Back to the Future: Applying a current geodemographic classification to historic data to produce trend-based population projections

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Abstract

A novel approach is described to developing population projections for minority groups for whom information used in traditional approaches is not directly available. Geodemographic assessment is a powerful tool for simplifying and interpreting complex patterns; but fixed classifications have rarely been used to compare and contrast population characteristics found in consecutive decennial censuses and establish trends for the future. This paper describes an innovative projection methodology, using an existing geodemographic classification and standard census outputs, that addresses and overcomes three challenges: the application of a geodemographic classification to a minority group – the Jewish residents of England and Wales – across multiple points in time; analysis of changes in that population between the 2001 and 2011 censuses, by geodemographic class; and the development of a projection based on these recent observed trends. The approach adopted specifically allows for temporal changes in the influence of population characteristics. The balance between the impact of births, deaths and migration on area / class population over time is determined and, after consideration of future fertility and mortality levels, used to develop class-by-class population projections for Anglo-Jewry and an overall projection for 2021 and 2031. The analysis indicates that there will be material differences between the demographic futures of the areas in which the various classes are found, and predicts a reversal in the numerical decline of the Jewish population that has prevailed over the last half century. As a result, the projections raise significant policy implications; additionally, the approach could be applied to other groups and other places.

Keywords: geodemographics, population projection, census, Jewish, England and Wales

1 Introduction

The research described in this paper grew from a need to examine recent population trends and produce an analytically-based population projection for a small sub-population – Anglo Jewry. The absence of age-specific fertility measures, or mortality analysis based on accurate life-tables for this group, precluded the use of traditional approaches (Newell 1988; Rees et al 2012). For religion-based groups, the lack of the type of medium term supplementary data that could be linked with ethnic group fertility and mortality, as used by

Rees et al, together with a desire to take account of heterogeneity within the group, meant that Rees's methodology could not be applied to this problem. Instead, an innovative alternative methodology using geodemographic classification has been developed to examine recent socio-economic and demographic trends, and allow a population projection for Anglo-Jewry to be developed. Whilst the focus of the paper is the Jewish population of England and Wales in the early twenty-first century, the approach described would be equally applicable to any population group for whom group-focussed fertility, mortality, or migration data cannot be directly ascertained with sufficient accuracy.

Geodemographic assessment is used to distil information from a wide range of characteristics of a population to produce a readily-understood spatially-related summary. As Vickers (2010 p37) puts it, 'The purpose of this analysis is not to produce a perfect representation of the world, but to simplify a complex pattern enough to make it easy to interpret and understand.' Such assessments have been carried out for both academic research purposes and to target private sector marketing campaigns over the last 30 years (Batey and Brown 1995; Singleton and Spielman 2014). Despite extensive analyses being carried out following the release of each census, there has been no substantive attempt to quantify change between censuses using geodemographic assessments – Vickers' report on an 'experimental' (2010 p39) exercise appears to be the sole example. Not only would such analyses provide a synoptic view of changes that have occurred, based on a wide range of underlying characteristics of the population, but changes quantified in this way might be used to establish trends. These could then be applied to classes within the later geodemographic assessment, in order to provide projections of population change overall, and expected changes in characteristics of groups at a local level. Such an approach would provide a way of gaining a deeper insight into current and future trends for minority/locality sub-populations.

In order to demonstrate the successful addressing of these challenges, this paper makes use of an existing geodemographic assessment based on 2011 census data characteristics of Jewish residents of England and Wales (Sapiro 2016). That paper describes how the challenges of carrying out a geodemographic assessment of a small unevenly distributed sub-population were overcome, whilst avoiding issues of the impact of outlier values and non-optimum local-minimum solutions. The key elements of the approach and results achieved are included in this new paper, insofar as they are essential to understand the current research. In the current paper, that classification is applied to information taken from

the 2001 census; that is, a retrospective application of a current classification system to an older census[1]. Forward projections for that population to 2021 and 2031 are then developed.

Vickers (2010) describes the application of a 2001 England and Wales Output Area classification system to 1991 data. Although Vickers used the same methodology as he had devised for the 2001 assessment (Vickers and Rees 2007), the absence of certain variables from the 1991 census outputs meant that, in practice, a fresh 2001 assessment was carried out (using a much-reduced number of variables) resulting in a new classification system. This system was then applied to the 1991 data (which had to be re-zoned to the 2001 output area geography), using the same cluster centres as had been produced by the 2001 assessment. The assessment described in the current paper does *not* re-work the later (2011) census analysis, but applies it directly to 2001 census data. Additionally, the classification technique applied in this work, as detailed in Sapiro (2016), provides more stable and optimal results through complete avoidance of the distorting impact of outlier results, and the potential local minimum/sub-optimal results to which the *k*-means clustering algorithm used alone is prone (Everitt et al 2011).

Of much greater significance is that the current research considers the potential for temporal societal changes between the censuses in comparing the results of the classification process, and it takes the trends established through this comparison as a basis for developing a future population projection. Although the approach is demonstrated using a small, unevenly distributed, minority population (Jews in England and Wales), it could be applied more widely to other population sub-groups, or a population at large.

This paper therefore has two foci – the development of a methodology to examine recent trends and produce population projections; and the presentation and interpretation of the application of this approach to Anglo-Jewry. Sections of this paper address the following challenges:

1 Can issues of inter-census geographic zone compatibility, changes in definition of characteristics, and modifications in output availability be overcome?

2 Does a comparison of the earlier and later categorisation of areas produce a meaningful assessment, or are there temporal issues that undermine it?

[1] Piekut et al (2012) demonstrate another method of applying a common classification system to two scenarios; however their method (which pools data from both scenarios) is best suited to scenarios which cover separate study areas, with a small number of poolable variables, and similar timeframes, which is not the case for the current study. Most importantly, addressing the issue of temporal change in the impact of a particular level of a characteristic (as described in Section 3 of the current paper) would have not been possible had the data from the two censuses been pooled.

3 Can the trend-by-class analysis produced be applied to the newer census to make future projections?

2 Challenges in applying the 2011 approach to 2001 census data

The main data challenges focus on sometimes subtle changes between characteristics measured at the two censuses; and availability of data for a consistent zoning system.

2.1 Consistency of definition of variables between 2001 and 2011

ONS has provided information as to whether output from the 2011 census is 'fully comparable' or 'broadly comparable' with the equivalent 2001 data (ONS 2012a). All outputs used to define the variables used in the 2011 geodemographic assessment (which are all listed in Table 1, and all of which relate solely to the Jewish residents of the analysis areas) are 'fully comparable' with those produced in 2001, except for: 'Marital and civil partnership status' and 'Industry'.

The addition, in 2011, of same sex civil partnerships to the 2001 'married' category has minimal impact (see Table 1). However, changes in SIC (standard industrial classification) used for Industry of employment between the censuses create some inconsistencies. Insofar as categories relevant to this assessment are concerned, only 'Professional, scientific and technical activities' (referred to as Group M in the 2011 census output, and largely a sub-section of 2001 Group K) was materially affected (Prosser 2009). It did not prove possible to 'extract' sub-elements of 2001 Group K in order to produce the same variable for the 2001 assessment; instead (for each analysis area individually) a 2011 Group M to Groups L, M, and N ratio was applied to the 2001 Group K total, to produce a 2001 'professional, scientific, and technical activities' proxy variable.

Thus it was possible to transfer the variable definitions used for the 2011 assessment to 2001 with only minor discrepancies. The scale of any discrepancies is returned to in examining the precise way in which the 2001 assessment should be implemented.

2.2 Differences in output availability between the two censuses

The geographic base used by Sapiro (2016) for the 2011 assessment of Jewish residents employed a hybrid geography as Jews are very unevenly distributed across England and Wales (Simpson, 2012). About 90% of Jews live in middle layer super output areas[2]

[2] The basic geographic building block for outputs from the 2001 and 2011 England and Wales censuses is the Output Area (OA). These include about 300 residents in areas with a consistent housing type. ONS groups typically five OAs to form LSOAs, and typically five LSOAs to form MSOAs (with an average population of

(MSOAs) containing 18 or more Jews. Contiguous MSOAs exceeding a population threshold based around this figure were identified, and the 29 accumulations of spatially contiguous MSOAs that exceeded a Jewish population of 200 were retained for analysis. More populous accumulations were subdivided into analysis areas of around 500 Jews along MSOA (or in the most densely Jewish populated areas, LSOA) boundaries to produce 407 analysis areas, each of whose Jewish population fell within a consistent range, but was sufficiently large to provide data reliability. Large sections of England and Wales (with a very low density of Jewish residents) were excluded from the assessment. Table 2 summarises the situation; see Sapiro (2016) for further details.

ONS greatly eased earlier difficulties in comparing small areas between censuses by basing the 2011 output area system on that devised for the 2001 census; an approach made possible by the development work carried out by Samantha Cockings and colleagues (Cockings et al, 2011). Indeed, although ONS (2012b) reported that 2.1 per cent of 2001 MSOAs were changed for the 2011 census, the majority of changes were simply merging or splitting of 2001 areas, generally along boundaries of lower level areas; indeed, insofar as this study is concerned the issue is one of data availability at different geographic levels rather than the census geography itself.

As part of the process of avoiding identification of individuals in the census outputs, ONS provides the greater level of detail in 2011 for regions, local authorities, wards and MSOAs, with less detail for LSOA and OA tabulations. In 2001, despite the average population of an MSOA being slightly larger than the average ward, the higher level of detail was provided for wards but *not* for MSOAs. Thus although 100% compatibility of analysis areas could be achieved, not all data were available directly for the preferred geographic level.

The primary source for calculating the 2001 variables needed for each analysis area were data relating to wards, though where MSOA or LSOA data were available (values for age 0-15, age 65 and over, UK born, room overcrowding, housing tenure, and car ownership) these were taken from the census outputs for MSOAs and LSOAs directly. The main issue for extracting data that needed to be taken from the census ward files related to the 64 single MSOA analysis areas that overlap ward boundaries. The issue of re-zoning census data has been the subject of many suggested algorithms (see, for example, Norman Rees and Boyle 2003). However, a relatively simple approach could be adopted for this study. The

7800) to provide outputs containing various levels of details of characteristics. See ONS (2012b) for more detail.

proportion of each ward falling into each analysis area (based on simple land area) was extracted to form a preliminary set of ward proportion to analysis area conversion factors (see Qiu Zhang and Zhou 2012). However, unlike most zonal conversions, the Jewish population for each final analysis area was already known, so the process was being used only to allocate the characteristics of that population. Through an iterative process the area-based proportions were corrected to match the known Jewish population of the analysis areas, ultimately producing a table with much improved ward to analysis area proportions. An alternative approach of deconstructing ward data into its constituent OAs, and then (subject to adjustments needed because of ONS's anti-disclosure/small cell adjustment process) re-assembling the OA values to form the required MSOA, produces near-identical results.

Thus, through the processes outlined above, a 2001 dataset providing values for the 17 variables/characteristics of the Jewish population used in the geodemographic assessment was produced, for each of the 407 analysis areas.

3 Assessment methodology

The methodology for carrying out the 2011 geodemographic assessment is described in detail in Sapiro, 2016. In summary, the following steps were undertaken:

1. Transform and standardise the variables.
2. Identify those cases where the closest neighbour distance can be regarded as an outlier, and (temporarily) exclude these cases from the dataset.
3. Use Ward's approach to cluster the cases (see Everitt et al 2011).
4. Calculate the centre of each cluster and use as initial cluster-centres for a *k*-means analysis to produce final cluster centres (see Everitt et al 2011).
5. Add the outliers back into the dataset and, using the final cluster centres, allocate the outliers to classes.

In order to apply the 2011 classification to the 2001 data, the same transformations and standardisations as used for 2011 were applied to the 2001 data (as used in step 1 above). The 2011 cluster centres file (produced in step 4 above) was then used to provide fixed cluster centres for a *k*-means assessment of the 2001 data (equivalent to step 5 above). The *k*-means algorithm was run twice; once with the 2001 data standardised around its own means and standard deviations, and also with the 2001 data standardised to the means and standard deviations of the equivalent 2011 variables. The first run can be thought of as producing a 2001 relative classification, and the latter a 2001 absolute classification. It might appear clear cut that the latter classification is the more appropriate to use to identify changes in analysis area to class allocation between 2001 and 2011. Indeed, this would clearly be the

case if the 2001 variable definitions and census response rates were absolutely identical to those in 2011, and if no temporal element to the classification needed to be considered; that is, whether the same value of a variable in 2001 and 2011 should automatically lead to the same overall social characterisation in both years.

An example of a temporal issue is the requirement for all nurses entering the profession after 2013 to hold a degree (Bernhauser 2010). The holding of a higher level qualification is unlikely to lead to proportionate increases in socio-economic status / affluence than would apply to a less-formally qualified nurse in any earlier time period. Indeed, in the context of the proportion of degree holders variable more generally, it is worth noting that the number of people entering higher education in the UK has increased rapidly over the decade 'with total student numbers rising from just under 2 million in 2000–01 to around 2.5 million by 2010–11' (Universities UK 2012 p5), and the number of people graduating with a first degree has increased by 17% between 2001 and 2011. However, the socio-economic prospects derived simply through being a degree holder have fallen during the period, with the proportion of those graduating in the previous six years working in jobs that do not require post-16 education rising from 27% in 2001 to 36% in 2011 (ONS 2012c). Applying the absolute classification would thus imply a constant effect of a variable whereas a temporal trend might mean that a higher or lower value might be needed at different times to have to same socio-economic outcome.

In order consider the data consistency and temporal issues in more detail, the actual values of variables in the two census datasets have been reviewed, as set out in Table 1.

In line with the above discussion, the proportion of Jewish residents with degree level qualifications shows a marked increase between the two censuses. Some of the change in the proportion employed in education relates to a slight broadening of the scope of the SIC grouping between 2001 and 2011 to include less-formal training within the definition (Prosser 2009). The issue of professional, scientific, and technical employment has already been discussed, and changes in other areas do not appear to have impacted on the resultant proportions, except for the 'inactive' variable that is related to a change in the way that those over age 74 are considered in the census outputs.

The overall conclusion is that the 2001 relative classification is the more appropriate one to use, because it should minimise the impact of any variable definition and temporal changes between 2001 and 2011, meaning that, for example, an analysis area that exhibits the 2001 average value for a variable in 2001 and the 2011 average for that variable in 2011 would (all other matters being equal) be allocated to the same class in each census.

4 Comparison of the 2001 and 2011 classifications

The 2011 classification (Sapiro 2016) split areas of Jewish residence into seven classes as described in Table 3. After first mention in the text below, classes are referred to by their letter rather than full name. The results of applying the 2011 class centres to the 2001 data are shown in Figure 1**.** The number of analysis areas allocated to each class in 2001 and 2011 and the changes between the two years are set out in Table 4**.** The changes are also summarised in Figure 2**.** The allocation and changes are represented in terms of the number of analysis areas, and the Jewish population of the areas falling into each class in 2011. The table indicates that almost 80% of areas and population are allocated to the same class in both 2001 and 2011. All of the analysis areas allocated to Class C (very young deprived traditionalists), and over 90% of those allocated to Class A (footloose cosmopolitan professionals) remain unchanged. (Note that Vickers (2010) reports that 70% of output areas were allocated to the same class in his Output Area comparison of the whole population in both 1991 and 2001).

Certain trends can be readily identified:

- In NW London, the boundary between the Class F (affluent home-grown commuters) and Class G (comfortable home-grown elders) areas has 'retreated' northwards, expanding the area now classed as comfortable home-grown elders. A similar pattern is found in Leeds and north Manchester (and also in Trafford, Liverpool, Nottingham, and Redbridge). The Jewish population of the totality of areas falling into Class F in 2001 was unchanged over the 2001 to 2011 period; however, the sub-group of areas that changed classes from F to G lost 20% of their Jewish population. As part of ongoing suburbanisation/counter-urbanisation an element of the younger and more economically able have moved out of the more-inner areas, reducing the population and changing the age and socio-economic balance sufficiently for the areas to now fall into Class G.
- A change in popularity of some places for tertiary education has led to an increase in areas classed as B (blue collar and student urbanites) instead of Class E (comfortable educated suburbanites) or G.
- Conversely, improving fortunes have led to Class B areas being re-classed as A in east London and as Class E a little further north, with other expansion of Class E occurring in the Surrey area.

Some of these changes will relate to the different age structures and fertility levels of the various classes, and these are considered in the next section.

5 Population change between 2001 and 2011

The names allocated to some of the geodemographic classes indicate the dominant age group and thus allude to the likely direction of population change. Now that the classification has been applied to 2001 data, the change in population of classes can be examined in more detail. The ratio of the 2011 to 2001 Jewish resident population has been calculated for each of the 407 analysis areas. Figure 3 is a boxplot of those ratios, with the analysis areas categorised by the geodemographic class into which they fell in 2001.

As can be seen, the inter-quartile range for the analysis areas in Class G falls entirely below 1.0 and the population for this class is falling. Conversely, Class C shows an interquartile range of 1.4 to 2.0, indicating a rapid expansion (see also Vulkan and Graham 2008; Graham 2013). Class D also demonstrates an expanding range, with classes A and B generally contracting slightly and E and F expanding slightly over the ten year period. These patterns are to be expected given the age profiles of the classes and reflect the very young, young, and elders epithets included in some of the class labels. Table 5 provides information on the total Jewish population falling into each class, and total and average population changes over the 10 year period, complementing Figure 3**.**

Anecdotally, it is believed that Jewish communities in the north of England are suffering from a north to south drift in population. However, examination of the data for the 407 analysis areas shows that the seven most depleted (retaining between only 44% and 52% of their 2001 Jewish population in 2011) consist of four contiguous areas in Wembley (NW London) and three in Ilford (NE London). Indeed, only two of the twenty three most shrinking areas (Hull and Southport) are outside of south-east England. At the other end of the scale are seven areas whose 2011 population ranges from 250% to over 500% of the 2001 value.

The growth ratio of eight areas can be considered to produce outlier results compared with their class inter-quartile ranges; all show higher growth than might be expected, and have been investigated further to ensure data validity. In all cases a logical explanation can be found – in most cases major housing development has taken place in the area; others are explained by an ‘overflow’ of a strictly-orthodox community into the adjoining MSOA, increased popularity of the University of Nottingham, and a greater non-recording of religion at Jewish seminaries in Gateshead in the 2001 census compared with the 2011 census.

6 Age Profiles and Sources of Intercensal Population Changes

Whilst examination of the population and population change within classes can provide useful information, a much more detailed understanding of the changes can be arrived at through an examination of the age profiles within the categories and the change between 2001 and 2011. A very informative diagrammatic summary of the information available is achieved through plotting the 2001 and 2011 profiles on the same graph, but with the 2001 profile advanced by 10 years (see Ballard 2004, for another example of the use of this technique). If there was no migration between categories, then the two lines would coincide (subject to births and deaths). Thus, difference between the lines is a useful starting point for assessing the relative importance in natural change and migration in the intercensal population change. Figure 4 shows the graphs for the Jewish population of England and Wales as a whole. The difference between the two lines in the (2011) 0 to 9 year area is largely attributable to births; growth in the 10 to 39 age range represents international immigration; losses from age 40 upwards represent international emigration, with deaths taking over as the main source of losses, particularly in the 70 plus age groups. The shape of the graphs are, however, markedly different for each of the geodemographic classes. Figure 5 shows the equivalent diagrams class by class, and these are now described as they are an important precursor to using the analysis to carry out population projections.

Class A and B both show distinct peaks. In the case of Class B this represents in-migration of students, who then largely move on once their studies are complete. The Class A peak is later – early twenties to early thirties; however, this too seems to be relatively short-lived, with an equivalent level of departures over the subsequent 10 to 15 year period, probably due to a combination of the footloose cosmopolitan nature of the population, the nature of employment taken up, and a preference for families to live elsewhere than inner London (where Class A is focused). The relatively low number of young children and the generally downward age profile after the peak are clear in both diagrams. The diagrams for Classes C and D are markedly different to A and B. Both classes show a very high number of young children; Class C shows a minor student age gain (and possible later retention); whereas Class D shows a net outflow post-school age (with post-university returns/replacement). Both classes exhibit a small elderly population. Classes E and F show more stable profiles, with some post-school losses and later returns/replacements. Class G illustrates lower births than the other classes, a generally rising age profile (until mortality takes over) and a clear net out-migration from mid-twenties upwards.

Examination of the underlying data in more detail allows a broad assessment of the relative importance of births, deaths, and net migration to population change in each class to be determined (see Voss et al 2004; Simpson Finney and Lomax 2008; Finney and Simpson 2009). The difference between the number aged 70 and over in 2011 compared with those aged 60 or more in 2001 (plus a small proportion of the difference in the next younger 10 year band) has been taken to represent inter-censal deaths. The number of 0-9 year olds present in 2011 has been used as the starting point for 2001 to 2011 births; this figure has been adjusted to allow for migration of 0-9 year olds by assuming that their rate is half that of the net rate for their likely parents' age band. That rate has been assessed by comparing the number of 35-44 year olds in 2011 with the number of 25-34 year olds (a range avoiding distortion due to post-education student moves) in 2001. Where net in-migration has occurred, the number of 2001 to 2011 births is fewer than the number of 0-9 year olds present in 2011, and net out-migration produces a figure for births in excess of the number of 0-9 year olds present. All other changes between the 2001 and 2011 age profiles are assumed to represent net migration; the gross values of in and out migration within age groups cannot be ascertained from these data. Table 6 summarises the changes to the overall 2001 population of each class that various elements make up.

The figures for births and deaths for England and Wales as a whole (14% and 12% respectively) represent 35,100 births and 30,800 deaths. These are in line with the estimates prepared by the Board of Deputies of British Jews in their annual community statistics report (Vulkan 2013).

The variation in importance of the different contributors to change between the classes is quite stark. It is important to note that the analysis is by each geodemographic class – so in and out migration refers to movements between classes (or internationally); a move within class, even if over a large distance, would not contribute to the net change.

7 Projecting future population levels

The technique of comparing the 2001 and 2011 data, and the estimation of the relative importance of natural change and migration to intercensal change can be extended to produce a general indication of possible future levels of the Anglo-Jewish population, on the basis that 'an area's age-sex structure is highly predictive of the future population' (Holdsworth et al 2013 p55). The approach used is based on the cohort component method (Hinde 2014; Smith Tayman and Swanson 2001) and, to improve the accuracy of the projections, the population has been categorised, based on the 2001 geodemographic classification. Although (in earlier

sections) separate estimates have been made of the contribution of birth, death, and migration to population change, the data do not provide sufficient information to fully disentangle these elements, so a detailed calculation of the future levels of these elements individually cannot be achieved. However, some comparison of the levels of fertility and mortality in the different classes can be established. A 'fertility proxy' variable was included in the geodemographic classification – a child/woman ratio based on the number of 0-9 year old children and 25-44 year old women (an age range selected to avoid any student-related distortion) (Sapiro, 2016). An indication of mortality can be gleaned by measuring a survival rate for an age cohort between the censuses. If there is a material amount of migration to/from an area in a different class, then some distortion of the figures will occur, but migration within class has no impact on the calculation. Table 7 summarises the assessment.

Insofar as the fertility indicator is concerned, both Jewish and general fertility levels have increased over the 2001 to 2011 period. This increase reflects a pattern seen in other European countries, resulting from a shift in age-specific fertility as women who postponed births in their 20s in the 1990s caught up by having children in their 30s in the 2000s, a situation that may now have stabilised (Kohler et al, 2002; Sobotka, 2004; Bongaarts and Sobotka, 2012). The overall rate for Jews has moved from around the national average to being well in excess of it; the indicator has increased for all classes, and the relative ranking of each class has hardly changed. This, however, masks considerable variation within the Jewish community. The very high levels of fertility found in the strictly orthodox areas (Classes C and D) mask the level of change found elsewhere, as the number of 25-44 year old Jewish females and 0-9 year old Jewish children approximately doubled in the Class C and D areas between 2001 and 2011, whereas numbers for the other classes overall fell slightly. Excluding Class C and D areas, the child/woman ratio for the Jewish population was 1.46 in 2001 and 1.64 in 2011 – that is, below the values for the wider population, but by a smaller margin in 2011.

As regards mortality, expressed in terms of cohort survival, Jews exhibit similar levels to the population at large – just over half of those aged 65 or more survived 10 years with the proportion being just over two-fifths and around one third for those aged 70 or over, and 75 and over respectively. There is a material variation between classes, with inner urban and deprived classes faring less well than other classes, largely reflecting the well-established linkage between socio-economic status and mortality (Smith Blane and Bartley 1994; Hunt and Batty 2009; Mackenbach Kunst et al 1997). However, the survival rate for Class D (young fairly comfortable conservatives) appears to be better than their more affluent

neighbours, and the low rate for Class A probably arises from the presence of a residual elderly more-deprived element to the Jewish population, not associated with the well-qualified professionals who dominate the younger age ranges in Inner London.

This investigation of fertility and mortality confirms the benefit to any projection in considering the population by class, but raises the question of the appropriate manner in which to project future births and deaths. Does the increased fertility measure for 2011 indicate a level likely to be sustained into the future, or is it an anomaly with the 2001 level representing the longer term situation? Despite extensive consideration of modern variation in fertility levels (for example, by Lesthaeghe and Willems 1999; Lesthaeghe 2010), 'what happens next is far from clear.' (Bongaarts 2002 p439). Delayed child-bearing in the 1990s will have suppressed the 2001 calculation, and 'catching up' in the 2000s would mean that the 2011 calculation over-shoots the general trajectory of fertility change. For the purposes of this high-level assessment, with the projection limited to the relatively near future, child/ woman ratios for 2021 and 2031 based on both the 2001 and 2011 child/woman ratios by class have been used to produce a range for the number of 0-9 year olds.

In order to ensure a cautious approach is being taken, an adjustment has been made to the fertility assumption for the strictly orthodox Class C and D areas. Demographic Transition Theory anticipates that fertility levels will fall in all parts of the world from high levels to replacement levels or below and, indeed, in western Europe the process is largely complete (van de Kaa 1996; Bongaarts 2002). However, this does not mean that small minority groups necessarily follow the same trend (or at the same time) as the population as a whole. Indeed, it might be argued that, for these groups, reproductive behaviour is strongly linked to religious and cultural traditions. Conversely, it is clear that the fertility levels for one 'orthodox enclaves' class, Class D, are lower than for Class C, and there is evidence of a small drift away from strict orthodoxy by the next generation (Graham Staetsky and Boyd 2014). The presented projection is based on there being 10% fewer births per decade in the Class C and D areas than would be the case without this adjustment.

Of course, mortality does not stand still either, with life expectancy continuing to increase (see, for example, Oeppen and Vaupel 2002). It does not follow that improvements will occur evenly across a nation or, more specifically, across a minority subpopulation, nor are the changes likely to materially impact on a 10 or 20 year population projection. Nevertheless there is strong evidence of continuing improvement, both nationally and at a local level (Mayhew and Smith 2013; Bennett et al 2015) at a similar rate to the medium term trend. A simple comparison of the age profile for the England and Wales total population

taken from the 1991, 2001, and 2011 census tables indicates that there has been a 10% increased likelihood of 10 year survival, assuming that net international migration flows are minimal, in the oldest age group. As an example, the number of persons aged 85 or more present in 2001 was 29% of the number aged 75 or more present in 1991; the equivalent calculation for 2011 compared with 2001 was 32% - a relative increase of 10%. Almost identical improvements are found for survivors aged 75 to 79 and 80 to 84. A conservative projection range has been produced by considering two scenarios: that the survival rates established over the 2001 to 2011 period will remain in force until 2031; and that survival levels will be 10% higher than those rates.

Other changes in the next twenty years for each class will arise through migration. For the Jewish population of England and Wales as a whole, the net level of international migration appears to be very small (Table 5 indicating a contribution to population change of less than 1% between 2001 and 2011). The data available do not allow anything other than a continuation of that level to be assumed. In reality, therefore, net migration will have little impact on the projections for England and Wales as whole; however, inter-class migration has been projected forward so that the contribution of each class to the future total can be understood and any projection could be broken down by locality. Thus the projection assumes that, in general, for each five year band within each class, the ratio of 2011 population to 2001 population (10 years younger) will apply in projecting forward from 2011 to 2021, and from 2021 to 2031. However, the scale of migratory 'spikes', associated with school-leavers moving to university, and from university to first employment, or other major life-course moves occurring in young adulthood (clearly present in many of the diagrams within Figure 5) are not a function of the size of Jewish population in the receiving area/class. The attractiveness of a particular study institution, or (for example) Central London for a particular employment type, will be more important determinants. In these cases, the absolute level of net migratory change has been assumed to continue into the future, save where the population of an age group is in decline.

A number of caveats must be attached to the calculation. Of major importance is that it assumes a similar level of Jewish response or non-response to the census question on religion at both 2001 and 2011 censuses, and thus predicts the number of people who would (similar circumstances holding) identify themselves as Jewish in a future census, rather than any other definition of a member of Anglo-Jewry (see, for example, Vulkan 2013). Clearly, as set out above, it also assumes that the migratory behaviour in the future will match that

which occurred in the 2001 to 2011 period and the view that has been taken as regards life expectancy and fertility rates is appropriate.

In view of all these reservations, projected figures have been rounded, and extend only to 2021 and 2031. They have also been presented as a range; however this should not be interpreted as the limits of likelihood or a confidence interval. This approach is merely intended to allow the sensitivity of the overall projection to credible variations in the fertility and mortality assumptions to be understood. They should be thought of as giving a general indication of trajectory. The assessment has been made class by class, and summed to produce an England and Wales national estimate (allowing for Jews living outside of the classified areas). Table 8 summarises the projection.

The table indicates that the strictly orthodox groups (Classes C and D), which formed about 9% and 15% of Anglo Jewry as reported in the 2001 and 2011 censuses respectively, would grow to 30% of the total by 2031, driving up the overall size of the population through their high fertility levels (see also Staetsky and Boyd 2015). Large increases in strictly orthodox enclaves mask major falls in population in Class G areas, which are largely focussed in the Harrow/Wembley area of NW London, Redbridge and adjoining areas in NE London, and many of the medium/larger sized provincial communities (such as Leeds, Brighton, Bournemouth, Southend, Liverpool, and Birmingham). This will increase the proportion of Anglo-Jewry to be found in the London area, with all provincial communities (except Gateshead and Greater Manchester) reducing in size.

This future projection is in contrast to the historic trend. Although census data by religion are not available prior to 2001, the Board of Deputies of British Jews research unit has been preparing estimates of the size of the British Jewish population since the 1960s (building on earlier pioneering work of others). Schmool and Cohen (1998), summarising the work of earlier studies (Prais and Schmool 1968; Haberman Kosmin and Levy 1983; Haberman and Schmool 1995), indicate the size of the British Jewish population as set out in Table 9. They also state that 'numerically British Jewry reached its peak immediately after the Second World War' (p5), so the trend had been a rising one for the first half of the twentieth century, and then a falling one for the second half. The 2001 census thus appears to mark a low point in the Jewish population[3], with a small increase between 2001 and 2011.

[3] Although the Board of Deputies figures refer to Great Britain and the census data are for England and Wales only, the Jewish population of Scotland (2001 census) was below 6,000, leaving 2001 as the population low point for England and Wales.

The analysis presented in this paper indicates that the trend is now an increasing one, albeit with a strong geographic focus (see Figure 6).

Of the assumptions that need to be made, predicting future fertility levels is the most difficult. Therefore, a number of sensitivity tests have been undertaken. These indicate that the fertility rate would have to fall by 25% immediately, and a further 25% after 10 years for the mainstream classes, and by 40% immediately and a further 40% after 10 years for the very young deprived traditionalists class, for the projected future population growth to become negligible; such fertility level changes appear to be beyond the likely range. We can thus be confident that the change in population over time presented here is in the correct direction.

8 Discussion and Conclusions

The work reported in this paper demonstrates that, despite a number of hurdles, it has proved possible to apply a geodemographic assessment carried out using data from one census to a preceding census. There have been a few issues of compatibility in data definitions and geographic availability but these, and possible temporal changes in the impact of certain variables, have been mitigated by the use of a relative assessment, whereby 2001 variables were standardised to their own means and standard deviations, rather than the absolute values derived from 2011 data. A comparison of the two assessments has shown that about 80% of the analysis areas have fallen into the same class in both censuses, and that many of the changes that have occurred have a spatial element to them – in that changes of the same class to class type have been frequently found in contiguous groups, with the territorial extent of one class 'advancing' and another 'retreating'.

An examination of the ratio of the 2011 to 2001 population by class confirms the general trajectory of population that can be deduced from the age profile within each class derived from either the 2001 or 2011 census. The strictly orthodox enclaves (Classes C and D) are expanding at a high rate (see also Graham 2013), inner urban areas (Classes A and B) are mainly shrinking slowly, whilst some of the suburban / commuter belt areas (Class E and F) are expanding slightly or maintaining their numbers. The Class G areas (which include suburban and coastal communities) are shrinking, some at a high rate. The impacts of these type of change are returned to in discussing the future projected Anglo-Jewish population.

The anecdotal view that communities in the south are expanding while those in the north are fading away is only partly confirmed – many of the northern communities, those that fall into Class G, are indeed shrinking, and some of the London area groups are increasing in size. However, the population levels amongst those large areas of Class G

characteristics in NW and NE London are shrinking at comparable rates to the provincial communities.

The presentation of Jewish age profiles from the two censuses, particularly in diagrammatic form with the earlier census data shifted by the intercensal period, provides a very easy to comprehend picture of the underlying causes of the overall population change in the 10 year period. This has allowed the relative importance of fertility, mortality, and migration in contributing to the change to be derived, and the differences between the various classes are large.

The breakdown of the source of intercensal change assists greatly in carrying out a population projection. The type of data required to carry out a traditional cohort component method (for example, age-related survival rates) are not available for the geodemographic classes around which the projections have been based, so the absolute and proportionate changes that have occurred between 2001 and 2011 have been used to produce some overall factors to be applied to the 2011 data to produce a 2021 estimate, and from that estimate, a projection for 2031.

A number of caveats have already been set out as regards the accuracy of the projection. In particular, what is being measured are the number of self-identifying census Jews (rather than Jew defined in any other way). It is worth noting that of those individuals identified as Jews in the ONS Longitudinal Study (an approximate 1% sample of the country's population whose census returns are anonymously linked), 9.2% of those who had ticked 'Jewish' in 2001 failed to answer the religion question in 2011, and 9.4% who had identified as 'Jewish' in 2011 had not responded to the question in 2001 (Simpson Jivraj and Warren 2014, Table 7). The similarity of these figures confirms a consistency between the 2001 and 2011 census outputs and therefore the stability of the projection. The implication of the methodology is that any behaviours or attitudes that held between 2001 and 2011 are assumed to remain unchanged during the projection period (save for the fertility and mortality assumptions set out in the text). For example, no account has been taken for any future changes in levels of out-marriage or other assimilation, though Schmool (2003) reports an increasing tendency in these areas and an inter-generational difference in attitudes. More generally, Crockett and Voas (2006) identify an inter-generational decline in affiliation to religion. In parallel, there is some evidence of some Jews considering themselves as Jewish by ethnicity, rather than by religion (Graham and Waterman 2005; Webber 1997). Furthermore, although the assessment carried out focuses on the pattern of change in the Jewish population, that group forms a small minority within the wider England and Wales

society, and is not isolated from it. Implicit in the approach adopted to produce the population projection is that the influence that actions of others have on the behaviour of Jewish residents between 2001 and 2011 will continue to exert the same influence in the subsequent 20 year period.

All this having been said, the overall direction of the figures produced in the projection are sufficiently robust for a general trajectory to be determined, even if the figures presented are just one set within what could be a widening range the further into the future is being considered. The undoubted major growth in the strictly orthodox population, and shrinkage of major parts of the mainstream Jewish population could well have far reaching impacts on the future balance of the Anglo-Jewish population. Gidley and Kahn-Harris (2010 p166) state that there are 'demographic trends that present a serious challenge to the British Jewish community. One is the rapid growth of the British haredi[4] community as an increasingly significant proportion of British Jewry'. The social impacts of this, both within the Jewish community, how it is organised and behaves, and how it is perceived by others are considered by those authors at some considerable length.

This is not the first projection of the future size of Anglo-Jewry to be presented. DellaPergola, Rebhun, and Tolts (2000) undertook a major study, examining the likely prospects for the size of world Jewry up to the year 2080. Their estimates for the UK as a whole (see Figure 6) were 272,000 for the year 2000, 253,000 for the year 2010, 221,000 for 2030 (and 137,000 for 2080). The estimate was based on their assessment of migration rates from the 1990s and a 'medium fertility' projection. It was part of a worldwide study (of which the UK was a minor element), and predated the publication of the UK 2001 census, and a full understanding of the scale of population growth among strictly orthodox Jews (whose size prior to the end of the twentieth century had not had a marked impact on the overall size and growth rate of Anglo-Jewry). The projection set out in the current paper is based on much more detailed and verifiable information than was available to DellaPergolla and colleagues; it also confirms the importance of breaking down the population into groups with similar characteristics, rather than considering the population as homogenous.

So, what can be concluded from this research? Firstly, a retrospective application of a geodemographic classification built from a new census onto data from an earlier census is possible. Secondly, this allows easy-to-comprehend spatially-based changes in a population

[4] Haredi Judaism is a strand of Orthodox Judaism that adheres strictly to the traditional form of Jewish law and rejects modern secular culture.

to be analysed. Thirdly, quantified trends for different elements of a population can be established, allowing population projections to be made, differentiated by the underlying characteristics of the group (rather than their being based on treating the group as a homogenous entity). The approach therefore allows projections to be made for sub-populations for whom traditional methods cannot be used because of lack of, for example, age-related survival rates. In the case of Anglo-Jewry, the analysis has shown that the balance between the various geodemographic classes and their underlying fertility, migratory and mortality differences points to a level of growth in the strictly orthodox community that will change the overall balance of Anglo-Jewry over the next decades, reversing a fifty-year decline, and that this may have significant societal impacts.

This analysis thus has wide-ranging policy implications for the Anglo-Jewish community and the various organisations and bodies that are interested in, and provide services for, that community nationally and in a variety of localities, both Jewish charitable organisations and local government bodies. For example, the projected growth in the number of children, particularly as this growth is focused in three or four particular areas, will require action to ensure that educational provision can be properly planned. At the other end of the spectrum, an increase in the number of elderly people will have implications (generally in other parts of the country) for the provision of social care and cemetery provision. Equally importantly, the relative and absolute reduction (certainly in the medium term) in the number of Jewish residents in the 45 to 74 age range may require a re-think in the way that voluntary bodies in the Jewish community are organised, led, and funded. It is only recently that the strictly-orthodox section of the Anglo-Jewish community has started to have a material impact on the size of the population. A number of other countries are also home to small orthodox populations within a wider Jewish group. The analysis presented here may thus have policy implications for other Jewish communities in other parts of the world.

Historically, fresh data (a new census) has led to old classification systems being discarded, and the building of new classifications ‘to better reflect the demographic, social and economic patterns of the time’ (Harris Sleight and Webber 2005 p73), and the opportunity to allow geodemographic analysis to quantify the changes that have occurred in an easily understood format has been lost. This work has demonstrated that geodemographic assessment has the capability to be used to quantify change over time. This principle, although demonstrated through consideration of a small sub-population, has the potential to be applied to other groups and to populations at large, and thus give rise to policy issues more widely.

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Tables

Table 1 Range of Values of Characteristics in 2001 and 2011

Characteristic of the Jewish population	2001 values			2011 values		
	lower quartile	median	upper quartile	lower quartile	median	upper quartile
Proportion age 16 or more with degree qualifications and above	20.3%	29.3%	39.6%	31.3%	42.5%	53.9%
Proportion age 16 or more with no qualifications	9.8%	13.2%	20.5%	9.8%	15.3%	24.3%
Proportion employed in professional, scientific and technical areas	12.8%	17.6%	21.7%	12.5%	15.6%	19.5%
Proportion employed in wholesale and retail trade	13.5%	17.5%	21.6%	10.9%	14.3%	16.8%
Proportion employed in education	6.8%	8.7%	11.9%	9.2%	11.8%	16.0%
Self Employed as proportion of all employed (exc students)	25.4%	30.4%	34.9%	24.9%	29.6%	34.7%
Looking after home as proportion of all 'inactive' aged 16 or more	11.7%	17.9%	23.0%	6.8%	11.8%	20.0%
Proportion of Residents age 0-15 (exc students)	12.4%	16.6%	23.1%	12.7%	16.9%	25.0%
Proportion of Residents age 65 and over (exc students)	14.8%	22.0%	29.3%	15.0%	21.6%	31.2%
Total Fertility Indicator (all age 0-9 cf age 25-44 females)	1.13	1.58	2.10	1.18	1.66	2.33
Migration Indicator (all age 25-34 cf 55-64 females)	1.42	2.23	3.73	0.97	1.73	3.66
Proportion of Residents UK born	75.5%	84.1%	91.5%	74.1%	81.9%	90.2%
Proportion of Jewish HRP 1 family households: married or in civil partnership	54.7%	62.3%	70.6%	53.8%	62.5%	69.7%
Married Jewish HRP households as proportion of married + cohabiting	0.83	0.91	0.95	0.82	0.90	0.95
Proportion of Jewish HRP households that are single person	27.3%	33.7%	42.3%	24.2%	32.5%	40.2%
Percentage of Jewish HRP households owned or shared ownership	67.3%	80.2%	89.2%	62.8%	77.4%	85.5%
Percentage of Jewish HRP households with 2+ cars	20.6%	34.4%	49.0%	19.2%	33.2%	47.3%
Populations for the Characteristics		2001			2011	
Total Jewish population		259,927			263,346	
Jewish population aged 16+		215,350			210,426	
Employed Jewish persons		115,717			122,846	
Inactive Jews aged 16+		80,229			66,216	
Jewish population (exc students)		242,031			243,010	
Jewish females age 25-44		33,332			31,825	
Jewish females age 55-64		15,132			17,360	
Jewish HRP 1 family h/holds		66,217			65,859	
Jewish HRP households		116,330			110,726	

Note – 'Jewish HRP' indicates households in which the Household Reference Person identified as Jewish.

Table 2 Summary of the analysis group system for the 2011 classification

analysis area type	No. of areas	MSOAs covered	median number of Jews	Jewish share of population	Proportion of E&W Jews	Proportion of E&W total population
single LSOA	92	18	625	37%	23%	0.3%
single MSOA	129	129	552	9%	35%	1.9%
multiple MSOAs	186	2108	466	0.5%	32%	31%
All analysis areas	407	2255	512	1.3%	90%	33%
Rest of E&W	-	4946	-	0.1%	10%	67%
Total	-	7201	-	0.5%	100%	100%

Table 3 Geodemographic Classes

Class	Class Name	Principal locations
A	Footloose cosmopolitan professionals	Central London, Oxford, Cambridge
B	Blue-collar and student urbanites	East London and 'university' areas of provincial cities
C	Very young deprived traditionalists	Strictly-orthodox enclaves in Hackney, Gateshead, and Salford (Greater Manchester)
D	Young fairly comfortable conservatives	Orthodox areas in Barnet and Salford
E	Comfortable educated suburbanites	South Barnet and south west London/ Surrey/Berkshire
F	Affluent home-grown commuters	Hertfordshire/Essex/north Barnet, Greater Manchester and other provincial cities
G	Comfortable home-grown elders	London NW and NE fringes, coastal towns and some provincial cities

Table 4 Analysis Area to Class Allocation 2001 and 2011

No of analysis areas 2001 class	2011 class										
	A	B	C	D	E	F	G	Total	unchanged	main changes	
A	55	1			2			58	95%	F to G	20
B	5	31			6		5	47	66%	G to B	9
C			27					27	100%	B to E	6
D		1	3	14	2	1		21	67%	E to D	6
E	2	5		6	54	4	2	73	74%	F to E	6
F		1		3	6	70	20	100	70%	B to A	5
G		9				1	71	81	88%	B to G	5
Total	62	48	30	23	70	76	98	407	79%	E to B	5

2011 population 2001 class	2011 class										
	A	B	C	D	E	F	G	Total	unchanged	main changes	
A	29241	319			1122			30682	95%	F to G	13532
B	2651	14666			2879		2454	22650	65%	G to B	3913
C			20720					20720	100%	E to D	3878
D		562	2890	13762	1494	505		19213	72%	F to D	3616
E	647	1773		3878	31103	3348	1333	42082	74%	F to E	3594
F		287		3616	3594	45176	13532	66205	68%	E to F	3348
G		3913				466	32747	37126	88%	D to C	2890
Total	32539	21520	23610	21256	40192	49495	50066	238678	79%	B to E	2879

Table 5 Summary of Class population and changes 2001 and 2011

2001 Class	2001 Jewish Residents	2001 Jewish Residents (exc students)	2011 Jewish Residents	2011 Jewish Residents (exc students)	10 year change in Jewish Residents	10 year change exc students	2011/2001 Jewish Residents	2011/2001 Jewish Residents (exc students)
A	31154	28641	30677	28047	-477	-594	98%	98%
B	25380	22045	22626	19185	-2754	-2861	89%	87%
C	11499	10224	20720	18054	9221	7830	180%	177%
D	13338	12410	19213	17838	5875	5428	144%	144%
E	38592	36318	42067	39468	3475	3150	109%	109%
F	66203	62818	66205	62766	2	-52	100%	100%
G	47360	44791	37126	34798	-10234	-9993	78%	78%

Table 6 Summary of contributors to class population change 2001to 2011

	Values are percentages of class 2001 population							
	England & Wales	A	B	C	D	E	F	G
Birth gains	14	10	9	56	35	16	11	5
Net Child departures (-) or arrivals (+)	0.5	-3	-1.4	11	8	2	2	-0.5
Net Post-school departures (-) or student arrivals (+)	0.7	3	9	5	-6	-3	-4	-0.1
Net 20s departures (-) or arrivals (+)	2	12	-2	4	9	5	-1.2	-3
Net 30s/40s departures (-) or arrivals (+)	-0.6	-9	-4	2	3	1.4	2	-2
Net Post 50 departures (-) or arrivals (+)	-2	-3	-4	1.4	2	-1.4	-2	-3
Death losses	-12	-13	-16	-6	-6	-10	-8	-18
Natural Change (Births less Deaths)	2	-3	-8	50	28	5	2	-13
Migration change	0.3	1.2	-3	23	16	4	-2	-9
Overall change	2	-2	-11	73	44	9	-0.2	-22

Table 7 Summary of Fertility and Mortality Indicators by Class

Class	A	B	C	D	E	F	G	All E&W Jews	All E&W residents
Fertility proxy									
in 2001	0.90	1.19	6.58	3.62	1.79	1.79	1.32	1.68	1.66
in 2011	0.96	1.48	7.13	4.13	2.03	2.17	1.41	2.18	1.72
Rank	7th	6th/5th	1st	2nd	4th	3rd	5th/6th		
Proportion surviving 10 years from 2001									
age 65 or over	0.46	0.41	0.47	0.62	0.56	0.61	0.49	0.52	0.53
age 70 or over	0.40	0.34	0.38	0.54	0.47	0.52	0.42	0.44	0.43
age 75 or over	0.32	0.27	0.30	0.43	0.37	0.40	0.32	0.34	0.32
Rank	=5th	7th	=5th	1st	3rd	2nd	4th		

Table 8 Jewish Population Projection

Jewish Population '000	Class							England
	A	B	C	D	E	F	G	& Wales
2001 census	31	25	11	13	39	66	47	260
2011 census	31	23	21	19	42	66	37	265
2021 projection	30-31	21	34-35	27-28	45-46	63-65	29	275-281
2031 projection	31	21	54-57	35-39	47-50	58-61	22	292-306

England and Wales	Age Range						
	0-14	15-29	30-44	45-59	60-74	75 and over	All Ages
2001 census	42	44	50	53	38	32	260
2011 census	50	46	48	47	44	30	265
2021 projection	57-61	50	50	45	43	30-32	275-281
2031 projection	62-72	59-61	53	45	39	33-36	292-306

Table 9 Board of Deputies British Jewish Population Estimates

Year	Population '000
1950	430
1960-65	410
1975-79	336
1984-88	308
1989-93	295
1995	285

Sources: Prais and Schmool (1968); Haberman, Kosmin, and Levy (1983); Haberman and Schmool (1995)

Figures

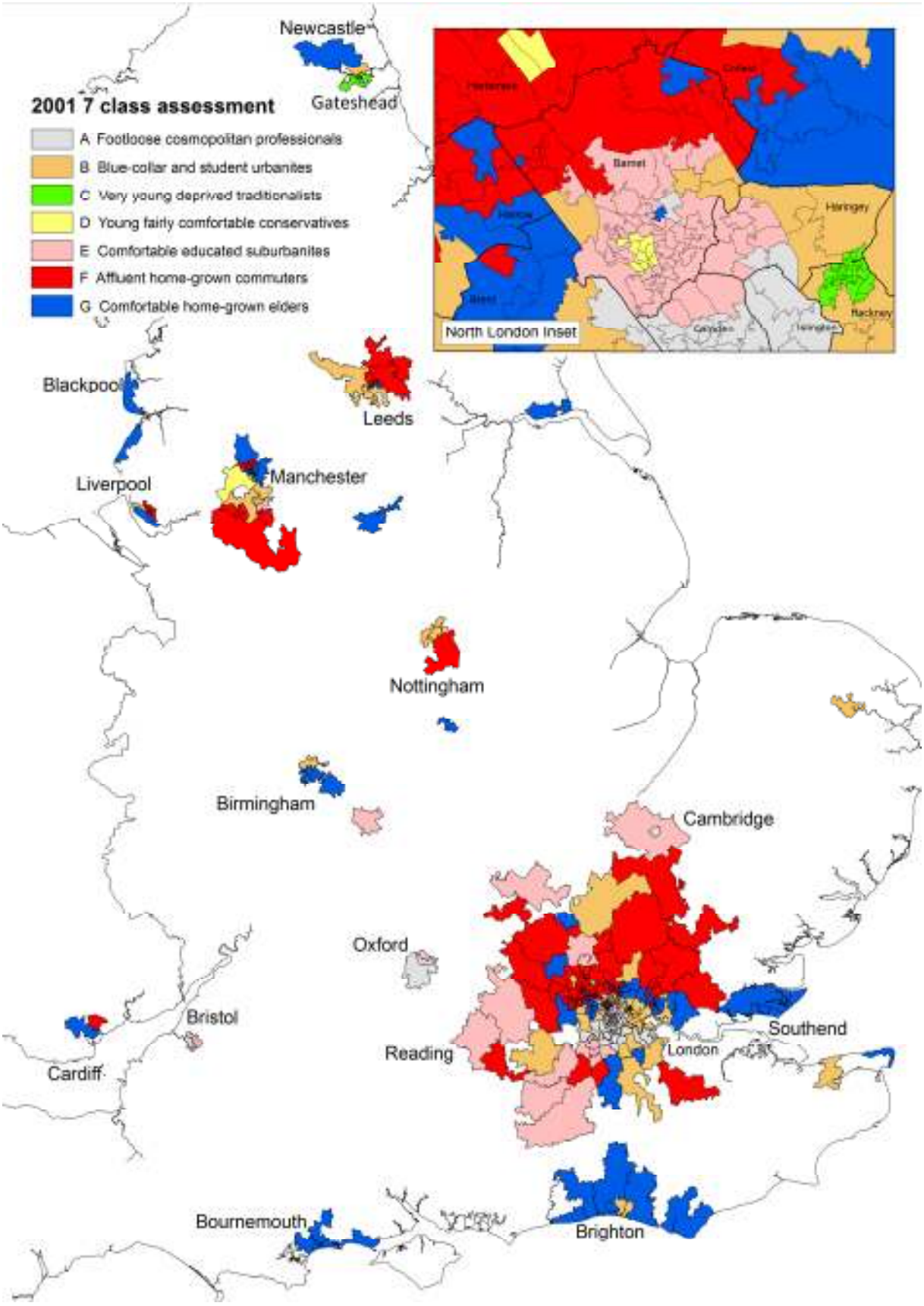

Figure 1 2001 Seven class Jewish geodemographic assessment

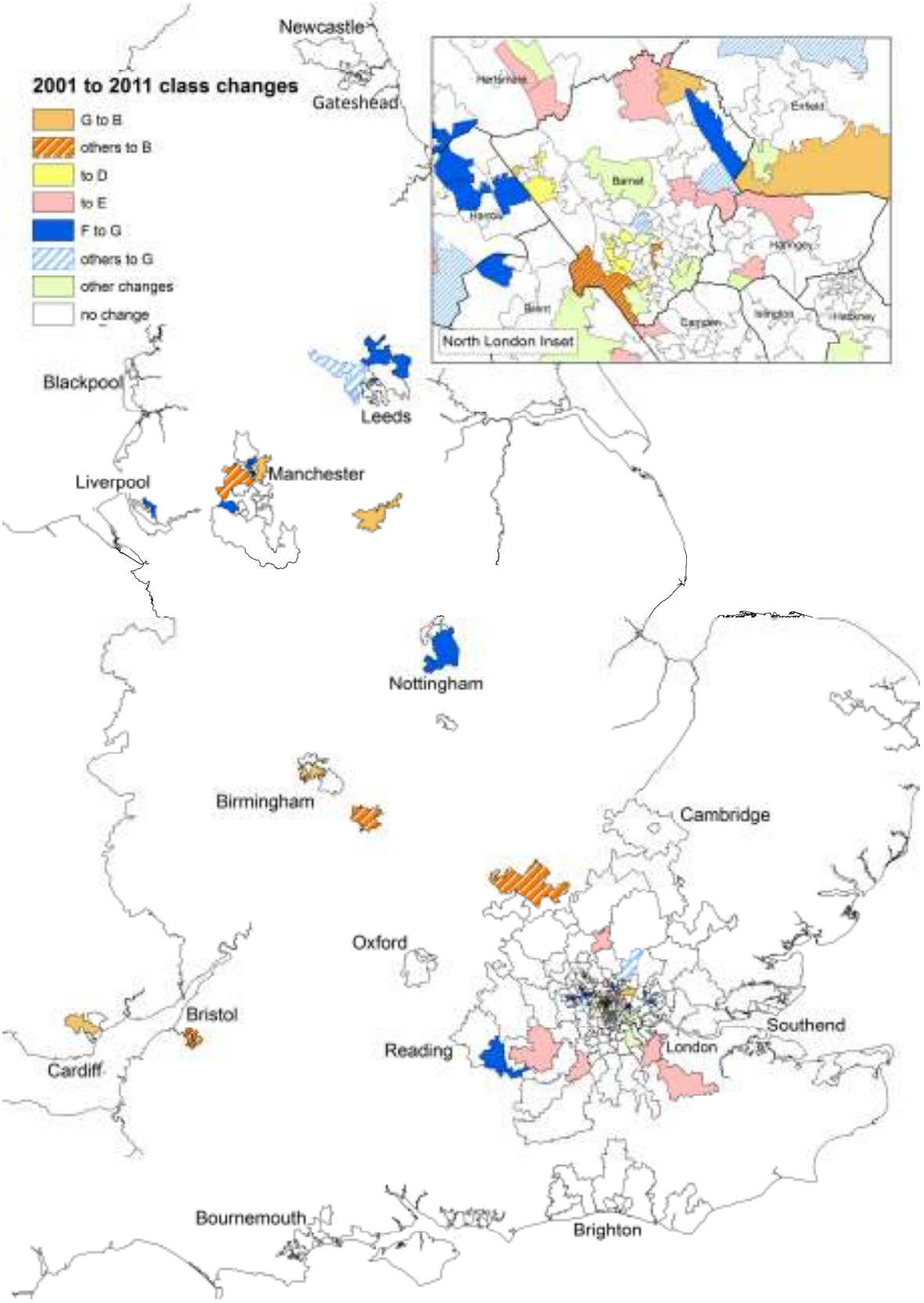

Figure 2 Class changes between 2001 and 2011 Jewish geodemographic assessments

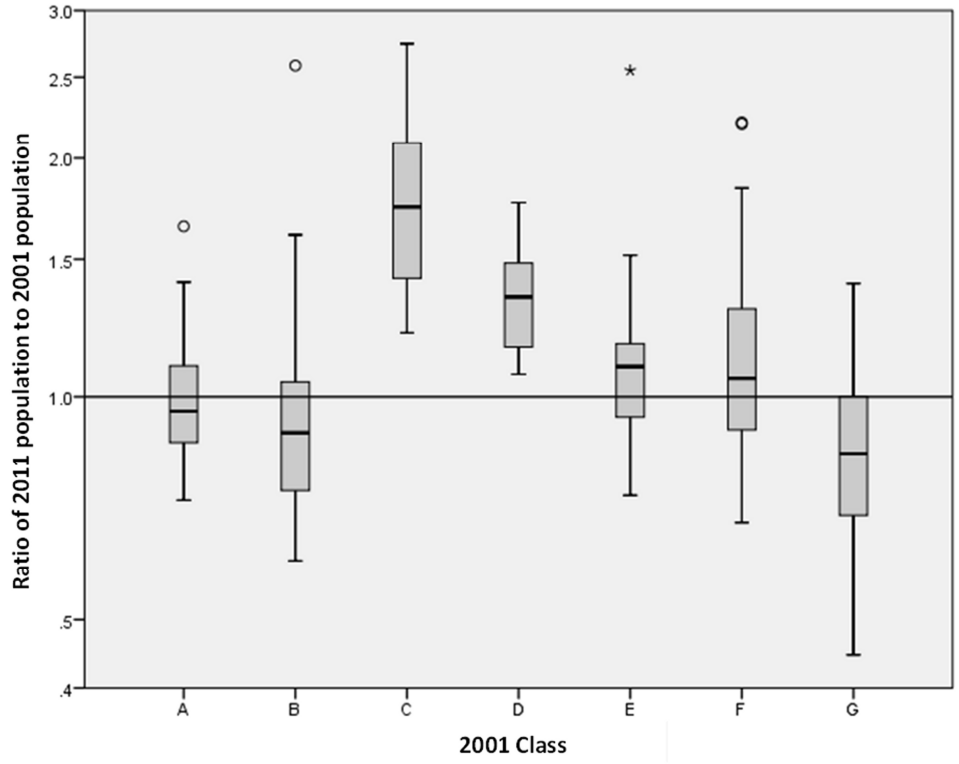

Figure 3 Class population change 2001 to 2011 (see Table 3 for class names)

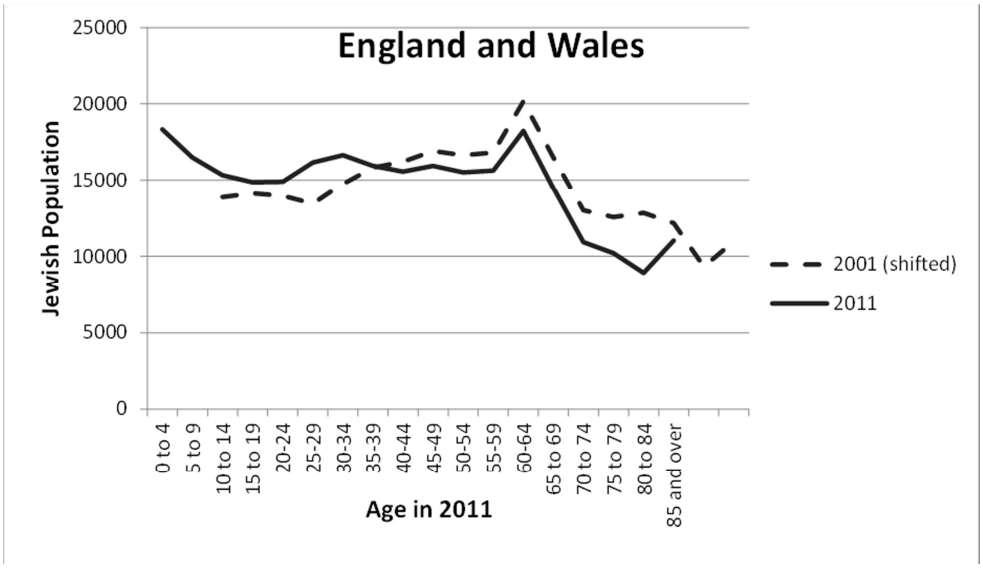

Figure 4 2001 and 2011 Jewish age profiles – England and Wales

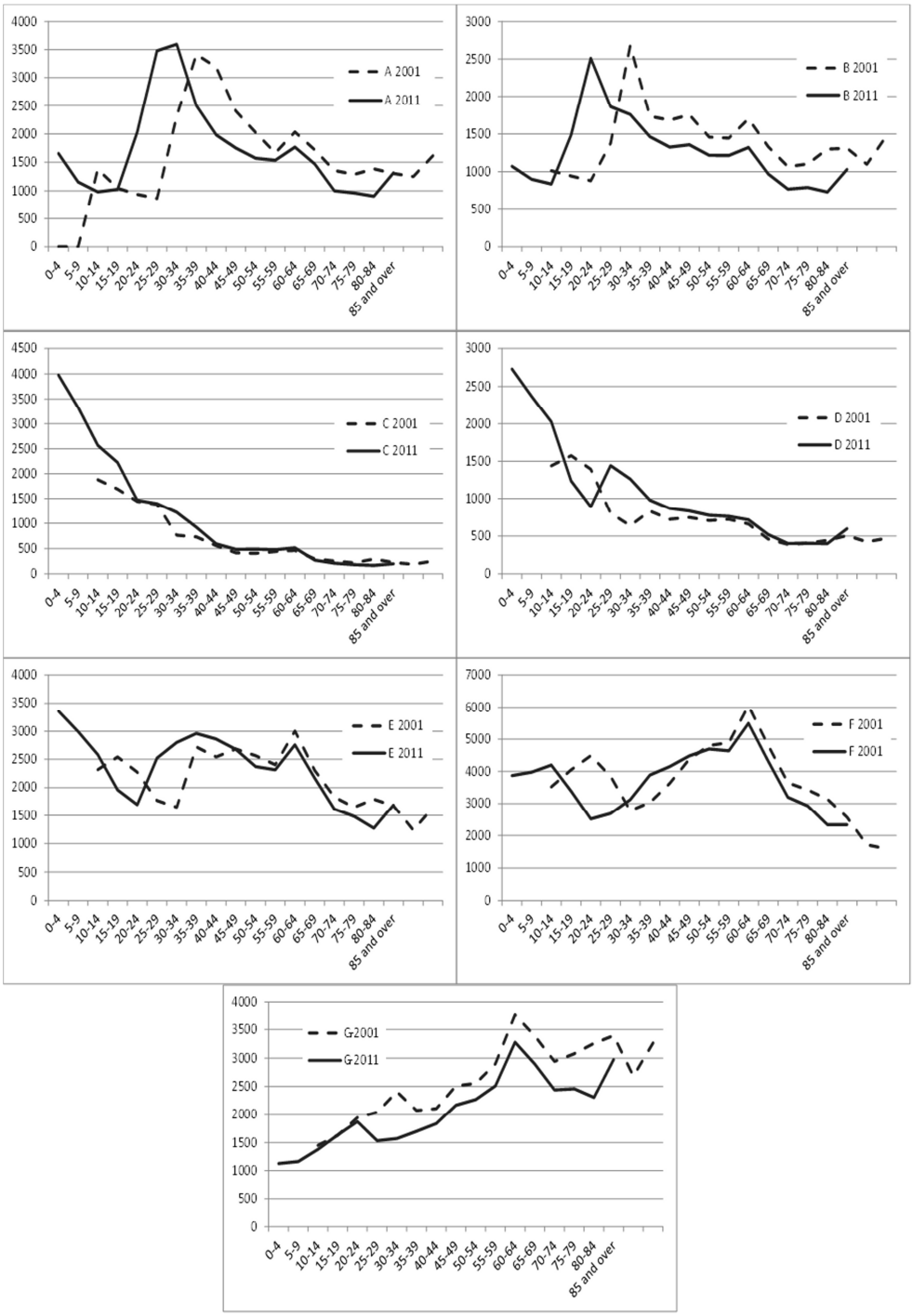

Figure 5 2001 and 2011 Jewish age profiles by class

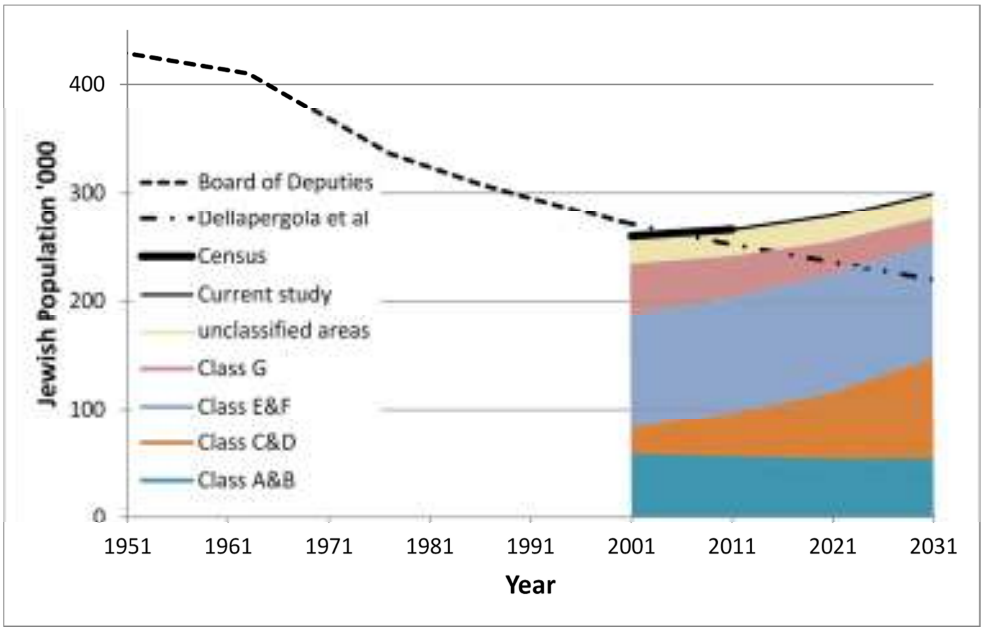

Figure 6 Jewish population estimates, census values, and projections