Mortality Trends Among Retirees

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Quebec City, September 25, 2003

Context

- Demographic, economic and financial perspectives 2003-2030
- Demographic component
- Actuarial analysis of Quebec Pension Plan to December 31, 2003
  - Mortality level?
  - Time trend?

Presentation Outline

- Relevance of study
- Data source and characteristics
- Methodology
- Types of findings
- Charts of main findings
- Comparison and observations

Accent on trends: QPP data

1- Relevance of study

Nature of my findings

- Research on mortality among Canadian beneficiaries
- Analysis of mortality level by
  - data source (Canada or Quebec)
  - income level
  - sex
  - age
  - calendar year

Relevance of findings

- Mortality trends analyzed for 1975-2000 period
- Findings corroborated
- Links with QPP, CPP
- Analysis and comparison of my findings

2- Data

Quality!

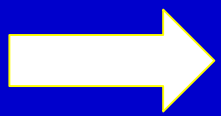
Data: Quality

- High quality: QPP + CPP
- Administrative data: retirement pensions
- Extracted from individual data
- Excellent cooperation with organizations
- Audits conducted on data

Important for measuring trends

Data: Nature

- Individual data 100% Canadian *
- Retirement only
- All pensions paid 1967 – 2000
- **Data source**: QPP/CPP, **Sex**
- Dates: birth, start, death (except day)



Age, Calendar year

$ of pension at start and end: Income

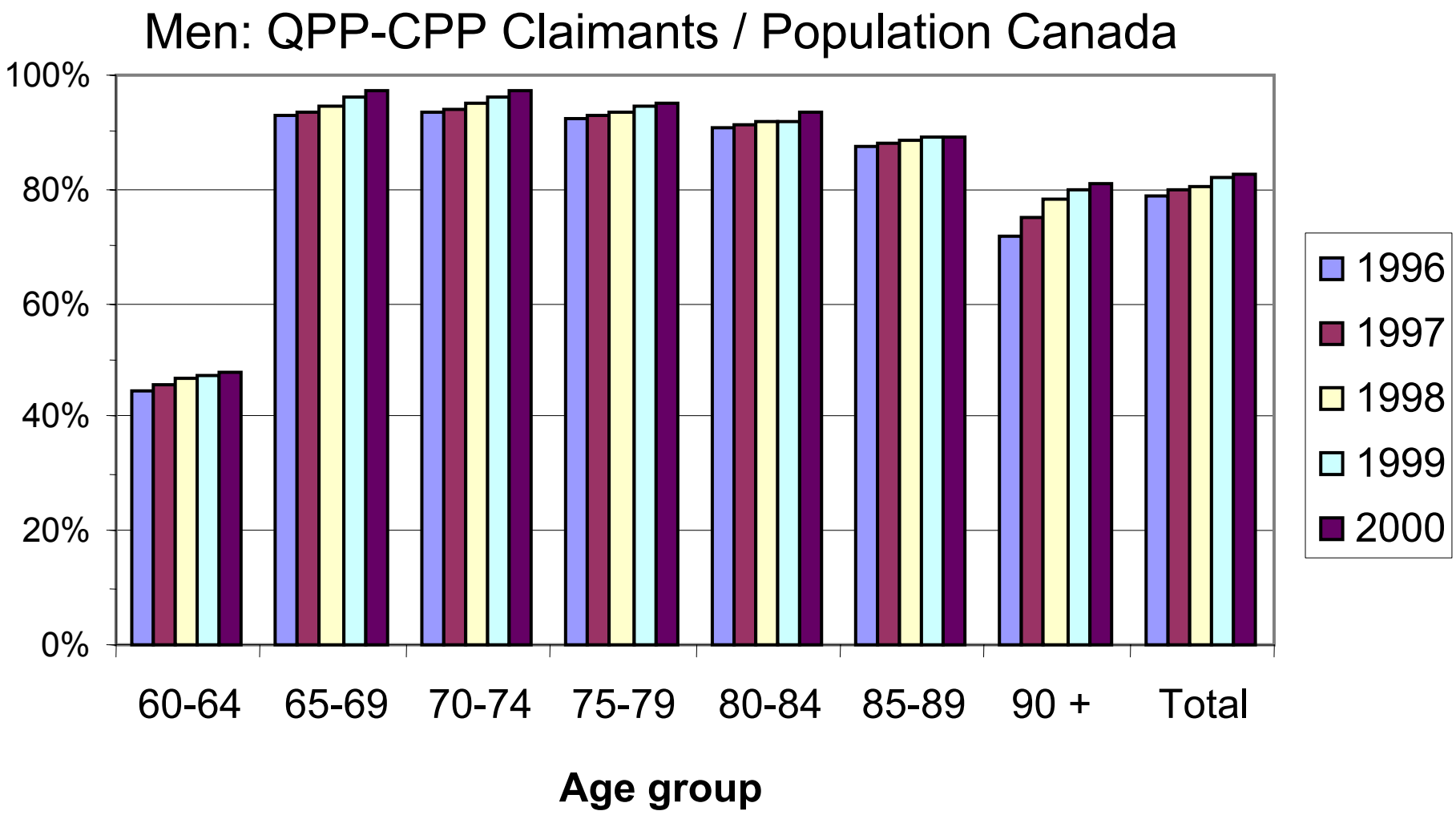
Data coverage

- **Question: enough data?**
- Comparison with what population?
- Population of Canada or Quebec
- Answer with following tables and charts: yes!

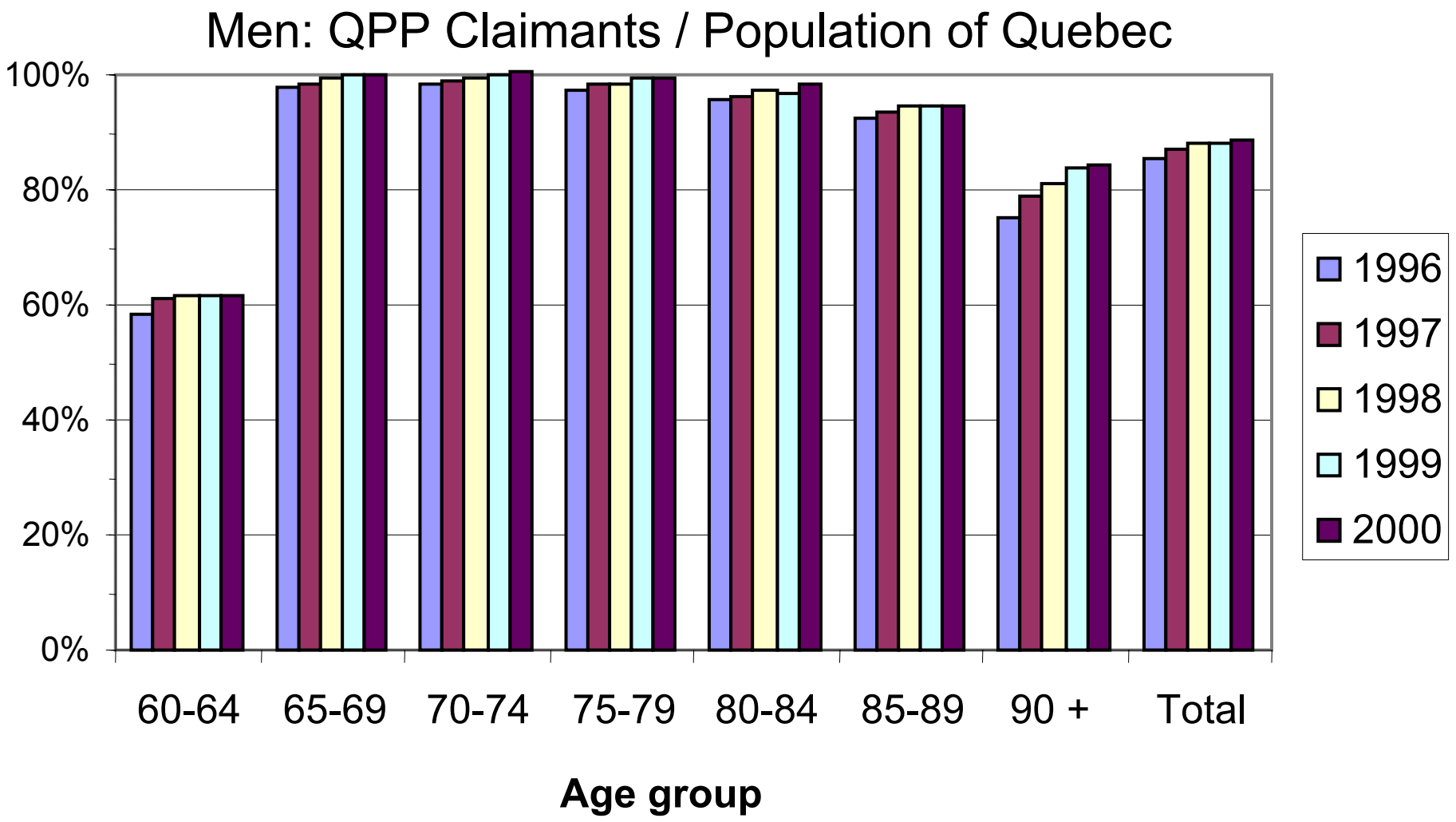
Retirees to 07-01-1999

	QPP	CPP	Total	
• Men	469,245	1,349,166	1,818,411	52.5%
	25.8%	74.2%	100%	
• Women	411,084	1,235,786	1,646,870	47.5%
	25.0%	75.0%	100%	
• Total	880,329	2,584,952	3,465 281	100%
	25.4%	74.6%	100%	

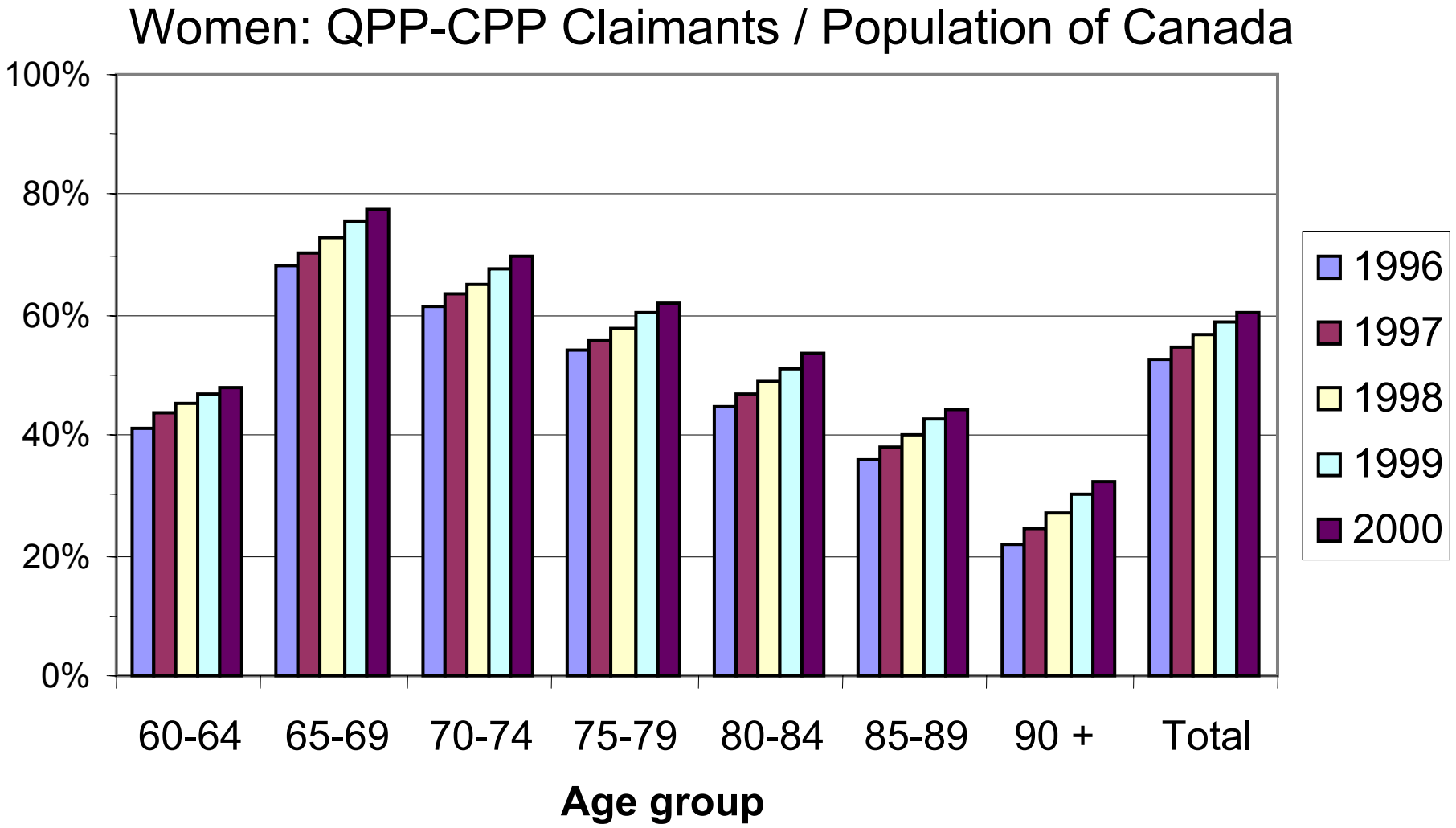
Data coverage: Men



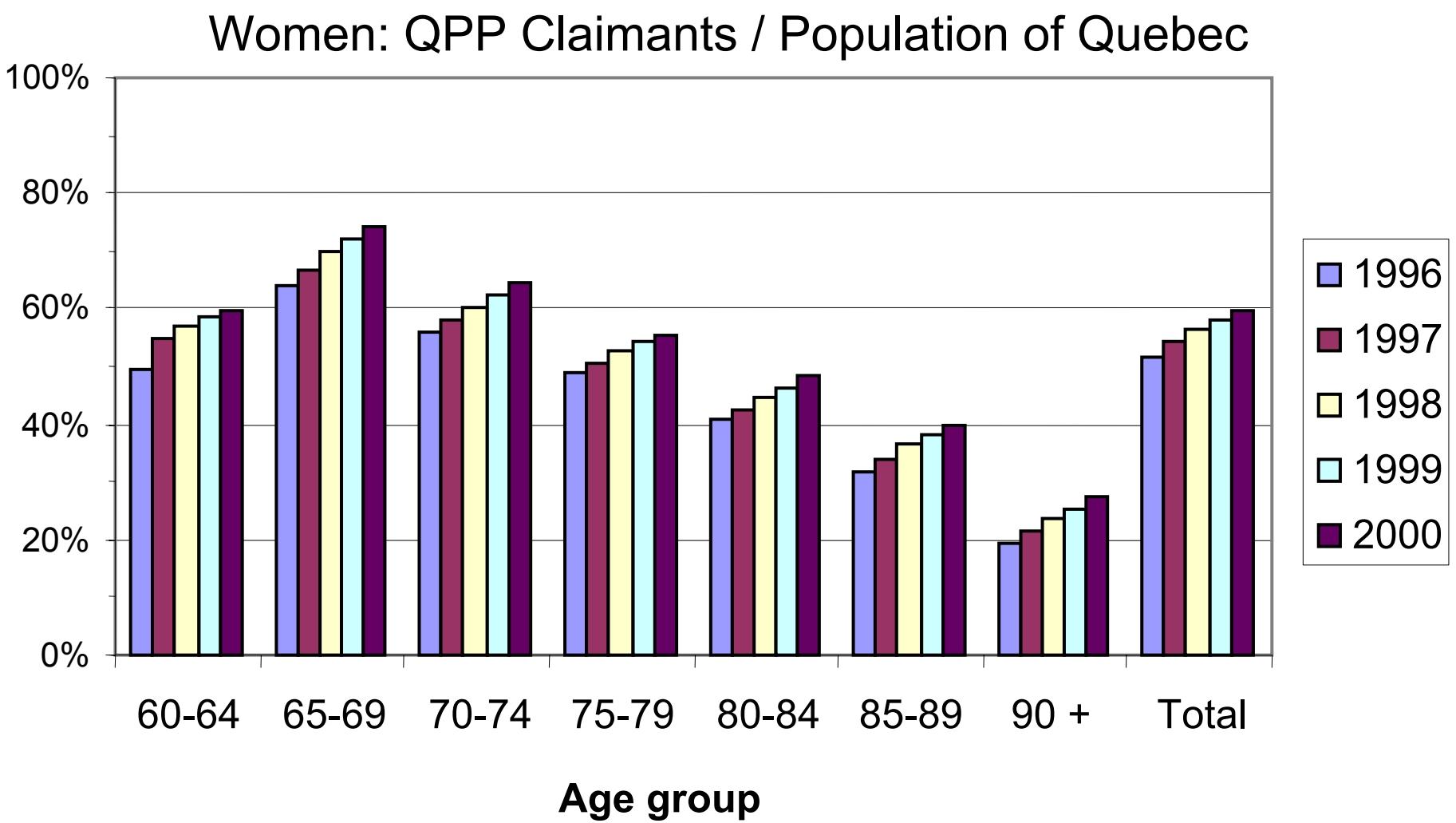
Data coverage: Men QPP



Data coverage: Women



Data coverage: Women QPP



Classification variables : 1

- Source: QPP, CPP, Total
- Sex: Men, Women
- Age
  - last birthday: whole number
  - accurate to 1/24th of a year at time of calculation
  - Adjustments for assumption of the day
  - ages 60 to 103 in 1999 (born 1896)

Classification variables : 2

- Year / period
  - 1967 –2000
  - Five-year grouping: 1995-1999 at 75-79
- Income level
  - $ of pension as a % of maximum pension
  - % at start of retirement = f(MPE)
  - Adjusted for retirement date: source, age, formula

Classification variables : 3

- 5 income classes
  - 1: < 35% MPE
  - 2: 35-94% MPE
  - 3: > 95% MPE
  - **4: > 35% MPE = 2+3**
  - **5: All = 1+ 2 + 3**

Class 4: small pensions excluded

Data limits

- Volume varies by year: 1967, 70, 90…
- Year 2000 excluded: death CPP
- Retirees only: impact women
- Nothing before age 60 (1984, 1987)
- Maximum age related to (Year – 1896)
  - 1967: 68 to 71 years
  - 1970: 65 to 74 years
  - 2000: 60 to 104 years

3- Methodology

Some formulas

Methodology: 1

- Exact exposure and deaths based on 5 variables
  - Source, sex, age, year, income class
  - Calculation of rates and probability of death

$$\mu_x = D_x / E_x$$

$$q_x = 1 - e^{-\mu x}$$

Sample calculation

- QPP, Men, age 70, All incomes, Year 2000

$\mu_{70} = D_{70} / E_{70}$

$0.028440 = 710.00 / 24{,}964.79$

$\mathbf{q_{70}} = 1 - e^{-\mu_{70}}$

$\mathbf{0.028039} = 1 - e^{0.028440}$

Methodology: 2

- Calculation of variance, limits and coefficient of variation

$$Var[\mu_x] = \mu_x^2 / D_x = \mu_x / E_x$$

$$Var[q_x] = e^{-2\mu_x} \times Var[\mu_x]$$

$$q_x^{min} = Max(0.0, \quad q_x - 1.96 \times (Var[q_x])^{0.5})$$

$$\text{Coefficient of variation} = (Var[q_x])^{0.5} / q_x$$

- **Calculation accuracy measurement**

Sample continued

- q_{70} = **0.028039**
- Variance μ_{70} = 1.13921E-06
- Variance q_{70} = 1.07622E-06
- Standard deviation q_{70} = 0.001037
- Coefficient of variation = 3.70%
- Absolute weight assigned = 929,180.9
- 95% interval for q_{70} :
  - between 0.026226 and 0.030072

Methodology: 3

- Smoothing
  - According to Gompertz law: $\ln(\mu_x)$ is linear
  - Linear regression with weight Ex / μ_x
  - Start at age 65, 65 –85, 85+ separately
- Recognize falling curve
  - Model after age 95: reduction de $\ln(\mu_x)$

$$\ln(\mu_{95+i}) = \ln(\mu_{95+i-1}) + k_i, \quad i = 1,2,3,\ldots n$$

terminal age 110, terminal value M/W

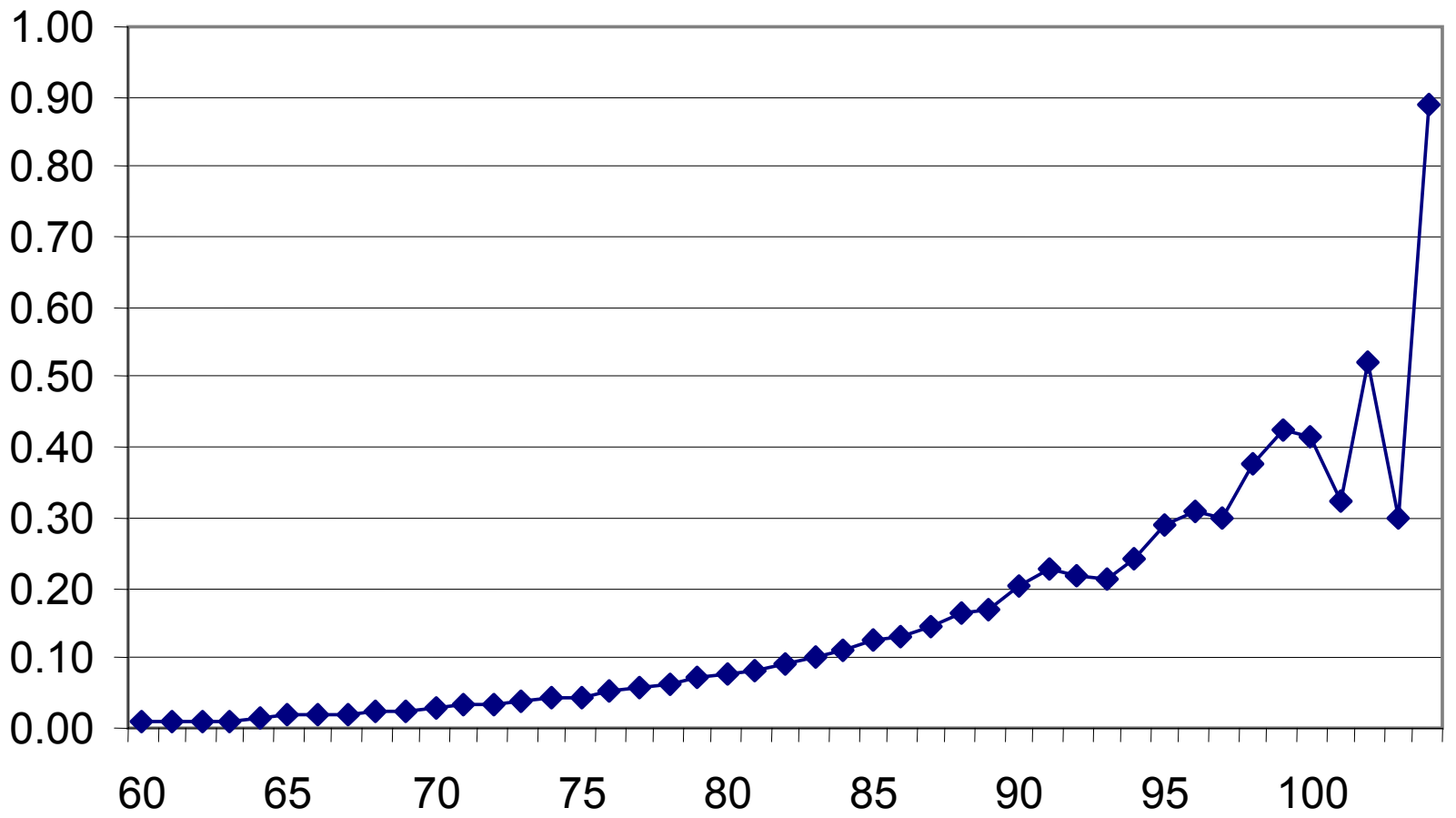
Methodology: 4

- Smoothing done for certain tables
  - Five-year groups: accent on 1995-1999
  - 4 income classes (>35% MPE) and 5 (All)
- Separate treatment < age 65
  - Impact of disabled persons
  - Relationship with tables for Canada 1990-1992 < age 60

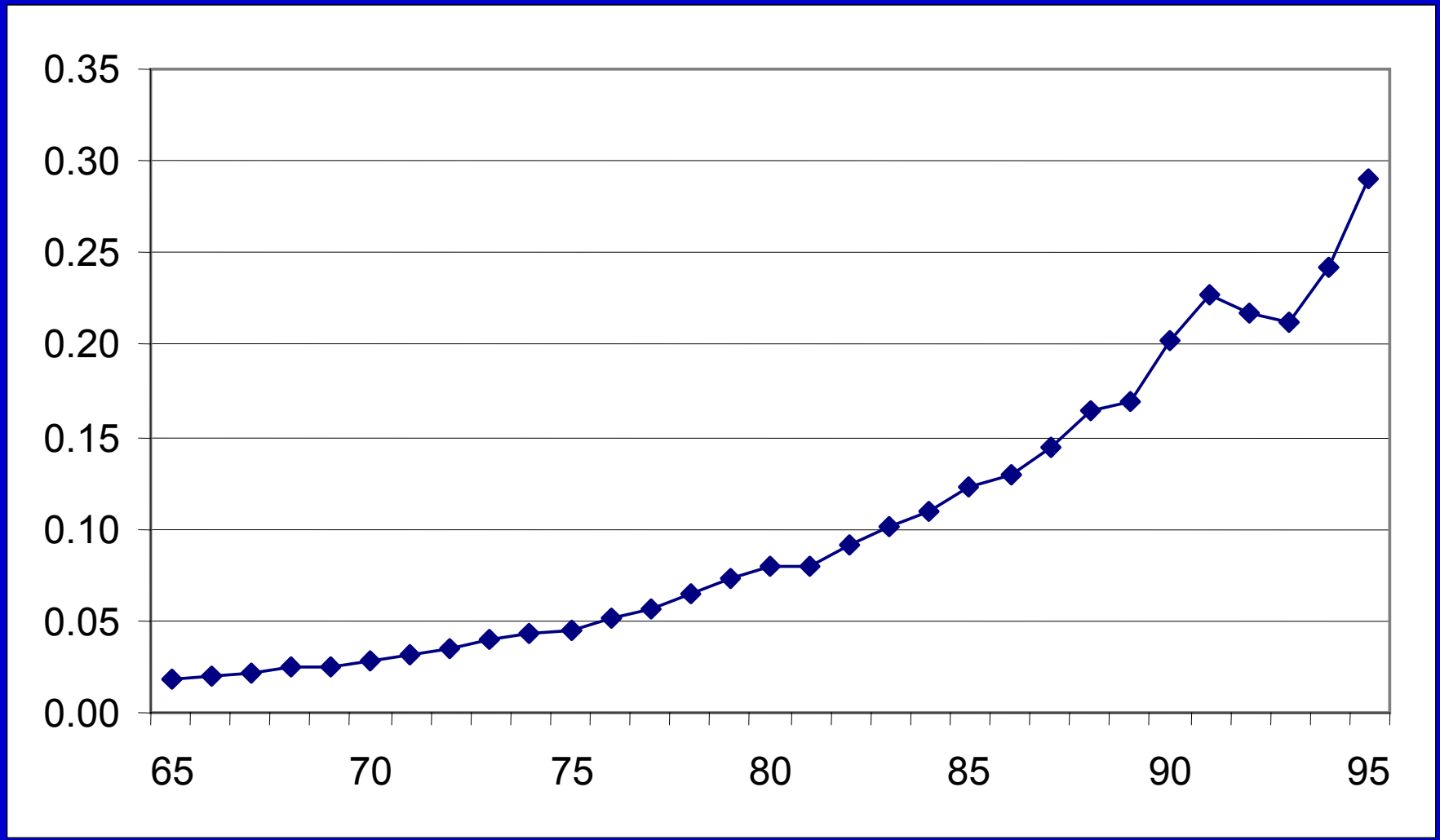
Example

- QPP, Men, All incomes
- Year 2000
- Chart q_x from age 60 to age 104
- Linear and logarithmic scale
- Sample treatment (not five-year)
- Separate application before and after age 85

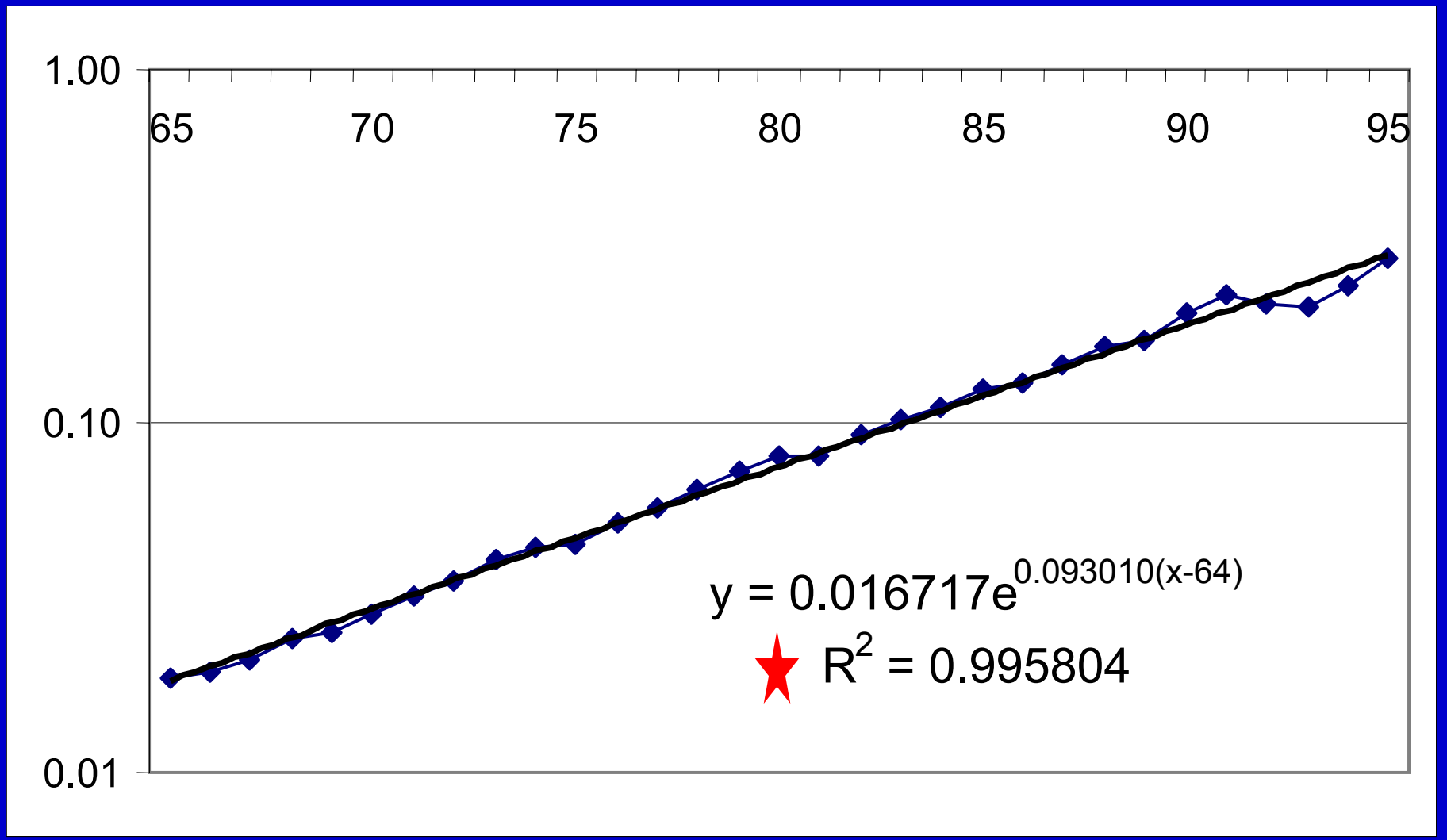
Men, Age 60 to Age 104, linear



Men, Age 65 to Age 95, linear



Men, Age 65 to Age 95, log.



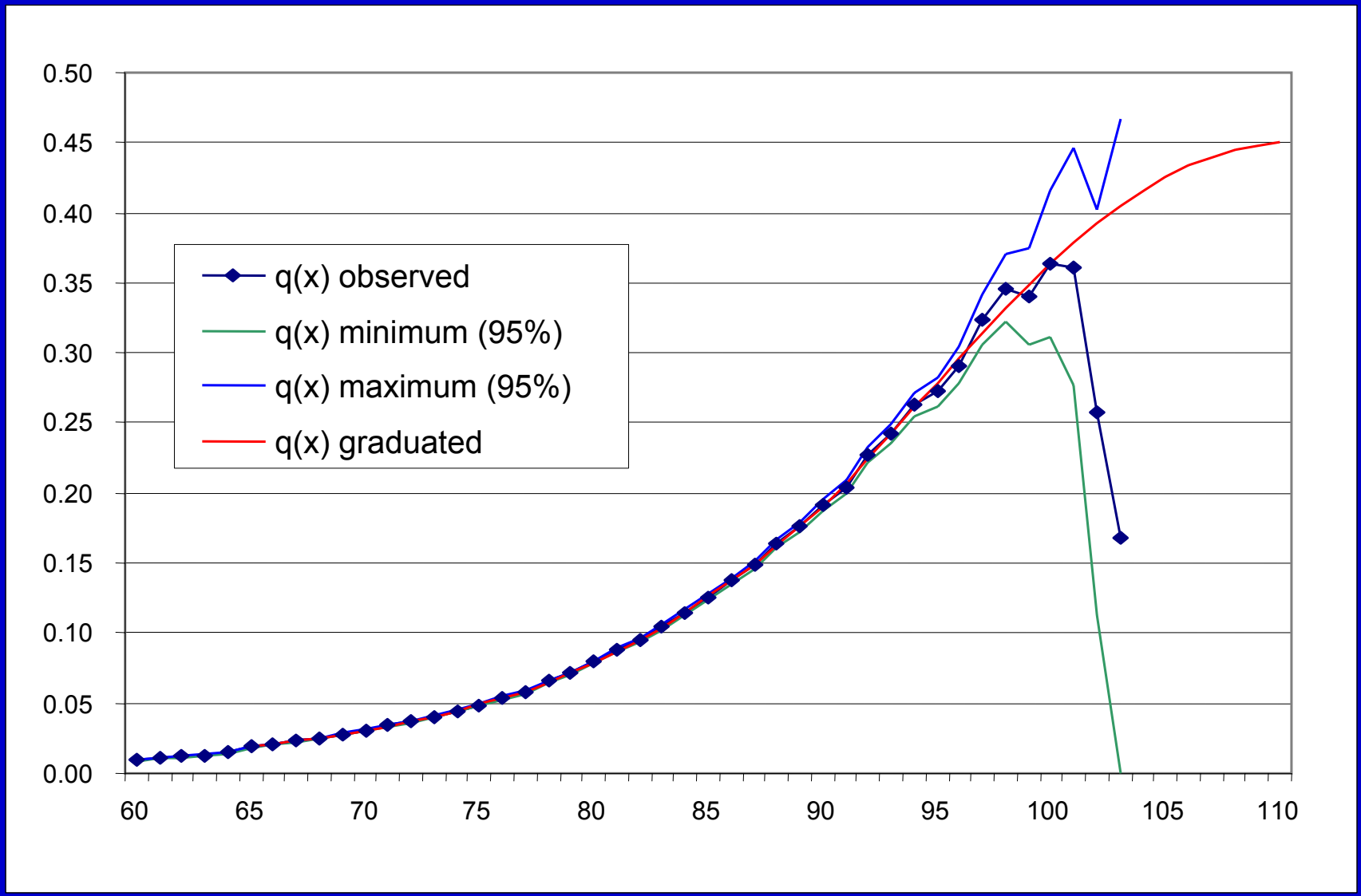
4- Findings

Some general findings

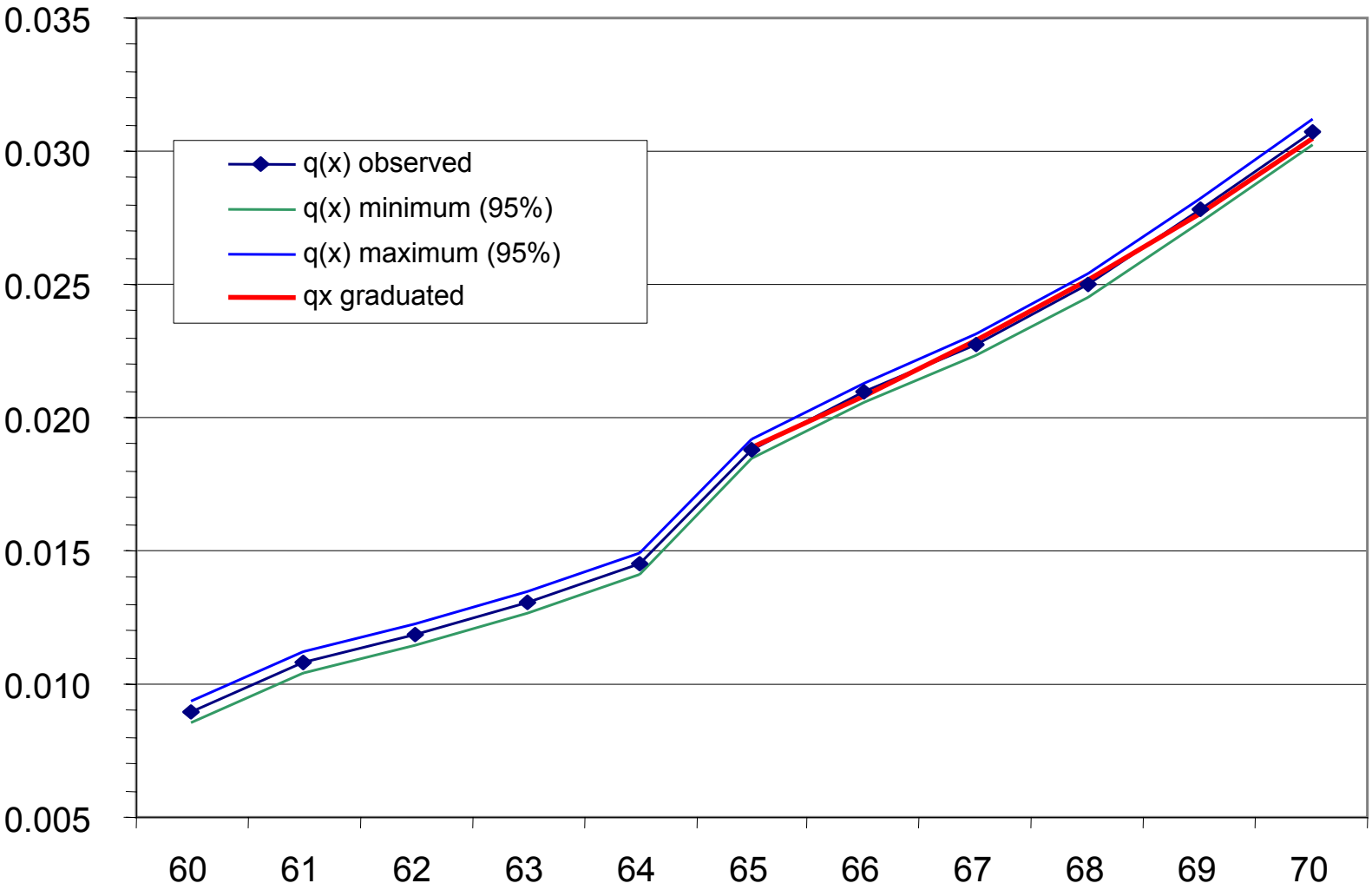
Findings

- Emphasis on Canada, 1995-1999, all incomes
- Differences mentioned for other variables
- Charts follow for men and women
- Comparison by age, sex, source, income

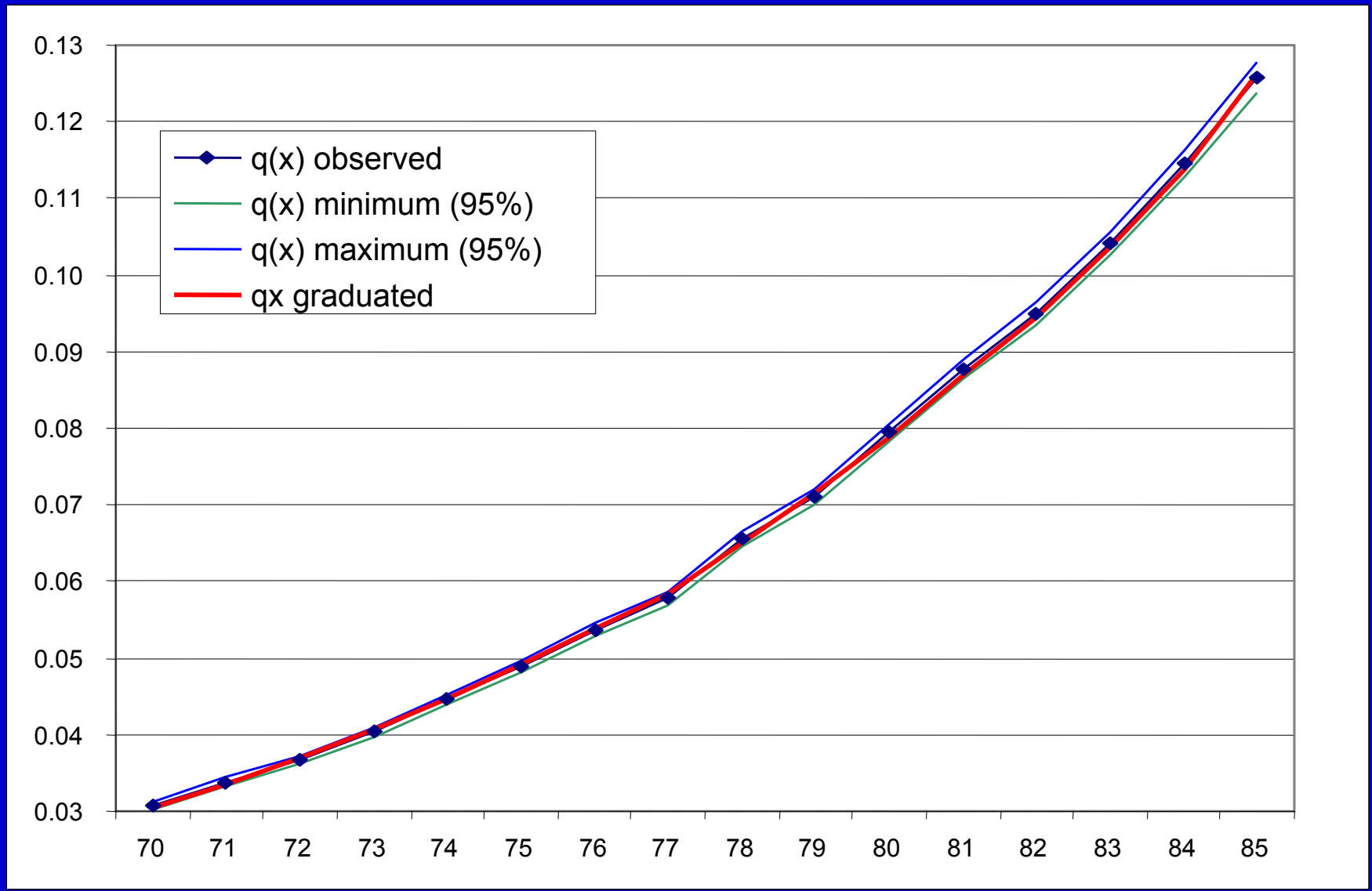
Canada, 1995-1999, Income = **5**, **Men**



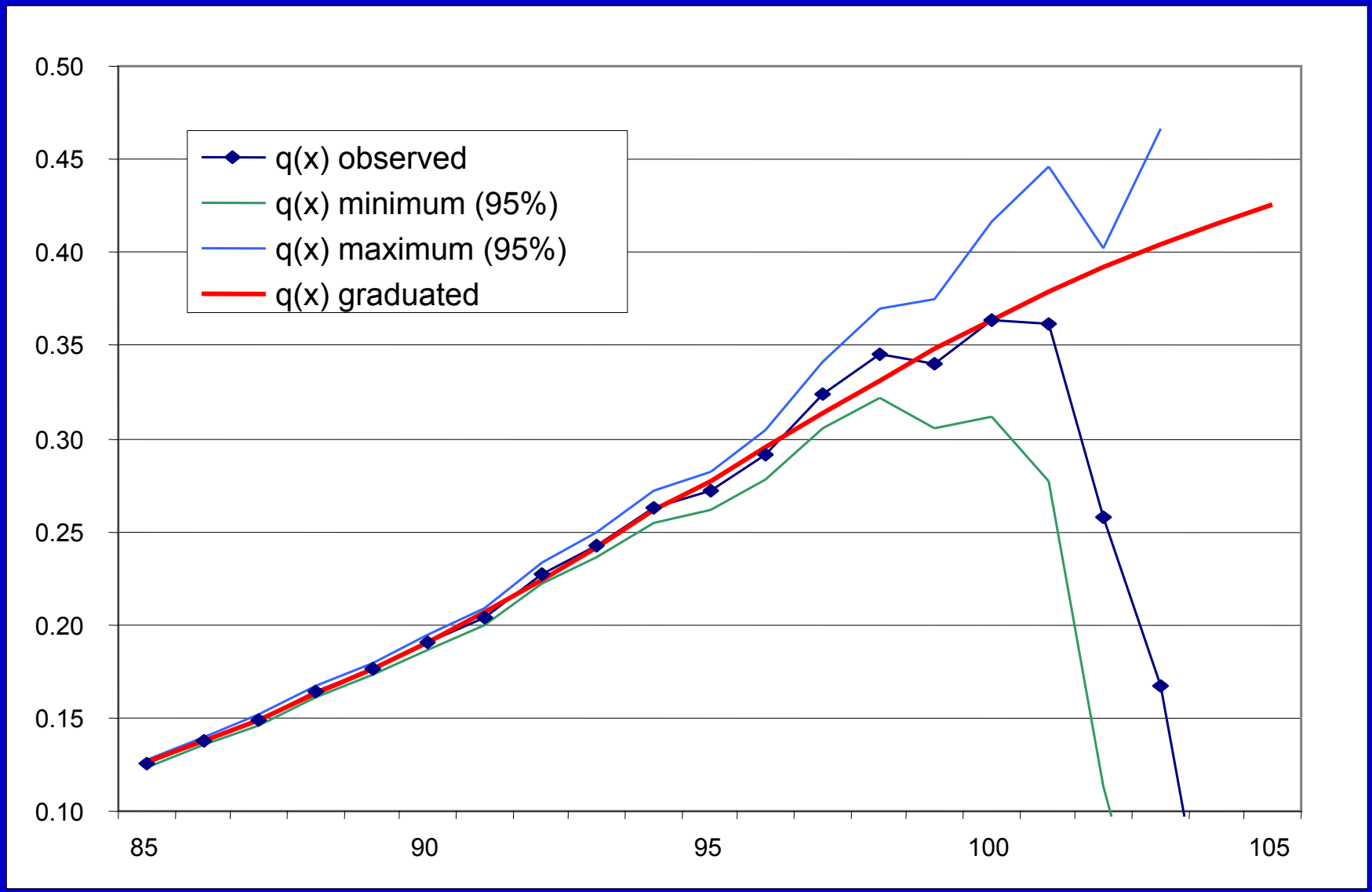
Income = 5, Men, Age 60 to Age 70



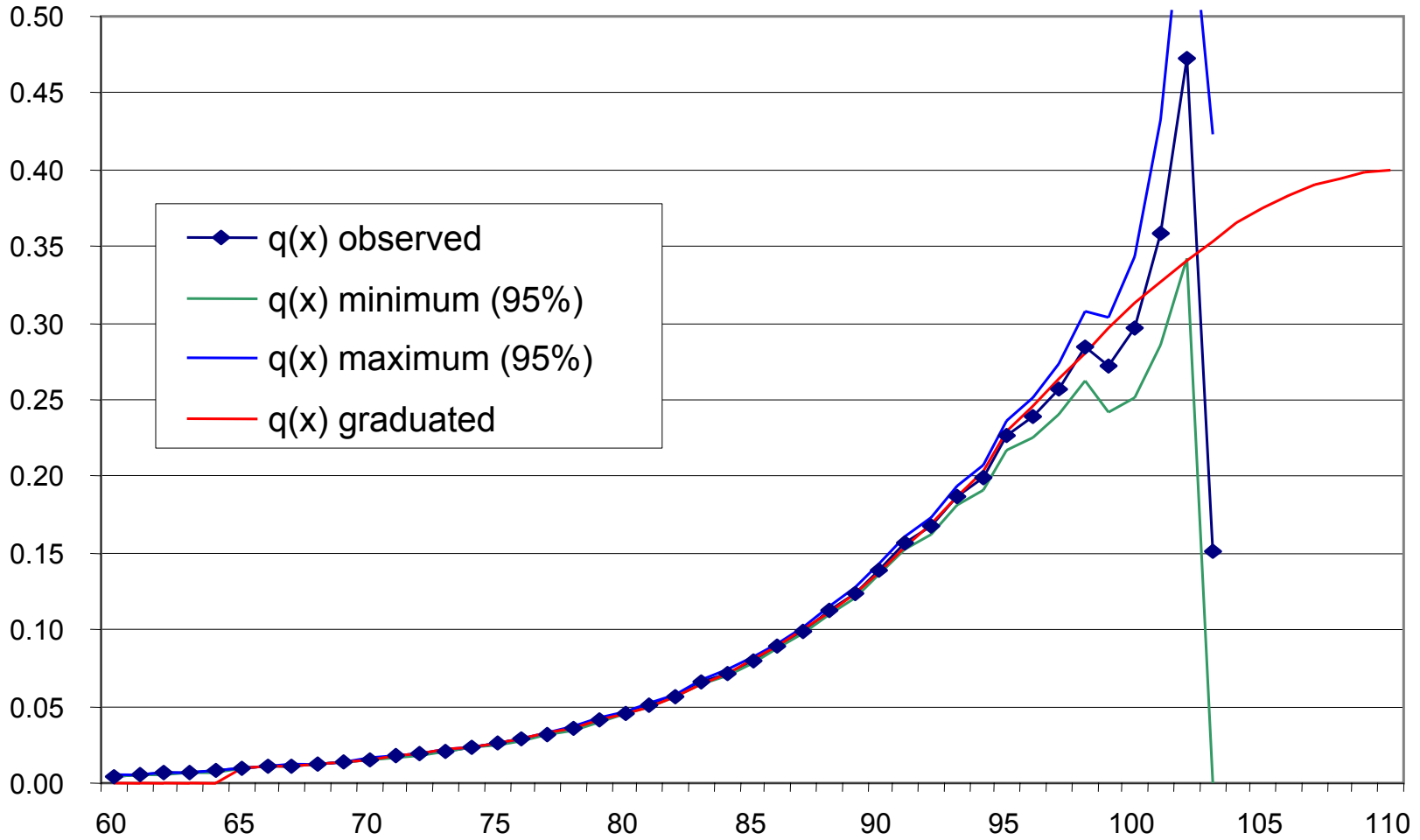
Income = 5, Men, Age 70 to Age 85



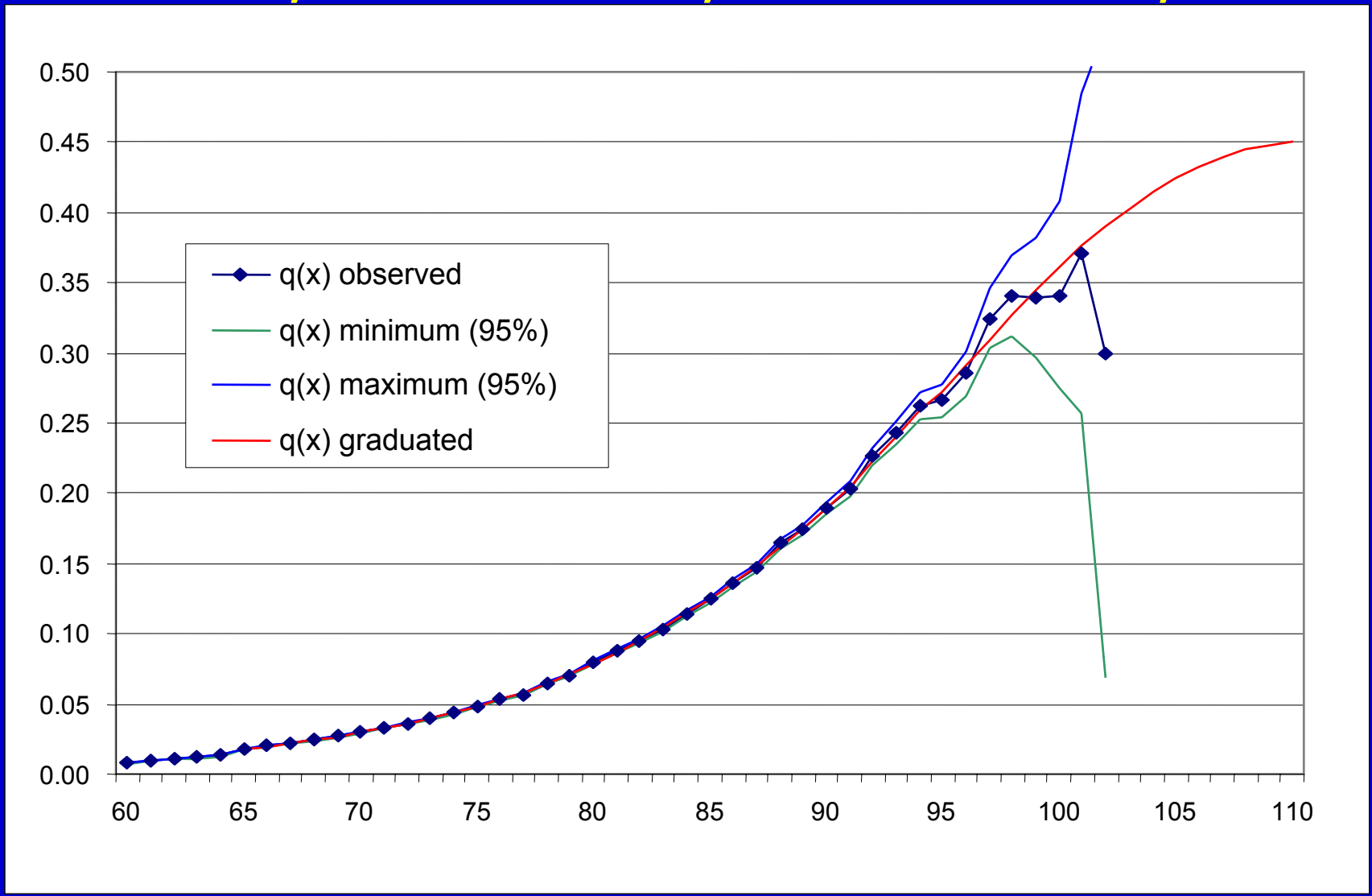
Income = 5, Men, Age 85 to Age 105



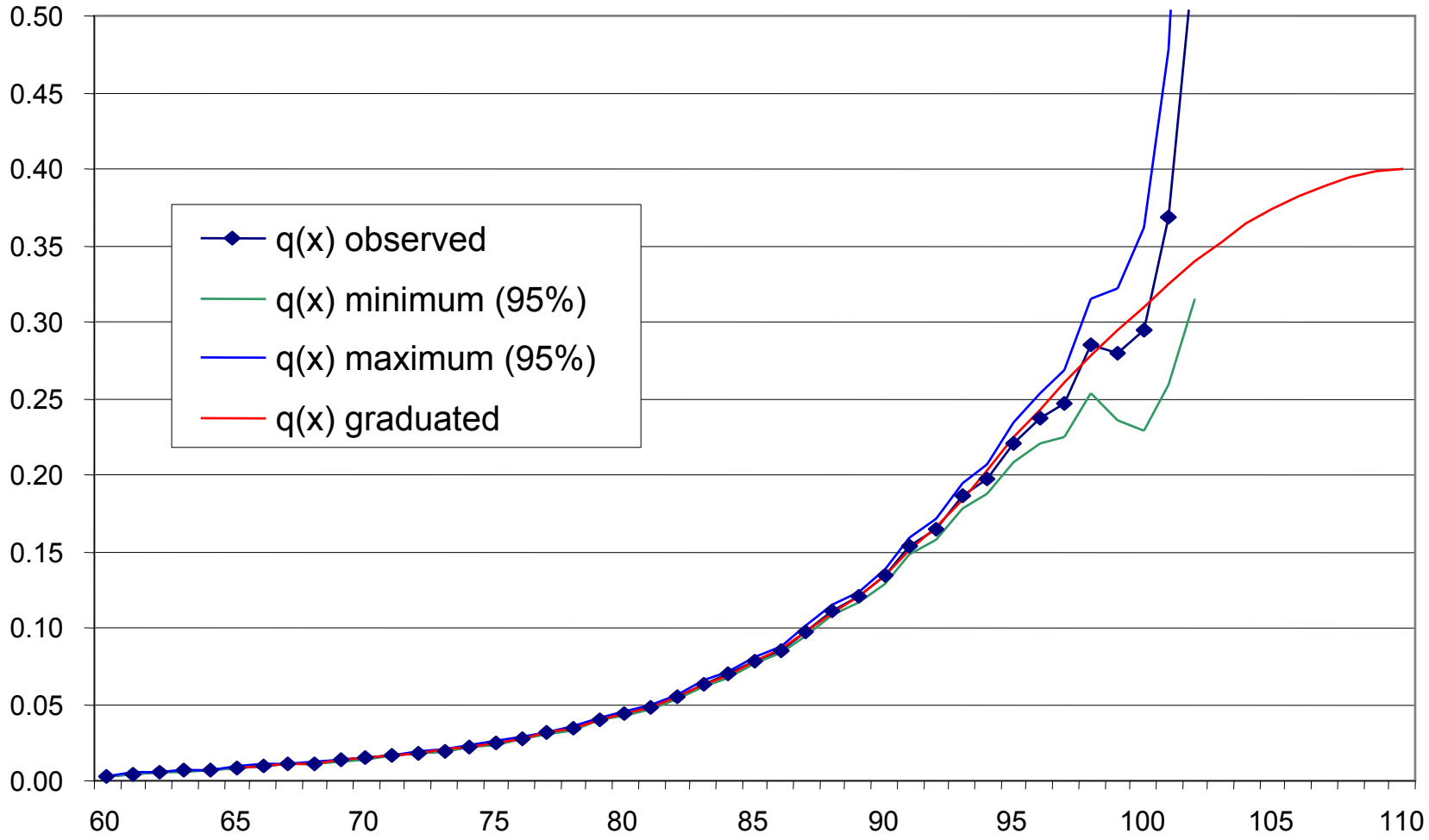
Canada, 1995-1999, Income = **5**, **Women**



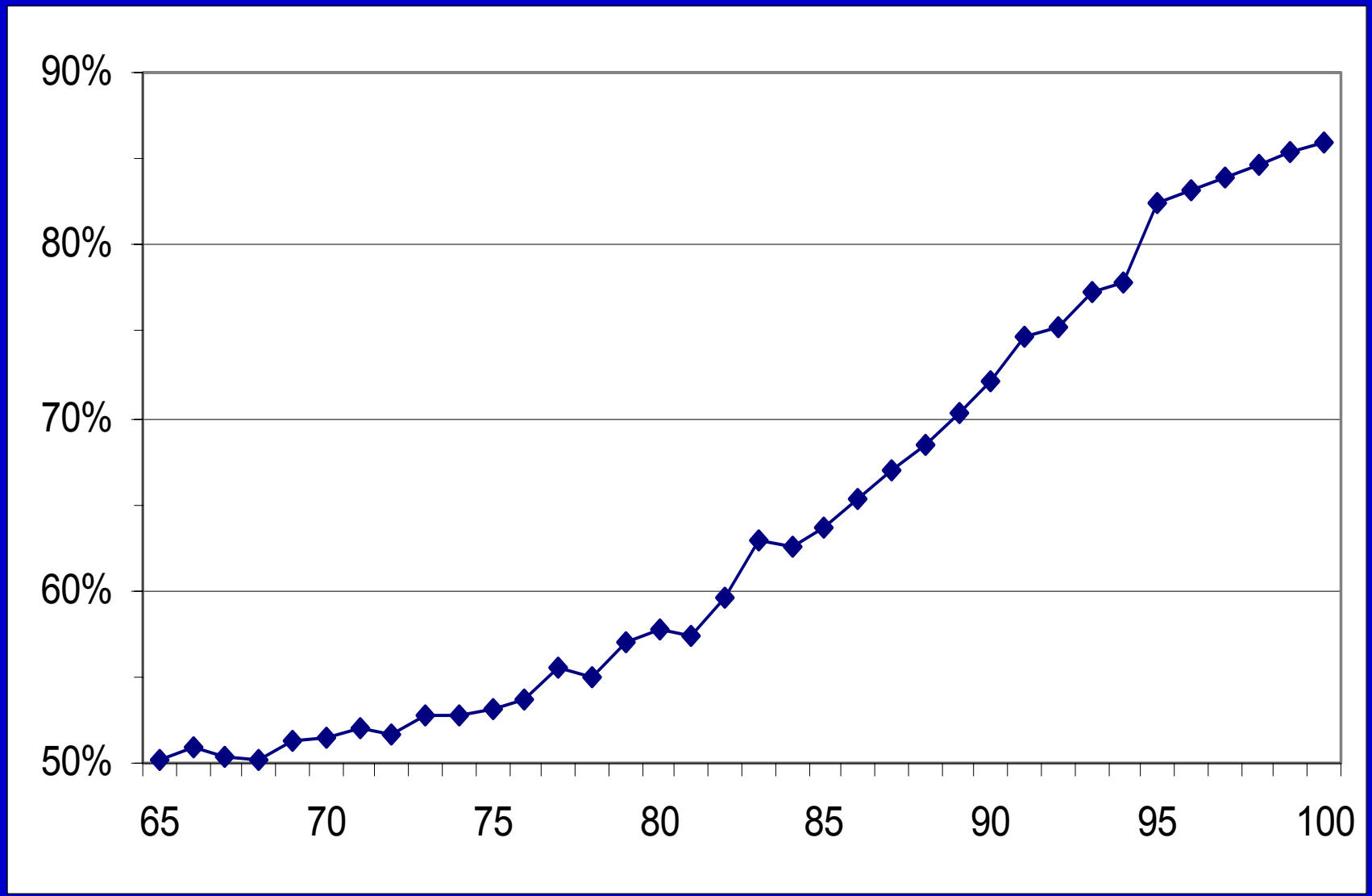
Canada, 1995-1999, Income = **4**, **Men**



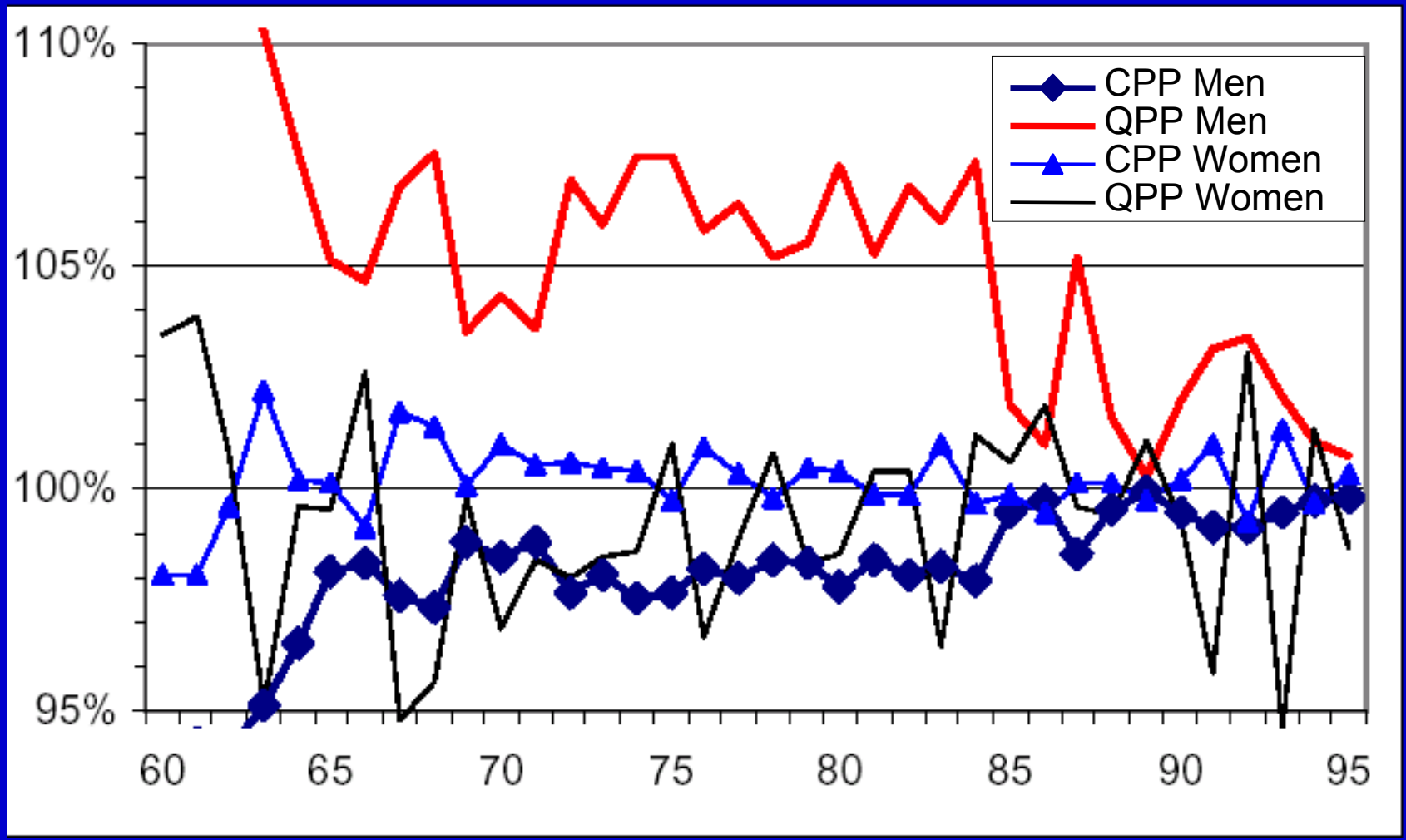
Canada, 1995-1999, Income = **4**, **Women**



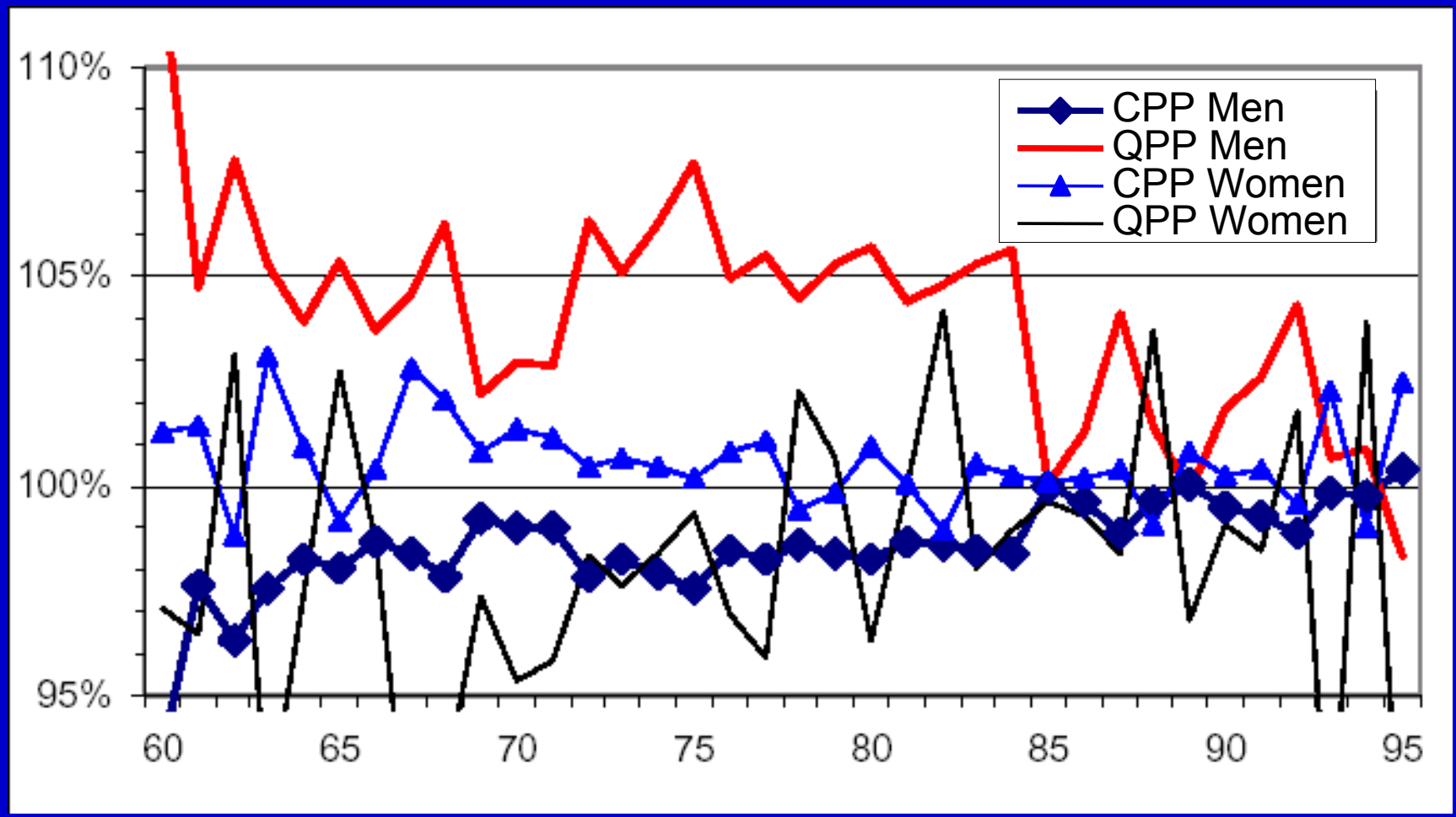
Comparison Women/Men



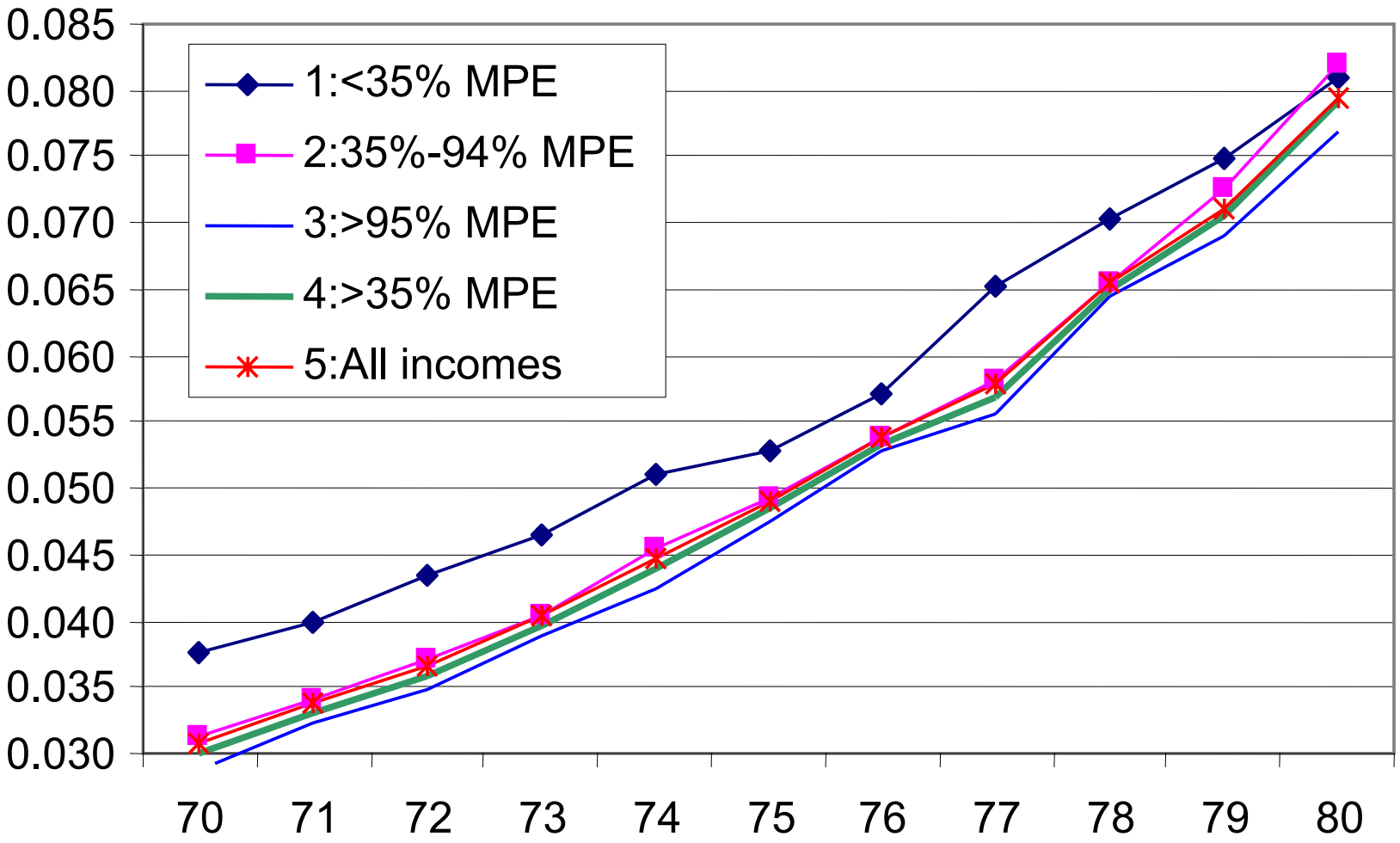
Comparison QPP – CPP, Income = **5**



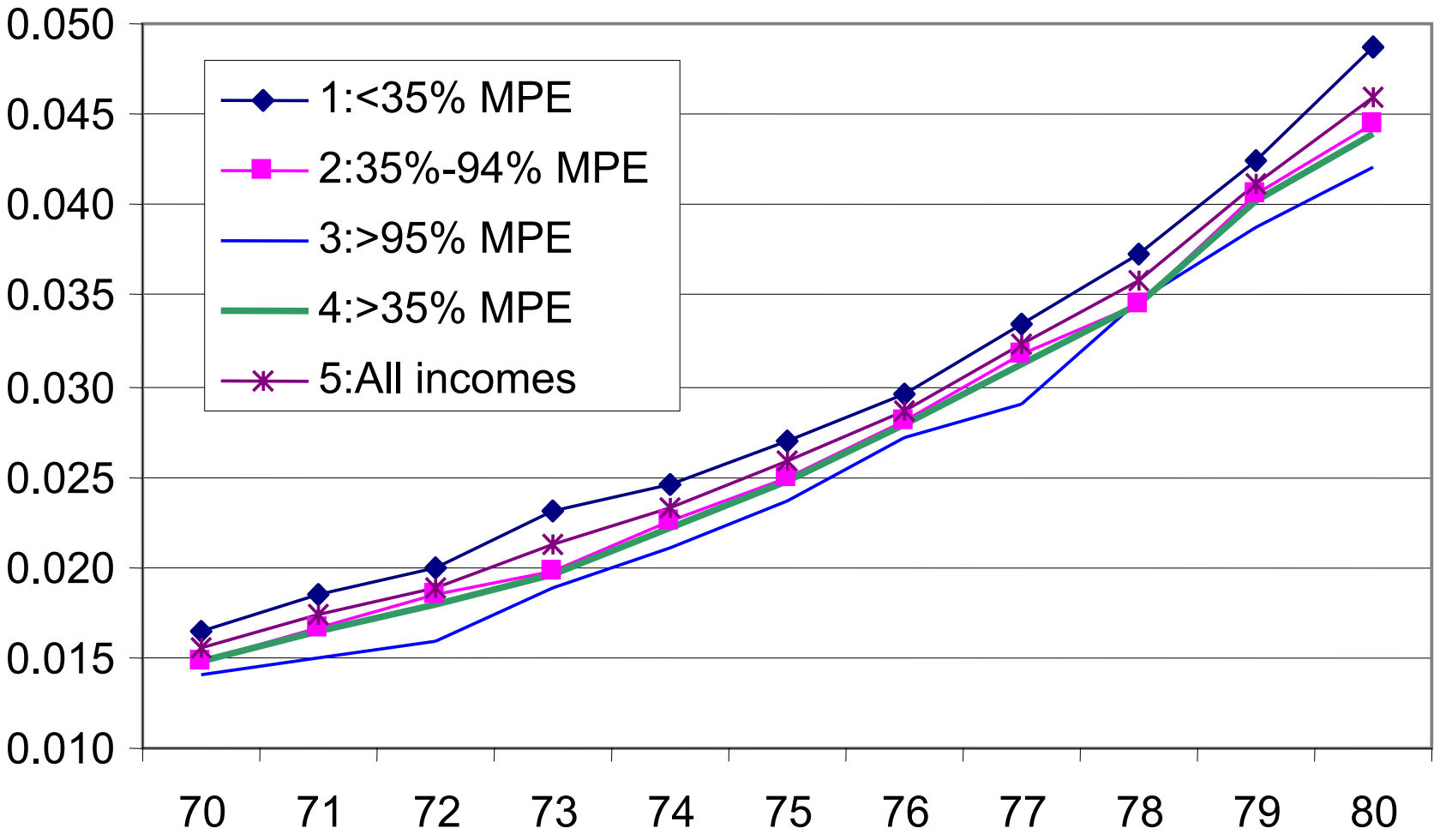
Comparison QPP – CPP, Income = **4**



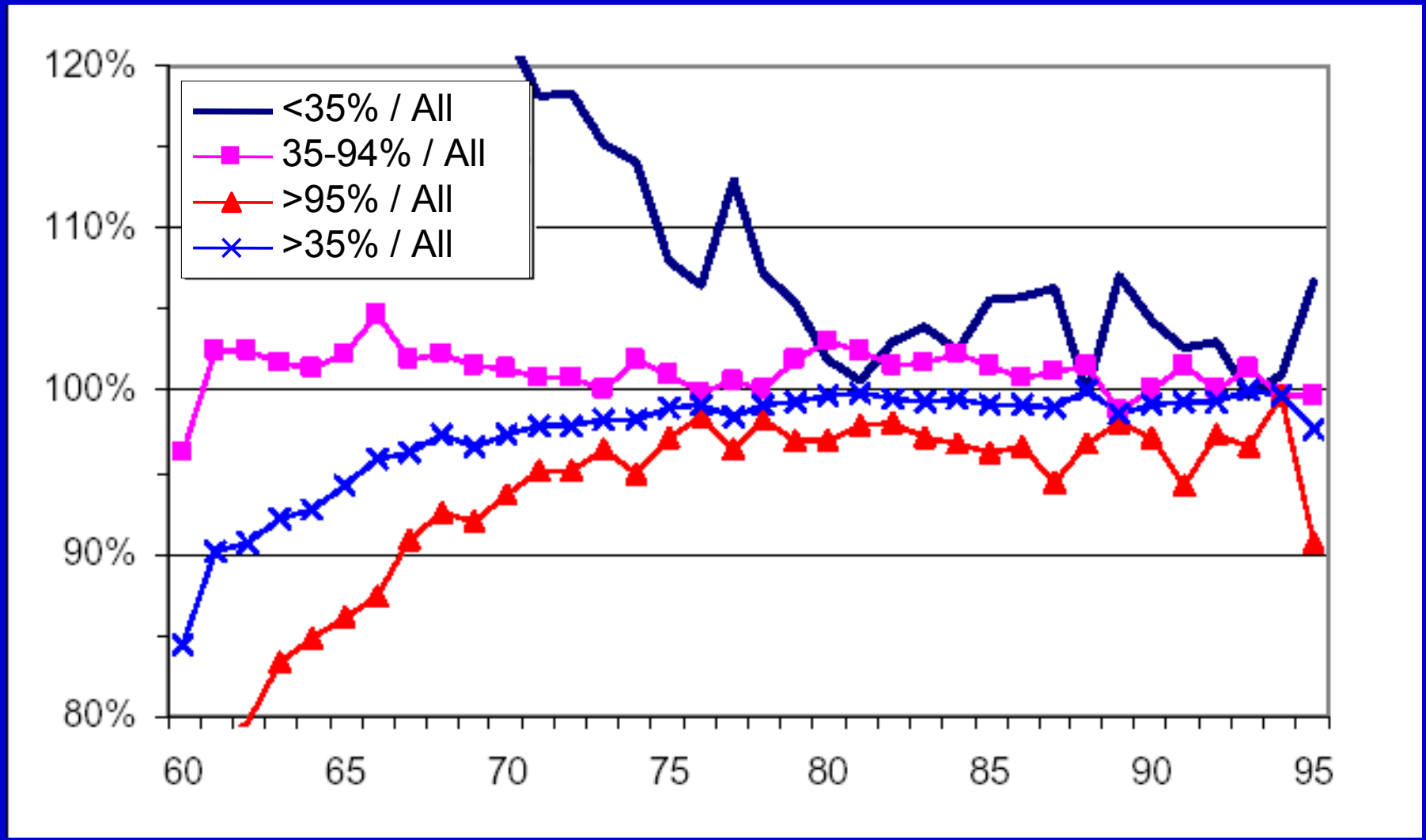
Mortality by income, Men, Age 70 to Age 80



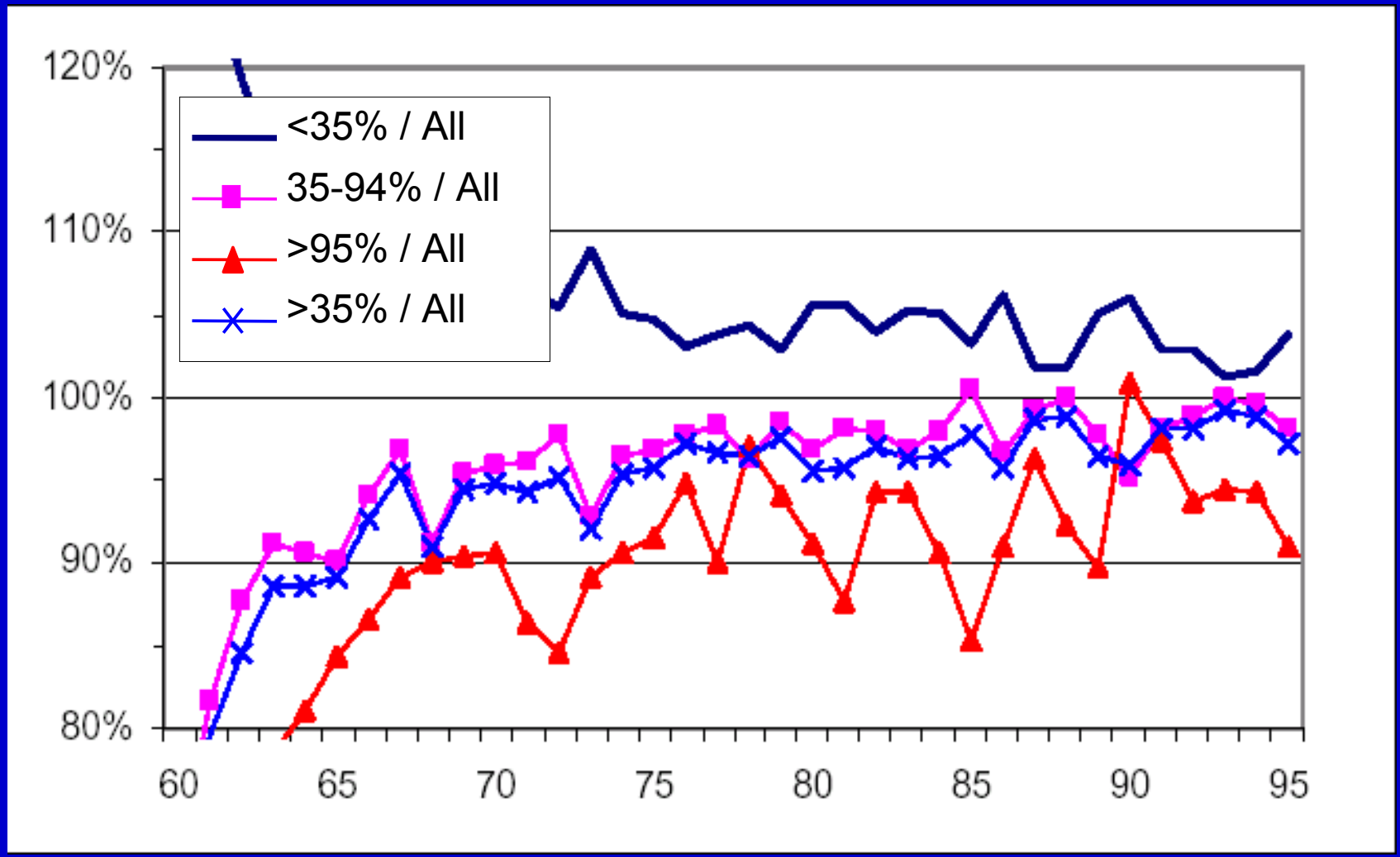
Mortality by income, Women, Age 70 to Age 80



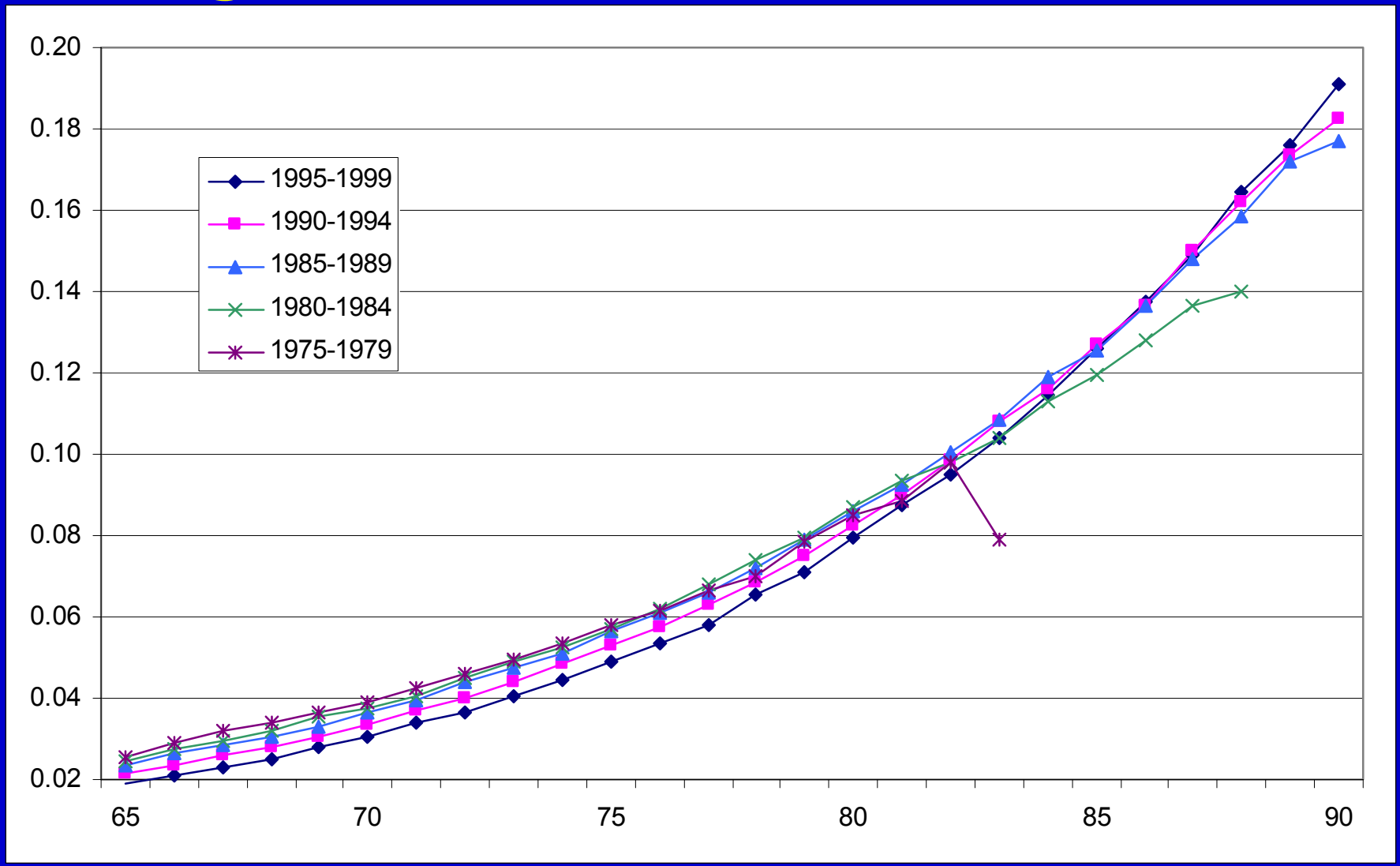
Effect of income, Men, in %



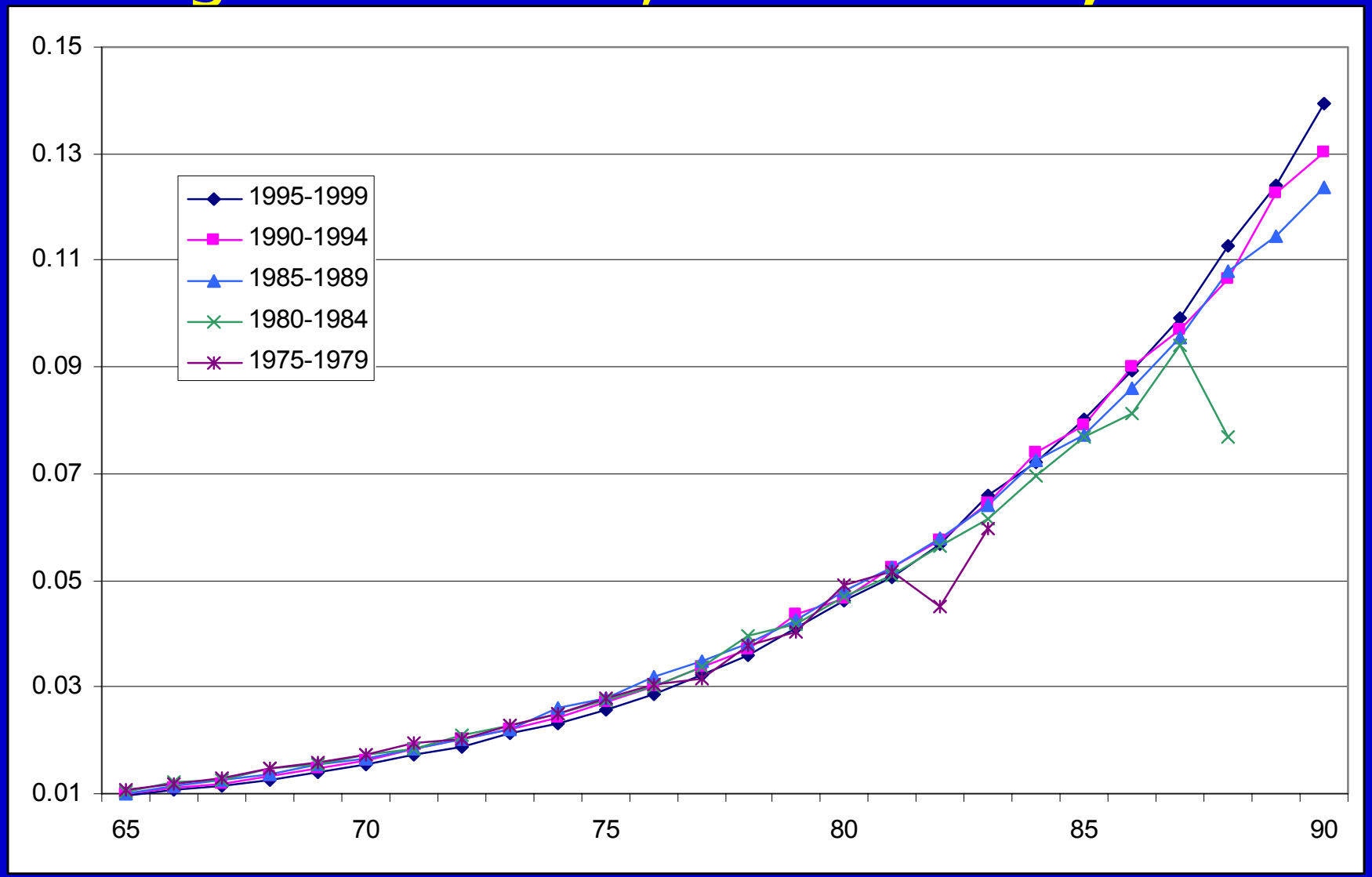
Effect of income, Women, in %



Changes over time, Income = **5,** Men



Changes over time, Income = **5,** Women



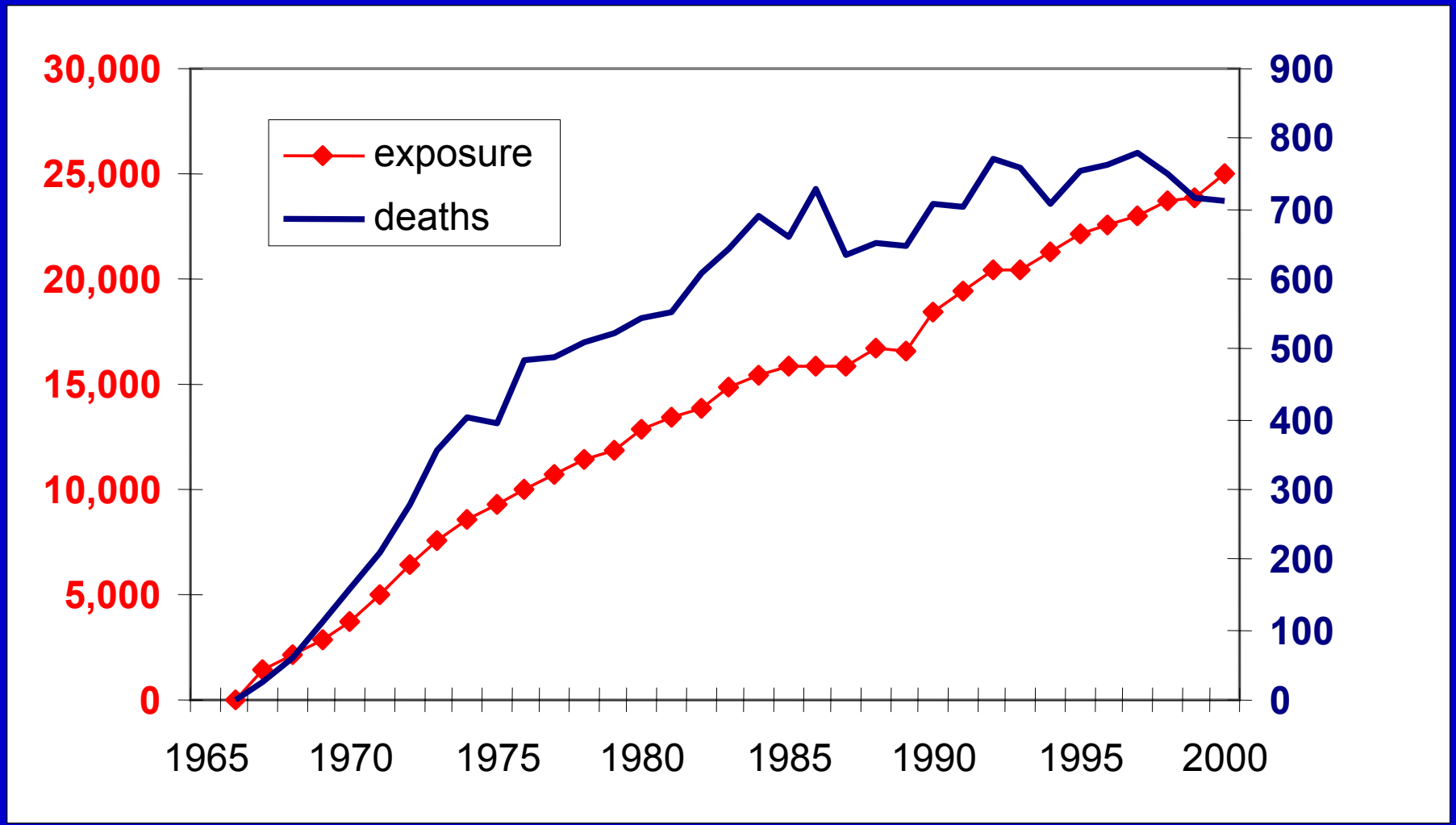
5- Trends over time

Some specific findings - QPP

Detailed calculation for trends

- Example with QPP data
- Men, all incomes, age 70
- Data from 1967 to 2000
- Trends from 1975 to 2000: 26 q_{70} values
- 25 mortality variation rates
- 1976 rate = $1 - {}^{1976}q_{70} / {}^{1975}q_{70}$
- Weight related to exposure and q_{70}

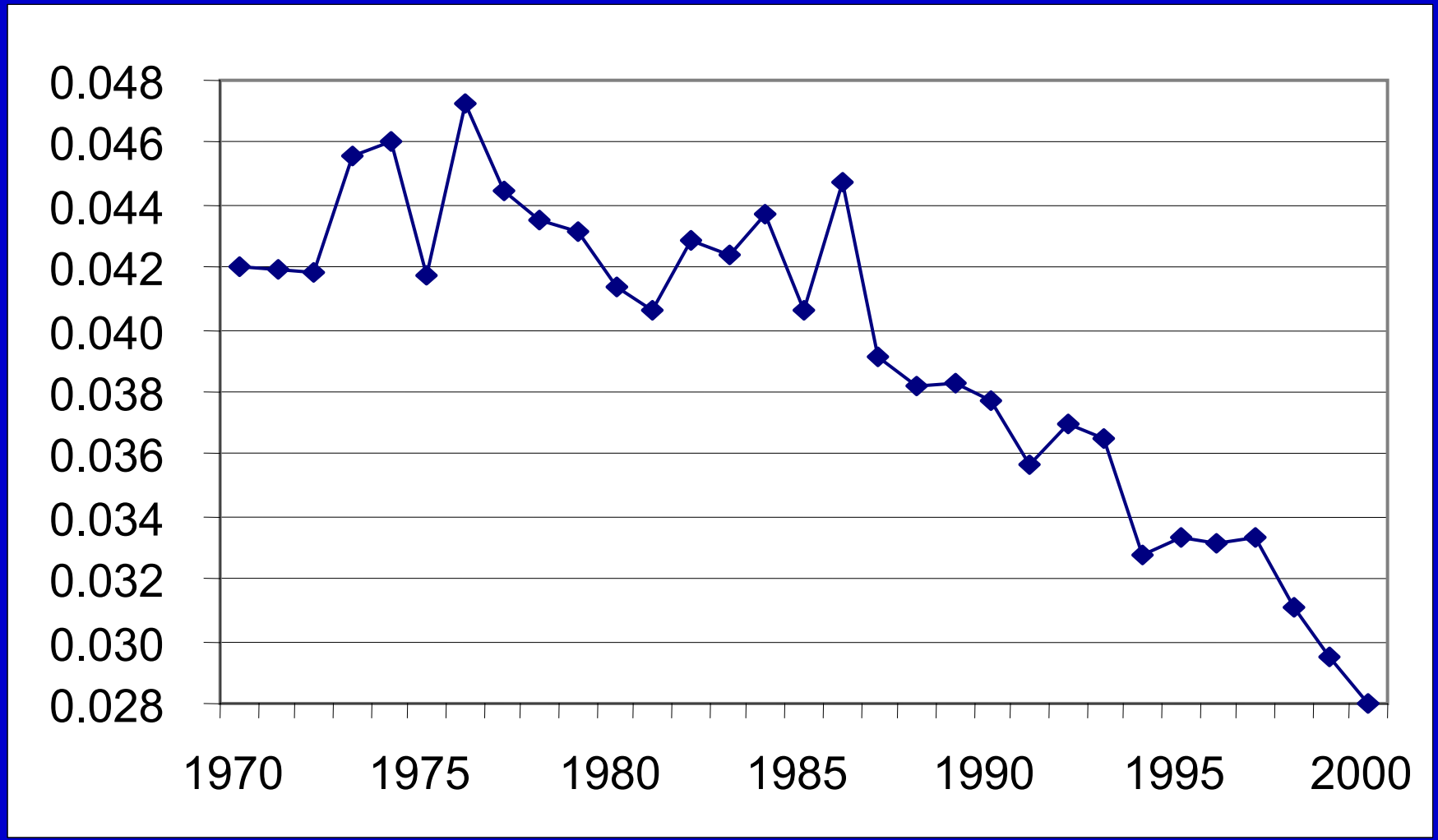
QPP, Men, age 70, all incomes
Changes in deaths and exposure



Calculation of year q_{70}

Year	Exposure	Deaths	Probability
1995	22,200.17	753.0	0.033350
1996	22,612.46	763.0	0.033180
1997	22,980.54	**779.5**	0.033351
1998	23,784.92	751.0	0.031081
1999	23,907.29	716.0	0.029505
2000	24,964.79	710.0	0.028039

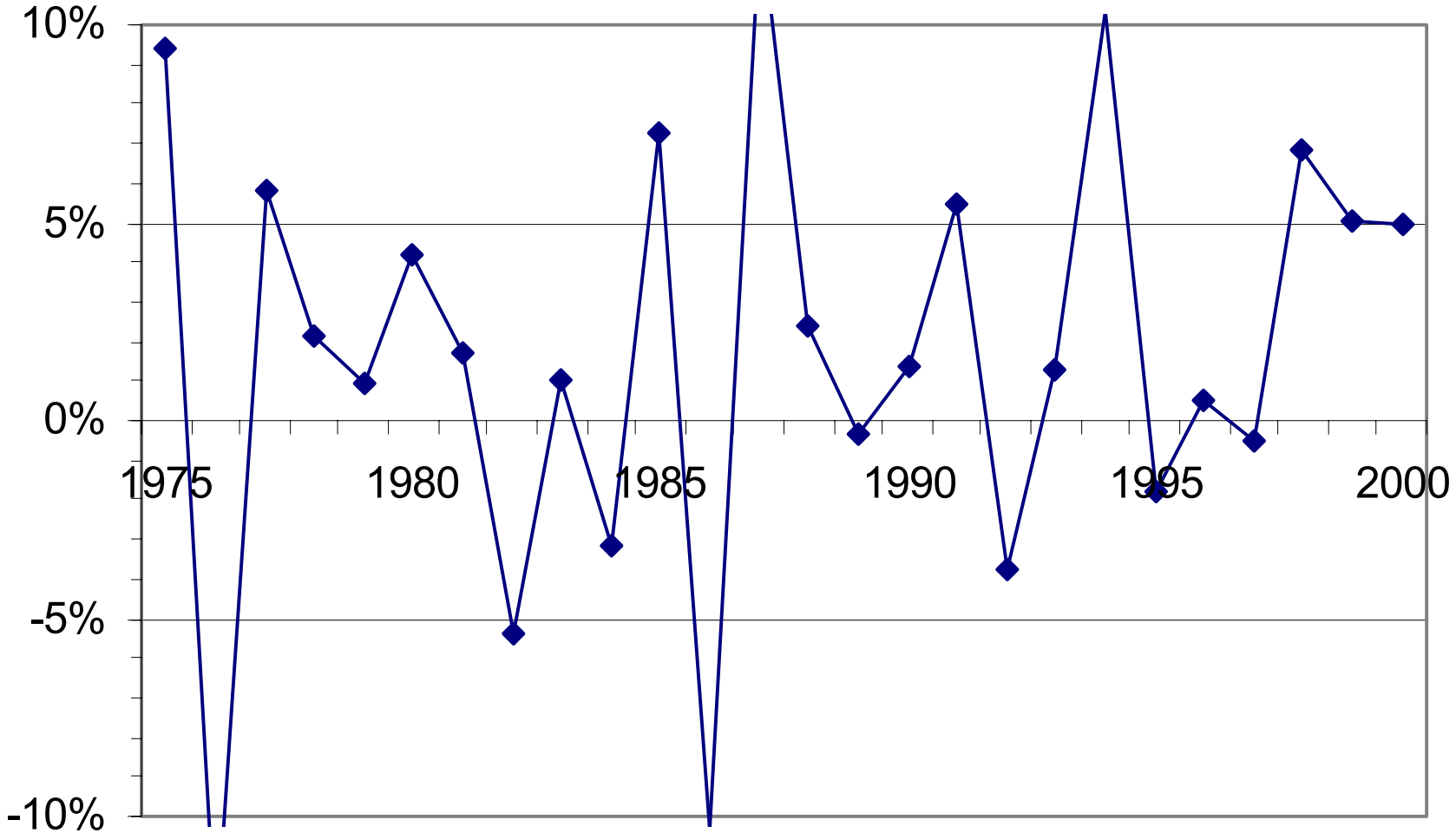
QPP, Men, age 70, all incomes
Changes in q_{70}



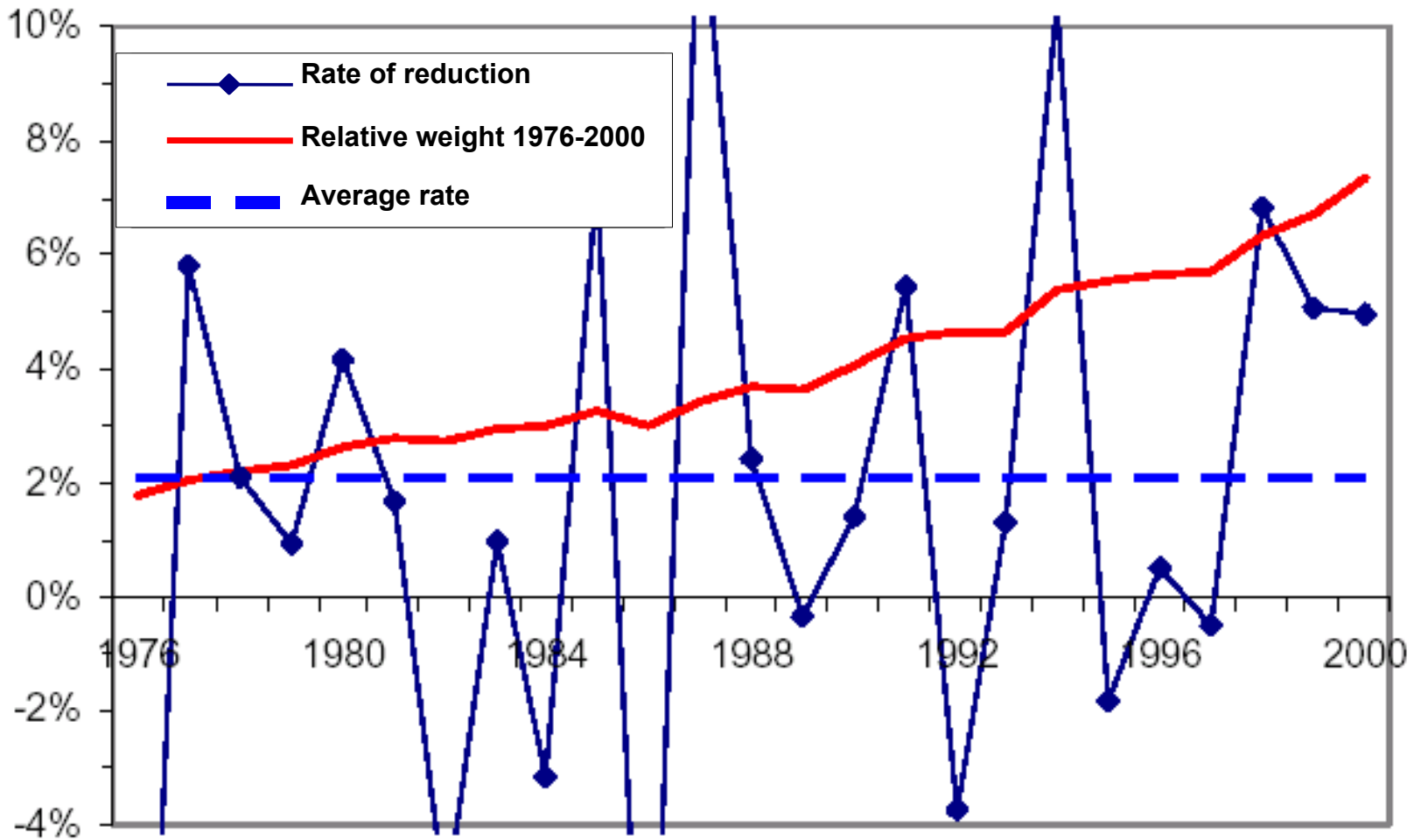
Calculation of rate of reduction

Year	Probability	Rate of reduction
1995	0.033350	-1.82%
1996	0.033180	0.51%
1997	0.033351	-0.52%
1998	0.031081	6.81%
1999	0.029505	5.07%
2000	0.028039	**4.97%**

QPP, Men, age 70, All incomes
Changes in rate of reduction



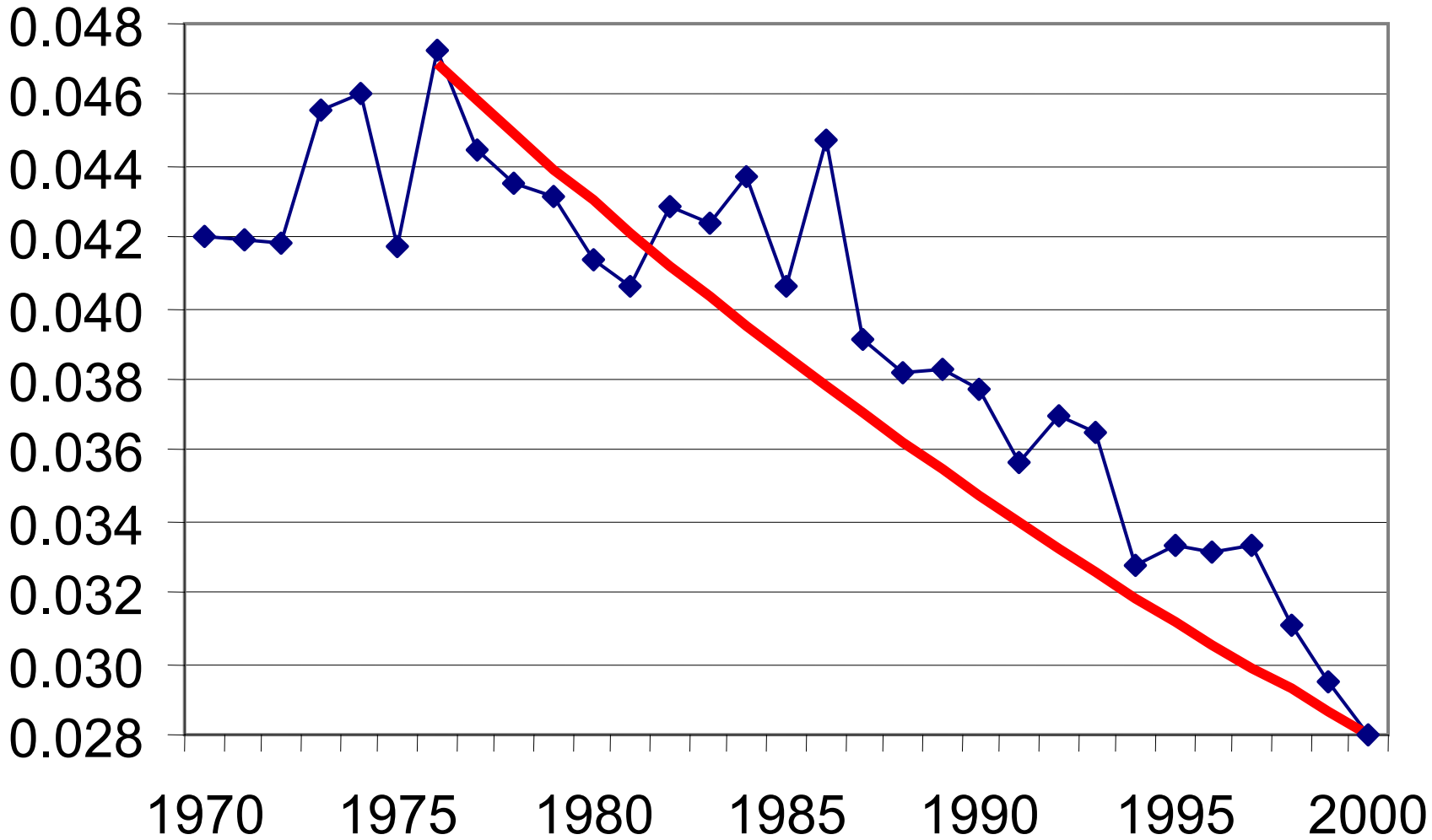
Weighted rate of reduction



Comments on weighted rate of reduction

- Relative weight = 1 / Variance [q_{70}]
- Weight proportionate to exposure
- Attaches more weight to recent values
- Unweighted values (25 rates of reduction)
  - Mean = **1.42%**
  - Standard deviation = **5.58%**
- **Weighted = 2.12%**
- Significant annual fluctuations

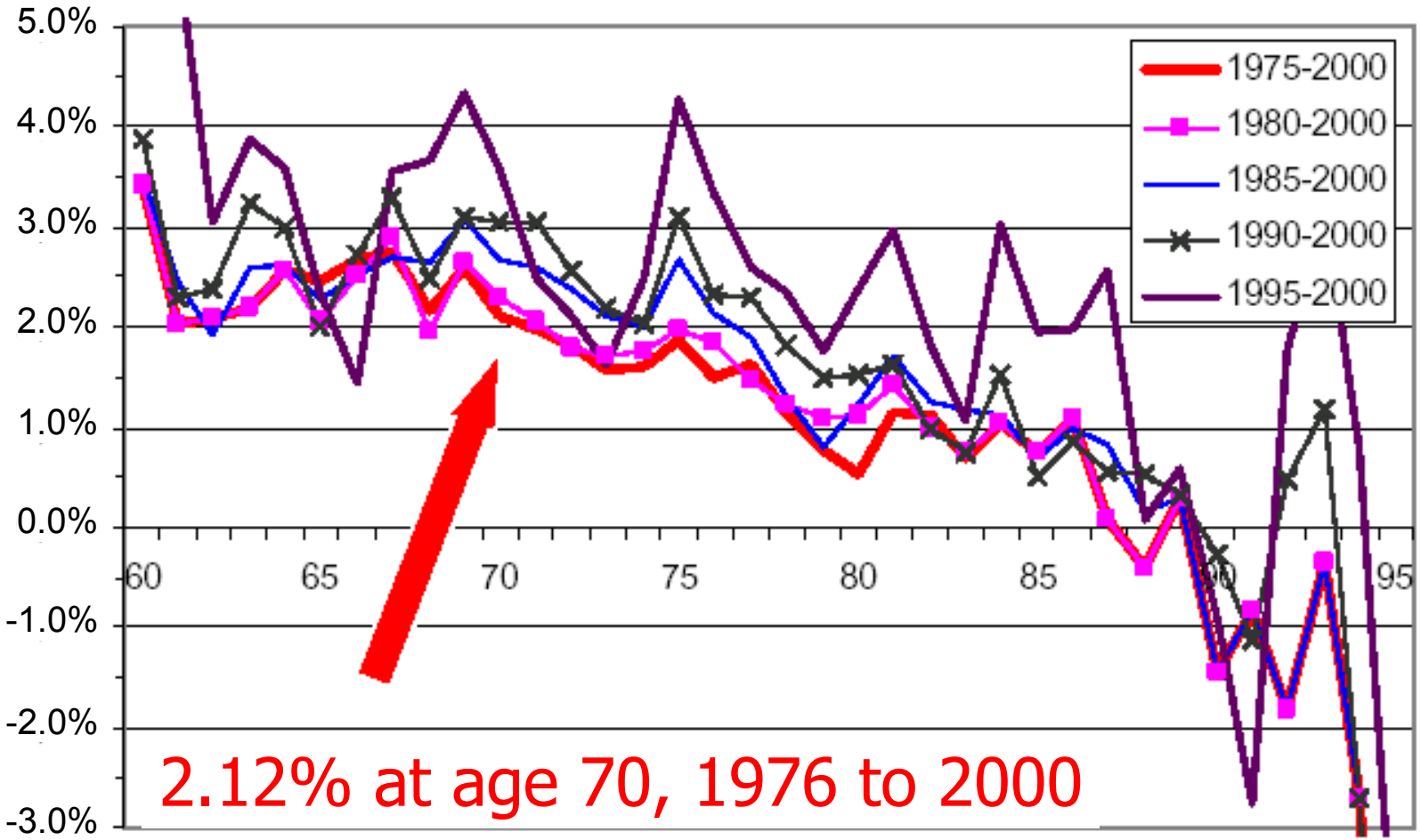
Changes in q_{70} with assumed rate



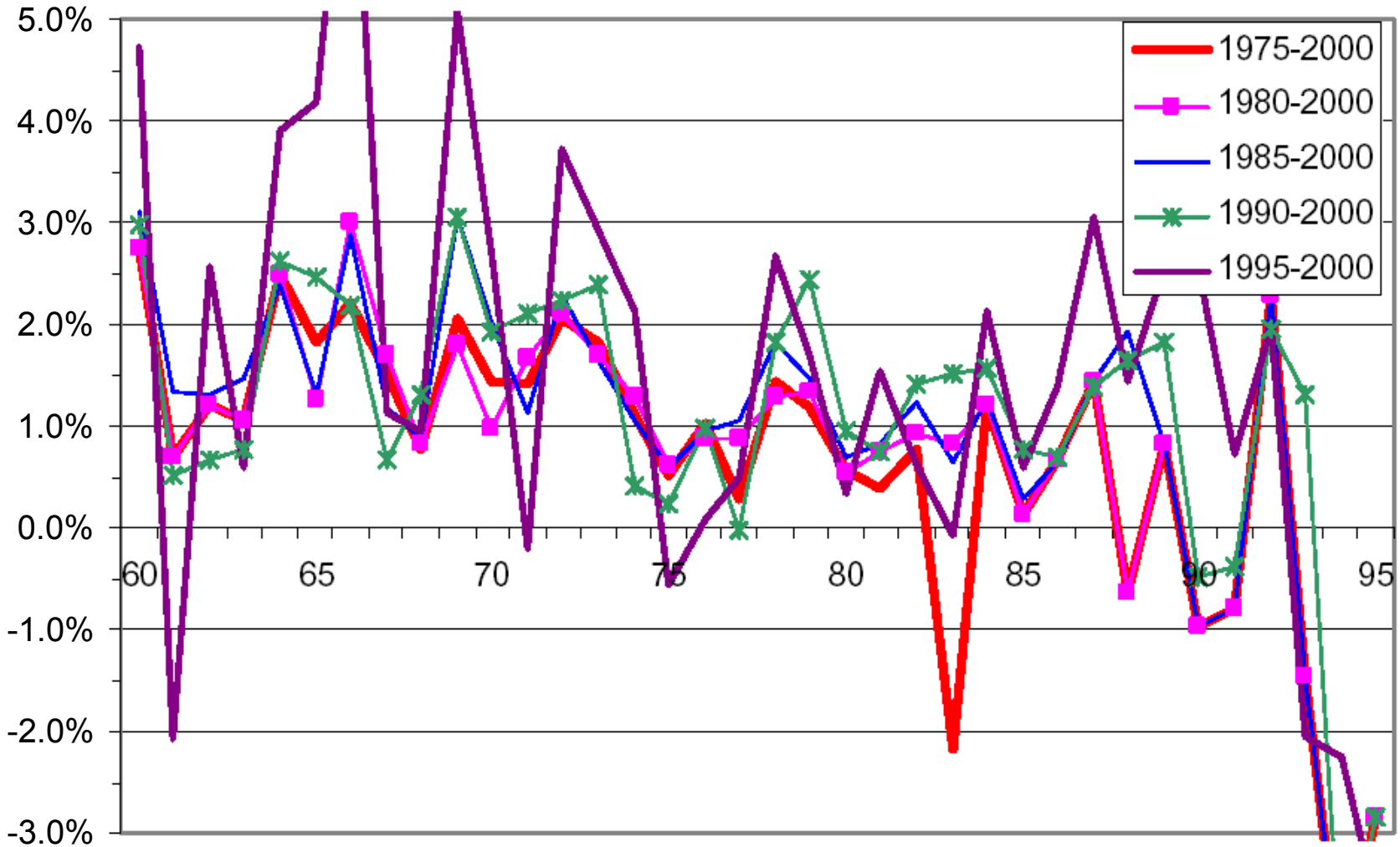
Rate of reduction vector

- Calculations done for each age
- Starting 1975, 1980, 1985, 1990, 1995
- Or later if data unavailable
- Advanced ages: no data in 1975
- Same weighting method
- Following chart

Rate of reduction QPP Men



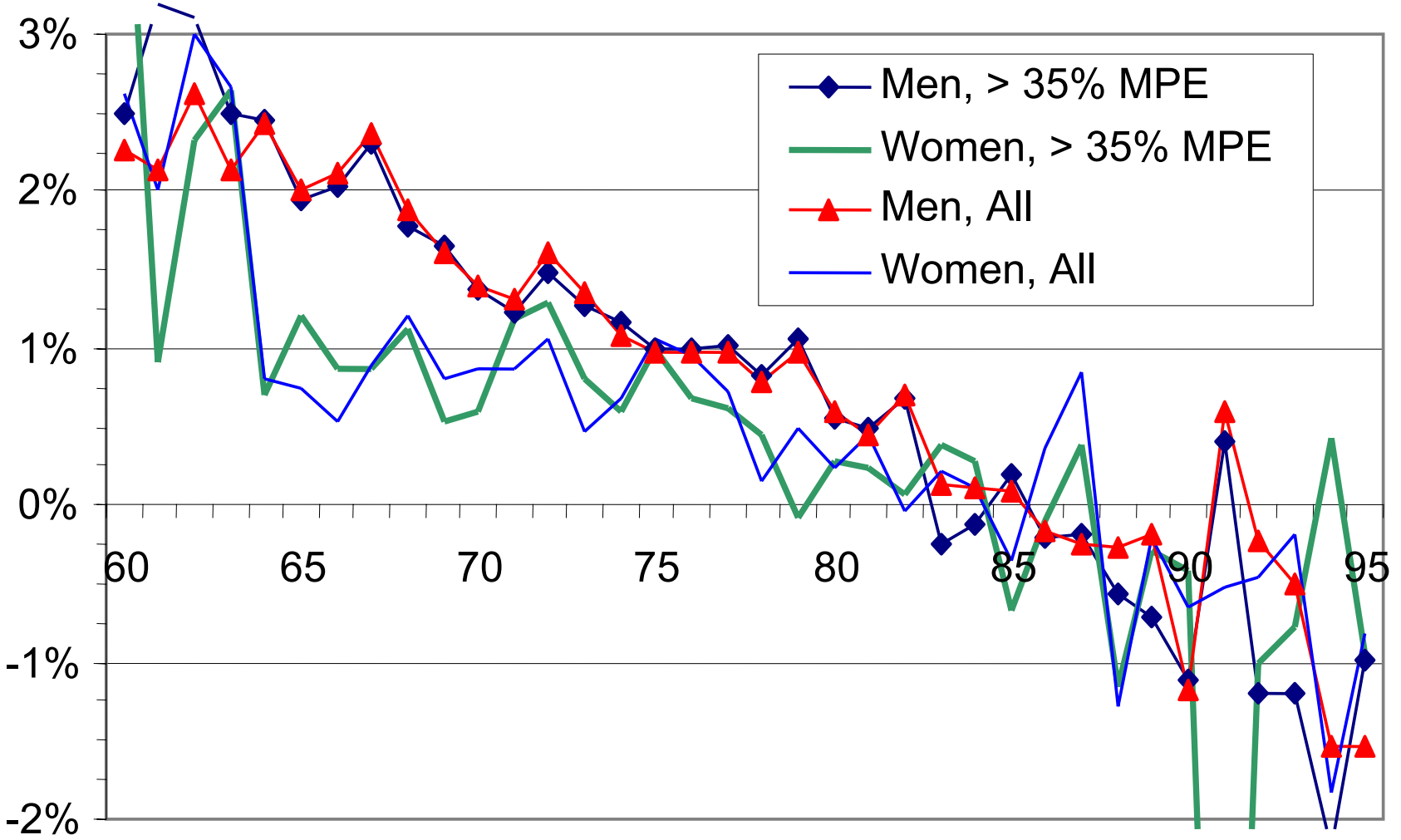
Rate of reduction QPP Women



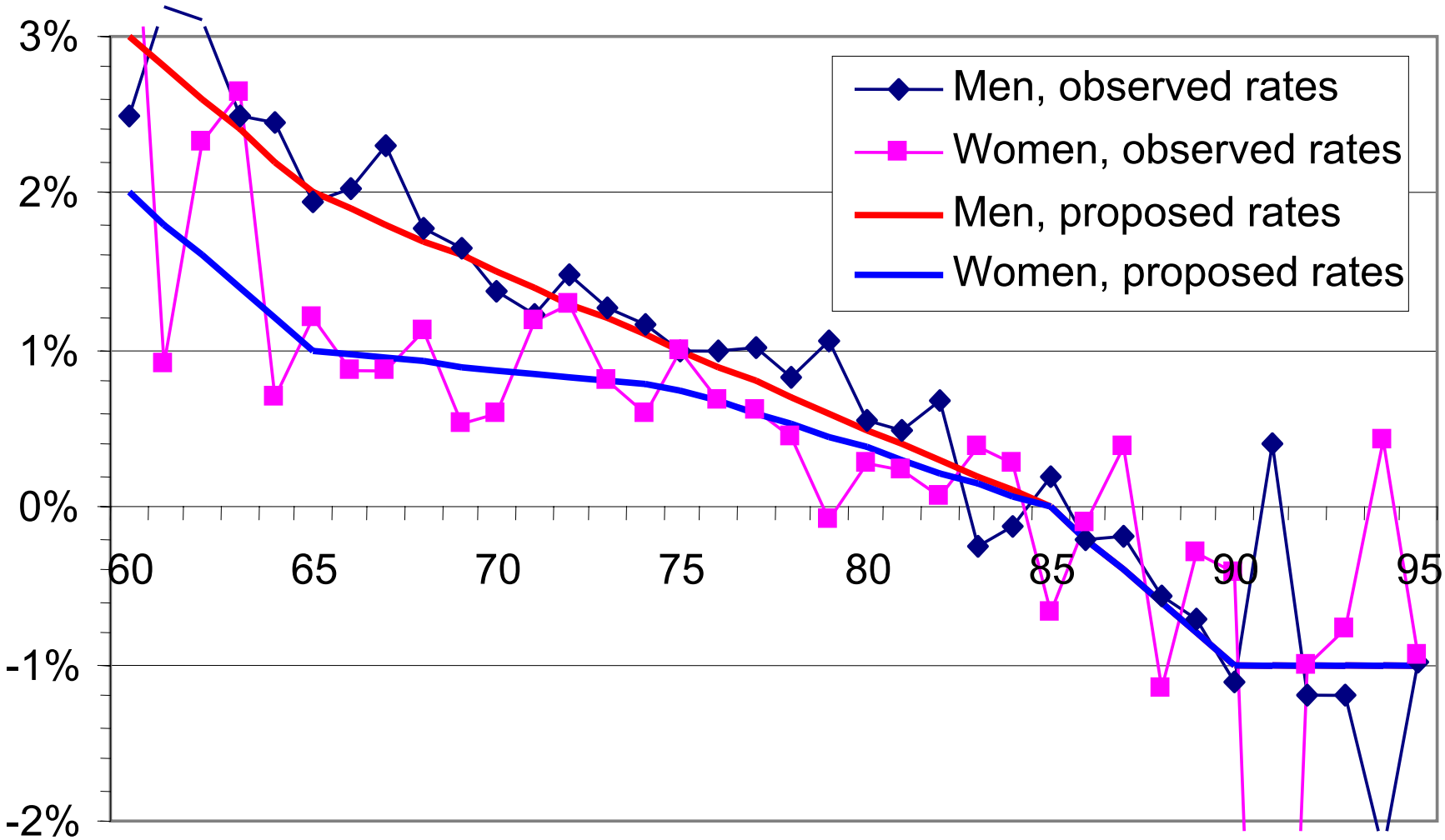
Reduction in mortality in Canada

- Following 4 charts
- QPP + CPP data, end 1999
- Canada: more data
- Men-women comparison
- Comparison by income level
- Changes in five-year curves

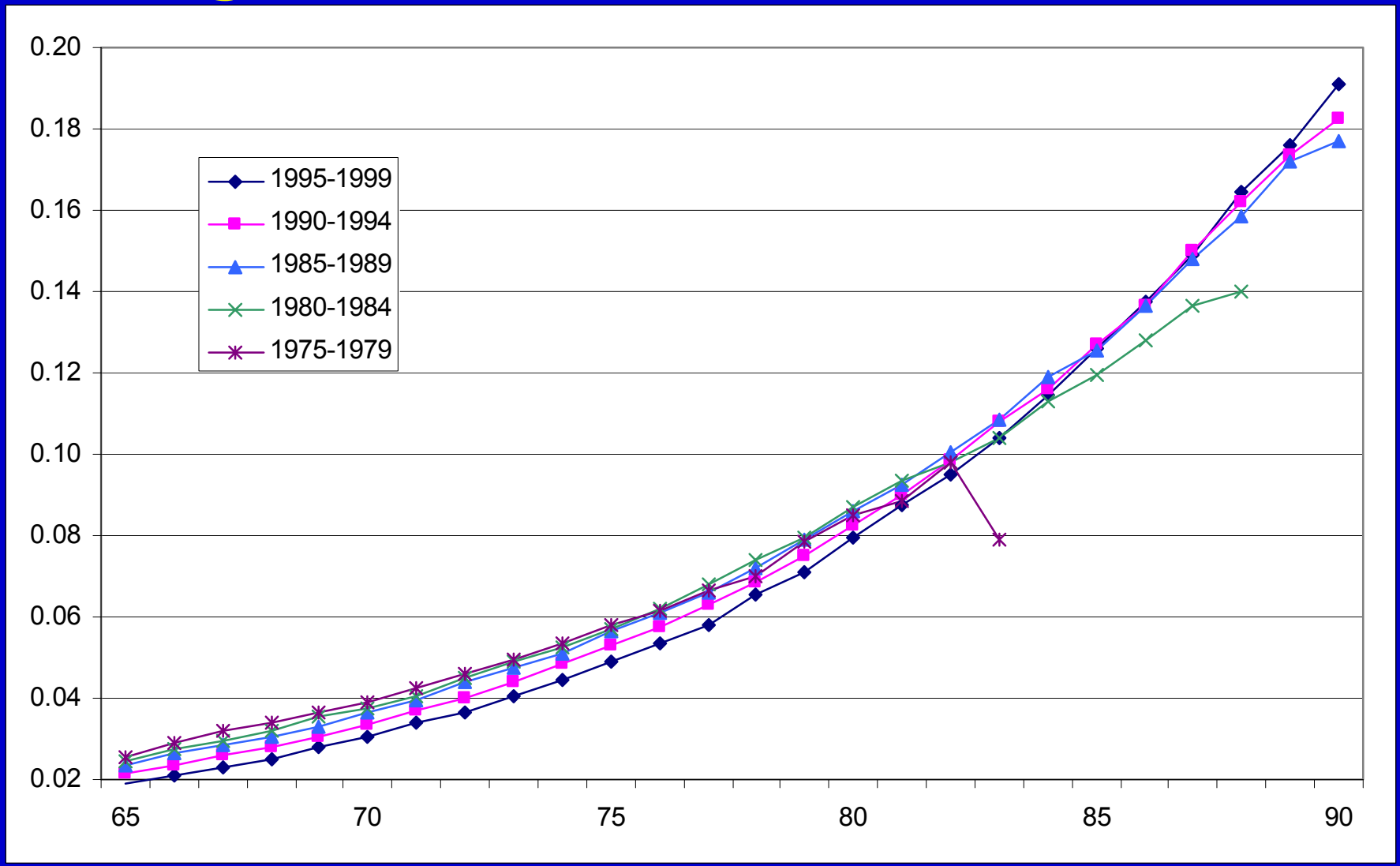
Weighted rates of reduction of observed q_x



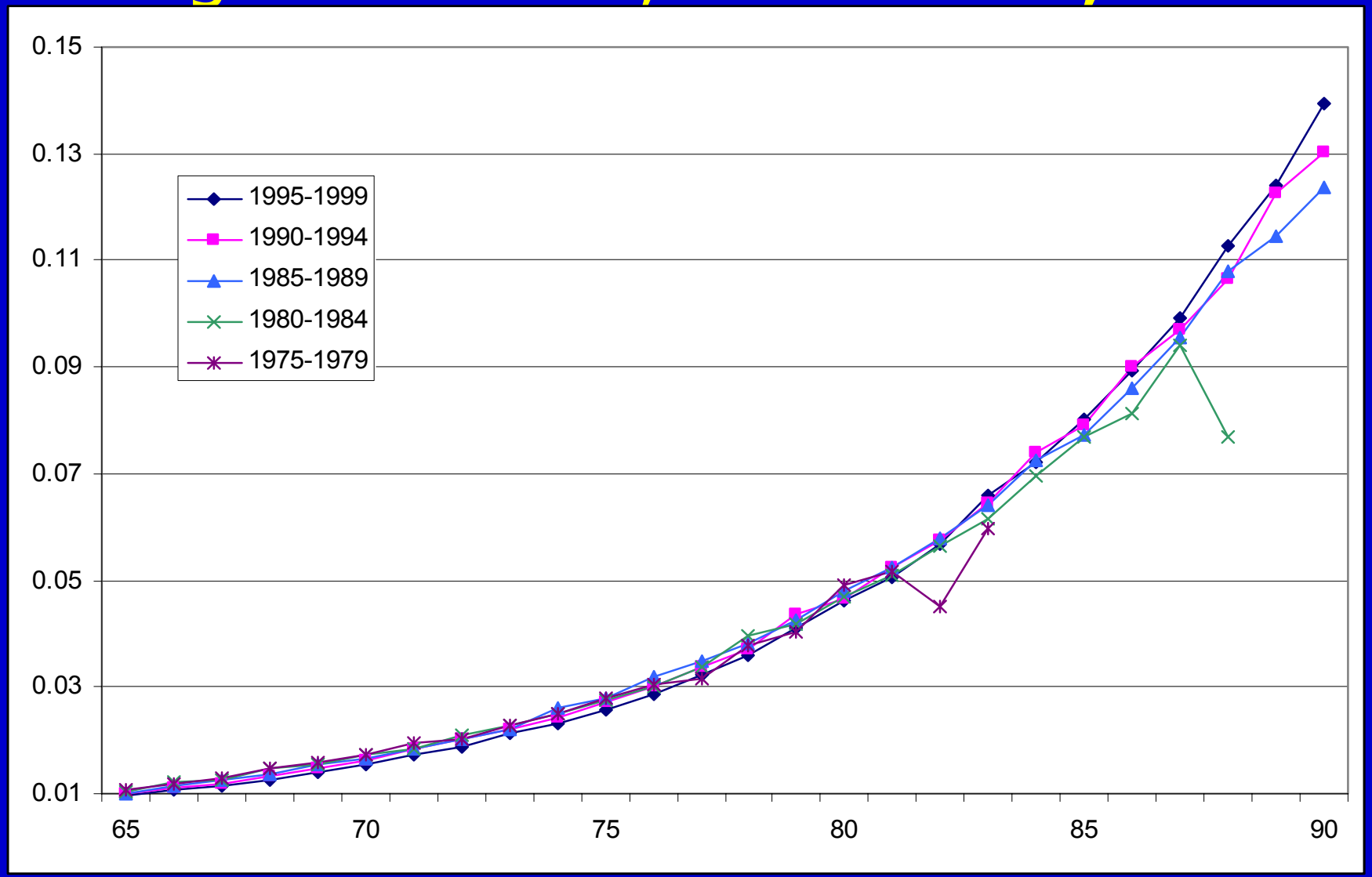
Weighted rates of reduction of proposed q_x



Changes over time, Income = **5,** Men



Changes over time, Income = **5,** Women



Comments on reduction

- Reduction varies by age and sex
- ★ True in Quebec and Canada
- Little difference by income level
- Probability of death declines with time
- But
- Decline slower at advanced ages
- ★ **Deterioration after age 85-90**
- ★ Rapid reduction recently observed

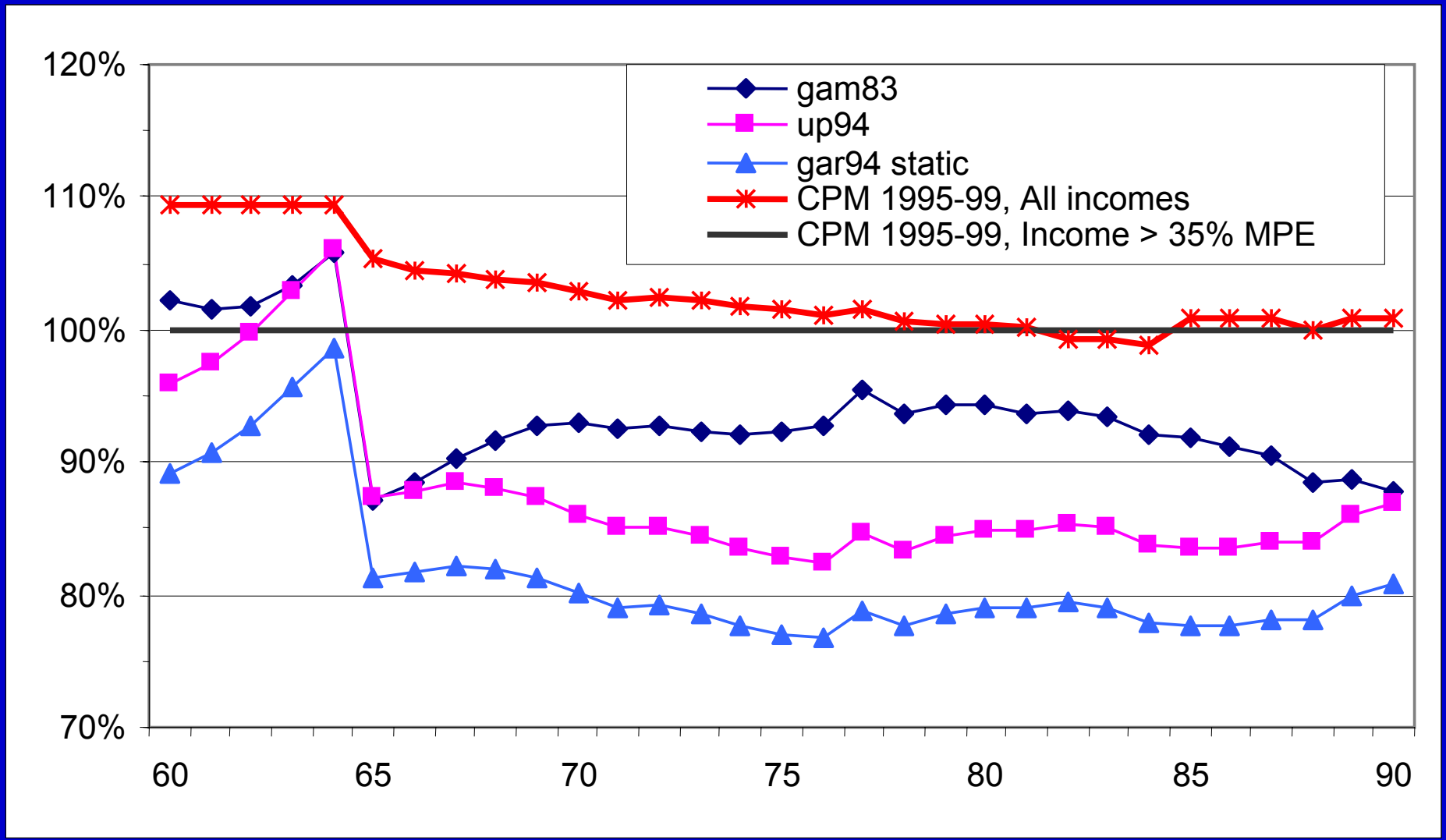
Conjectures on trends

- Past indication of future?
- Mortality higher in Quebec = more room for improvement?
- Impact of future immigration?
- Differences genetic, cultural, related to food (alcohol and tobacco)?
- Access to health care?

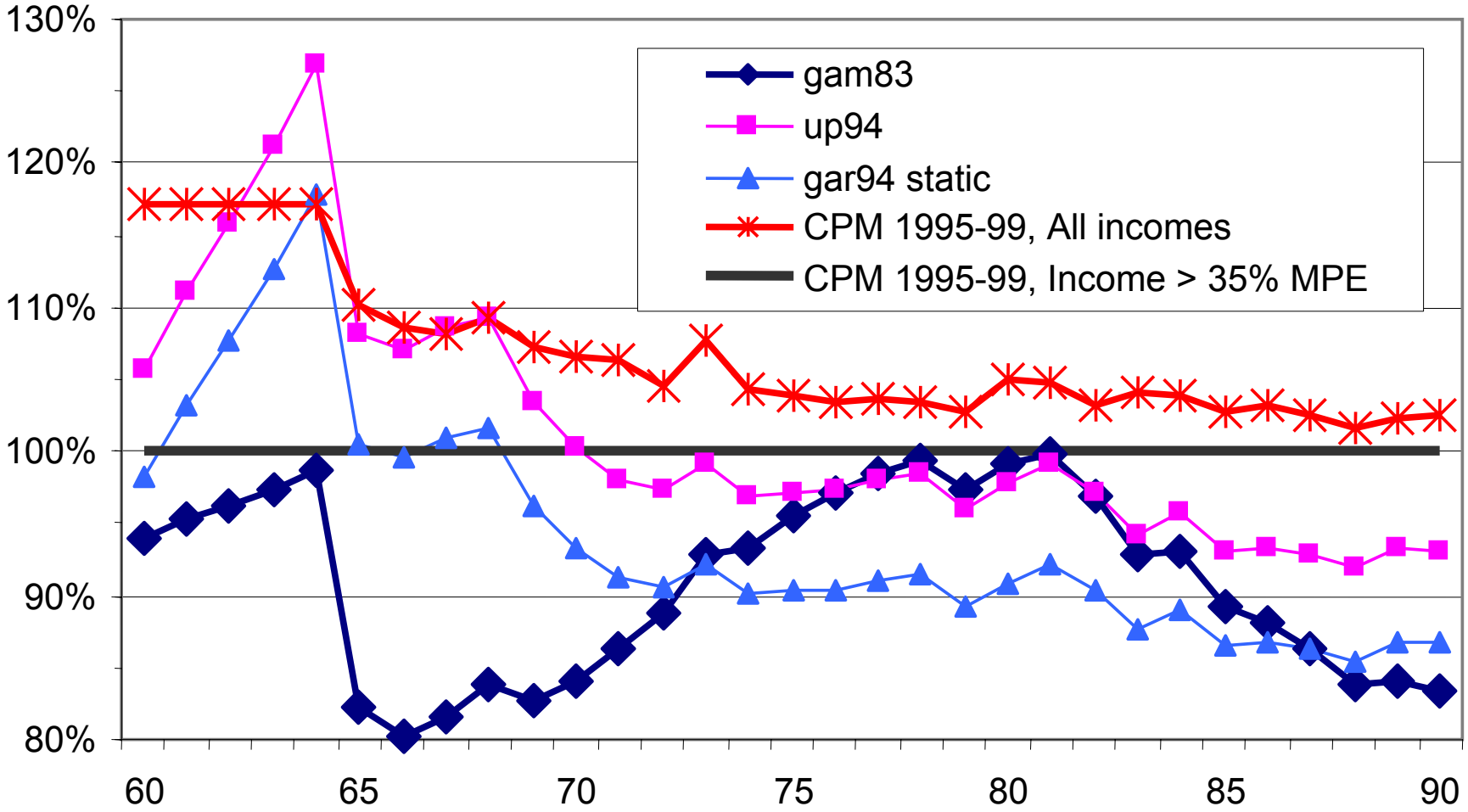
6- Other findings

Comparison with other tables

Men, Comparison of qx to other tables



Women, Comparison of qx to other tables



Comparison of $\dot{e}_x$: Men

age	gam83	up94	gar94 static	up94 @ 2002	CPM 9599 all income	CPM 9599 >35% YMPE
60	20.64	21.20	21.83	21.96	19.83	20.04
65	16.69	17.26	17.84	17.94	15.90	16.02
70	13.18	13.77	14.29	14.34	12.54	12.61
75	10.15	10.66	11.12	11.08	9.61	9.64
80	7.64	7.97	8.37	8.24	7.14	7.15
85	5.73	5.86	6.19	6.01	5.17	5.21
90	4.28	4.15	4.42	4.21	3.72	3.75

Comparison of $\dot{e}_x$: Women

age	gam83	up94	gar94 static	up94 @ 2002	CPM 9599 all income	CPM 9599 >35% YMPE
60	25.67	24.97	25.59	25.33	24.42	24.83
65	21.29	20.69	21.28	21.03	20.12	20.44
70	17.13	16.77	17.30	17.08	16.18	16.43
75	13.37	13.11	13.60	13.39	12.57	12.77
80	10.20	9.88	10.31	10.09	9.37	9.53
85	7.58	7.18	7.54	7.30	6.70	6.81
90	5.40	5.05	5.34	5.11	4.65	4.72

End

Questions ???