**The Actuarial Profession**
making financial sense of the future

Trends in social inequalities in life expectancy at older ages in England from 1981 to 2007: *decomposition by age and cause of death*

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# Outline

- Background , research questions
- Why use decomposition? Methods
- Trends in inequality in life expectancy (LE) by socio-economic circumstances (SEC)
- Decomposing LE change within SEC groups
- Decomposing LE difference between SEC groups
- Limitations
- Summary

# Background

- Actuaries set mortality assumptions for people in different socioeconomic groups

- May use pensioners data to establish current differences in mortality between groups

- But modelling of future trends by **socioeconomic position** uncertain because:

  – Lack of reliable historical trend data

  – Lack of understanding of contributory factors to change in mortality patterns

# Previous research: key insights into UK trends overall

- 'ageing of mortality improvement' in 2nd half of 20th C – *Willets.* Modal age of death peaking at progressively higher ages for both sexes

- Mortality improvements accelerated in last decade of 20th C

- Attributed mostly to rapid falls in heart disease mortality

- Inequality gap – manual workers mostly die from the same diseases as non-manual, but at a higher rate at any given age – *Ridsdale & Gallop*

# Why decomposition?

- Trends in the gap in LE between groups are a function of both:
  - Differentials in the pace of decline in age-specific mortality (**differentials in rates of improvement**)
  - Inter-group differences in the age pattern of mortality (**differentials in baseline mortality**)
- Decomposition quantifies and summarises the effect of both these sets of changes:
  - across time AND between groups;
  - by age and cause of death (CoD)

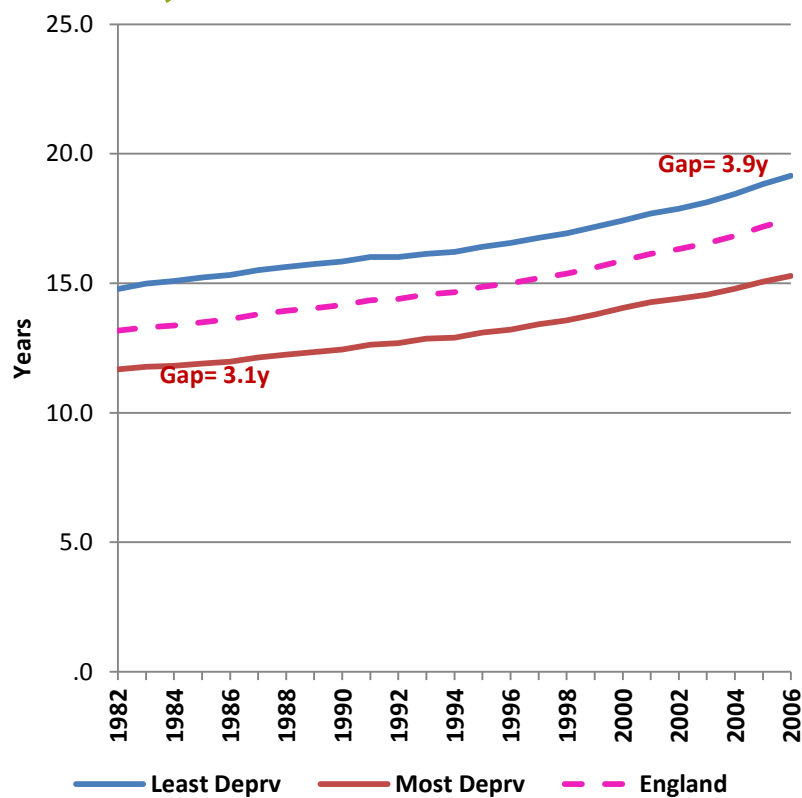- *Method – Andreev E, Shkolnikov V.*

# Our research questions

- Primary focus on trends in INEQUALITIES

- Which causes of death contributed to gains in life expectancy at older ages between 1985 and 2005 in different socioeconomic groups ? By how much and at what age?

- Which causes of death contributed most to the inequality gap in life expectancy? And have these changed over the period?
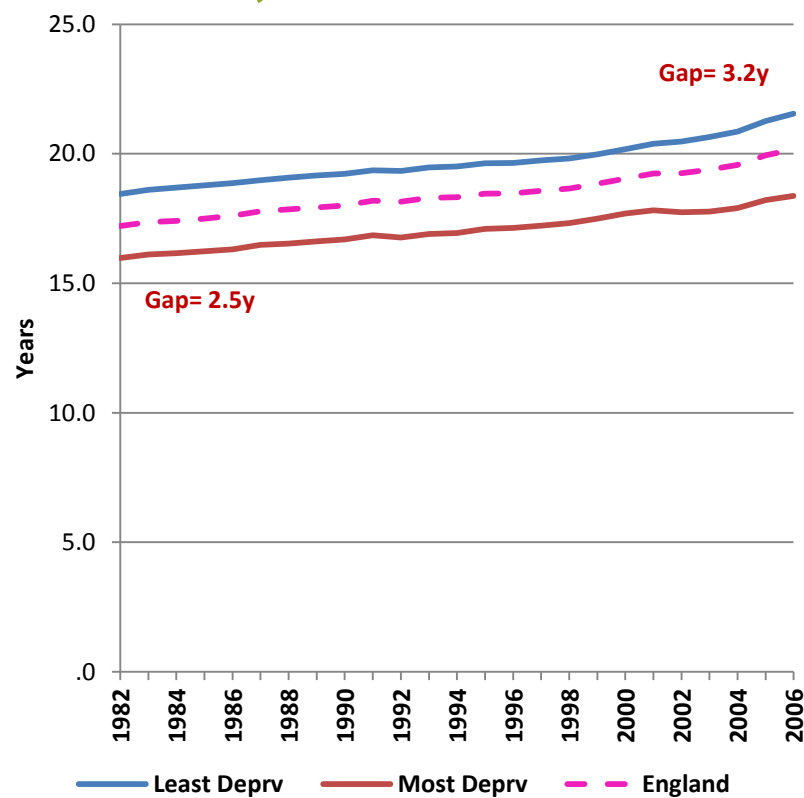
# Methods

- *Inequalities by socioeconomic circumstances (SEC): census areas grouped into quintiles by increasing deprivation (IMD 2007)*

    ***Q1=least deprived   Q5=most deprived***

- *Data: 1981-2007, England by SEC quintiles. Mortality counts from ONS;  population estimates  from Dr Paul Norman, Leeds University*

- *Estimates calculated as 3-year averages*

- *Cause of Death (CoD) – adjusted for ICD change using ONS bridge coded dataset 1999*

- *Decomposition method : Shkolnikov, Andreev*

# Trends in life expectancy at age 65, least and most deprived quintiles, England
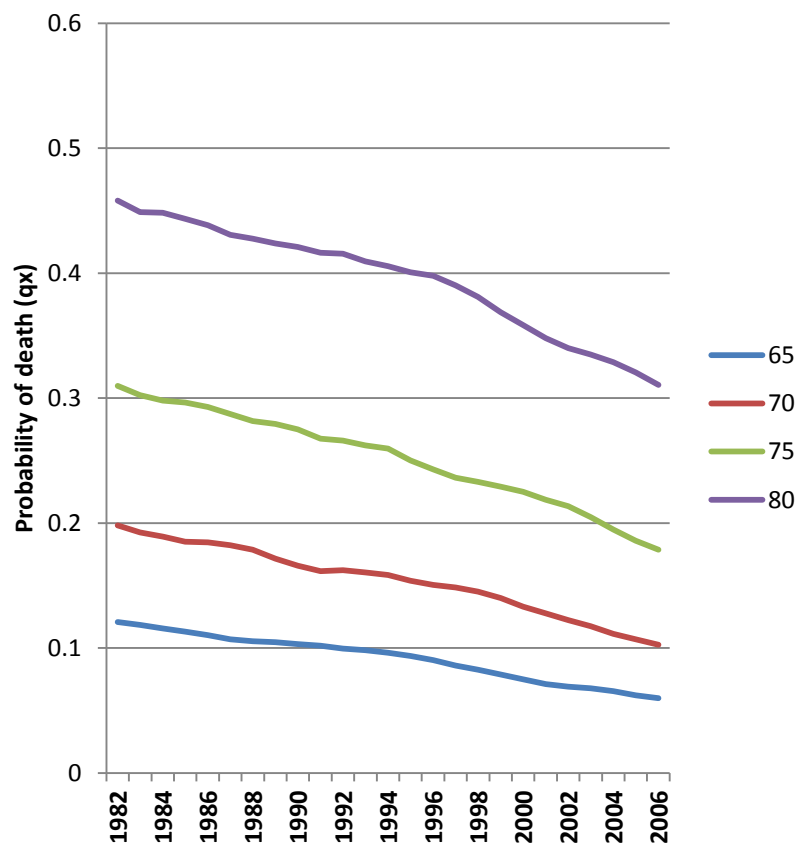


**Males, 1982-2006**

Gap= 3.9y
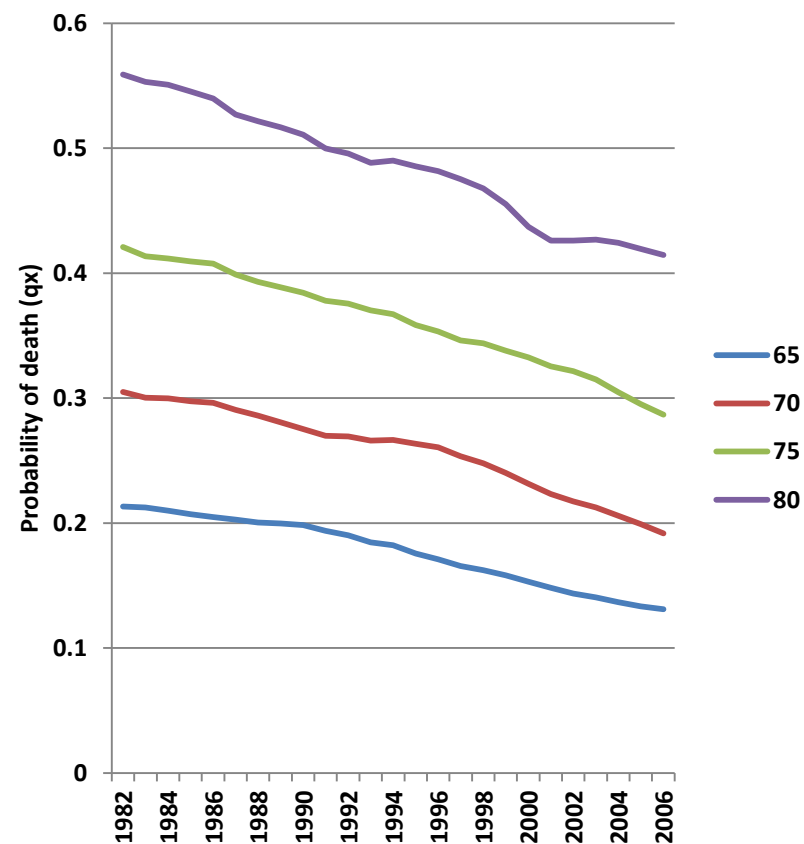
Gap= 3.1y

Legend: Least Deprv — Most Deprv — England

**Females, 1982-2006**

Gap= 3.2y

Gap= 2.5y

Legend: Least Deprv — Most Deprv — England

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# Males: Trends in Qx's for ages over 65 least *vs* most deprived



**Least Deprived, 1982-2006**

**Most Deprived, 1982-2006**

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# 25 year trends in Qxs for ages over 65, Females: least *vs* most deprived
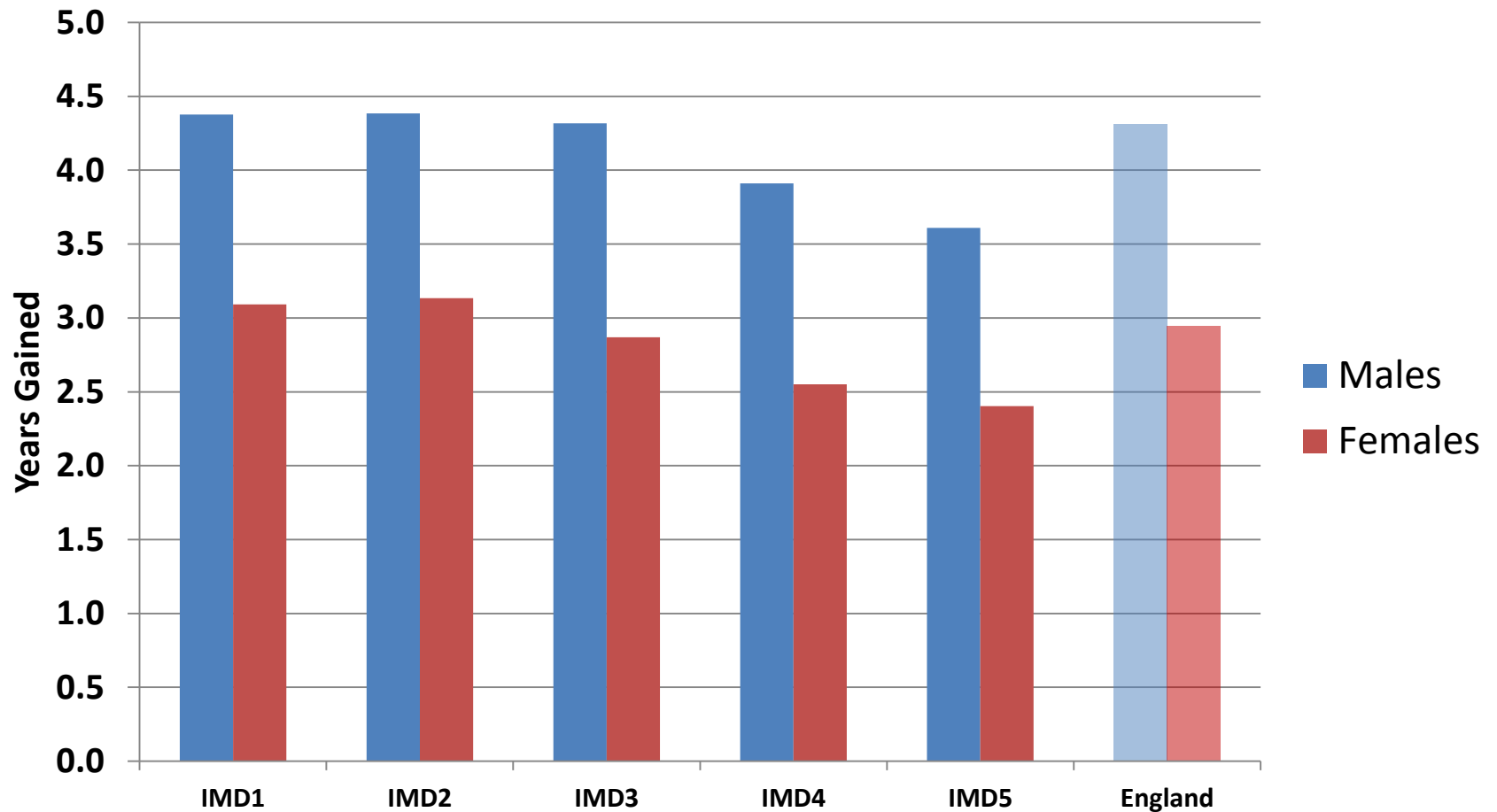


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# Gradient in LE@65 gains, 1981-2007

# To recap..

- LE@65 has increased year on year for both men and women in England

- It has increased both in advantaged and deprived groups

- But there is a social gradient in gains, with differentials greater in men than in women

- The gap in LE between the most and least deprived fifths of the population has increased by about one year in both sexes

- ….similar results to previous analysis, but more robust with annual trend data of total population

# Decomposition of LE@50

**Analysis of change:**

1. Within SEC groups over time (trend decomposition):
    1. which age groups contributed most to the increase in LE?
    2. Which causes of death contributed most to gains?

2. Between SEC groups (gap decomposition):
    1. Which causes of death contributed, and by how much, to the SEC differential in years 1985, 1995 and 2005?

- Decomposition into 6 ICD chapters + 'Other'
- Separate analysis by sex

# Common causes of death under each ICD Chapter group (age 50+, England)

| ICD Chapter | |
|---|---|
| Cancer | Lung (trachea, bronchus), Colon (rectum, anus), Breast, Prostate |
| Circulatory | Ischemic heart disease, Cerebrovascular disease |
| Respiratory | Influenza & pneumonia, Chronic obstructive respiratory disease (bronchitis, emphysema, asthma, other chronic ) |
| Digestive | Peptic ulcer, Cirrhosis and chronic liver disease, Hernia |
| Mental/Behavioural | Dementia, Substance abuse |
| Injury/Poisoning | Non-transport accidents, Intentional self-harm, Motor vehicle accidents |
| Other | Diabetes mellitus, Renal failure, Parkinson's, Alzheimer's disease |

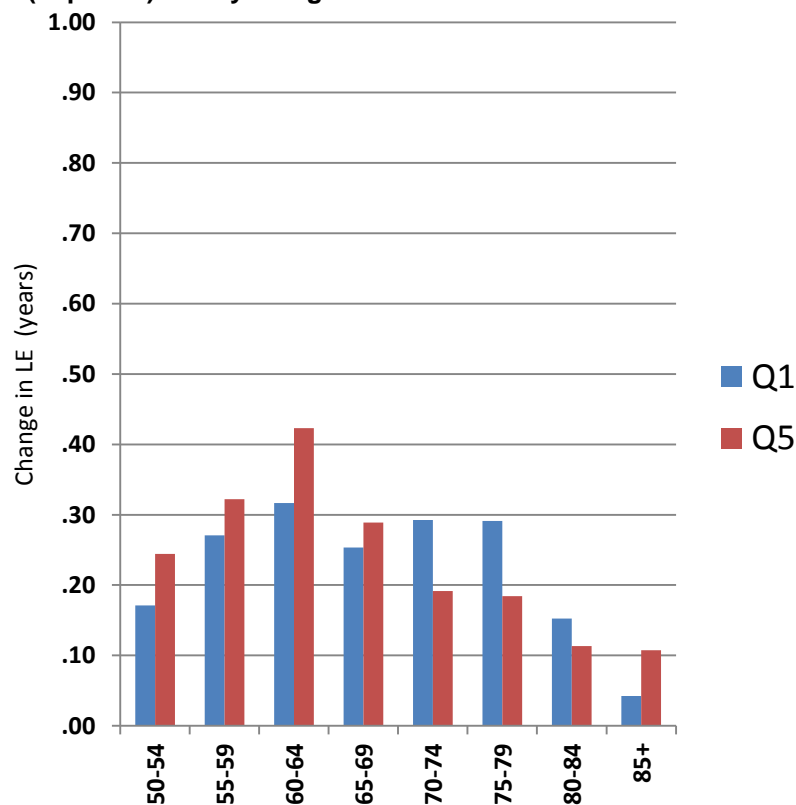# Within group change: (1)
## *Gains in LE@50 over time*

| LE@50 | 1985 | 1995 | 2005 | Total Change 1985-2005 (years) |
|---|---|---|---|---|
| MALES | | | | |
| Q1 | 27.5 | 29.3 (+ 1.8) | 32.1 (+2.8) | **4.6** |
| Q5 | 22.2 | 24.1 (+1.9) | 26.3 (+2.1) | **4.0** |
| FEMALES | | | | |
| Q1 | 31.9 | 33.0 (+1.2) | 34.9 (+1.9) | **3.0** |
| Q5 | 27.8 | 29.2 (+1.4) | 30.6 (+1.4) | **2.8** |

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# Decomposition by age of **within** group difference in LE@50 *over 2 decades*: Men
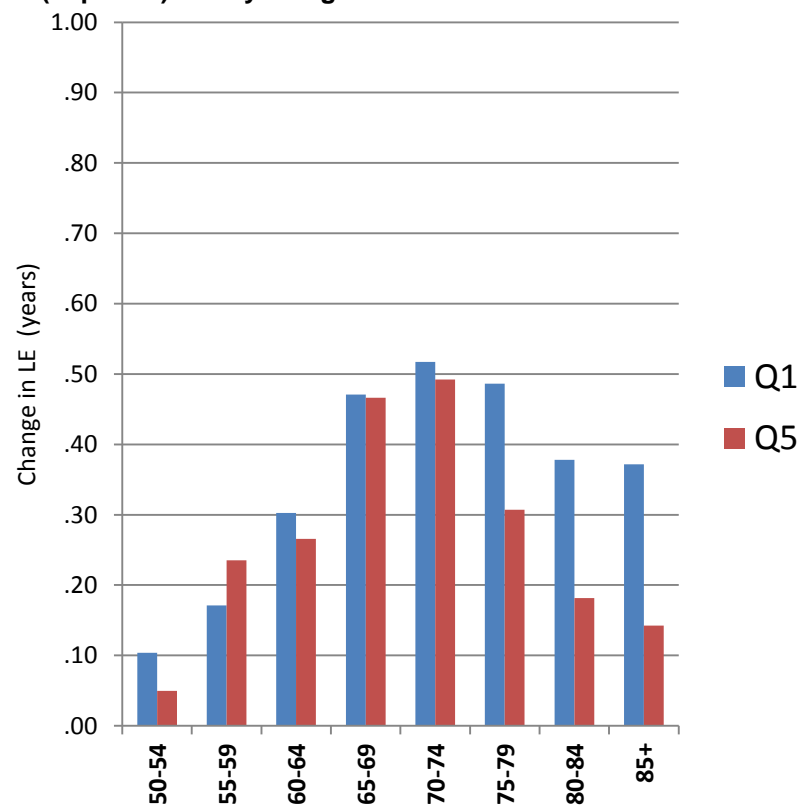
**Men 1985 to 1995**

**Q1 (affluent)= 1.8 years gained**

**Q5 (deprived) = 1.9 years gained**



**Men 1995 to 2005**

**Q1 (affluent)= 2.8 years   gained**

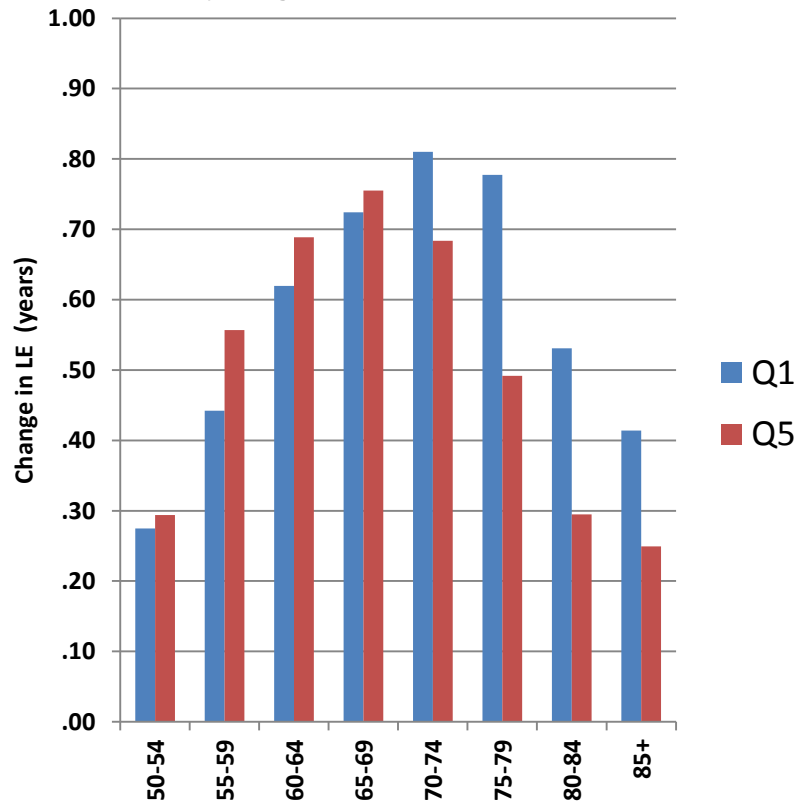**Q5 (deprived) = 2.1 years gained**



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# Decomposition of **within** group difference in LE@50 over whole period 1985 to 2005, Men and Women

**Men**

**Q1 (affluent)= 4.6 years gained**
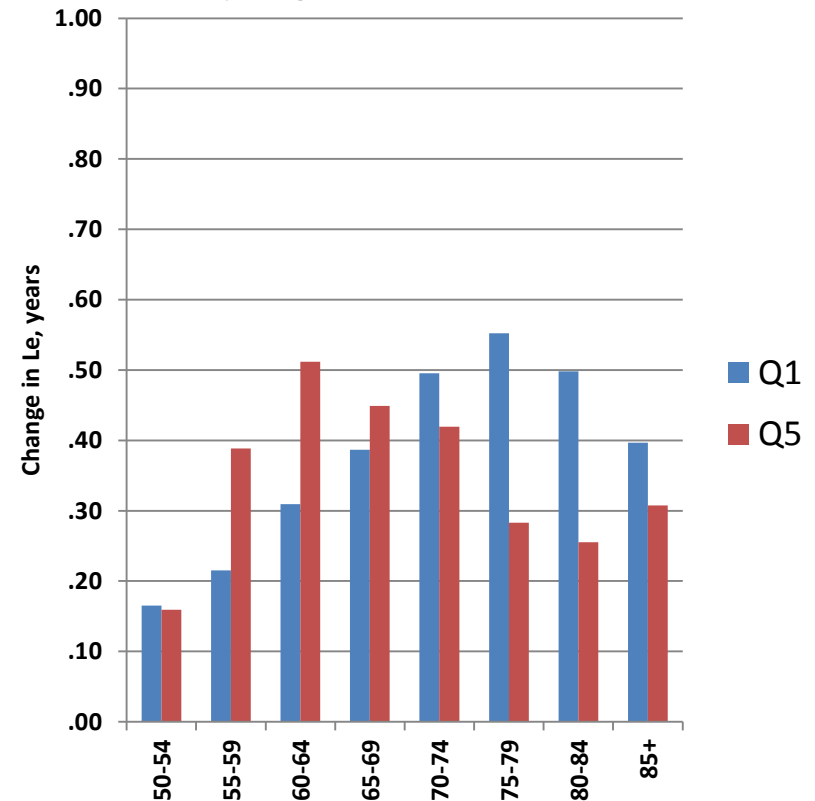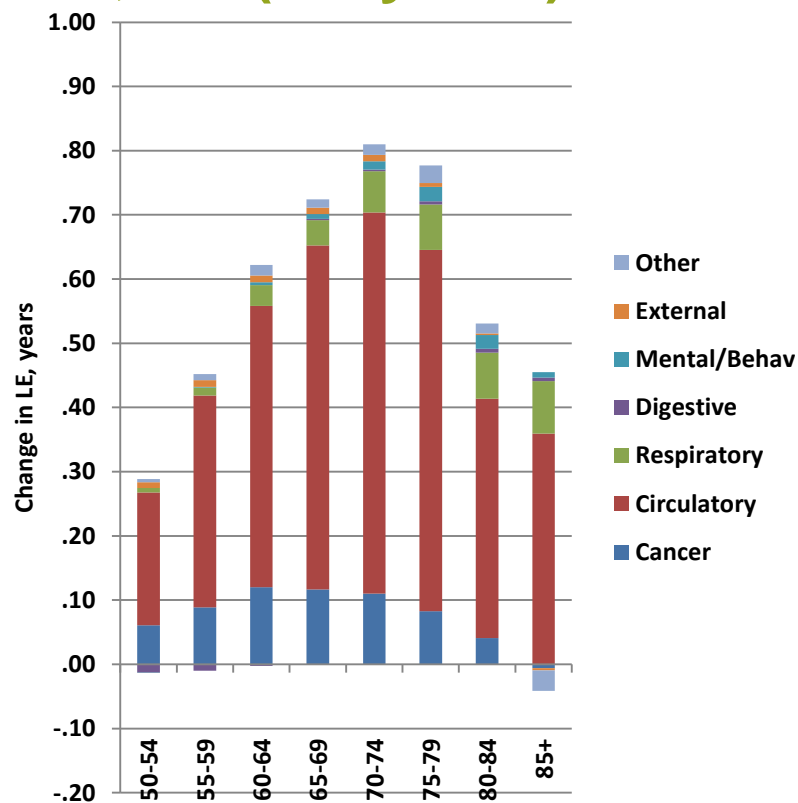
**Q5 (deprived) = 4.0 years gained**

**Women**

**Q1 (affluent)= 3.0 years gained**
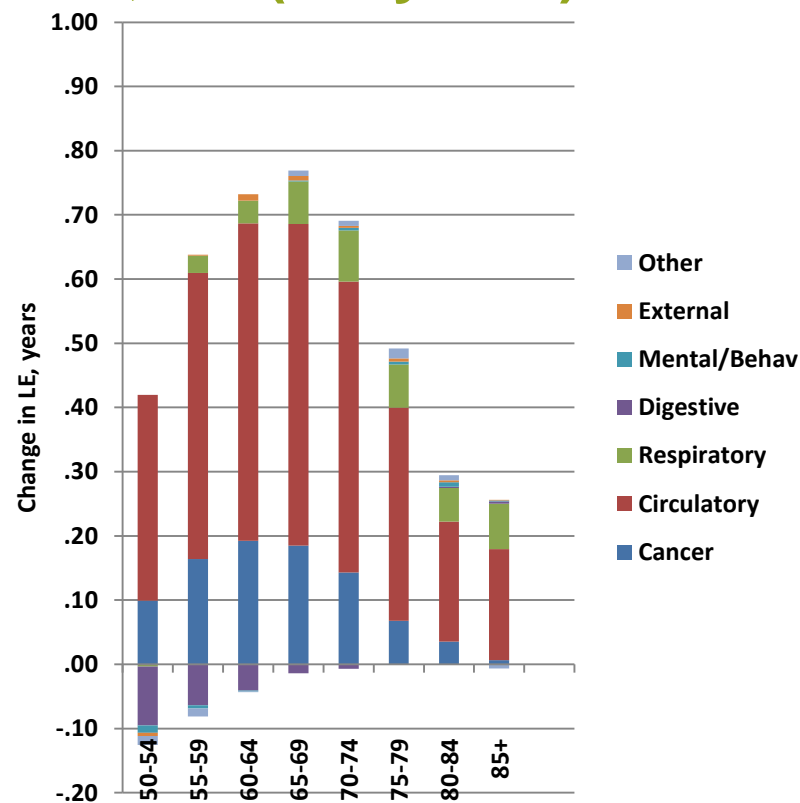
**Q5 (deprived) = 2.8 years gained**



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# Cause decomposition of within group change in LE@50: 1985 to 2005, Men
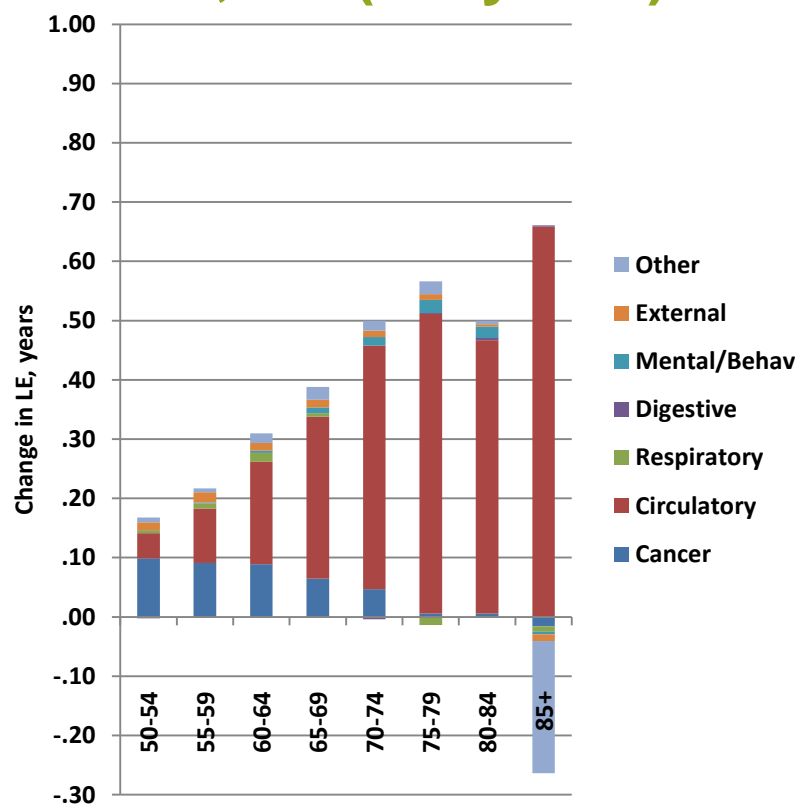


Men, Q1 (4.6 years)
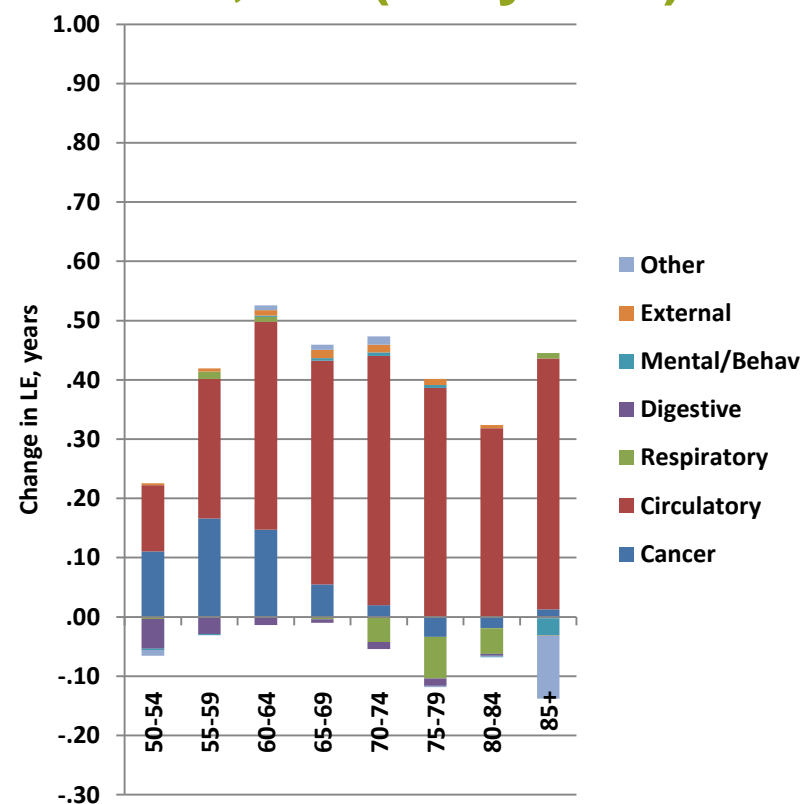
Men, Q5 (4.0 years)

# Cause decomposition of **within** group change in LE@50: 1985 to 2005, Women



Women, Q1 (3.0 years)

Women, Q5 (2.8 years)

# Summarising the 'within group' trends: Men

- LE gains concentrated in ages 70+ (55%) affluent men , but in ages <70 in deprived men (57%)

- For both affluent and deprived groups, decline in heart disease mortality major contributor to LE gains, adding more years in Q1 than Q5 (3.4y vs 2.9y).

- In contrast,  gains from redn in  Cancer mortality were larger in Q5 (0.9y vs 0.6) but were negated by increases in digestive disease mortality -0.2y).

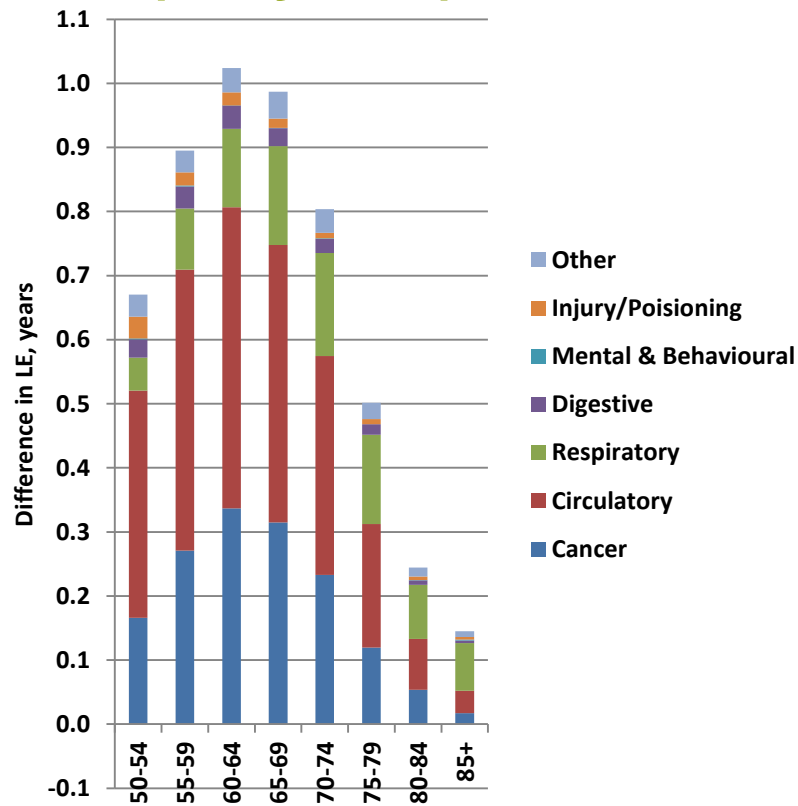# Summarising the 'within group' trends: Women

- Large gains in years at older ages due to declining circulatory disease, particularly in most affluent

- Decrements in gains in Q1 only at the oldest age (85+) attributable to Alzheimer's/ Parkinson's

- But decrements for women in Q5 due to excess mortality from digestive diseases <65, and respiratory  diseases 65+

# Between group change: *Gaps in LE@50 over time*

| LE@50 | 1985 | 1995 | 2005 | Total Change 1985-2005 (years) |
|---|---|---|---|---|
| **MALES** | | | | |
| Q1 | 27.5 | 29.3 | 32.1 | 4.6 |
| Q5 | 22.2 | 24.1 | 26.3 | 4.0 |
| **Gap, M** | **5.3** | **5.2** | **5.9** | |
| **FEMALES** | | | | |
| Q1 | 31.9 | 33.0 | 34.9 | 3.0 |
| Q5 | 27.8 | 29.2 | 30.6 | 2.8 |
| **Gap, F** | **4.0** | **3.8** | **4.3** | |

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# Inequality: difference **between** groups, Q1 vs Q5, Men



**1985 (5.3 years)**

**2005 (5.9 years)**

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# Inequality: difference between groups, Q1 vs Q5, Women



## 1985 (4.0 years)

## 2005 (4.3 years)

# Summary - 1

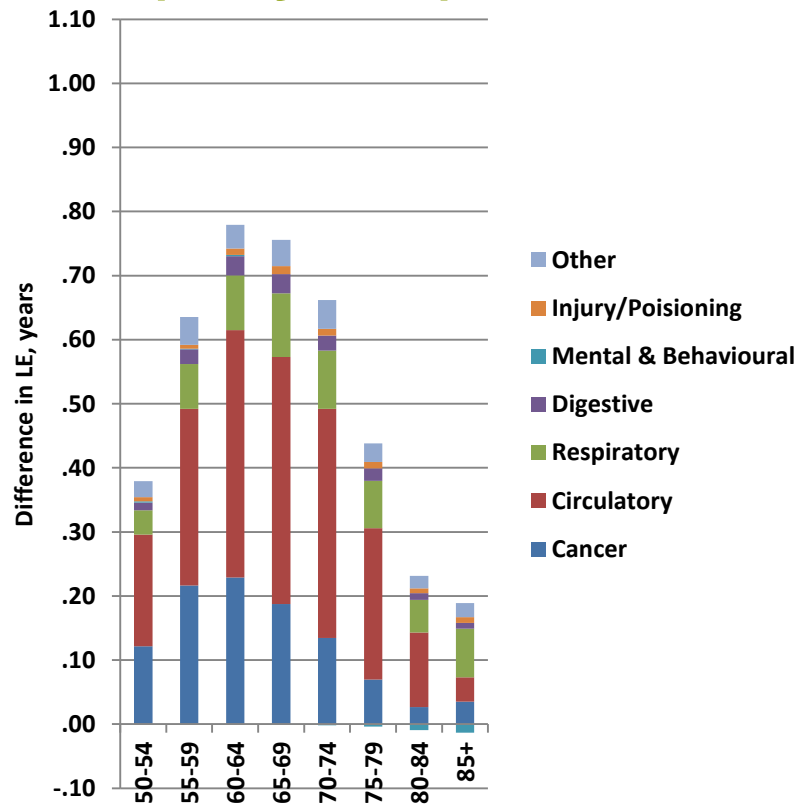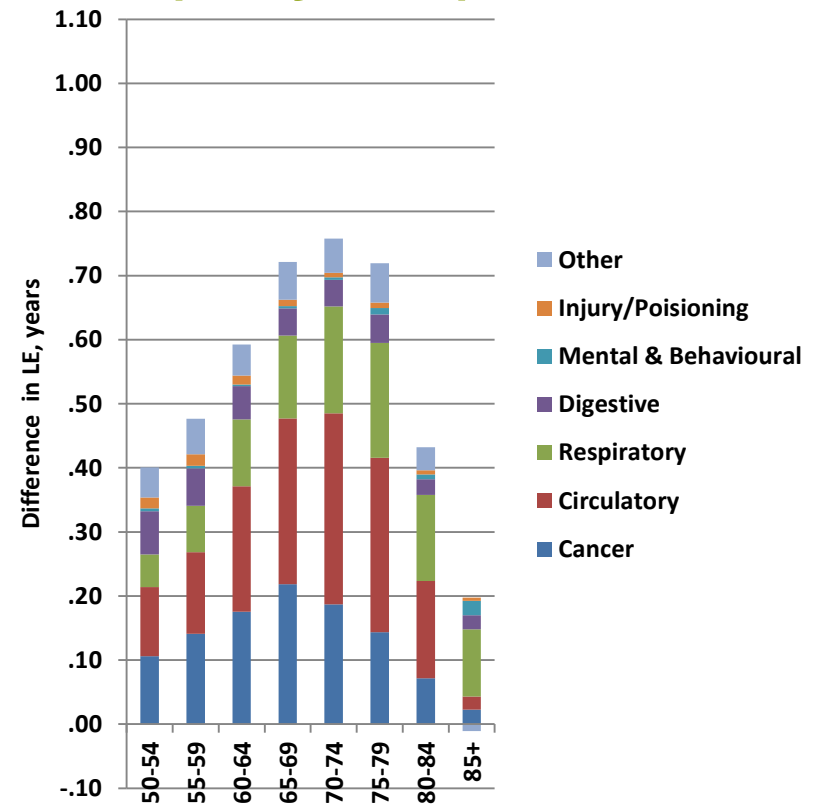- Inequalities in the life expectancy gap at age 50 have increased between 1985 and 2005 for both sexes
- Because
    - The pace of decline in mortality rates in all age groups faster in affluent areas, particularly from 1995 onwards
    - Large gains from fall in heart disease mortality across all SEC groups, but again faster in affluent areas particularly at older ages
    - Heart disease gains offset by **real** increases in rates of digestive and respiratory disease mortality in deprived groups
    - The contribution of cancer to the inequality gap remained relatively constant (ie pace of change similar in Q1 and Q5)

# Summary - 2

- Men gained more years than women overall, but women gained more years at oldest ages.

- Life expectancy gap remained wider for men than women, and increased more between 1985-2005

- Wider messages:
  - Attention needed to stem the increase in digestive, respiratory deaths in deprived populations by focusing on behavioural change (alcohol, smoking) at younger ages
  - Considerable scope to reduce heart disease mortality in disadvantaged groups
  - With continued falls in heart disease mortality at older ages, cancer may soon overtake it as the leading cause of death (NZ)

# Limitations

- Vulnerable to systematic changes in cause coding over time or between groups

- Reliability of cause-coding at oldest ages?

- Affords insights not explanations: difference in death rates between 2 groups/2 periods may be due to changing:
  - Severity of disease
  - Quality of care

- Quintile allocation fixed over time

- IMD - Health domain included, ecological fallacy

# Next steps

➢ Understand trends in annual rates of improvement in total mortality by SEC 1981- 2007 (paper in progress)

  ➢ ….and by main causes of death by SEC (paper in progress)

➢ ……. Build epidemiological CHD model by SEC 2000-07 (completed, paper submitted)

➢ …………to help develop epidemiological projection models.

# Thanks to my co-authors..

- **Shaun Scholes,** Research Fellow, UCL

- **Joseph Lu,** Mortality Risk Actuary, L&G

- **Prof David Blane,** Imperial College

- **Prof Rosalind Raine,** Head, Healthcare Evaluation Group, UCL

# Questions or comments?

Thank you.

The views expressed in this presentation are those of the presenter.

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**RESERVE slides**

# Index of Multiple Deprivation, 2007

- **IMD 2007: a composite Index of Multiple Deprivation calculated at lower super output area (LSOA) level (av pop=1,500).**
- **IMD combines 7 domains of relative deprivation:**
  - **Income, employment, health & disability, education & skills, access to services & housing, crime, quality of physical environment**
- **LSOAs grouped into equal fifths of areas by increasing deprivation (*Q1 = affluent; Q5 = most deprived*)**
- **LSOA deprivation group allocation in 2007 remained fixed over the whole analysis period (1994-2008**

# Decomposition Method

- Decomposition aims at estimating contributions of differences between elementary rates of demographic events (age-specific rates) to the overall difference between two values of the aggregate measure (eg life expectancy).

- Uses stepwise replacement method to calculate the contribution of age components of overall life expectancy difference.

- Age component difference partitioned in proportion to the cause-specific death rate difference in each age group

Refs

- **Andreev E, Shkolnikov V, Begun A. Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity progression ratios and total fertility rates. *DEMOGRAPHIC RESEARCH,* vol7, pp- 499-522, Oct 1 2002.**

- **Shkolnikov V, Andreev E: Age-decomposition of a difference between two populations for any life-table quantity in Excel. Max Planck Institute of Demographic Research (MPIDR), report 2010-002, May 2010.**

# Age decomposition equations

$$e_0^2 - e_0^1 = \sum_{x=0}^{\omega-1} \delta_x^{2-1}$$

$$\delta_x^{1-2} = l_x^1(e_x^1 - e_x^2) - l_{x+1}^1(e_{x+1}^1 - e_{x+1}^2)$$

$$\delta_x = \frac{1}{2} \cdot (\delta_x^{2-1} - \delta_x^{1-2})$$