



Mortality Improvements

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Indian Context

Importance of Mortality Assumptions

Relevant Characteristics of Indian Market

Actuarial Perspective

- Reasons why mortality assumptions have historically not been too significant:
 - Products were savings biased.
 - Products were on a with-profits basis.
 - Competition was less, so margins weren't squeezed.
- Why the future might be different:
 - Pure term assurance products now growing in popularity.
 - Pensions will lead to annuities in payment.
 - Competitive pressures are increasing.
 - Dropping interest rates makes mortality assumptions relatively more significant.



Lessons Learned

If we could do it all over again...

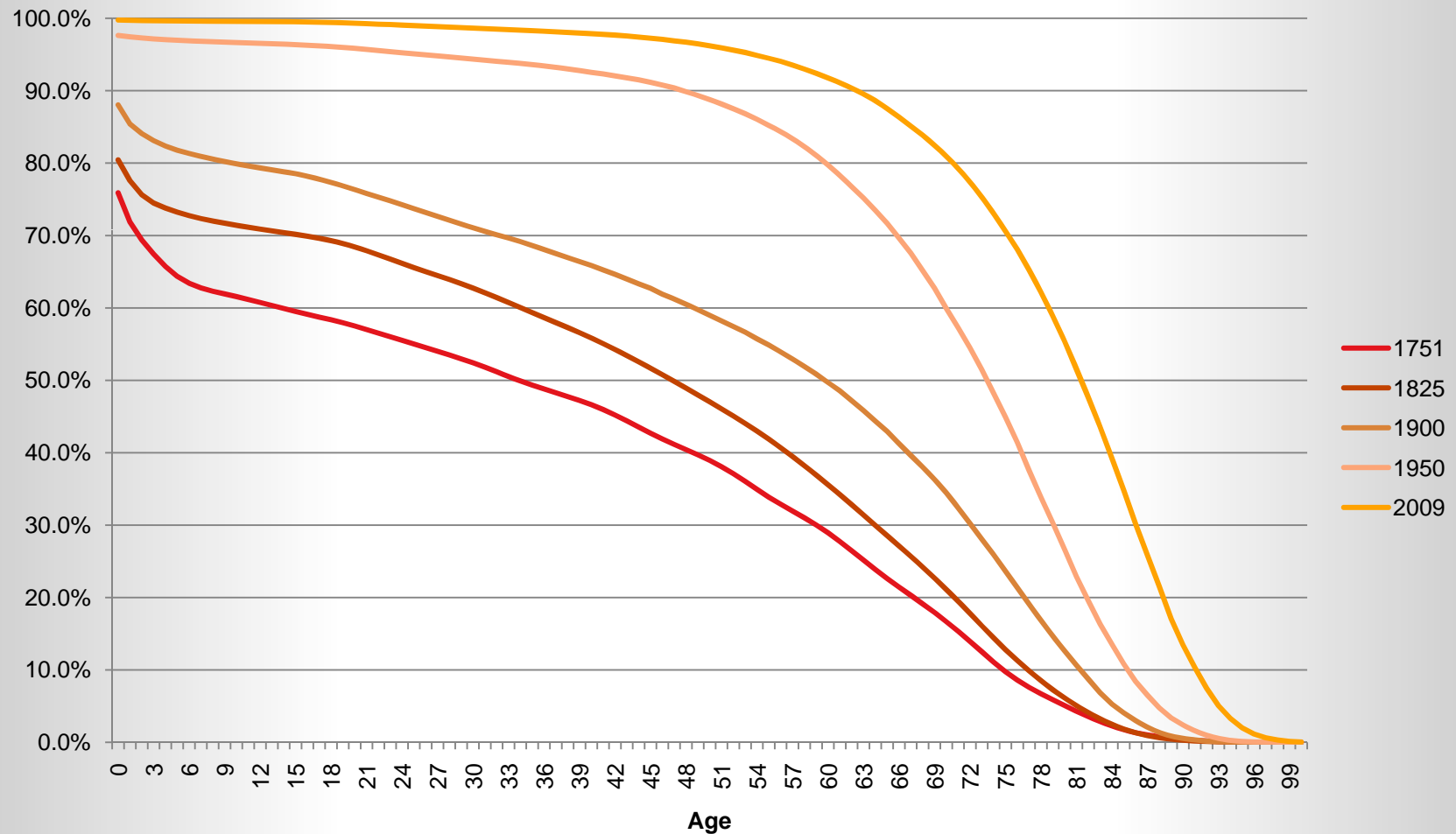
Lessons Learned Abroad

In a Perfect World

- Start collecting data a long time ago.
- Capture numerous data points.
- Retain full granularity.
- Make 100% industry participation mandatory.
- A fancy model is still just a guess.
- Allow for risk of having made a wrong guess.

Mortality Improvement

Sweden Male Life Table - Percentage Surviving

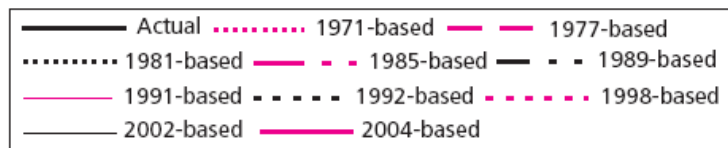
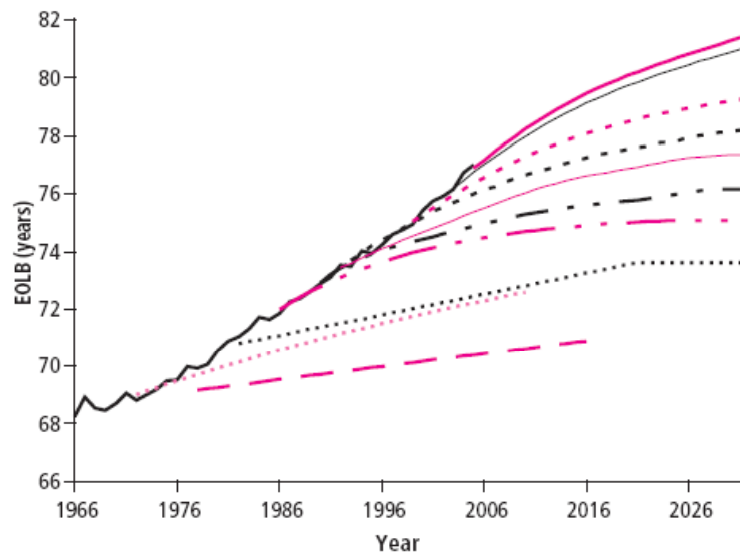


A history of underestimating life expectancy

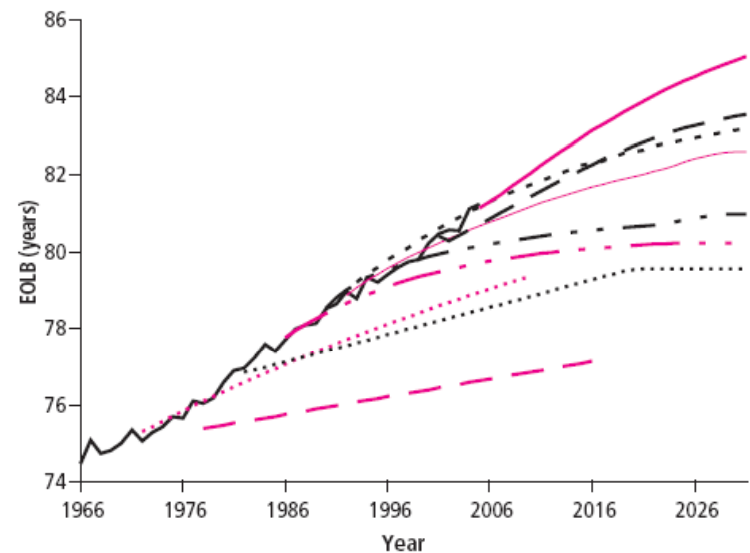
Figure 5

Accuracy of mortality assumptions

(a) Actual and projected period life expectancy at birth, males, 1966–2031



(b) Actual and projected period life expectancy at birth, females, 1966–2031



Source: Fifty Years of United Kingdom national population projections: How accurate have they been? Chris Shaw, Office for National Statistics (2007), © Crown copyright 2007

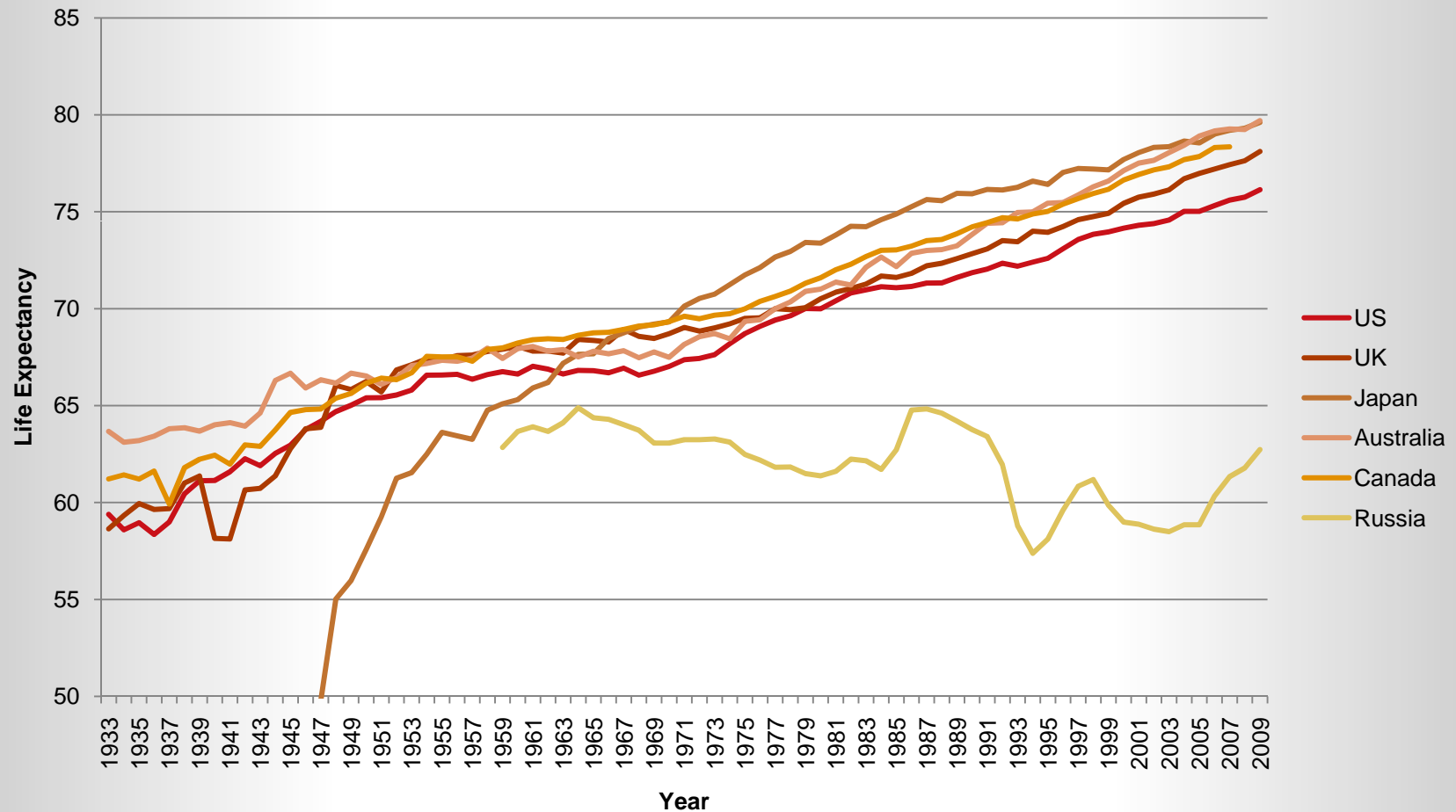


Historical Mortality Improvements

Parametrising the Question

Global Life Expectancy Improvements

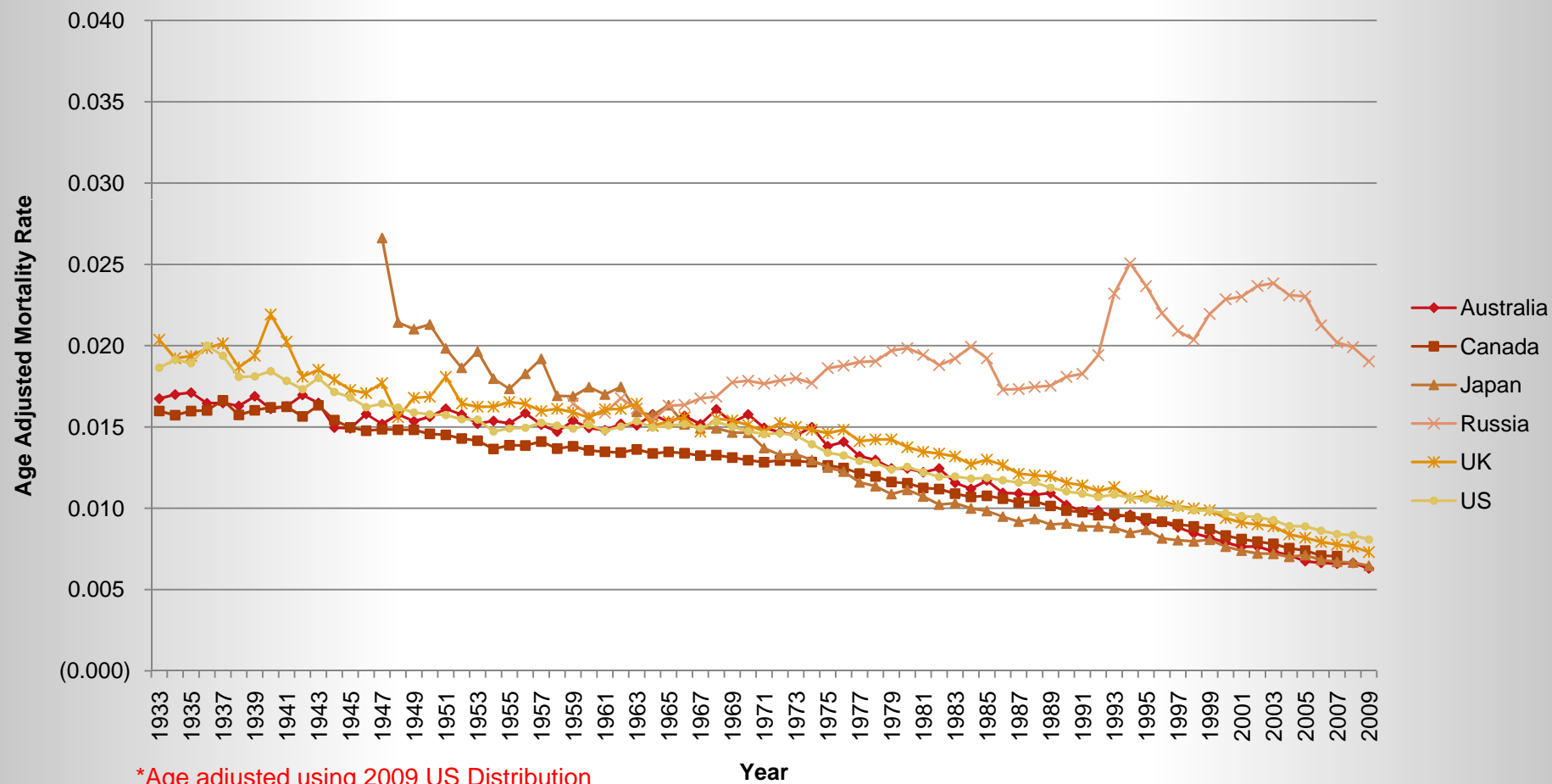
Male Life Expectancy at Birth



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/>

Country Specific Mortality Trends

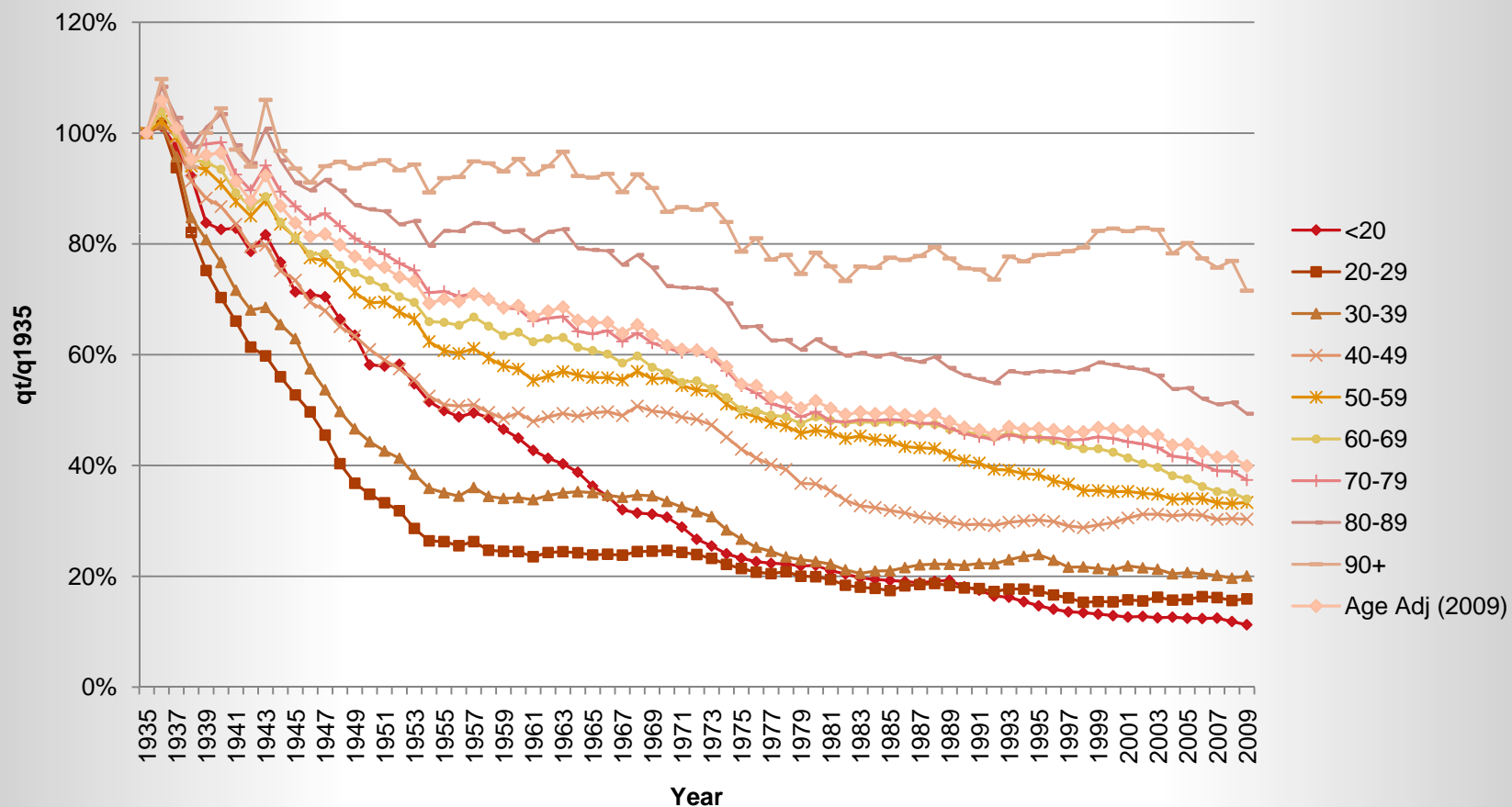
Age Adjusted Mortality by Country - Male



*Age adjusted using 2009 US Distribution

Country Specific Mortality Trends

US Female Mortality by Year/Age



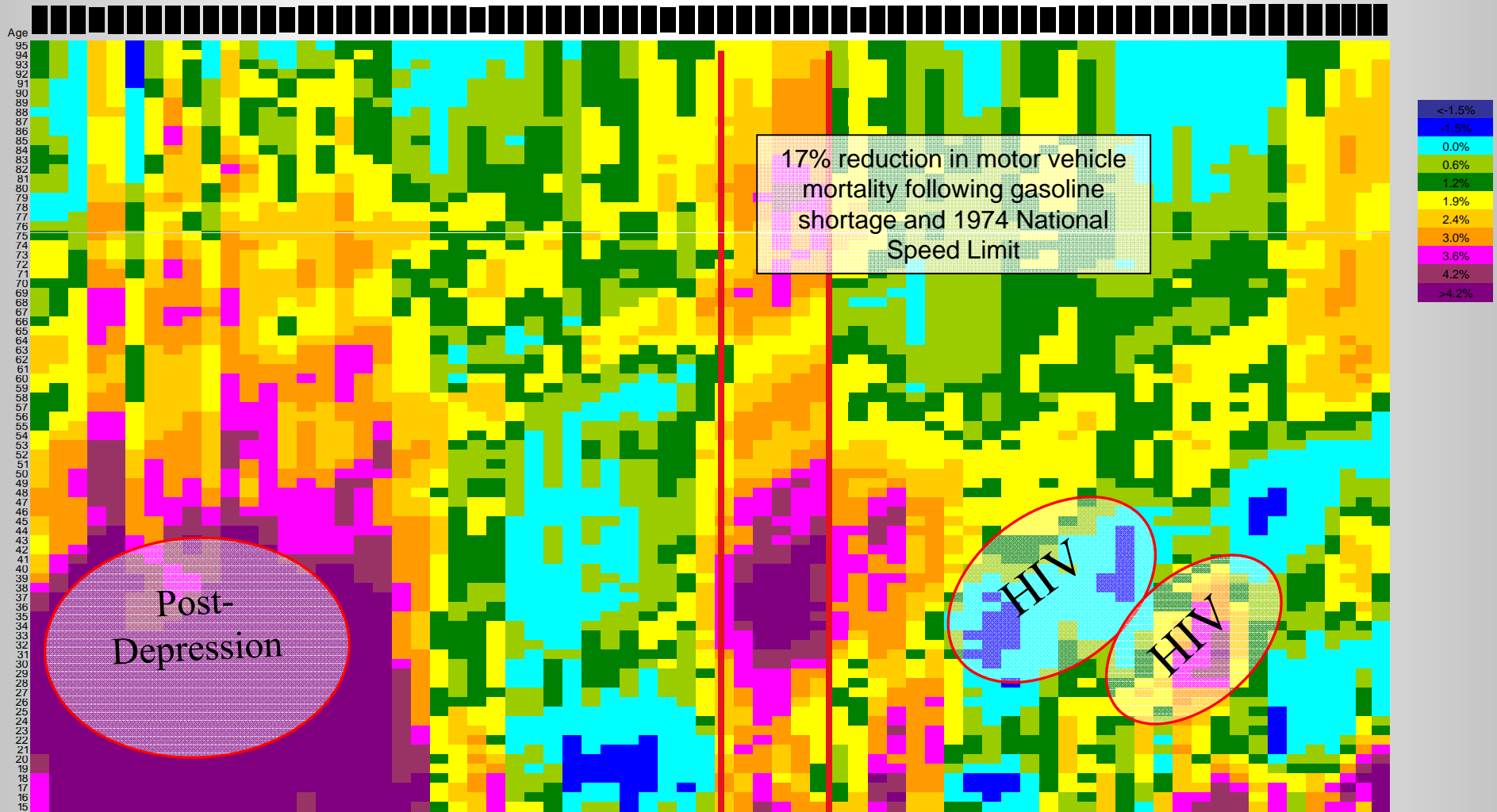


Cohort Effects

Types of Mortality Improvement

Cohort Effects seen around the world

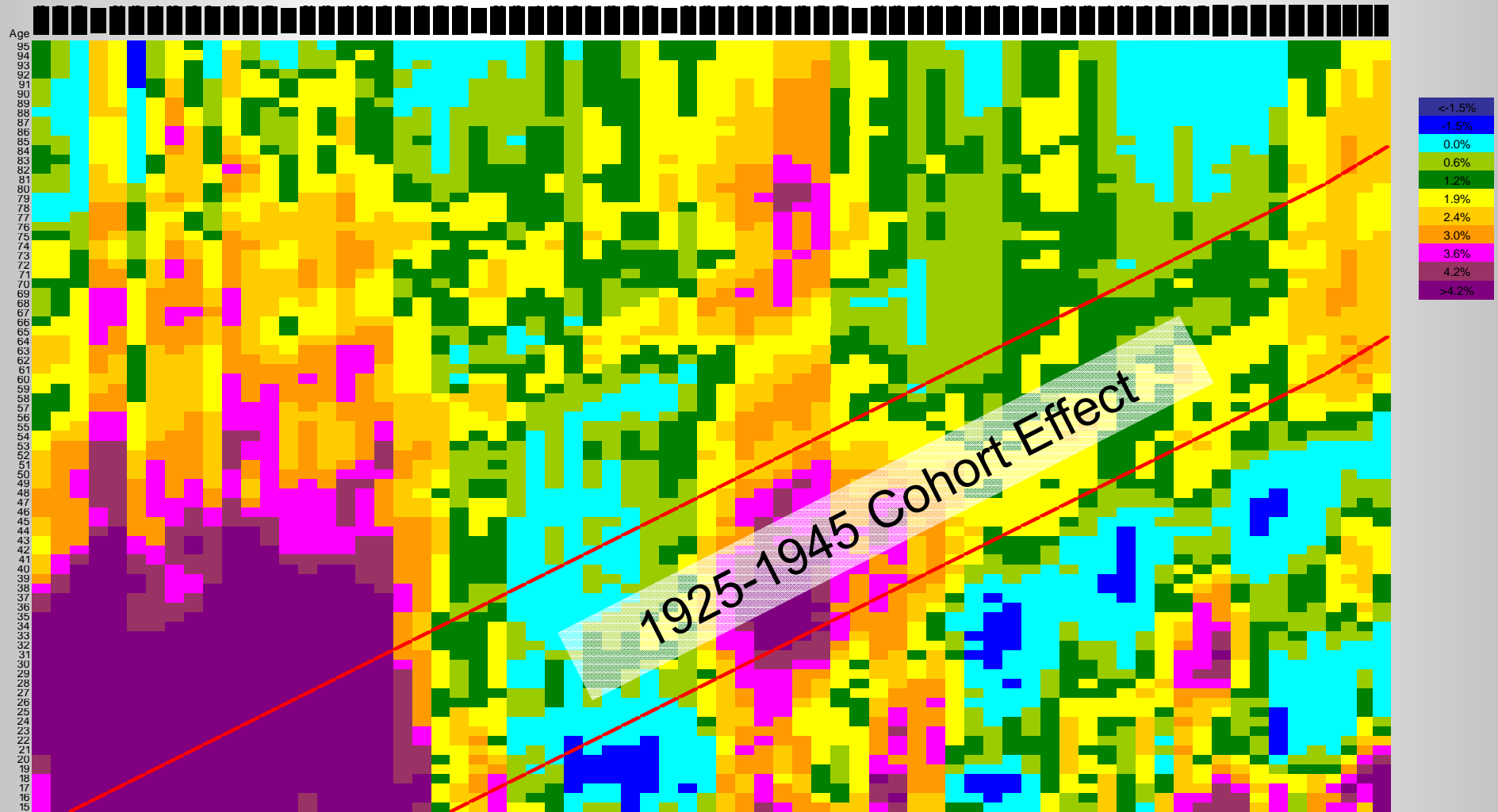
US Female Improvement by Age/Year



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 13

Rolling 5-year, 3-age average reduction in life table mortality rate

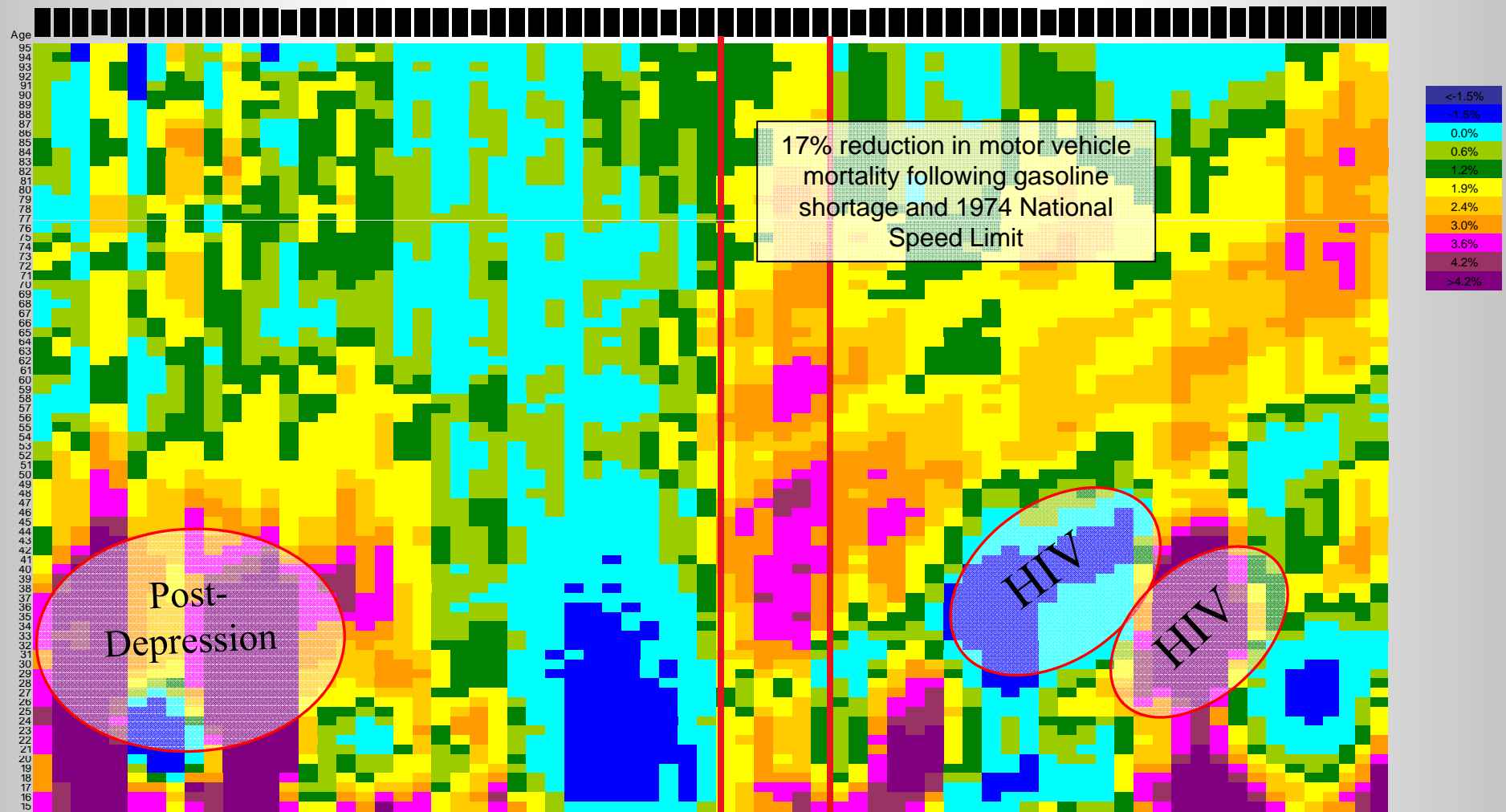
Cohort Effects seen around the world US Female Improvement by Age/Year



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 14

Rolling 5-year, 3-age average reduction in life table mortality rate

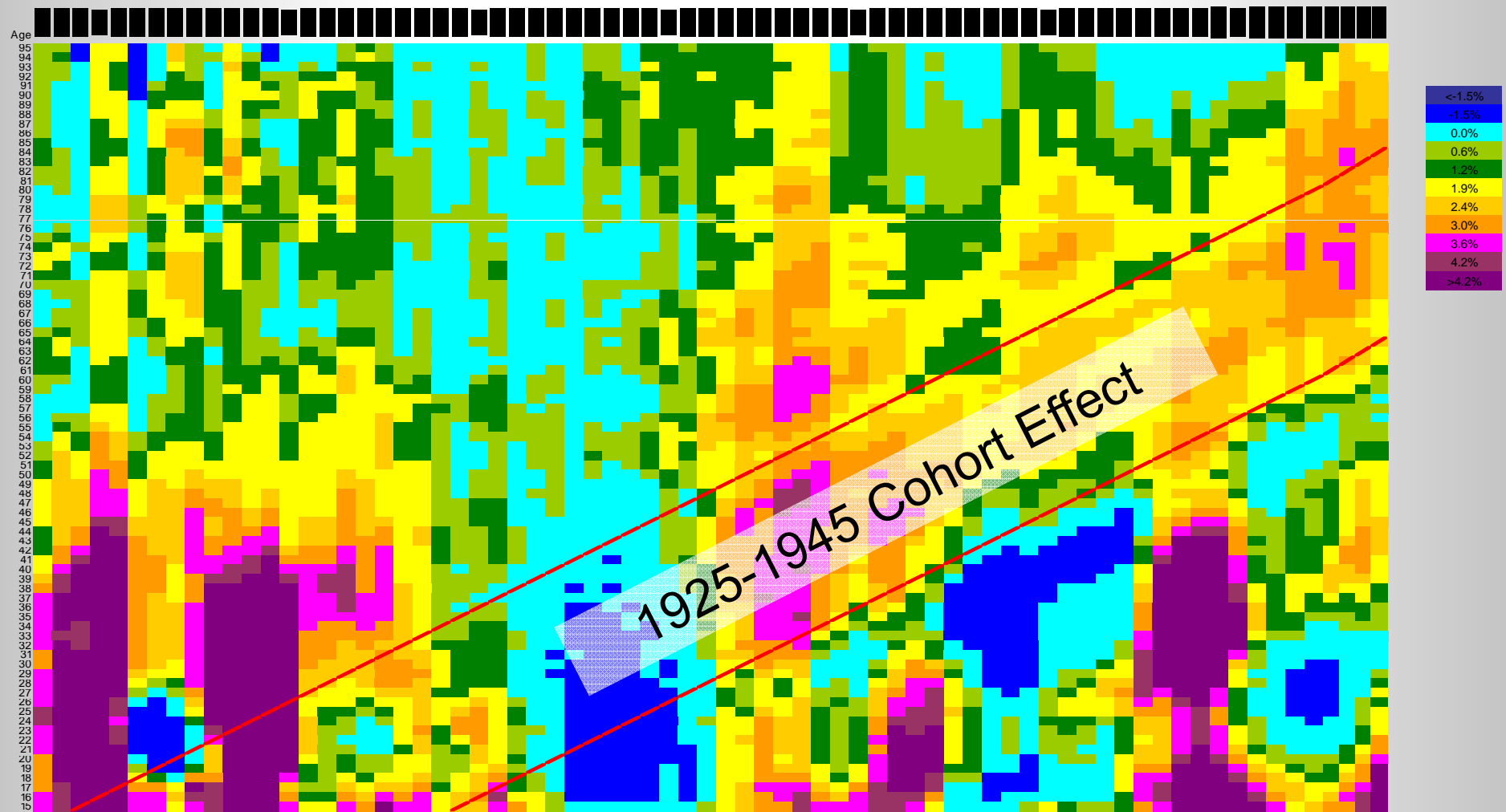
Cohort Effects seen around the world US Male Improvement by Age/Year



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 15

Rolling 5-year, 3-age average reduction in life table mortality rate

Cohort Effects seen around the world US Male Improvement by Age/Year

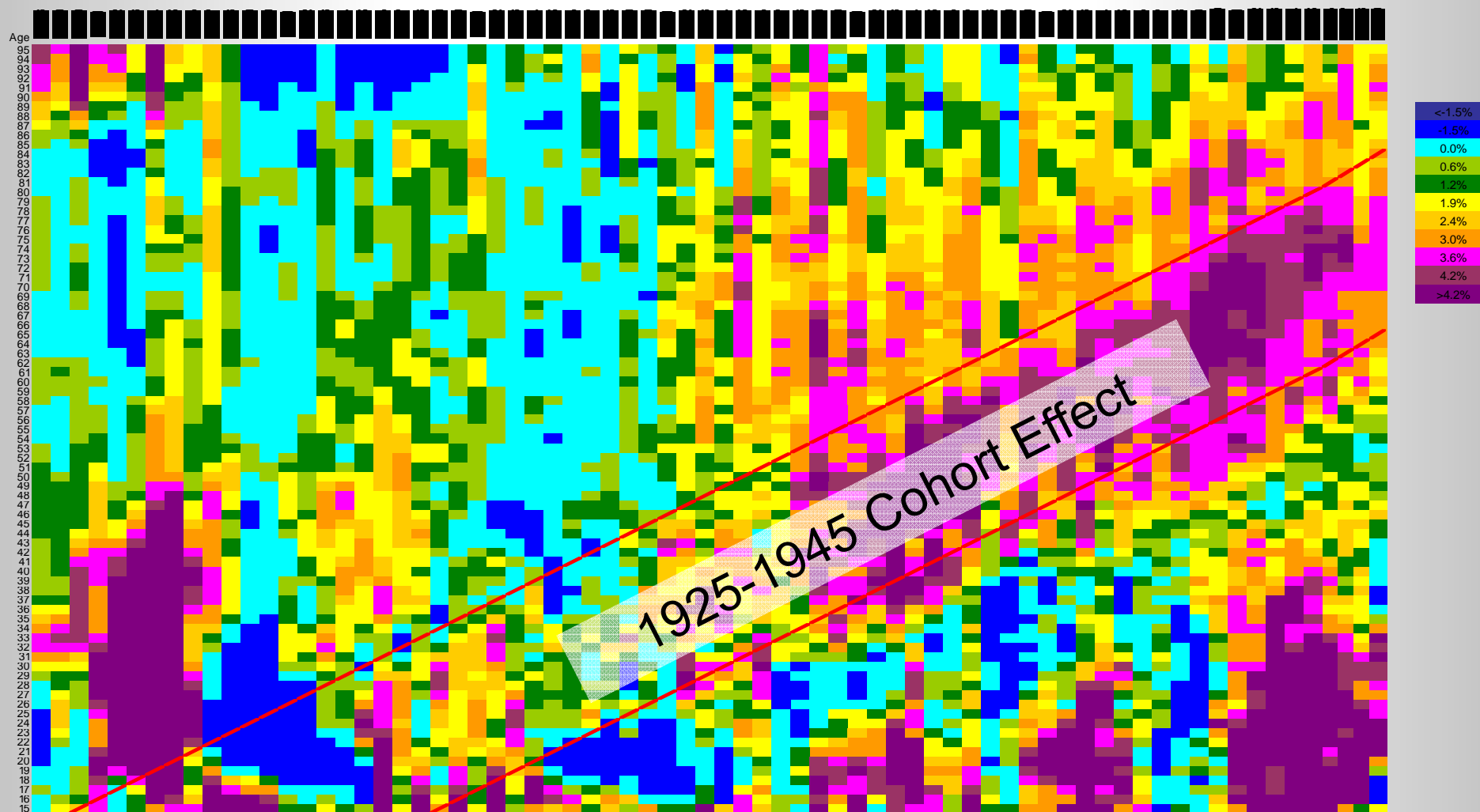


Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 16

Rolling 5-year, 3-age average reduction in life table mortality rate

Cohort Effects seen around the world

Australia Male Improvement by Age/Year

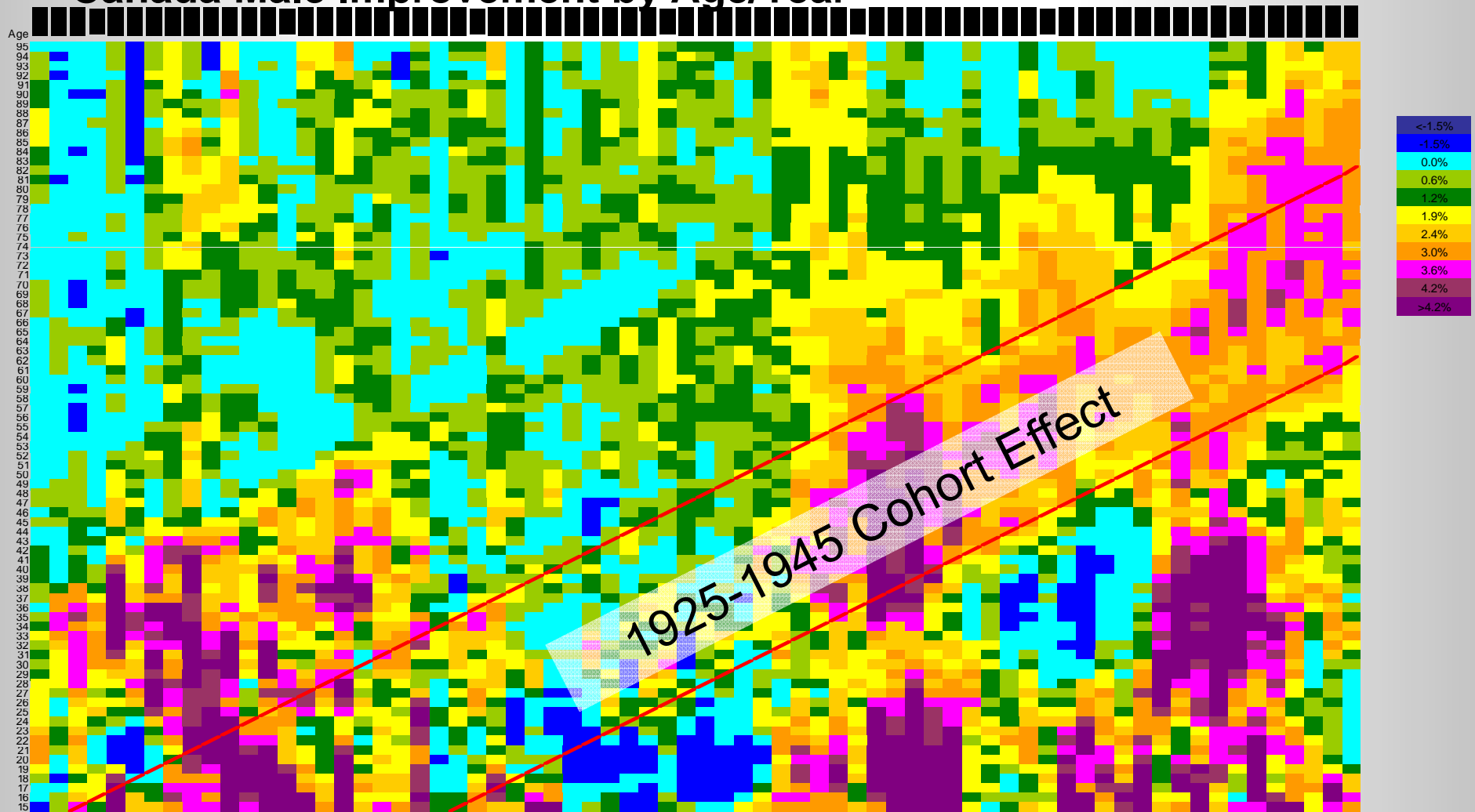


Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 17

Rolling 5-year, 3-age average reduction in life table mortality rate

Cohort Effects seen around the world

Canada Male Improvement by Age/Year

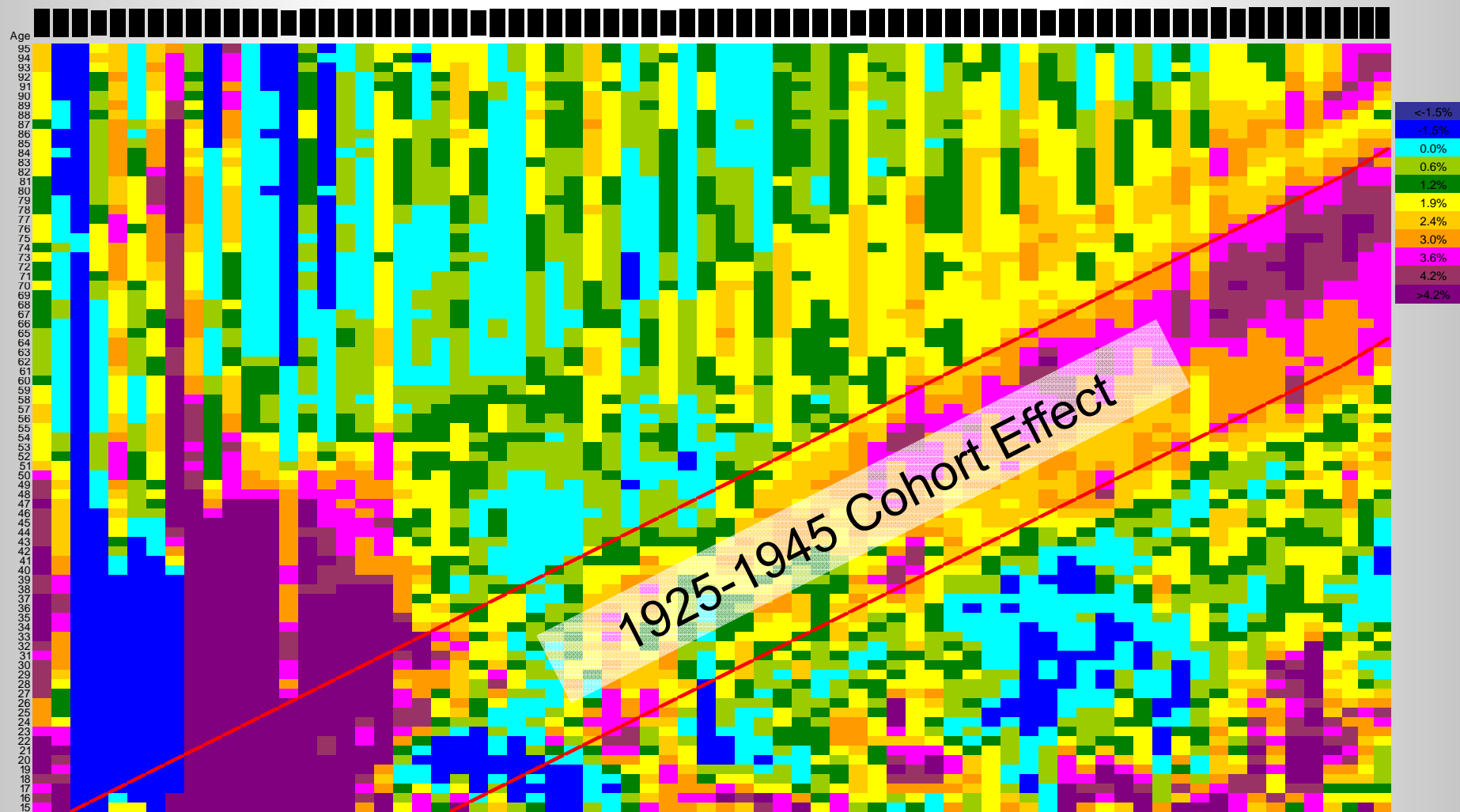


Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 18

Rolling 5-year, 3-age average reduction in life table mortality rate

Cohort Effects seen around the world

England & Wales Male Improvement by Age/Year

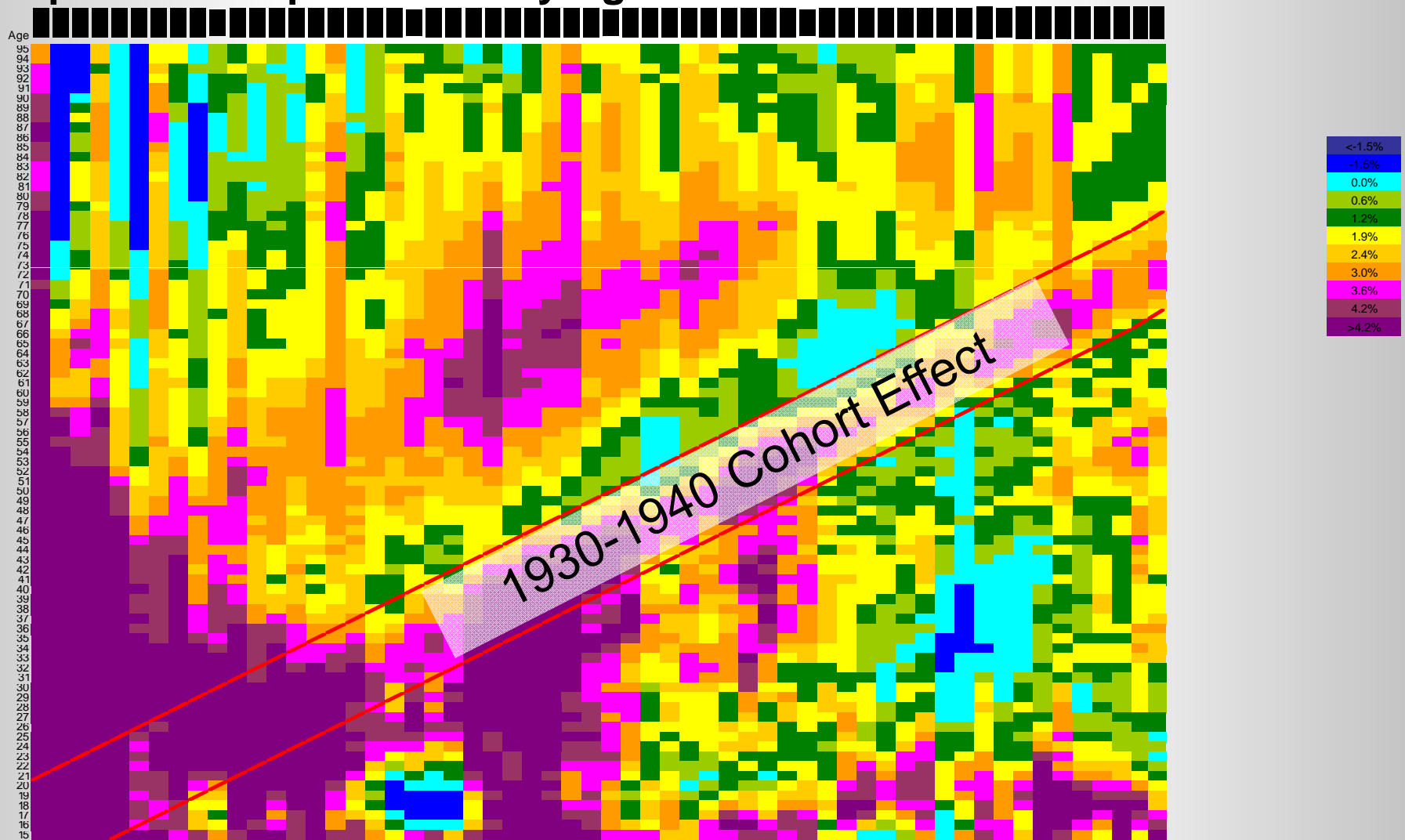


Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 19

Rolling 5-year, 3-age average reduction in life table mortality rate

Cohort Effects seen around the world

Japan Male Improvement by Age/Year

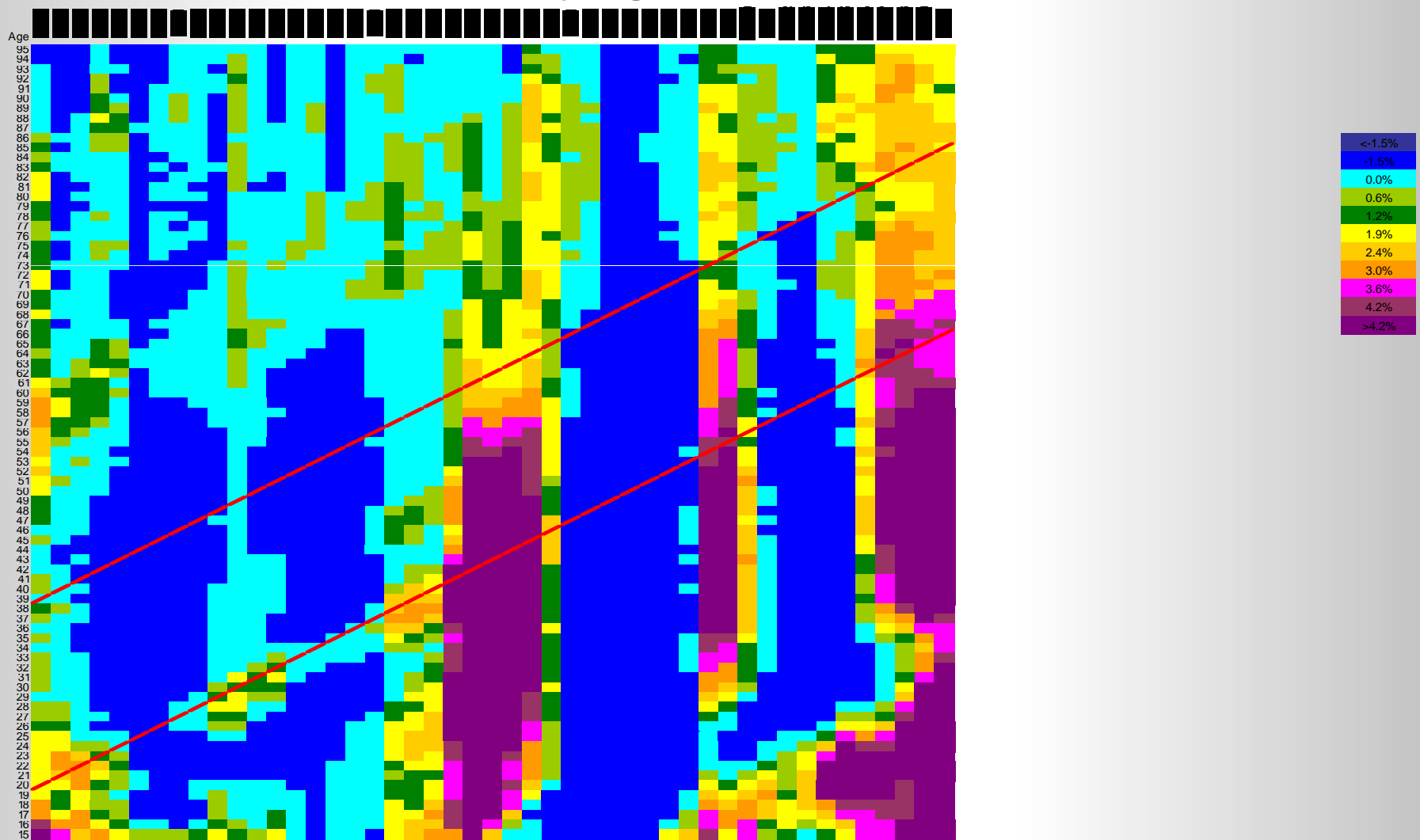


Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 20

Rolling 5-year, 3-age average reduction in life table mortality rate

Cohort Effects seen around the world

Russia Male Improvement by Age/Year



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/> 21

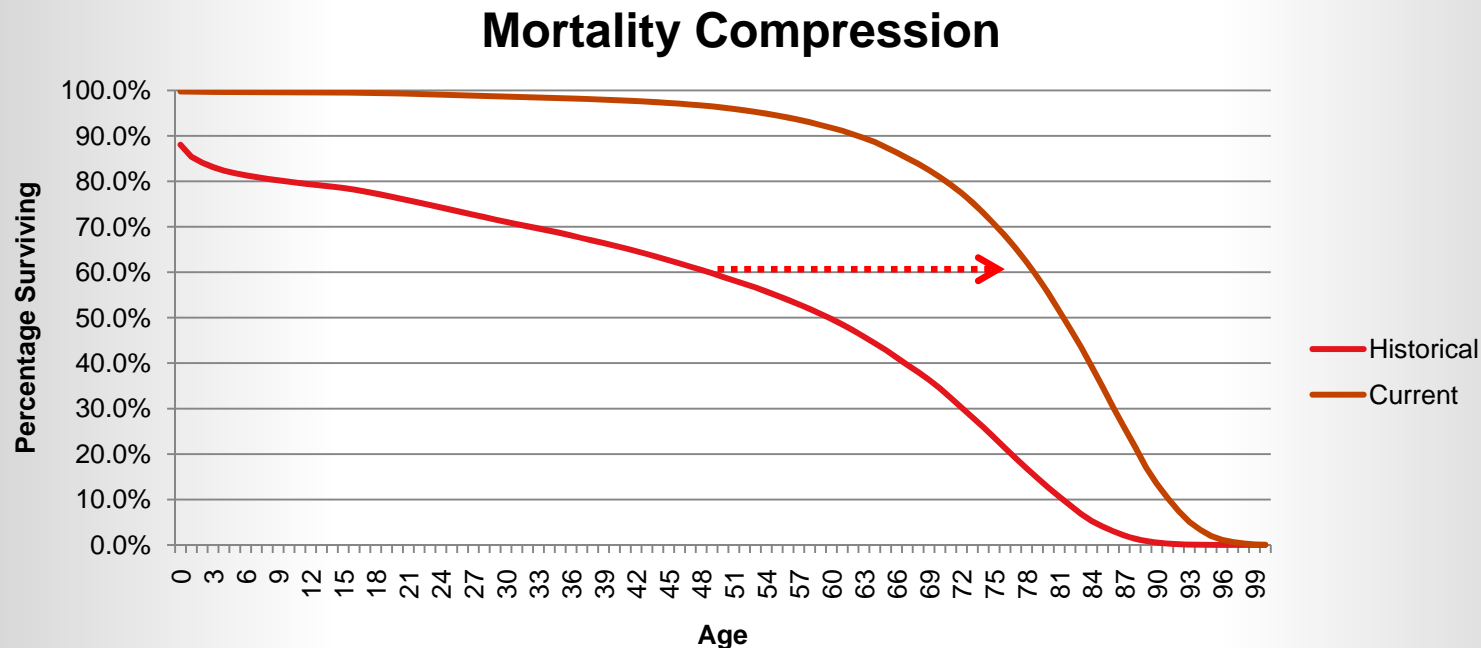
Rolling 5-year, 3-age average reduction in life table mortality rate

Mortality Compression

Compression:

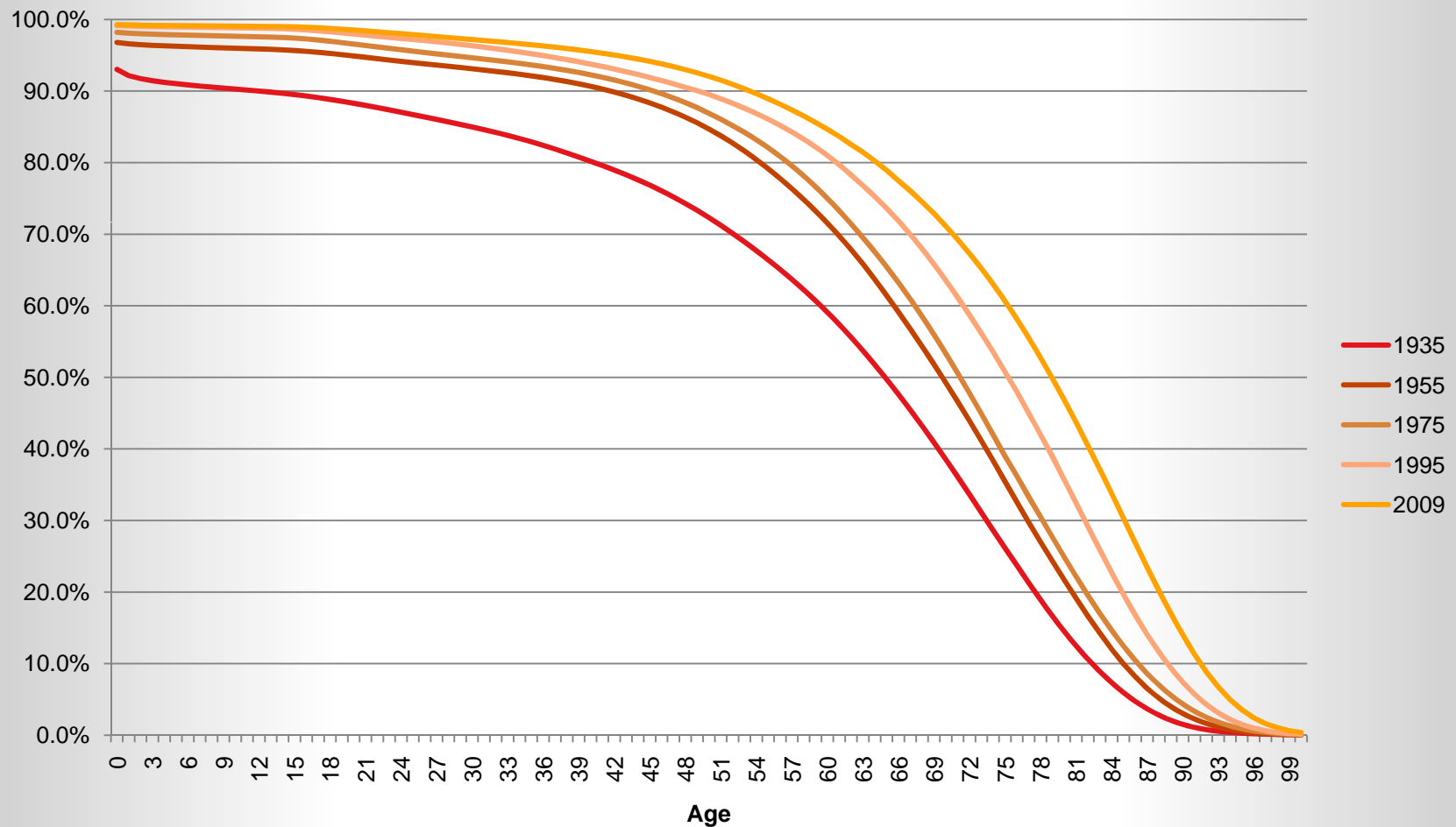
The tendency of older age mortality to improve at a slower rate than younger ages, leading to a rectangularisation of the survival curve.

- Improvement at younger ages leads to increased deaths at the older ages



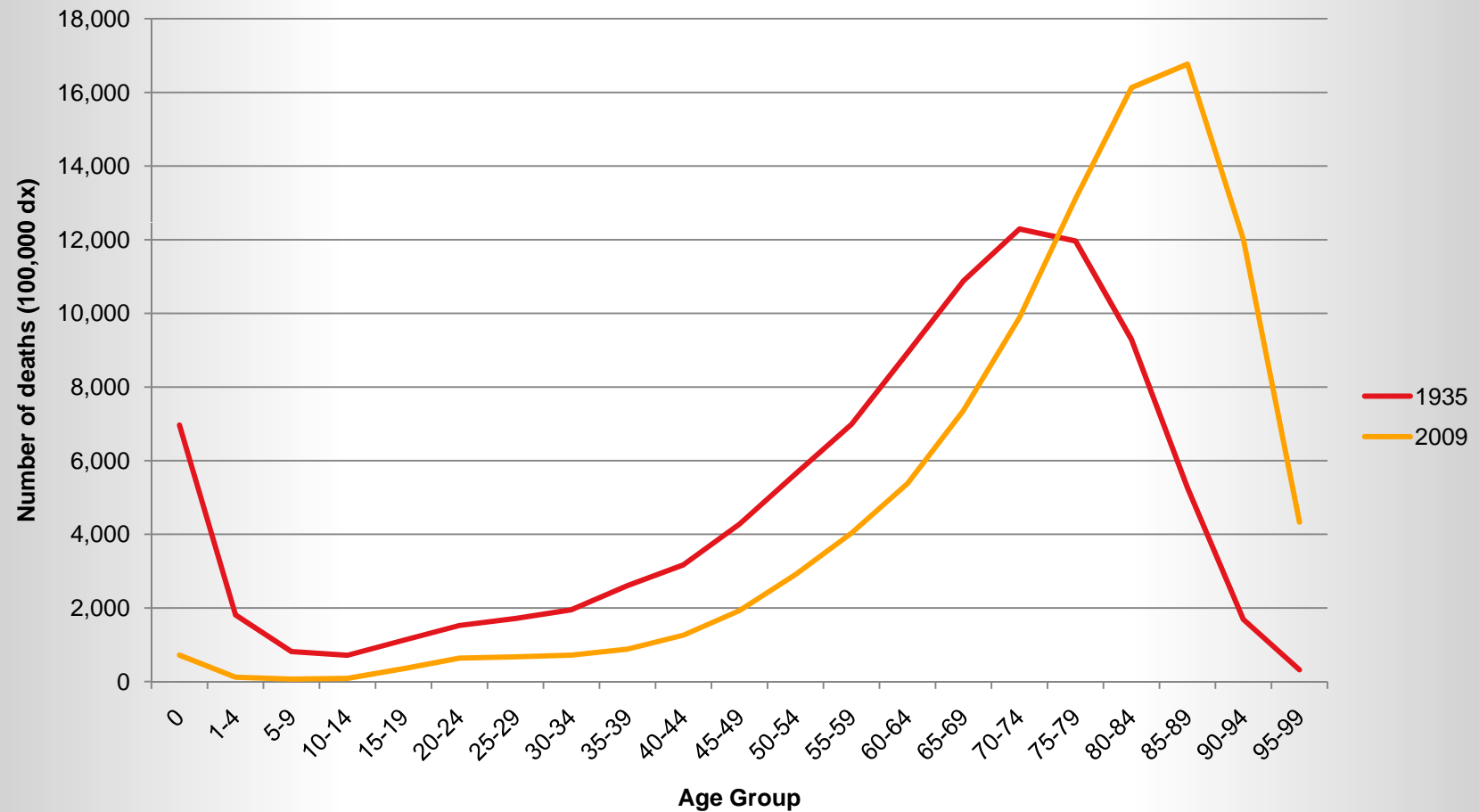
Mortality Compression

US Male Life Table - Percentage Surviving



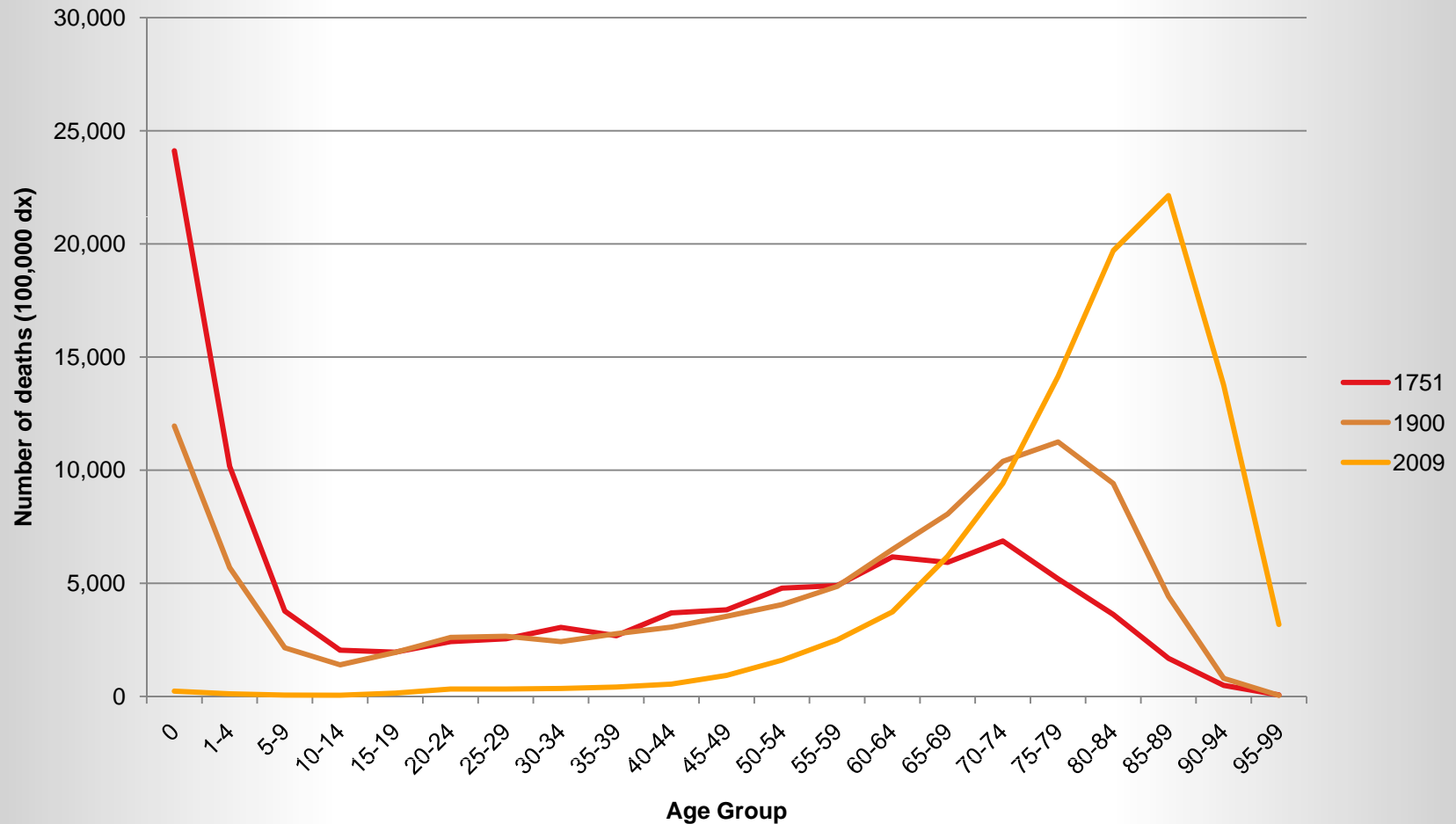
Mortality Compression

US Male Life Table - 100,000 dx



Mortality Compression

Sweden Male Life Table - 100,000 dx



Key Features Globally

Conclusion

- Mortality improvement steadily increasing for US, UK, Australia, Canada
- Japan has seen extremely high improvement since the 1940s
- Russia has seen negative improvement since 1959 but beginning to reverse
- Important to look at “Cohort Effect” when looking at historical improvement rates
- Slower rates of improvement at older ages leads to mortality compression (i.e. rectangularisation of survival curve)
- The theory of mortality deceleration suggests a slowing of mortality curve at highest ages, although the debate continues



Projecting Mortality Improvements

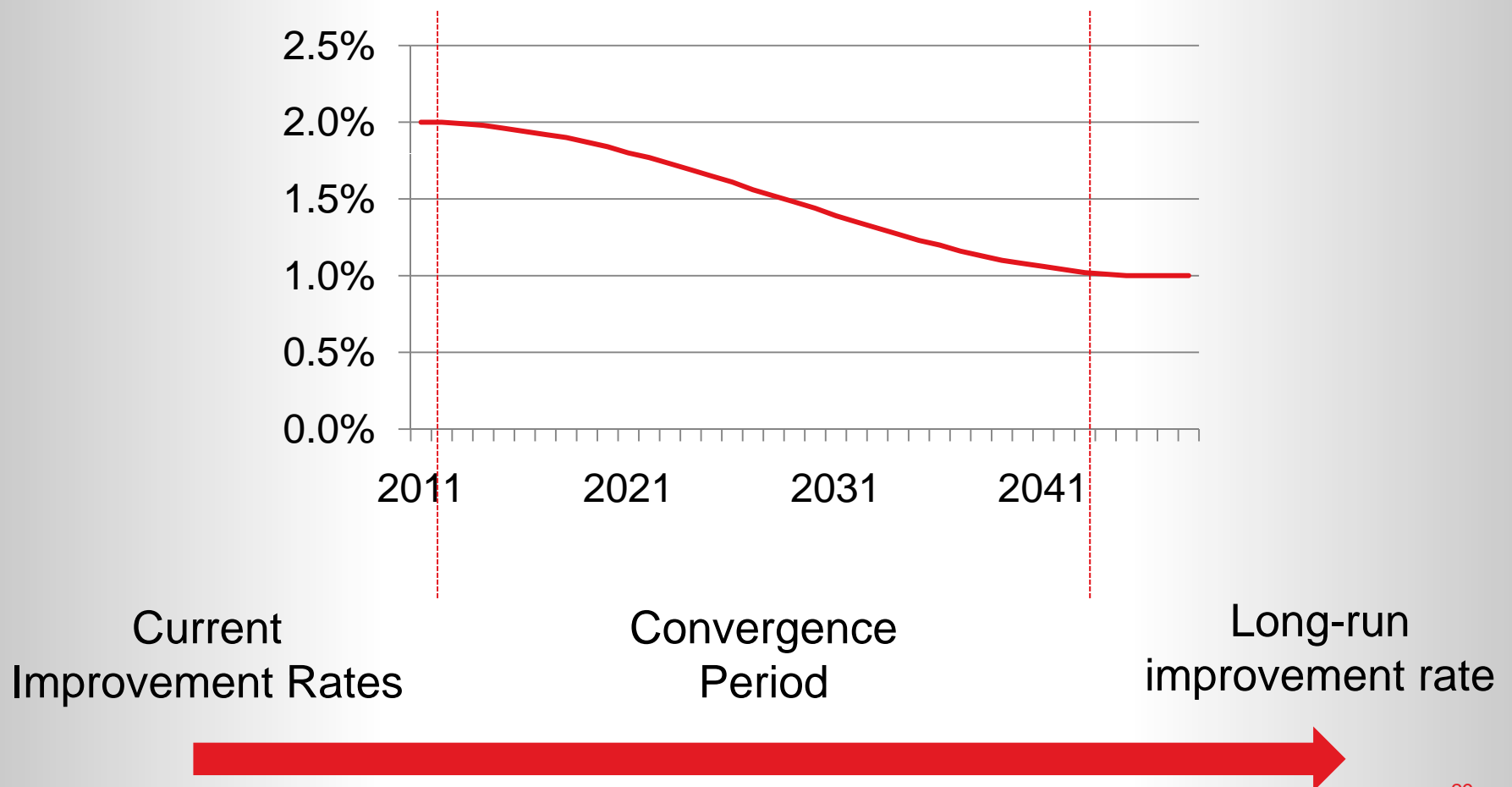
Projecting Mortality Improvements

Two broad approaches

- Deterministic models, where the future outcomes is set with reference to an understanding of emerging biomedical influences
- Stochastic Modelling, where the simulation of future outcomes where a range of values drawn from probability distributions are used for each variable
- Both approaches will use past data to parameterise current levels of mortality improvements;
- In many cases, no “right” answer to how much past data should be used.

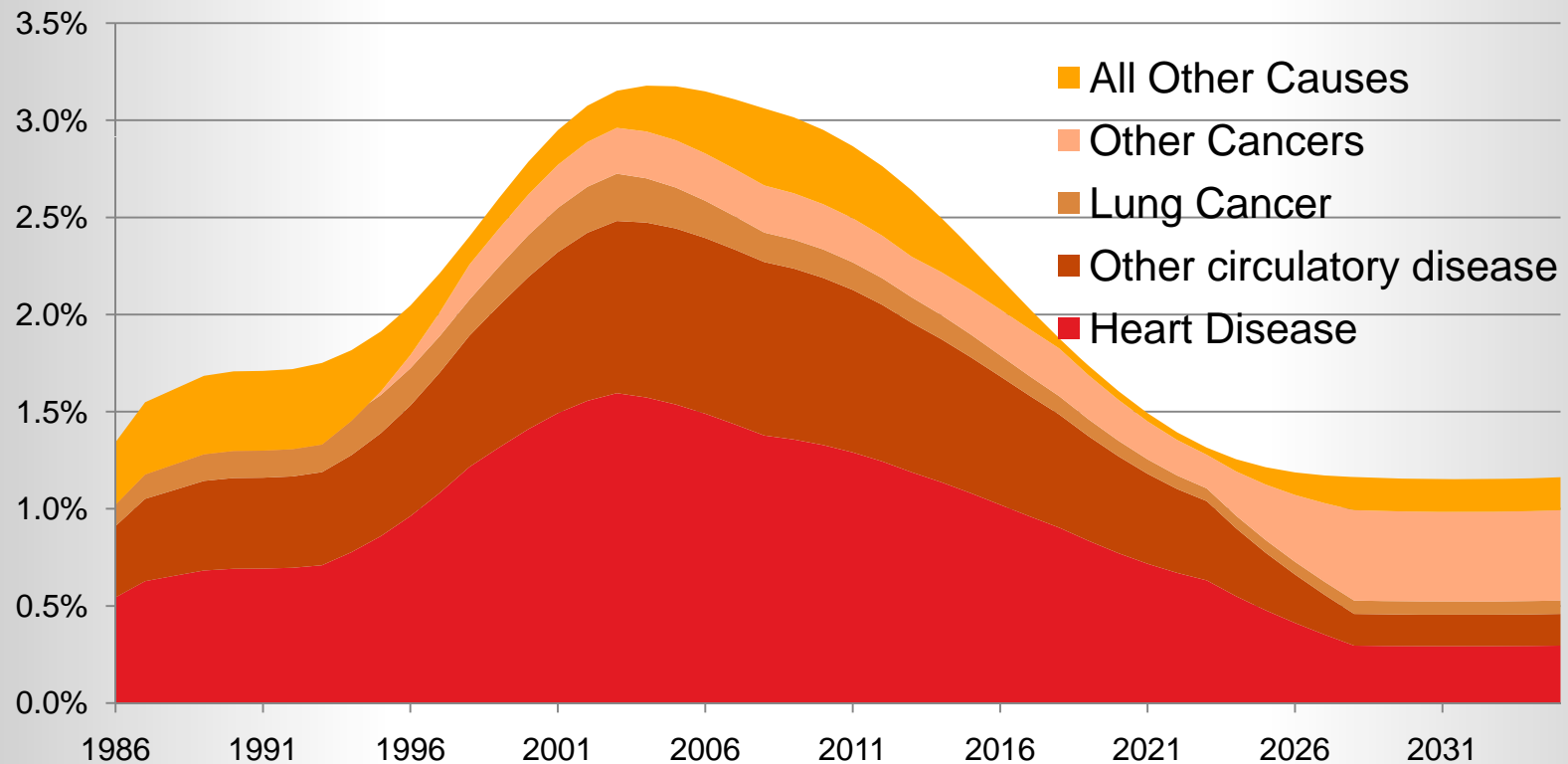
Deterministic Models

Overview of approach



Cause of death models

Building the deterministic model up



Deterministic Models – Strengths and Weaknesses

Strengths

- Allows for structural changes by explicitly modelling how drivers of mortality improvements might persist or attenuate in the future;
- Creation of descriptive scenarios to explain the range of outcomes looks like.

Weaknesses

- Expert opinion has in the past been conservative;
- Impact of correlations of causes of deaths hard to quantify;
- No quantification of random variability;
- Lower reliability of data;

Stochastic Projections

Many models exist

- Lee Carter (1992);
 - Renshaw-Haberman (2006);
 - Currie Age-Period-Cohort (2006)
 - Cairns-Blake-Dowd (CBD) (2006);
 - Multiple variants of CBD (2007 onwards).
-
- Can be computationally intensive to fit;

Model	Male Aged 70 Annuity Value (3%)	99.5%-tile Capital Loading
Lee-Carter (1992)	12.20	6.3%
CBD (2006)	11.96	6.2%
Age-Period-Cohort	12.59	4.4%

Source: Longevity

Projecting Mortality Improvements

Conclusions

- Extrapolation methods have intuitive appeal and mathematical rigor, but lack biological foundation;
- Ideal method would fit historical data and reflect medical insights into future drivers of mortality;
- Structural shifts in mortality, changes in aggregate health status, and/or new causes of death are difficult (if not impossible) to forecast;
- Understanding and modeling causal relationships of age, period, and cohort simultaneously is an enormous challenge;

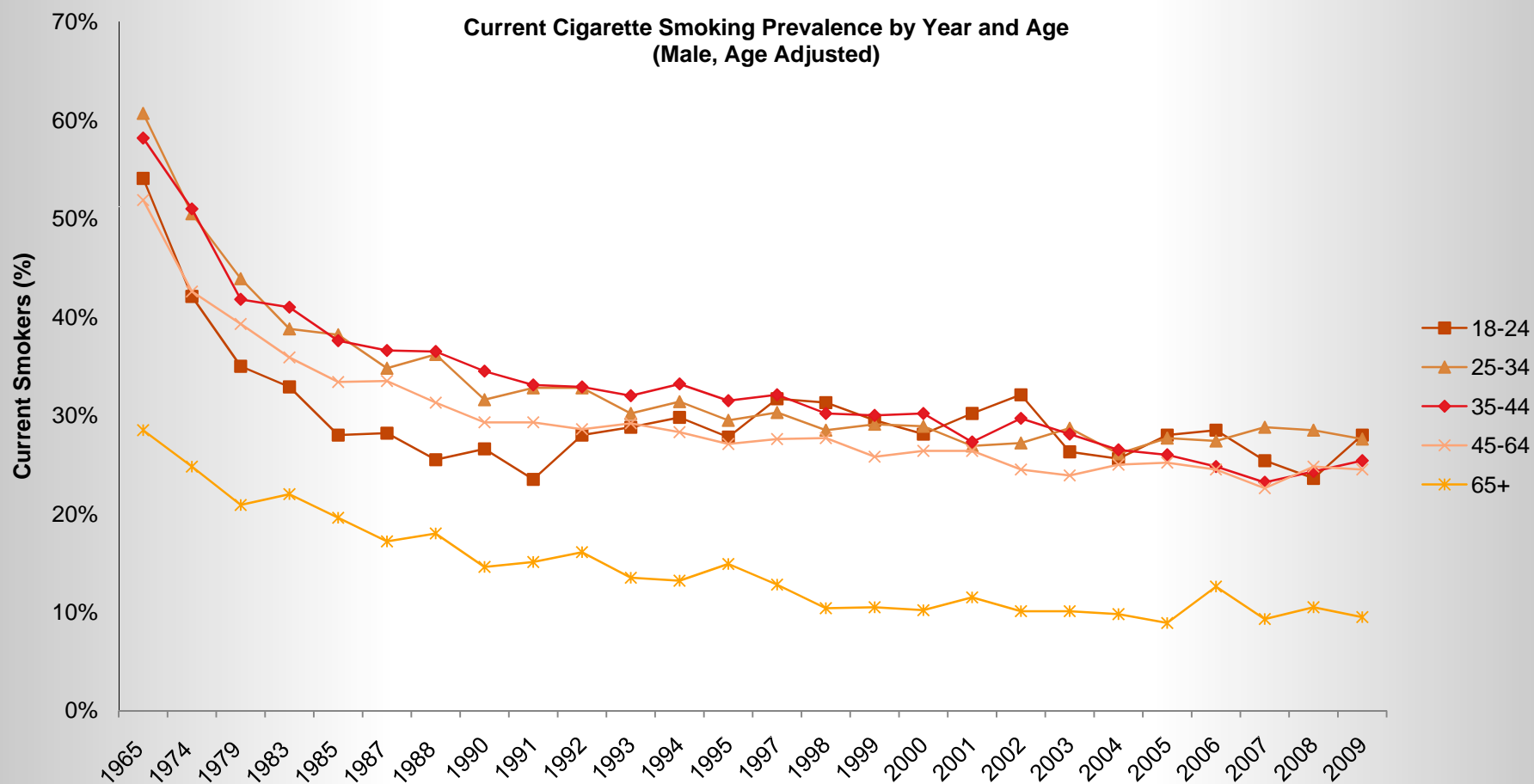


Understanding the Past

Smoking Cessation

Smoking Cessation

US Smoking Statistics



Source: CDC Health, United States, 2009



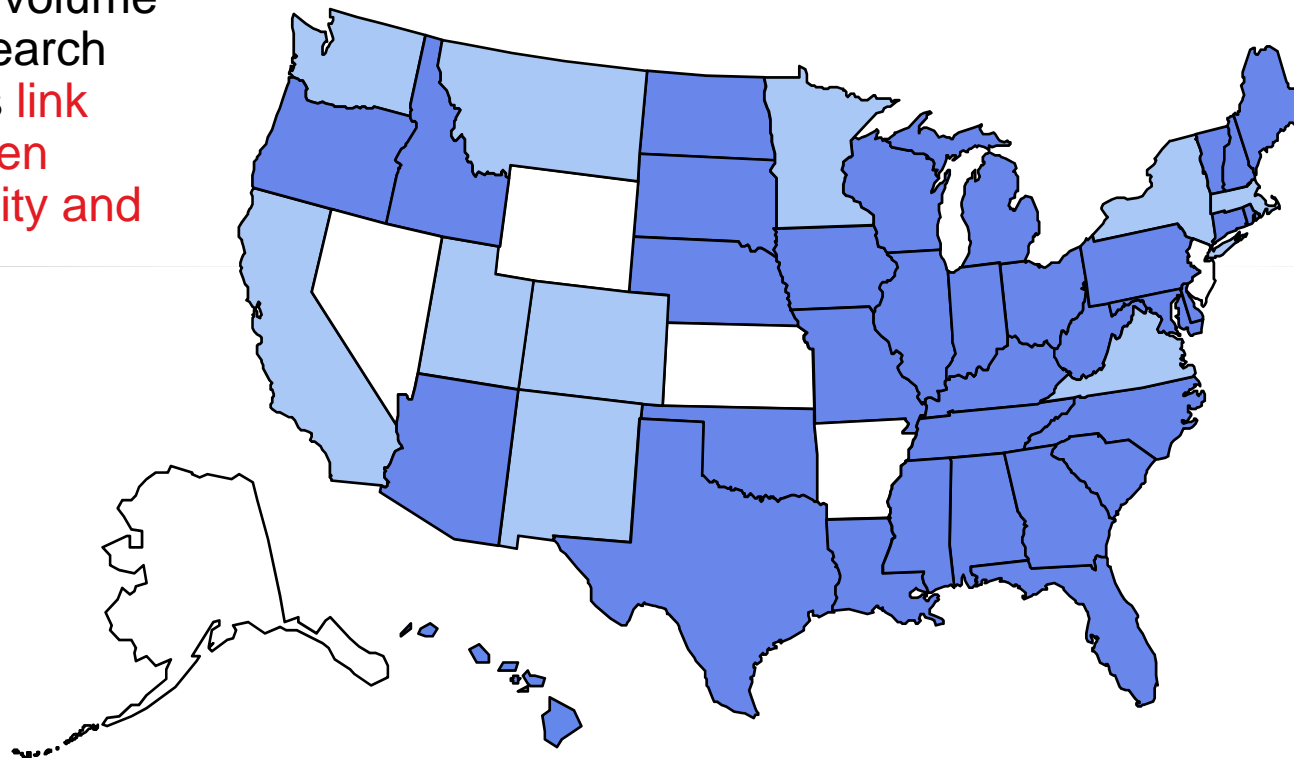
Understanding the Past

Obesity

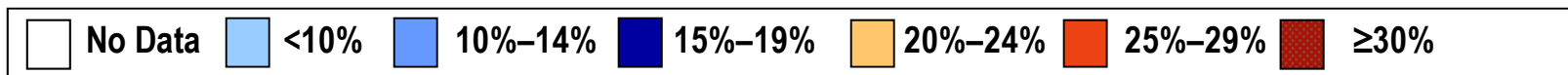
Obesity Trends* Among U.S. Adults 1990

(*BMI ≥ 30 , or ~ 30 lbs. overweight for 5' 4" person)

Large volume of research shows **link** between mortality and BMI

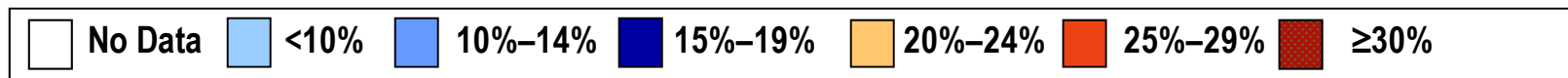
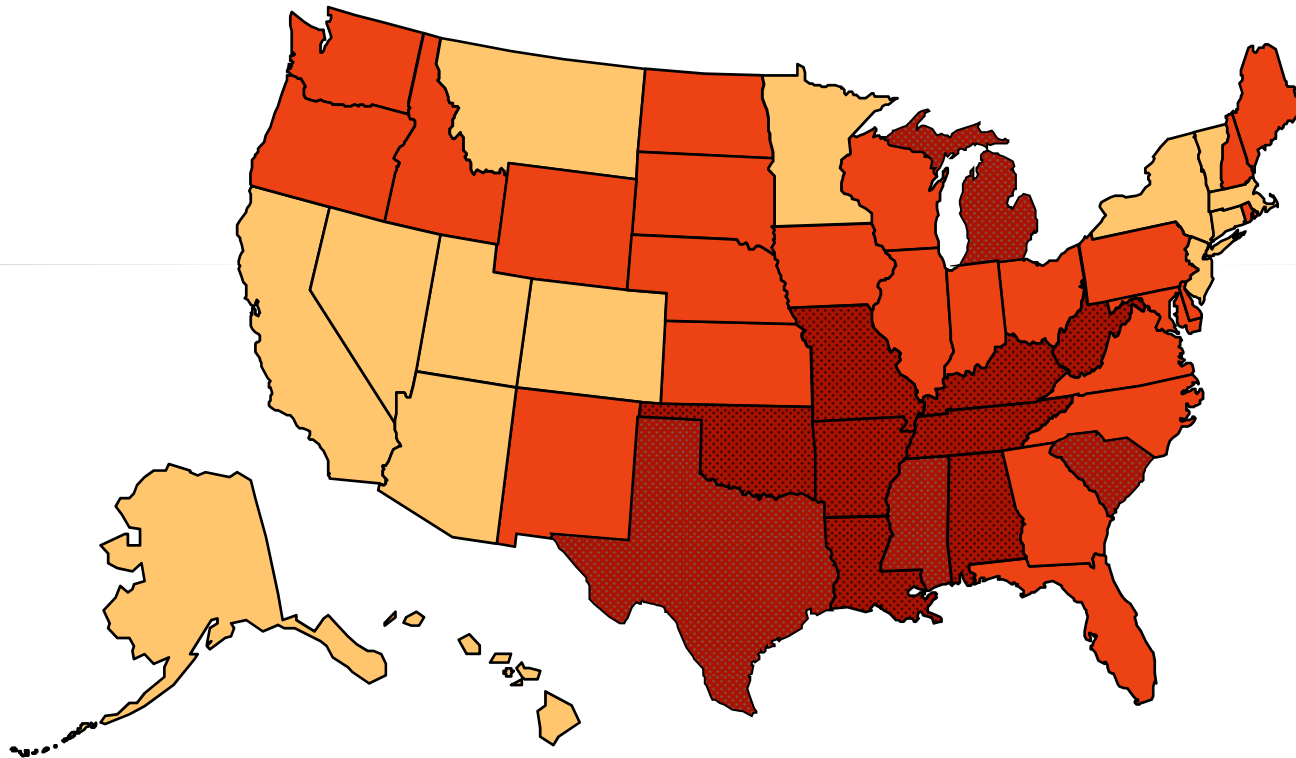


Increasing trend in obesity and leads to concerns about **mortality rates** and **trends** in the future



Obesity Trends* Among U.S. Adults 2010

(*BMI ≥ 30 , or ~ 30 lbs. overweight for 5' 4" person)

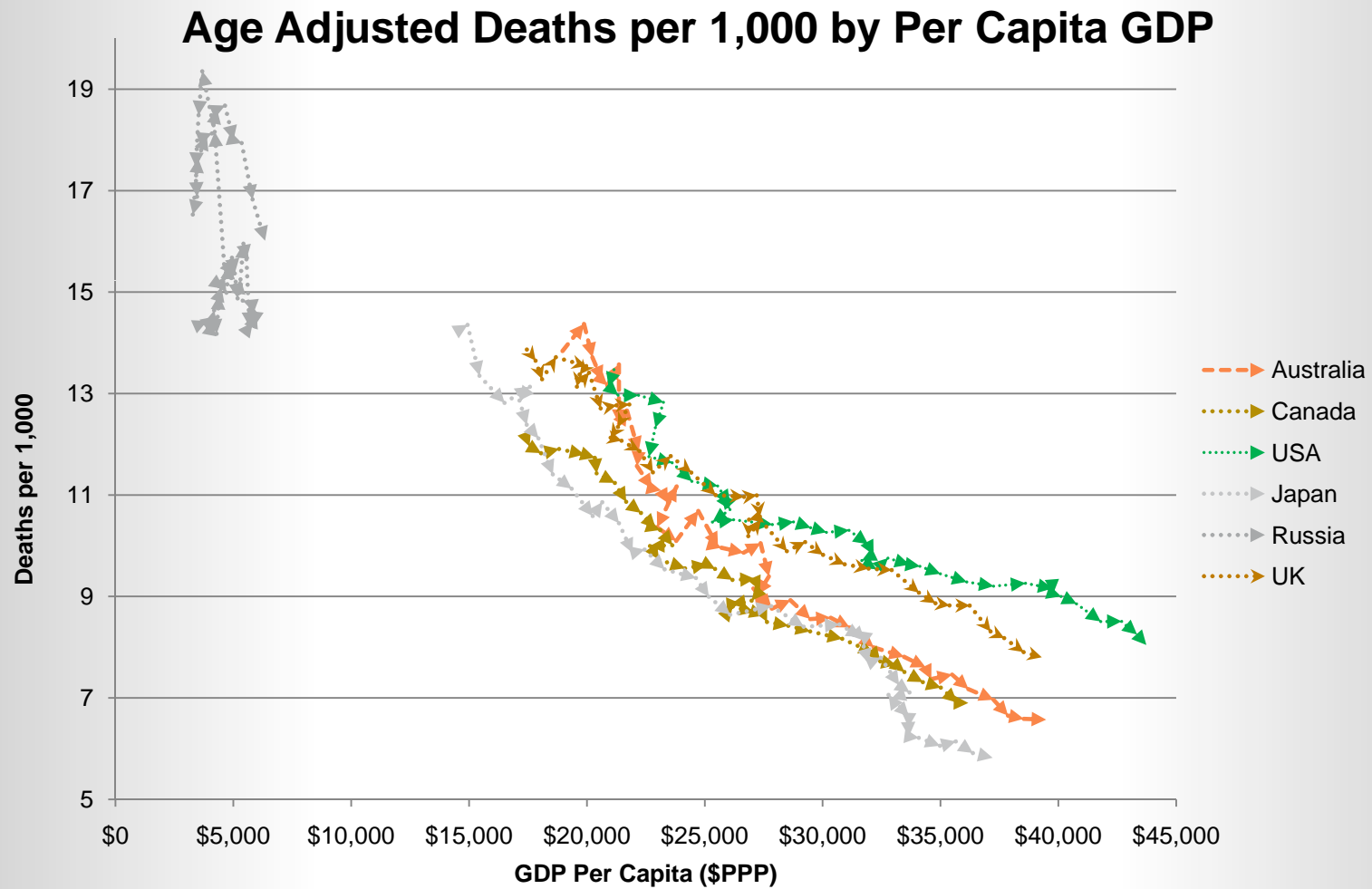




Understanding the Past

Socio-Economic Variations

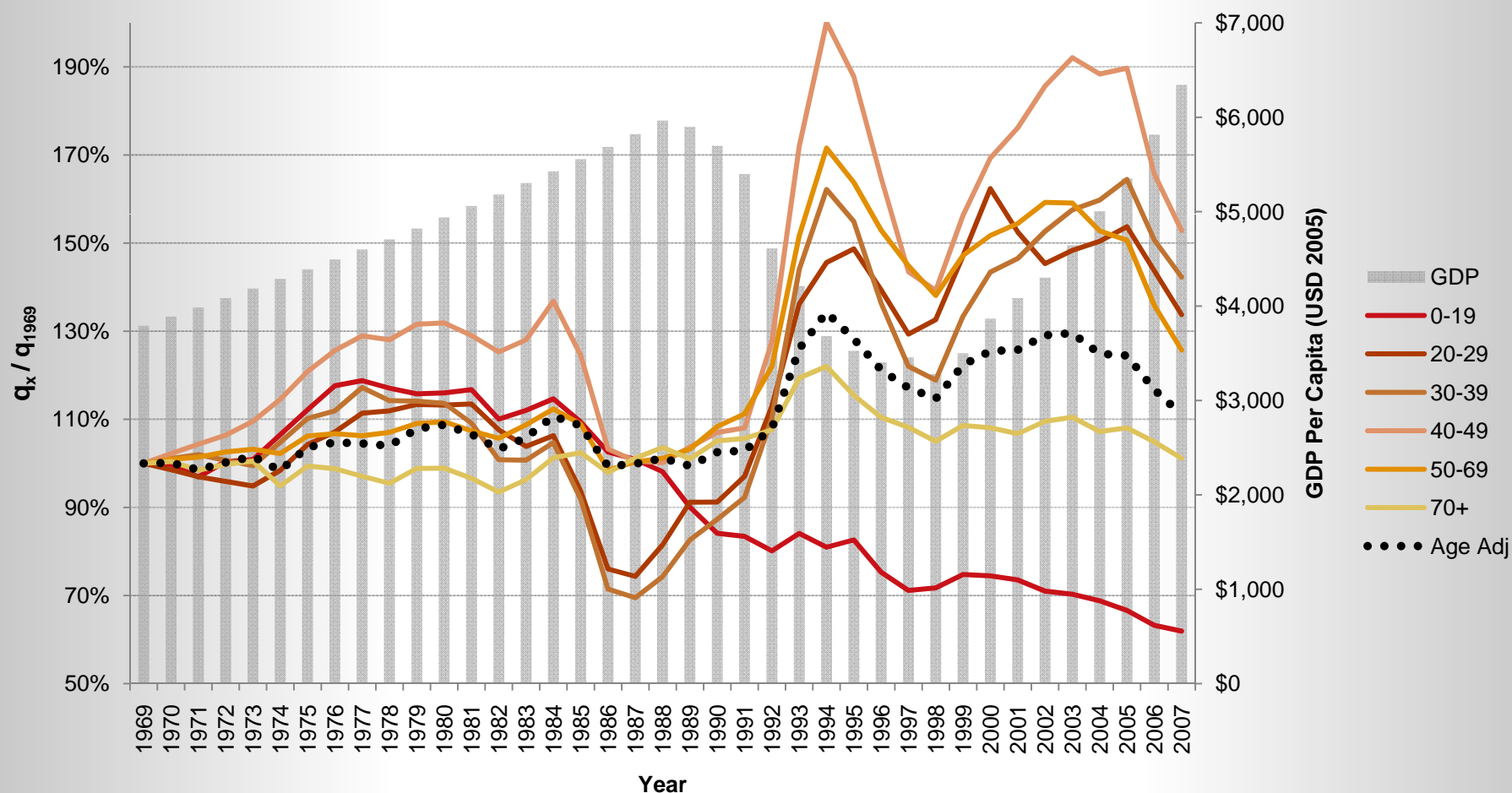
Socio-economic variations



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/>;
<http://www.ers.usda.gov/data-products/international-macroeconomic-data-set.aspx>

Socio-economic variations

Russia - Mortality Trend by Age



Source: RGA; Data downloaded 8/15/12 from Human Mortality Database: <http://www.mortality.org/>;
<http://www.ers.usda.gov/data-products/international-macroeconomic-data-set.aspx>

Understanding the Past

Conclusion

- Changes in medical research and lifestyles have had a direct impact on the primary causes of death over time
- Heart disease, the number one cause of death in the US, has shown mortality improvement
- Smoking habits play a crucial role in mortality improvement
- HIV/AIDS trends, especially at younger and middle ages, can cause dramatic swing in mortality improvement
- Obesity continues to increase, which will have a direct impact on future mortality improvement rates and causes of mortality
- Socio-economic differences can directly impact mortality



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Factors impacting mortality in the future



Factors Impacting Mortality in the Future

6 Areas of Interest

- Population risk factor changes
- Healthcare policy and execution
- Emergence of new or mutated pathogens
- Specific disease based medical interventions
- Regenerative medicine
- Anti-ageing technology

Factors Impacting Mortality in the Future

Jumping to Conclusions

- Six key drivers of mortality improvements
 - Four in the short to medium term
 - Two more drivers in the longer term
 - Healthcare policy and execution will impact the other drivers
- Changing population risk factors are key – some risk factors are improving and some are deteriorating
- Many exciting avenues for medical advances but progress is hard to predict and is largely incremental – not breakthrough

Overall Conclusions

- Past trends are not necessarily an indication of future results
- Some drivers of past improvement may not be expected to continue
- No consensus among experts as to the “right” projection
- Medical discovery continue to develop at an impressive pace
- Many challenges to continued rate of mortality improvements

- Remember lessons learned abroad



Thank you for your attention.