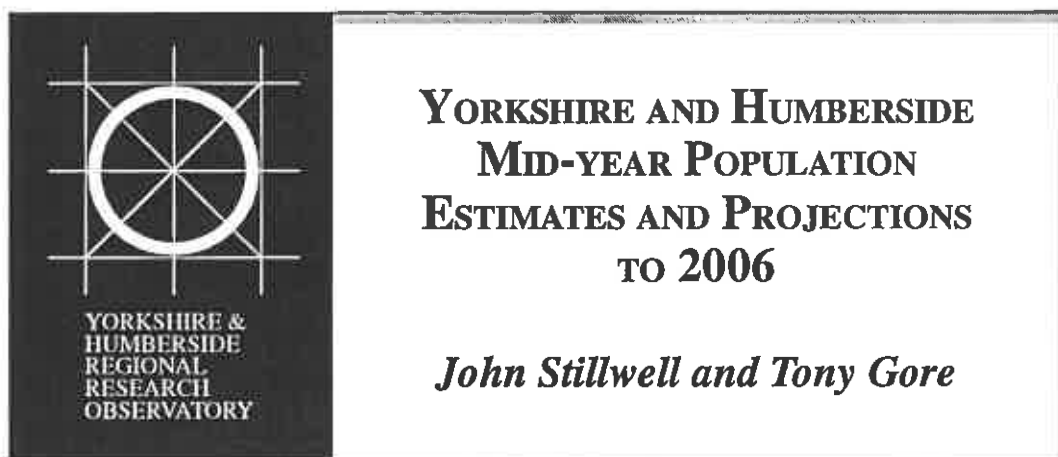

The Yorkshire & Humberside Regional Research Observatory



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Yorkshire and Humberside Regional Research Observatory

Working Paper 93/4

**YORKSHIRE AND HUMBERSIDE
MID-YEAR POPULATION ESTIMATES AND PROJECTIONS TO 2006**

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ABSTRACT

In late 1992, the Yorkshire and Humberside Regional Research Observatory was contracted by the Yorkshire and Humberside Regional Planning Conference and the Department of the Environment to undertake a study to evaluate the current projections of population and households in the metropolitan districts and shire counties within the region to 2006. A report was prepared which contained a series of population and household projections based on the provisional rebased population estimates for mid-1991. Since then, the Office of Population Censuses and Surveys (OPCS) has produced a set of revised final estimates for mid-1991 that take into account new information on underenumeration identified by the Census Validation Survey and which distribute a high proportion of the estimated underenumeration to local authorities within England and Wales using sex ratios rather than on a pro rata basis.

The principal aim of this paper is to document the preparation of a series of population projections for local authority areas in Yorkshire and Humberside to 2006 which make use of the revised final mid-year estimates. However, the paper also contains a detailed description of the components of the region's underenumeration and of the adjustments that are used to convert the 1991 Census counts into mid-1991 population estimates (Section 2). Changes in the population estimates for local authorities in Yorkshire and Humberside between 1981 and 1991 are briefly discussed in Section 3.

The paper contains two comparative analyses in Section 4. Firstly, the mid-1991 population estimates are compared with the 1989-based projections for 1991 to establish where inaccuracies are most evident and to generate the factors with which to adjust projected populations in 2001 and 2006 to take into account possible 1989 base population errors. Secondly, the net migration assumptions for 1989-92 used in the OPCS/DoE projection methodology are compared against 'observed' net migration data from the National Health Service Central Register (NHSCR). The NHSCR data is used to conduct an analysis of time series migration trends in the region since 1975, the results of which enable three new sets of net migration assumptions to be prepared on the basis of different net migration scenarios. A methodology is presented in Section 5 which allows existing population projections to be adjusted to take account of the results of the population base and net migration analyses. All the adjusted projections indicate that the official projections to 2001 and 2006 are too low for West Yorkshire and too high for North Yorkshire. The use of different net migration assumptions for South Yorkshire and Humberside results in population projections on either side of the published OPCS/DoE figures.

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1. INTRODUCTION

1.1 Aims

The availability of the results of the 1991 Census of Population presents an opportunity for central government and local authority departments concerned with population matters to obtain comprehensive and reliable information about the demographic structure of the population of any part of Great Britain. It also enables assessments to be made of the existing projections of population and households and judgements to be delivered on the suitability of the existing assumptions upon which those projections are based.

In May, 1993, the Yorkshire and Humberside Regional Research Observatory published a report which used the results of the 1991 Census and data from other sources to examine the 1989-based population and household projections for local authority areas in Yorkshire and Humberside and to identify whether the assumptions that underpinned those projections were appropriate for the 1990s (Yorkshire and Humberside Regional Research Observatory, 1993). The report presented a detailed investigation of several of the components of the projections deemed to be of particular importance to the local authorities concerned: the age-gender structure of the population, migration to and from the rest of the UK, marital status, household formation and headship rates. It also considered particular subgroups of the population, including students and institutional populations, whose existence presents certain local authorities with the need to collect additional data and to incorporate particular adjustments into their projection methods.

The study also produced a series of alternative sets of projections of population and households for 2001 and 2006 based on differing assumptions about migration, marital status and headship rates. These are summarized at county level in Stillwell, Ramsden, Gore and Beatty (1993). The methodology adopted in the study was one of adjustment rather than the construction of a new projection model and all the projections were prepared using the provisional mid-1991 population estimates rebased using the 1991 Census results by the Office of Population Censuses and Surveys (OPCS, 1992b). Since the publication of the study, OPCS have announced two revised (final and a revised final) sets of rebased population estimates for mid-1991. In the first half of this paper, we outline how the mid-1991 estimates were prepared (Section 2) and examine the population change between 1981 and 1991 (Section 3). In the second half, we report the results of comparisons between population estimates and projections for 1991 and net migration projections and observations between 1989 and 1992 (Section 4) and present new sets of aggregate population projections based on different net migration scenarios (Section 5).

1.2 Context

Subnational population projections

Subnational population projections for local authority areas in England are produced periodically by the OPCS. The results of the 1981 Census were used to produce a set of re-based mid-1981 population estimates that formed the starting point for the 1981-based projections, and there have been five sets of projections since then - those based on the mid-year estimates for 1983, 1985, 1988 and 1989. The mid-1989 population estimates are

therefore the current 'official' projections. The next round of population projections is planned to be based on mid-1992 population estimates so that the results of the 1991 Census reported in the Special Migration Statistics (SMS) due in early 1994 can be incorporated. The target publication date for the mid-1992 projections is September 1994.

The population projections rely heavily on the Department of the Environment (DoE) for assumptions about internal migration and OPCS provide the assumptions about the other components - fertility, mortality and international migration. The 1989-based projections are calculated by single years of age for each sex for each mid-year up to 2015; although most of the published information is in more aggregate form. All the projections are generated so as to be consistent, when summed together, with population projections for England as a whole that are made by the Government Actuary's Department (GAD).

The DoE have indicated that the OPCS/DoE population projections are intended as planning guidance tools:

"The availability of a consistent set of official projections provides a framework within which producers of strategies, structure plans and other proposals for particular parts of the country may be required to justify their use of different figures" (OPCS, 1991a).

The availability of mid-1991 rebased population estimates provides an opportunity to compare them against the 1989-based population projections for 1991.

Regional Guidance

The initial research project undertaken by ReRO was commissioned to help in the preparation of draft advice on Regional Guidance by the Yorkshire and Humberside Regional Planning Conference on behalf of the local authorities in Yorkshire and Humberside. Draft advice on Regional Guidance has now been published (Yorkshire and Humberside Regional Planning Conference, 1993) and the Guidance to be produced by the Secretary of State for the Environment in due course will provide a framework for the two county Structure Plans and the nine Unitary Development Plans in the metropolitan districts. The Guidance will therefore suggest a broad framework for development in the region over the next 20 years.

One important part of this Guidance relates to the provision which needs to be made in the development plans for new housing. Regional Guidance will indicate the total number of new houses that will be required in the region between 1991 and 2006 and may suggest a phasing of housing land provision in line with the broad objective of environmentally sustainable development.

Whilst it was not within the remit of the commissioned research to make an assessment of future dwelling requirements, it is nevertheless important to recognise that the future demand for new houses will reflect changes in the number of people in the region and in their propensity to form households.

1.3 Spatial framework

The analysis focuses principally on the 11 local authority areas for which the OPCS/DoE/BRE produce population and household projections as part of the subnational projection exercise. These local authority areas include the five metropolitan districts of West Yorkshire (Bradford, Calderdale, Kirklees, Leeds and Wakefield), the four metropolitan districts of South Yorkshire (Barnsley, Doncaster, Rotherham and Sheffield) and the two shire counties of Humberside and North Yorkshire (Figure 1.1). The districts of the two shire counties are referred to in Sections 3 and 4 and part of the migration analysis reported in Section 4 involves a wider set of areas which includes those adjacent local authorities whose boundaries coincide with those of Yorkshire and Humberside local authorities. These include Cleveland, Durham, Cumbria, Lancashire, Oldham, Rochdale, Derbyshire, Nottinghamshire and Lincolnshire. In addition, the rest of England is distinguished from the rest of the UK.

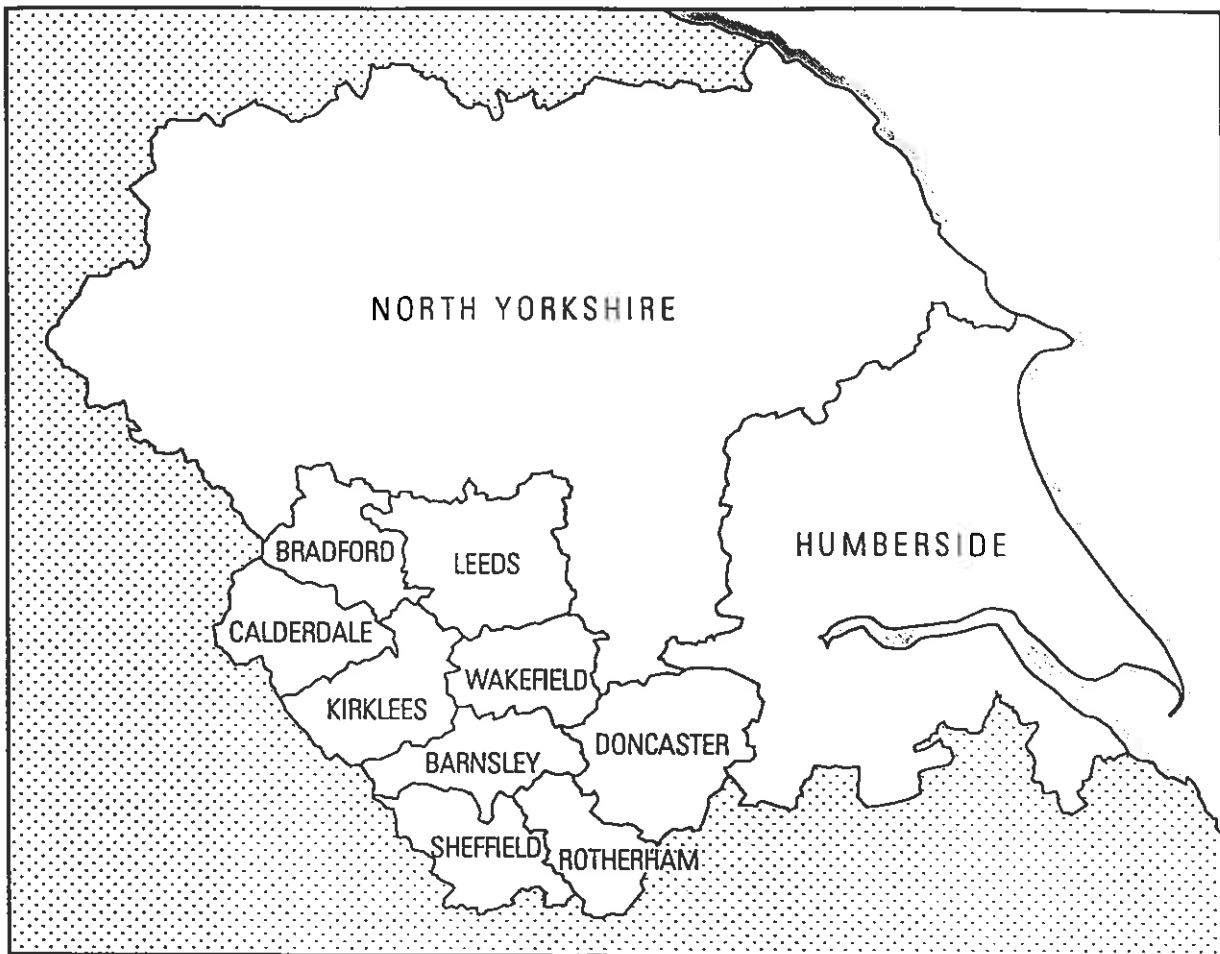


Figure 1.1: The boundaries of the metropolitan districts and shire counties of Yorkshire and Humberside

2. CENSUS UNDERENUMERATION AND THE REBASED POPULATION ESTIMATES FOR MID-1991

2.1 Census data and the rebasing procedure

One of the key data sources used in this work is the last decennial Census of Population, conducted on 21 April 1991. The Census forms collected by enumerators in England and Wales were processed into computer readable form by the OPCS and have been made available as published reports and machine readable data (Small Area Statistics (SAS) and Local Base Statistics (LBS)). The SAS and LBS were purchased from OPCS for use by the academic community through the Census Programme of the Economic and Social Research Council (ESRC). A full set has been deposited at the University of Manchester where the Census Dissemination Unit is responsible for their distribution to researchers across the Joint Academic NETWORK (JANET) using SASPAC91, a package written for the purpose of facilitating data extraction.

The Census is a very important source of population data insofar as it is used to rebase the mid-year population estimates in the first year of each decade, which are in turn used as the population base for the rolled forward population estimates in subsequent years and for the projections of subnational populations into the future. Three sets of adjustments to the 1991 Census data for local authority areas are necessary as part of the rebasing procedure:

- (i) adjustments to take account of Census underenumeration;
- (ii) adjustments to take account of definitional differences between the Census count and the mid-year population estimate of the resident population; and
- (iii) adjustments to take account of the natural change and net migration occurring between 21st April and 30th June, 1991.

OPCS produced three sets of mid-1991 population estimates. The first or *provisional* rebased estimates were prepared using incomplete Census results in October 1992 (OPCS, 1992b). The second or *final* rebased estimates were produced in June 1993 using additional information that became available and a different methodology for distributing parts of the identified underenumeration. In preparing these estimates the 1991 Census results were adjusted to agree with what was judged to be the best estimate available for England and Wales as a whole (OPCS, 1993a), derived by updating the mid-1981 estimate to allow for subsequent births, deaths and migration. A third or *revised final* set of rebased estimates was produced in August 1993 after it was discovered that the estimates of the amount of net inward migration between 1981 and 1991 had been understated (OPCS, 1993b). Given the importance of these rebased estimates which are used in later sections of this paper, the remainder of this section contains a detailed description of their derivation.

2.2 Adjustments for Census underenumeration

In England and Wales, the basic Census count of usual residents in households and communal establishments was 49,890,000, of whom around 806,000 were 'imputed' members of wholly absent households who did not voluntarily complete a form on returning home after the Census. The latter were excluded from the tables of the previous Census in 1981 and consequently the definition of the population base is different in the two

Censuses. Detailed investigation by the OPCS revealed that the 1991 Census coverage was around 98%. OPCS (1993a) estimated that the undercount of 2%, the so-called 'missing million', was due to six different sources of error in the Census count as reported for England and Wales:

- (i) errors identified by the Census Validation Survey (CVS);
- (ii) errors due to the underenumeration of visitors omitted from the usual resident count;
- (iii) errors due to the underenumeration of infants;
- (iv) errors due to the underenumeration of armed forces and their dependents;
- (v) errors due to underenumeration of elderly residents; and
- (vi) errors due to the underenumeration of people aged 1-44.

The relative magnitudes of the errors associated with these components for England and Wales are presented in Table 2.1.

Table 2.1: Sources and levels of underenumeration in the 1991 Census, England and Wales

	Provisional (000)	Final (000)	Revised Final (000)	% of under- enum.
1991 Census count of usual residents	49,890	49,890	49,890	
Census Validation Survey adjustments				
Over-imputation of absent households	-85	-115	-115	-10
Missed/misclassified dwellings	200	178	178	16
Persons missed in responding households	177	177	177	16
Allowance for omitted visitors	-	200	200	18
Enhancement for infants	21	21	21	2
Enhancement for armed forces	79	42	42	4
Modification for elderly		63	63	6
	572			
Enhancement for persons aged 1-44		402	547	49
Total underenumeration	964	968	1113	
Adjusted 1991 count of usual residents	50,855	50,858	51,003	

Source: OPCS (1992b; 1993a; 1993b)

Errors identified by the CVS

The coverage errors identified by the CVS account for 240,000 or 22% of total underenumeration and are of three types:

Absent households

The CVS initially suggested a net over-imputation of 85,000 residents of occupied households in England and Wales wholly absent on Census night and with whom the Census enumerators made no contact; i.e. it does not include those who were willing to voluntarily return their Census forms in the weeks immediately after the Census. This total was modified to 115,000 as some of the responses to the CVS were clarified.

Residents in missed households

In the provisional rebased estimates this was the most important component of the error identified by the CVS. It refers to that underenumeration which occurred because residents in households were missed altogether from the Census or because dwellings were misclassified as vacant. In England and Wales, the provisional estimated underenumeration total of 200,000 was composed of 122,000 occupied addresses missed or erroneously classified, 111,000 occupied addresses classified as vacant and 32,000 addresses double counted by more than one enumerator. The total was amended to 177,513 in the light of further evidence from the CVS.

Residents missed in responding households

This error relates to residents omitted from Census forms and amounted to 177,000 in England and Wales. In a few instances, non-residents had been counted as residents; in rather more cases, residents in private households had simply been missed.

Because of the small size of the CVS, only a crude geographical breakdown of the net undercount identified by the CVS for England and Wales was possible (inner London, outer London, metropolitan areas, non-metropolitan areas). In making adjustments to offset these errors exposed by the CVS for the provisional rebased estimates, the OPCS Population Estimates Unit (OPCS, 1992c) used the following procedures:

- * Over- or under-imputed households were distributed between constituent local authorities in England and Wales according to the total number of persons imputed within the Census resident count in each local area.
- * Missed or misclassified households were distributed in proportion to the number of dwellings found to be shared or converted in the 1991 Census. Use of the shared or converted dwellings variable did introduce variation between local authorities.
- * Persons identified by the CVS as missing in responding households were distributed evenly within each of the four district types used by the OPCS; i.e. pro rata within each individual age-sex group of Census residents aged 1-34.

In preparing the final and revised final estimates, OPCS used a disaggregation of the national estimates into six rather than four broad area types in order to distribute the first and third CVS components. Two of the estimates of underenumeration identified by the CVS for local authorities in Yorkshire and Humberside are presented in Table 2.2. Net over-imputation occurred in all local authorities with the result that for the region as a whole there was net over-imputation of 7,126. The estimates indicate that there were 15,720 persons missed in responding households.

Table 2.2: Undercount estimated by the CVS for absent households and missed residents in local authority areas, Yorkshire and Humberside, 1991

	Over- imputation	Persons missed in responding households
Bradford	-486	1728
Calderdale	-488	568
Kirklees	-636	1118
Leeds	-1038	3311
Wakefield	-397	547
West Yorkshire	-3045	7272
Barnsley	-253	336
Doncaster	-461	662
Rotherham	-296	274
Sheffield	-485	1905
South Yorkshire	-1495	3177
Humberside	-1292	2055
North Yorkshire	-1294	3216
Yorkshire & Humbs	-7126	15720
England & Wales	-115393	177513

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing steps

The other component of underenumeration identified by the CVS, arising from missed or misclassified dwellings, was distributed to local areas using the same method as that for distributing the under-enumeration of those aged 1-44 (see below).

Errors due to the underenumeration of visitors omitted from the usual resident count

About 200,000 people were estimated to have been enumerated as Census visitors who were either omitted from residents at usual addresses in England and Wales which they provided, or who gave no identifiable usual address. These people were not identified in the provisional rebasing procedure.

Errors due to the underenumeration of infants

An adjustment was required for infants aged less than one year omitted from Census forms. This is simply the difference between the rolled forward mid-1991 estimate for those aged less than one year (based largely on births and infant deaths in the previous year) and the Census count of infants aged less than one year. In England and Wales, the total underenumeration of infants was 21,000 or 2% of total underenumeration.

Errors due to the underenumeration of the armed forces and their dependants

Military personnel and their dependants are known to be underenumerated by population censuses in GB, due partly to absent residents in communal establishments such as barracks. The adjustment procedure for the armed forces involved uprating the numbers recorded in the Census according to totals available from the Ministry of Defence (MoD). Enhancements totalling 42,000 were made to Census residents in all areas containing armed forces bases.

Errors due to the underenumeration of elderly residents

The number of pensioners aged 80 and over who receive a pension from the Department of Social Security has been used to correct the Census resident count for the very elderly. This added a further 62,972 to the population of England and Wales.

The adjustments for infants, the military and the elderly in Yorkshire and Humberside are presented in Table 2.3. The most significant addition is of 1,580 armed forces personnel and their dependents to North Yorkshire of which 1,550 were allocated to the district of Richmondshire.

Errors due to the underenumeration of people 1-44

A comparison of the age-sex structure of the 1991 Census population with the population estimates rolled forward from 1981 suggested that a substantial number of people had been missed by both the Census and the CVS. The CVS, infant and armed forces adjustments accounted for only an estimated 40% of total underenumeration in the provisional rebased estimates and OPCS indicated that there were a further 572,000 people that needed to be adjusted for. This total underenumeration was referred to as the 'unexplained' underenumeration and it was argued that the group of people missed was mainly concentrated in the age groups below 35 years, particularly young adult males. These shortfalls were considered to be broadly consistent with the hypothesis that it is amongst some younger adults that there would be those most prepared to disregard the legal obligation to be enumerated within the Census.

In the provisional rebasing procedure, OPCS therefore adjusted Census residents by sex and single year of age between 1 and 44 and at age 85+ so that they were the same as the rolled forward estimates. 'Boost' factors were created by which Census counts of residents were multiplied to allow for this underenumeration. This enhancement at each age group for males and females was distributed pro rata across local authority areas according to the numbers enumerated for that age-sex group in each local area, giving a total provisional unexplained underenumeration in Yorkshire and Humberside of over 55,000 (Stillwell, 1993).

Table 2.3: Infants, armed forces and elderly underenumeration estimates for local authority areas, Yorkshire and Humberside, 1991

	Infants	Armed forces & dependents	Elderly
Bradford	379	0	561
Calderdale	50	0	257
Kirklees	175	0	441
Leeds	433	0	868
Wakefield	87	0	298
West Yorkshire	1124	0	2425
Barnsley	73	0	236
Doncaster	124	0	289
Rotherham	86	0	242
Sheffield	270	0	697
South Yorkshire	553	0	1464
Humberside	206	0	1026
North Yorkshire	209	1580	1053
Yorkshire & Humbs	2092	1580	5968
England & Wales	21372	41883	62972

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing steps

The even distribution of the unexplained underenumeration became the focus of criticism. Simpson et al. (1993) suggested that, if it was reasonable to assume that the missing individuals were to be found in difficult areas to enumerate and where there was a higher propensity to ignore the legal obligation to be enumerated, then more rather than less variation between districts was likely to occur, but following the same geographical pattern as for those underenumerated that were found. In other words, unexplained Census

underenumeration would occur disproportionately in urban rather than rural areas. Evidence from birth registrations compared with those enumerated aged under one year suggested a 3% overall underenumeration which is much higher in many urban areas.

OPCS recognised that the pro rata allocation model was producing implausible sex ratios. The underenumeration of males appeared much greater than the underenumeration of females. Consequently OPCS have argued that:

"areas with too high a sex ratio should be allocated a smaller apportionment of this component of underenumeration whilst areas with an implausibly low sex ratio should be allocated a larger apportionment" (OPCS, 1993c).

The procedure adopted in the final and revised final rebasing was to group areas with similar socioeconomic characteristics together into 10 groups whose members could be expected to have similar levels of under-enumeration: inner London; outer London; main central metropolitan districts; other metropolitan districts; cities in non-metropolitan districts; industrial areas; districts with new towns; resort, port and retirement districts; urban and mixed urban/rural districts; and remoter mainly rural districts.

A revised sex ratio for each group was estimated by taking the mean percentage differences in 1971 and 1981 from the national figure and then applying this mean difference to the 1991 national sex ratios for a particular five year age group (Diamond, 1993). A set of simultaneous equations was then developed to determine the adjustment for each of the ten groups, resulting in a higher proportion of unexplained underenumeration being distributed to city areas and a lower proportion to rural areas.

This procedure was used to allocate the CVS underenumeration in responding households and visitors not recorded as usual residents as well as the unexplained underenumeration. The OPCS spreadsheet of rebased estimates refers to the total as 'filling gap' and the estimates for Yorkshire and Humberside local authority areas are presented in Table 2.4 (column 5). A total of 109,102 persons was distributed between the local authority areas in the region. Table 2.4 provides a summary of the adjustments for underenumeration used in the revised final population estimates. As expected, the most important adjustments occur in Leeds (4.0%), Sheffield (4.0%) and Bradford (3.8%). Overall, the adjustments raise the population of Yorkshire and Humberside by 2.6% from 4,836,500 to 4,963,900.

2.3 Adjustments for definition and time differences between Census and mid-year population estimates

In adjusting the Census figures to prepare the provisional rebased mid-1991 population estimates, OPCS have taken into account two further differences.

Allowance for students and boarding school pupils

Whilst a student's parental home has been treated as the usual residence for Census purposes, the mid-year population estimates are produced on the understanding that students are included at their term-time addresses. The 1991 Census contained a new question on

students' term-time addresses to enable the distinction to be made. In 1991, there were some 54,250 more students studying in England and Wales than went to study overseas.

Table 2.4: The adjustment of Census resident populations for underenumeration for Yorkshire and Humberside local authority areas, 1991

	Census persons (000)	CVS Under- (000)	Infants, Armed forces & elderly (000)	Filling gap (000)	Adjusted Census persons (000)	Difference (%)
Bradford	457.3	1.2	0.9	15.1	474.6	3.8
Calderdale	191.6	0.1	0.3	3.2	195.2	1.9
Kirklees	373.1	0.5	0.6	6.4	380.6	2.0
Leeds	680.7	2.3	1.3	23.5	707.6	4.0
Wakefield	310.9	0.2	0.4	5.4	316.8	1.9
West Yorkshire	2013.7	4.2	3.5	53.6	2075.0	3.0
Barnsley	220.9	0.1	0.3	3.7	225.8	1.9
Doncaster	288.9	0.2	0.4	4.9	294.4	1.9
Rotherham	251.6	0.0	0.3	4.3	256.2	1.8
Sheffield	501.2	1.4	1.0	17.4	531.0	4.0
South Yorkshire	1262.6	1.7	2.0	30.4	1296.7	2.7
Humberside	858.0	0.8	1.2	15.1	875.1	2.0
North Yorkshire	702.2	1.9	2.8	10.0	717.4	2.1
Yorkshire & Humbs	4836.5	8.6	9.6	109.1	4963.9	2.6
England & Wales	49890.3	62.1	126.2	923.9	51002.6	2.2

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing steps

Students and pupils within the Census resident figures for an area who had a term-time address outside the area were removed; those shown in the Census as having a term-time address within the area although their home addresses were elsewhere were added. These adjustments for local authority areas in Yorkshire and Humberside are indicated in Table 2.5. The result is an extra 14,728 individuals to the overall regional total. Leeds and Sheffield, with their large higher education institutions, each have their populations incremented by over 8,000 and Humberside, North Yorkshire, Bradford and Kirklees also have positive balances. The remaining districts were all net losers of students.

Table 2.5: Estimates of students and pupils removed and added to local authority areas, Yorkshire and Humberside, 1991

	Removed	Added	Balance
Bradford	-2544	2725	181
Calderdale	-1267	232	-1035
Kirklees	-2446	3066	620
Leeds	-3894	12529	8635
Wakefield	-1558	665	-893
West Yorkshire	-11709	19217	7508
Barnsley	-944	162	-782
Doncaster	-1569	350	-1219
Rotherham	-1391	65	-1326
Sheffield	-2661	10819	8158
South Yorkshire	-6565	11396	4831
Humberside	-5173	6687	1514
North Yorkshire	-8691	9566	875
Yorkshire & Humbs	-32138	46866	14728
England & Wales	-391749	445999	54250

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing procedure

Allowance for changes between 21 April and 30 June 1991

The 1991 Census was taken 10 weeks before the end of June and it was necessary, therefore, to make some allowance for the births, deaths and migrations taking place during this time interval. Whilst births and deaths adjustments come from the Registrar General's vital statistics, net migration adjustments come from the mid-1990 to mid-1991 migration estimates produced by OPCS in preparing the unpublished mid-1991 population estimates rolled forward from 1981. The adjustments used in preparing the rebased estimates have been calculated as 10/52 of the annual figures.

The natural change and net migration adjustments for Yorkshire and Humberside local authorities are presented in Table 2.6, adding a further 4,209 to the regional population total. Only in Calderdale was the adjustment negative.

Table 2.6: Estimates of natural change and net migration between 21 April and 30 June 1991 for local authority areas, Yorkshire and Humberside

	Natural change	Net migration	Overall adjustment
Bradford	566	53	619
Calderdale	79	-203	-124
Kirklees	329	-138	191
Leeds	506	453	959
Wakefield	216	69	285
West Yorkshire	1696	234	1930
Barnsley	169	-29	140
Doncaster	276	-151	125
Rotherham	203	-187	16
Sheffield	194	-106	88
South Yorkshire	842	-473	369
Humberside	579	29	608
North Yorkshire	100	1202	1302
Yorkshire & Humbs	3217	992	4209
England & Wales	33759	9347	43106

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing procedure

The results of the application of the student and timing allowances is to raise the population of Yorkshire and Humberside to 4,982,797 as indicated in Table 2.7. These provisional rebased mid-1991 population estimates have been compared with the estimates rolled forward from 1981. The difference for Yorkshire and Humberside shows the rebased mid-1991 figure to be some 13,000 under the rolled forward estimate (0.26%). The most appreciable differences in relative terms (Table 2.8) are to be found in North Yorkshire and Calderdale, where the rebased totals are 1.84% and 1.64% respectively below the rolled forward estimates. In Humberside and Kirklees, the rebased totals exceed the rolled forward estimates by 1.75% and 1.4% respectively.

Table 2.7: Revised final mid-1991 population estimates for local authority areas, Yorkshire and Humberside

	Census popn adjusted for underenum.	Students and pupils	Natural change & migration	Rebased mid-year population
Bradford	474.6	0.2	0.6	475.4
Calderdale	195.1	-1.0	-0.1	193.9
Kirklees	380.6	0.6	0.2	381.5
Leeds	707.6	8.6	1.0	717.4
Wakefield	316.8	-0.9	0.3	316.2
West Yorkshire	2075.0	7.5	1.9	2084.5
Barnsley	225.0	-0.8	0.1	224.4
Doncaster	294.4	-1.2	0.1	293.6
Rotherham	256.2	-1.3	0.0	254.9
Sheffield	521.0	8.2	0.1	529.3
South Yorkshire	1296.7	4.8	0.4	1301.9
Humberside	875.1	1.5	0.6	877.3
North Yorkshire	717.0	0.8	1.3	719.1
Yorkshire & Humbs	4963.9	14.7	4.2	4982.8
England & Wales	51002.6	54.3	43.1	51099.5

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing procedure

Table 2.8: Comparison of revised final mid-1991 population estimates with those rolled forward from 1981 for local authority areas, Yorkshire and Humberside

	Rebased mid-1991 estimates	Rolled forward estimates for mid-1991	Difference No %	
Bradford	475436	471575	3861	0.81
Calderdale	193982	197165	-3183	-1.64
Kirklees	381489	376161	5328	1.40
Leeds	717388	716769	619	0.09
Wakefield	316211	317216	-1005	-0.32
West Yorkshire	2084506	2078884	5622	0.27
Barnsley	224422	222269	2153	0.96
Doncaster	293302	294137	-853	-0.28
Rotherham	254926	254582	344	0.13
Sheffield	529268	525498	3770	0.71
South Yorkshire	1301918	1296486	5434	0.42
Humberside	877302	861986	15316	1.75
North Yorkshire	719071	732272	-13201	-1.84
Yorkshire & Humbs	4982797	4969628	13169	0.26
England & Wales	51099521	50903367	196154	0.38

Source: OPCS Population Estimates Unit (1993) Computer printout of rebasing procedure

There are implications from the foregoing discussion of underenumeration for analysis of Census results. According to OPCS (1992a), there are two particular circumstances in which it is necessary to make adjustments. The first situation is when absolute numbers are being used. In view of this, we have chosen to present the analysis of population change between 1981 and 1991 in Section 3 using mid-year estimates. The second situation is when studying Census characteristics which depend strongly upon age and sex and where comparisons might be slightly distorted by the known age-sex bias in the missing 2%. OPCS suggest that the user can check for this distortion and, if necessary, correct for it by making some adjustments for the relevant age-sex groups using the boost factors indicated in OPCS (1993d, pp. 15-16).

3. POPULATION CHANGE, 1981-91

As identified in the previous section, the OPCS mid-year population estimates for an individual local authority area include all members of the resident population, whatever their nationality, together with members of HM and non-UK armed forces stationed within the area as well as students assumed to be resident at their term-time address.

3.1 Aggregate population change and its components

The mid-year population estimates (Table 3.1) show an increase of 64,400 or 1.3% from 4,918,448 in 1981 to 4,982,797 in 1991 for Yorkshire and Humberside in comparison with a 2.9% increase in England and Wales as a whole. This increase comprised a rise of 2% in the male population and a rise of 0.7% in the female population.

Table 3.1: Population change by local authority area, Yorkshire and Humberside, 1981-91

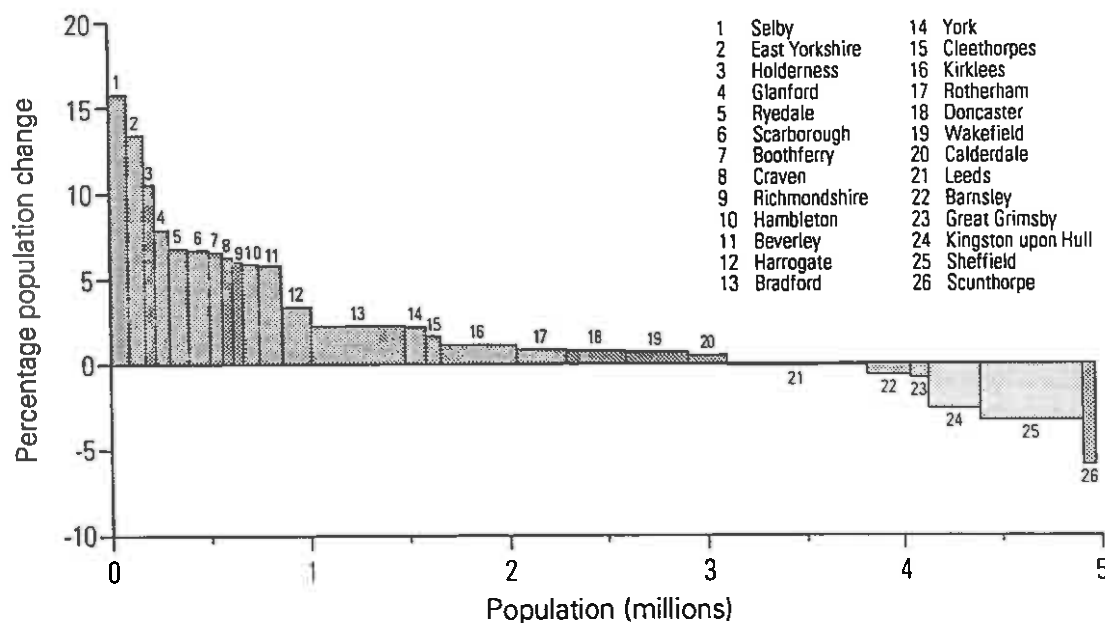
	Revised final estimates		Change		Natural	Net
	1981	1991	1981-91	(%)	change	migration
	(000)	(000)	(000)		(000)	(000)
Bradford	464.9	475.4	10.5	2.3	18.7	-8.2
Calderdale	192.9	194.0	1.1	0.6	1.0	0.1
Kirklees	377.1	381.5	4.4	1.2	7.4	-3.0
Leeds	717.9	717.4	-0.5	-0.1	9.5	-9.6
Wakefield	314.1	316.2	2.1	0.7	6.8	-4.7
West Yorkshire	2066.9	2084.5	17.6	0.8	43.3	-25.8
Barnsley	225.8	224.4	-1.4	-0.6	3.0	-4.4
Doncaster	290.9	293.3	2.4	0.8	9.0	-6.6
Rotherham	252.7	254.9	2.2	0.9	7.8	-5.6
Sheffield	547.8	529.3	-18.5	-3.3	-6.2	-12.3
South Yorkshire	1317.1	1301.9	-15.2	-1.1	13.6	-28.8
Humberside	857.7	877.3	19.6	2.3	14.9	4.7
North Yorkshire	676.7	719.1	42.4	6.3	-6.7	49.1
Yorkshire & Humbs	4918.4	4982.8	64.4	1.3	65.1	-0.7

Notes: (i) Figures may not sum exactly due to rounding

(ii) Net migration figures for Bradford include loss of population (-0.1) and for North Yorkshire include population gain (0.1) due to boundary change

Source: OPCS (1993a; 1993b)

The spatial variation in aggregate population change between districts (Figure 3.1) is emphasised by comparing the losses sustained by the region's major cities of Leeds, Hull and Sheffield and the gains evident in all the rural districts of North Yorkshire and several of those in Humberside, with the particular exception of Scunthorpe, whose fall in population over the decades was the most marked of all the region's districts. The principal growth areas were in the east of the region with the districts of East Yorkshire, Holderness and Selby recording increases of 10% or more. There was also a consistent pattern of steady growth across the whole of North Yorkshire. Without exception, such increments were the result of district net in-migration, in many cases more than compensating for natural decreases. Many urban districts suffered population losses with Sheffield worst affected. However, those that experienced substantial natural increases, such as Bradford, Doncaster and Kirklees, were able to offset the impact of net out-migration resulting in relatively small scale growth overall.



Source: OPCS (1993)

Figure 3.1: Percentage population change by metropolitan and shire district, Yorkshire and Humberside, 1981-91

At the county level (Table 3.1), the urban influence resulted in a marginal increase in West Yorkshire, in contrast to an overall decline in South Yorkshire. North Yorkshire recorded the highest growth rate whilst the lower rate for Humberside reflected the more rural districts gaining at the expense of Grimsby, Hull and Scunthorpe.

3.2 Population change by gender and quinary age group

The changes in total population between 1981 and 1991 conceal considerable growth or reduction in quinary age populations across the region as a whole (Table 3.2) as five year birth cohorts of different size progress through the age structure.

Table 3.2: Population change by age and gender, Yorkshire and Humberside, 1981-91

	1981		1991		1981-91 change	
	Male (000)	Female (000)	Male (000)	Female (000)	Male (%)	Female (%)
0-4	152.6	145.0	172.8	164.4	13.2	13.4
5-9	167.3	158.0	163.8	154.4	-2.1	-2.3
10-14	206.2	195.5	154.0	144.9	-25.3	-25.6
15-19	209.9	203.0	168.6	159.4	-19.7	-21.2
20-24	189.9	184.6	207.3	195.2	9.2	5.8
25-29	165.9	160.7	210.3	196.6	26.8	22.3
30-34	182.5	178.6	183.3	177.5	0.5	-0.6
35-39	153.7	150.1	161.9	158.8	5.4	5.8
40-44	139.5	137.6	179.5	177.1	28.7	28.7
45-49	135.0	134.3	148.4	146.9	9.9	9.4
50-54	136.6	139.6	132.0	132.9	-3.4	-4.8
55-59	142.8	147.0	124.5	128.5	-12.8	-12.6
60-64	122.4	136.4	119.6	130.1	-2.3	-4.7
65-69	111.3	136.1	114.4	130.8	2.8	-3.9
70-74	87.6	122.6	85.6	112.5	2.4	-8.2
75-79	54.7	95.9	62.3	99.2	13.7	3.5
80-84	25.2	59.8	35.8	73.3	41.8	22.5
85+	11.6	38.6	17.6	58.6	51.6	51.6
Total	2395.0	2523.5	2441.6	2541.1	2.0	0.7

Source: Mid-year estimates from NOMIS

The age group which had the largest decrease from 1981 to 1991 was the 10-14 year old group with both male and female populations falling by over 25%. Consistent with the nation having an increasingly ageing population, the largest increases were for those aged 80 and over, with increases of 42% and 23% for the 80-84 year old males and females and growth of over 50% of men and women aged 85 and over.

There were also large relative increases in two other age groups. The 25-29 year olds increased by nearly 25% and the 40-44 year olds increased by nearly 29%. Males and females followed a similar pattern of increases and decreases throughout the age structure with the most marked differences being in the older age categories of 70 and above. Here it can be seen that the elderly male population increased more rapidly than females of the same age.

Some geographical variations in age-specific population changes are evident in Yorkshire and Humberside although, as Figure 3.2 indicates, the major percentage falls in the teen ages and the main increases in the 25-29, 40-44 and 80+ ages occurred with equal magnitude across all the local authorities. The decline of the population aged 5-19 will mean a smaller number of entrants to the labour market during the next decade. Spatial variations occurred in other age groups. Doncaster was the only area to experience a fall in 20-24 year olds, whereas Sheffield's population aged 35-39 and Bradford's population aged 45-49 both fell whilst populations of similar age increased elsewhere. North Yorkshire was the only area to experience an increase in 50-54 year olds. Whilst the 55-59 year old populations of all local authority areas declined during the 1980s, greater variation in population gains and losses were evident for the younger elderly than for the very old (80+) whose increase was manifest in each area.

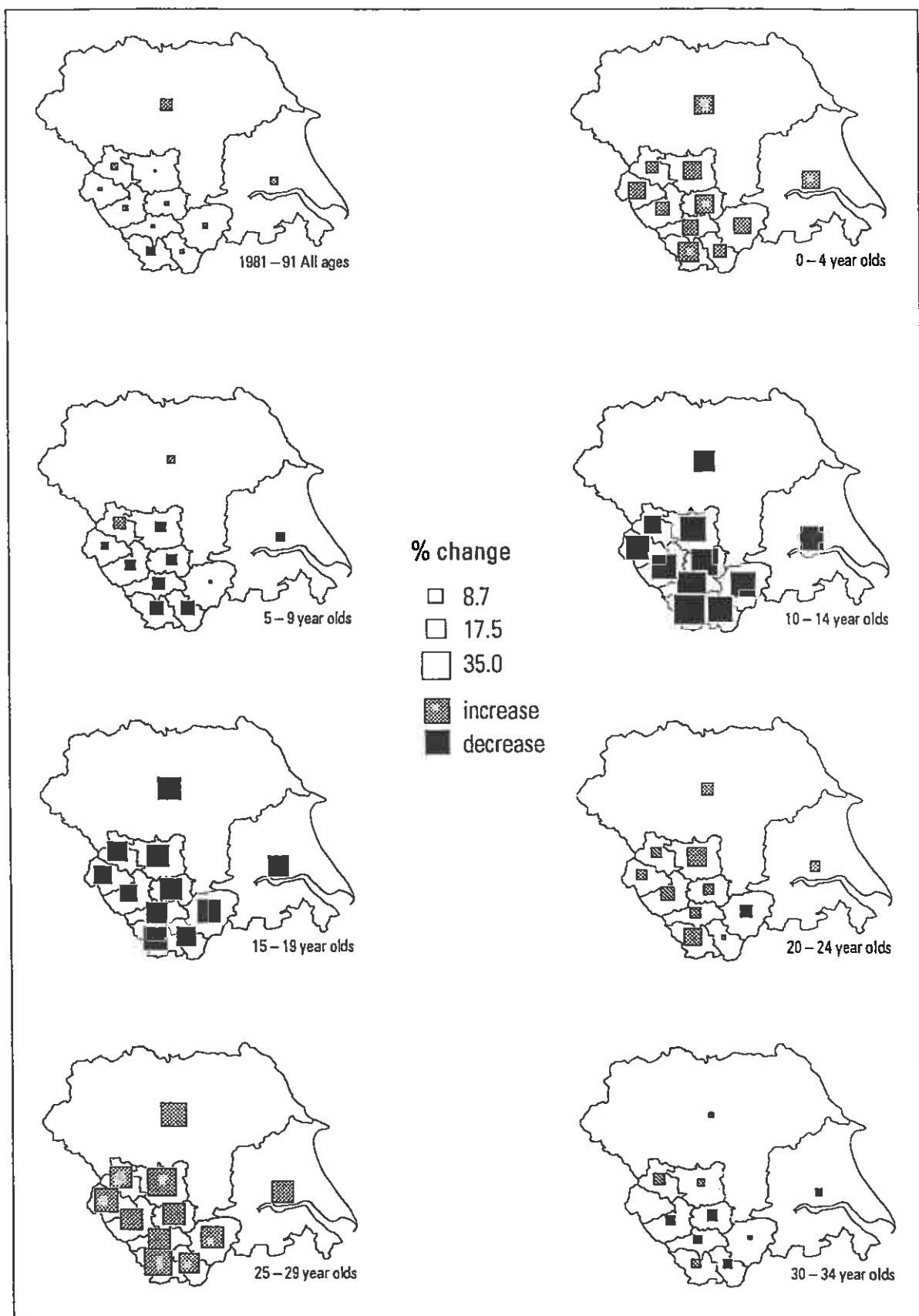


Figure 3.2: Percentage population change by quinary age group, local authority areas in Yorkshire and Humberside, 1981-91

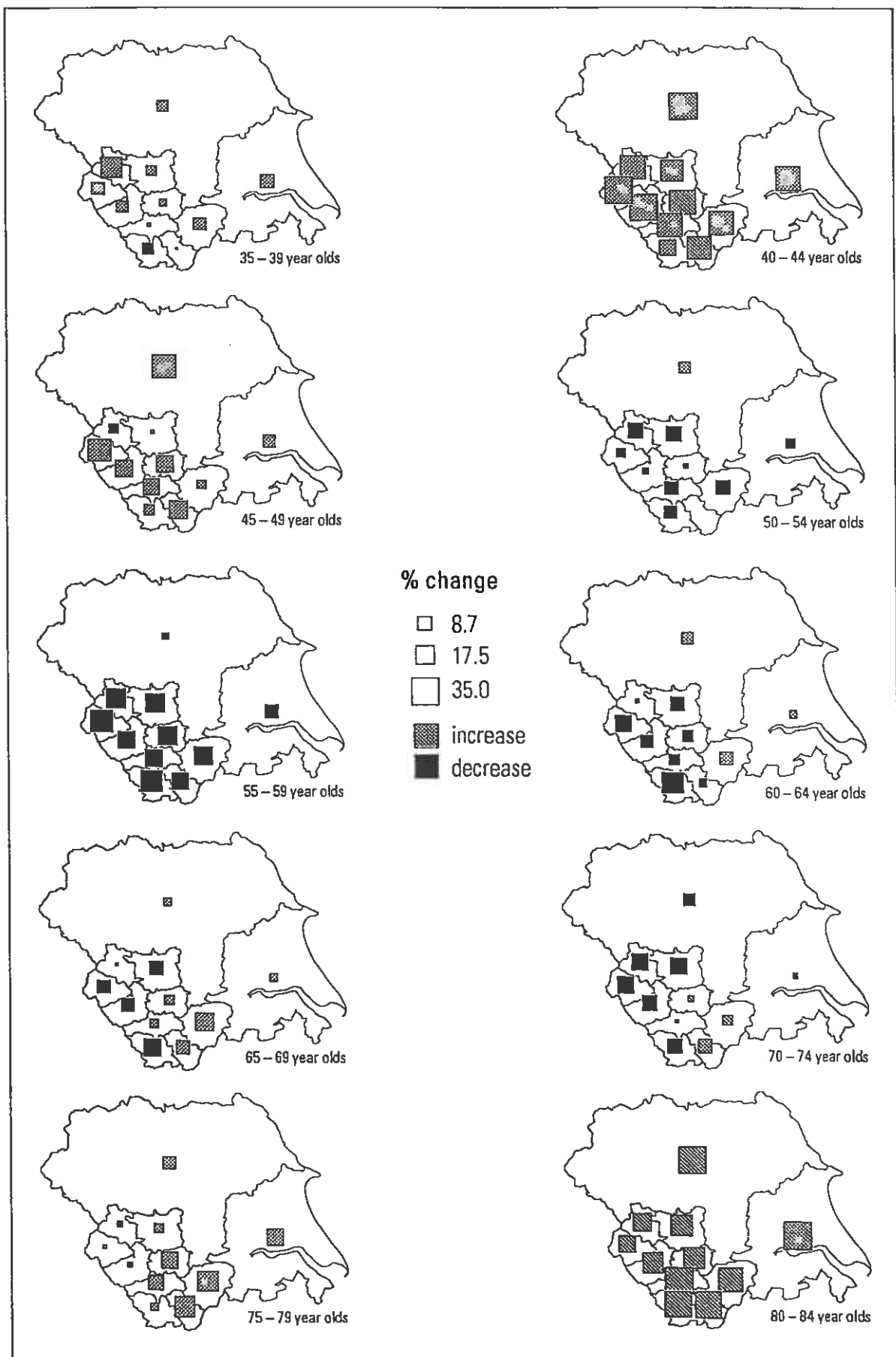


Figure 3.2: Continued

4. ANALYSIS OF POPULATION PROJECTIONS AND MIGRATION

4.1 The 1989-based population projections

The 1989-based population projections to mid-2011 supplied by the DoE were for quinary age group totals for males and females for each of the projection years. In addition, the DoE supplied population projections by broad age group (0-16, 17-28, 29-59 and 60+) for mid-1989, mid-1991, mid-1996, mid-2001, mid-2006 and mid-2011. This section of the paper outlines some of the characteristics of change in the region's population as indicated by the 1989-based OPCS/DoE projections.

The 1989-based projections of total population for local authority areas to 2011 in Yorkshire and Humberside are summarized in Table 4.1 and show that the region is forecast to grow by 1.8% between 1991 and 2001 and by only 0.5% during the subsequent decade. The metropolitan districts of Bradford, Calderdale, Wakefield and Doncaster show projected percentage increases diminishing in size between the 1990s and the 2000s. Kirklees, Leeds

Table 4.1: 1989-based population projections by local authority area, Yorkshire and Humberside, 1991-2011

	1989	1991	1996	2001	2006	2011	1991- 2001 (%)	2001- 2011 (%)
	(Thousands)							
Bradford	467.7	470.6	479.6	488.6	495.9	502.6	3.8	2.9
Calderdale	197.4	198.8	202.0	205.0	207.6	209.9	3.1	2.4
Kirklees	375.6	374.9	373.8	372.7	370.7	368.6	-0.6	-1.1
Leeds	711.7	711.3	710.9	711.2	709.8	707.4	-0.0	-0.5
Wakefield	314.2	315.2	317.9	319.7	320.3	320.5	1.4	0.3
West Yorkshire	2066.6	2070.8	2084.2	2097.2	2104.3	2109.0	1.3	0.6
Barnsley	221.7	222.0	222.8	222.9	222.4	221.6	0.4	-0.6
Doncaster	293.3	294.9	298.7	301.4	303.0	304.2	2.2	0.9
Rotherham	253.6	254.7	252.5	259.1	259.3	258.9	1.7	-0.1
Sheffield	526.6	523.0	515.9	510.4	504.5	498.4	-2.4	-2.4
South Yorkshire	1295.2	1294.6	1294.8	1293.8	1289.2	1283.2	-0.1	-0.9
Humberside	856.3	860.9	869.9	875.2	876.0	874.1	1.7	-0.1
North Yorkshire	722.3	732.8	759.3	782.3	798.1	808.1	6.8	3.3
Yorkshire & Humbs	4940.3	4959.0	5008.2	5048.4	5067.6	5074.3	1.8	0.5

Source: DOE (Regional Office) Computer printout of 1989-based projections

and Sheffield on the other hand, are shown to have declining populations, with the percentage fall increasing in the case of the two West Yorkshire authority areas. Barnsley and Rotherham are set to experience a change from slow growth in the 1990s to declines in the following decade; Humberside likewise. In contrast, North Yorkshire is forecast to experience a 6.8% growth in population during the 1990s which diminishes to 3.3% in the following decade.

Separate projections for total male and female populations can be compared relative to one another using a time series index in which the 1989 population base is set equal to 100 and projections each year ahead are calculated as a percentage of this base figure. The time series indices for projections from mid-1991 to mid-2011 for counties and for Yorkshire and Humberside are presented in Figure 4.1. At the county scale, the figures emphasise the relative population growth prospects of North Yorkshire. At the metropolitan district scale, the projected growth in population of Bradford and Calderdale contrasts with the projected decline of Sheffield's population and the stability of population change in Barnsley.

Time series indices can also be used to indicate the relative magnitude of changes that are projected to take place in the age structure of male and female populations from 1989. Figures 4.2 and 4.3 illustrate the relative changes in population from 1989 in the region, in the four counties, and in the metropolitan districts of South Yorkshire and West Yorkshire respectively by the four broad age groups: under 16, 17-28, 29-59 and 60+ that are used by OPCS/DoE in the projection methodology. Similar patterns are evident in each set of schedules.

The trend over time for the 0-16 age group is to increase from the 1989 base to a peak (in 2001 in most cases) and thence decline. Humberside and North Yorkshire illustrate the most extreme cases. Humberside has only a very small gain to 1996 and falls thereafter, whereas North Yorkshire is projected to increase its 0-16 year old population by 15% by 2001.

Significant declines are projected to occur in the younger working age populations in all local authority areas. In Sheffield, in particular, the 17-28 year old population in 2001 is projected to be less than 75% of its size in 1989, with only a marginal upturn by 2011. Large gains in populations aged 29-59 are projected in all local authority areas in the region by 2001. Relative gains are most noticeable to 2011 in Bradford. Male and female schedules for this age group are similar in all local authority areas apart from North Yorkshire, where a more substantial increase in females is projected.

The most significant variation between local authority areas and between males and females is apparent in the 60+ age range. Very significant increases are set to occur in North Yorkshire in both male and female populations from 1989 onwards, whereas in the West Yorkshire districts and Sheffield, the numbers of women aged 60+ are projected to decline during the 1990s.

Local authorities use population projections such as these for a number of uses: in the assessment of housing need for development planning; in the assessment of employment need for economic development strategies; in the assessment of pupil numbers for education planning; in the assessment of the demand for social services; in the assessment of the

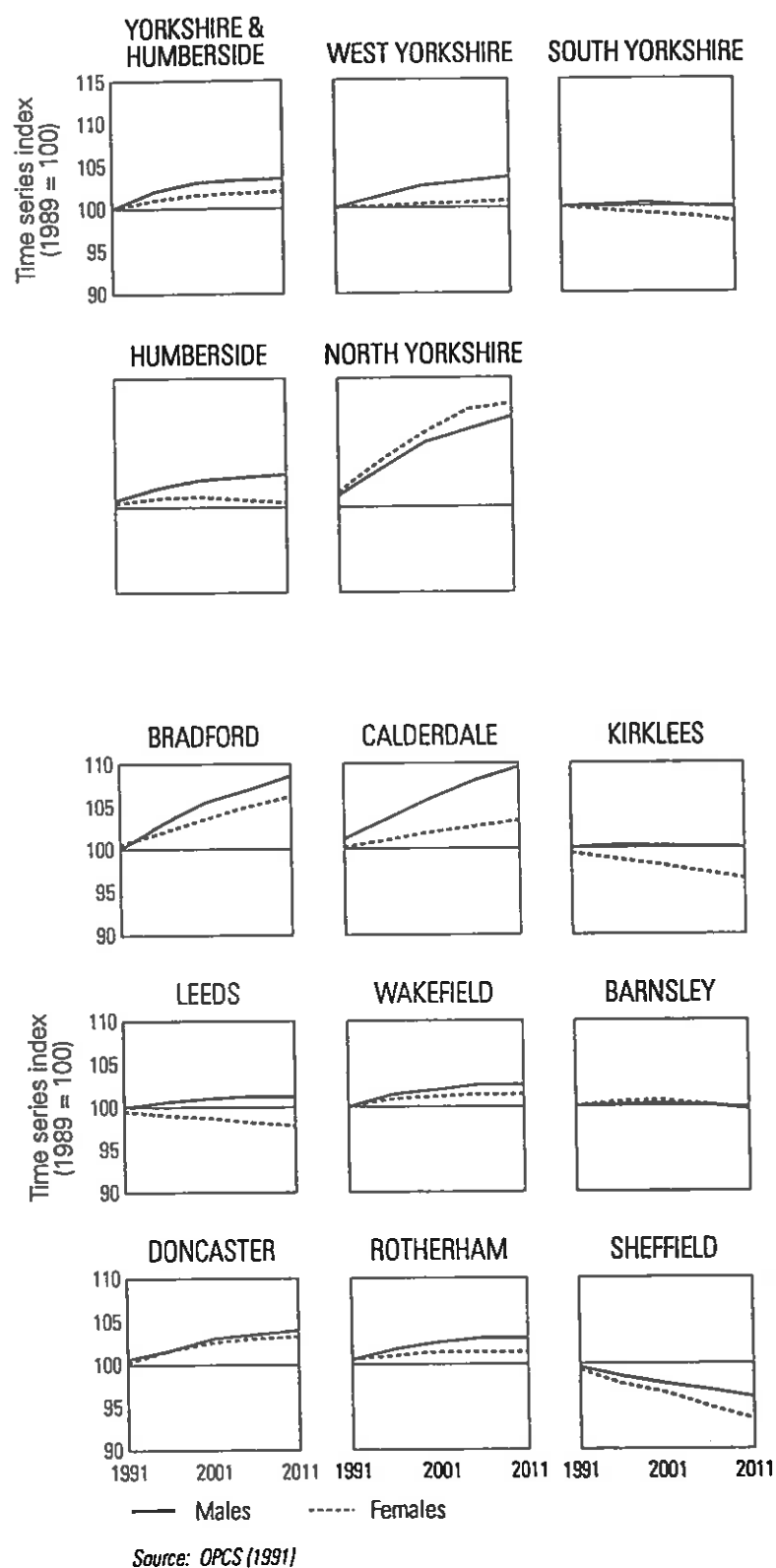


Figure 4.1: Population projections, 1989-2011, time series indices by county and metropolitan district

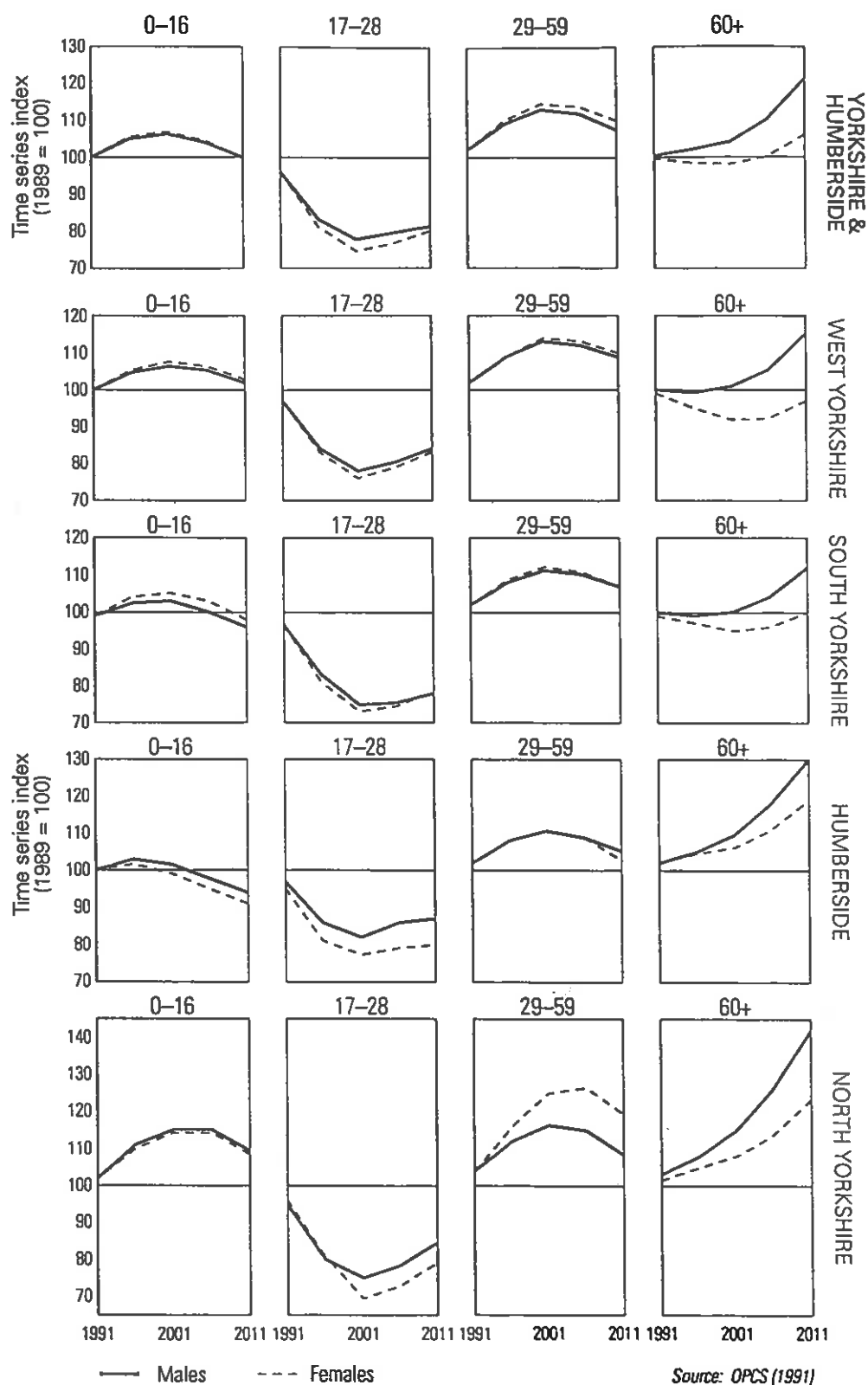


Figure 4.2: Population projections, 1989-2011, time series indices for counties by gender and broad age group

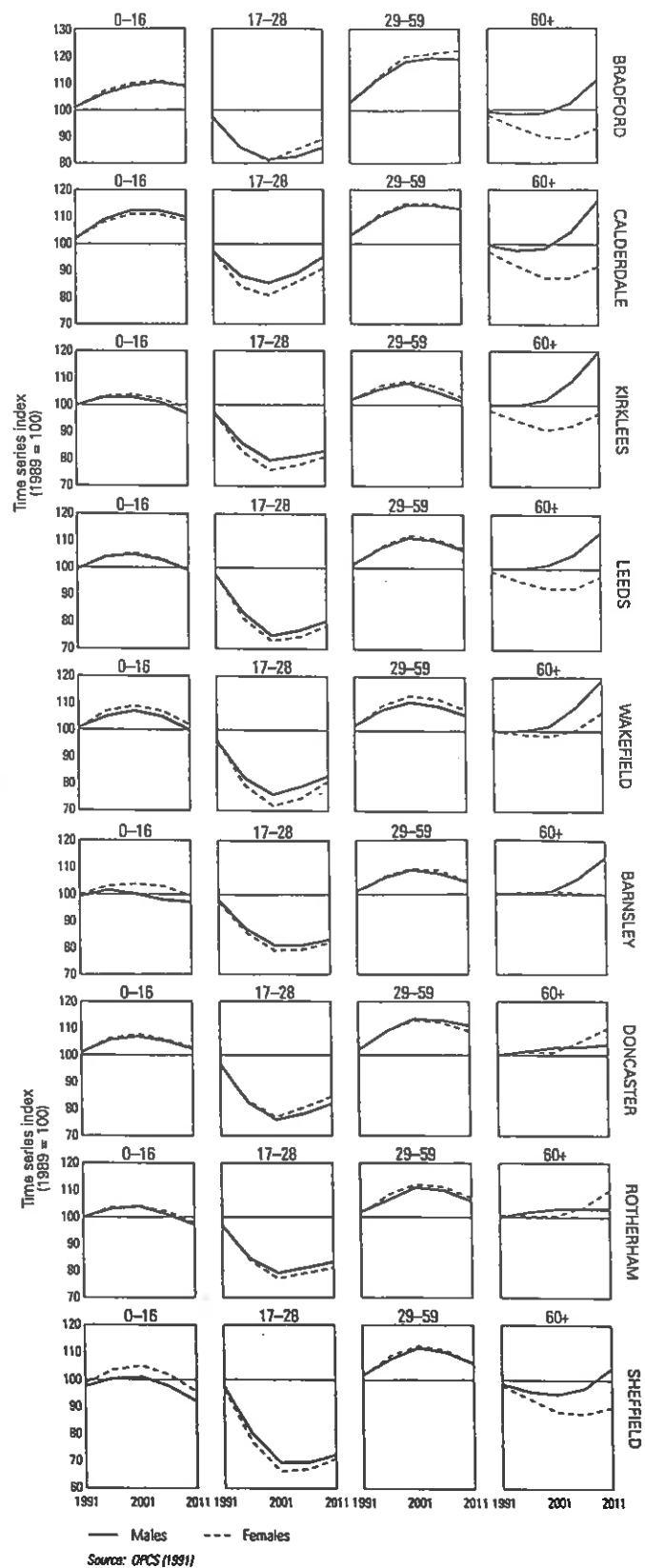


Figure 4.3: Population projections, 1989-2011, time series indices for metropolitan districts by gender and broad age group

budget by the Treasurer; in the validation of the local authority's own projections; to assist policy reviews; and for responding to general requests for information internally and externally.

However, most local authorities in Yorkshire and Humberside do not accept the 'official' OPCS/DoE projections and have expressed concern about the components of the projections, including the base populations, the natural change assumptions, the internal (within England) net migration assumptions and the external (outside England) net migration assumptions. The results of a consultation exercise with each of the local authorities, reported by the Yorkshire and Humberside Regional Research Observatory (1993), indicates that local authorities were most concerned with the base population estimates and the internal migration assumptions. Consequently, attention is this paper on the two analyses based on comparing these projections/assumptions against observed data and identifying a method of adjusting the 'official' projections to take into account recent change.

4.2 Evaluation of the 1989-based population projections for 1991

An assessment of the 1989-based population projections can be made by comparing the projections for mid-1991 with the revised final mid-1991 population estimates rebased from the Census as discussed in Section 2 of the paper.

Two sets of aggregate populations and their differences are presented in Table 4.2 where underprojections are represented as negative values and overprojections as positive values. The figures indicate that for Yorkshire and Humberside as a whole, there is an underprojection of 23,800. Although this is only a difference of 0.5%, the total conceals wider variations between local authorities.

In West Yorkshire, the rebased estimate for Calderdale is 2.4% above the projected population, whereas for the remaining districts, there is underprojection. In South Yorkshire, only Doncaster has been overprojected. Rotherham's projection conforms most precisely with the rebased estimate. At the county scale, the largest inconsistencies in absolute terms are found in Humberside, whose population has been underprojected by 16,400. The population of North Yorkshire, on the other hand, appears to have been overprojected. The comparison reveals that an aggregate underprojection of 37,400 in West Yorkshire, South Yorkshire and Humberside has been offset by the overprojection of 13,600 in North Yorkshire.

However the figures reported in Table 4.2 are the aggregates of estimates and projections calculated for males and females by quinary age group. The comparative analysis is extended by examining the absolute differences between the mid-1991 estimates and the projections of populations disaggregated by age group and gender (Figure 4.4).

The graphs indicate a number of interesting features:

- * there is considerable variation between local authorities in the extent to which differences vary by age;

- * the variations by age for males tend to be similar to the variations by age for females;
- * in the major cities of Leeds and Sheffield, there appears to be appreciable underprojection of those aged 20-24 (and those aged 25-29 to a lesser extent) and overprojection of those aged 35-49;
- * the aggregate underprojection for Humberside is accounted for by underprojection in all age groups except 10-14, 45-49 and 85+; and
- * in North Yorkshire, most overprojection is apparent in the age groups 20-39, with underprojection in most of the older age groups.

Table 4.2: Comparison of final rebased estimates and 1989-based projections of population for mid-1991 for local authority areas, Yorkshire and Humberside

	1991 population		Difference	
	Final rebased estimate	1989-based projection		
	(000)	(000)	(000)	(%)
Bradford	475.4	470.6	-4.8	-1.0
Calderdale	194.0	198.8	4.8	2.4
Kirklees	381.5	374.9	-6.1	-1.8
Leeds	717.7	711.3	-3.1	-0.9
Wakefield	316.2	315.2	-1.0	-0.3
West Yorkshire	2084.5	2070.8	-13.7	-0.6
Barnsley	224.4	222.0	-2.4	-1.1
Doncaster	293.3	294.9	1.6	0.5
Rotherham	254.9	254.7	-0.2	-0.1
Sheffield	529.3	523.0	-6.3	-1.2
South Yorkshire	1301.9	1294.6	-7.3	-0.6
Humberside	877.3	860.9	-16.4	-1.9
North Yorkshire	719.1	732.7	13.6	1.9
Yorkshire & Humberside	4982.8	4959.0	-23.8	-0.5

Notes:

- (i) Negative differences represent underprojection
- (ii) Positive differences represent overprojection

The explanation of these differences is likely to vary between local authorities and may be a combination of a variety of factors including fluctuations in births, deaths and migrations between 1989 and 1991. However, consultations with particular local authorities suggest that there are two situations involving particular population subgroups in which the 1989 base year populations are felt to be inaccurate and are consequently likely to be responsible for a significant proportion of the differences.

The first case involves the differences associated with age groups 20-49 in the cities of Leeds and Sheffield. There is an underprojection in the 20-24 age group which is likely to be due in part to the underprojection of students. However, OPCS includes students within the cohort that is rolled forward from 1981 to produce the 1989 population base. Students are therefore assumed to remain in the cohort and to behave demographically in a manner equivalent to the rest of the population in those age groups. Because of the relatively high fertility and propensity to form households of this age group, the inclusion of students may have a distorting effect on estimates of the population in 1989, thus causing part of the overprojection identified in Figure 4.4.

The second case is the particular situation in North Yorkshire where considerable overprojection is evident in the age range 20-39, especially for males. This overestimation may be explained in part as the cumulative effect of rolling forward a mid-1981 population which so happened to contain half a battalion of around 500 military personnel together with their dependants returning from Germany. The application of survival, fertility and migration rates to this sub-cohort grosses up the numbers quite considerably by 1989.

There are also problems with the estimation of the institutional population in North Yorkshire. This is particularly relevant to the Richmondshire district where it constitutes approximately 25% of total population. OPCS figures only cover establishments containing 50 or more persons; all others are included in the private household population. Military personnel living in married quarters are thus counted in the private household population and are rolled forward within their respective age groups by OPCS in the usual way. This is, therefore, a further source of overprojection since such families typically tend to stay for relatively short periods and are replaced by people of the same age group.

The specific problems associated with students and armed forces are a central feature of the dissatisfaction that the relevant local authorities in Yorkshire and Humberside express about the 1989-based projections and the base population estimates upon which these projections are built. These problems are among the reasons why the local authorities concerned are unable to accept OPCS/DoE projections and feel the need to generate projections which make use of local assumptions.

NYCC collects local information on institutional populations by means of an annual survey of all establishments with four or more residents, using the Census definition with respect to the provision of some form of communal catering. The survey excludes sheltered housing but includes married quarters of the military. New establishments are tracked via planning applications and the electoral register. The survey also enables the identification of wards in the military garrison areas so that adjustments can be incorporated into projections for areas within the county to allow for lower rates of natural increase in such areas.

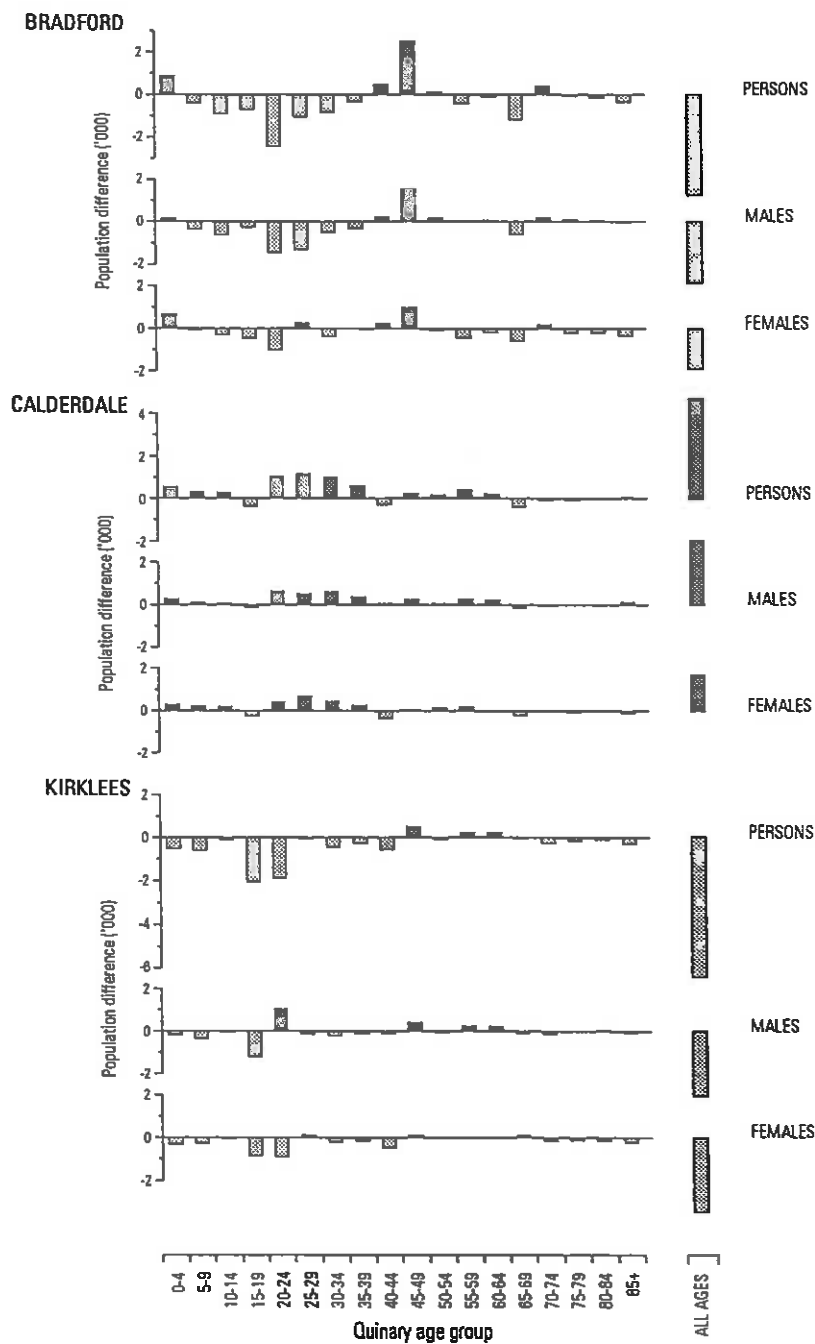


Figure 4.4: Differences between the 1989-based population projections and the final rebased estimates for mid-1991

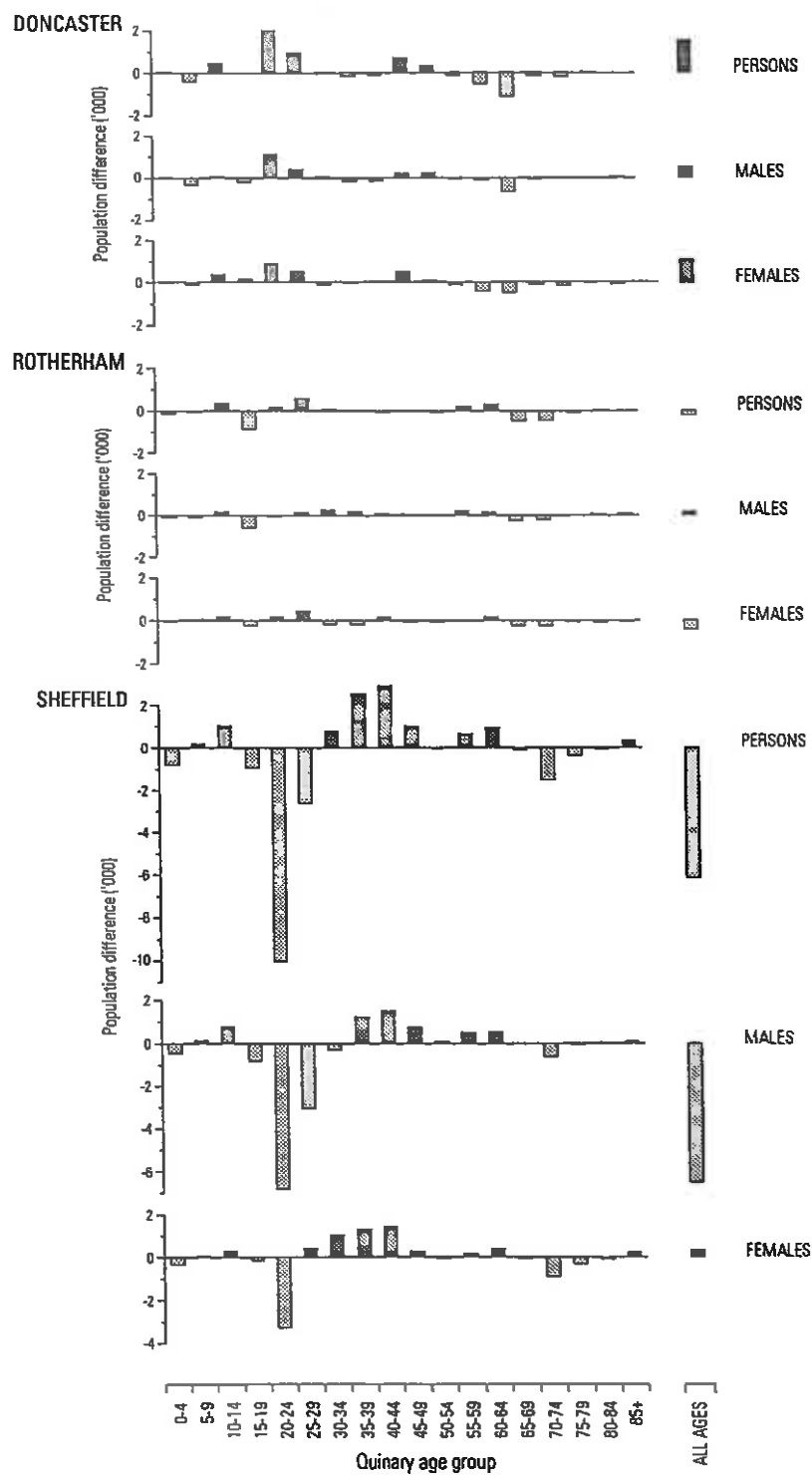


Figure 4.4: Continued

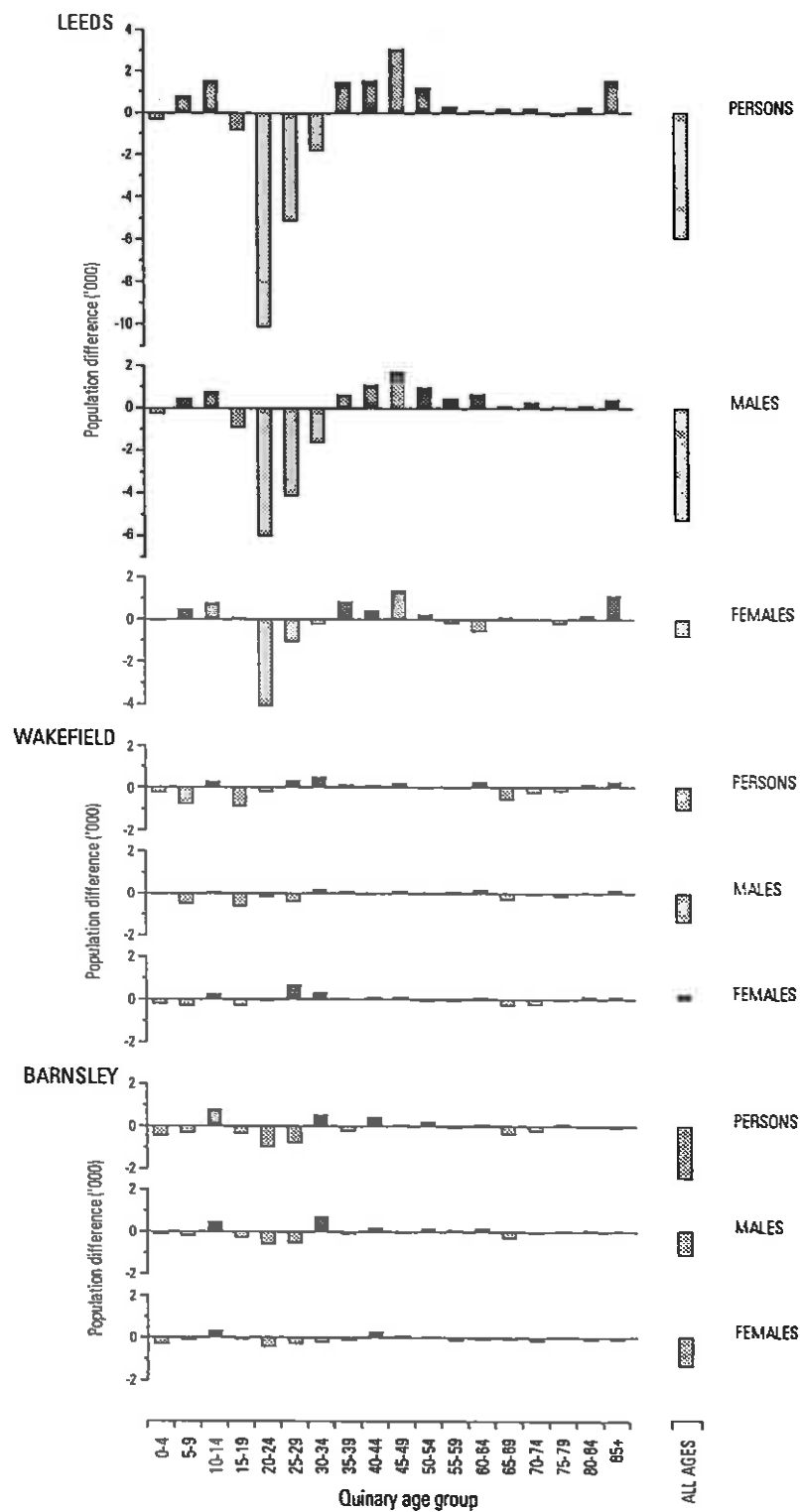


Figure 4.4: Continued

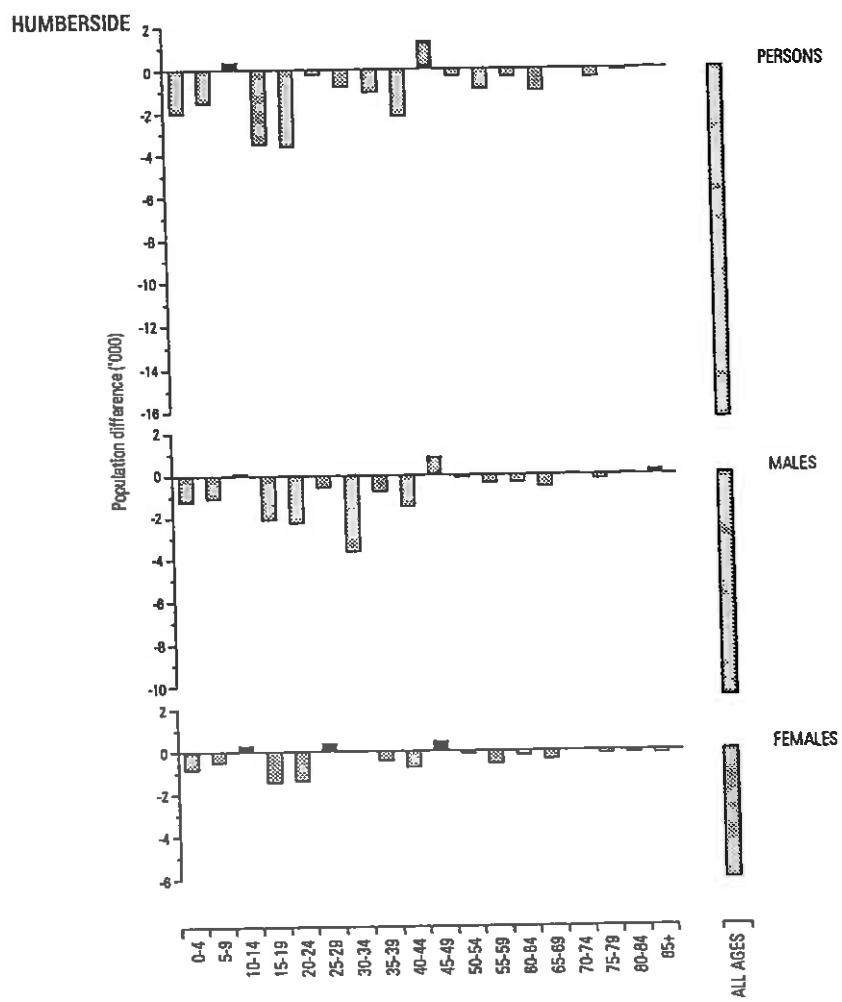


Figure 4.4: Continued

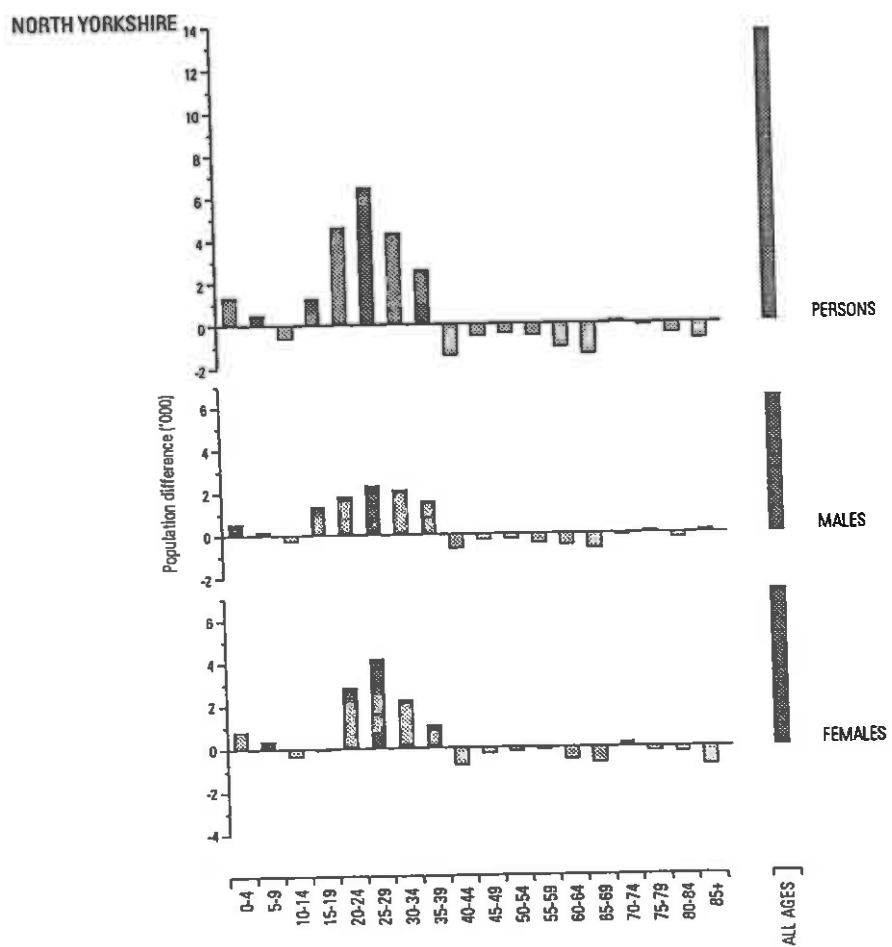


Figure 4.4: Continued

The results outlined in this section provide supporting evidence for the existence of inaccuracies in the populations upon which the 1989-based projections are founded. This suggests that OPCS should look closely at the current treatment of students and institutional populations in the mid-year population estimation procedures and should seek to utilise more local information on particular sub-groups that local authorities would be able to provide.

4.3 Evaluation of net internal migration assumptions for 1989-92

A second contentious issue relating to the 1989-based population projections is that which concerns net migration flows between local authority areas and the rest of England - the so-called 'internal migration' assumptions whose derivation is explained in more detail in an Appendix.

A number of local authorities in Yorkshire and Humberside have expressed disquiet that the 1989-based net migration assumptions do not reflect current trends in migration. It is unfortunate that the 1991 Census LBS data currently available does not provide any information on out-migration and consequently prevents the net migration assumptions for the period from mid-1990 to mid-1991 being compared with Census-based net migration balances for the 12 months prior to the Census.

NHSCR patient reregistrations

Over the past 25 years, OPCS has developed a system for reporting the reregistration of patients between the areas used to administer the general practitioner services of the National Health Service (NHS). The NHS Central Register (NHSCR) is now recognised as an increasingly valuable source of information about population redistribution between Family Health Service Authorities (FHSAs), particularly since the register is continuously updated and data is available on a quarterly basis. FHSAs in Yorkshire and Humberside are equivalent to the two shire counties and the nine metropolitan districts.

The characteristics of this data set have been fully reported in Stillwell et al. (1992) but it is worthwhile reiterating the fact that the NHSCR records a count of migration events (moves) whereas the Census records a count of the number of persons migrating (migrants). Similarly, the shortcomings of the data set such as the omission of short-distance moves across FHSA boundaries where no reregistration takes place or the undercounting of young adult males are now well documented (Devis and Mills, 1986; Bulusu, 1992) but OPCS/DoE nevertheless recognise the utility of the data set in the procedures for population estimation and projection.

Over the course of several years, an annual mid-year to mid-year time series of NHSCR moves between FHSAs has been assembled in the School of Geography at the University of Leeds. The analysis reported here draws on the data that has been supplied over a number of years and has recently been incorporated into an information system which provides easy and flexible access (Duke-Williams and Rees, 1993; Stillwell, Duke-Williams and Rees, 1993). A consistent set of data has been compiled from computer summaries of a 10%

sample of reregistrations from 1975 to 1983 and from 100% primary unit data (PUD) for subsequent years up to the middle of 1992.

Comparison of NHSCR data with net assumptions

The NHSCR data can be used as a basis against which to compare the net migration assumptions used by the OPCS/DoE. Totals of out-migration to, in-migration from and net migration with the rest of England by broad age group have been provided by DoE for the years ending mid-1989, mid-1991, mid-1996, mid-2001, mid-2006 and mid-2011, together with all ages totals of net migration to or from outside England.

A comparison of 'observed' NHSCR net movements for the period from mid-1989 to mid-1992 with the aggregation of the net migration assumptions for the three corresponding years is contained in Table 4.3. This comparison suggests that in all metropolitan districts, with the exception of Rotherham, the 1989-based net migration assumptions provide larger net losses than those recorded by the NHSCR data. Where net migration gains are evident in Humberside and North Yorkshire, the NHSCR suggests a slightly lower gain than the assumptions. The conclusion is that the metropolitan districts of Yorkshire and Humberside are not suffering migration losses in the early 1990s on the scale forecast by the 1989-based projections.

4.4 Migration trends

The great value of the NHSCR data is that it can be used to monitor migration trends on a quarterly or annual basis and thus be used to track fluctuations in the level, composition and geographical pattern of migration between Censuses. This section reports the analysis of a consistent time series of NHSCR migration flows for Yorkshire and Humberside local authorities from mid-1975 to mid-1992, with particular emphasis on the last decade. This historical analysis has been undertaken to establish what changes have occurred in patterns of migration as a context for the selection of some net migration scenarios for use in generating new projections.

The level of migration

A measure of the changing level of migration (or the propensity to migrate) over time can be established by examining the total movements registered by the NHSCR into and out of the region and between counties within the region. In 1975-76, a total of 196,760 such moves were recorded. When moves in subsequent years are calculated as a proportion of the 1975-76 total, a time series of index values is constructed (Figure 4.5) which illustrates how the level of migration fell during the second half of the 1970s to a low of 168,010 in 1981-82, 15% below its 1975-76 level. The time series index then rises during the 1980s to a peak in 1988-89 of 222,452 moves, before falling again between 1989 and 1991 and rising in the final year for which data is available.

This temporal fluctuation can be related in broad terms to changes in the economy and the housing market. Economic recession was at its most severe in the early 1980s and the increase in migration thereafter was a predictable outcome of the renewed prosperity which

peaked in 1989 and was followed by a sharp economic downturn, resulting in lower levels of migration in the early 1990s as labour and housing markets contracted. The changes in the migration propensity for Yorkshire and Humberside reflect those occurring in the country as a whole.

Table 4.3: Differences between observed and projected net migration balances for local authority areas, Yorkshire and Humberside, 1989-92

	1989-92 net migration		Observed - projected net migration	
	Observed(i)	Projected(ii)	Out	In
Bradford	-2349	-4800	-2451	
Calderdale	-654	-1500	-846	
Kirklees	-2028	-3150	-1122	
Leeds	-3969	-9450	-5481	
Wakefield	136	-1950	-2086	
Barnsley	-123	-600	-477	
Doncaster	-170	-2100	-1930	
Rotherham	-1033	-900	133	
Sheffield	-2402	-6150	-3748	
Humberside	4318	4800		-482
North Yorkshire	11777	12750		-973

Notes:

- (i) NHSCR net migration with rest of England for the period mid-1989 to mid-1992
- (ii) 1989-based assumptions of net-migration with rest of England for the period mid-1989 to mid-1992

Sources: NHS Central Register; DoE (Regional Office) Computer printout of 1989-based projections

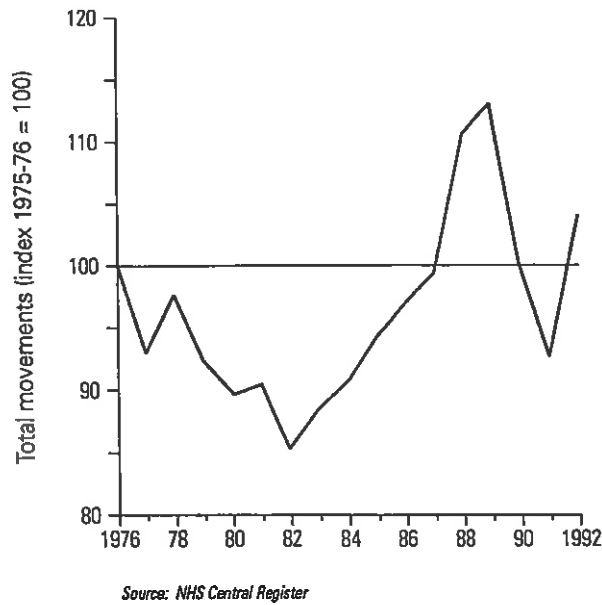


Figure 4.5: The changing level of migration, 1975-92

Net migration

During the course of the 1980s, and in the context of the changing levels of migration referred to previously, the region's net migration balance experienced a dramatic turnaround. In 1986-87, Yorkshire and Humberside lost over 10,000 persons through its migration exchange with the rest of the country; in 1988-89, the region gained over 10,000 (Figure 4.6). This experience was paralleled in the North West whilst the North also achieved a positive balance by 1991-92. Table 4.4 shows the net migration balances for a system of English regions in four selected 12 month periods.

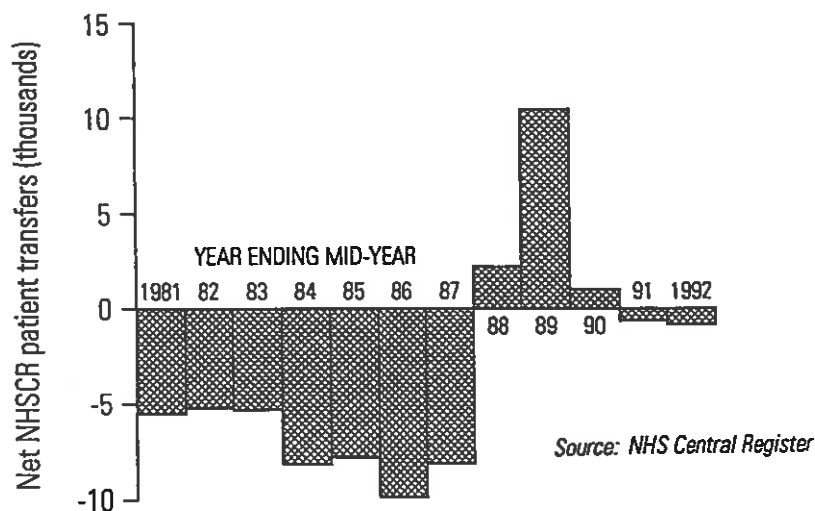


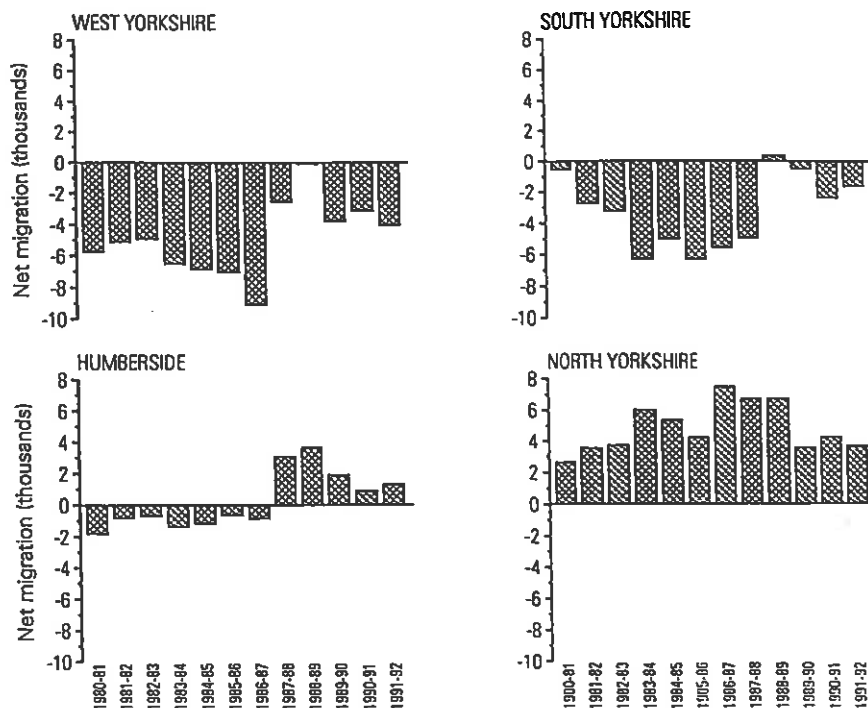
Figure 4.6: Net migration, Yorkshire and Humberside, 1981-92

Table 4.4: Net migration by region, selected years, 1980-92

Region	1980-81	1986-87	1988-89	1991-92
North	-8970	-9716	-1218	960
North West	-15930	-22930	4739	-5704
Yorkshire & Humberside	-4560	-8928	8712	546
East Midlands	7190	11652	14216	8779
West Midlands	-11020	-1202	-6454	-5399
East Anglia	11270	18125	9889	10292
South West	22690	44740	27656	22620
Rest of South East	41600	33256	14279	19543
Greater London	-42270	-64997	-71819	-51637

Source: NHSCR data

At the county scale (Figure 4.7), the patterns of net migration over the decade indicate a reduction in net losses from the two metropolitan counties, a transformation from net loss to net gain in Humberside and a reduction in net gain by North Yorkshire in the 1990s relative to the late 1980s. Examination of the gross components of these net migration balances enables the identification of whether changes in in-migration have been more important than changes in out-migration in explaining the fluctuating net balances of the region's counties. Expressed as time series indices based on 1980-81, the gross migration components are graphed in Figure 4.8.



Source: NHS Central Register

Figure 4.7: Net migration by county, 1981-92

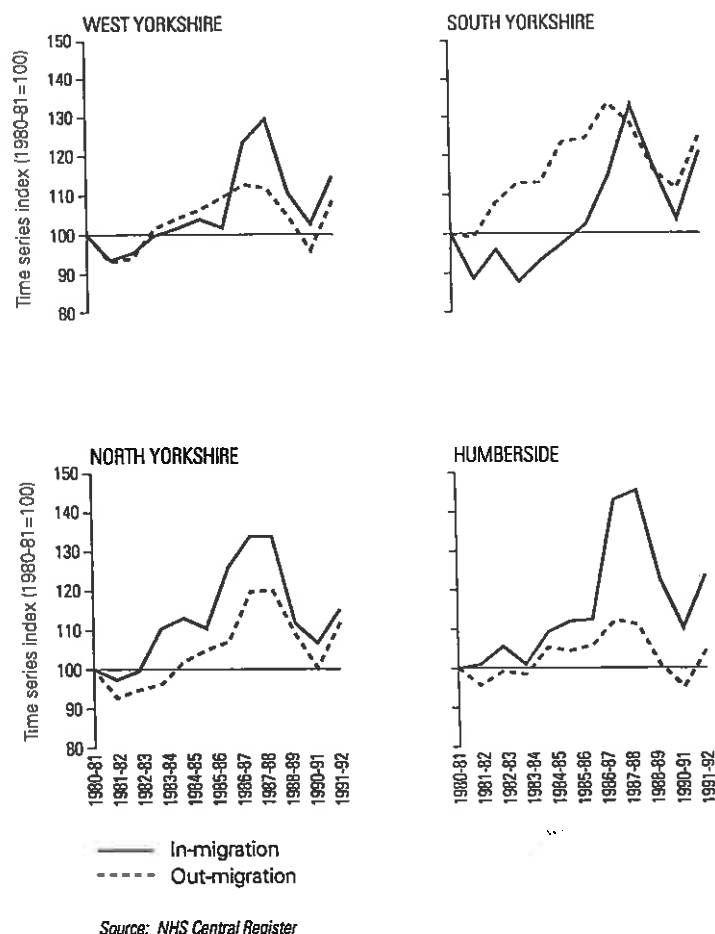
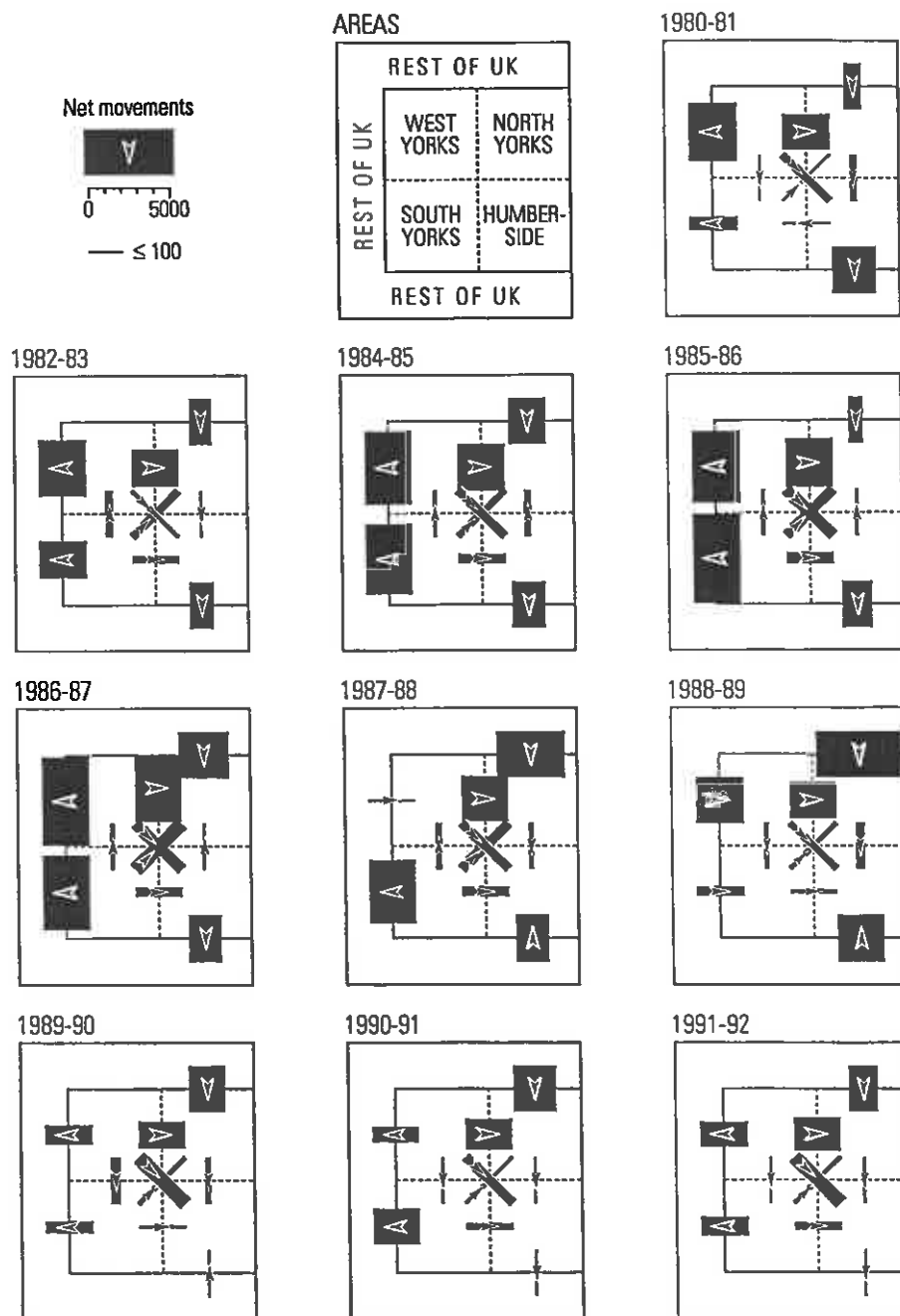


Figure 4.8: Time series indices of gross migration by county, 1981-92

Each of the county schedules illustrates a different time series in comparison with the general migration level schedule shown in Figure 4.5. Out-migration increased most noticeably in South Yorkshire in the first half of the decade and reached a peak in 1986-87 whilst in other counties, the increase from the low point in 1981-82 was less impressive and the peak was later in West and North Yorkshire. In all four counties, the pattern of net migration appears to have been most influenced by the increase in in-migration which occurred in mid-decade and which peaked in 1987-88.

The mid-1980s was a period which saw the most substantial net exchanges of migration between the region's counties and the rest of the UK, as indicated by the net flows in the schematic framework presented in Figure 4.9. Within the region, inter-county exchange has been dominated by the net losses from West Yorkshire to North Yorkshire. West Yorkshire has also lost fewer numbers consistently to Humberside whilst South Yorkshire has also lost consistently to North Yorkshire. The directional patterns of inter-county net movement have not changed very much over time. Greater fluctuation is apparent in the net flows between counties and the rest of the UK. Gains by North Yorkshire increased between 1985 and 1989, whilst losses from West Yorkshire and South Yorkshire were transformed into net gains by 1988-89. Humberside experienced losses to the rest of the UK in the first half of the decade, substantial gains in 1987-88 and 1988-89 and much smaller balances thereafter.



Source: NHS Central Register

Figure 4.9: Directional net migration by county, 1981-92

Full time series of net migration balances for each of the 11 local authority areas in Yorkshire and Humberside and for the region as a whole are presented in Figure 4.10. This set of histograms shows variations in the relative magnitudes of net losses and gains since 1975. Whereas all the metropolitan districts apart from Calderdale lost migrants in net terms between 1982 and 1987, the last five years have seen either reduced losses or losses turning to gains. Calderdale is the exception although population change through net migration appears to be relatively unimportant in this district.

Further insights into the Yorkshire and Humberside migration system can be derived from a more detailed examination of directional net balances for each district (or county) with the remaining districts (or counties) in Yorkshire and Humberside, the local authority areas contiguous with the region, the rest of England and the rest of the UK. Figures 4.11 and 4.12 illustrate the patterns of net migration at the start of the 1980s and a decade later. Most of the region's local authority areas do not tend to be involved in major net losses or gains with more than three or four other areas and areas with the largest net balances are the same in 1990-91 as they were in 1980-81 to a large extent. Certain net migration balances have continued to be relatively substantial: North Yorkshire's gains from Leeds and Cleveland; Wakefield's gain from Leeds; Rotherham's gain from Sheffield; and Sheffield's loss to Derbyshire. Calderdale, Barnsley and Doncaster have experienced relatively small net losses and gains with other areas. The most noticeable difference between the two sets of figures is for the balances with the rest of England. In 1980-81, Humberside, Bradford and Leeds in particular experienced substantial losses to the rest of England. In 1990-91, Humberside and Leeds were net gainers and Bradford's net loss had been reduced to near zero. In addition, the most important net exchange in 1990-91 was the net in-migration into North Yorkshire from the rest of England.

Two important conclusions can be drawn to summarise the analysis reported in this subsection. Firstly, migration appears to be volatile and time series schedules of net migration for individual local authority areas do not easily lend themselves to time series extrapolation. Secondly, the net migration flows during the last few years provide a distinct contrast to the mid-1980s balances used to generate the 1989-based net migration assumptions. It is for these reasons that three sets of adjustments to the migration assumptions are outlined in Section 5.

4.5 Natural change and external net migration

Most local authorities in Yorkshire and Humberside felt that the natural change assumptions contained in the official projections were acceptable but several felt that the external net migration assumptions were unacceptable. However, the lack of detailed documentation of how these assumptions (Table 4.5) are produced, as indicated in the appendix, suggests that any detailed investigation of the figures would be fruitless at the present time.

The mechanisms for adjusting the external net migration balances for net movements into England of armed forces and dependants and for students should be clarified in the next round of official OPCS projections. Furthermore, there is a strong argument to suggest that different components of the external migration assumptions should be published separately to allow local authorities the opportunity of having a clearer understanding of what the figures mean.

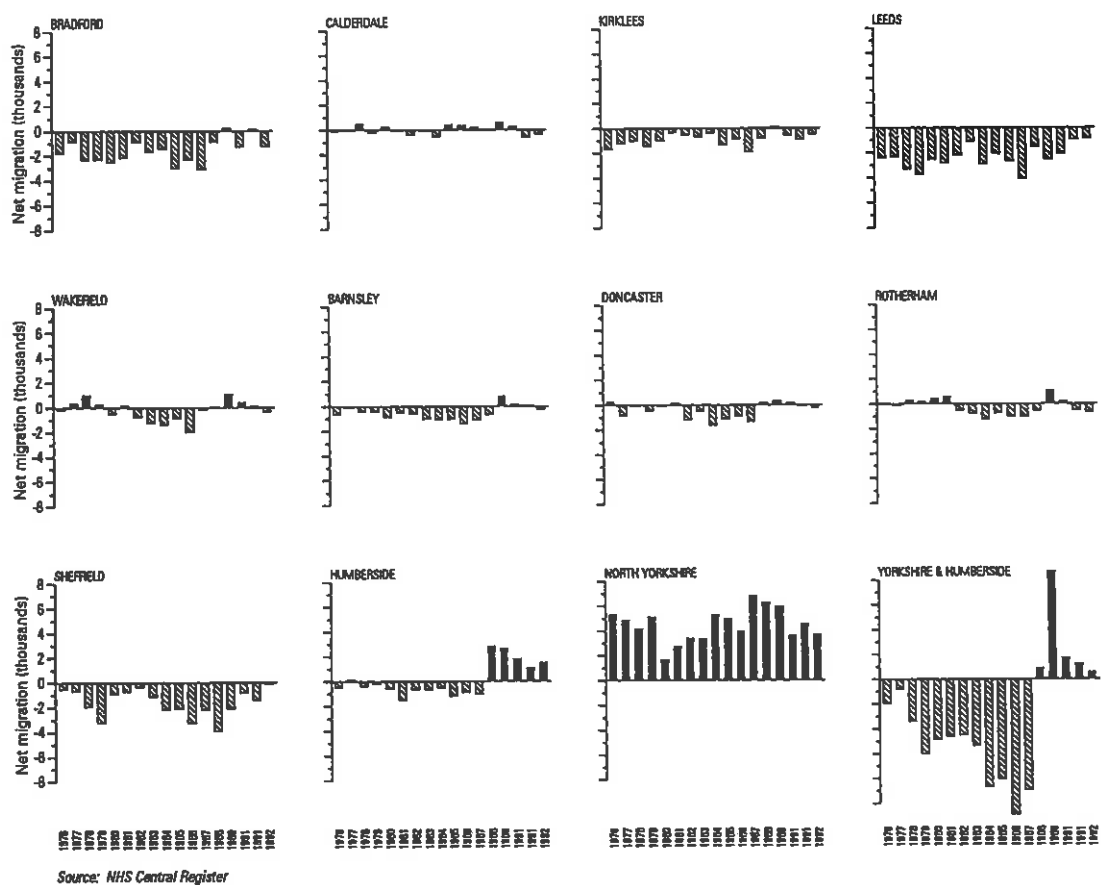


Figure 4.10: Net migration by local authority area, 1975-92

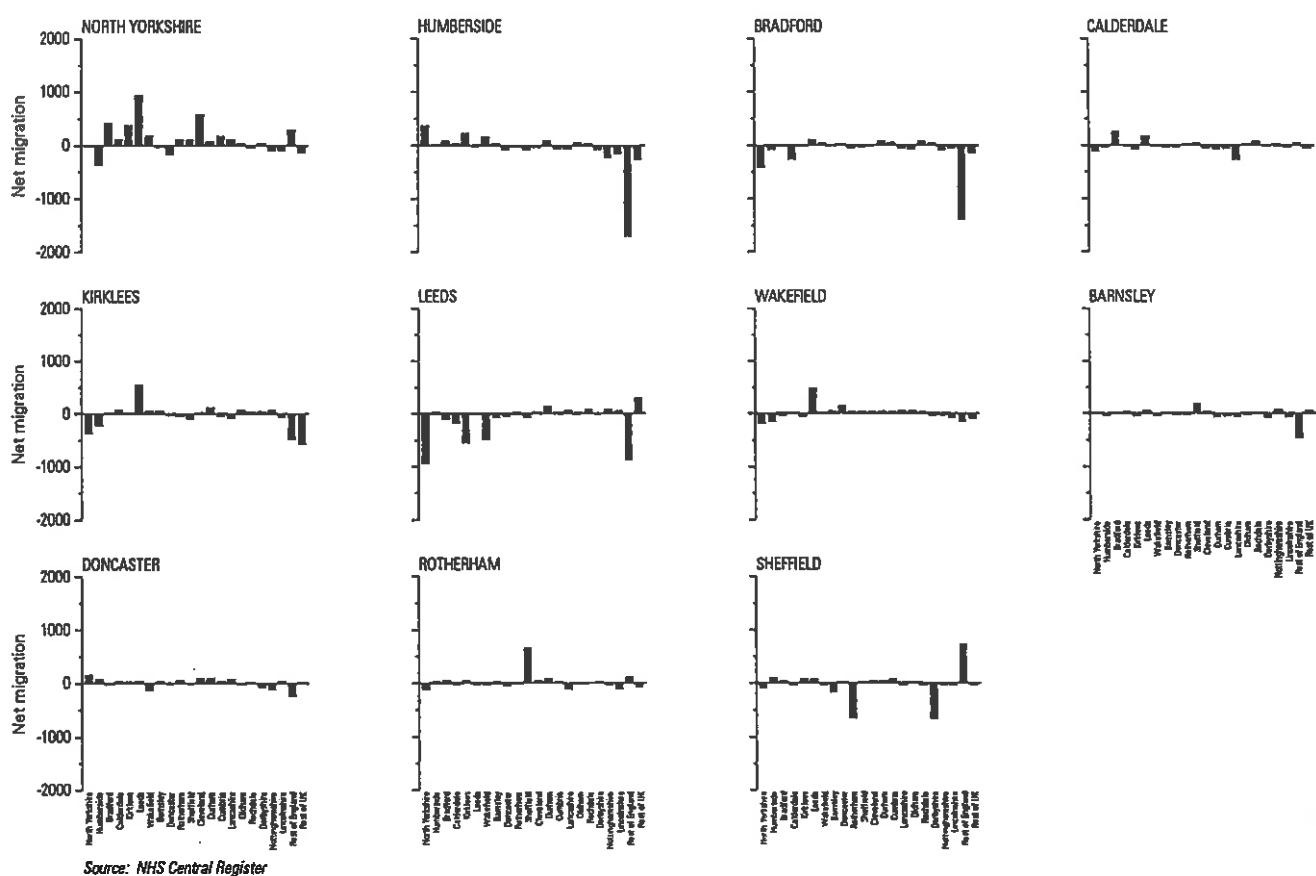


Figure 4.11: Directional net migration by local authority area, 1980-81

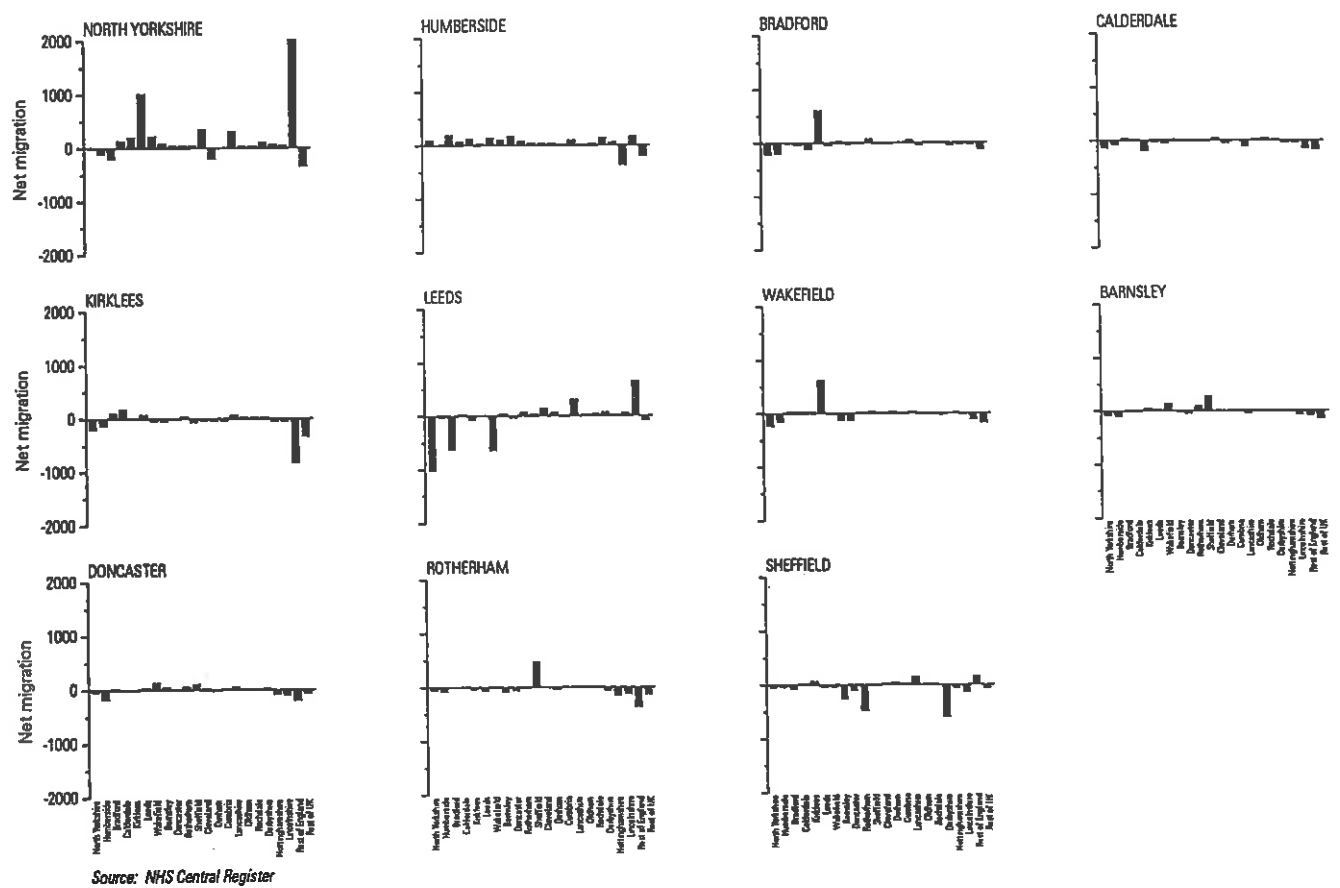


Figure 4.12: Directional net migration by local authority area, 1990-91

Table 4.5: Assumed net migration for local authority areas in Yorkshire and Humberside to/from outside England (including some within England adjustments)

	Mid-1989 (000)			Mid-1990 and thereafter (1000)		
	Persons	Males	Females	Persons	Males	Females
Bradford	0.7	0.3	0.4	0.5	0.2	0.2
Calderdale	0.9	0.4	0.4	0.5	0.3	0.3
Kirklees	-0.4	-0.2	-0.2	-0.6	-0.4	-0.3
Leeds	1.5	0.7	0.8	1.0	0.5	0.5
Wakefield	0.2	0.1	0.1	0.1	0.1	0.1
West Yorkshire	2.9	1.4	1.5	1.5	0.7	0.8
Barnsley	-0.1	0.0	-0.1	-0.1	-0.1	-0.1
Doncaster	0.4	0.2	0.2	0.2	0.1	0.1
Rotherham	-0.1	-0.1	0.0	-0.1	-0.1	-0.1
Sheffield	0.5	0.3	0.3	0.4	0.2	0.2
South Yorkshire	0.8	0.4	0.4	0.3	0.2	0.2
Yorkshire and Humberside	3.7	1.8	1.9	0.5	0.1	0.3
Humberside	-1.0	-0.5	-0.5	-1.9	-1.0	-0.9
North Yorkshire	1.1	0.6	0.5	0.6	0.3	0.3

Notes:

- (i) Figures are for the annual period starting mid-year
- (ii) Figures may not sum correctly due to rounding errors

Source: DOE (Regional Office) computer printout of 1989-based projections

5. REVISED POPULATION PROJECTIONS

5.1 Population projection adjustment methodology

The analyses of population structure and migration reported in previous sections will have implications for future totals of population in the region. The optimum solution to understand the implications of the changes identified is to build a comprehensive multiregional population projection model which can then be used to evaluate the impacts of particular assumptions. This is a fundamental requirement if evaluation is to be undertaken in a comprehensive and efficient way and if reliable sets of alternative projections are to be generated. The methodology adopted here does not proclaim to be a provide the facilities of a fully-fledged demographic projection model. An ad hoc solution has been developed that enables the construction of a series of alternative projections of population that take into account issues which have been investigated.

The aim is to adjust the existing 1989-based population projections by quinary age group for males and females to take account of, firstly, the differences that were identified in the comparison of the final mid-1991 population estimates and the 1989-based population projections for mid-1991, and secondly, changes in the net migration assumptions from 1989 to the end of the projection period. Since most local authorities were happy with the natural change assumptions and since the external migration assumptions proved impossible to improve with any degree of reliability, both these sets of assumptions are retained in the projections unchanged.

The first stage in the adjustment procedure is to apply the population base factors (revised final mid-1991 estimate/mid-1991 projection) to the existing projections in 2001 and 2006 respectively. This simply assumes that the error in the population base, as recognised and measured in 1991, remains constant over the projection period.

The second stage is to adjust the migration assumptions. This is done in a series of steps:

- (i) The all age net internal migration assumptions for males and females, rounded to the nearest 100 are summed for individual years over the projection period (Table 5.1).
- (ii) The 'observed' NHSCR net migration balances are summed over the first three years of the projection period, 1989-92.
- (iii) The net migration balances for the remaining years of the projection period (1992-2001 and 1992-2006) are recalculated using three alternative assumptions about annual net migration behaviour:
 - * using annual balances based on observed data for the last three years of the net migration time series, 1989-92;
 - * using annual balances based on observed data for the last five years of the net migration time series, 1987-92; and

- * using annual balances based on observed data for the last ten years on the net migration time series, 1982-92.

These three sets of assumptions allow three alternative scenarios to be incorporated which represent a range of possible net migration behaviour. The three sets of projected balances for each projection period summed with the observed net migration balances for 1989-92 are illustrated in Table 5.2.

- (iv) The new migration assumptions are subtracted from the official assumptions to give a set of all age adjustments to be made to the population totals in 2001 (Table 5.3) and 2006 (Table 5.4). The additional assumption in producing the new population projections is that natural change attributable to the additional in-migrants is zero.
- (v) The all age net migration adjustments are disaggregated into males and females using the sex ratio evident from the NHSCR in-migration totals for the 1990-91 and distributed into quinary age groups using the same NHSCR in-migration data but adjusted to take the direction and size of net migration into account.

Table 5.1: Net migration projections (assumptions) for Yorkshire and Humberside local authority areas with the rest of England, 1989-2001 and 1989-2006

	1989-2001		1989-2006	
	Total	Annual	Total	Annual
Bradford	-20300	-1692	-30000	-1765
Calderdale	-6000	-500	-8700	-725
Kirklees	-10550	-879	-13850	-815
Leeds	-34450	-2871	-46250	-2721
Wakefield	-7150	-596	-9650	-568
Barnsley	-1700	-142	-2200	-183
Doncaster	-8400	-700	-11900	-992
Rotherham	-3600	-300	-5100	-300
Sheffield	-20350	-1696	-25450	-1497
Humberside	23800	1983	35300	2076
North Yorkshire	50950	4246	71750	4221

Source: Computer printout, DoE Regional Office

Table 5.2: Projected net migration gains and losses for Yorkshire and Humberside local authority areas with the rest of England, 1989-2001 and 1989-2006

	1989-2001			1989-2006		
	A	B	C	D	E	F
Bradford	-9346	-7659	-15003	-13311	-10609	-22033
Calderdale	-2616	-897	-348	-3706	-1032	-178
Kirlees	-8112	-6996	-9120	-11492	-9756	-13060
Leeds	-15876	-18414	-22752	-22491	-26439	-33187
Wakefield	541	2278	-3725	766	3468	-5870
Barnsley	-492	-159	-5118	-697	-179	-7893
Doncaster	-683	172	-4895	-968	362	-7520
Rotherham	-4129	-2041	-5866	-5849	-2601	-8551
Sheffield	-9611	-17459	-19988	-13616	-25824	-29750
Humberside	17269	21832	9196	24464	31562	11906
North Yorkshire	47111	54797	55076	66741	78697	79131

Notes:

- (i) All the above projected net migration figures use observed NHSCR balances for first 3 years of projection period, 1989-92
- (ii) Columns A and D use mean annual balances, 1989-92, for other years
- (iii) Columns B and E use mean annual balances, 1987-92, for other years
- (iv) Columns C and F use mean annual balances, 1982-92, for other years

Table 5.3: Adjustments to 2001 populations due to differences between internal net migration assumptions and recomputed net migration projections for 1989-2001

	A	B	C
Bradford	10904	12641	5297
Calderdale	3384	5103	5652
Kirklees	2438	3554	1430
Leeds	18574	16036	11698
Wakefield	7691	9428	3425
West Yorkshire	42991	46762	27502
Barnsley	1208	1541	-3418
Doncaster	7717	8572	3505
Rotherham	-529	1559	-2266
Sheffield	10739	2891	362
South Yorkshire	19135	14563	-1817
Humberside	-6531	-1968	-14606
North Yorkshire	-3839	3847	4126
Yorkshire & Humberside	51756	63204	15205

Notes:

- (i) Positive value indicates that either net out-migration was less than official assumption or that recomputed net in-migration was more than official assumption
- (ii) Negative value indicates that either recomputed net out-migration was more than official assumption or that recomputed net in-migration was less than official assumption
- (iii) Columns A, B and C are the differences between the 1989-2001 assumptions in Table 5.1 and columns A, B and C in Table 5.2.

Table 5.4: Adjustments to 2006 populations due to differences between internal net migration assumptions and recomputed net projections for 1989-2006

	D	E	F
Bradford	16689	19391	7967
Calderdale	4994	7668	8522
Kirklees	2358	4094	790
Leeds	23759	19811	13063
Wakefield	10416	13118	3780
West Yorkshire	58216	64082	34122
Barnsley	1503	2021	-5693
Doncaster	10932	12262	4380
Rotherham	-749	2499	-3451
Sheffield	11834	-374	-4308
South Yorkshire	23520	16408	-9072
Humberside	-10836	-3738	-23394
North Yorkshire	-5009	6947	7381
Yorkshire & Humberside	65891	83699	9037

Notes:

- (i) Positive value indicates that either net out-migration was less than official assumption or that recomputed net in-migration was more than official assumption
- (ii) Negative value indicates that either recomputed net out-migration was more than official assumption or that recomputed net in-migration was less than official assumption
- (iii) Columns D, E and F are the differences between the 1989-2001 assumptions in Table 5.1 and columns D, E and F in Table 5.2.

5.2 Interpretation of projections to 2001 and 2006

The implication of selecting different net migration scenarios is summarised by the total adjustment to the regional population in each case. Under the assumption of future net migration at 1989-92 levels, an additional 52,000 persons are added to the Yorkshire and Humberside population whereas a further 63,000 are added using the five year net migration levels. Alternatively, if the ten year net migration levels are used, the increment to the population is much lower at around 15,000. Under all the scenarios, the population of the region is increased, indicating that official assumptions of migration were too low. However, individual local authority areas are affected in different ways as the figures shown in Tables 5.3 and 5.4 indicate.

Five sets of projected populations are presented in Table 5.5 for 2001. The first set is the official 1989-based projections which are used as the benchmark against which to compare the new projections. The second set of projections is that which adopts the official net migration assumptions but adjusts for the population base errors. The three remaining sets (A, B, C) are those which adjust for the revised population base and assume a different net migration adjustments.

The effect of simply applying the population base adjustment is to increase the Yorkshire and Humberside population by around 15,000 but this overall change is the aggregation of an increase in West Yorkshire of 6,800, an increase in South Yorkshire of approximately 2,300, an increase in Humberside of around 16,000 and a fall in North Yorkshire of 10,400.

Under each of the projections including adjustments for net migration, the population of Yorkshire and Humberside is shown to be higher than the current projection. This difference is as high as 78,000 under the five year migration scenario, 67,000 under the 3 year net migration scenario, and 28,500 under the ten year scenario. The populations of the county of West Yorkshire and Humberside are projected to be higher in all three cases. For South Yorkshire, the three and five year net migration projections suggest a higher population but the ten year scenario suggests a lower population. In North Yorkshire, all three projections indicate that the current projection of the population to 2001 is too high. On the assumption of the most recent migration levels, the population of North Yorkshire by 2001 might be some 14,200 under that projected.

If we assume the ten year net migration average, the adjustment methodology produces a population projection for West Yorkshire of 2.131 million in 2001 and 2.144 million in 2006. These projections are 1.6% and 1.9% above the official projections of 2.097 million and 2.104 million. In the case of South Yorkshire, the adoption of the same assumption results in populations of 1.293 million in 2001 and 1.282 million in 2006, 0.06% and 0.6% respectively below the OPCS/DoE projections. On the basis of the same migration assumption, the population of Humberside in 2001 is projected to be 876.5 thousand, marginally above the 875.1 thousand projected officially; and in 2006, it is projected to be 0.8% above the official projection. However, the population of North Yorkshire is projected to be 776.1 thousand in 2001 compared with the 1989-based projection of 782.3 thousand, and 797.2 thousand in 2006 compared with 798.1 thousand.

In conclusion, under the most conservative migration assumptions, the revised projections suggest that the metropolitan districts of West Yorkshire plus Doncaster, Sheffield and Humberside will have higher populations in 2001 than projected by OPCS/DoE from the 1989 base. On the other hand, Barnsley, Rotherham and North Yorkshire will have populations lower than the official projections suggest.

Table 5.5: Revised population projections for Yorkshire and Humberside local authority areas, 2001

	1989-based projection	Adjusted projection	A	B	C
Bradford	488588	492206	503110	504847	497503
Calderdale	205043	200246	203629	205348	205898
Kirklees	372658	378975	381412	382529	380405
Leeds	711198	711962	730716	727995	723659
Wakefield	319693	320563	328253	329991	323987
West Yorkshire	2097180	2103952	2147120	2150710	2131452
Barnsley	222942	225072	226280	226613	221654
Doncaster	301374	300255	307972	308827	303670
Rotherham	259070	259289	258760	260852	255777
Sheffield	510386	511430	522168	514320	511792
South Yorkshire	1293772	1296046	1315180	1310612	1292893
Humberside	875173	891185	884654	889217	876580
North Yorkshire	782315	771953	768115	775799	776081
Yorkshire & Humberside	5048440	5063136	5115069	5126338	5077006

Notes:

- (i) Adjusted projection calculated by applying adjustment factors derived from comparison between 1989-based projections for 1991 and rebased mid-1991 estimates
- (ii) Projection A calculated from adjusted population base revised with reference to last three years' net migration differences
- (iii) Projection B calculated from adjusted population base revised with reference to last five years' net migration differences
- (iv) Projection C calculated from adjusted population base revised with reference to last ten years' net migration differences

Table 5.6: Revised population projections for Yorkshire and Humberside local authority areas, 2006

	1989-based Projections	Adjusted Projection	A	B	C
Bradford	495922	499099	515788	518490	507066
Calderdale	207610	202888	207882	210556	211410
Kirklees	370672	376931	379288	381025	377721
Leeds	709797	709985	733744	729796	723047
Wakefield	320295	321282	331698	334400	325062
West Yorkshire	2104296	2110185	2168400	2174267	2144306
Barnsley	222407	224420	225923	226441	218728
Doncaster	302981	301830	312762	314092	306210
Rotherham	259320	259536	258787	262035	256085
Sheffield	504491	505280	517114	504906	500972
South Yorkshire	1289199	1291066	1314586	1307474	1281995
Humberside	876033	892127	881291	888389	868733
North Yorkshire	798089	789837	784828	796783	797217
Yorkshire & Humberside	5067617	5083215	5149105	5166913	5092251

Notes:

- (i) Adjusted projection calculated by applying adjustment factors derived from comparison between 1989-based projections for 1991 and rebased mid-1991 estimates
- (ii) Projection A calculated from adjusted population base revised with reference to last three years' net migration differences
- (iii) Projection B calculated from adjusted population base revised with reference to last five years' net migration differences
- (iv) Projection C calculated from adjusted population base revised with reference to last ten years' net migration differences

6. CONCLUSIONS

The value of the results of the 1991 Census for evaluating existing projections is recognised but it is important to clarify the nature and extent of the problem of underenumeration in Yorkshire and Humberside. The evidence indicates that an estimated 127,300 people in the region, or 2.6% of the population, were not enumerated by the Census. The paper outlines how the OPCS produced the revised final mid-1991 population estimates rebased on the Census by taking into account the various underenumeration and adjustment components.

The paper has identified characteristics of the populations of Yorkshire and Humberside and its constituent local authorities since 1981 and to 2011. Revised final rebased population estimates have been used to illustrate the characteristics of both aggregate populations and populations by gender and quinary age group in 1991 together with changes since 1981; NHSCR data has been used to trace the changing pattern of migration in the 1980s and early 1990s.

The final rebased population estimates provide an important data set for the research reported in this paper both in terms of the analysis of changes occurring over 1981-91, and also as a data set for comparison against the 1989-based projections for 1991. The mid-year estimates show, for example, that the population of the region rose by 1.3% between mid-1981 and mid-1991, but that changes in the four counties varied considerably: the population of North Yorkshire grew by 6.5% and that of Humberside grew by nearly 2% whereas the population of West Yorkshire declined by 0.03% and that of South Yorkshire fell by 1.9% during the 1980s. Age-specific population changes were more substantial with the highest rates of increase apparent for the very old (80+) and the highest declines (of 25%) for those aged 10-14.

A comparison of the final rebased mid-1991 population estimates with the 1989-based population projections for mid-1991 indicates an underprojection of 23,800 for Yorkshire and Humberside. In absolute terms, an underprojection of 13,700 in West Yorkshire, 7,300 in South Yorkshire and 16,400 in Humberside was only partially offset by overprojection of 13,600 in North Yorkshire. The differences between the rebased and projected mid-1991 aggregate populations conceal considerable variations between age groups whose under- and overprojection may cancel out. Particular underprojection is noted in the 20-24 age group in Leeds and Sheffield.

Since the 1991 Census data currently available on migration are limited to counts of in-migrants, time series data from the NHSCR have been assembled and used to show that during the mid-1980s, the region's net migration balance experienced a dramatic turnaround from net loss to net gain. In each of the counties, the pattern of net migration appears to have been most influenced by the increase in in-migration which occurred in mid-decade and which peaked in 1987-88. Patterns of inter-county net migration within the region have not changed very much over time; greater fluctuation has occurred in the net flows between the counties and the rest of the UK. However, the overall migration component of population change for local authorities in Yorkshire and Humberside appears to be volatile and the time series schedules of net migration for individual local authority areas do not easily lend themselves to time series extrapolation.

An adjustment methodology for generating alternative sets of population projections was developed which used the results of the previous analyses. An initial set of population projections to 2001 and 2006 was produced by adjusting the existing projections according to the differences between the provisional rebased 1991 estimates and the 1989-based projections for 1991. Three additional sets of population projections to 2001 and 2006 were then constructed using the adjusted population projections and three new scenarios of net migration assumptions based on the annual net migration over short, medium and long time periods: 1989-92, 1987-92 and 1982-92. The population projected using this methodology for the region was higher than the 1989-based projection by 51,700, 63,200 and 15,200 respectively for 2001 and 65,900, 83,700 and 9,000 for 2006. In other words, the future population of Yorkshire and Humberside in 2001 and 2006 will be considerably higher than the 1989-based projections suggest if the short term trends in net migration continue but even the use of longer term net migration trends indicates that the official figures are underprojected.

Many of the problems encountered and the issues raised by this study point to the need for a comprehensive multiregional population projection model. Not only might a model-based demographic information and projection system provide local authorities in the region with a valuable source of up to date demographic data but such a system would also enable a whole range of historical demographic analyses to be undertaken as well as providing the opportunity to test out a variety of projection scenarios based on different sets of detailed assumptions. Such a model would have been invaluable for this project and should be included on the agenda for future resourcing.

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APPENDIX: SUMMARY OF THE OPCS/DOE METHODOLOGY FOR SUBNATIONAL POPULATION PROJECTION

Introduction

The methodology for population projections is summarized in Capron and Corner (1990) and in OPCS (1991a). The projection starts with the mid-year population estimates for an area by single year of age for males and females separately. The methodology for producing the Registrar General's mid-year population estimates rolled forward from 1981 is outlined in an OPCS Occasional Paper (Population and Hospital Statistics Division, OPCS, 1991).

The mid-year estimates refer to persons who are usually resident in the area, whatever their nationality. Usual residents temporarily away from home are included; visitors are excluded; members of the armed forces stationed in the area are included; students are taken to be resident at their term-time addresses. Mid-year population estimates for mid-1989 at subnational level are only available for quinary age groups and thus the national single year of age estimates are used to subdivide the quinary age groups into single years of age. Projections for single years of age are therefore less reliable than those for larger age groupings. The single year of age estimates are then projected one year ahead using a cohort survival model.

Survivals and deaths

Initially an estimate is made of those surviving to be one year older by applying a series of mortality rates to the population estimates, to give the numbers of deaths at each age, which are then subtracted. The age-specific mortality rates for England, produced by the GAD are multiplied by local age and sex specific mortality differentials to reflect local area deviations from the national mortality rates. The mortality differentials, which are not able to be published without permission of OPCS, are thus used to adjust the assumed national mortality rates for each single age in each projection year. Separate mortality differentials are used for men aged 0-59, 60-74 and 75+ and for women aged 0-59, 60-74, 75-84 and 85+. These differentials have been calculated as the three-year average of the differentials from mid-1985 to mid-1988 and are assumed to remain constant for all the years in the projection period.

Age-specific mortality rates are mostly higher than the national average in Yorkshire and Humberside so most of the differentials are above 1.0. For males, Calderdale has the highest differentials in the ages 60-74 whereas men in North Yorkshire aged 60+ and in Leeds aged over 75 have differentials below 1.0. The highest female differentials are in Bradford for women aged 0-59, in Wakefield for women aged 60-74 and in Kirklees for women aged 85+. Female differentials below 1.0 are found in North Yorkshire in the ages 0-74, in Rotherham for aged 0-59, in Leeds for more aged 75-84 and in Rotherham and Leeds for the 85+ group. The total number of deaths in all areas is controlled to the GAD national projections.

Births

The number of births in any one projection year is produced by applying age-specific fertility rates to the female population aged 15-44. For each area, and for each female age group 15-19, 20-24, 25-29, 30-34 and 35-44, a fertility differential is calculated as the ratio of the local fertility rate to the corresponding national rate. These differentials, which are not able to be published without permission of OPCS, are worked out as an average of the three years birth registration data from mid-1985 to mid-1988 and are assumed to remain constant for all the years in the projection period.

The age-specific fertility differentials in Yorkshire and Humberside are generally above 1.0 for females aged 15-24 and below 1.0 for females aged 30-44. Bradford has the highest fertility differentials across all the five age groups, whilst North Yorkshire has values below 1.0 in all age groups, but most significantly in the 15-19 and 20-24 ages. The differentials are applied to projected national fertility rates to make preliminary projections of births which are then subject to adjustment to constrain the total number of births in England to the national projections by the GAD.

The national assumptions on future fertility and mortality are supplied by the GAD. A full explanation of the analysis of past periods and a statement of future national assumptions is found in OPCS (1991b).

Internal migration

The third component of population change is internal migration and the normal procedure is for OPCS and DoE to prepare preliminary projections on which local authorities are invited to comment by the DoE. Internal migration is regarded as migration taking place between each local authority area and the rest of England.

The current methodology was designed by Martin Voorhees Associates and John Bates Services (1981) for the 1981-based projections (OPCS 1983) and has been used in all subsequent projections during the 1980s. The modelling methodology has been described in algebraic form by Boden et al. (1992) and the procedure is summarized in Capron and Corner (1990).

There are four stages in the model: the generation of age-specific out-migration projections for each area; the assignment of these flows to destinations; the generation of age-specific in-migration projections; and the calculation of age-specific net migration balances. In the *first* stage the model projects age-specific out-migration from each area by sex as a product of the area's mid-year population estimate or projection, an adjusted gross migraproduction rate (GMR) for the area by sex, and the proportion of the GMR accounted for as by particular age and sex group. The GMR is the sum of the age-specific out-migration rates. The calculated GMR for 1989 is assumed to remain constant over the projection period and in any one year is disaggregated into single year of age out-migration projections using out-migration projections derived from the sex-specific model migration schedules. Thus the age profiles of out-migrants from clusters of local authorities in 1981 are assumed to be constant during the projections.

The calibration of model migration schedules is based on work by Rogers and Castro (1981) and the method of deriving model schedules for local authorities in England is outlined in Bates and Bracken (1982; 1987). To reduce the data storage requirements of the model (i.e. to avoid having to use and store male and female age-specific out-migration rates for each area), a clustering procedure was undertaken based on similarities between the parameters of individual local authority schedules calibrated on 1981 data for males. A set of 13 clusters was identified for male out-migrants, North Yorkshire and Humberside were included in a group of shire counties; eight of the metropolitan districts in Yorkshire and Humberside were included in a group of metropolitan districts; and Bradford was included in a separate cluster with Lancashire, having a schedule that exhibited a retirement component. The same 13 groups defined for males were then used for females.

The *second* stage of the model involves the assignment of male or female out-migrants from each area to destinations using origin-destination matrices of movement probabilities derived from the 1981 Census. The assignment is simplified by distributing flows by sex in four broad age groups which correspond with different types of migration: 0-16 and 29-59 year olds (family movement); 17-28 year olds (labour force movements); 60+ year olds (retirement movements). The 1981-based assignment probabilities are assumed to remain constant throughout the projection period.

The *third* stage of the model involves summing up the inflows into each local authority destination area for each sex and then disaggregating the totals into single year of age in-migrants using a model migration schedule calibrated on 1981 in-migrant data. A classification of areas on the basis of their 1981 in-migration profiles results in 13 groups of local authority areas, each with a distinctive profile. Thus the age profiles of in-migrants for clusters of areas in 1981 are assumed to be constant during the projections. The Yorkshire and Humberside local authorities fall into three groups: eight out of nine metropolitan districts are included in a group of 31 metropolitan districts; North Yorkshire is included with Lincolnshire and Hampshire sharing on retirement component in their profiles; and Humberside and Bradford are included in a separate group with Lancashire, Salford and Liverpool.

The *fourth* and final stage of the model involves adjusting the totals of out and in-migrants for all areas, by age and sex, to ensure that they cancel each other out. Adjustments were necessary in some areas to maintain favourable sex ratios for each year of age. OPCS also used some information supplied by the local authorities during the consultation period for the previous set of 1985-based subnational projections, although the adjustments made for this reason were relatively small scale.

Adjustment of internal migration assumptions after consultation

Comments on the internal migration assumptions were invited from local authorities through the DoE (Regional Office) as well as from District Health Authorities and the Department of Health. It was pointed out that the assumptions represented the most likely future net migration scenario on the basis of past trends. Local authorities were only asked to comment on the aggregate net migration assumptions up to 2011, and to state factors that they believed to be different from the trend-based assumptions of the preliminary results, identifying separately the expressed impacts of plans and policies already in place. They

were also advised that changes proposed for one authority area might affect net migration balances of other areas.

The DoE Census Unit included a 'pro-forma' for consultees (local authorities) to complete and responses were co-ordinated by DoE (Regional Office) who then submitted the returns along with their own comments based on a broader regional view of the figures. Many comments were received from local authorities and many changes were incorporated into the model where discrepancies were glaring or where arguments were convincing and with supportive evidence. In most cases, changes were made to the GMRs but, in addition, adjustments to the age profiles and the matrix of assignment probabilities were also incorporated.

DoE asked OPCS to inform them of the implications of recommended changes for other areas. If these were implausible, further adjustments had to be made. In practise several reruns of the entire internal migration model were undertaken before a final set of figures was agreed and the official set of net migration assumptions produced. The 1989-based projections round actually involved a second consultation with local authorities for a further assessment of the changes introduced after the initial consultation.

International migration

The final component of the population projection methodology is referred to as 'international' migration to and from areas outside England, although this component does in practise, serve as a means of introducing further adjustments to internal migration. The net balance of international migration by age and sex was apportioned to areas using (i) a three year (1985-6 to 1987-8) average of NHSCR flows of civilians moving to and from other nations of the UK, and (ii) a five year (1983-88) average of International Passenger Survey data for flows between England and countries outside the UK in conjunction with some 1981 Census data. Adjustments were made to allocate the movements of Armed Forces personnel and their dependents into England to local authority areas using existing military populations.

A further set of adjustments are made to this component to allow for the size and structure of student populations in some areas and for consistency with the other data. The definition of usual residence of students in the 1981 Census differs from that used in the population estimates and projections: their vacation address is implied in the former; their term-time address in the latter. The procedures for adjusting the international migration component for 'students' and for the movements of armed forces and their dependents within England is contained in OPCS internal working papers unavailable for scrutiny.

The OPCS methodology produces different assumptions for net 'international migration' in the first 2 projection years but constant assumptions thereafter. The total net number of migrants (internal and international) is then applied in the aged-on population with births added and deaths subtracted to provide a final projected population for each area.

Concluding comments on methodology

A number of conclusions can be made from this summary of the methodology for producing the official subnational population projections.

- * The migration submodel uses age and sex-specific out- and in-migration profiles based on 1981 Census data. These might be updated using more recent NHSCR data.
- * The method of grouping local authority age profiles on the basis of the parameters of their model migration schedules is both unclear and unnecessary. Individual age schedules for each local authority could be used in the migration submodel.
- * The age grouping used in the assignment stage of the migration submodel is not necessarily optimum and has not been derived in any systematic way.
- * Patterns of origin-destination migration have changed since 1981. These are not captured by the migration submodel in its current form other than through various adjustments that may be made after consultation with local authorities. Better use could be made of the NHSCR data.
- * Whilst recalibration of the existing migration submodel using 1991 Census data is necessary, the time is right for a new model to be developed which makes better use of data from sources like the NHSCR and the LFS.
- * The next round of population projections provides the opportunity for OPCS/DoE to improve the information available to local authorities on the population projections and their assumptions (particularly on the net external migration component) and to introduce methods of incorporating locally supplied data which provides better information about students and institutional populations.