



Department for
Communities and
Local Government

Updating Department for Communities and Local Government's household projections to a 2011 base

Methodology Report

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1. Introduction

The methodology for the 2011-based interim projections was based on the methodology used for the 2008-based projections, which was agreed after a review of the previous methodology and a public consultation. For the 2011-based interim household projections some changes needed to be made to the methodology in order to incorporate valuable information from the Census 2011 where available.

Stage One produces the national and local projections for the total number of households by age group and marital status group over the projection period. The total number of households in each local area form the basis of the control totals for Stage Two of the projection methodology, which gives the detailed household type breakdown by age.

For Stage One household representative rates for 2011 have been derived at England level using the aggregate household representative rate from the 2011 Census, data from the LFS and previous household projections. This enables the 2011 Census point to be added to the estimation process for Stage One. At local authority level, the household projections have been controlled to both the national projections and the aggregate household representatives rate from the 2011 Census for each local authority. This approach means that the households projections are consistent with the available information on household representatives and average household size from the Census 2011.

For Stage Two, information on household types has been taken from the available Census 2011 data and used to produce estimates of Stage Two types by age. These estimates have then been used together with the 2001 Census to produce a projection of detailed household types. This process captures the substantial shifts in household types that have occurred between 2001 and 2011 which would not have been captured if 1991 and 2001 Census data had been used instead.

This note describes the household projections methodology and highlights where changes have been made for the 2011-based projections.

The household projections are guided and verified by an independent group of expert advisors. Throughout the production of the results, the outputs are quality assured by the Steering Group including consideration of national and sub-national results and the trends in household representative rates by age.

2. Stage One

Stage One produces the national and local projections for the total number of households by age group and marital status group over the projection period. It applies projected household membership rates to a projection of the private household population disaggregated by age, sex and relationship status, summing the resulting projections of household representatives.

The method uses a simplified three-way relationship categorisation to represent marital/cohabitational status. The categories are people in couples (including married couples who are living together and cohabiting couples); separated marrieds, divorced and widowed not in couples; and people not in couples (not cohabiting, never married). This is an aggregation of the detailed categories in the previous DCLG Household Projections model System (known as HOPS) which captures the key household formation characteristics of the relationship status groups while retaining relative simplicity.

The projection methodology for Stage1 from the 2008-household projections has been maintained but adapted. The 2011 interim update includes information from the 2011 Census, which together with data from the LFS, has been used to create an additional data point that can be used in the household projections methodology at national level. The updated national projections are then used to control previous projections at the regional and local authority level. The regional and local authority data is also controlled to the 2011 Census aggregate household representative rate.

The projections methodology uses time-series modelling, with a combination of simple and dampened logistics trends. Cohort modelling is not used. The simplified time-series based projections are referred to as the Stage One projections to distinguish them from the detailed projections by household type described in Stage Two.

There are five key components to the household projections produced in Stage One, each of which is detailed further below:

- a. Population projections
- b. Marital status composition
- c. Institutional population
- d. Household representative rates
- e. Regional and local household projections

a. Population projections

National and sub-national populations are taken from the most recent population projections published by ONS on 28 September 2012. For the 2011-based household

projections, the 2011-based¹ interim population projections are used by sex and five-year age band at both national and sub-national levels. They are based on the latest population estimates data published on 25 September 2012, which take into account results from the 2011 Census.

The population projections are trend-based, making assumptions about future levels of fertility, mortality and migration based on levels observed over a five-year reference period. Therefore, they give an indication of what the future population, by age and sex structure, might be if recent trends continue, and take no account of policy or development aims in local authorities.

The population projections generally update underlying demographic assumptions on fertility and migration in line of new available data, but for the 2011-based sub-national population projections trends from the 2010-based projections were used. These population projections are known to over-project the number of births at national level. This particularly affects some areas where the 2011 population estimates have higher numbers of women aged 16-44 than in the 2010 estimates. Therefore caution should be used in the application of these projections for planning purposes at the younger ages. Further information on the limitations of the 2011-interim population projections are provided in the user guide² and methodology document³. The 2011-based population projections are a key input and driver for the household projections model so the limitations of the 2011-based population projections should be considered when assessing the 2011-based household projections.

b. Marital Status Composition

The 2008-based population projections by marital status for England & Wales were published on the 24 June 2010 by the ONS and incorporated into the household population projections for the 2008-based household projections. ONS have not produced updated marital status projections since. The existing marital status projections in the household projections have therefore been controlled to the 2011-interim population projections by age and gender.

The marital status projections cover both legal marital status and (opposite-sex) cohabitation for the period to 2021. As the household formation behaviour of married and unmarried cohabiting couples is similar and distinct from the characteristics of other marital status groups, cohabiting as well as married couple households need to be identified. This means that the following marital status types are initially identified:

Single	-	not cohabiting
Married	-	not cohabiting

¹ <http://www.ons.gov.uk/ons/rel/snpp/sub-national-population-projections/Interim-2011-based/stb-2011-based-snpp.html>

² <http://www.ons.gov.uk/ons/rel/snpp/sub-national-population-projections/Interim-2011-based/stb-2011-based-snpp.html#tab-User-guidance>

³ <http://www.ons.gov.uk/ons/rel/snpp/sub-national-population-projections/Interim-2011-based/stb-2011-based-snpp.html#tab-Methodology>

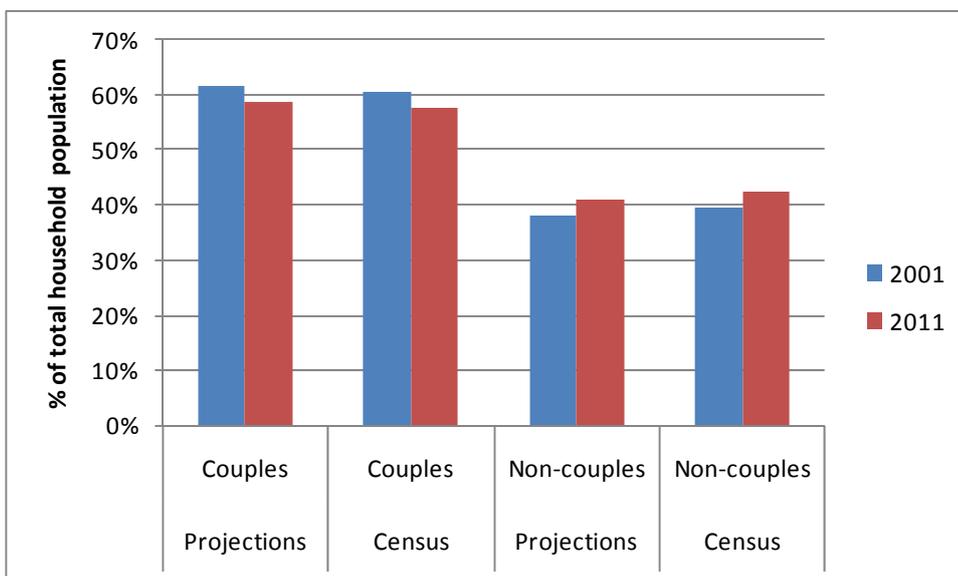
(other than with spouse, i.e. either living with spouse or living alone)

Widowed	-	not cohabiting
Divorced	-	not cohabiting
Single	-	cohabiting
Married	-	cohabiting (not with spouse)
Widowed	-	cohabiting
Divorced	-	cohabiting

The marital status projections are at national level only. Population estimates of resident population by single year of age, sex and legal marital status which ONS has updated to include marriages abroad are also included at the national level from 2002 to 2010. No official cohabiting population estimates which are consistent with the revised marital status estimates were available for this period. Estimates have therefore been produced for the cohabiting population by marital status between 2002 and 2010 using trends in cohabitation shares of total marital status population as found in the marital status projections. Estimates of marital status in future years at sub-national level are made by applying national/local differentials in marital status from the Census to projected marital status factors.

Projections of marital status composition have been compared with the estimates of household population composition from the 2011 Census at national level. Due to definitional differences between the statuses used in the household projections and those used in the Census 2011, only very broad comparisons with the figures are possible. The estimated change between 2001 and 2011 in the marital status projections and the change between the 2001 and 2011 Censuses are shown in figure 1 below.

Figure 1: Household population split by couples and non-couples – comparison between Censuses and the household projections



Population estimates from the eight marital status / relationship categories are aggregated into three broader groups. This has the advantages of presenting a smaller and hence simpler set of groupings to aid user understanding and to minimise the potential impacts of errors in the projection data sets, whilst still capturing the key features of household formation behaviour:

People who are part of a mixed-sex couple. This includes both married couples (where they live together) and cohabiting couples. This does not include people in same-sex couples⁴;

Male and female separated, divorced or widowed (once married) people⁵;

Male and female single people who have never been married, and are not cohabiting ('single' as in not in a couple or separated, divorced or widowed; not necessarily a one-person household⁶);

c. Institutional Population

The household projections are based on the projected household population rather than the total population. The difference between the two is the population in communal establishments, also termed the 'institutional' population. This population comprises all people not living in private households. These include people living in nursing homes, halls of residence, military barracks and prisons.

Estimates of the total institutional population are available from the 2011 Census at England and local authority level. However the household projections methodology requires that estimates of institutional population are split by age, gender and marital status.

For the household projections, the assumption is made that the institutional population stays constant at 2001 levels by age, sex and marital status for the under 75s and that the share of the institutional population stays at 2001 levels by age, sex and marital status for the over 75s. Data taken from the prison element in the mid year estimates of population component of change tables from 2002 to 2010 has been used to adjust institutional population up to this point.

The estimates of institutional population are then controlled to the 2011 Census in 2011 and the levels for the under 75s are then held constant for 2012 to 2021 whilst the 2011 shares are held constant for the over 75s. The rationale here is that ageing population has

⁴ The Census 2011 identifies same-sex couples but Census 2011 data by type has not been used to derive marital status composition in the household projections. When this information is available from the Census 2011, same sex couples would not be included in this mixed-sex couple category to ensure consistency with data taken from previous Censuses.

⁵ Does not include previously cohabiting (not married) people who are now separated.

⁶ This group, for example, will include single (never married) lone parents and people living in other multi-person households. It will also include those who previously cohabited although never married.

and will lead to greater level of population aged over 75 in residential care homes that would not be picked up if levels were held fixed, but holding the ratio fixed will.

A full investigation testing the assumptions used for institutional population and the options available to improve the estimates and projections of institutional and private household population at the national, regional and local level can be found in Annex 2 of the methodology report for the 2008 household projections. When institutional population is available by age, gender and marital status from the 2011 Census, the methodology for deriving institutional and household population estimates and projections may be revised.

The institutional population is subtracted from the total resident population projections by age, sex and marital status to leave the private household population, analysed by sex, age and marital status (cross classified by cohabitation status) in the years required for household projections.

d. Household Representative Rates

The number of households is essentially the household population multiplied by the appropriate household representative rate. The household representative rate is the probability of anyone in a particular demographic group being classified as being a household representative and can take any value between 0 and 1.

A household representative is a person chosen for statistical reasons by virtue of age and/or sex as the representative of a household. The total number of projected households is equal to the sum of households represented by all age, sex and marital/relationship status types.

Note that the eldest male is taken as the household representative in the Stage One methodology. This is to preserve consistency with earlier Censuses.

The household representative rates can be represented algebraically for any year as:

$$HH_{total} = \sum_{a=0-4}^{85+} \sum_{s=m}^f \sum_{r=c}^s HRR_{a,s,r} . HP_{a,s,r}$$

Where:	HH	is the number of households
	HRR	is the household representative rate
	HP	is the household population
	a	are age groups (0-4....85+)
	s	is male or female
	r	is marital/relationship status

Incorporating the Census 2011

The 2008-based projections used data from the 1971, 1981, 1991 and 2001 Censuses to project household representative rates by demographic group. In consultation with the Steering Group, it was agreed that it would add great value to the interim projections if the 2011 Census was included in the estimation process to produce the 2011-based projections.

To produce household representative rates by demographic group requires detailed data which is often non-standard data from the Census. At the time of producing the 2011-based household projections only the total count of households and household population was available at England, regional and local authority level from the Census 2011 in a format that could be used for Stage One. Household data from the Census 2011 was not available split by the necessary demographic groups for Stage One but data that could be used for the Stage Two household types was available (see 'Stage 2' below).

In consultation with the Steering Group it was decided that the best approach given the data available was to estimate household representative rates for England by age using the aggregate household representative rate from the 2011 Census and household representative rates split by age from the Labour Force Survey. The estimates by age are then split by marital status and gender using the previous (2008-based) household projections. The final estimates of household representative rates by age, gender and marital status are then included in the estimation process at national level, providing a fifth (2011) estimation point.

Further details on this approach are set out below.

The Census 2011 showed that the aggregate household representative rate (total households/ total population) was 0.424, which is lower than the value of 0.434 suggested by the 2008-based projections. However no information was available from the Census 2011 to split this aggregate figure across age, gender and marital status.

LFS data suggests that there have been some steep falls in household representative rates for some age groups since the 2001 Census and the 2011 Census results – although not split by age – reinforce the trends observed in the LFS. It was therefore decided to use changes in the household representative rates by age-band from the LFS to estimate the changes that have occurred between the 2001 and 2011 Census.

Unweighted LFS data was used and processed as follows:

1. The quarterly LFS household representative rate data by age (but not) sex are seasonally adjusted
2. The seasonally adjusted data are smoothed using a Henderson 9-point moving average
3. The smoothed quarterly LFS data are converted to annual series and are further smoothed using another Henderson 9-point moving average
4. The smoothed LFS household representative rates are spliced onto the 2001 Census data points.

The 2011 LFS based household representative rates by age were then applied to the household population by age to produce an initial estimate of households by age band. The total was then controlled to the 2011 Census aggregate household representative rate and the final 2011 household representative rates by age were then calculated.

Household representative rates by age, gender and marital status for 2011 were estimated on the basis of the following:

1. The estimated household population by age, gender and marital status for 2011;
2. The estimated household representative rates by age for 2011; and
3. The household representative rates by age, gender and marital status for 2001 taken from the previous household projections.
4. The projected household representative rates by age, gender and marital status from the 2008-based projections to split by marital status for 2011

In contrast, for the 2008 households projections the Labour Force Survey (LFS) was used to adjust the household representative rates by age-band at the national level between 2002 and 2009. After 2009 the projections reverted to pre-LFS adjustment trends and the post-2009 projections were not affected directly by the LFS adjustments between 2002 and 2009. The LFS data was also weighted, with a greater weight given to data further away from the 2001 Census point.

Projecting household representative rates

The procedure followed to project the household representative rates at the national level is as before but with inclusion of the 2011 point as follows. There are now 5 observations to project forward but there are still issues that some of the points (particularly the 1991 Census) look to be quite strange.

The projections of the household representative rates use a combination of two fitted trends:

1. A simple logistics trend - a straight line fitted to $\ln (X_t / (1-X_t))$
2. A dampened logistics trends where an S-shaped curve is fitted to $\ln (X_t / (1-X_t))$

These functions were developed as part of the development for the Stage One methodology⁷ to fit through the Census points as some of the trends are linear whilst others have a curve.

As with the 2008-based projections, it is still not clear which of these is the most appropriate. The dampened trend provides a better fit for the Census data. But consideration has to be given to the extent to which data errors may have affected measured past trends and also to the fact that the 2011 estimates by demographic type are based on the trends from the LFS as well as from actual results from the 2011 Census. Further detail on concerns with some of the previous Census points (particularly 1991) is provided in the 2008-based methodology document.

⁷ Testing methodological changes to the household projection model, DCLG 2010

Given the uncertainty, the projections are weighted together using the following weights:

15 to 29 year olds: 80:20 weights for dampened / simple trend

30 year olds and over: 60:40 for dampened/ simple trend

The reason for the differential weights is that Labour Force Survey (LFS) data indicate declining aggregate household representative rates for the younger age groups and, consequently, there is evidence that it is more appropriate to give a bigger weight to the dampened trend in these cases.

Regional and local projections

The Stage One household projections model uses a top-down approach with projections first produced at England level, then regional level⁸ and then finally local authority district level.

We do not have household representative rates by age, gender and status from the Census 2011 for any geographic level. At the England level we have imposed the change in household representative rate by age in the LFS between 2002 and 2011 on to the 2011 Census point. At the regional and local level the LFS data does not provide estimates which are considered robust enough to use the same approach as used at the national level. In consultation with the Steering Group it was decided to control the 2008-based regional household representative rates to both the England 2011-based projections and to the Census 2011 aggregate household representative rate for each area. The same process was then repeated for the local authority areas, controlling the local household representative rates to the regional household representative rates and the Census 2011 aggregate household representative rate.

The process was to apply the regional 2008-based household rate to the regional 2011-based household population projection by age, gender and marital status to produce an initial set of Stage One household projections. The regional totals by age, gender and marital status were then controlled to the England totals by age, gender and marital status and the aggregate household representative rate by region from the 2011 Census to produce a final set of Stage One household projections by region. The process was then repeated at local authority level.

The regional and local controlling procedure adjusts the household projections so that there is consistency across spatial levels and in the age/ sex/ marital/relationship status composition of the population, as given in the ONS resident population projections. Priority has been given to ensure internal consistency within a given area before consistency across demographic type at regional and national level. The controlling process ensured that the data is consistent across local authority level and demographic types to England totals by demographic type to within 0.01%.

⁸ DCLG does not publish projections at regional level but the projection methodology still applies regional controls.

3. Stage Two

a. Summary

Stage Two utilises adjusted 2001 Census commissioned tables⁹, together with information on household types taken from the 2011 Census, to disaggregate the household projections produced in Stage One into more detailed household types. This enables the projections to provide information on the size of households, particularly the number of adults and the number of dependent children in each household. The use of Census 2011 data on household types required an additional stage to be built into the household projections methodology for Stage Two, compared to the process used for the 2008-based projections.

b. Estimating Stage Two types for 2011

The Stage Two household types for the 2008-based projections were derived from 2001 Census commissioned tables, however comparable tables were not available for the 2011 Census in time to be used for the 2011-interim update. Census 2011 Key Statistics and Quick Statistics tables are standard tables available that provide information on household types. However in most cases the data on household types is not split by age or gender. Data was compared from the table commissioned from the Census 2001 which was used to build Stage Two types in the 2008-based projections, against a number of 'standard' Census 2001 tables (key statistics and univariate statistics tables) that were also available from the 2011 Census. The following Census tables were identified as containing data comparable to the content of the commissioned tables:

- KS105 – Household composition (table KS20 in 2001)
- QS113 - Household composition – Households (table UV65 in 2001)
- QS116 - Household type – Households (table UV68 in 2001)

Estimates for Stage Two were generated split by age (and gender for one person households) for each local authority in England. The approach taken was to generate headship rates¹⁰ by type and age (and gender for one person households) for 2011 from the 2008-based projections. These headship rates were then applied to the 2011-based

⁹ Census tables were supplied with the City of London and Isles of Scilly data merged with adjacent districts. Projections for the City of London and Westminster have been merged; likewise the Isles of Scilly and Penwith have been merged.

¹⁰ The headship rate is defined as the proportion of people in each age group and household type who are the 'head' of a household. This differs from the household representative rate used in Stage One which represents the probability of a household being formed by a person of a given age, gender and relationship status.

household population by age and gender for 2011 to produce initial estimates of households by type and age in 2011. The first estimates were then aggregated and controlled to published Census 2011 type totals where available.

The control types derived from the Census 2011 and their source table are detailed below:

- One person households (under 65 and over 65) – Table KS105
- One family and no other: Couple households: no dependent children – Table KS105
- A couple and one or more other adults: No dependent children – Derived
- Households with dependent children – Table QS116
- Couple households (including households with one or more adults) – Table QS116
- Couple households with dependent children (including households with one or more adults) - Table QS116
- Couple households no dependent children (including households with one or more adults) - Table QS116
- Lone parent households with dependent children (including households with one or more adults) - Table QS116
- Lone parent households with no dependent children and others - Table QS116

The closest match for household types with children comes from table QS116, however this table does not split out households by number of children. Data from table QS113 was therefore used to split households with dependent children into households with one dependent child and households with two or more dependent children.

One person households were also controlled by age to the Census 2011 for one person households aged under and those aged over 65.

c. Aligning definitional differences between Stage One and Stage Two

Stage Two combines data with two different definitions of the household representative:

1. The existing DCLG/ HOPS definition which is used in the Stage One projections – the oldest male then the oldest female if there is no male;

2. The Census definition (introduced for the 2001 Census) – the eldest economically active person then the oldest inactive person if there is no economically active person.

The approach taken to counter the different definitions was as follows:

3. The 2001 Stage Two household type shares were lined up with the definitions in the 2001 Census by calculating the 2001 Census distribution of households by age, split by couples and non-couples. Then these shares were applied to the Stage One household estimates by couples and non-couples to derive the Stage Two control totals. Then the 2001 Stage Two household types were adjusted so that they were consistent with the new Stage Two control totals.
4. The above process was repeated using 2011 values.
5. The Stage One household totals remained the overall control total.

Ideally, Stage One and Stage Two would use fully consistent definitions but this is not possible if the link with the old time series-based model needs to be retained, and in order to make use of the new household typology available from recent Censuses. By adjusting the data to account for definitional differences, the new methodology retains consistency with the old time series approach, and makes use of available time series back to 1971 (in Stage One) while permitting a move to the new, and potentially more useful, household typology from recent censuses (in Stage Two)¹¹.

d. Projection Methodology

The 2008-based Stage Two household projections used a two-point projection methodology using data from 1991 and 2001. In determining the Stage Two methodology for the 2011-update, the following issues were considered:

- Whether three Census points (1991, 2001 and 2011) could be included in the projection methodology.
- If three points was not viable, which two Census points would be most appropriate to use, 1991 and 2001 or 2001 and 2011.

¹¹ In addition to the different definitions of the household representative between the recent Censuses (2011 and 2001) and previous Censuses, the 2011 Census has a slightly different definition of 'households'. It is anticipated that the different definition has a minimal impact on household numbers, however data was unavailable from either the 2011 Census or 2001 Census to investigate this point further. As a result it has been assumed that the change in definition will have little material impact on the household projections. This may require further investigation in future.

The 2008-based approach used a two-point exponential method - calculating an average annual growth trend between 2 data points (1991 and 2001) and extrapolating that forward. The main benefit of the two-point approach is that it allows the projections from Stage One to be split into more meaningful household types, including information on number of adults and children in households.

This approach cannot directly be extended to include all 3 data points, and any alternative would require a change in the functional specification for the projections equation, together with a different approach to estimation. It would be possible to specify projection functions that ensured the interpolated annual estimates and projections passed through all of the Census points, however these would not have the natural 'constant growth trend' interpretation of the existing functions and could potentially appear rather arbitrary.

It was concluded that the possibility of using three Census points may be reviewed when the full results are available from the Census 2011. The full set of 2011 Census results by household type were published at the end of January, towards the end of the timetable for producing the updated household projections, which meant that there was not time to develop and test these alternative functions. On this basis a two-point methodology would be carried forward for this update.

In consideration of which Census points to use the potential issues with the two approaches lie in the quality of the Census data as well as the trends that using different points would create. For 2011 estimates of household types were produced as outlined above, and whilst these appear sensible (and were reviewed by the Steering Group) they are estimates (not actual Census results). For 1991 the data is based on a 10% sample and uses a different definition of household representative to the 2001 and 2011 Census. The 2001 point is from the 100% sample and uses a consistent definition of household representative as the 2011 Census data.

To explore the impact of using different Census points some tests were run on a sample set of local authority districts. The tests showed that:

- As expected, using approach 1991 and 2001 data points, produces higher household estimates for younger age groups (most notably 25-34) and lower projections for older age groups than using 2001 and 2011 data points. Note from Stage One that household representative rates have fallen between 2001 and 2011 – particularly for younger age groups.
- Using 2001 and 2011 data points produces results that are much closer to Stage One total households before controlling to the Stage One total, which was considered a more desirable outcome.

Given the results of the testing and potential concerns over 1991 data and definitions, it was decided to continue with the '2 point' methodology applied to the 2001 and estimated 2011 census data.

Stage Two therefore utilises adjusted 2001 Census commissioned tables and estimated 2011 data to disaggregate the household projections produced in Stage One into more detailed household types.

Stage Two initially works with data at the local authority level. Adjacent five year age bands from Stage One have been merged into 10 year age bands to provide more robust estimates (except for the 55 to 59 and 60 to 64 year old age bands which have been kept to provide information on pensioner households). Stage One total household series are used to constrain the Stage Two household projections for each local authority.

The proportions of households by household type and age group of the head of household are derived from the adjusted 2001 Census data and estimated 2011 data point. The sum of households by type and age group does not sum to total household population, since some of the household population are not household representatives. The difference represents data on non-household reference persons and is calculated by age band. The proportions of each household type and non household reference persons, known as the headship and non headship rates, sum to one within each age band.

The headship and non-headship rates by age band are projected forward using a two-point exponential method using the following formula.

$$p_{t,a,r,i} = d + ab^{c_i}$$

where $p_{t,a,r,i}$ = headship rate by household type t by age band a by local authority r in year i

i = the year, from 2001 to 2021

$$d = 1 \text{ if } p_{t,a,r,2011} \geq p_{t,a,r,2001} \text{ else } d = 0 \text{ if } p_{t,a,r,2011} < p_{t,a,r,2001}$$

$$a = p_{t,a,r,2001} - d$$

$$b = (p_{t,a,r,2011} - d) / (p_{t,a,r,2001} - d)$$

$$c_i = (i - 2001) / (2011 - 2001).$$

The same technique has been used to provide headship and non headship rates for 2002 to 2010. The formula ensures that the individual headship and non-headship rates are limited so that they cannot be less than zero or greater than 1. The individual headship and non-headship rates are then aggregated and constrained so that they sum to 1 within each age band. Regional growth rates have been applied for any individual cell at the household type, age and local authority level with a 2001 population count of less than 10. This rule has been implemented as there was some concern that the two point exponential projection was sensitive to changes between 2001 and 2011 for small numbers which can lead to compounded future growth that may not be plausible. This was observed when there was a household number and subsequent headship rate of zero (or close to zero) in 2001 and a small increase has occurred in the 2011 census.

The initial Stage Two local authority level household projections are calculated by applying headship rates to the household population projections by age band to give an estimate of the number of heads of household for each household type and age band. The Stage Two local authority level household projections are summed to total households and compared with the Stage One projections. This is a simple check to ensure that the trajectories of

household growth from Stage One and Stage Two are not so divergent as to be implausible. This was not found to be the case for any local authority.

The initial Stage Two local authority level household projections are then constrained to be consistent with Stage One total households at local authority level before two checks are run.

e. Minimum adults check

The initial household projections are tested to ensure the minimum number of adults required to fill the projected households is not greater than the projected private adult household population. This was not found to be an issue at the local authority district level and subsequent regional and national level checks. No further adjustment is made for any period. This test is also run after the dependent children adjustment is made, where again no problems were identified.

f. Dependent children adjustment

A second check is run to ensure the minimum number of dependent children as suggested by the projected household types does not exceed projections of dependent children in the population. This check required an estimate and projection of the number of dependent children for 2002 to 2021. By definition, dependent children include all 0 to 15 year olds so single year ONS sub-national Population Projections were used for this element. However, 16-18 year olds require a further assumption concerning the proportion of the 16 to 18 total population that are dependent children (i.e. single and inactive and a student). This has been calculated at the local authority level by pushing forward 2001 Census shares with growth rates in the number of full time students from the LFS in the corresponding age band. Equivalent information was not yet available from the Census 2011. Full time student data has been sourced from the LFS as a proxy to capture changes in the levels of dependent children due to increasing participation in post-16 education. Proportions for full-time students have been kept fixed from the last data point (2011).

In the Stage Two projections, a comparison of the implied number of dependent children from the household projections against the number of dependent children calculated from the population projections was made for each local authority district. Within each district an adjustment was made to the number of households with children so that the ratio of the actual number of dependent children to the implied household projection outcome of dependent children is constant in the future. A ratio is used as we do not hold further information on the distribution of the number of children in household types where there are three or more dependent children. The ratio assumes the distribution remains the same as the estimates for 2011 (which in turn are based on the 2001 Census).

This condition is required because the two point extrapolation method for Stage Two does not adequately capture the short term deviations around the long term trend present in the population projections for children. Without the adjustment the results would tend to underestimate the number of households with dependent children, largely as a result of underestimating the number of households within the 3 or more dependent children types that have 4 or more children.

In the Broxtowe example shown below (Figure 2), the number of households with children were adjusted down to achieve the constant ratio. In the North Norfolk example (Figure 3), the adjustment to households with children is upwards to ensure the constant ratio.

It is important to note that these adjustments do not affect the total number of households projected within each local authority area as this is fixed by the Stage One projections. Rather, any adjustments result in redistribution across the household types, moving household numbers into and out of the types with and without dependent children as required.

Figure 2: Dependent children adjustment example, Broxtowe

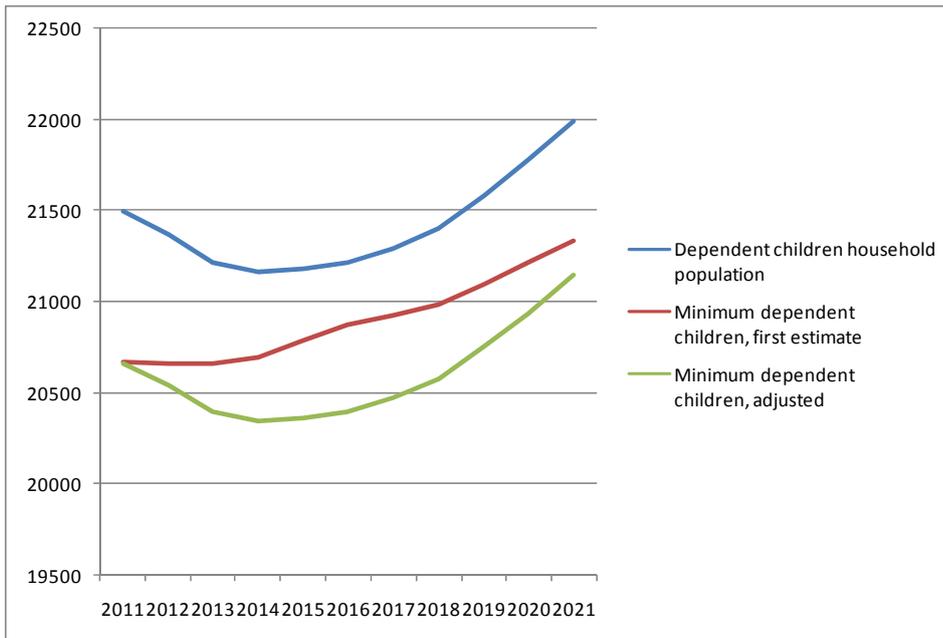


Figure 3: Dependent children adjustment example, North Norfolk

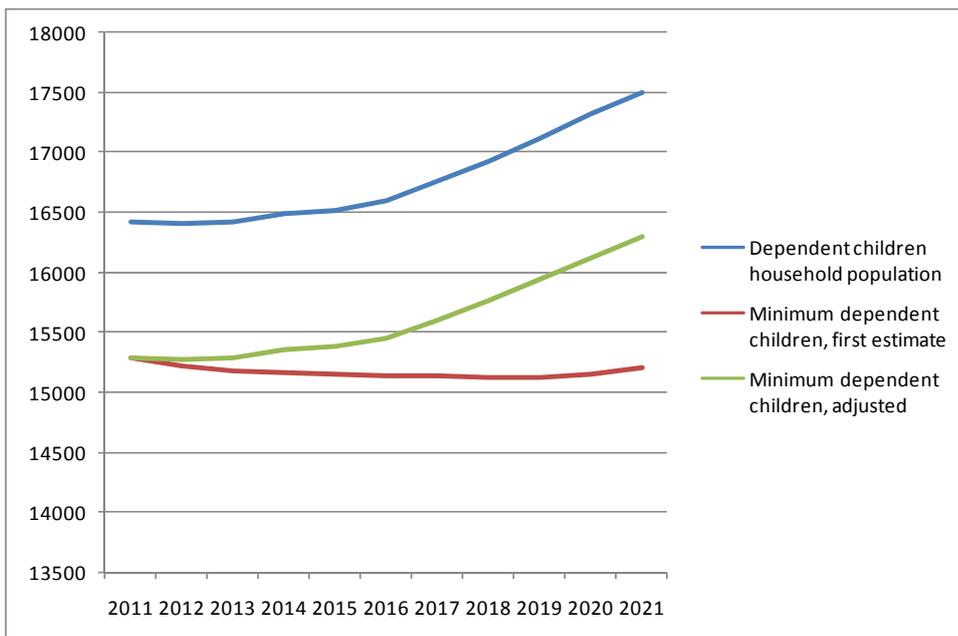


Table 1 indicates the extent of the dependent children adjustments on average and at the extremes. The mean adjustment by 2021 was to increase the number of households with dependent children by 1,876 per local authority. This means that the first estimates of Stage Two household projections underestimated the number of households with dependent children relative to the population projection of dependent children. The percentiles presented in the table show that 25% of results for local authority districts are adjusted by 1023 or less in 2021, 50% are adjusted by 1764 or less and 75% of local authority districts are adjusted by 2775 or less.

Under the 2008-based household projections the dependent children adjustment was negative on average, whilst the 2011-based adjustment is positive. This reflects the fact that the number of children in the 2011-based population projections is significantly higher than under the 2008-based projections.

Table 1: Minimum children adjustment: number of children, 2021

Statistics	Number of children	
Mean	1,876	
Minimum (Camden)	-10,068	
Maximum (Liverpool)	13,621	
Sum	608,140	
Percentiles	25	1023
	50	1764
	75	2775

N=324

g. Household types

Table 2 outlines the 17 household types produced in Stage Two.

Table 2: Household Type Summary

Type	
One person households	Male
	Female
One family and no others	Couple: No dependent children
	Couple: 1 dependent child (1)
	Couple: 2 dependent children (1)
	Couple: 3+ dependent children (1)
	Lone parent: 1 dependent child (1)
	Lone parent: 2 dependent children (1)
A couple and one or more other adults	Lone parent: 3+ dependent children (1)
	No dependent children (2)
	1 dependent child (2)
	2 dependent children (2)
Lone parent and one or more other adults	3+ dependent children (2)
	1 dependent child(2)
	2 dependent children(2)
Other households	3+ dependent children(2)
	Total

(1) Households with dependent children and no non-dependent children.

(2) In these categories, the other adults may include another couple and/or another lone parent and/ or a non-dependent child.

A dependent child is a person in a household aged 0 to 15 (whether or not in a family) or a person aged 16 to 18 who is a full time student in a family with parent(s). 'Couple households' are either married or cohabiting. The 'Other households' category above is an aggregation of five categories from the original Census table C1092 supplied by ONS: One family and no others: Lone parent households: All children non-dependent, A lone parent and one or more other adults: no dependent children (2), Other households with 2 adults, Other households with 3 or more adults & Other households. The 'Other households with 2 adults' category originally included 'all pensioner' households in the Census table. In the household projections, these households have been removed from the 'Other' category and added to the 'One family and no others: Couple households: No children' category.

4. Sensitivity testing

For previous household projections, variant household projections have been run alongside the main projection. These variant projections used the Office for National Statistics variant national population projections which demonstrated the effect of assumptions regarding fertility, life expectancy and net migration on future levels of population. Applying the household formation rates from the household projections to the variant population projections gave a broad indication of the sensitivity of the household projections to demographic assumptions at national level. Variant projections are not available for the 2011-interim population projections.

As an alternative, a sensitivity test was performed by applying the 2011-based assumptions on household formation to the 2008-based household population projections, which were used for the 2008-household projections. The sensitivity test was run at local authority level to help users understand the impact of the changes to the population projections on the household projections.

The sensitivity test highlights the reduction in household formation rates between the 2011 and 2008 projections. At the national level the sensitivity test results in 88 thousand fewer households in 2011 compared to the 2011-based projections and 375 thousand fewer households than compared to the 2008-based projections. The sensitivity test also produces weaker household projections, with an average annual change between 2011 and 2021 of just 210 thousand household per year compared with 221 thousand per annum under the 2011-based projections and 245 thousand per annum under the 2008-based household projections (Table 3).

A similar pattern is found across many local authority districts (Table 4). On average for local authorities, the Sensitivity Test has 270 fewer households than the 2011-based household projections in 2011 and 1150 fewer households in 2011 than projected by the 2008-based household projections. Similarly, the growth rates are generally weaker for local authorities for the sensitivity test than for the 2011 and 2008-base projections. On average the annual growth rate for the sensitivity test is 33 households per annum lower than the 2011-based household projections and 109 households per annum lower than the 2008-based household projections.

Table 3: Sensitivity analysis results and 2011-based and 2008-based household projections

<i>Sensitivity Analysis</i>		hhs 2011	hhs 2016	hhs 2021	Total Change	Annual average change	% Change
2011- based population	Number of Households (000s)	22,102	23,215	24,307	2,205	221	10.0
	Private Household Population (000s)	52,153	54,503	56,660	4,507	451	8.6
	Average Household Size (population/households)	2.36	2.35	2.33			
2008- based population, 2011- based HRRs	Number of Households (000s)	22,014	23,066	24,112	2,098	210	9.5
	Private Household Population (000s)	51,634	53,500	55,417	3,783	378	7.3
	Average Household Size (population/households)	2.35	2.32	2.30			
2008- based projections	Number of Households (000s)	22,389	23,608	24,843	2,454	245	11.0
	Private Household Population (000s)	51,634	53,500	55,417	3,783	378	7.3
	Average Household Size (population/households)	2.31	2.27	2.23			

Table 4: Sensitivity test summary for local authority districts

Statistics	Difference between Sensitivity Test and 2011-based projections 2011	Difference between Sensitivity Test and 2008-based projections 2011	Difference between sensitivity test and 2011-based projections 2011-2021	Difference between sensitivity test and 2008-based projections 2011-2021
Mean	-270	-1150	-33	-109
Minimum	-21607	-13722	-1768	-713
Maximum	32346	1537	1349	15
Sum	-88031	-374775	-10736	-35653

N=324

5. Comparison with the 2008-based projections

The 2011-based projections show a lower growth in households compared with the 2008-based projections, equating to 24,900 fewer households per year between 2011 and 2021 in England. This is despite the fact that adult household population growth is stronger under the 2011-based projections than the 2008-based projections (28,800 additional adults per annum). The difference therefore largely reflects lower household representative rates compared with the previous projections.

There is a lower level of growth in all age bands except the 45-64 and 55-64 age bands. For these age bands the additional growth stems from both higher population levels than in the 2008-based projections and higher household representative rates.

Table 5: comparison with the 2008-based projections by age, England

	2011-based projection	2008-based projection	
	Average annual change	Average annual change	
<i>thousands</i>	Average annual change 2011 – 2021	Average annual change 2011 – 2021	Difference
Under 25	-2	-6	3.2
25 – 34	23	49	-26.3
35 – 44	15	22	-7.5
45 – 54	17	11	6.6
55 – 64	50	47	3.1
65 – 74	46	48	-2.5
75 – 84	40	41	-1.4
85 +	32	33	-0.2
All households	221	245	-24.9

6. Uncertainty in the projections

As with any set of projections, the household projections are subject to error if any of the components – household population, relationship status or household representative rates – are wrong.

At the present time the results from the Census 2011 show that the previous projections were overestimating the rate of household formation and support the evidence from the Labour Force Survey that household representative rates for some (particularly younger) age groups have fallen markedly since the 2001 Census. By imposing the change in household representative rates by age from the LFS onto the aggregate Census point in 2011 we are assuming that the trends observed in the LFS by age are correct. It is possible that the full results from the Census 2011 reveal that the trends by age group were different to those observed in the LFS, but at this stage it is not possible to quantify the differences. The changes in household representative rates between 2001 and 2011 have an impact on the projections of household representative rates, so if the decline in the household rate for a given age band has not been as great as suggested by the LFS then the projected growth rate would have been stronger than originally projected.

There could also be cohort effects that are ignored by the current methodology. Recent falls in household representative rates for younger age groups may carry forward through a cohort process into older age groups in future years. However such cohort effects will have less of an impact on the 2011-based projections since the projections only extend 10 years into the future and full results from the 2011 Census are unlikely to determine whether such cohort effects are occurring at the present time. For any future update that projects over a 25 year horizon however it may be important to fully consider and explore if falling household representative rates for the younger age groups continue as these younger age groups move into older age groups through time. If there is evidence in the future from the Census and the LFS of cohort effects then it may be necessary to consider whether introducing cohort effects into the model would improve the household projections – especially given the additional complexity and data requirements that this approach would entail.

There is also an inherent uncertainty in the household projections resulting from the use of the 2011-interim population projections which are known to over project the population in certain areas. ONS highlight that caution should be used in the application of these projections for planning purposes at the younger ages and this factor will also impact the Stage Two household projections of household types with children.

Finally, the Stage Two types have been estimated for 2011 and will not exactly match the actual values from the Census 2011 by age (and gender) when they are published. However the controls ensure that the aggregate estimates used are consistent as far as possible with the 2011 Census.

7. Properties of the System

The household representative rate method used to produce the projections has a number of basic characteristics that tend to shape the projections:

- All other things being equal, the higher the adult population the higher the number of households. Similarly, higher adult population growth means higher household number growth;
- For a given population, the number of households will be determined by the age, sex and marital status composition of the population;
- Household representative rates tend to be higher the higher the age band (Figure 4a and Figure 4b);
- Because of the convention that the male is the household representative in couple households, the household representative rates for males will be close to one for older age groups and zero for females.
- Singles' (never married) household representative rates tend to be below previously married rates for both genders and all age groups. The male and female under 30's singles household representative rates tend to be lower than the others and reflect a higher degree of living at home and sharing.
- Household representative rates for older age groups (40-44 and over) tend to trend upwards over time, though the scope of household representative rates that are already close to one is obviously more limited than those that are low.
- Household representative rates for younger age groups (35-39 and below) tend to be flat or declining over time – largely reflecting the trends between 2001 and 2011 and in some cases (20-24, 25-29 and 30-34) declining rates between 1991 and 2011.
- Socio-demographic events have a marked impact on the number of households given the size of the population. These include the increase in marriage and divorce rates and the ageing of the population, both of which will tend to increase household numbers relative to population.

Figure 4: Male Household Representative Rates in England (2011)

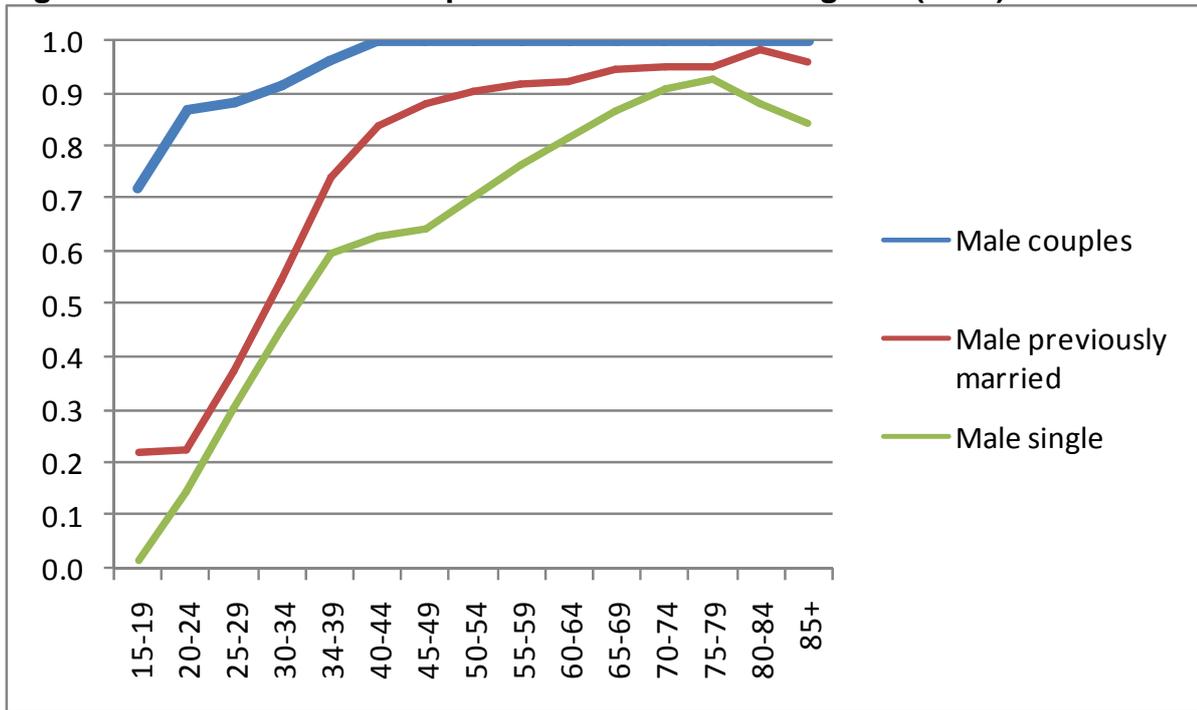


Figure 5: Female Household Representative Rates in England (2011)

