Emerging Trends in Longevity and Mortality
Greg Becker and Garth Lane

From fast food to fast runners: changing mix, clouding conclusions

September 2011
Agenda

1. Longevity Models
2. Heterogeneity (model risk)
   - Generational Heterogeneity
   - Heterogeneity in sub-Populations
3. Predicting the future
   - Cohorts
   - Causal Effects
4. Conclusions
Graph illustrating Longevity and distribution
We need models: Otherwise how do we estimate life expectancy improvements?

Past data

Industry studies

Population studies

Medical studies

Life tables

Future life tables

Trend Extrapolation

Expert Judgement

Life Tables
Black Swans – another name for model risk?
Did you hear that brontosaurus mortality has been improving every year?

Yeah, I was thinking about investing in that retirement pond down in Florida.
What do we ‘know’?

1. Measured expectations of life are increasing
2. This measure is improving faster for certain ages than others and differs between males and females
3. Certain cohorts seem to have faster improvement rates – the so-called ‘golden generations’
4. Everybody dies

It ain’t what you know that hurts you but what you do know that ain’t so
Donald Rumsfeld on Longevity

- There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know.
- "I would not say that the future is necessarily less predictable than the past. I think the past was not predictable when it started."

"We do know of certain knowledge that you will either be alive a long time, alive a short time or you will be dead."
Heterogeneity – A model breaker?

Curves look the same?
Heterogeneity – A model Breaker

Curves look the same?
The two graphs are different time periods for the same two series
What is the difference between Series 1 and Series 2?

- Each series reflects the survival of 2000 lives from age 50
- Series 1 assumes that everyone has the same qx profile
- Series 2 assumes that there are 3 kinds of people
  - Some with standard qx mortality
  - Some with higher mortality and
  - Some with lower mortality

After 30 years, one would not have the data to separate the models and identify which is most accurate!
Fast Food and Fast Runners

- Metaphors
  - Heterogeneity within sub populations
  - Healthy and non-Healthy lives
  - Differential Attitudes towards Health Consciousness
  - Relative ability to select against people placing bets on longevity
  - ‘Golden’ cohorts vs ‘Normal’ cohorts

- We need to distinguish between what we know and what we assume we know!
Generational Heterogeneity

• Can be anomalous
  – Early period record keeping
  – Misclassification of cause of death
• Key Generational analysis – so called cohort analysis
  – Aggregate population analysis
  – P-Spline
  – Heatmaps
  – Postcode differentiation (socio economic proxy)
  – Stochastic projections
Cohort effect it is not
This is the gulf stream off the coast of Europe
Real Heatmap?

Improvement heatmap for males in England & Wales.

Source: Own calculations using smooth 2D age-period P-spline model applied to ONS data for males in England and Wales, 1961–2007. (Richards S www.longevitas.co.uk)
Furthermore, an analysis of patterns of cigarette smoking suggests that there is a degree of inevitability in some element of likely future improvement, especially for mortality at older ages from conditions strongly linked to smoking.

There are a number of reasons to believe that the cohort effect will have an enduring impact on rates of mortality improvement in the U.K. in future decades.”
As exploratory techniques, graphical and statistical modelling methods may suggest the existence of cohort patterns (or indeed period ones, although a review of the literature suggests that this is rarely if ever done, since the overwhelming interest is in establishing cohort effects), but they do not elucidate the underlying causes.
“In an authoritative consensus view of this area, the British National Statistician (Dunnell, 2008, p19) accepts the existence The ‘Golden Generations’ of the ‘golden generations’, but concludes that there are still only a series of explanatory hypotheses that include:

1. Changing smoking patterns between generations
2. Better diet and environmental conditions during and after the Second World War
3. Those born in periods of low fertility facing less competition for resources as they age
4. Benefits from the introduction in the late 1940s of the Welfare State
5. Benefits from medical advances..”

Not proven
“The analysis presented here suggests that the evidence for the existence of cohort effects based on an analysis of simple mortality tables using increasingly sophisticated computational techniques has sometimes been over-interpreted, and that there has been a lack of attention to the underlying mechanisms. If the changes are driven by some as yet unidentified series of events that occurred many decades ago, it is unclear whether such effects will continue until the highest ages”
Generational Heterogeneity: Murphy 2009

Cohort Mortality Rates and Improvement

![Graph showing mortality rates for non-smokers, smokers, and aggregate over cohorts from 1890 to 1956.]

Apparent Cohort Effect

Cohort Smoker Proportion

![Graph showing the proportion of smokers in cohorts from 1890 to 1956.]

- Non-Smoker
- Smoker
- Aggregate
In 2001 Ausubel, Meyer and Wernick examined US mortality since 1900

- Fitted logistic curves to underlying causes of mortality
- Used a competing risks model
- Examined problems with data carefully and identified areas of bias
- No age adjustment
Generational Heterogeneity: Medical Advances

Ausubel, Meyer and Wernick 2001
Generational Heterogeneity: Medical Advances

![Graph showing the fraction of all deaths due to various causes over time.](image-url)

- Cardiovascular
- Neoplastic
- Influenza + Pneumonia
- Tuberculosis
- Gastrointestinal
- AIDS
- Typhoid
- Diphtheria

Ausubel, Meyer and Wernick 2001
Generational Heterogeneity: Medical Advances
Generational Heterogeneity: Rise and fall of Ischaemic Heart Disease in the US

Stallones: Scientific American 1980

Age adjusted to 1940 census

Log scale on vertical axis
Medical Advances or an Epidemic of Heart Disease?

- Caused by inflammation in a generation affected by the Spanish flu that took decades to work its way through?
- A period effect as illustrated by Murphy?
- Can we venture that there is no golden generation, merely a diseased generation returning to health?
- Did antibiotics help?
- James Le Fanu claimed this was an epidemic in his book “The rise and fall of Modern Medicine”
Medical Advances or an Epidemic of Heart Disease?

Fig 1 Mortality from coronary heart disease (per 100 000) in men aged 45-64 in (a) the United States, Canada, Australia, and New Zealand; (b) western European countries; and (c) eastern European countries

BMJ 2002
Sub-population Heterogeneity

- Fast-food eaters and fast runner in the literal sense
- Active inclusion in the sub-population versus passive inclusion
- Movement between groups
- Long term health effects or benefits
- Clouded by presence of ‘knowledge’ that ain’t so
- Counterintuitive outcomes
Woody Allen on Health clip from Sleeper
Not just an American problem...

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Obesity Trends* Among US Adults
(*BMI>=30, or ~ 30 lbs overweight for 5'4" women)

http://lamarguerite.wordpress.com/2008/07/04/can-americans-downsize/
Hospital obesity admissions increase by 30% in a year

The number of people admitted to hospital in England for obesity-related reasons rose by more than 30% last year.

But NHS statistics also show a rise in obesity rates in adults seen in recent years may be flattening out.

Experts believe it is too early to say if rates of obesity are now decreasing.

The health watchdog NICE recently advised that more cases of serious obesity should be treated in hospital.

There has also been a change in the way hospital procedures are recorded, meaning more obesity-related operations make their way into the statistics.

The number of weight-loss hospital procedures (bariatric operations) carried out in England rose by 70%, from just over 4,200 in 2008/09 to just over 7,200 in 2009/10.
Sub-population heterogeneity: Fast Food Eaters

UK HSE BMI Trends - All Adults

Log Proportion

- Underweight
- Normal
- Overweight
- Obese
- Morbidly Obese

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Obesity all Bad?

National Health and Nutrition Examination Surveys (NHANES I and NHANES II) follow-up studies

Hazard Ratio for all cause mortality

Lowest Hazard at BMI of 27.5!
Diabetes and obesity – a link?

References: National Institutes of Diabetes & Digestive & Kidney Diseases (NIDDK), WebMD.com, Centers for Disease Control.

Sub-population heterogeneity: Fast Runners

- The picture of health?
- Will this convert into longevity?
- Will extreme exercise stress reduce age spans
Sub-population heterogeneity: Fast Runners

- Long distance runners and skiers lived longer than reference cohorts (LE = 2.8–5.7 years longer; OR=0.59)
- Ice-hockey and basket-ball players, track and field jumpers, short and middle-distance runners and hurdlers survived longer than reference cohorts (LE = 4.0 years longer; SMR= 0.68)
- Not so good for footballers and power-lifters and abusers of steroids and other supplements
- The big question is whether these elite athletes have been selected essentially through their genetic fitness for these activities?
Fast Runners – Calorific Restriction

Fig. 1. Animal appearance in old age. (A and B) Photographs of a typical control animal at 27.6 years of age (about the average life span). (C and D) Photographs of an age-matched animal on CR.

Works for rats
Works for monkeys
Will it work for you?
Fast Runners – Calorific Restriction

2009 – Is it really working?

Picture Copyright 2000 Scientific American Inc
How easy is it to significantly affect one’s own longevity?
Can the Fast Runners rely on Modern Medicine and Epidemiology?

- Eggs are bad for you
- Eggs are good for you (2009)
- Saturated fat is bad for your heart
- “There’s no connection whatsoever between cholesterol in food and cholesterol in blood. And we’ve known that all along. Cholesterol in the diet doesn’t matter unless you happen to be a chicken or a rabbit” – Ancel Keys 1997
- Statins reduce the number of incidences of heart related events (absolute effects low – relative effect high)
- Statins don’t affect total mortality end-points but have numerous side-effects – Cochrane 2010
Are the Fast Food Eaters really destined for an early grave?

- Chocolate
- Saturated Fat
- Salt
- Apples versus Pears
- BMI
Predicting the Future: Heterogeneity Blender

Certainty Blender
- Obesity
- Diabetes
- Resurgence of smoking

Speculative Blender
- Drugs
- Calorific Restriction
- Exercise and Health

Period Effect
Uncertain Outcome
Conclusions

• It is stating the obvious but be very careful of heterogeneity
• Without proven causes why should we extrapolate cohort effects?
• Without a quantum leap in our ability to affect ageing (a ‘black swan’) the diseases of old age are not going away.
• Infectious disease may make a comeback
• There does not seem to be an elixir
• The pendulum has possibly swung too far towards high estimates of longevity improvement
• We would advocate Moderation in everything
Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged. The views expressed in this presentation are those of the presenters who can be reached at:

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