Communities and Local Government

Updating the Department for Communities and Local Government's household projections to a 2008 base

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November 2010
Department for Communities and Local Government

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Email: product@communities.gsi.gov.uk
Online via the website: www.communities.gov.uk

November 2010

ISBN: 978 1 4098 2663 7

Contents

1. Introduction

The methodology used for the 2008-based household projections differs in some regards to that used for the 2006-based and previous projections. This reflects analysis of the impacts of different methodology approaches and testing of user needs, as reported in a review of the 2006 based household projection methodology[1] published at the start of 2010, and a public consultation exercise undertaken by the Department for Communities and Local Government in March 2010.

The main drivers for the change were two fold; firstly testing revealed that a simpler model with less disaggregation would have enhanced the performance of projections, as shown by a comparison of 2001 projections, produced using data available up to 1991, with 2001 Census data. Second, the proposed new typology allows the inclusion of the number of households with children which was absent from the previous projections and was identified as of key interest to users.

This note describes the new household projections methodology and highlights where changes have been made for the 2008-based projections. A description of the data sources used in the 2008-based and previous projections is given in Annex 1. Annex 2 outlines the options considered to improve the estimates and projections of institutional and private household population at the national, regional and local level.

There are a number of attributes of the previous projections methodology which do remain unchanged. The component data inputs remain the same and the basic principle of applying projected household representative rates to private household population projections is retained.

[1] Testing methodological changes to the household projection model, Department for Communities and Local Government, February 2010.
http://www.communities.gov.uk/publications/housing/testingchangeshousehold?view=Standard

2. Summary of the stage one methodology

The household projections are compiled using a two stage process. Stage one produces the national and local projectoins 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.

Stage one retains the principles of the previous methodology by applying projected household membership rates to a projection of the private household population disaggregated by age, sex and relationship status and summing the resulting projections of household representatives[2]. However, the method now 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 System, known as HOPS) model which captures the key household formation characteristics of the relationship status groups while retaining relative simplicity.

A revised projection methodology has also been introduced which aims to project forward using more aggregate data therefore reducing the potential for errors in the underlying data to influence the resulting projections. The revised projections methodology uses time-series modelling which weights together simple and dampened logistics trends. Cohort modelling is no longer 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; population, marital status composition, institutional population, household representative rates and subnational controlling – each of which is given in detail below.

a. Population estimates and projections

Revised population estimates for local authorities in England for mid-2002 to mid-2008 were published by the Office for National Statistics in May 2010 and have been included in derivation of the household estimates for these years. The household estimates are produced as part of the 2008-based household projections. The population estimates reflect the work undertaken by ONS to improve the population and migration statistics.

National and subnational populations are taken from the most recent population projections published by ONS on 21 October 2009 and 27 May 2010. For the 2008-based household projections, the 2008-based[3] population projections are used by

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[2] http://www.communities.gov.uk/documents/statistics/pdf/1172197.pdf

[3] http://www.statistics.gov.uk/statbase/Product.asp?vlnk=8519
http://www.statistics.gov.uk/statbase/Product.asp?vlnk=997

sex and five-year age band at both national and subnational levels. The 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 projections take as their starting point the revised 2008 Mid-Year Population Estimates released on 13 May 2010 and assume that recent trends continue. To model recent trends, data for the five preceding years are used, so in the case of the 2008-based projections, trends are based on data from years 2004 to 2008. The projections are produced for 25 years, for each local authority by age and sex[4].

The difference in the latest long-term assumptions on fertility, mortality and net migration for the 2008-based national population projections lead to a lower and older projected population in the 2008 based population projections for England. A long-term average number of 1.85 children per woman was assumed in the 2008-based principal projections for England, this is unchanged from the 2006-based projections although fertility rates are assumed to fall to reach this level more quickly. Life expectancies are assumed to be higher than in the 2006-based projections; projected period life expectancies at birth for the year 2033 are around 0.3 years higher than in the previous projections for males and 0.5 years higher for females. The long-term level of net migration into England for the principal projection is assumed to be 157,000, down from 171,500 in the 2006-based projections. This decrease is due to taking account of final migration data for two extra years (2006 and 2007) and provisional data for 2008.

b. Marital status composition

The 2008-based population projections by marital status for England and Wales were published on 24 June 2010 by the ONS and have been incorporated into the household projections. The projections cover both legal marital status and (opposite-sex) cohabitation for the period to 2033. 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
		(other than with spouse, i.e. either living with spouse or living alone)
Widowed	-	not cohabiting
Divorced	-	not cohabiting
Single	-	cohabiting

[4] http://www.statistics.gov.uk/downloads/theme_population/snpp-2008/2008_based_SNPP_Methodology_Guide.pdf

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 have been updated to include marriages abroad are also included at the national level from 2002 to 2007. No official cohabiting population estimates which are consistent with the revised marital status estimates were available for this period. We have therefore produced estimates for the cohabiting population by marital status between 2002 and 2007 using trends in cohabitation shares of total marital status population as found in the projections. Estimates of marital status in future years at subnational level are made by applying national/local differentials in marital status from the 2001 Census to projected marital status factors.

Population estimates from the eight marital status / relationship categories are aggregated to 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 but still capture the key features of household formation behaviour:

1. 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 couples.
2. Male and female separated, divorced or widowed (once married) people[5].
3. 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 household[6]).

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. 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.

A full investigation testing this assumption 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. Due to various data

[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.

limitations and uncertainties around future policy direction, the Steering Group agreed that the outcomes from this exercise should be limited to enhancing the prison population component in estimates of the institutional population. Data taken from the prison element in the mid year estimates of population component of change tables from 2002 to 2008 has been used to adjust institutional population up to this point. The projections are then made using the same methdology as in previous projections.

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. 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 2001 Census uses the eldest economically active person then the oldest inactive person if there is no economically active person. The total number of projected households is equal to the sum of households represented by all age, sex and marital/ relationship status types. This 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 (see paragraph 2.2 above)

The main issue with projecting the Stage One household representative rates is that there are only four observations (the 1971, 1981, 1991 and 2001 Censuses) and some of those (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))

It is 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.

The 1991 Census had particular problems with under-recording particularly of younger single males in multi-person households which could have had the effect of increasing the overall household representative rate although the household representative rates for once married but separated, widowed or divorced males and females stand out as looking particularly odd. Of particular concern is the pattern for many of the male once married but separated, widowed or divorced where estimated household representative rates increase sharply between 1981 and 1991 only to fall back in 2001. While it is not possible to say absolutely that this did not happen, other household representative rates tend to evolve smoothly between Census points and it is suggestive of data errors in 1991 with the true 1991 data point being somewhere midway between the 1981 and 2001 points. The very large adjustments made, as a result of under-counting, to the 1991 Census estimates by ONS in generating the 1991 mid-year estimates may be a further indicator of unreliability of some of the 1991 Census data.

If the 1991 household representative rate is an over-estimate then the observed deceleration between 1991 and 2001 will be exaggerated and the dampened logistics curve will incorrectly extrapolate an imaginary slowdown. In this case, the simple logistics curve may actually be a better representation of reality.

Given the uncertainty, the alternative 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.

The previous (HOPS) model used for the projections up to, and including, the 2006-based projections also made use of cohort information. There were sound theoretical and practical reasons for using cohort modelling in early versions of HOPS but the 2008 methodology review found that this was only likely to be useful for groups aged 40-44 and over and that a simpler model without cohort modelling tended to outperform HOPS in terms of predictive accuracy. Given the additional concerns about the accuracy of some historical data, cohort modelling is not used for any age groups in the Stage One methodology.

e. Labour Force Survey adjustments

Labour Force Survey (LFS) data suggests that there have been some steep falls in household representative rates for some age groups since the 2001 Census. If these shifts in household formation behaviour are sustained in the longer term, and this can only be truly assessed once the 2011 Census results are available, the household projections using the method as in the 2006-based and previous projection rounds would turn out to be too high.

The LFS is a sample survey and as such subject to a margin of error but the data are far more up-to-date than the last Census and some allowance for recent movements in the LFS are considered necessary. The LFS data has been incorporated into the England level projections for the 2002 to 2009 period.

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.

Adjustments are then made to all age and relationship status groups so that they move towards the smoothed LFS value with:

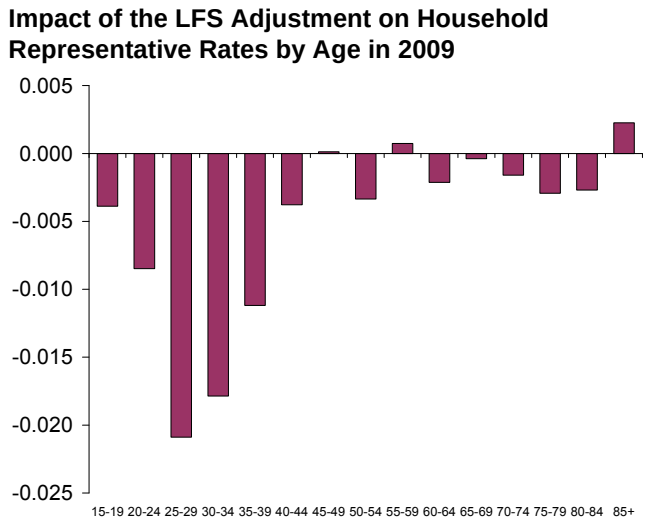
a The maximum weight of 50% to reflect uncertainty over accuracy and

b the LFS weight is linked to the time since the last census (the longer the time elapsed since the last census, the less time there is for household representative rates to get back on to trend).

For example in the 2008-based projections, the LFS data receives a 40% weight derived as the maximum weight (50%) multiplied by the time in years elapsed since the 2001 census divided by the maximum years between censuses (8/10). After 2009, the projections revert to the pre-LFS adjustment trends, reflecting the importance of retaining a view of long term trends. The post-2009 projections are not affected directly by the 2002 to 2009 LFS adjustments but recent movements in LFS data are taken into account in deciding on the relative weights used for the simple and dampened trends (see Section 2.d. above)

The main revisions, shown in Figure 2-1, were to the household representative rates for males and females aged 20 to 39.

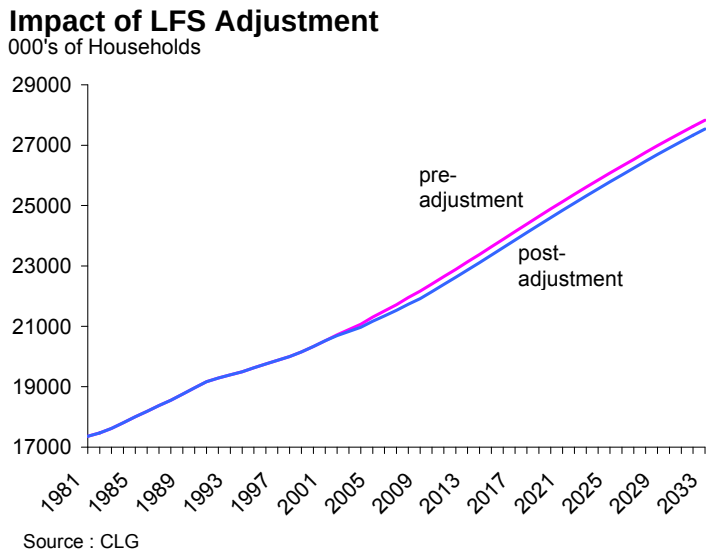
Figure 2-1



Source : CLG

The overall impact is small and reduced the projected number of households in 2033 by 292,000, or 1.0 per cent compared to what would have been produced using the unadjusted household representative rates (see Figure 2-2). As the adjustment is only applied to to 2009 with the projections reverting to the original trend thereafter, there is little difference between the annual average changes between 2009 and 2033 in the pre- and post-LFS adjusted projections.

Figure 2-2



Source : CLG

f. Uncertainties 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 rate – are wrong. At the present time, the large deviation of the LFS data for some groups from the trends evident in Census data are a particular source

for concern. The LFS adjustment makes some adjustment for the post-2001 trends in LFS data for the household estimates between 2002 and 2008. The projections then revert to trend. This approach is seen as a reasonble compromise reflecting a range of considerations, primarily:

a. The LFS data may be giving an exaggerated picture of the fall in household representative rates. This is one of the reasons why the methodology gives the LFS a less than 100% weight.
b. The LFS may be giving a fully accurate picture of the fall in household representative rates in which case the adjustment to recent estimates will be under-done.
c. The reversion to previous trends in the methodology might not be appropriate.
d. There are cohort effects that are ignored by the methodology.

The last of these is of particular concern if recent falls in household representative rates for younger age groups are carried forwards through a cohort process into older age groups in future years. This is not allowed for in the methodology used for the 2008-based projections as the assumption used in the methodology is that recent falls in household representative rates represent a postponement, but not a permanent fall for the cohort, of household formation by a substantial number of younger people in response to economic circumstances since 2001. These include affordability problems initially and then problems with obtaining mortgage finance and the impact of the recession in more recent years. The implicit assumption is that higher household representative rates resume as people get older. This is a plausible assumption as income and access to finance and the desire to form a separate household all tend to increase with age but the unprecidented fall in household representative rates in the LFS data inevitably lead to a concern that there may have been a more serious step change in household formation behaviour. This remains to be seen and the 2011 and future Census data will be key in assessing this.

g. Regional controlling

The non-linearity of the household membership rate model and use of LFS-based national data means that the projected number of households in a given area is not normally precisely equal to the sum of the household projections for its constituent sub areas. Therefore, the projections for the English Government Office Regions (GOR) are calibrated to the national projections for England. This procedure is continued down the "tree", with the controlled projections for each area being used to calibrate the projections of its sub areas. The purpose of the regional controlling procedure is therefore to adjust 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. Stage One projections are produced initially at the national level, then at the GOR level and finally at the Local Authority District (LAD) level with the GOR projections being controlled to the national projections and the LAD projections being controlled to the GOR projections.

In the *Testing methodological changes to the household projection model* report we tested the implications of removing the controlling procedure using different bases of both population and household representative rates. Both controlling exercises confirmed that controlling in the absence of significant new demographic data has only a marginal impact on the aggregate household projections.

h. Steering Group

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 subnational results and the contributions of different factors to household growth.

3. Stage two household types

a. Introduction

Stage two utilises adjusted 1991 and 2001 Census commissioned tables[7] to disaggregate the household projections produced in Stage one into more detailed household types. This will enable the projections to provide information on size of household, particularly the number of adults and the number of dependent children in each household.

In Stage two we combine data with three 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 1991 Census definition – the first named person on the census form.

3 The 2001 Census definition – 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:

1 The 2001 Stage two household type shares are lined up with the 2001 Census definitions. This is done by calculating the 2001 Census distribution of households by age, split by couples and non-couples and applying these shares to the Stage one household numbers by couples and non-couples to derive the Stage two control totals. The 2001 Stage two numbers by household type are then adjusted so that they are consistent with the new Stage two control totals.

2 The 1991 Census tables are adjusted to reflect definition changes between 1991 and 2001 i.e. that in the 1991 Census, the person named first on the census form was defined as household representative. This has increased the number of couples households in 1991.

3 The 1991 adjustments are at the couples/non-couples level. The share of the detailed household types within these aggregates does not change nor does the share of single person households, by age, change within the non-couples aggregate group.

4 The Stage one household totals remain the overall control total.

[7] 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.

Ideally, Stage one and Stage two would use fully consistent definitions but this is not possible if we are to retain the link with the old time series-based model and make use of the new household typology available from recent Censuses. By adjusting the data to account for definitional differences, the proposed 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).

b. Methodology

Stage two therefore utilises adjusted 1991 and 2001 Census commissioned tables to disaggregate the household projections produced in Stage one into more detailed household types. This will enable the projections to provide information on size of household, particularly the number of adults and the number of dependent children in each household.

Stage two initially works with data at the Local Authority District (LAD) level. Adjacent five year age bands from Stage one have been merged into 10 year age bands (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 LAD.

The proportions of households by household type and age group of the head of household are derived from the adjusted census tables for 1991 and 2001. This data is supplemented by data on non household reference persons 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 2002 to 2033

d = 1 if $p_{t,a,r\ 2001} \geq p_{t,a,r\ 1991}$ else d = 0 if $p_{t,a,r\ 2001} < p_{t,a.r\ 1991}$

$a = p_{t,a,r\ 1991} - d$

$b = (p_{t,a,r\ 2001} - d) / (p_{t,a,r\ 1991} - d)$

$c_i = (i - 1991)/(2001-1991)$.

The same technique has been used to provide headship and non headship rates for 1992 to 2000. 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 1991 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 1991 and 2001 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 1991 and a small increase has occurred in the 2001 census.

The first cut of Stage two LAD 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 first cut Stage two LAD level household projections are then constrained to be consistent with Stage one total households before two checks are run.

c. Minimum adults check

The first cut 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 LAD 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, again no problems were identified.

d. 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 2033. By definition, dependent children include all 0 to 15 year olds so we have used single year ONS Sub-national Population Projections 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 LAD level by pushing forward 2001 Census shares with growth rates in the number of full time students in the corresponding age band. 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 have been kept fixed from the last data point (2009).

In the stage two projections, the 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 2001 Census distribution. In the Kirklees, West Yorkshire example shown below, we have adjusted the number of households with children down to achieve the constant ratio. In the Hambleton, North Yorkshire chart the adjustment to households with children is upwards to ensure the constant ratio. The divergence between the minimum dependent children projection and the dependent children projection in the Hambleton example, whilst feasible, would require a significant increase in the proportion of households with more than three dependent children for the household projections to fit with the population projections. In each case the number of households without children is also adjusted to maintain overall consistency with the stage one household projections.

It is important to note that these adjustments do not affect the total number of household 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 1: Dependent children adjustment example, Kirklees

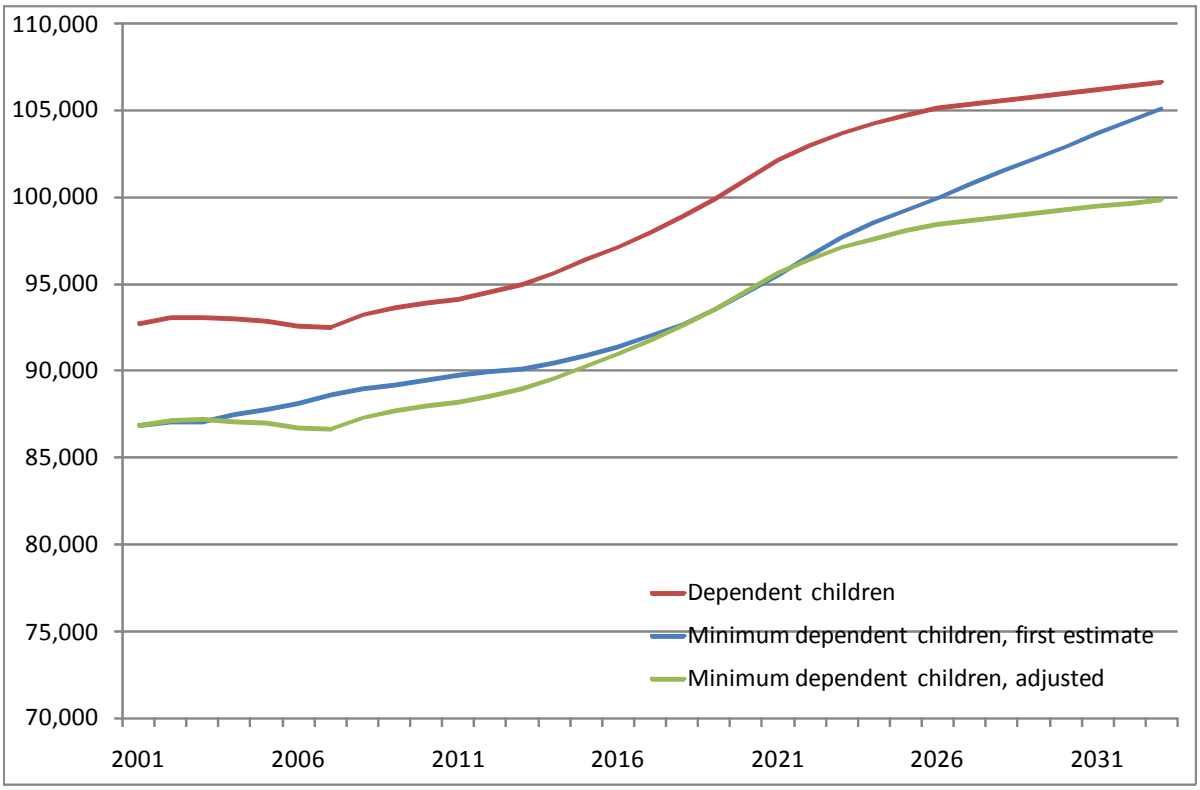


Figure 2: Dependent children adjustment example, Hambleton

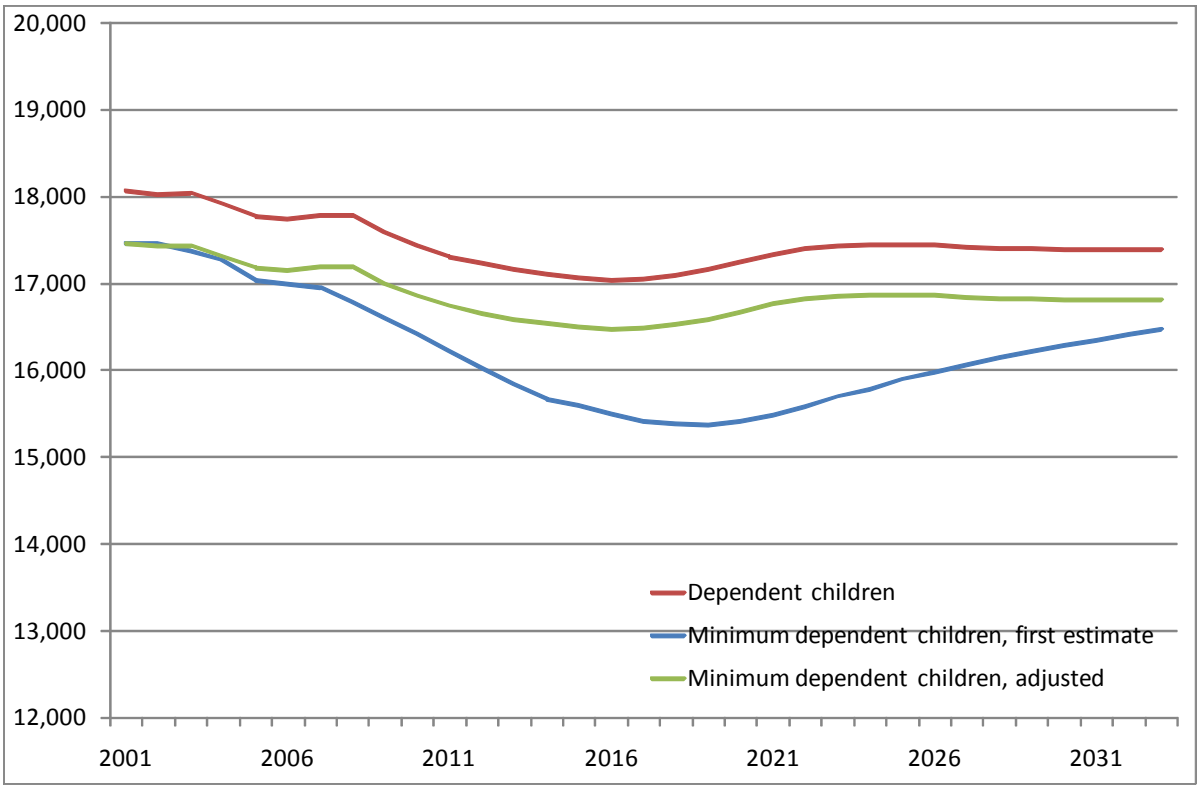


Table 3c indicates the extent of the dependent children adjustments on average and at the extremes. The mean adjustment by 2033 was to reduce the number of dependent children by 625 per LAD.

Table 3c: Minimum children adjustment: number of children, 2033

Statistics		Number of children
Mean		-625
Minimum (Leeds)		-53,724
Maximum (Oxford)		10,653
Sum		-219,914
Percentiles	25	-1,804
	50	5
	75	1,499

N=352

e. 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)
	Lone parent: 3+ dependent children (1)
A couple and one or more other adults	No dependent children (2)
	1 dependent child (2)
	2 dependent children (2)
	3+ dependent children (2)
Lone parent and one or more other adults	1 dependent child

	2 dependent children
	3+ dependent children
Other households	
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. Categories sourced from the 1991, 2001 Census.

4. Variant projections

The Office for National Statistics produces a set of variant national population projections showing the effect of assumptions about fertility, life expectancy and net migration on future levels of the population. As the population projections are a key component of the household projections, it is informative to consider how the projected number of households varies with the variant population projections. These give a broad indication of the sensitivity of the household projections to the demographic assumptions. The variant household projections are simply produced by applying projected household formation rates to the variant population projections using inputs from the Stage one methodology only.

Standard variants for high/low fertility, high/low life expectancy and high/low migration are produced alongside standard combination variants for high population and low population and special case variants for no mortality improvement and zero net migration. The assumptions within the main variant projections are shown in the table below.

Table 2: Long-term assumptions for the 2008-based national population projections and main variants, England

		Low variant	Principal	High variant
Fertility (average number of children per woman)		1.65	1.85	2.05
Mortality (life expectancy at birth, 2033)	Males	81.5	83.4	85.3
	Females	85.9	87.1	88.3
Net migration from 2014/15		97,000	157,000	217,000

5. 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 1a and figure 1b).
- 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 widows/widowers and divorcee's 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 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.
- Socio-demographic events that have either already happened, or are expected to happen, 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 1a: Male Household Representative Rates in England (2001)

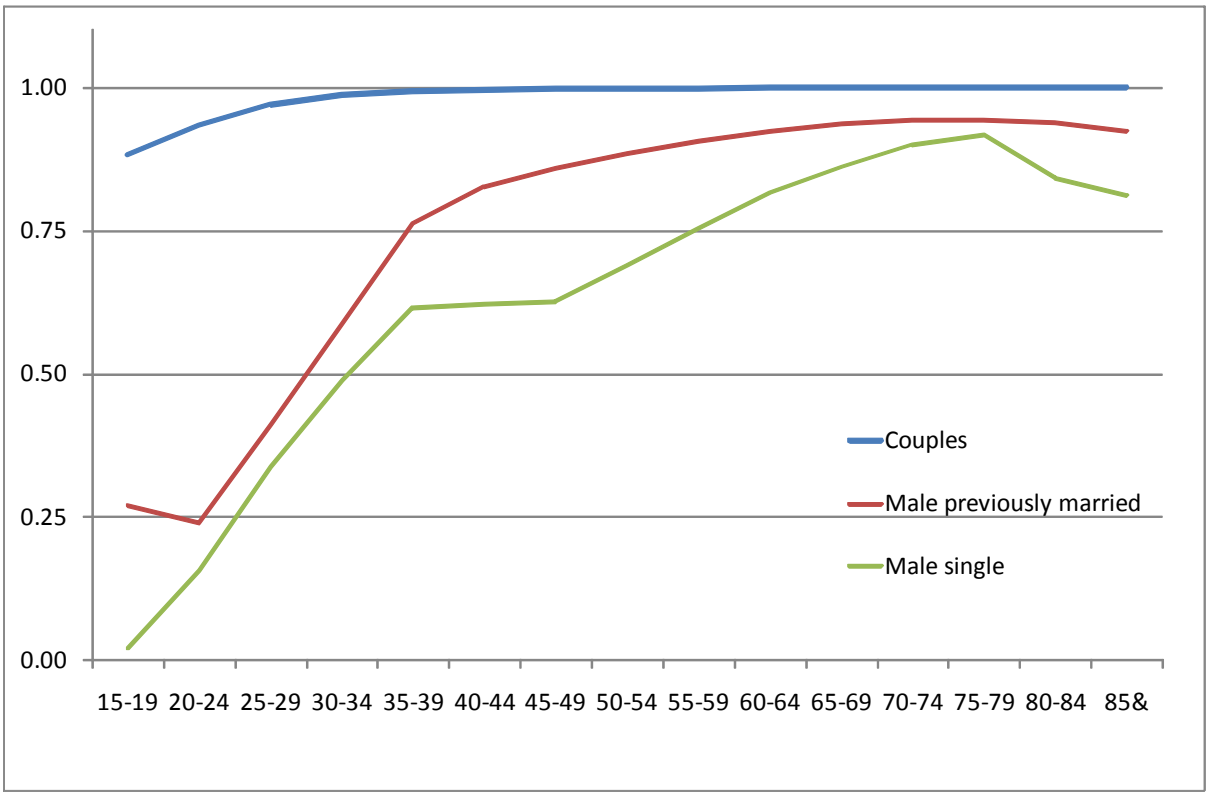
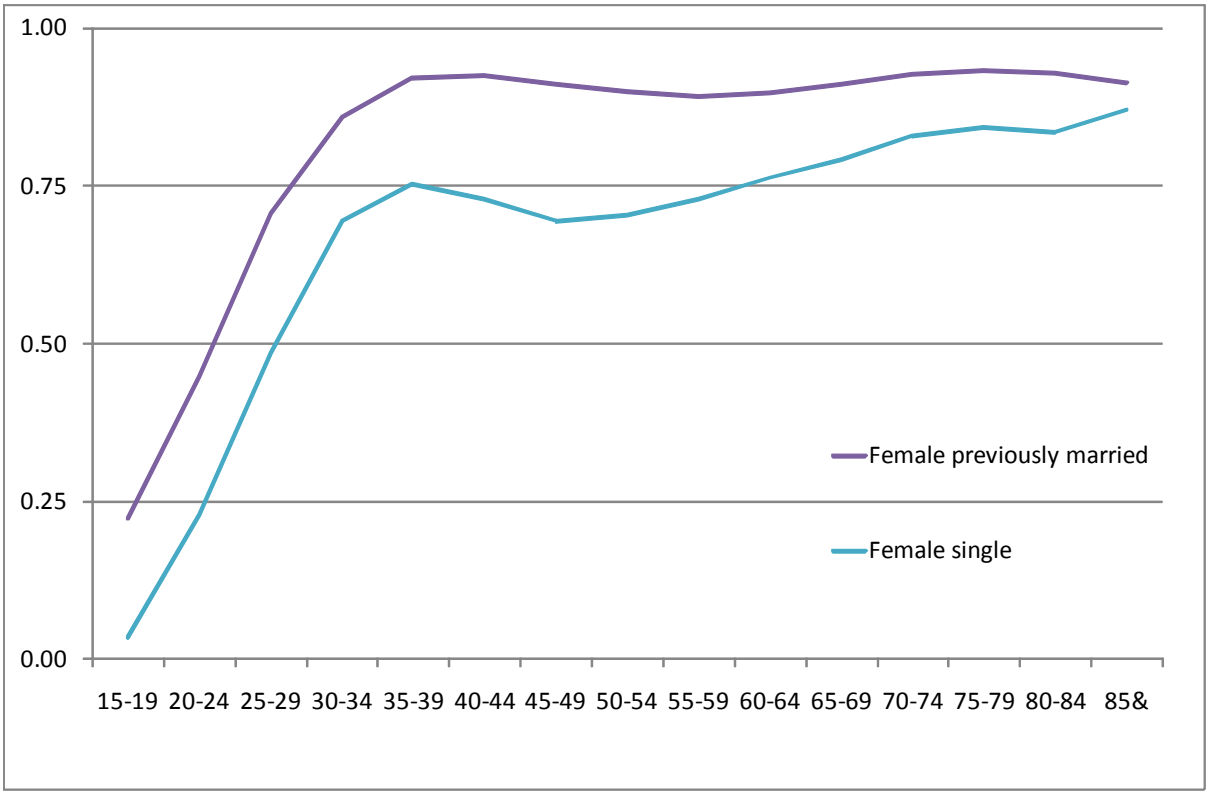


Figure 1b: Female Household Representative Rates in England (2001)



Annex 1: Data Sources for the Household Projections

As the 2008-based projections are an update of the previous projections it is useful to capture the data sources used in the previous projections.

The data sources used for projecting household membership rates were the 2001 Census (commissioned table CT598; 100 per cent), special analyses of 10 per cent samples of the 1971, 1981 and 1991 Censuses; the ONS Longitudinal Study samples from the 1971 and 1981 Censuses and the Labour Force Survey (LFS) from 2002 to 2004. The Labour Force Survey is considered the best available source of data about household membership rates after the 2001 Census.

Some adjustments to these data were implemented on advice from the Steering Group, which advised on the development of the projections. Some adjustments were made to data used in previously published projections. The 2001 Census enumerates students as being usually resident at term-time address, whereas previous Censuses enumerated them on the basis of parental address. At the sub-national level the 1971, 1981 and 1991 Census data was adjusted, where possible, to allow for the impact that the different treatment of students would have on marital composition and household membership rates in those earlier years, to achieve consistency in the time series for projection purposes.

Some adjustments were also made to the household membership rates derived from the 2001 Census. The first adjustment was to resolve differences between the Census and the 2001 mid-year estimates: population (ONS) and marital status (GAD). This amounted to a 187,000 adjustment to the population made by ONS attributable primarily to people deemed to have been missing from within households in the Census count (rather than being household representatives or persons in communal establishments). About 160,000 of these were males aged 25-34. The large majority of the 187,000 are assigned to the single non-cohabiting marital status group, and this has the effect of moderating their 2001 household representative rates in those cases. In addition there was further minor revision of 2001 household membership rates, based on reassigning a limited number of representatives in the commissioned table aged under 15 on advice from ONS, as a result of follow-up examination of those cases.

The Labour Force Survey was used to extend the time series of household representative rates beyond the most recent available Census year. Compared with the Census 100 and 10 per cent samples, the Labour Force Survey samples are small, less than 1 per cent of the population. To minimise the effect of any systematic bias, the LFS data for 2002 to 2004 were adjusted to reflect the discrepancies between Census and LFS data in 2001. Because of the smaller sample used in the LFS, LFS household representative rates are calculated only by age and sex. Fully disaggregated household membership rates for 2002 to 2004 were produced by projecting Census data and then controlling the results to be consistent with the LFS based age/sex membership rates. These household membership rates were then used in conjunction with the Census data for national projections of household representative rates.

The new data sources used in constructing the 2008-based household representative projections were the 2008-based population projections and the Labour Force Survey data from 2004 to 2008. Consequently, the methodology adopted was one of modifying and extending the existing 2004-based trajectories, described previously, to the latest available population projections.

Annex 2: Improving institutional population estimates and projections

Introduction and current methodology

This annex outlines the options available to improve the estimates and projections of institutional and private household population at the national, regional and local level. The estimates and projections are a key input into the household projection methodology. The 2006-based household projection method used for estimating institutional population post 2001 Census is the same across each element of the institutional population. Here we examine possible trends for each element of institutional population separately.

A communal establishment is defined in the Census as 'an establishment providing managed residential accommodation'. 'Managed' means full-time or part-time supervision of the accommodation. In most cases (for example, prisons, large hospitals, hotels) communal establishments can be easily identified. Identification is less easy with small hotels, guest houses and sheltered accommodation. Special rules apply in these cases.[8]

Indicative results by type under the 2006-based method

The Census standard table S126: Type of communal establishment and sex by resident type and age has been utilised to provide indicative results for how projections for each component of institutional population would look under the 2006-based methodology. The age-bands in this standard table are broader than the usual quinary age bands used in the existing method.

The approach requires deriving individual institutional population rates for the separate age-bands over 75 for nursing homes, prisons, educational establishments and a residual category capturing all other types of institution. For age-bands under 75, levels have been fixed at Census levels throughout the forecast period. For the over 75s, we have applied the individual rates of institutional population as a proportion of total population to 2008 based population projections. The differences in the projections of each component of institutional population will be driven by the different age profile of residents of each type of institution. Table A2.1 shows the indicative results of what the institutional population would have been in England if we simply applied the 2006-based methodology to the 2008-based population projections. Using the 2006-based methodology, prison and education establishment populations would be unchanged in the projections due to having few residents in the over 75 age-bands. The remainder of this report explores the plausibility of the different assumptions for age-bands under and over 75 and outlines the changes that have been made in the 2008-based household projections.

[8] Census 2001 Definitions, ONS

Table A2.1: Institutional population, England (indicative results using the 2006-based method, 2008-based population projections)

	2001	2008	2033	2001 to 2008 change p.a.	2008 to 2033 change p.a.
Nursing homes[9]	322,200	349,200	637,800	1.2%	2.4%
Prison Service establishments	45,200	45,200	45,500	0.0%	0.0%
Educational establishment (including Halls of residence)	239,900	239,900	240,300	0.0%	0.0%
Other[10]	212,900	215,900	248,700	0.2%	0.6%
Resident staff and families	72,200	72,200	72,200	0.0%	0.0%
Total institutional population	892,400	922,400	1,244,500	0.5%	1.2%
Household population	48,557,400	50,542,100	59,470,900	0.6%	0.7%
Total population	49,449,700	51,464,600	60,715,300	0.6%	0.7%

Source: Experian / OE based on ONS Census 2001 and 2008 based population projections

ONS household population methodology

Experimental household population estimates by broad age group, sex and region produced by the ONS are based on the proportion of the total population categorised as 'household' from the 2001 Census.[11] The method calculates rates of household population from the 2001 Census by single year of age and gender as a proportion of total population from the 2001 Census by single year of age and gender and applies the rates to mid-year estimate of population. It assumes that the percentage of the population in household accommodation remains constant; therefore these proportions are applied to subsequent MYE's.

The ONS method has similarities with the method currently applied in the household projections but there are also differences as outlined below:

- The ONS method uses household population rates instead of institutional population.

[9] Nursing homes includes Local authority and Other Nursing homes and residential care homes.

[10] Other includes Children's homes, Psychiatric hospital / homes, Defence establishments (including ships), Hotels, Boarding Houses, Guest Houses and Hostels.

[11] Publication of the household estimates is currently suspended, but experimental household estimates are available on request from ONS (Contact pop.info@ons.gsi.gov.uk)

- Each age group is treated the same in the ONS whereas the household projections method treats over 75 and under 75 age bands differently.
- The ONS method uses single year of age rates instead of five year age bands.

Given the differences in methodologies, especially around the treatment of different age bands, the ONS method results in a lower private household population estimate for England in 2008 (50,467,800 persons) than we are likely to see in the 2008 based household projections assuming an unchanged methodology (approximately 50,542,100 persons).

Prison population

As the prison population is concentrated in young males, under the 2006-based methodology it would remain unchanged from 2001 Census levels in the projections. However, the prison population in custody in England and Wales has increased by approximately 19,000 persons (or 29%) since June 2001. For the purposes of the ONS mid-year population estimates, prisoners are regarded as usually resident in a prison if they have been convicted and spent at least six months in prison. Under this definition, prison population in England and Wales has increased by 17,700 persons (or 37%) between 2001 and 2010. Those who are awaiting trial or have shorter sentences are included in the population estimates at their usual residence address rather than at the prison.

Table A2.3a: Total population in custody, England & Wales

	Male	Female	Total
2001	62,700	3,700	66,400
2008	79,000	4,700	83,700
2010	81,100	4,300	85,400

Source: Ministry of Justice/Home Office

Table A2.3b: Prison population, sentence greater than 6 months, England & Wales

	Male	Female	Total
2001 [12]	46,000	2,500	48,500
2008	59,300	3,000	62,200
2010	63,200	3,000	66,200

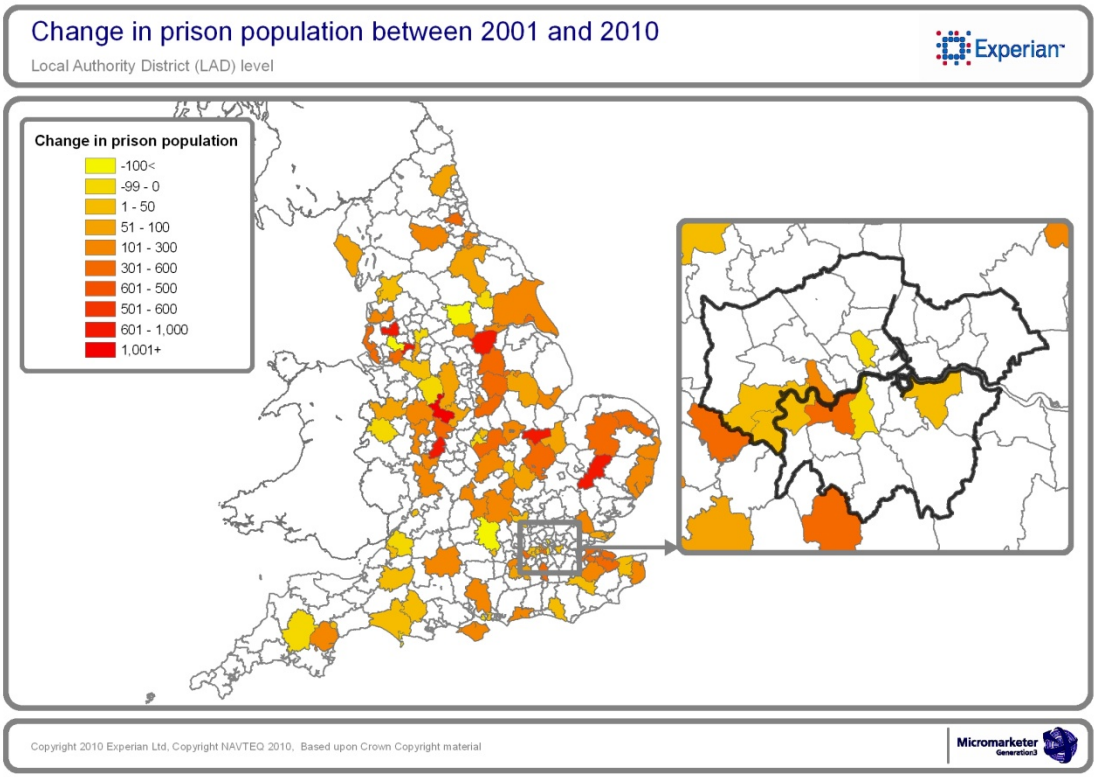
Source: Ministry of Justice/Home Office

The Ministry of Justice (and formerly the Home Office) produces monthly estimates of prison population in custody by individual prison and gender (all prisons with the exception of Peterborough are currently single sex). Institutional detail for those serving greater than six months is not publicly available, nor is an age breakdown by prison. However the data does allow local estimates of how the current prison population in custody has changed since 2001, as shown in figure A1. Producing this data requires geo-coding the institution postcode, appending a local authority variable and then aggregating the prison level data to local authorities.

The imbalance in growth across local authorities is perhaps not surprising given the variation in prison capacity and local crime patterns. Some local authorities experience a fall in prison population; this is unlikely to be picked up by any of the institutional population methods. There have also been new prisons built since the census in the local authorities of Sefton, Peterborough, Broadland, East Staffordshire and Spelthorne; these districts account for some of the biggest changes in prison population but we do not have an equivalent census point to provide an age breakdown for these areas.

[12] The 2001 figures have been estimated as data published only at less than twelve months

Figure A1: Change in total population in custody



Prisoners are treated separately in the MYE population methodology and any annual changes in prison population are recorded at the local level in the ONS MYE component of change tables.

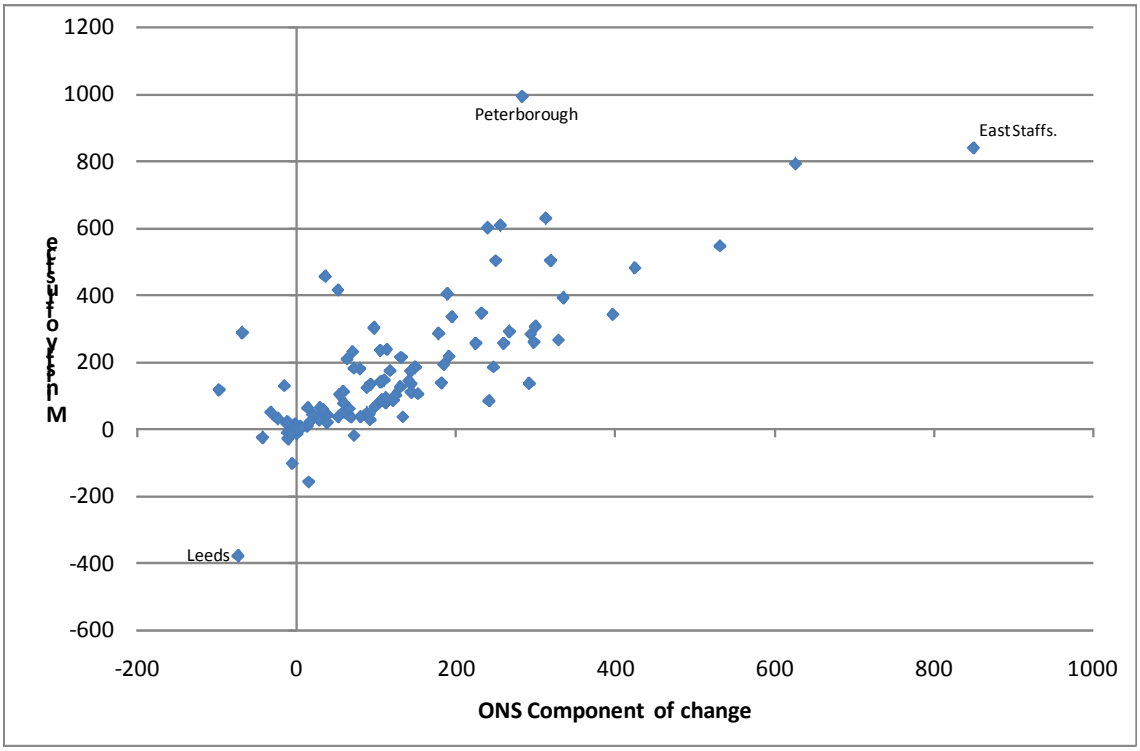
"Prisoners are not subject to the ageing on process in the MYEs since their age distribution is fairly stable. Instead the number of prisoners in the previous year is subtracted from the population of each LA before ageing on and the number of prisoners in the current year is added after ageing on, to allow for changes in the number of prisoners between the two mid-year points. The method takes into account new prisons and wings of prisons, as well as prisons that have closed during the year. The Home Office supplies data on the number of prisoners resident in each prison on 30 June by age and sex. For the purposes of population estimates, a person is regarded as usually resident in a prison if they have been sentenced and have served six months or more of their sentence in any prison. The Population Estimates Unit allocates each prison to an LA based on its postcode and then aggregates the data by age and sex to LA level"[13].

The approach used in the MYEs for prisoners serving over six months replicates the previous exercise which uses publicly available data on all prisoners in custody. The age and sex profile of the changing prisoner population is not in the public domain so assumptions would be required to enable the inclusion of post census prison

[13] Making a population estimate in England and Wales, Julie Jefferies and Ruth Fulton, ONS 2005

population estimates into a revised institutional population methodology. A comparison of the changes between 2001 and 2008 from each dataset is shown in figure A2. The differences are explained by the different sentence lengths used in each approach.

Figure A2: 2001 to 2008: Total change in population in custody vs. Component of change



Source: Experian based on ONS, MoJ

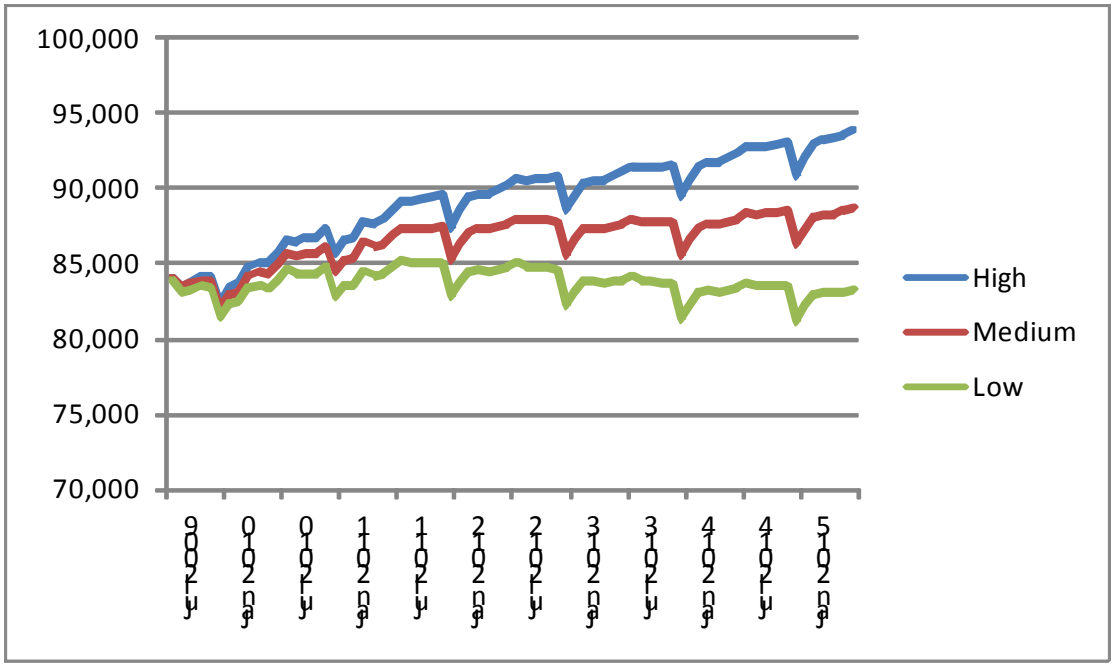
A big issue with the prison population however, is the way that past changes might distort the population projections. Whilst we have sufficient data to improve the estimates up to 2008, we cannot assume the rate of change since the Census will apply throughout the forecast period. The Ministry of Justice report that *"…two factors caused the increase in the prison population of England and Wales from 1995 to 2009: tougher sentencing and enforcement outcomes, and a more serious mix of offence groups coming before the courts"*[14]. Changes to legislation and policy changes have lengthened sentences and the future trajectory of prison population is likely to be influenced by future policy changes in this area.

The Ministry of Justice produces short term and long term projections of prison population. The latest projections were published on 10th August 2010. The 2009 based long term projections run to 2016 and are published at the England and Wales

[14] Story of the prison population 1995 – 2009 England and Wales, Ministry of Justice Statistics bulletin, published 31 July 2009

level only with no age breakdown. Three scenarios (High, Medium and Low) have been projected based on assumptions about future sentencing trends. The Medium scenario assumes no increases or decreases in custody rates or determinate sentence lengths. The High/ Low scenarios reflect a 1% per annum increase/decrease in custody rates and a 0.5% per annum increase/ decrease in the average (determinate) custodial sentence lengths.

Figure 3: Projected prison population



Source: MoJ 2010

The current household population methodology assumes a fixed 2001 level of institutional population for all ages under 75, whereas the prison population is overwhelmingly young and male. We therefore need to make an adjustment to the methodology to pick up the growth in prison population amongst young males which the current methodology will not have identified. We propose to utilise the estimates as used in the MYEs of population as a starting point to improve the estimates of prison population between 2002 and 2008. Given the uncertainty in policy concerning custody rates and sentence lengths, and the lack of demographic detail available in the official projections, we do not propose to utilise the Ministry of Justice projections in the revised institutional population methodology.

Educational establishments (including Halls of residence)

Similarly to the prison population, with only small elements of the population aged over 75 engaged in education, projections of institutional population within educational establishment (including Halls of residence) will remain fixed at census levels in the projections. There has been concern that this method is not adequately picking up the expansion in the higher education (HE) sector witnessed since the 2001 Census.

Two alternative data sources are available to monitor how institutional population has changed; Higher Education Statistics Agency (HESA) and also the Annual Population Survey (APS). Despite being a household survey the APS has a question on whether there are household members currently living in a hall of residence but there are limitations with this approach; the sample size at local level would be too small and the local authority of the hall is not recorded.

Table A2.4: Term-time accommodation

	Academic year	
	2001/02	2008/09
Institution maintained property	268,100	261,300
Own home (2001/02 only)	388,600	n/a
Private-sector halls (2008/09 only)	n/a	50,100
Own residence (2008/09 only)	n/a	218,300
Other rented accommodation (2008/09 only)	n/a	324,600
Parental/guardian home	162,000	223,800
Other	83,800	67,200
Not known	92,800	87,100
Not in attendance at the institution[15]	20,000	12,500
Total	1,015,200	1,244,900

Source: HESA Student Record 2001/02, 2008/09

Note: English institutions only

In the HESA student records, the term-time accommodation field identifies where the student is living during the academic year. It is only compulsory for full-time and sandwich students and data commissioned from HESA has been restricted to these students. The “Institution maintained property” category includes housing owned by the institution and sub-let to students. For 2006/07 and prior data, students classed as residing in their own home includes those renting accommodation through the private sector and those students who are home owners. From 2007/08 onwards, the ‘own home’ category is split into the following:

[15] 'Not in attendance at the institution' to be used for full-time and sandwich students not currently in attendance at the institution for reasons such as industrial placement or language year abroad.

- Own residence.
- Other rented accommodation and
- Private sector halls.

This creates a problem when making comparisons with the 2001 Census. What we can determine from Table A2.4 is that there has been a small fall (3%) in the number of students residing in institution maintained properties and a significant increase (38%) in students staying in the parental / guardian home. This trend is a continuation of a longer term trend as reported for young first degree entrants by HEFCE: *"In 1984-85, around 8 per cent of young first degree entrants were living at home. This proportion remained relatively static for each cohort of entrants up to 1990-91. During the 1990s, the proportion of entrants living at home in their first year of study rose steadily to around 20 per cent by 2000-01. The proportion levels at around 20 per cent between the years 2001-02 and 2006-07"*.[16]

Whether private-sector halls should be included as part of an educational establishment (including Halls of residence) definition is a grey area. As private sector halls are included in housing supply monitoring, it suggests that they should be excluded from the institutional population definition for students to avoid double counting. Given that the number of students residing in institution maintained properties has marginally fallen between 2001 and 2008, the HESA data lends support to the current method. This issue should, however be revisited after the 2011 Census.

We have commissioned the underlying data behind table A2.4 with institution, gender and quinary age-band variables. Whilst there is potential to replicate the prison exercise and link institution postcode to local authority and aggregate institutions to local authorities for inclusion in the household projections at a local level there are further problems to be overcome:

- Postcode information is typically available for the institution address which is not necessarily in the same location or local authority as the accommodation. This is further complicated where the accommodation is split across a number of sites.
- There has been a large number of mergers, name changes and new institutions in higher education in the last decade which makes comparison over time difficult.

[16] Patterns in higher education: living at home, HEFCE 2009

Residential care homes

Identifying the population living in residential care homes should be possible as they are regulated but we have not found administrative statistics publicly available. The funding of care homes and the variety of different establishments has meant that finding one definitive and comprehensive data source outside of the Census has not been possible.

The Department of Health produces projections of people aged 65 and over living in a care home with or without nursing by local authority / non-local authority, by age, projected to 2030 as part of the Projecting Older People Population Information (POPPI) program. This system has been developed by the Institute of Public Care (IPC) for the Care Services Efficiency Delivery Programme (CSED). The projections have been calculated by applying percentages of people living in care homes / nursing homes in 2001 to projected population figures[17]. The methodology replicates the existing household projections approach for this section of institutional population except the focus is on the 65 and over age bands only and it uses rates starting earlier than in the household projections (from 65 onwards instead of 75). The growth in the 65 to 74 age band under the POPPI methodology would not be experienced under the current household projections.

Table A2.5a: People aged 65 and over living in a care home with or without nursing, England

	2010	2030	% of Total Population
65 to 74	29,900	40,900	0.7%
75 to 84	96,800	146,700	3.3%
85 plus	193,200	388,600	16.2%
Total 65 plus	319,900	576,200	3.7%

Source: POPPI, 2010

[17] http://www.poppi.org.uk/

Table A2.5b examines the trends in care home shares of total population by age and gender in England using data from both the 1991 and 2001 Census. The assumption that the rate of institutional population for age groups over 75 is fixed in the projections appears sensible given historic trends.

Table A2.5b: Care home share of Population by age and gender, England

	1991				2001		
Male	Care home	Total Population	Care Home %	Male	Care home	Total Population	Care Home %
0-15	211	4,833,016	0.0%	0-15	428	5,061,067	0.0%
16-44	8,608	9,846,589	0.1%	16-49	16,308	11,347,117	0.1%
45-64	7,917	5,093,162	0.2%	50-64	10,408	4,231,204	0.2%
65-74	11,454	1,895,626	0.6%	65-74	11,835	1,921,450	0.6%
75-84	23,493	966,357	2.4%	75-84	25,010	1,096,284	2.3%
85&	17,887	178,139	10.0%	85&	25,912	265,022	9.8%
Total	69,570	22,812,889	0.3%	Total	89,901	23,922,144	0.4%

Female	Care home	Total Population	Care Home %	Female	Care home	Total Population	Care Home %
0-15	142	4,603,291	0.0%	0-15	390	4,823,268	0.0%
16-44	5,738	9,939,000	0.1%	16-49	11,855	11,539,421	0.1%
45-59	3,215	3,943,939	0.1%	50-59	5,418	3,111,381	0.2%
60-74	21,925	3,568,367	0.6%	60-74	18,733	3,398,764	0.6%
75-84	74,406	1,646,979	4.5%	75-84	66,179	1,654,851	4.0%
85&	98,804	540,739	18.3%	85&	128,614	689,002	18.7%
Total	204,230	24,242,315	0.8%	Total	231,189	25,216,687	0.9%

Source: ONS

Other sources of institutional population

Prisons, educational establishments and care homes house the largest groups of non-household population. However there are other sources that combined form approximately a quarter of institutional population. The main remaining types can be summarised as follows:

- Children's homes.
- Psychiatric hospitals.
- Defence establishments including ships.
- Hotels, Boarding Houses and Guest Houses.
- Hostels (including youth hostels, hostels for the homeless and people sleeping rough).

Over 65% of this group is aged under 35 but there is a small component (14%) aged over 75 hence the small levels of growth witnessed in the indicative projections for the current methodology (see section 1.1.1). The final component of institutional population as identified in the 2001 Census is the 72,200 resident staff members and their families in England. In theory, we could assume that the numbers of staff living in residential accommodation has grown in line with employment increases in the associated nursing occupations, but we have little to test this theory against.

Conclusions

Examining each of the three main components of institutional population reveals the 2006-based method for projecting institutional population had its strengths and weaknesses. The strengths of the method are its simplicity and transparency. Further, the HESA data comparison shows that the assumption that the student cohort of institutional population remains fixed at 2001 levels in the projections is reasonable.

The previous method was not found to have picked up the changes witnessed since the 2001 Census in the prison population. The previous method would have missed the expansion in prison population but as a high proportion of the change is due to legislative change and increased sentencing lengths, this was always going to difficult to build into a model. We have therefore updated our institutional population method to include the 2002 to 2008 prison population estimates. These have been taken from the ONS components of change tables.

The conclusion for care homes is more subjective as there is a paucity of comparable data. The previous institutional population method is also broadly replicated by POPPI, albeit with marginally different age band rules. After input from the steering group it was decided to leave the age band rules unchanged for this component of institutional population.

Department for Communities and Local Government

ISBN: 978 1 4098 2663 7