Compendium

Background and Methodology, 2012-based NPP Reference Volume

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1 . Introduction

The 2012-based national population projections for the UK and its constituent countries were produced by the Office for National Statistics (ONS) on behalf of the National Statistician and the Registrars General of Scotland and Northern Ireland.

This chapter provides the background to the national population projections, including their history, purpose and availability. It describes the methodology used to produce the projections and provides an outline of the related projections available.

2 . Background

Purpose

Projections relate to the usually resident population of the UK and its constituent countries, regardless of their nationality. The usually resident population includes all long-term international migrants (people changing their country of usual residence for at least one year). However, it does not include short-term migrants who come to or leave the UK for less than a year.

The projections are based on the population estimates as at 30 June 2012 and a set of underlying demographic assumptions regarding future fertility, mortality and migration. The assumptions were based on the best statistical evidence available at the time and were agreed in liaison with the devolved administrations – Welsh Government, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA) - following consultation with key users of projections in each country and advice from an expert academic advisory panel.

The primary purpose of the national population projections is to provide an estimate of the future population of the UK and its constituent countries which is used as a common framework for national planning in a number of different fields. They are also used as the base for other official population projections such as subnational projections, household projections and in the calculation of life tables. These official sets of projections ensure that the many users of projections can work on consistent assumptions.

Due to the inherent uncertainty of demographic behaviour, any set of projections will inevitably be proved wrong, to a greater or lesser extent, as a forecast of future demographic events or population structure. To give users of the projections an indication of this uncertainty, a number of variant population projections have also been produced based on alternative assumptions of future levels of fertility, mortality and migration. These are discussed in the variants chapter.

The 2012-based principal and key variant projections were published by ONS on 6 November 2013, with additional variants released on 10 December 2013.[1]

Projections history

The first projections of the population of the UK were made by the Government Actuary's Department (GAD) in the 1920s. One of the main uses of these earliest projections was in connection with long-term financial estimates under the Contributory Pensions Acts and other schemes of social insurance. Projections made since the war, however, have been increasingly used in all areas of Government planning. New projections were produced each year from 1955 to 1979 and were made generally available and then every second year until 1991. There was then a 1992-based set and since then projections have been produced every second year.

Additional 'interim' projections are occasionally produced. 2001-based projections were published following the 2001 Census and an additional set were produced based on the 2003 estimates to incorporate revisions to the population estimates for England and Wales. Responsibility for the production of national population projections transferred to ONS on 31 January 2006.

Publications

This volume, the latest in a regular series started in 1970, gives details of the 2012-based national population projections produced by ONS (based on the estimated population at mid-2012). These replace the 2010-based projections published on 26 October 2011.

Expert advisory panel

As part of the production process for the 2004-based projections round, an expert academic panel was convened in 2005 to advise ONS on current and emerging demographic trends and their possible implications for the national population projections. This panel has met to discuss appropriate assumptions for each subsequent round of projections. The expert panel's role is to advise only. Responsibility for final decisions on the assumptions remains with ONS and the statistical offices of the devolved administrations.

A note of the 2013 meeting of the expert panel is included in the 2012-based projections November release, in Appendix A of the Background and Methodology paper.

3 . Base population and projection period

Population estimates

The projections are based on the mid-2012 population estimates [2] produced by ONS, NRS and NISRA, published by ONS on 8 August 2013. The estimates for the UK and the constituent countries are based upon 2011 Census results with allowance for subsequent births, deaths, migration and ageing of the population. The population includes all persons resident, or intending to stay, for 12 months or more. Members of HM armed forces in the UK are included, as are foreign armed forces stationed in the UK. Members of HM armed forces and their families who are abroad are excluded from the population estimates and are treated as migrants when they return home. Table 1-1 shows the estimates of the population at mid-2012 upon which the 2012 projections are based.

Table 1-1: Base population estimates for 2012-based projections

	thousands
England	53,494
Wales	3,074
Scotland	5,314
Northern Ireland	1,824
United Kingdom	63,705

Source: Office for National Statistics

Notes:

1. Figures may not sum due to rounding

Estimates of the population aged 90 and over

Official mid-year population estimates produced by ONS, NRS and NISRA are prepared by individual age to the age of 89, with an upper age band for all those aged 90 and over. Estimates of the population aged 90 to 104 by single year of age and for the 105 and over age group are prepared using the Kannisto Thatcher survivor ratio method[3], with the results controlled to agree with the official estimates of all those aged 90 and over. Estimates for those aged 90 and over[4] are published for England and Wales on an annual basis. Scotland have published population estimates of people aged 90 to 104[5] by single year of age, and the number of people aged 105 and over, for mid-2011 and mid-2012.

Projections period

The main focus of the 2012-based projections is on the next 25 years up to mid-2037, though longer term projections to mid-2112 are also produced. Long-term figures should be treated with great caution since population projections become increasingly uncertain the further they are carried forward particularly so for smaller geographical areas and age-sex breakdowns.

For more information on how ONS projections meet users' needs along with information on their fitness for purpose, please see the report on quality and methodology (109.5 Kb Pdf)[6] on the ONS website.

4 . Methodology

The cohort component method

The projections are made for successive years running from one mid-year to the next using the cohort component method[7]. For each age, the starting population plus net inward migrants less the number of deaths produces the number in the population, aged one year older, at the end of the year. To this has to be added survivors of those born during the year. Age is defined as completed years at the last birthday.

Migration is assumed to occur evenly throughout the year. For computing purposes, this is equivalent to assuming that half the migrants in a given year at a given age migrate at the beginning of the year and half at the end of the year. The number of net migrants to be added to obtain the population aged x+1 at the end of the projection year therefore consists of half of those migrating during the year at age x and half of those migrating during the year at age x+1.

The number of deaths in a year is obtained by adding half of the net inward migrants at each age to the number in the population at the beginning of the year, then applying mortality rate q_x (known as the initial mortality rate, or the probability of dying).

The number of births in a year is calculated by multiplying the average number of women at each single year of age during the year (taken as the mean of the populations at that age at the beginning and end of the year) by the fertility rate applicable to them during that year. The total number of births in a year is assumed to be divided between the sexes in the ratio of 105 males to 100 females, in line with recent experience.

The number of infants aged 0 at the end of the year is calculated by applying a special 'infant mortality rate' to the projected number of births, and adding half the number of net migrants aged 0 last birthday. This special mortality rate is equivalent to about 85% of the conventional full first year of life infant mortality rate used in official statistics.

The projections are computed for each of the constituent countries of the UK and the results are added together to produce projections for England and Wales, Great Britain and the UK.

The majority of assumptions have been set using rates based on revised series of population estimates and thus take into account the results of the 2011 Census. The exceptions to this are the mortality and fertility assumptions for Scotland. A revised back series of population estimates for Scotland was not available at the time of publication of the population projections so data rolled forward from the 2001 Census were used. Observed differences between the rolled forward estimates and Census results did not raise significant concerns about this approach.
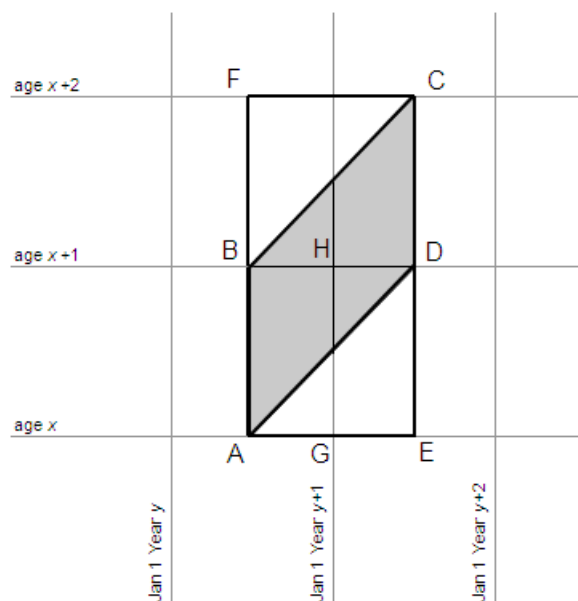
Lexis diagram

The projection process can be illustrated by means of a Lexis diagram (see Figure 1-1) where age is represented on the vertical axis and time on the horizontal axis. The life of an individual (or of a birth cohort), is represented by a diagonal line (or parallelogram) running from bottom left to top right.

The line AB represents the population aged x at mid-year y. The size of this cohort one year ahead, that is, aged x+1 at mid-year y+1, is represented by the line DC. To calculate this population one year ahead (for x greater than or equal to 0), it is necessary to project deaths and net migration occurring to this cohort between mid-year y and mid-year y+1. The relevant interval of time for this cohort is represented by the shaded parallelogram ABCD.

The net number of migrants aged x between mid-year y and mid-year y+1 is represented by the square ABDE in the Lexis diagram. Similarly, the net number of migrants aged x+1 between mid-year y and mid-year y+1 is represented by the square BFCD.

As noted above, it can be assumed that half the migrants in a given year at a given age migrate at the beginning of the year and half at the end of the year. Thus, of net migrants aged x between mid-year y and mid-year y+1, it can be assumed that half add to the population represented by the line AB in the diagram and the other half to the population represented by the line ED. Similarly, of the migrants aged x+1 in this period, half can be added to the population denoted by the line BF and half to the population represented by the line DC. Net migration in the parallelogram ABCD is therefore obtained by adding half of the net migrants aged x (that is, those adding to the population AB) and half of those aged x+1 (that is, those adding to the population DC) in this interval.

Figure 1-1: Lexis diagram

The number of deaths in a year is obtained by adding half of the net inward migrants at each age to the number in the population at the beginning of the year and applying the mortality rate q_x. This produces the number of deaths in the parallelogram ABCD. Finally, there is the special case of projecting the number of infants aged 0 at mid-year y+1. So if x=0, the required population is represented by the line ED and it is therefore necessary to project births, deaths and net migration in the triangle represented by ADE.

The relationship between m_x and q_x

The mortality rates (q_x) are given, for each individual age, in the data tables available on the ONS website. However, in other statistical publications, and in the [mortality chapter](), mortality rates are often shown as central death rates (m_x). These are obtained by dividing the number of deaths during a year at a given age by the average population at that age during the year (usually taken to be the population at the midpoint of the year). The relationship between q_x and m_x is shown by the following equation:

$$q_x \cong \frac{m_x}{1 + 0.5 m_x}$$

Note that this equation is an approximation as it assumes deaths occur evenly between exact age x and exact age x+1. It does not hold for infant mortality, as infant deaths are concentrated in the first few months of life.

The q_x rates used in the projections are the results of two interpolations. The first interpolation takes place between the q_x rates for adjacent calendar years and produces rates on a mid-year to mid-year basis. The second interpolation is between adjacent ages and gives a set of q_x rates that, in life table terms, relate to exact age x+½ on a mid-year basis. These are assumed to be applicable to the mid-year population at age last birthday.

5 . Related projections

Subnational population projections

Subnational population projections are the responsibility of the statistical offices of the constituent countries of the UK. The latest set of subnational projections are available for England on the [ONS release page](https://)[8], for Wales on the [Welsh Government release page](https://)[9], for Scotland on the [National Records of Scotland release page](https://)[10] and for Northern Ireland on the [Northern Ireland Statistics and Research Agency release page](https://)[11].

Other related projections

A number of more specialised projections, all consistent with the national projections, are also prepared by government. [Marital status projections](https://)[12], consistent with the 2008-based national projections, were published on 24 June 2010. These are produced on an ad hoc basis and there are currently no plans to produce marital status projections using the 2012-based national projections.

The [Department for Communities and Local Government (DCLG)](https://)[13] published 2011-based interim household projections for England on 9 April 2013.

ONS no longer produce labour force projections, however, the Office for Budget Responsibility (OBR) now produce regular forecasts independent of Government, which include labour force projections. The latest available are for the period 2009 to 2019 which were published on 5 December 2013[14].

Population projections for other countries, carried out on a comparable basis, are produced by organisations such as Eurostat[15] and the United Nations[16].

6 . Data availability

Website

Detailed results of the 2012-based national population projections for the UK and its constituent countries are available from the ONS website. The results include the principal and variant projections for each country, and a summary of the assumptions upon which they are based. The key datasets can be downloaded in Microsoft Excel format for each country.

For each projection, the following datasets can be downloaded:

- Components of change, summary age distributions and dependency ratios

- Population in five-year age groups

- Population by individual age (to age 90)

- Fertility rates by individual age

- Fertility rates in five-year age groups

- Mortality rates by individual age

- Net migration by individual age

These can be more easily found using the NPP interactive table download tool[17].

The projected population numbers are shown in thousands but stored to three decimal places (that is, to unit level). This does not imply that the projections are accurate to that level of detail. Results should always be presented in thousands.

In addition a number of datasets have been published as part of the government's open data agenda, mainly for modelling purposes. These files contain the 2012-based national projections by country, single year of age (0 to 105 and over) and sex, mid-2012 to mid-2112.

The UK interactive population pyramids[18] allow the user to analyse the age structure of the population more easily. By animating the graph, the user can compare the alternative projections and show how the population is projected to change over time.

For the principal population projection and the associated components of population change, the interactive graphs[19] allow the user to view trends to mid-2037 graphically by sex and for predefined age groups.

[Period and cohort life expectancy data](#)[20] derived from historic mortality rates (from 1981 to 2012) and assumed calendar year mortality rates from the 2012-based national population projections are also available.

Further information

Further information about the National Population Projections may be obtained from the Office for National Statistics, Population Statistics Division, Population Projections Unit, Segensworth Road, Titchfield, Fareham, Hampshire, PO15 5RR.

Telephone: +44 (0) 1329 444652

E-mail: projections@ons.gsi.gov.uk

7. References

1. Full results of the 2012-based principal and variant projections can be found at: http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-21600

2. Mid-2012 estimates for each constituent country of the UK are available at: http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/mid-2011-and-mid-2012/index.html

3. Thatcher AR, Kannisto V and Andreev K. The Survivor Method for Estimating Numbers at High Ages. Demographic Research – Max Planck Institute online journal, Vol 6-1 (2002). Available at: http://www.demographic-research.org/volumes/vol6/1/default.htm

4. Mid-2012 estimates of the very elderly (including centenarians). Available at: http://www.ons.gov.uk/ons/rel/mortality-ageing/estimates-of-the-very-old--including-centenarians-/2002-2012/stbevo2012.html

5. Population estimates for Scottish Centenarians. Available at: http://www.gro-scotland.gov.uk/statistics/theme/population/estimates/special-populations/centenarians/index.html

6. ONS national population projections quality and methodology report: http://www.ons.gov.uk/ons/guide-method/method-quality/quality/quality-information/population/quality-and-methodology-information-for-national-population-projections.pdf

7. For a good introduction to projections methodology see Chapters 16 to 18 of Hinde A Demographic Methods. Arnold. (1998)

8. Subnational population projections (England). Available at: http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-21850

9. Subnational population projections (Wales). Available at: http://wales.gov.uk/statistics-and-research/local-authroity-population-projections/?lang=en

10. Subnational population projections (Scotland). Available at: http://www.gro-scotland.gov.uk/statistics/theme/population/projections/sub-national/index.html

11. Subnational population projections (Northern Ireland). Available at: http://www.nisra.gov.uk/demography/default.asp47.htm

12. 2008-based marital status projections for England & Wales. Available at: http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-23636

13. Department for Communities and Local Government. Interim household projections to 2021, England. Available at: https://www.gov.uk/government/publications/household-interim-projections-2011-to-2021-in-england

14. See: http://budgetresponsibility.org.uk/economic-fiscal-outlook-supplementary-economy-tables-december-2013/

15. Regional population projections produced by Eurostat. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/population/publications/population_projections

16. United Nations World Population Prospects: Available at: http://esa.un.org/wpp/unpp/panel_population.htm

17. National population projections interactive data download tool can be found at: http://www.ons.gov.uk/ons/interactive/2012-npp/index.html

18. UK interactive population pyramid: http://www.ons.gov.uk/ons/interactive/uk-national-population-projections---dvc3/index.html

19. National population projections interactive graphs are available at: http://www.ons.gov.uk/ons/interactive/ppu-2012-v2/index.html

20. Period and cohort life expectancy data: http://www.ons.gov.uk/ons/rel/lifetables/historic-and-projected-data-from-the-period-and-cohort-life-tables/2012-based/index.html

8. Background notes

1. The 2012-based Population Projections for United Kingdom and constituent countries were published on 6 November 2013 (main release) and 10 December 2013 (extra variants).

2. Details of the policy governing the release of new data are available by visiting www.statisticsauthority.gov.uk/assessment/code-of-practice/index.html or from the Media Relations Office email: media.relations@ons.gsi.gov.uk

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