Running to a standstill: How responsive have successive ONS life expectancy forecasts been to stalling life expectancy gains since 2010?

Abstract

**Background**

The UK Office for National Statistics (ONS) updates their life expectancy forecasts every two years. During much of the 2000s these forecasts tended to underestimate life expectancy improvement, and were successively uprated, but since 2010 they have tended to underestimate life expectancy improvement, and have been successively downrated. The most recent 2018 forecast was released in 2019. This paper asks whether the assumptions in this most recent forecast is still too optimistic given recent life expectancy improvement rates in the UK have still been very modest.

**Methods**

Period life expectancy at birth (e­­0) was extracted from the Human Mortality Database (HMD) to allow comparison between the UK and other high income nations, and from the ONS to allow comparison within UK nations and groups. Annual change in life expectancy across European and Anglophone nations was calculated to assess the extent to which a slowdown in e0 improvement rates is seen internationally, and within UK nations to assess how similar trends in slowdown are within the UK. For UK nations changepoint analysis is performed to assess whether the slowdown is contemporaneous, suggesting common exposure. ONS forecasts from 2012 onwards for the UK as a whole are shown to demonstrate the extent of the slowdown assumed by each biennial projection, including as heatmaps showing changes in conditional life expectancy between successive projections.

To better determine the amount of annual gain in e0 that should be assumed if current e0 improvement rates were to continue, 101 different e0 gain scenarios, ranging from 0% slowdown, assuming no slowdown since the breakpoint year, to 100% slowdown, assuming no gain since the breakpoint year, and the Bayes Factor (ratio of likelihoods) for each of these scenarios calculated as compared with the 0% slowdown scenario. The scenario that maximises the Bayes Factor is identified. Each ONS biennial projection is converted into an improvement rate scenario, and the Bayes Factor for each of these scenarios calculated as well.

**Results**

Slowdowns in e0 gain have been observed in a number of high income nations in recent years, but have been more severe in the UK than in all other nations except USA. In all UK nations except Northern Ireland, a breakpoint in improvement rates between 2010 to 2011 was identified. Between 2010 and 2012 ONS life expectancy forecasts were reduced first for females, then for both genders. If average rates of e0 gain since 2010 were to continue then the assumption that life expectancy improvement rates have slowed down by xx% is most likely (Bayes Factor: XX cf no slowdown). This compares with an implied slowdown of xx% for the 2018 ONS life expectancy projection (Bayes Factor: XX cf no slowdown).

**Discussion**  
The most recent ONS life expectancy forecast still appears to be too optimistic, and to underestimate the extent of the slowdown seen in the UK since 2010. Without clear agreement as to the cause of the slowdown, which is more severe than almost any other high income nation, no consistent action is being taken that should cause us to believe that the problems facing UK populations have been addressed, and so there is no good reason to believe that the stalling in e0 gains observed since 2010 will not continue. The Bayes Factor strategy used here can be used to update our beliefs about how life expectancy trends are likely to continue whenever a new observation becomes available, and the addition of observed life expectancies for 2018 added weight to belief that life expectancy improvement rates have, since 2010, slowed to around a fifth their previous levels.

Introduction

Every couple of years, the UK’s ONS produces new population projections, including new assumptions about mortality and longevity. Such projections, whether carried out by national statistical bodies or by private insurers, are vital inputs to a wide range of important decisions for the effective provision of state services and assets, including schools, social and healthcare needs at UK, national and local levels.

Up until 2010, ONS forecasts of life expectancy gains consistently underestimated rates of improvement, and the assumptions were consistently uprated and made more optimistic in successive revisions. However, since 2010 the life expectancy improvement assumptions made by the ONS have been too optimistic, and now been successively made more pessimistic for the fourth revision in a row.

In parallel with the ONS’ attempts to accurately project and predict life expectancy trends, academic demographers and commercial actuaries working for the life insurance and financial industries have also been making predictions.

A number of different approaches to forecasting life expectancy have been tried. The most technically sophisticated approaches have involved forecasting the individual components of life expectancy, mortality rates at individual ages, and calculating life expectancies based on estimated lifetables, (1) made use of Bayesian methods for ‘smoothing’ observations from neighbouring years and age groups, (2,3), and/or incorporating cohort effects in improvement rates which allow for faster or slower gains in some cohorts than others. (4) An important example of this, which when identified by commercial actuaries led to substantial increases in projected life expectancies, was the identification of a so-called ‘Golden Cohort’ in the UK, persons born between around 1925 and 1945, whose rates of mortality improvement appeared systematically higher than for earlier or later cohorts. (5) Though cohort effects had been identified many decades previously, (6) they had often been deleterious rather than positive (7,8), and the UK’s cohort effect was of particular interest to the actuarial profession as they constituted a source of substantial ‘longevity risk’ affecting the viability of both private and state pensions. (9)

Perhaps surprisingly, more complex approaches to demographic forecasting have not been found to outperform simpler approaches, (10), and a very simple approach to forecasting life expectancy, which does not involve forecasting mortality at individual ages, has also been found to be effective. (11) This approach simply involves assuming that life expectancy improvements will tend to continue to improve linearly on average over the long term. This assumption seems to hold more for the average of many similar populations, or for the best performing of a collection of high income nations, (12–14) than for any single population, but has the dual advantages of simplicity, and of allowing uncertainty intervals in projections to be generated using the observed variation in annual changes in life expectancy using well-established time series modelling strategies. (15) This will be the main approach taken in this paper.

Since around 2014, worsening trends in life expectancy improvement have been an increasing area of focus and concern in the UK amongst public health researchers and academics. (16–21) Much of the analysis and commentary surrounding the slowing improvement rates in life expectancy has focused on the role of UK-government austerity policies, and corresponding changes in funding and provision of out-of-work benefits, social and healthcare funding (22–24), continuing concerns raised previously about the adverse health effects of austerity in an international context. (25–27) Analyses conducted and commissioned by Public Health England, The Kings Fund, the Health Foundation, and the OECD have instead focused more on extensive description of trends broken down into disease categories, emphasised the multifactorial nature of the slowdown, and the role of influenza (in 2013-14) and slowing cardiovascular disease improvements in particular. (28–32)

This paper aims to bring some of these divergent strands of researchers together by focusing on the way ONS mortality projections have changed over this period of stalling UK life expectancy, and how new data about UK life expectancies can be better used to inform our assumptions about future life expectancy trajectories in the UK. Though the paper does not aim to resolve disagreement between researchers as to the causes of the recent slowdown, it does aim to make the process of reasoning about the extent and persistence of the post 2010 slowdown more explicit, along with the process of updating our beliefs about the extent of this slowdown as and when new annual life expectancy estimates become available. To the extent the approach can be used to formally quantify and assess divergence between the UK’s life expectancy gains and those in other high income countries, and to demonstrate that slowdown has continued to persist longer than would be expected if it were due to transient factors like ‘bad winters’, the paper does aim to advance causal thinking about the slowdown indirectly, through establishing commonly acceptable strategies for analysis and interpretation of UK life expectancy data, and ‘ground truths’ around which researchers with divergent beliefs and perspectives can agree.

The rest of this paper proceeds as follows: Firstly, we will present annual change rates in life expectancy in the UK as compared with a number of other high income countries, to determine the extent to which the recent slowdown in life expectancy in the UK is an international phenomenon. Secondly, we will calculate changes in life expectancy for each UK nation or group of nations, to see whether the slowdown is similar in magnitude and contemporaneous throughout UK populations; this will be supported by performing change-point analysis of annual life expectancy changes for each of these UK populations. Thirdly, we will present the ONS life expectancy projections for the UK from 2012 onwards, to show how these projections have been successively downrated with each biennial projection. Fourthly, we will formally quantify the extent of the slowing in life expectancy improvement rates since 2010 by proposing a series of 100 modelled scenarios, each corresponding to a different percentage slowdown from earlier trends, and identifying the slowdown rate that maximises the Bayes Factor (ratio of model likelihoods, as compared with no slowdown) given observed life expectancy. Finally, we will estimate the Bayes Factors implied by each of the average improvement rates implied by each of the recent ONS mortality projections, discussing how optimistic or pessimistic each of these scenarios seems to be, and how the Bayes Factor strategy can be applied to more openly update our beliefs about the persistence and extent of a life expectancy slowdown in the UK as and when the 2019 period life expectancy estimate becomes available.

Methods

The Human Mortality Database (HMD) is a joint initiative by the Max Planck Institute for Demographic, the University of California, and INED in Paris, which aims to provide detailed mortality and population data for research, including life expectancy estimates produced using a standard set of methods for many different populations. It currently covers 41 countries or areas

Period life expectancy at birth (e­­0) was extracted from the Human Mortality Database (HMD) to allow comparison between the UK and other high income nations, and from the ONS to allow comparison within UK nations and groups. Annual change in life expectancy across European and Anglophone nations was calculated to assess the extent to which a slowdown in e0 improvement rates is seen internationally, and within UK nations to assess how similar trends in slowdown are within the UK. For UK nations changepoint analysis is performed to assess whether the slowdown is contemporaneous, suggesting common exposure. ONS forecasts from 2012 onwards for the UK as a whole are shown to demonstrate the extent of the slowdown assumed by each biennial projection, including as heatmaps showing changes in conditional life expectancy between successive projections.

To better determine the amount of annual gain in e0 that should be assumed if current e0 improvement rates were to continue, 101 different e0 gain scenarios, ranging from 0% slowdown, assuming no slowdown since the breakpoint year, to 100% slowdown, assuming no gain since the breakpoint year, and the Bayes Factor (ratio of likelihoods) for each of these scenarios calculated as compared with the 0% slowdown scenario. The scenario that maximises the Bayes Factor is identified. Each ONS biennial projection is converted into an improvement rate scenario, and the Bayes Factor for each of these scenarios calculated as well.

Results

Firstly, we will present annual change rates in life expectancy in the UK as compared with a number of other high income countries, to determine the extent to which the recent slowdown in life expectancy in the UK is an international phenomenon.

Secondly, we will calculate changes in life expectancy for each UK nation or group of nations, to see whether the slowdown is similar in magnitude and contemporaneous throughout UK populations; this will be supported by performing change-point analysis of annual life expectancy changes for each of these UK populations.

Thirdly, we will present the ONS life expectancy projections for the UK from 2012 onwards, to show how these projections have been successively downrated with each biennial projection.

Fourthly, we will formally quantify the extent of the slowing in life expectancy improvement rates since 2010 by proposing a series of 100 modelled scenarios, each corresponding to a different percentage slowdown from earlier trends, and identifying the slowdown rate that maximises the Bayes Factor (ratio of model likelihoods, as compared with no slowdown) given observed life expectancy.

Finally, we will estimate the Bayes Factors implied by each of the average improvement rates implied by each of the recent ONS mortality projections, discussing how optimistic or pessimistic each of these scenarios seems to be, and how the Bayes Factor strategy can be applied to more openly update our beliefs about the persistence and extent of a life expectancy slowdown in the UK as and when the 2019 period life expectancy estimate becomes available.

Discussion

Scrapbook

Bibliography

1. Lee RD, Carter LR. Modeling and forecasting U.S. mortality. J Am Stat Assoc. 1992 Sep;87(419):659–671.

2. Bijak J, Bryant J. Bayesian demography 250 years after Bayes. Popul Stud (NY). 2016 Feb 23;70(1):1–19.

3. King G. Demographic Forecasting. 2008;

4. Renshaw AE, Haberman S. A cohort-based extension to the Lee–Carter model for mortality reduction factors. Insurance: Mathematics and Economics. 2006 Jun;38(3):556–570.

5. Willets R. THE COHORT EFFECT : INSIGHTS AND EXPLANATIONS. Willets Consulting Limited; 2003 p. 1–38.

6. Kermack WO, McKendrick AG, McKinlay PL. Death-rates in Great Britain and Sweden. Some general regularities and their significance. Int J Epidemiol. 2001 Aug;30(4):678–683.

7. Minton J, Vanderbloemen L, Dorling D. Visualizing Europe’s demographic scars with coplots and contour plots. Int J Epidemiol. 2013 Aug;42(4):1164–1176.

8. Almond D. Is the 1918 Influenxa Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post-1940 U.S. Population. Journal of Political Economy2. 2006;114(4):672–712.

9. Willets RC, Gallop AP, Leandro PA, Lu JLC, Macdonald AS, Miller KA, et al. Longevity in the 21st century. Br Actuar J. 2004 Oct 1;10(4):685–832.

10. Pascariu MD, Lenart A, Canudas-Romo V. The maximum entropy mortality model: forecasting mortality using statistical moments. Scand Actuar J. 2019 Mar 29;1–25.

11. White KM. Longevity Advances in High-Income Countries, 1955-96. Popul Dev Rev. 2002 Mar;28(1):59–76.

12. Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. Lancet. 2009 Oct 3;374(9696):1196–1208.

13. Pascariu MD, Canudas-Romo V, Vaupel JW. The double-gap life expectancy forecasting model. Insurance: Mathematics and Economics. 2018 Jan;78:339–350.

14. Torri T, Vaupel JW. Forecasting life expectancy in an international context. Int J Forecast. 2012 Apr;28(2):519–531.

15. Box GEP, Jenkins GM, Reinsel GC, Ljung GM. Time Series Analysis: Forecasting And Control (wiley Series In Probability And Statistics). 5th ed. Hoboken, New Jersey: Wiley; 2015.

16. Hiam L, Dorling D. Rise in mortality in England and Wales in first seven weeks of 2018. BMJ. 2018 Mar 14;360:k1090.

17. Hiam L, Dorling D, McKee M. The cuts and poor health: when and how can we say that one thing causes another? J R Soc Med. 2018 Jun;111(6):199–202.

18. Hiam L, Harrison D, McKee M, Dorling D. Why is life expectancy in England and Wales “stalling”? J Epidemiol Community Health. 2018 Feb 20;72(5):404–408.

19. Hiam L, Dorling D, Harrison D, McKee M. What caused the spike in mortality in England and Wales in January 2015? J R Soc Med. 2017 Apr;110(4):131–137.

20. Hiam L, Dorling D, McKee M. Rise in mortality-when will the government take note? BMJ. 2018 Jun 25;361:k2747.

21. Fenton L, Minton J, Ramsay J, Kaye-Bardgett M, Fischbacher C, Wyper GMA, et al. Recent adverse mortality trends in Scotland: comparison with other high-income countries. BMJ Open. 2019 Oct 31;9(10):e029936.

22. Green MA, Dorling D, Minton J, Pickett KE. Could the rise in mortality rates since 2015 be explained by changes in the number of delayed discharges of NHS patients? J Epidemiol Community Health. 2017 Nov;71(11):1068–1071.

23. Green M, Dorling D, Minton J. The Geography of a rapid rise in elderly mortality in England and Wales, 2014-15. Health Place. 2017 Feb 12;44:77–85.

24. Lambie-Mumford H, Green MA. Austerity, welfare reform and the rising use of food banks by children in England and Wales. Area. 2017 Sep;49(3):273–279.

25. Stuckler D, Basu S. The Body Economic: Eight experiments in economic recovery, from Iceland to Greece. London: Penguin; 2013.

26. Karanikolos M, Mladovsky P, Cylus J, Thomson S, Basu S, Stuckler D, et al. Financial crisis, austerity, and health in Europe. Lancet. 2013 Apr 13;381(9874):1323–1331.

27. McKee M, Karanikolos M, Belcher P, Stuckler D. Austerity: a failed experiment on the people of Europe. Clin Med. 2012 Aug;12(4):346–350.

28. Raleigh V. Trends in life expectancy in EU and other OECD countries: Why are improvements slowing? 2019 Feb.

29. Public Health England. Recent trends in mortality in England: review and data packs - GOV.UK. 2018.

30. Murphy M, Luy M, Torrisi O. Stalling of mortality in the United Kingdom and Europe: an analytical review of the evidence [Internet]. LSE; 2019 Nov [cited 2019 Dec 10]. Report No.: 11-19. Available from: http://www.lse.ac.uk/social-policy/Assets/Documents/PDF/working-paper-series/11-19-Mike-Murphy.pdf

31. Marshall L, Finch D, Cairncross L, Bibby J. Mortality and life expectancy trends in the UK: stalling progress. Health Foundation; 2019 Nov.

32. Raleigh VS. Stalling life expectancy in the UK. BMJ. 2018 Sep 27;362:k4050.