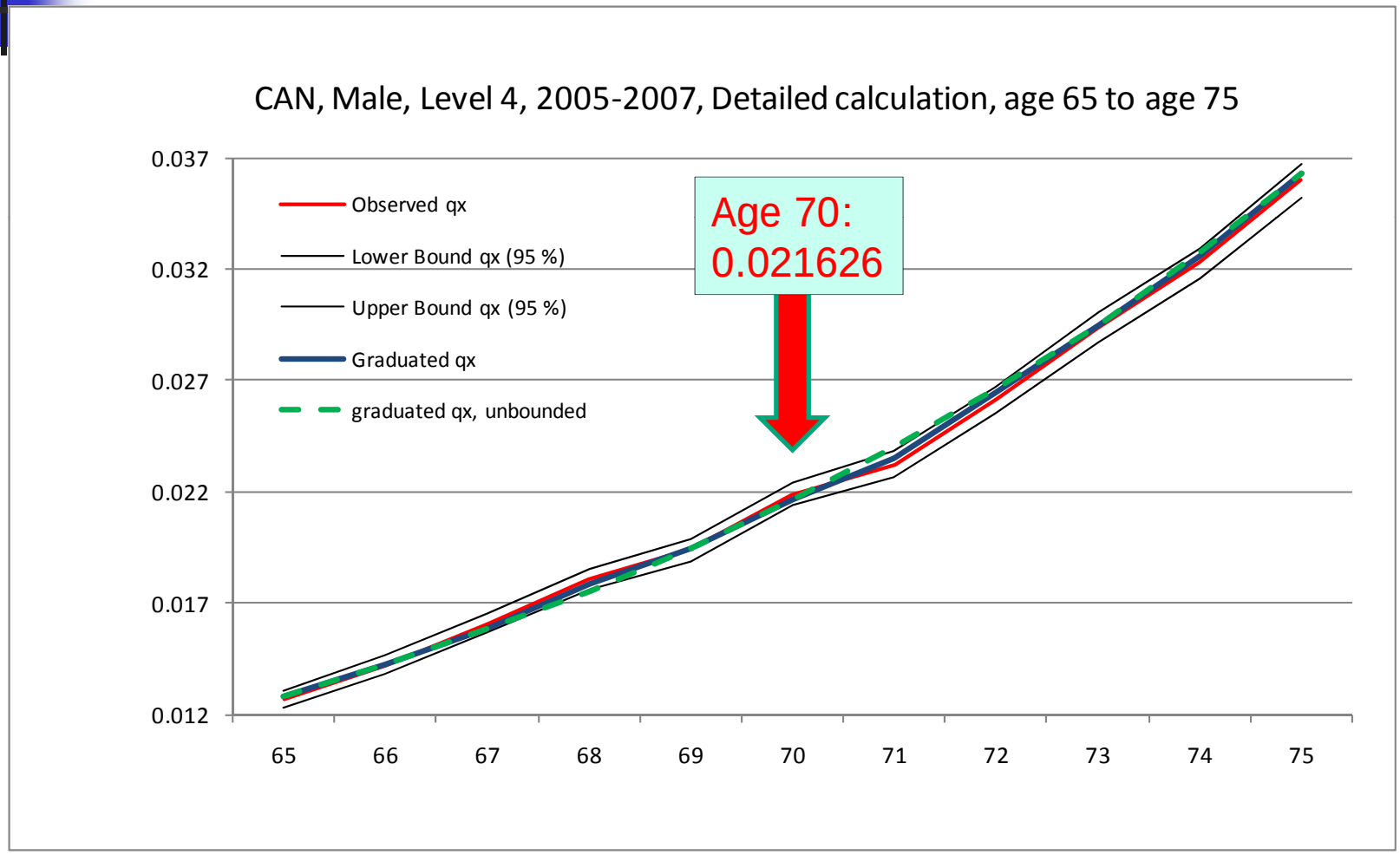
Calculations & Interpretation

- Observed Value $\hat{q}_{70}$: **0.021903**
- Lower Bound (95 %): 0.021360
- Upper Bound (95 %): 0.022447
- Value obtained by smoothing (graduation) q_{70}: **0.021626**
- Graduated value obtained takes into account results for several ages, but bounded by ± 1 standard deviation

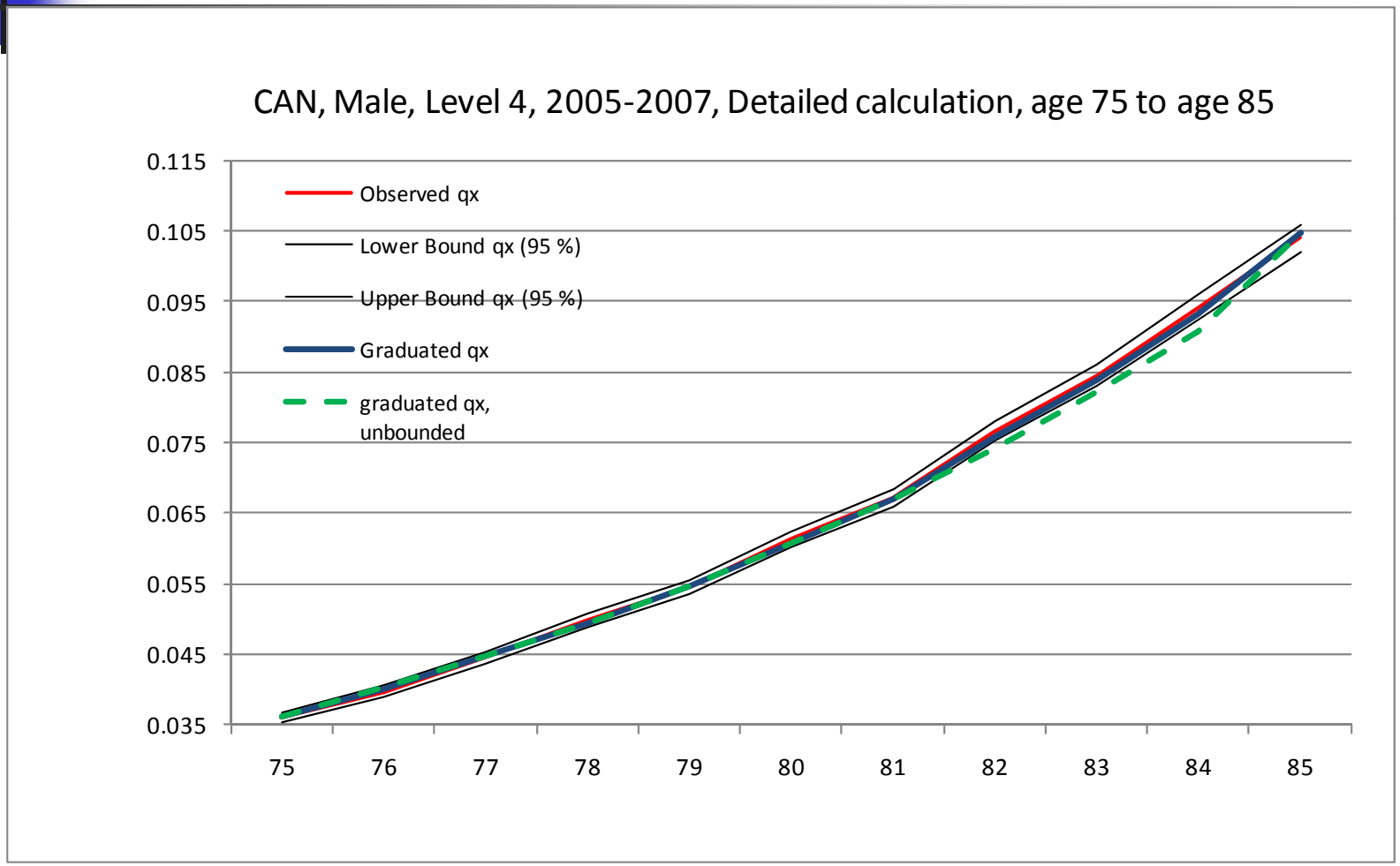
Rationale $\log(\hat{\mu}_x), 65 \leq x \leq 85$



Graduation, with Constraints, Ages 65-75

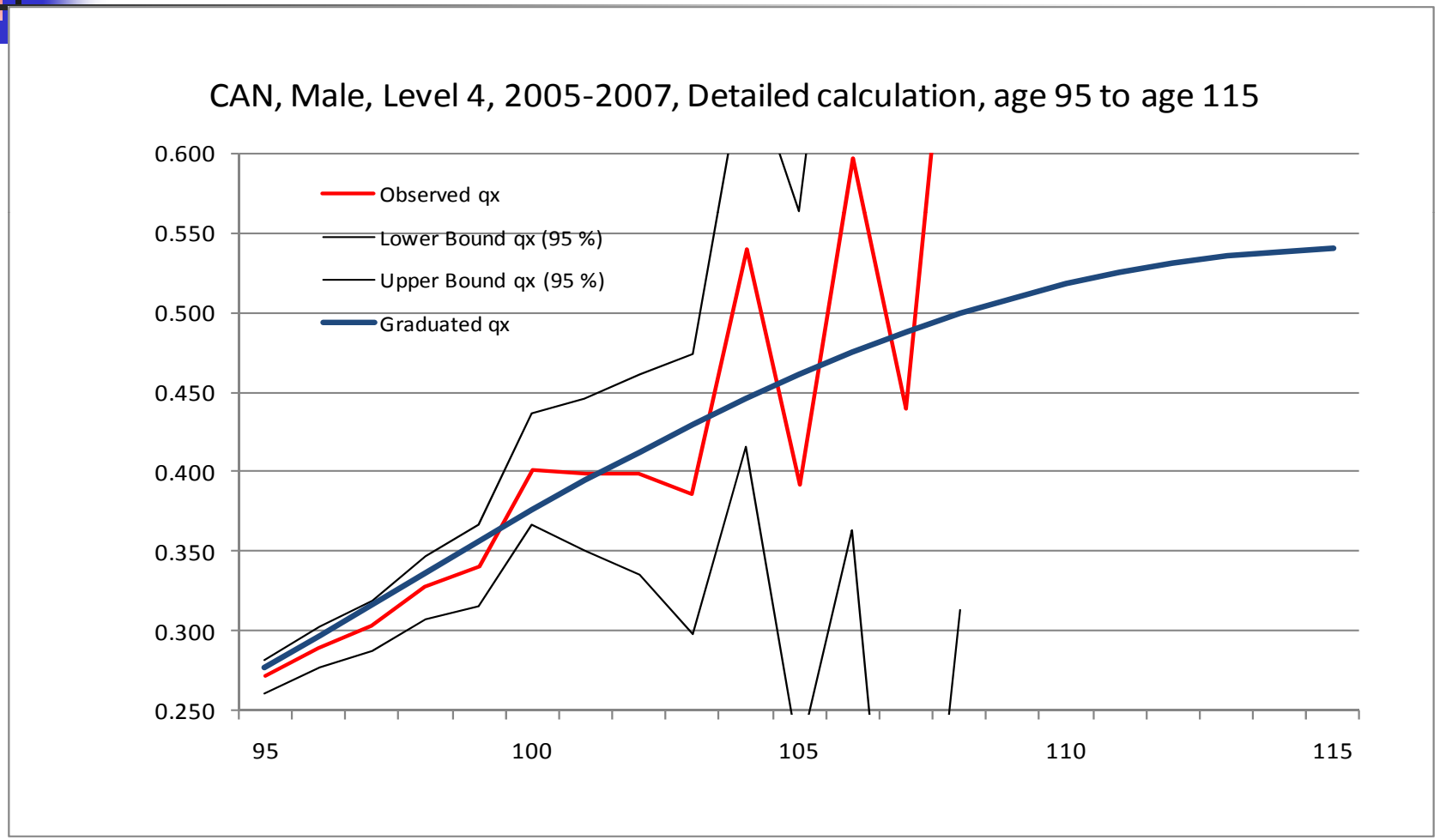


Graduation, with Constraints, Ages 75-85



Graduation, with Constraints, Ages 85-95

Graduation, with Constraints, Ages 95-115



Terminal Values

- Male : 0.54 at age 115
- Female: 0.51 at age 115
- Values obtained by comparing combined data at extreme ages over several years (1991-2007)
- Materiality: less significant for pension
- Modification to an exponential model (Gompertz, with asymptotic limit)

End of table

$x \leq 95$:

$$\mu_x = Bc^x$$

$$\log(\mu_x) = \log(B) + x \bullet \log(C)$$

$95 \leq x \leq 115$:

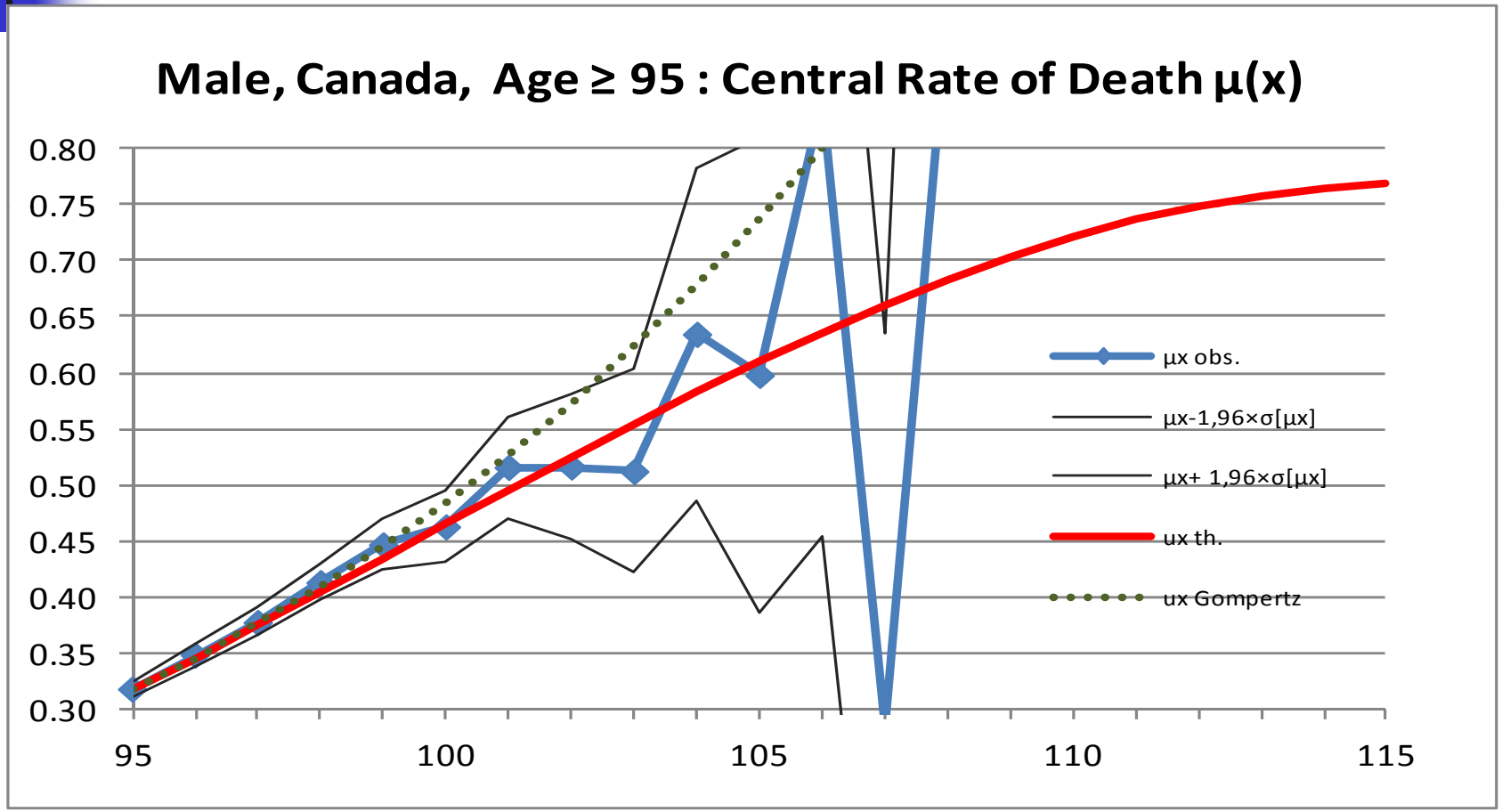
$$\log(\mu_{115+}) = \text{constant (0.54 Male, 0.51 female)}$$

$$\log(\mu_{95+k}) = \log(Bc^{95} \bullet c_{96} \bullet c_{97} \ldots \bullet c_{95+k})$$

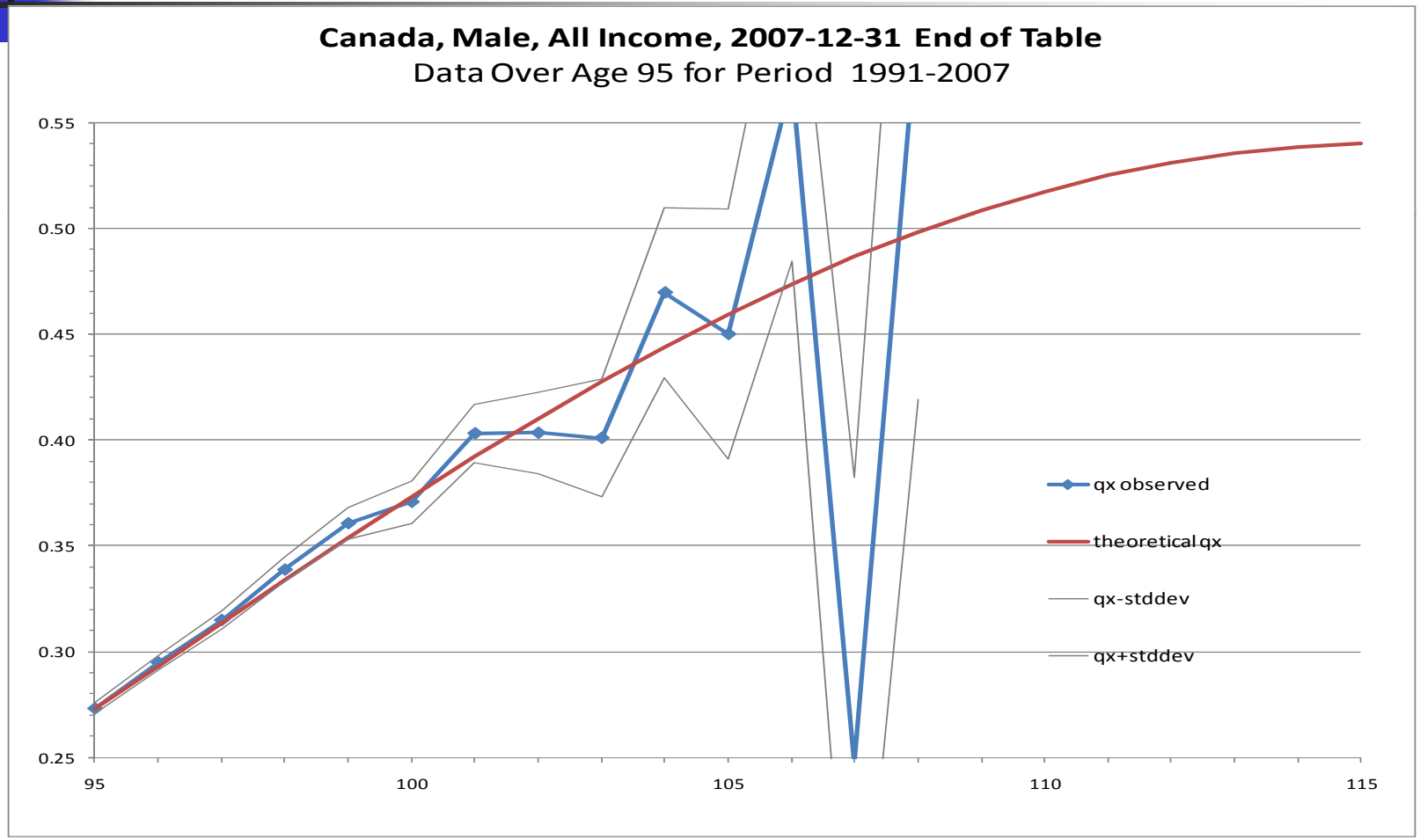
$$\log(c_{96}) > \log(c_{97}) > \ldots > \log(c_{115}) \text{ (linear decrease)}$$

$$\log(\mu_{115}) - \log(\mu_{95}) = \sum_{k=1}^{20} \log(c_{95+k})$$

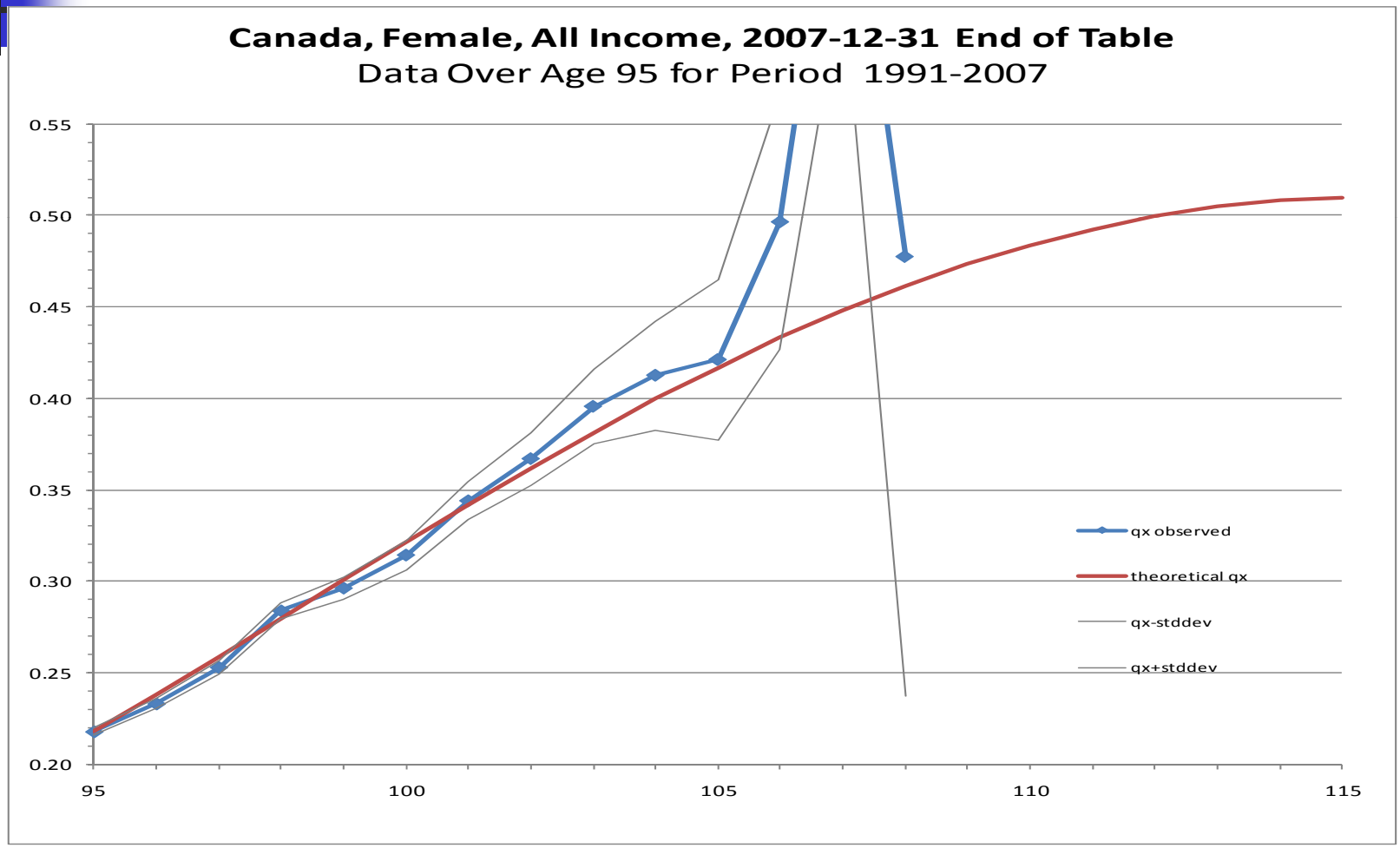
End-of-Table Model



Male: 0.54 at Age 115



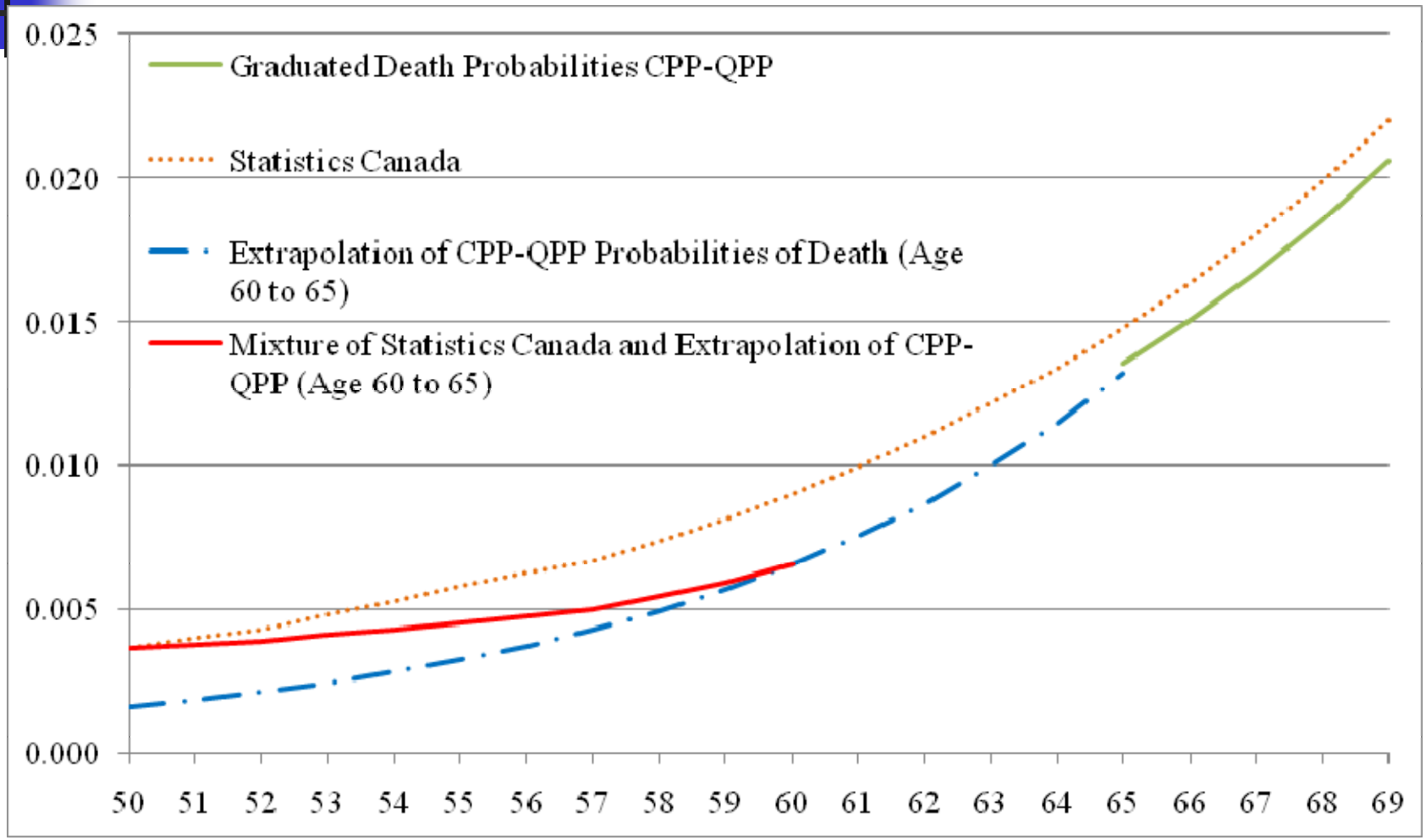
Female: 0.51 at Age 115

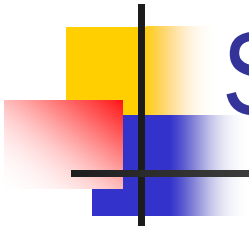


Values below age 65: extrapolation

- Tests not completed...
- No data below age 60
- Potention solution: blend of Statistics Canada with extrapolation of CPP-QPP (Age 60 to 65), Male Class 4, 2003-2005 Period
- Done here for 2003-2005 Period

Values under age 65

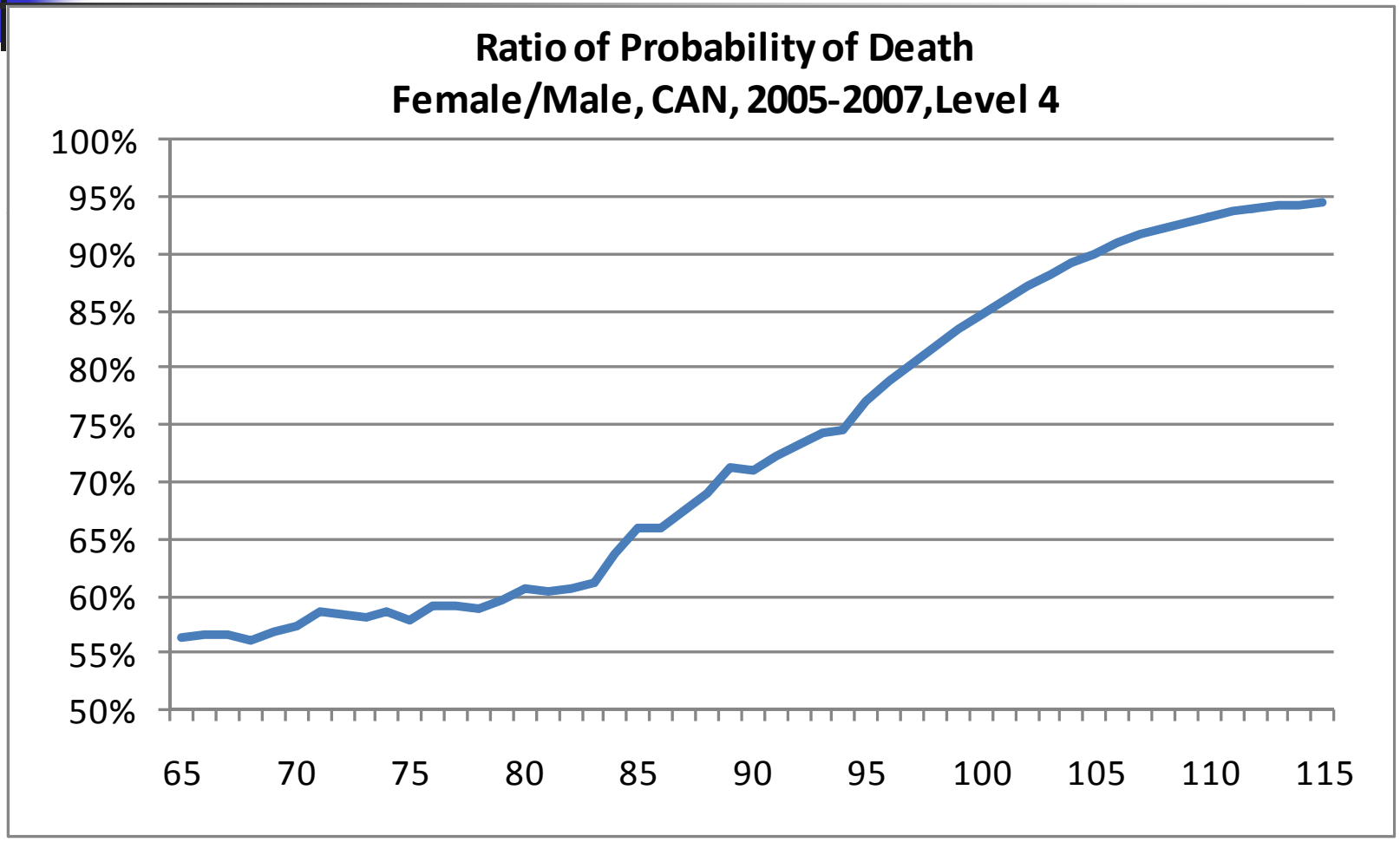




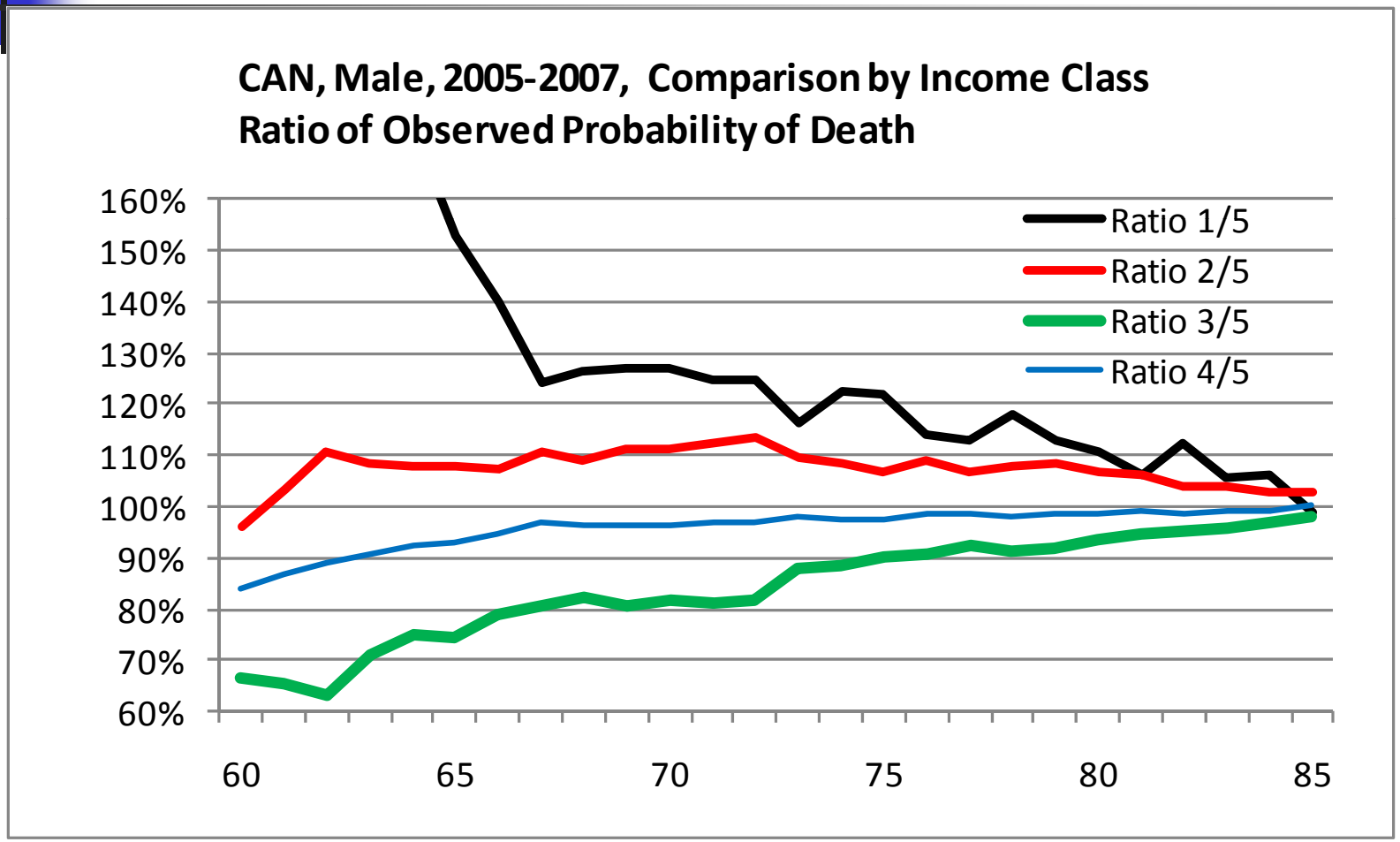
Section 4

Comparisons

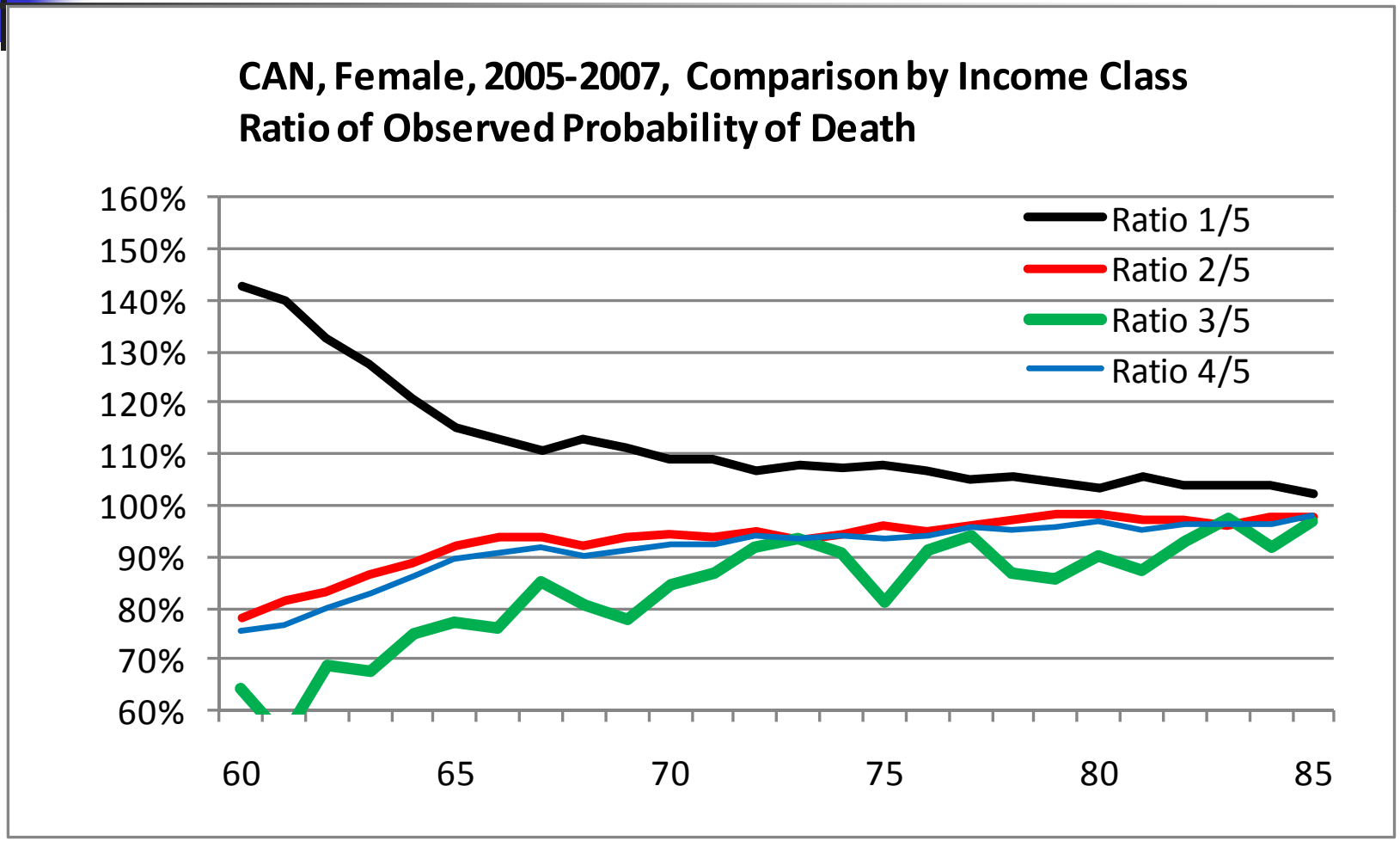
Male/Female Comparison



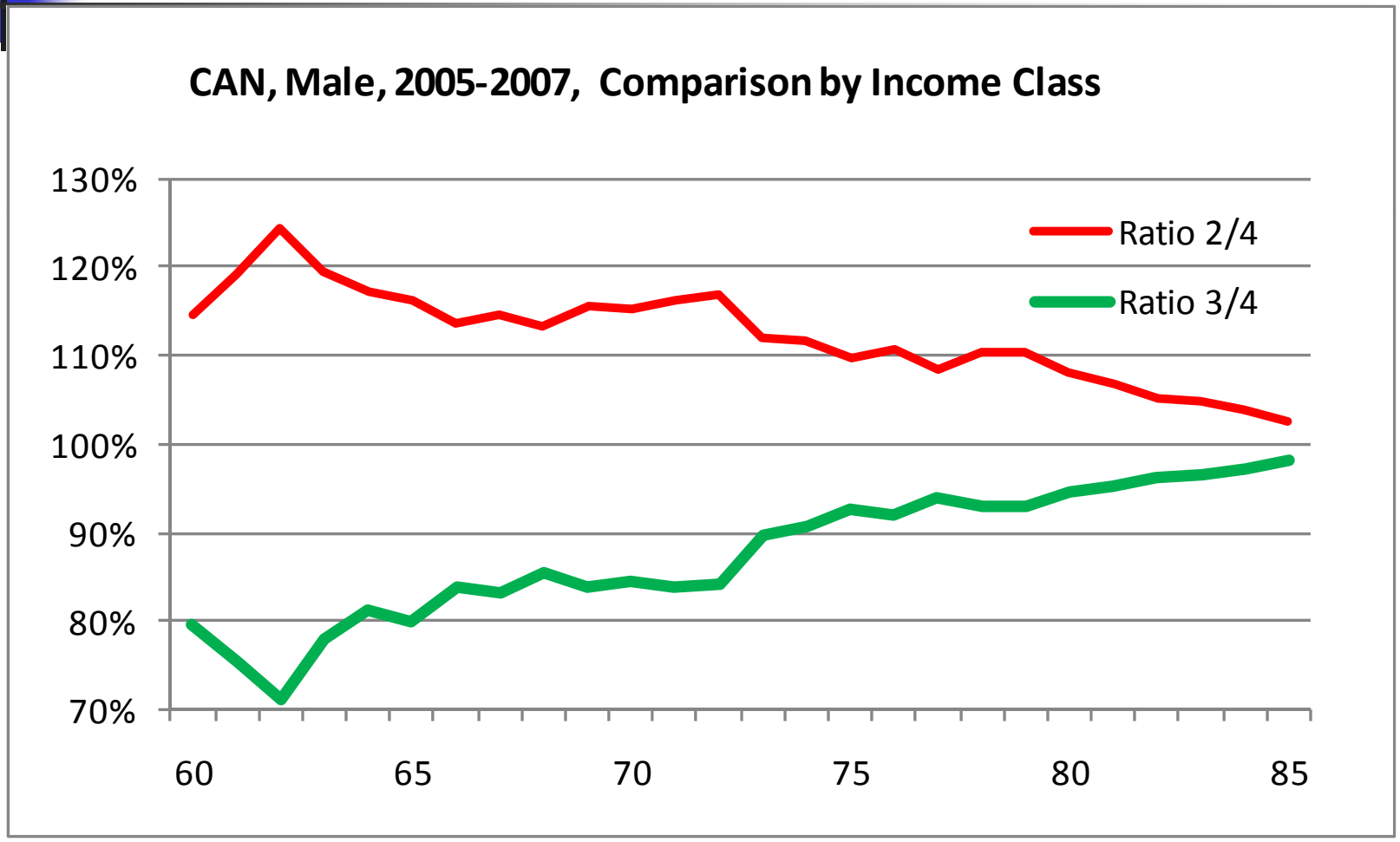
Comparison by Income: Male 1,2,3,4/5



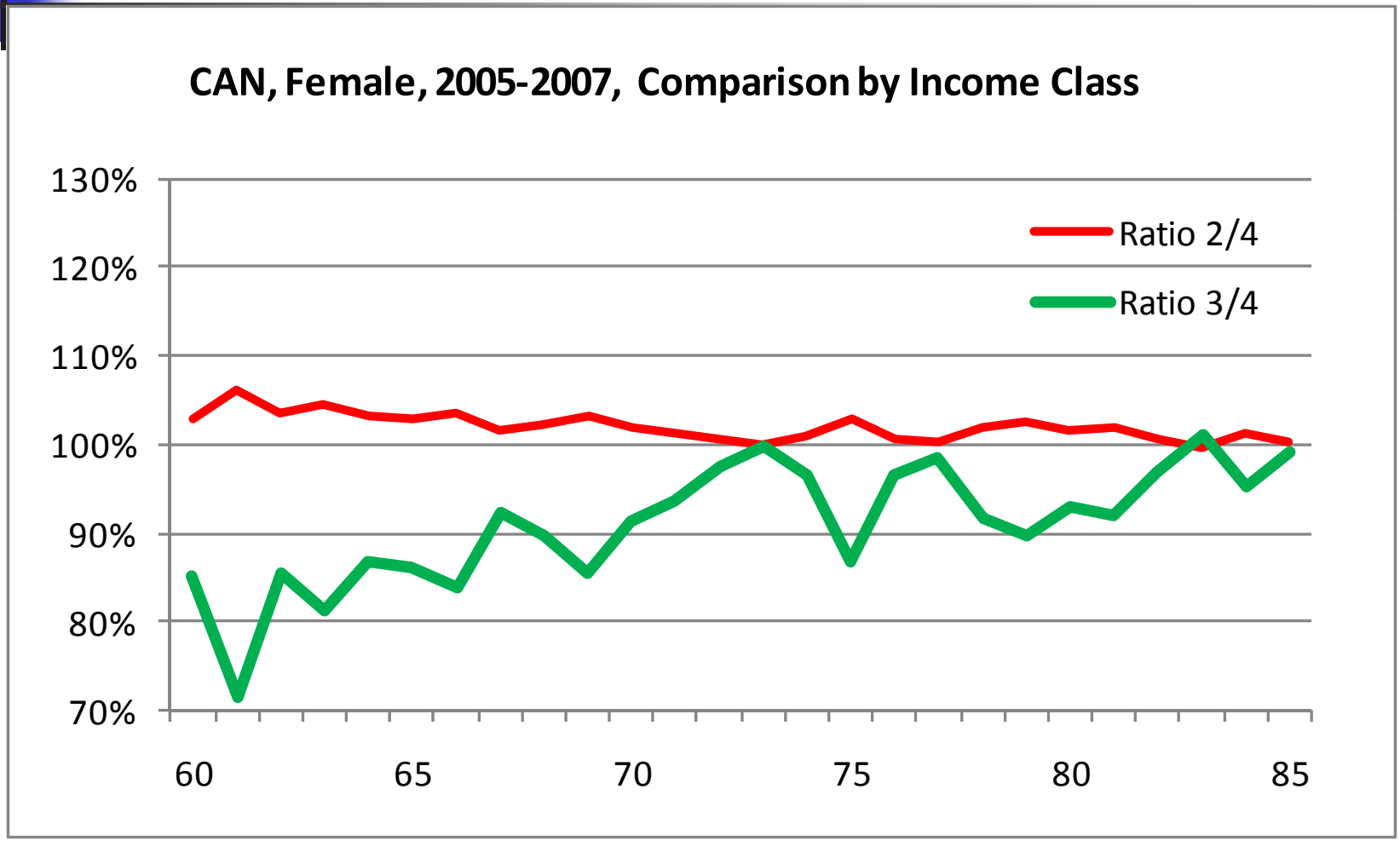
Comparison by Income: Female 1,2,3,4/5



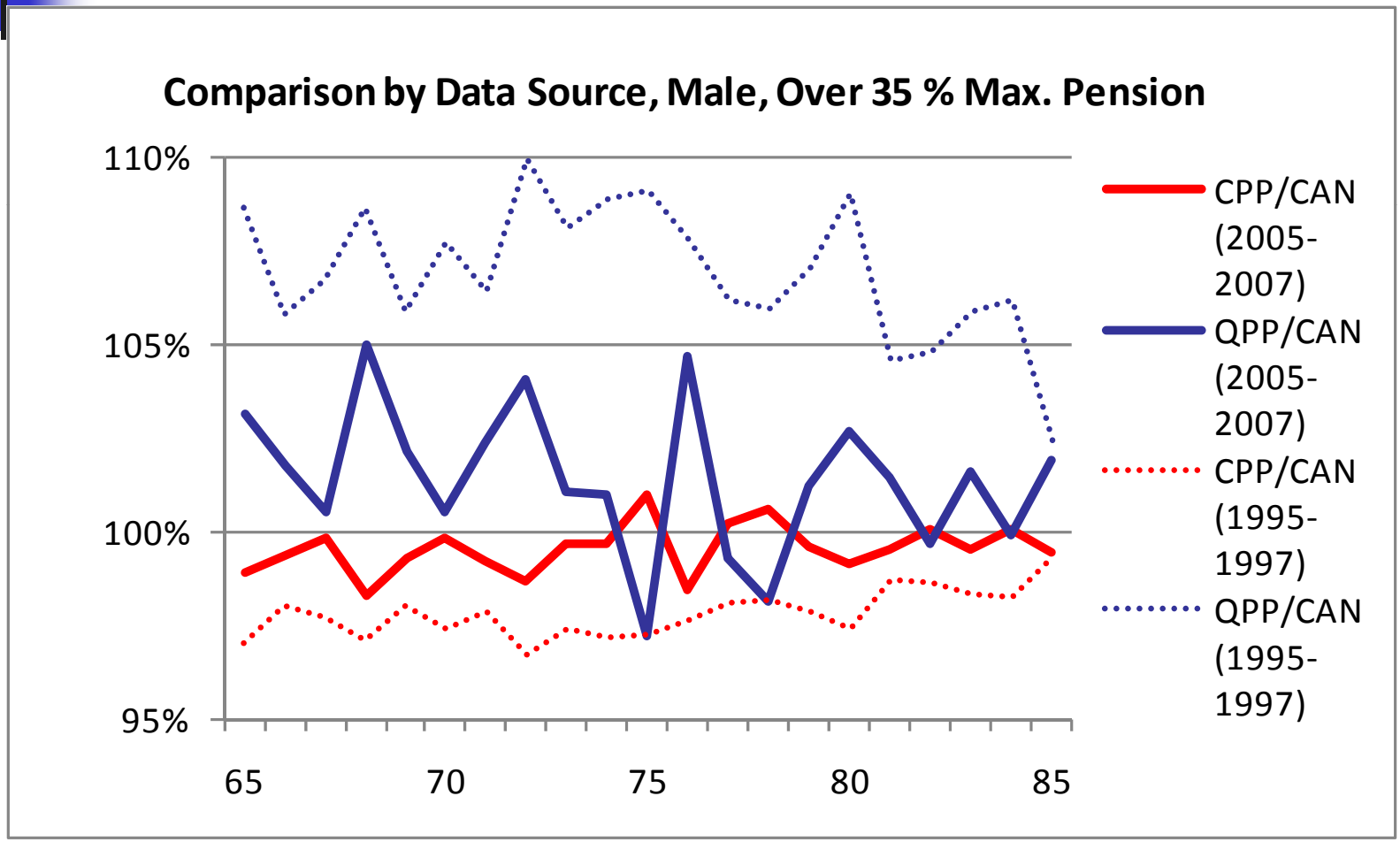
Comparison by Income: Male 2,3/4



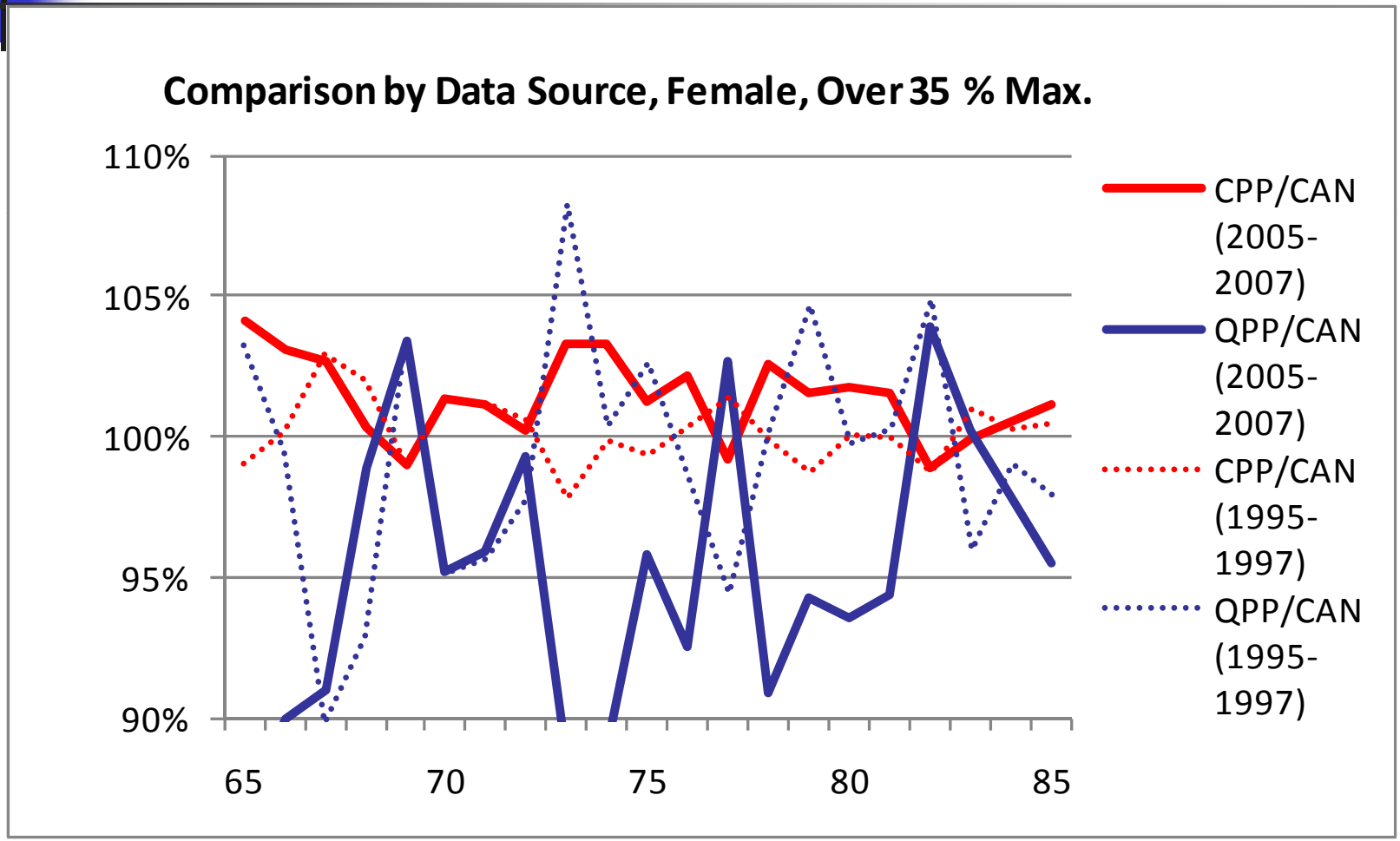
Comparison by Income: Female 2,3/4

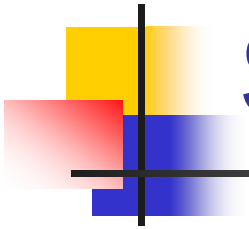


Comparison by Source: M



Comparison by Source: F

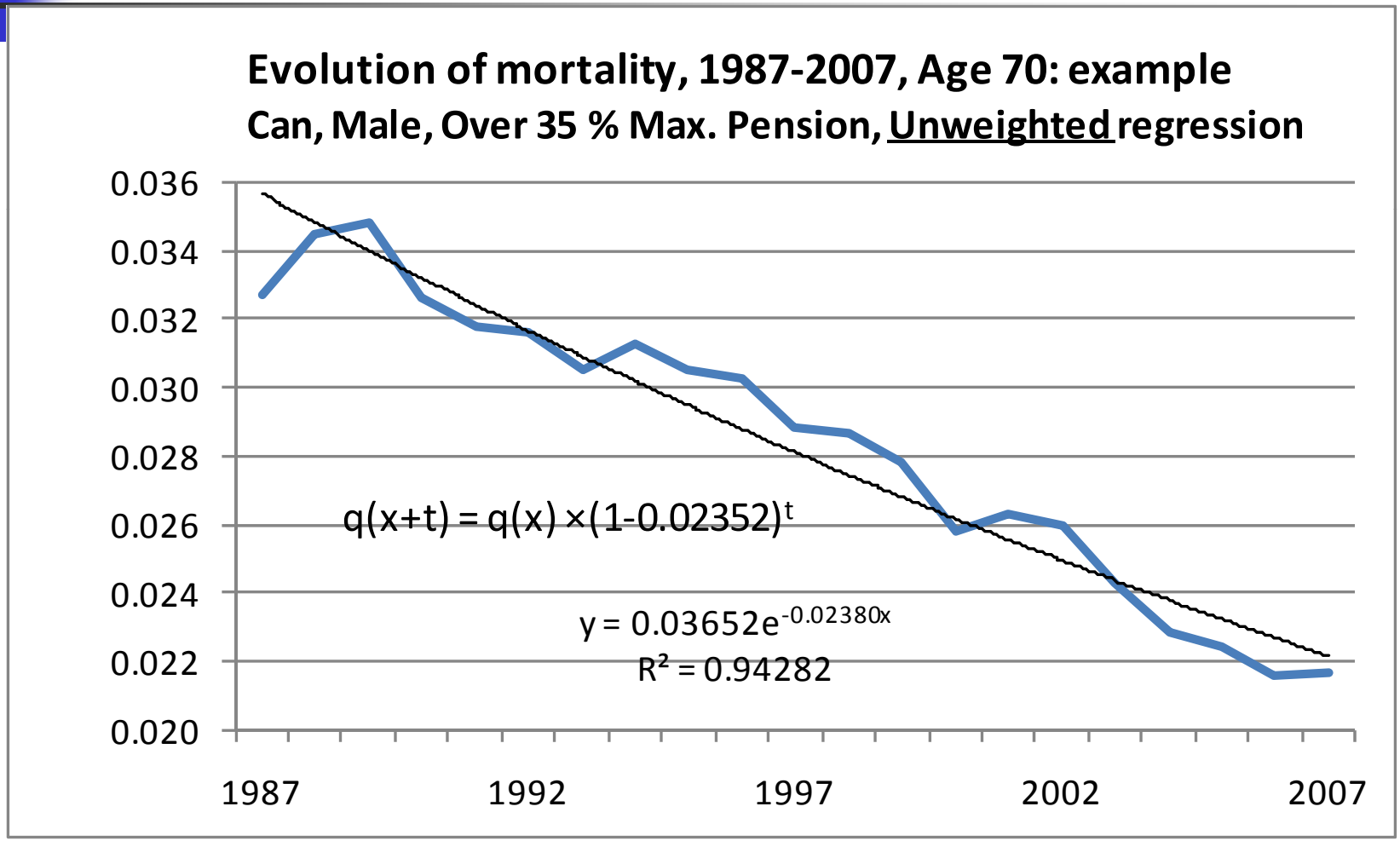




Section 5

Short-term Projection Scale

Evolution of Mortality



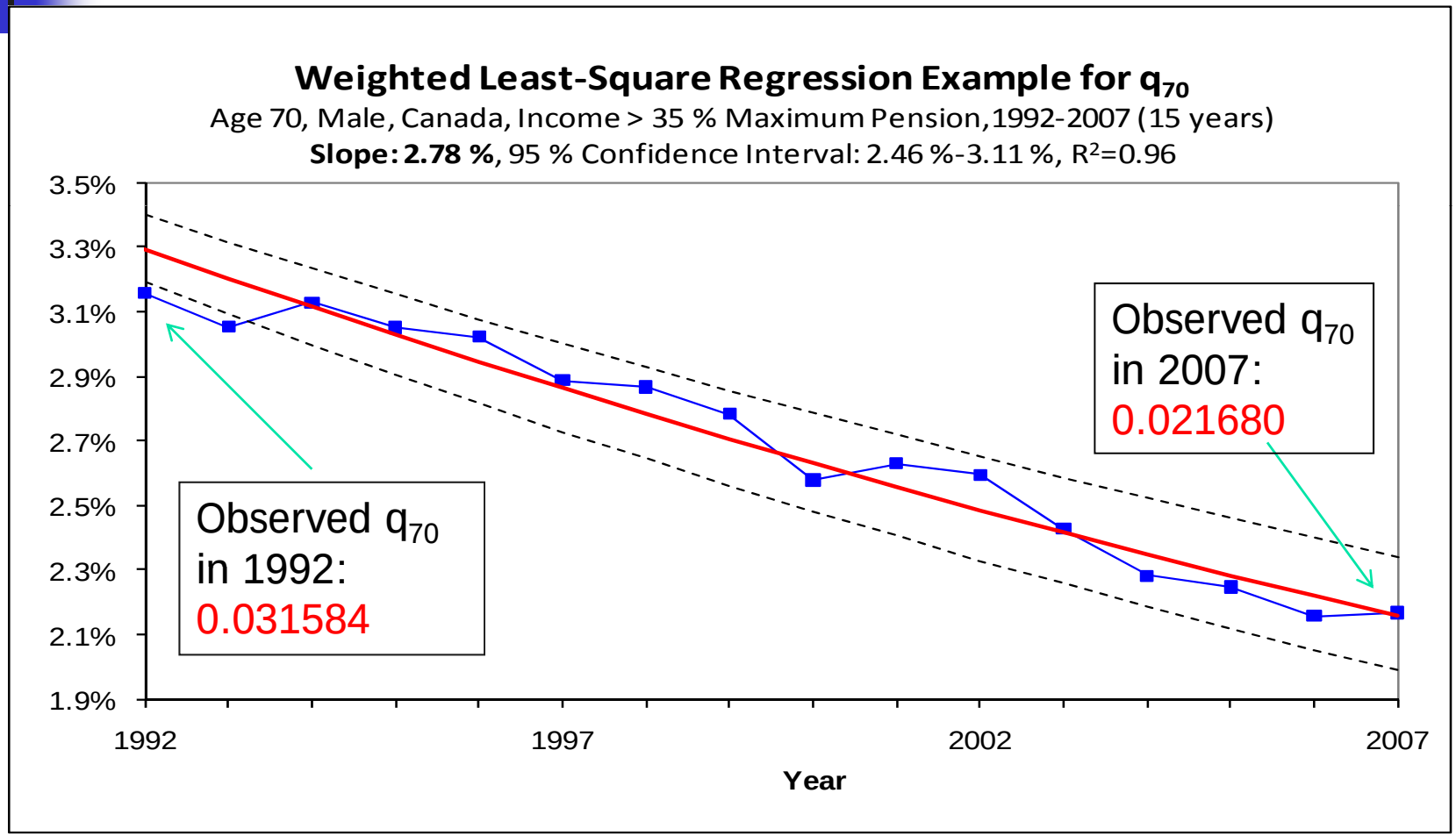
Reduction Rate

- Example: $q_{2010} = q_{2005\text{-}2007} \times (1\text{-rate})^4$
- Rate = reduction (projection) scale
- Decreases over time the probability of death in a year (example: 2%/year)
- Calculated for various combinations of variables (source, age, sex, class)
- Here: CAN, 70, Male, >35% max. pension

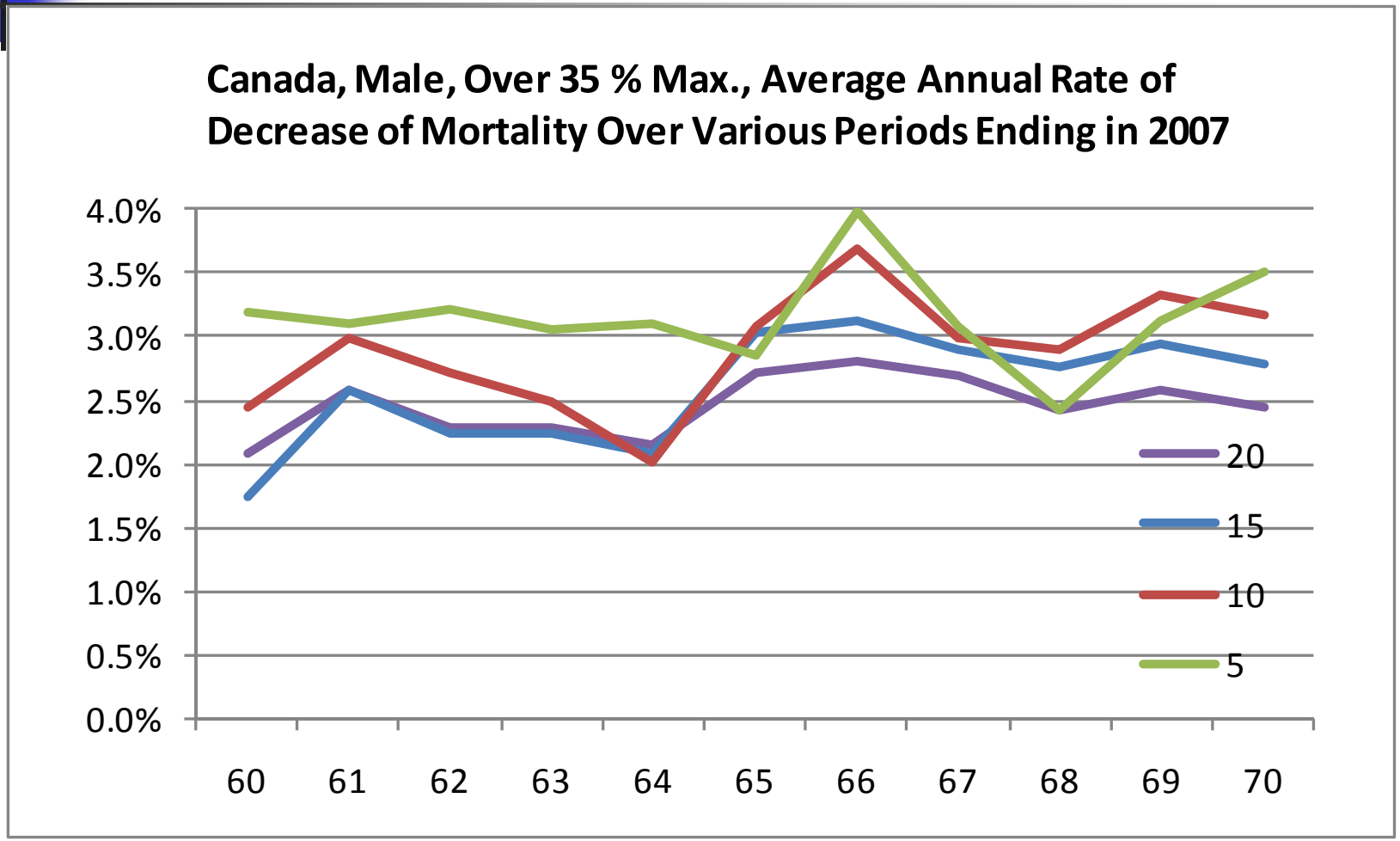
Explanation on Reduction Rate

- Previous chart: same weight given to each calendar year figure for q_{70}
- Method used here: Average annual rate obtained by weighted linear regression
- Weight related to the quantity of data
- Different period ending in 2007
- Each rate varies according to: age/period
- 15-year rate for age 70: **2.78**%/year

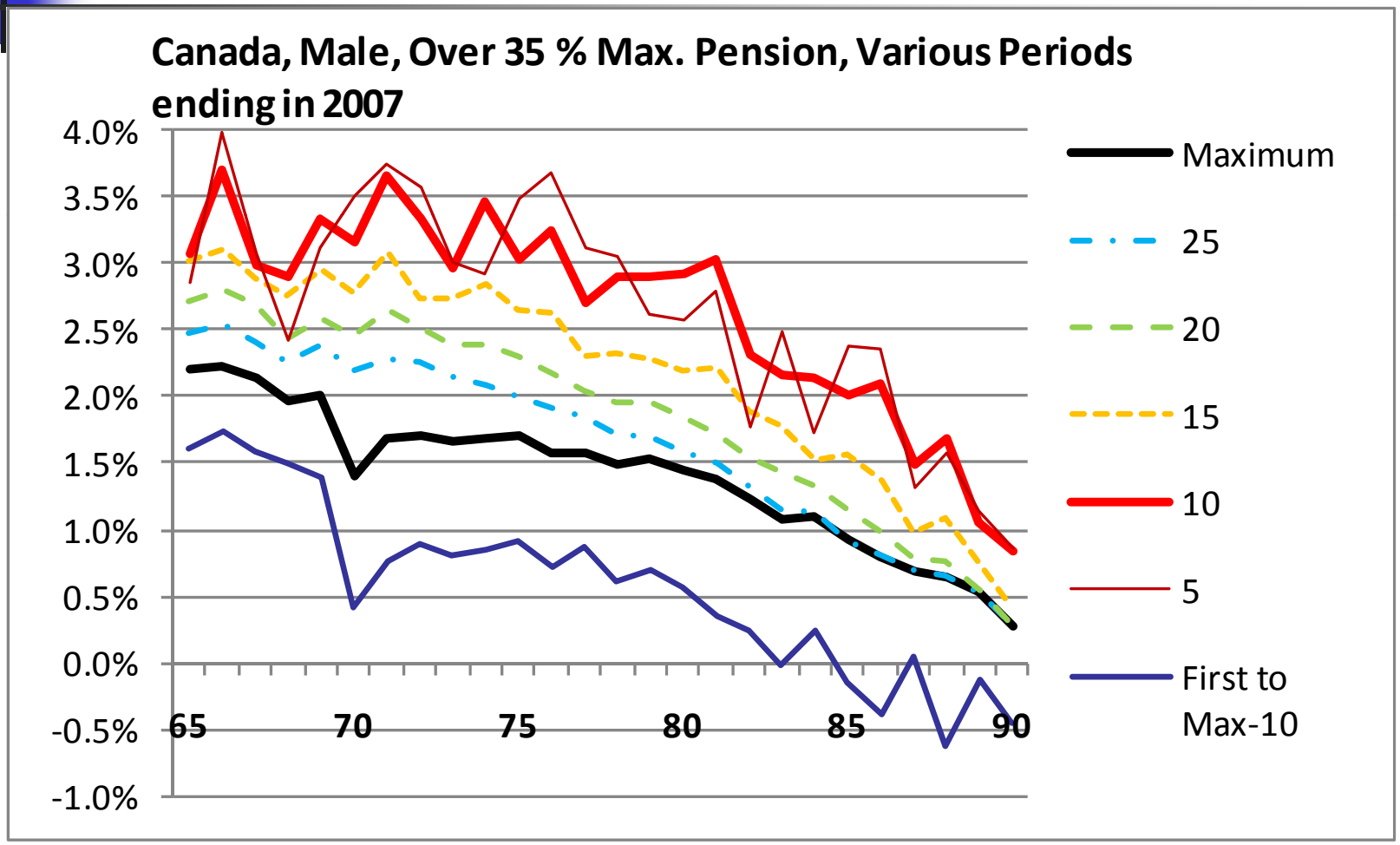
15-year Period, Ending in 2007



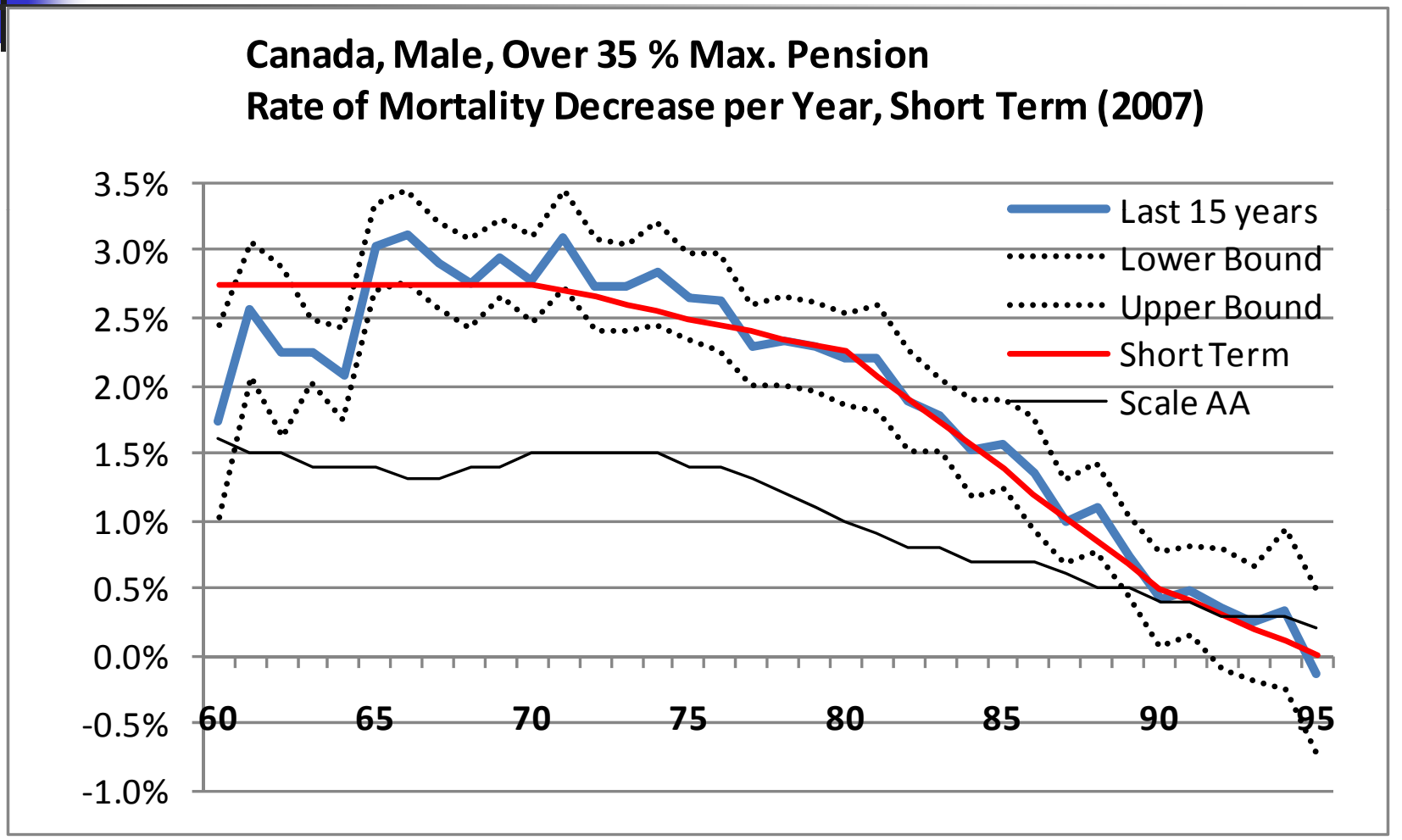
M, Can, 4, Ages 60 to 70



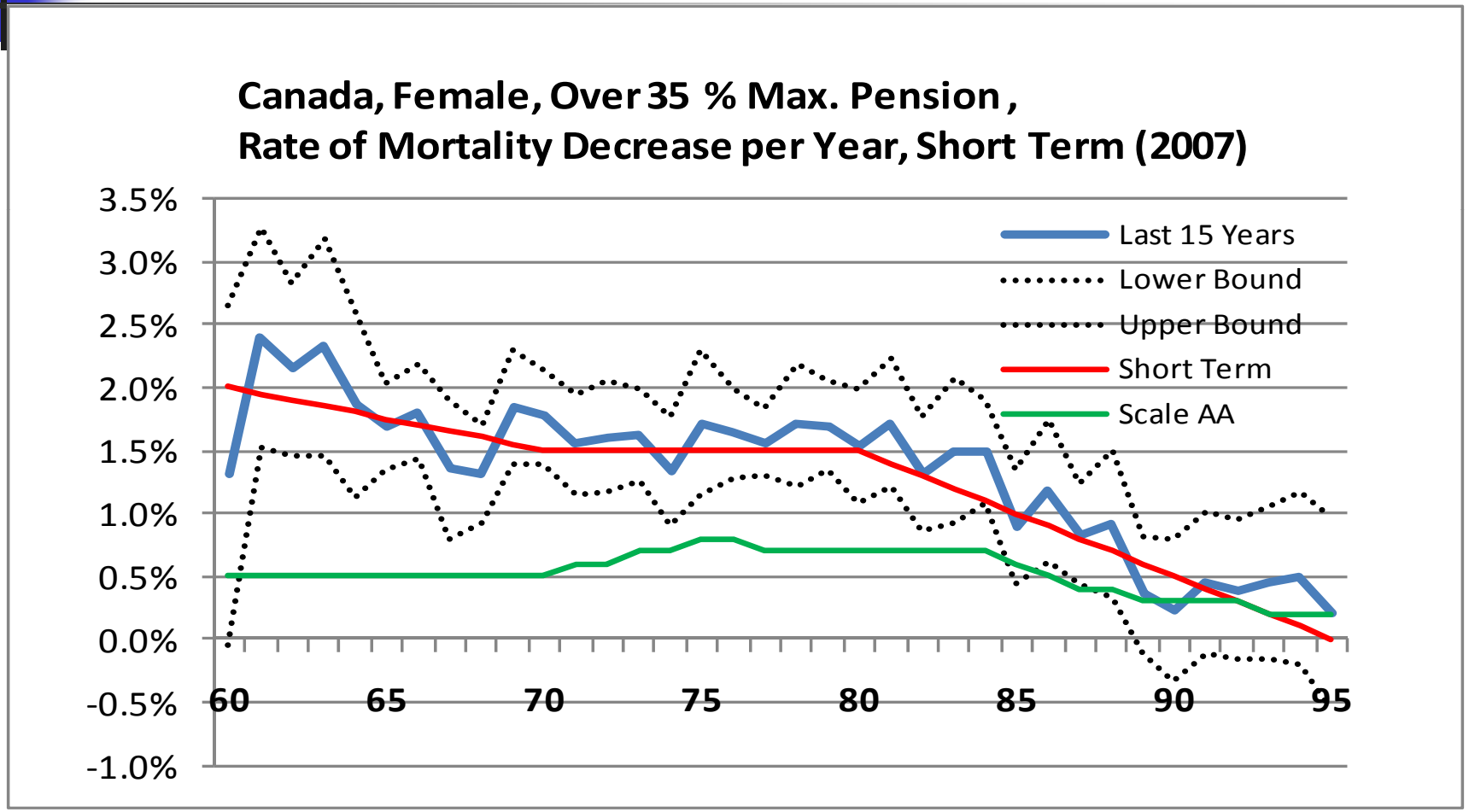
Short Term/Long Term Comparison



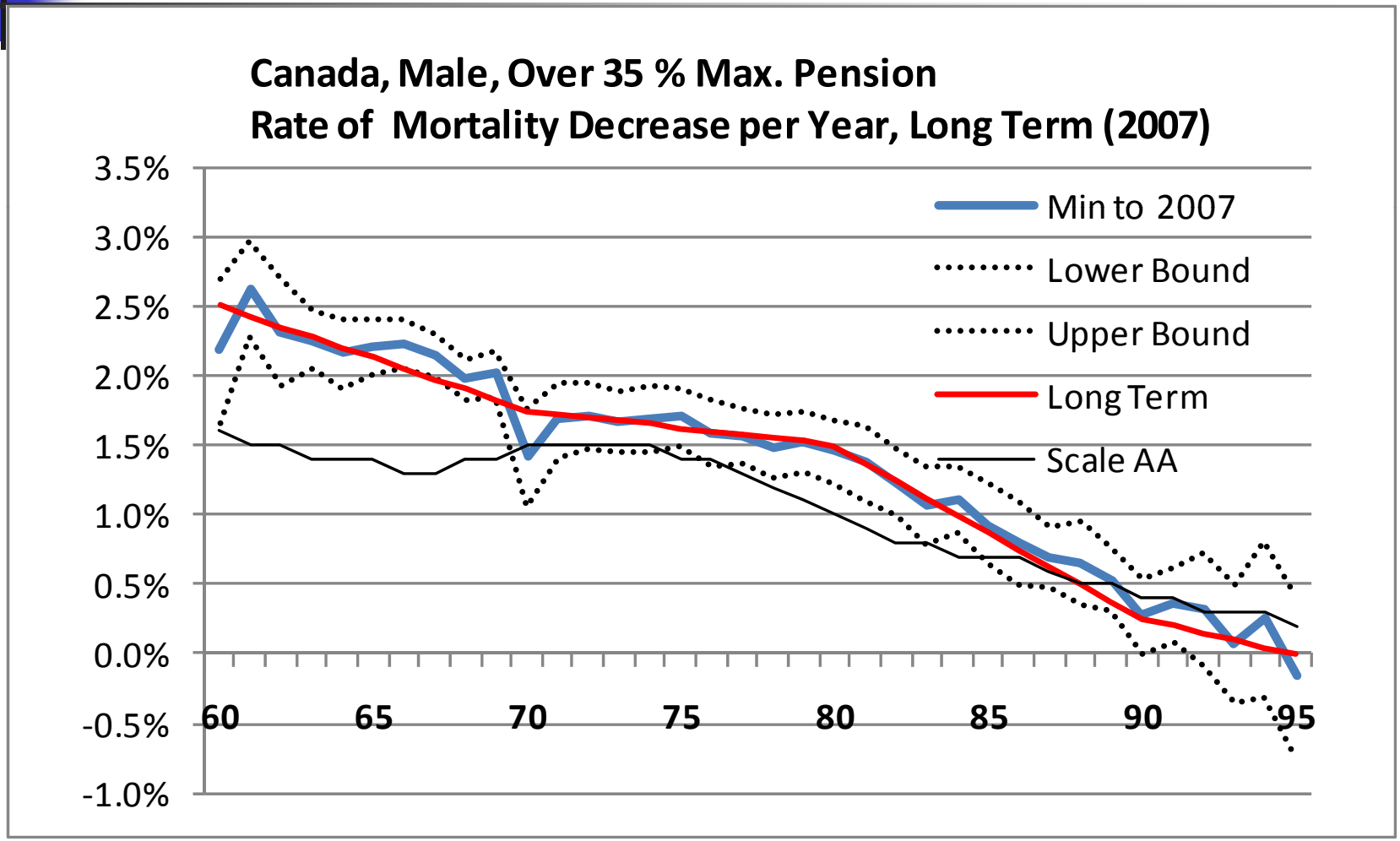
Short Term, with Bounds: M



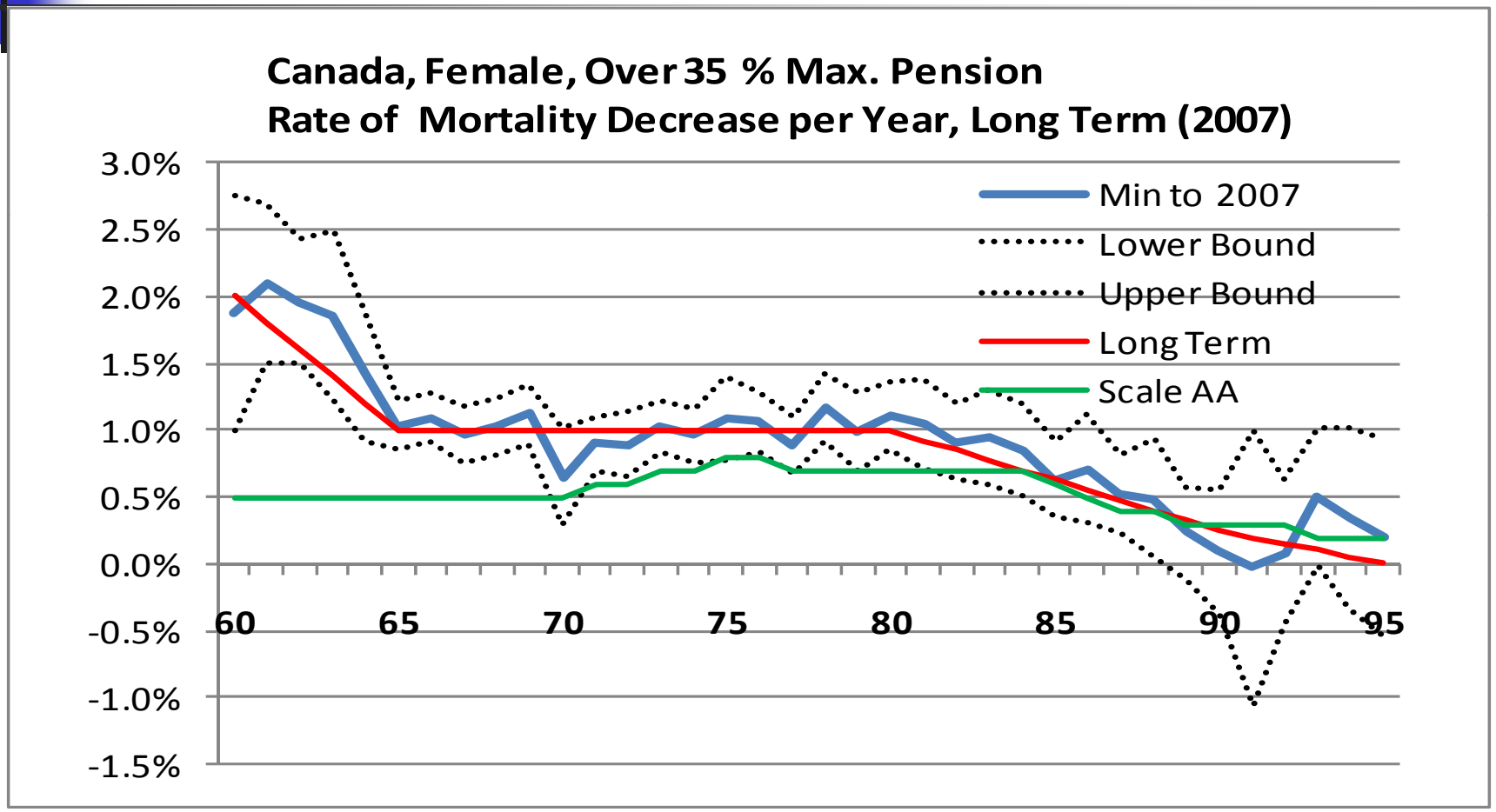
Short term, with bounds: F

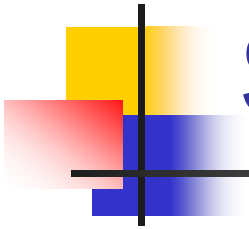


Long Term, with Bounds



Long term, with bounds: F





Section 6

Materiality: Impact on Present Values

Impact on Actuarial Liabilities

- Change of mortality tables: from UP-94 to Canadian Pensioners Mortality (CPM)
- Male - Female
- without projection beyond 2006, or up to 2010, 2015, 2020
- **Income class effect : not the same impact for upper income pensioners**

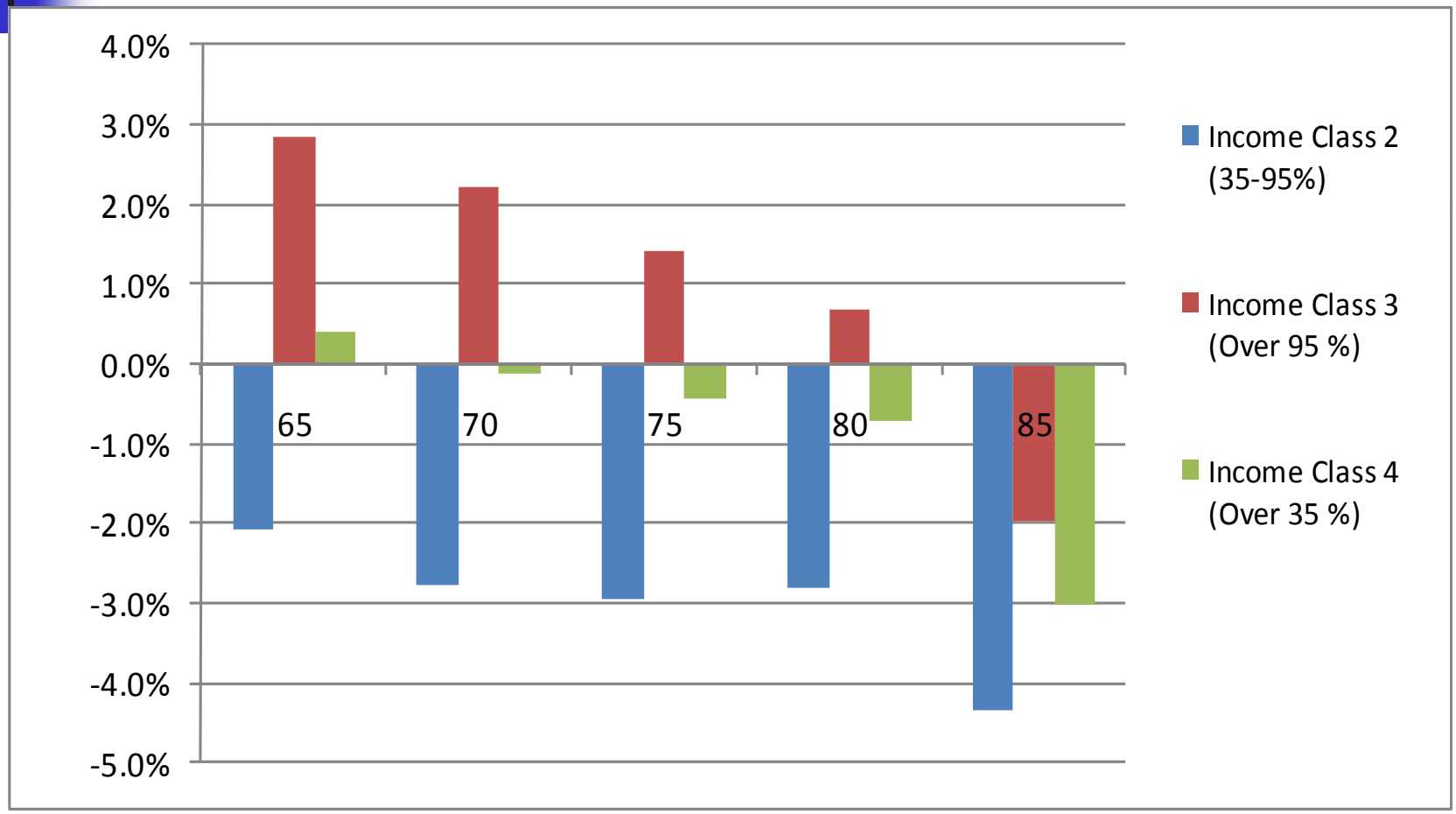
Assumptions and notes

- UP-94 figures calculated using "**Age last birthday**" assumption for consistency : not typical
- Ie: table UP-94 @2006 "LB"
- Present value of a $ 1,000/year life annuity-due, payable annually, interest rate= 6 %
- Charts: % Increase from UP-94 to CPM

Male, 2006: $1,000 \times \ddot{a}_x$

Age	UP-94 @2006 LB	CPM-CAN-2 2005-2007	CPM-CAN-3 2005-2007	CPM-CAN-4 2005-2007
65	10,828.25	10,605.38	11,138.05	10,871.85
70	9,480.96	9,217.13	9,692.17	9,468.40
75	8,003.83	7,767.76	8,118.65	7,968.22
80	6,497.16	6,315.05	6,541.35	6,451.26
85	5,161.53	4,937.19	5,059.69	5,006.96

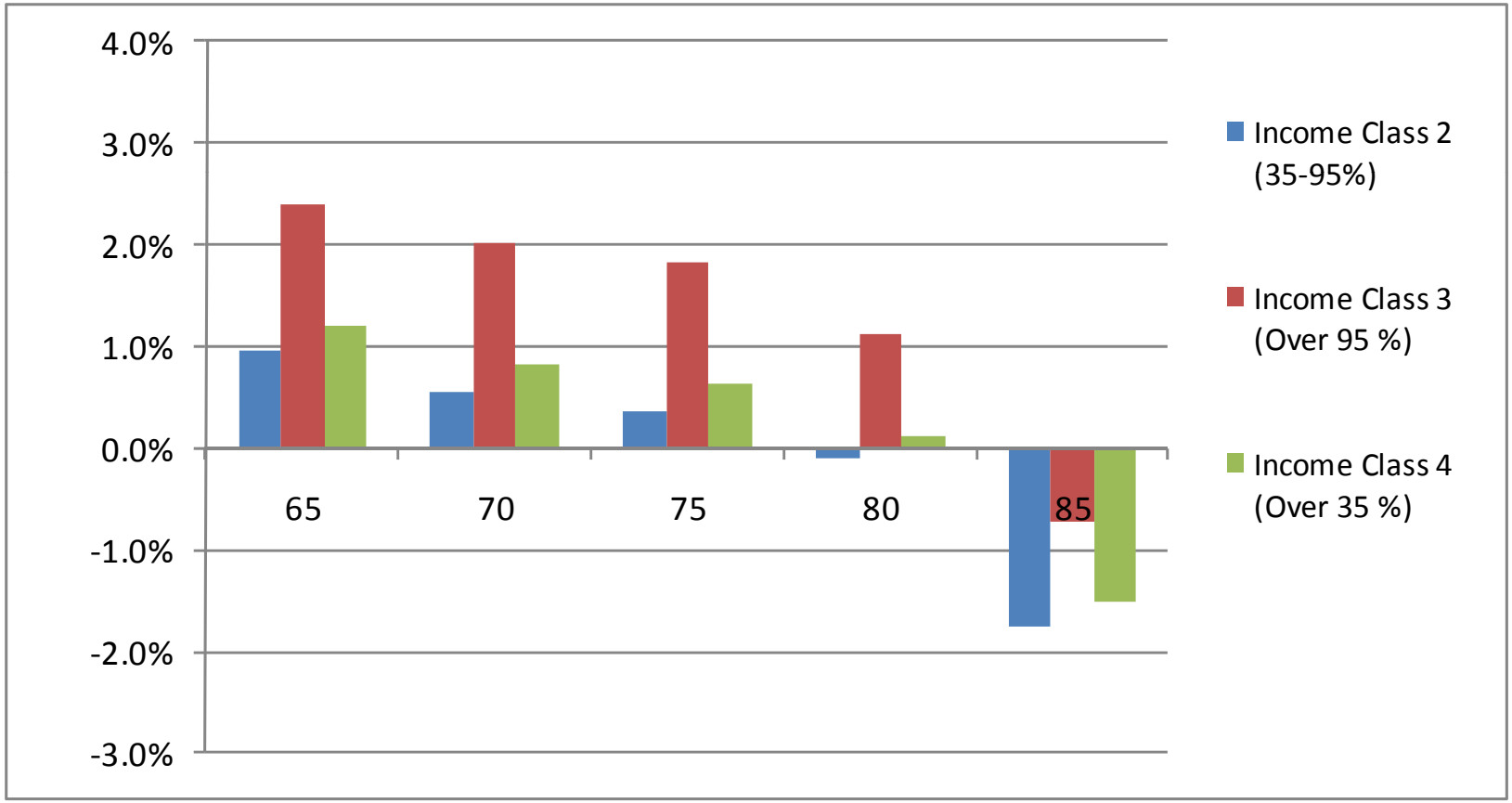
Male, 2006: % Change



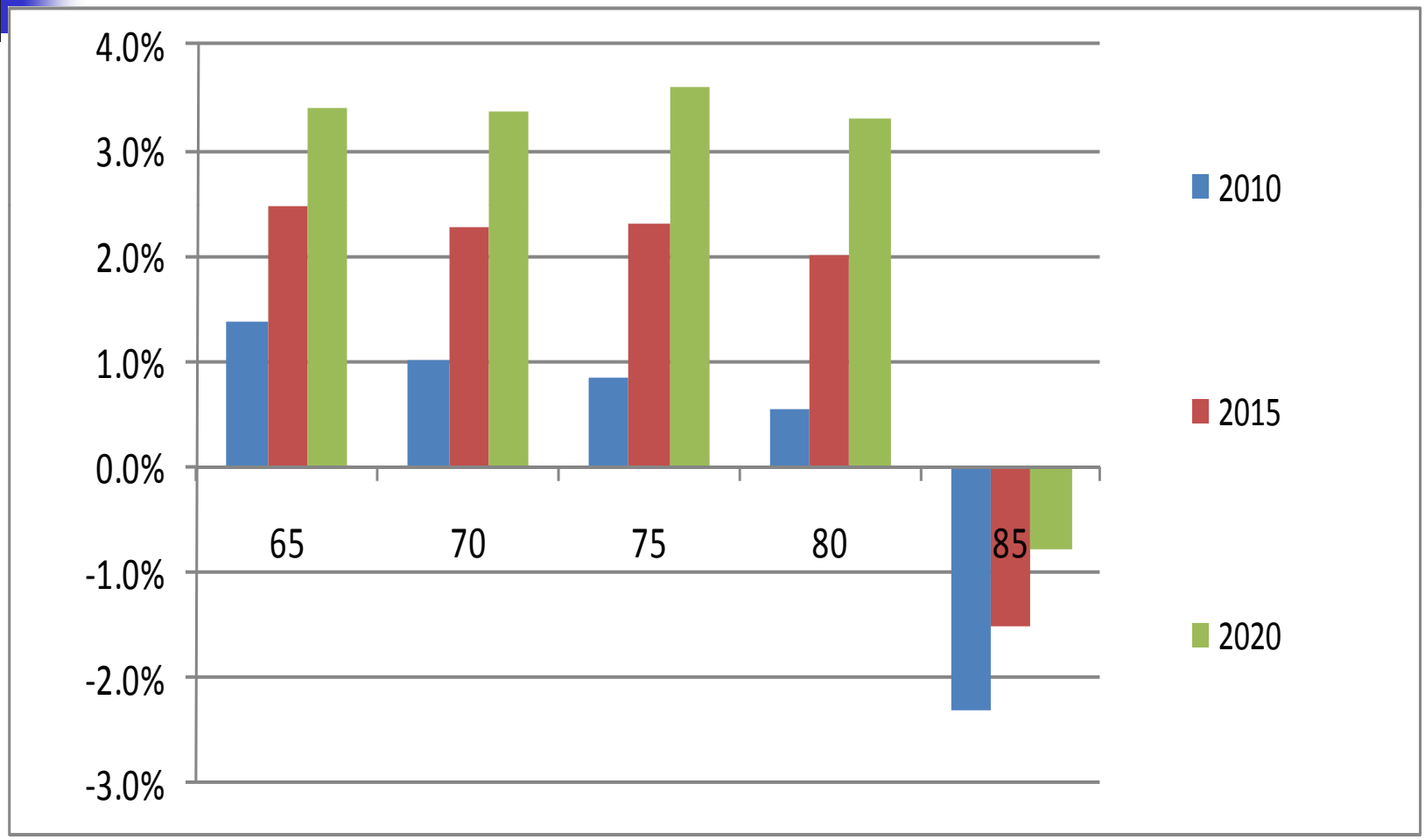
Female, 2006: $1,000 \times \ddot{a}_x$

Age	UP-94 @2006 LB	CPM-CAN-2 2005-2007	CPM-CAN-3 2005-2007	CPM-CAN-4 2005-2007
65	11,808.29	12,046.04	12,217.46	12,076.83
70	10,526.27	10,727.17	10,881.78	10,755.14
75	9,053.84	9,245.26	9,380.01	9,272.03
80	7,485.81	7,640.73	7,734.13	7,657.65
85	5,926.42	5,975.72	6,037.88	5,991.27

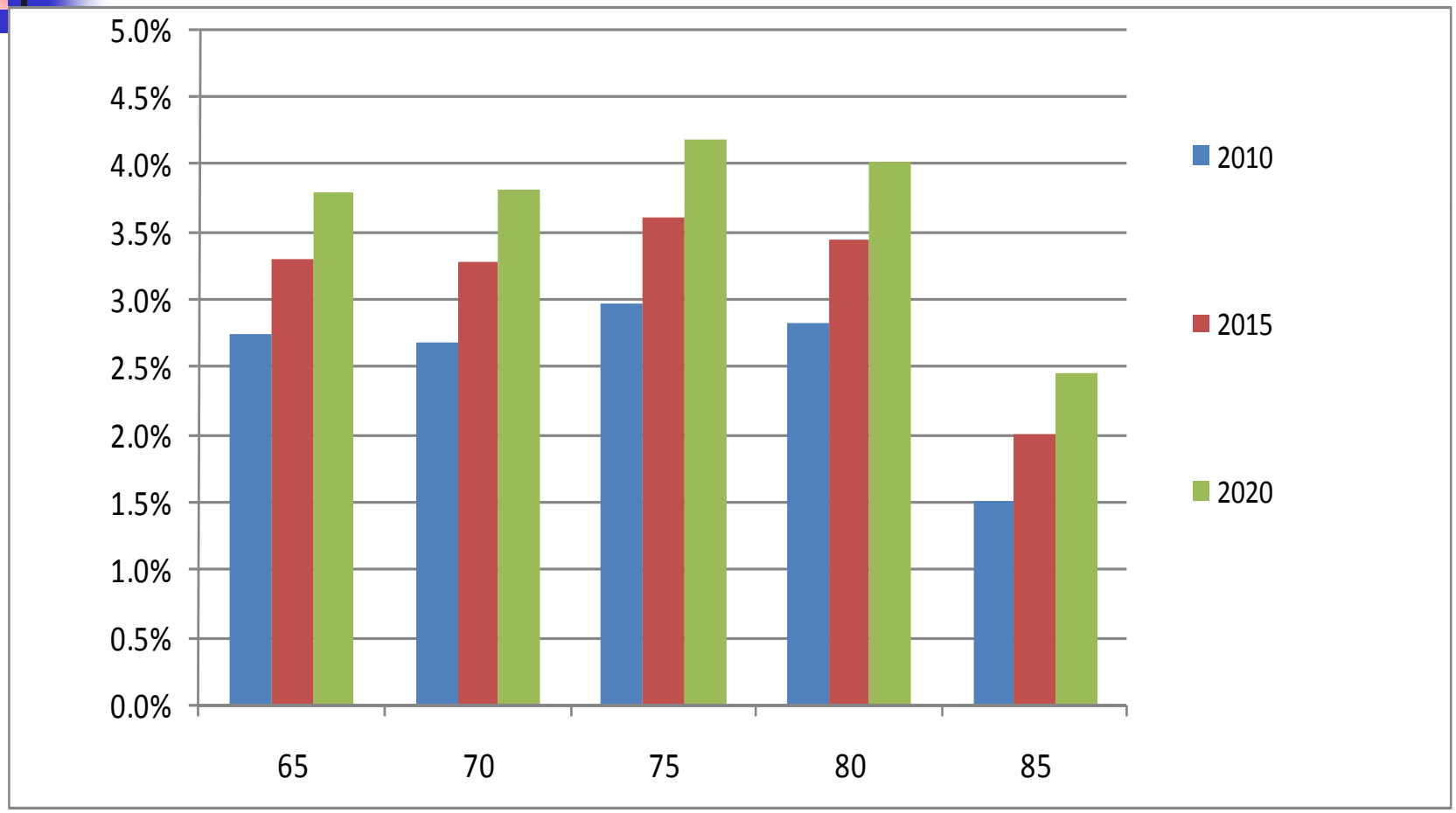
Female, 2006, % Change



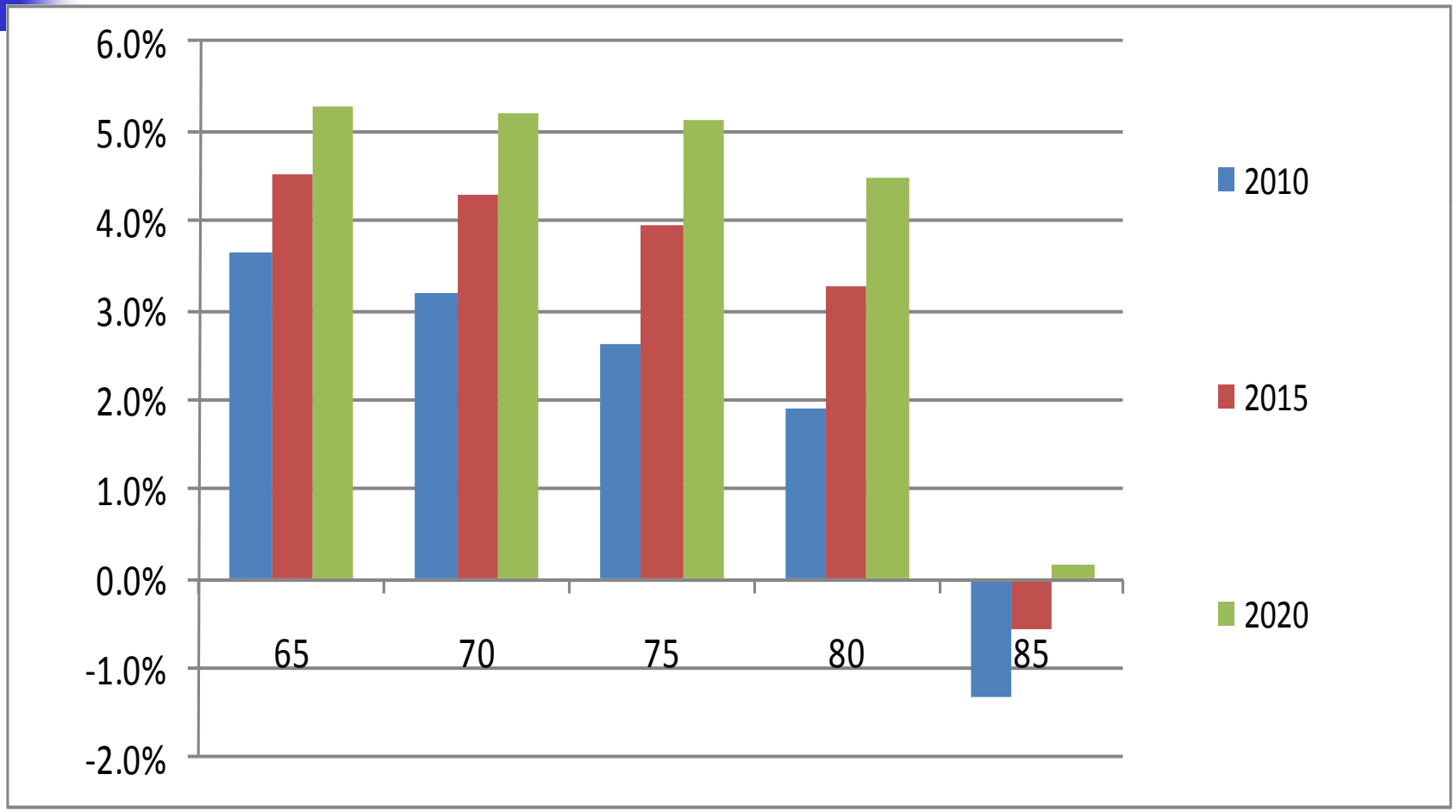
Male, Class 4, with Projection



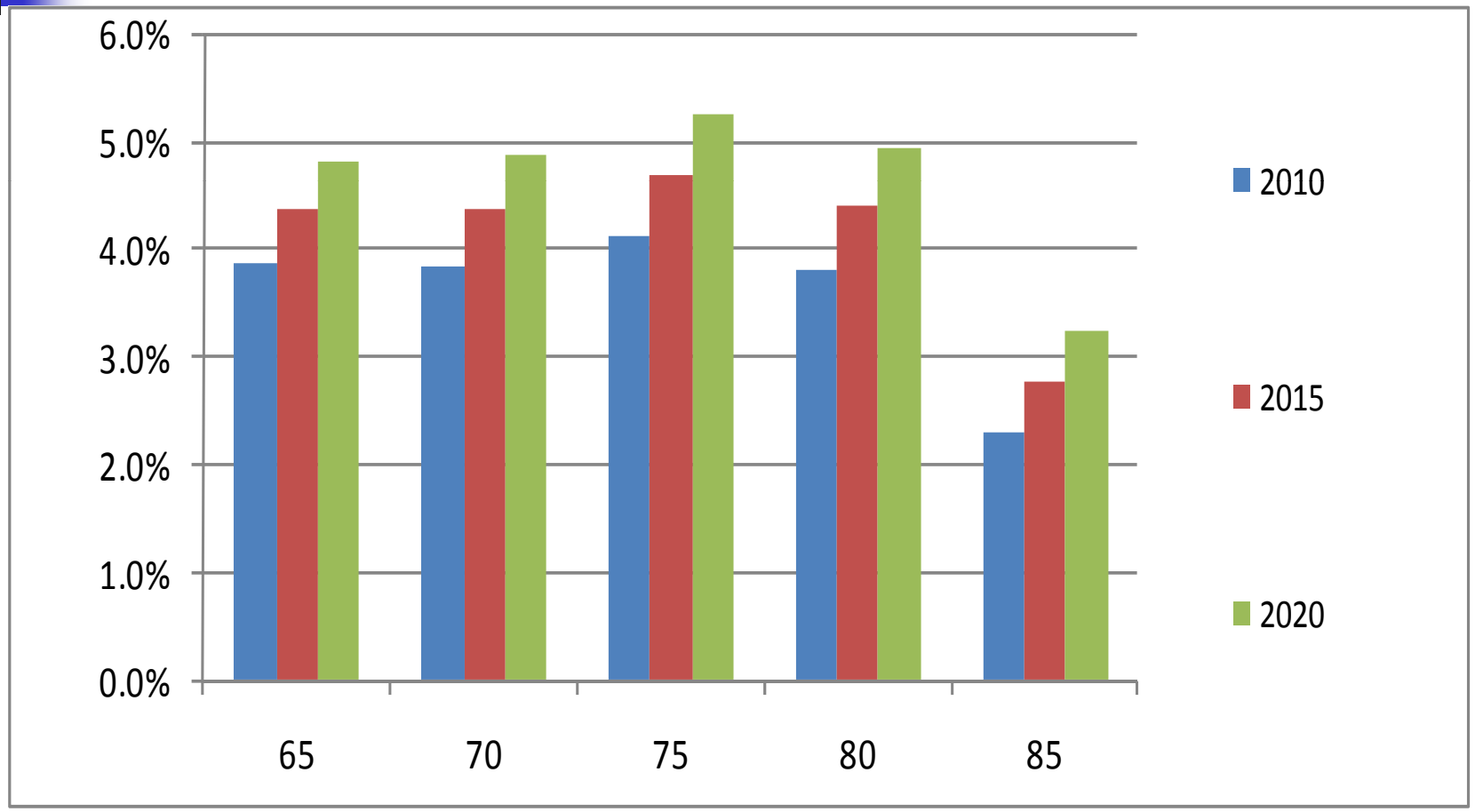
Female, Class 4, with Projection

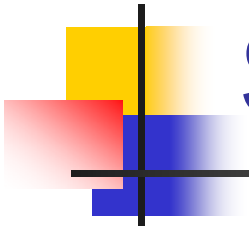


Male, Class 3, with Projection



Female, Class 3, with Projection





Section 7

Conclusion:

Next Steps

General Comments

- Canadian mortality rates affect many private and public pension plans
- Mortality is significant, at least at high ages (unrealistic to conclude that all will live until age 120)
- Mortality varies according to: age, sex, income, year, source

General Comments

- Study carried out with recent and reliable Canadian data
- The rate of decrease of mortality is not constant
- Multiple external factors must be considered, along with past data, to develop a suitable assumption for the intended purpose

Comments on Reduction Rate

- Varies from year to year
- Lower for female than for male
- Higher at age 65, close to 0 at age 90 (negative afterwards ?)
- Proposal: linearly decreasing scale by age group
- Faster decrease in the recent past: **troubling**
- Slower decrease over a longer period
- Faster decrease than American AA scale
- **The past may not be an indication of the future…**

Thank you !

Questions ?

Data by Income Level (5%-interval): CAN, Female