(International) Developments in Actuarial Mortality Research

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Current Developments in Ageing and Mortality, Budapest 2017

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Plan

- Background
- Major research programmes
- Stochastic mortality modelling
- Danish population insights
- Ongoing research

ARC: Actuarial Research Centre

- 2016: Institute and Faculty of Actuaries scaled up significantly its programme of funded and commissioned research
- Funding focus: substantial, long-term research problems
- Shorter term research problems: volunteer working parties
- ARC:
  - vehicle for oversight and delivery of commissioned research
  - development of an international, virtual network for actuarial researchers with specific interests in applied actuarial research
  - Objective: *research with impact*

ARC: Actuarial Research Centre (cont.)

Major funded research programmes (2016-2020/21):

- Use of Big Health and Actuarial Data for Understanding Longevity and Morbidity
  - The development of new statistical and actuarial methods in the use of Big Data, in the context of health and wider applications
- Modelling, Measurement and Management of Longevity and Morbidity Risk
  - A new generation of mortality and morbidity models, with a specific focus on the drivers for mortality
- Minimizing longevity and investment risk while optimising future pension plans
  - Future pension products that meet customer needs, balancing stability, performance and cost

ARC: Actuarial Research Centre (cont.)

- Medium-sized commissioned projects:
  - Longevity basis risk
  - New approaches to economic modelling
  - Behavioural finance

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Big Health Actuarial Data

- Professor Elena Kulinskaya, University of East Anglia, UK
- Development of novel statistical and actuarial methods for key factors affecting mortality
- Use of "big data"
- E.g. The Health Information Network (THIN)
  - General practitioner records
  - $\sim$ 12 million patient records
  - 1987 – present
- New insights
  e.g. linking treatments to outcomes
- Refinement of existing knowledge (e.g. blood pressure treatment)

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Modelling, Measurement and Management of Longevity and Morbidity Risk

Heriot-Watt University, UK; led by Andrew Cairns

- WP1: New/improved models for modelling longevity
- WP2: Underlying drivers of mortality
- WP3: Management of longevity risk
- WP4: Modelling morbidity risk for critical illness insurance

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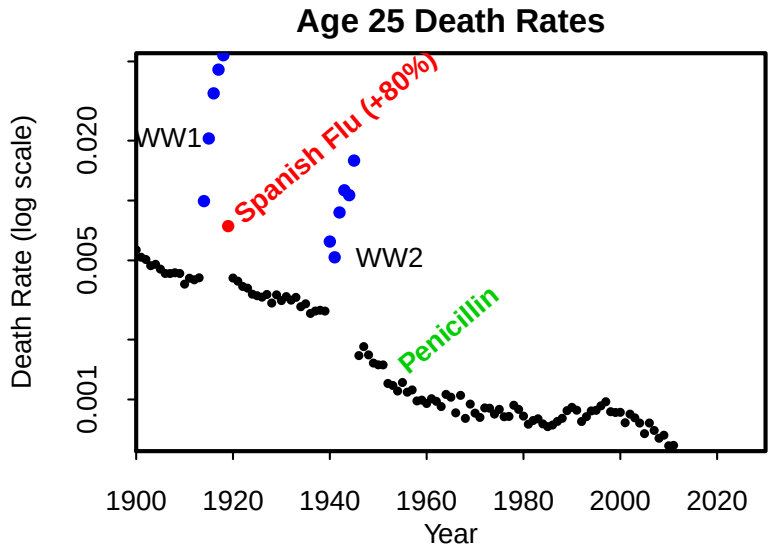
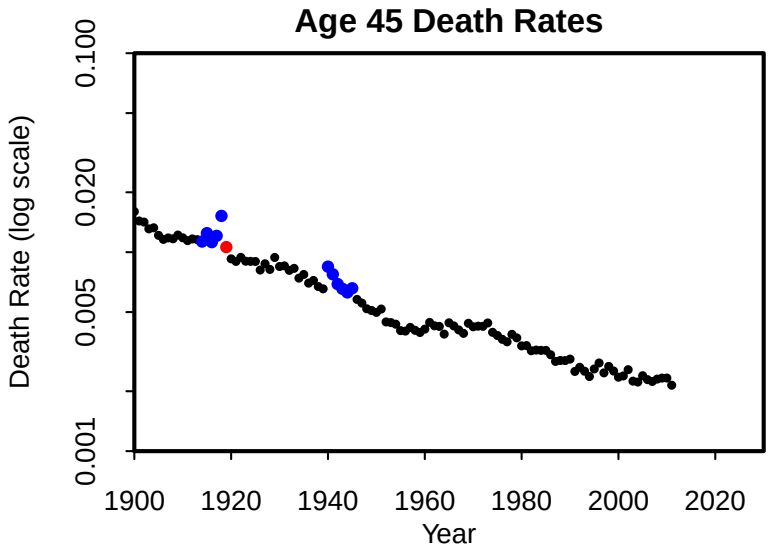
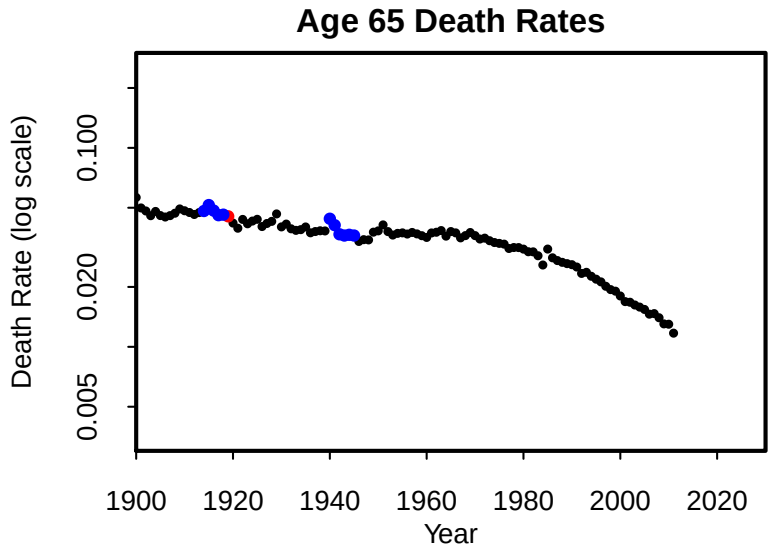
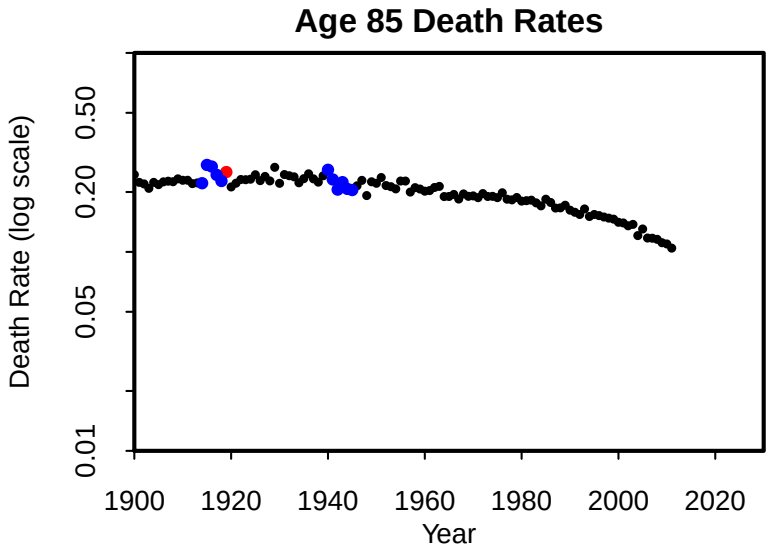
Historical Mortality Rates: Males, England and Wales



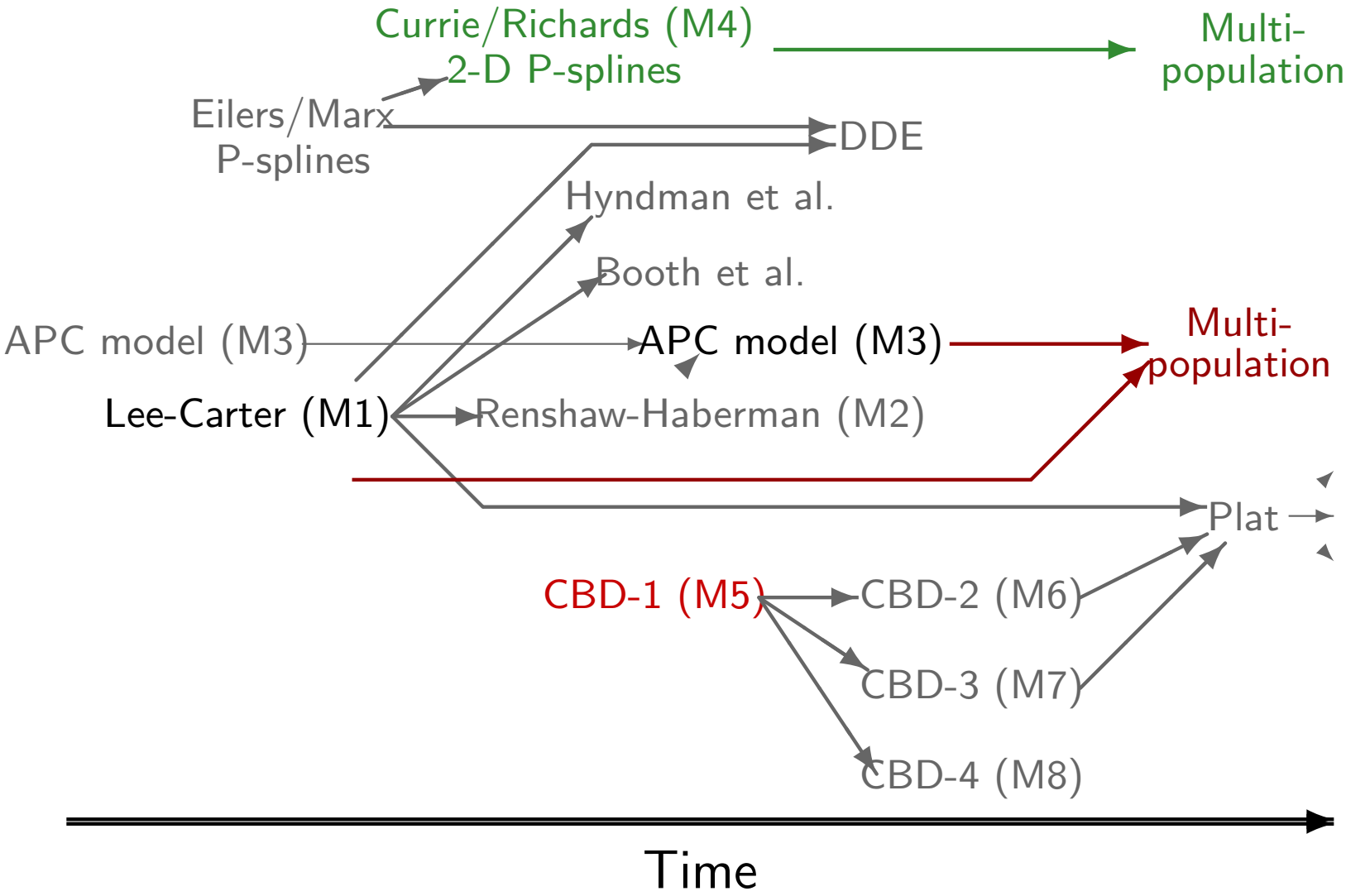






Future forecasts $\Rightarrow$ need for stochastic mortality models

A Genealogy of Stochastic Mortality Models



Stochastic Mortality Models

- Data $\Rightarrow$ uncertain future
- Modelling and measuring longevity risk is important in many actuarial applications
  - General risk assessment
  - Pricing: margin for systematic risk
  - Reserving: systematic risk in runoff
  - Reserving: systematic reserving risk over a 1-year horizon
  - Reserving: diversification benefit between two populations
  - Assessment of risk reduction in longevity hedges

Big Data and Multi-Population Modelling

Datasets:

- National datasets: Human Mortality Database
- Sub-populations: (what and why)
  - Different socio-economic groups
  - Typical pension plan or life insurer data
  - Sub-populations modelled alongside national population
  - Further road testing of stochastic models
- Big data
  - Danish national register database
  - UK: The Health Information Network (THIN)
  - US: CDC deaths

Danish Data

Many potential covariates

- Income and wealth $\rightarrow$ affluence
- Educational attainment
- Marital status, occupation, health information, cause of death, ...
- Much richer dataset than other countries e.g. UK
- UK: mortality by occupation group only
- Denmark: compare
  - Mortality by affluence
  - Mortality by occupation group
  - $\Rightarrow$ potential inferences about UK mortality by affluence

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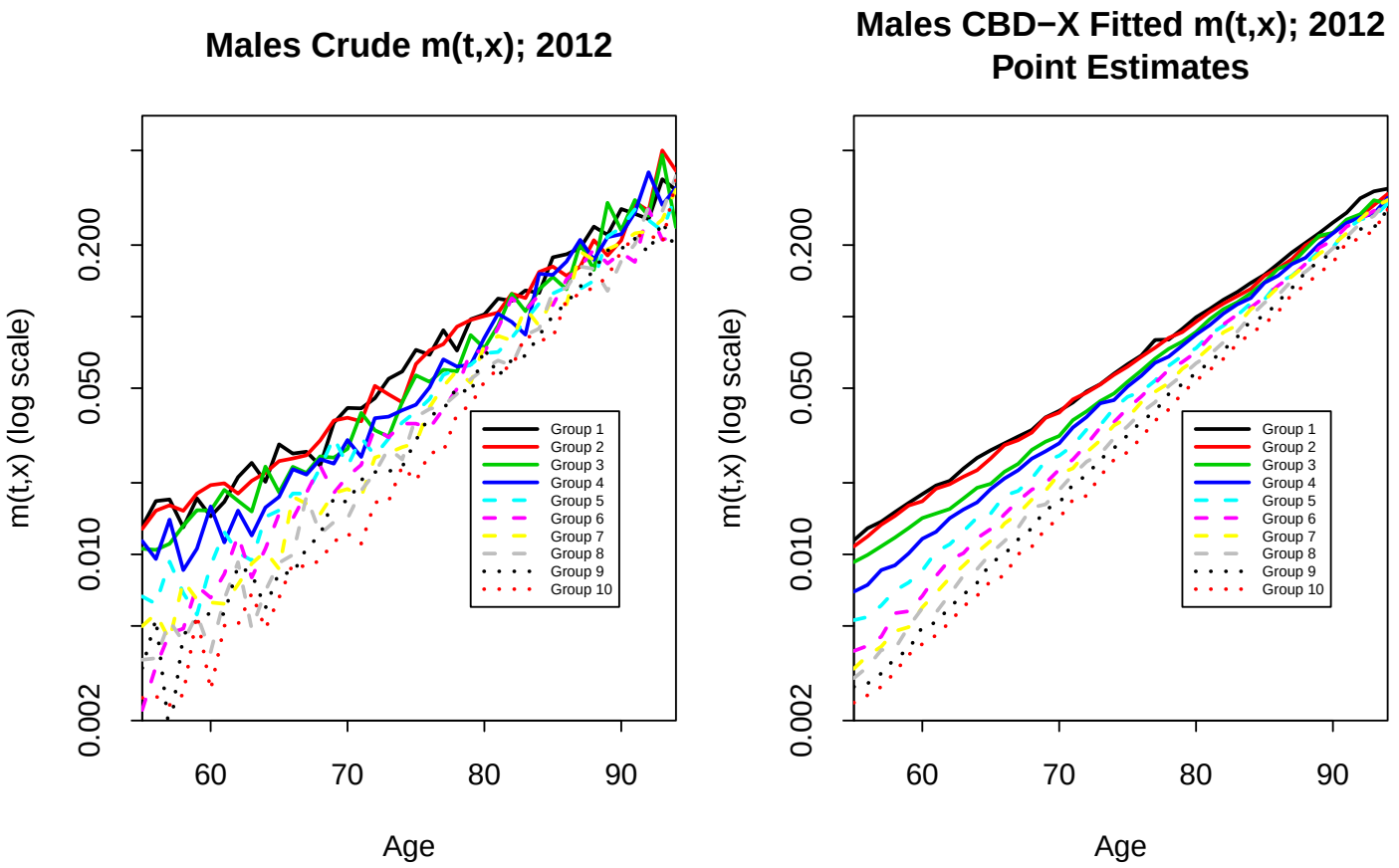
Example: Denmark, Male Death Rates in 2012



- National population → 10 affluence based subgroups
- Combination of good data/covariate and a good stochastic model
- Consistent picture over 1985-2012

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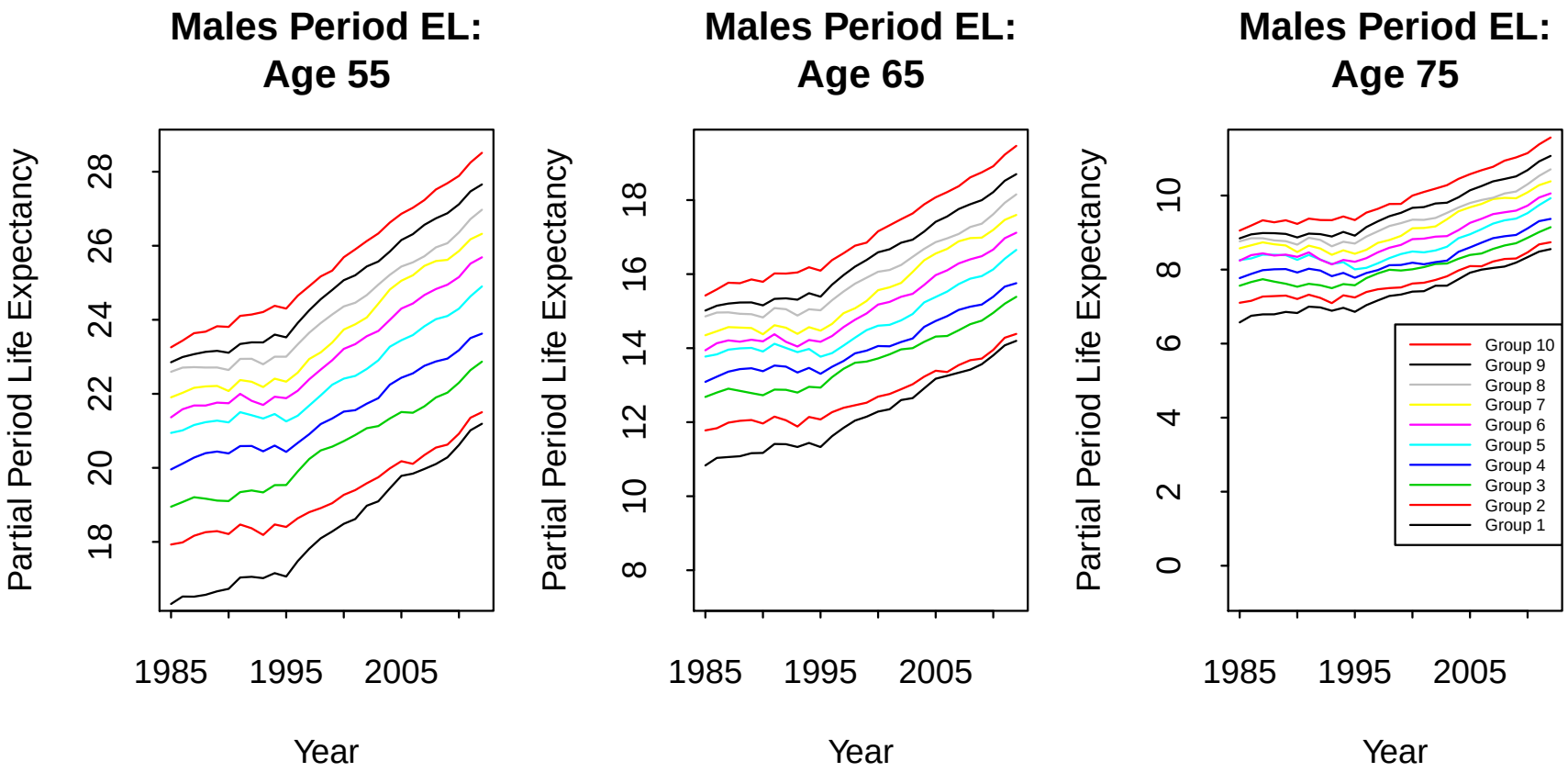
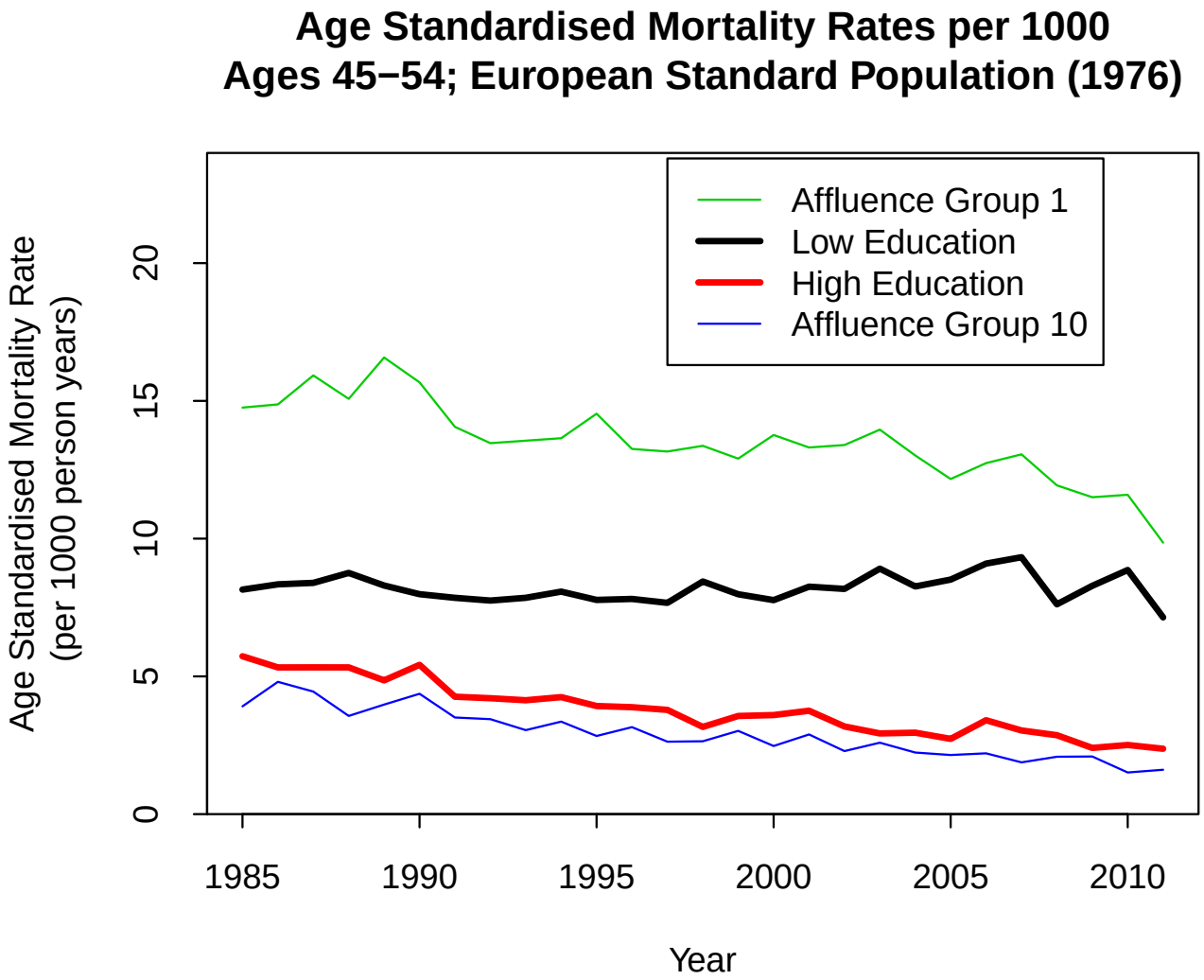
Partial Period Life Expectancy for Groups 1-10

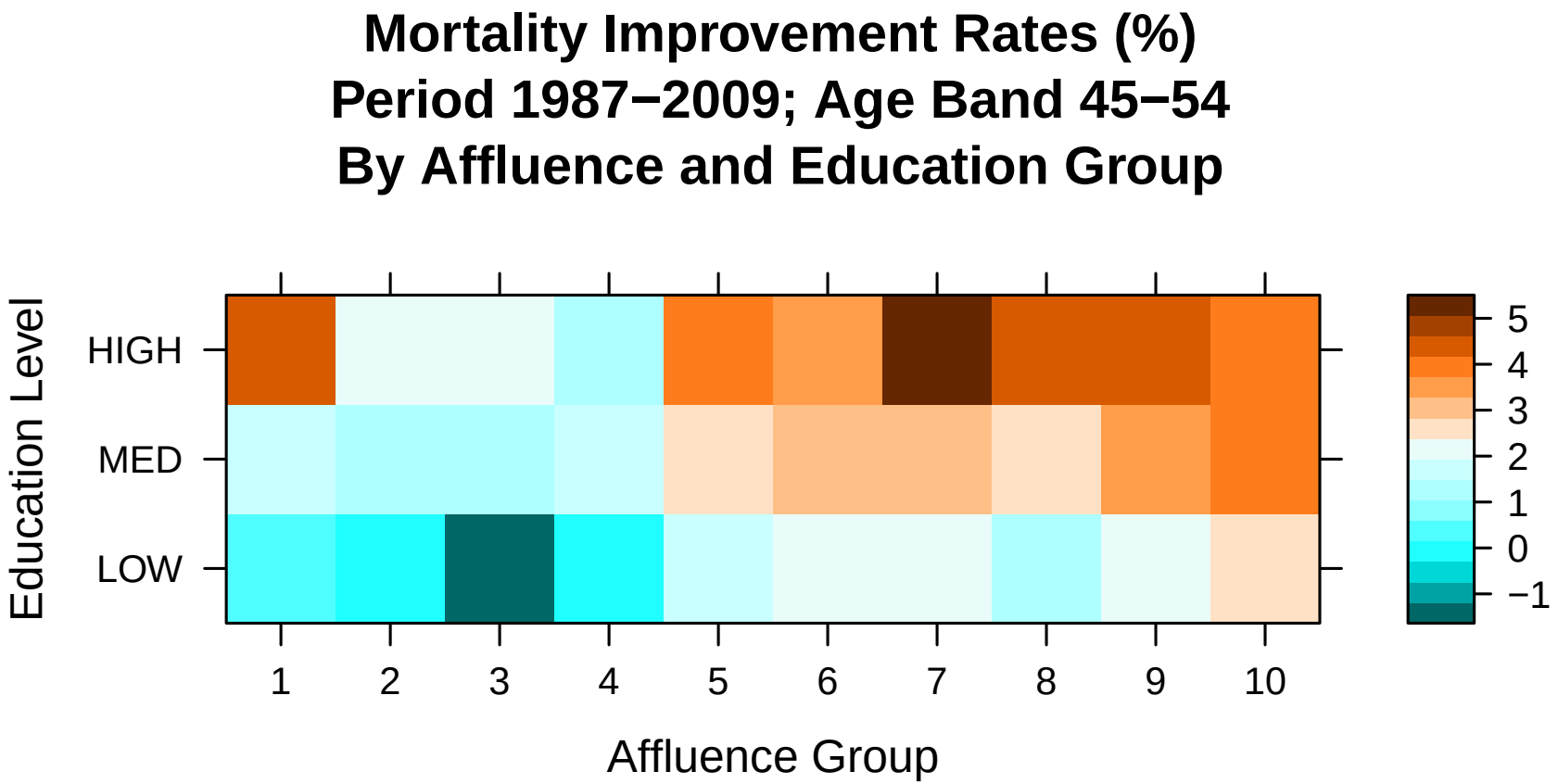


Education as an Alternative Covariate



Education as an Alternative Covariate

Dig a bit deeper:
Affluence + Education: average ASMR's over 5 years



Affluence and Education

Our conclusions based on Danish data

- Affluence is a superior predictor of high/low mortality
- Even after taking account of subgroup sizes
- Grade inflation $\Rightarrow$ education mortality trends must be treated with caution

  e.g. low educated increasingly concentrated in most deprived groups
- Combining affluence and education is potentially useful
- Some evidence that education as a second explanatory variable is growing in importance

- BUT education data is more prevalent in other countries

Denmark: Cause of Death Data

- Deaths subdivided into 27+ CoD groups
- Compare affluence groups
- Biggest differences at younger age groups e.g. 51-55
- Causes of death linked to lifestyle
  $\Rightarrow$ some CoD death rates are up to 20$\times$ higher
- *Almost all CoD groups have a strong statistically significant difference*

Denmark: Cause of Death Data (cont.)

- Some causes of death should not (???) be linked to lifestyle/affluence/education
- Possible explanations (a very non-expert view)
  - *onset* is not dependent on lifestyle/affluence/education
  - BUT less affluent/educated $\Rightarrow$
    - ??? later diagnosis
    - ??? engage less well with treatment process

Other Lines of Work

- Developing new datasets
  - More with Danish data
  - Pension plan data (various e.g. UK, Canada)
  - US: CDC deaths records
  - Objective: suitability of individual stochastic models for specific applications
  - Cause of death data: further insights

Other Lines of Work (cont.)

- Multipopulation stochastic mortality models
  - Refining existing models
  - Developing new models
  - Testing out existing and new models on real data
  - Risk management applications

Other Lines of Work (cont.)

- Single population stochastic mortality models
  - New models
  - New flexible and robust approaches to model fitting
  - Wider age ranges
  - Time series model calibration:
    Flexible approaches to determining central forecast
  - Using stochastic scenarios to select deterministic stress tests and scenarios

Other Lines of Work (cont.)

- Applications
  - Risk assessment $\rightarrow$ risk management
  - Assessment of longevity hedges
  - Impact!

Thank you!

Questions/Discussion

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