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THE DEMOGRAPHIC STRUCTURE OF BRITAIN'S POPULATION: FIRST RESULTS FROM THE 1991 CENSUS

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Abstract

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ABSTRACT

The paper presents preliminary findings about the age structure of the population and reported limiting long-term illness based on the 1991 Census Monitors produced for counties in England and Wales and regions in Scotland. Among key findings are that Britain's population is ageing, with fewer 0-17 year olds and with numbers aged 75 and over up by a third. For England and Wales a clear differentiation exists between the younger age structures of metropolitan county and shire county populations in the area to the north-west of London and the older age structures of peripheral, coastal counties. However, the fastest increases in 75-84 and 85+ populations have been in places with fewest of them in 1981. People with "limiting long-term illness" (new Census question) are most numerous in the North and West, particularly in the industrial towns and cities and in coal-mining communities.

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1.   INTRODUCTION

This paper examines the geography of the different age groups of the
population across the counties of England and Wales and the regions of
Scotland, drawing on recently published results from the 1991 Census of
Population and from the population estimates based on the 1991 Census.
Age is an important characteristic of all individuals in the population
and one which changes inexorably with time. Age is highly associated
with events in a person's life course, and is used as a convenient
surrogate for stages in life. The age composition of national and
local populations is important for all kinds of public service and
private market functions.

Section 2 provides a short background to 1991 Census publications and
computer readable datasets, and to the dataset used in the paper. The
third section takes an overview of the 1991 national population and
changes since 1981. Section 4 of the paper describes the spatial
patterns of a set of consecutive age groups and suggests a dynamic
interpretation of the structures revealed. Section 5 examines the
geography of limiting long-term illness, a new variable measured for
the first time in the 1991 Census that is superficially related to age.
The sixth section describes the very different geography of change,
while section 7 describes the theoretical framework that will need to
be used to decompose change into its relevant components. This work is
not described here, as it is much more conveniently carried out when
the better Local Base Statistics data are fully available.

2.   BACKGROUND TO THE CENSUS DATA

On Sunday, April 21st 1991, the United Kingdom conducted its latest
decennial census of population. This involved delivering to every
household in the country and to every institution simple census
questionnaires which had to be returned to the enumerator. These forms
were then processed into computer readable form by the national Census
Offices[1] over the next few months. From these primary data an
extensive series of published reports and computer readable datasets
are produced. Currently available in whole or in part are:

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[1]   The national Census Offices are:

England and Wales	- Office of Population Censuses and Surveys, in London and Titchfield
Scotland	- General Register Office, Scotland, in Edinburgh
Northern Ireland	- Census Office Northern Ireland, Department of Health and Social Security, in Belfast

(1) the Preliminary Reports for England and Wales, Scotland and Northern Ireland[2] (July 1991)

(2) the County Monitors (England and Wales) and the Region Monitors (Scotland) (July 1992 to October 1992)

(3) the County Reports (England and Wales) and the Region Reports (Scotland): Part 1, 100% tables (July 1992 to December 1992)

(4) the Small Area Statistics and the Local Base Statistics (Great Britain): 100% variables (July 1992 to December 1992)

(5) the National Summary Report for Northern Ireland (November 1992)

Detailed citations to these publications are given in the references at the end of the paper.

The machine readable datasets are being purchased for use for research and teaching by the academic community through the Census Programme of the Economic and Social Research Council (Rees 1992). By January 1993 a full set of SAS and LBS data for Great Britain should be available at the Census Dissemination Unit, University of Manchester, to researchers via the Joint Academic Network (JANET) on the Amdahl mainframe (UK.AC.MCC.CMS) of Manchester Computing Centre.

To make available a smaller computer readable dataset in 1992, one of ESRC's Census Programme projects (at Leeds) undertook the job of placing the table data from the summary Census Monitors into computer readable form, and these will be made available via the Census Dissemination Unit in December 1992. The national analyses reported in this paper and in other parallel papers presented at the Royal Geographical Society are based on these machine readable data.

Figure 1 outlines the structure of the data files prepared for general use. The county file containing data from Tables A to L of the Census Monitors are the principal source of results described in this paper. All the data from which these data files are constructed are Crown Copyright.

3.   NATIONAL AGE STRUCTURES

We begin with an analysis of the detailed age structure of the population of England and Wales (89% of the UK total) in 1991. Table 1 shows the breakdown of the population at mid-years 1981 and 1991, using the age groups employed in Table E of the Census Monitors.

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2   The Preliminary Reports are produced from the enumerators' head counts rather than the Census forms.

CENSUS MONITORS
— Counties (Eng. & Wales)
— Regions (Scotland)

County/Regional Files

Tables A to L | Table M

Files: COGBAL.DAT | COWAMM.DAT
COSCMM.DAT

District Files

Tables B to L | Table M

DIGBBL.DAT | DIWAMM.DAT
DISCMM.DAT
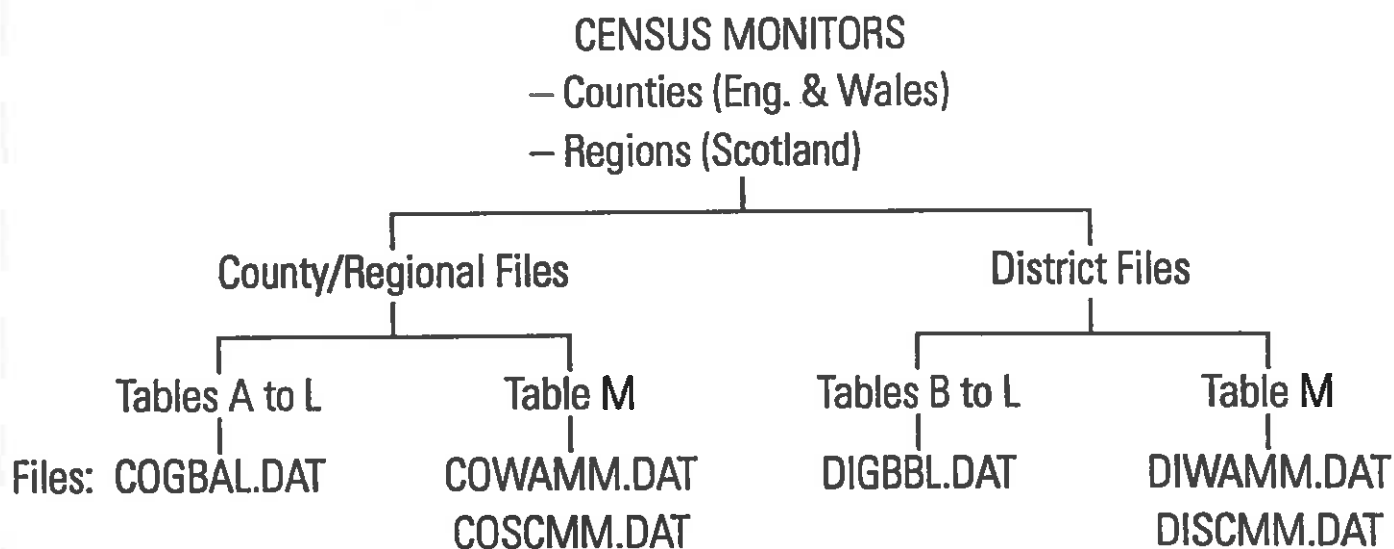
File names: Units   1-2   CO = County   DI = District
            Universe 3-4   GB = Great Britain   WA = Wales   SC = Scotland
            Tables   5-6   AL = Tables A to L
                           BL = Tables B to L
                           MM = Table M

Source: OPCS and GRO(S) (1992) County and region monitors. Crown Copyright.

Figure 1. Computer readable files compiled from the OPCS and GRO(S) Census Monitors

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Table 1. The age structure of the England & Wales population, 1981 and 1991

Census Monitor age group	% in age group		% change
	1981	1991	1981-91
0-4	6.1	6.7	+14.0
5-15	15.9	13.5	-13.1
16-17	3.4	2.5	-25.2
18-29	17.6	18.7	+ 9.3
30-44	19.6	21.1	+10.8
45-pen	19.5	19.0	~ 0.1
pen-74	12.1	11.5	- 2.7
75-84	4.8	5.5	+16.6
85+	1.1	1.6	+50.1
Total	100.0	100.0	+ 2.7
0-17	25.4	22.7	
18-pen	56.7	58.8	
pen +	18.0	18.6	
Number	49,634.3	50,954.8	1,020.5

Notes

1. pen = pensionable age. This currently starts at 65 for men and 60 for women for state benefits (Old Age Pension), but is likely to change in the next year or so to either 65 for both men and women or 63 for both or to a flexible system in which variable pensions can be taken between ages 60 and 70.

Sources: OPCS (1982) and OPCS (1992c)

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Although the detailed picture is complicated, the population has aged a little in the decade. The percentage of the population aged under 18

has dropped by 2.7% while the percentage of pensionable age or above has risen by 0.6%. Working age population has increased by 2.1%.

However, within these broad age categories some age groups have experienced growth while others have shrunk. For example, the age group of retirement (pensionable age to 74) has decreased in size while that for the oldest elderly, those aged 85 and over, has increased by 50% between 1981 and 1991. Because those over 80 need more than four times the care input of those aged 60, the demands on health and social services for the elderly have increased greatly.

Figure 2 uses single year of age statistics to compare the England and Wales population in 1981 and in 1991. The shape of the population pyramid reflects, to about age 65, the past history of fertility; after age 65 mortality becomes the dominant force. Migration has a rather minor influence (though this is not true at subnational scale).

At ages 0-6 there were more children in the 1991 population than in the 1981, because births in 1985-91 exceeded those in 1975-81, when fertility rates were at an historic low. Between ages 8 and 20, the 1981 populations exceed their 1991 counterparts because the former derive from the high birth cohorts of 1961-72 whereas the latter derive from the lower birth cohorts of 1971-82.

Between ages 22 and 32 and between ages 38 and 48, the numbers were greater in the 1991 population, whereas between 50 and 61 they were greater in the 1981 population. Between ages 62 and 74 the differences vary age by age. Beyond age 74, all ages show higher numbers in 1991 than in 1981.

What happens in any age group between two points in time is that one set of birth cohorts is replaced by another. The events between birth and those two points in time make some difference but not a great deal at the national scale. This argument is developed more fully in a later section where a methodology for decomposing age group change into cohort-change, mortality effects and migration effects at subnational scale is outlined.

4.   THE SPATIAL PATTERNS OF THE AGE GROUPS IN 1991

The geography of each age group is now reviewed by examining maps showing the percentage of county populations made up of that group.
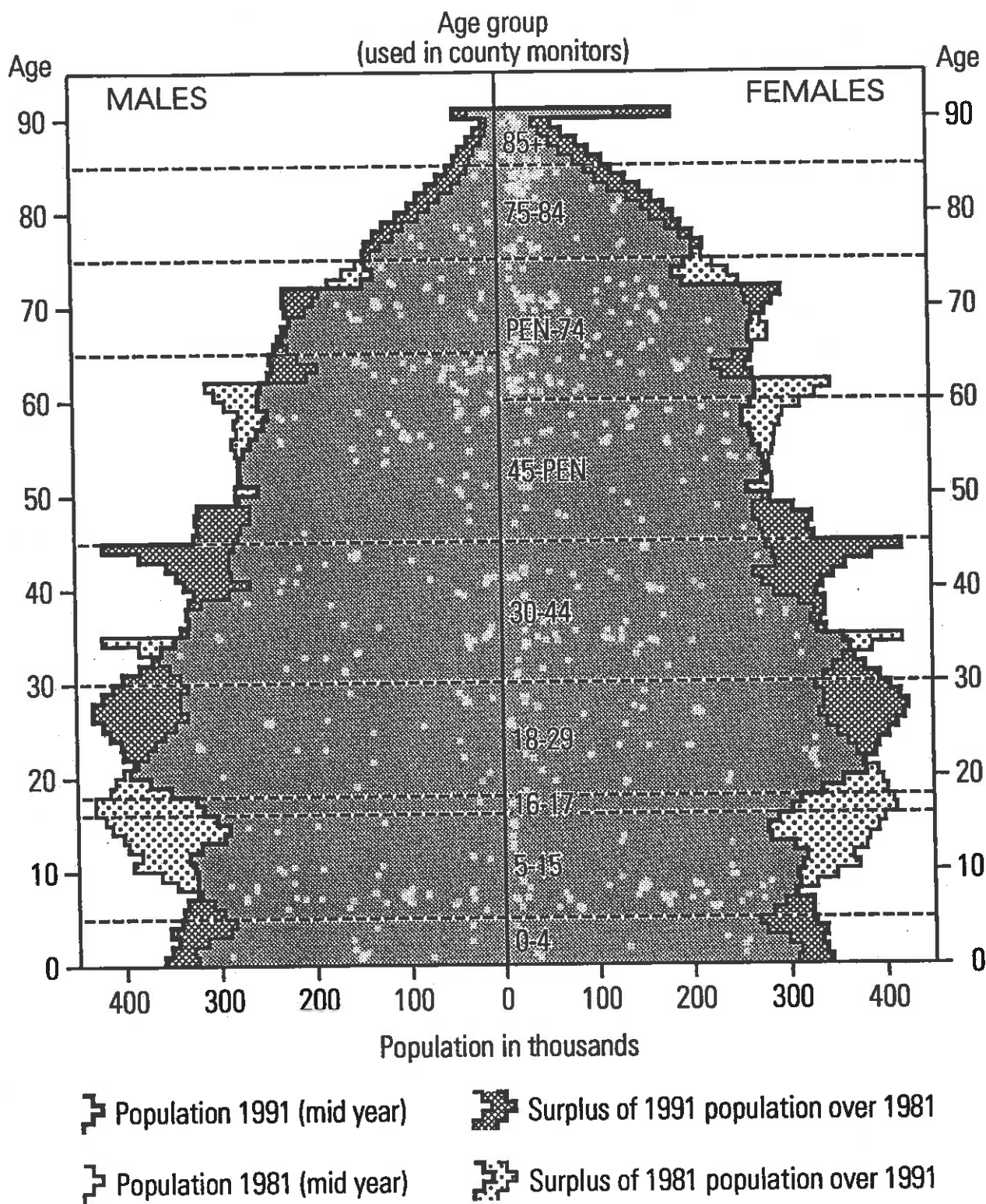
Figure 2. The age structure of the England and Wales population, 1981 and 1991

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The maps were produced using the GIMMS mapping package running under UNIX. The boundary data used derive from the 1981 Census: there have been minor changes since 1981 in a few district boundaries but these do not show up on larger scale maps.

On each map counties are assigned to one of six classes which contain nearly equal numbers of cases/counties (5 classes of 11 counties and 1 class of 12). This has the advantage of making the maps comparable and in providing useful statistics in the legend. The map legend shows the class intervals: the top figure is the county maximum, the middle figure is the median and the bottom figure is the county minimum. Subtracting the minimum from the maximum gives the range statistic.

4.1 Young infants: ages 0-4

Percentages in this age group are a function of fertility rates, the concentration of the parental population in the fertile age range and the relative size of other populations (older children, persons aged 45 and over).

The highest percentages of young infants are found in three types of county (Figure 3):

(a)   the largest metropolitan counties which contain high concentrations of the high fertility ethnic groups from South Asia (Greater Manchester, West Midlands, Inner London and West Yorkshire);

(b)   the counties containing high percentages of working class or underclass families living on council estates (Cleveland, Mid-Glamorgan)

and

(c)   counties which are attractive to young families because of good employment prospects (Bedfordshire, Northamptonshire and Berkshire with adjacent counties located in the second sextile).

At the other extreme of the distribution we see counties on the seaboard periphery with elderly age structures (Dorset, Cornwall, East Sussex, West Sussex, Norfolk, Lincolnshire, Parys; Dyfed, Borders, Northumberland, Western Isles).

% 0-4 1991

▓	7.4
▨	7.0
▧	6.7
▨	6.5
▨	6.3
▨	6.0
▨	5.5
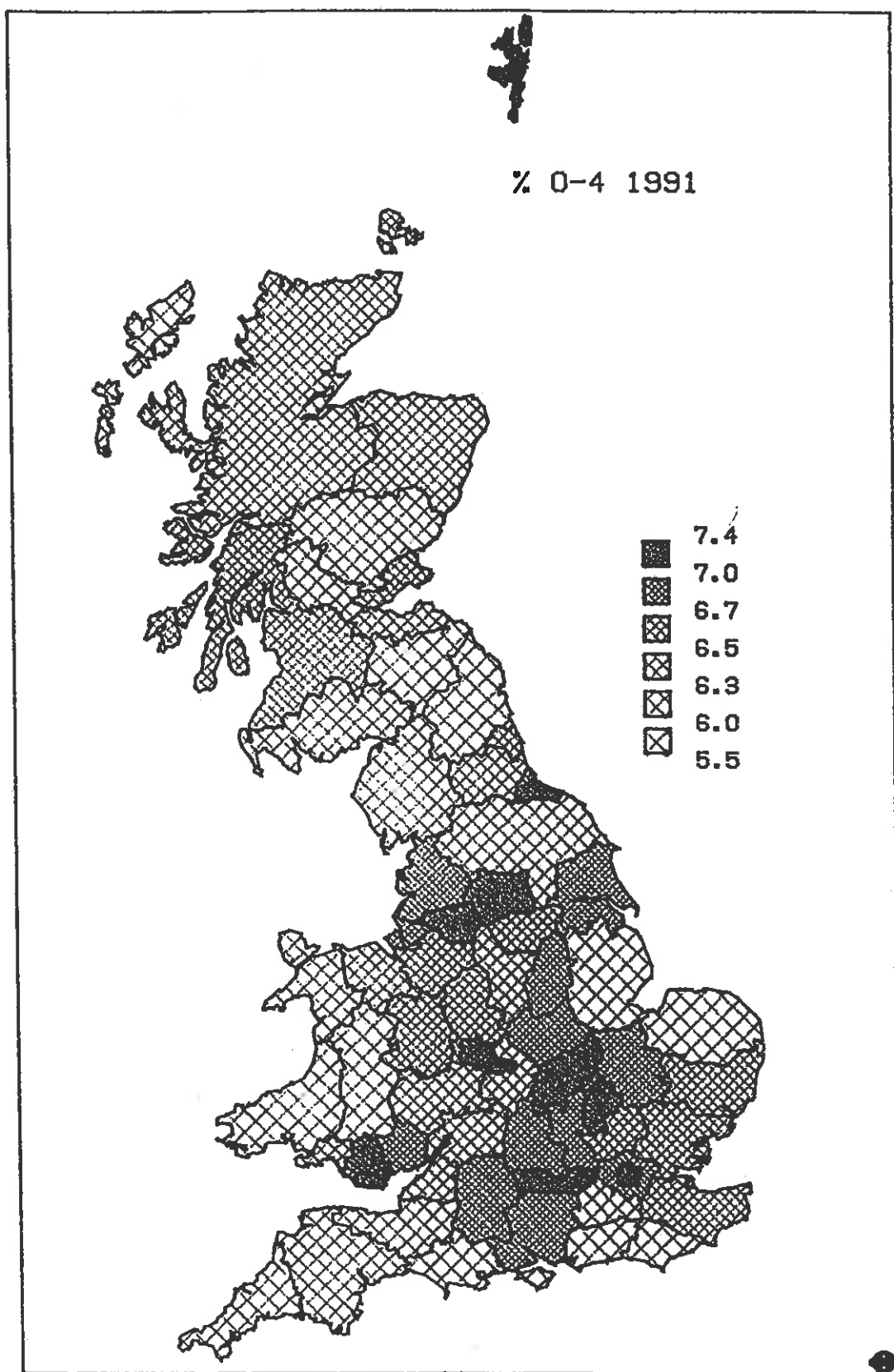
Figure 3. Percentage aged 0-4, GB counties/regions, 1991 Census

4.2   School children and adolescents: ages 5-15 and 16-17

The maps showing the percentage of the population of compulsory school age (Figure 4) and voluntary school age (Figure 5) shows that some shift has occurred in these age groups compared with infants. Areas outside metropolitan cores are more important, particularly in Northern Scotland, though the degree of dispersion is not great.

4.3   Young adults: ages 18-29

This age group has its highest concentration in the counties containing most opportunities in further and higher education, and in the sectors of the economy which graduates move to (Figure 6). Care must be taken in interpreting the statistics for the younger part of this age range (18-24). Many at these ages will be in higher education (up to 30% in some areas) but the Census Monitor table records students at their usual residence. For most undergraduates this will be their parental residence and they will have a different term-time residence. However, a small minority of undergraduates, most foreign students and most postgraduates will have reported their term time address as their usual residence. Further investigation of the different ways students can be mapped will be possible using Table 10 in the Local Base Statistics which records students by term-time address for all LBS areas and Table 100 which provides the matrix doubling clasifying students by usual and term-time residence. The capital counties of Wales (South Glamorgan) and Scotland (Lothian region) are present in the highest sextile. This age group exhibits the greatest variability across counties/regions with a range of 10 percentage points (or 50 percent of the medium) between the top ranking area (Inner London) and the bottom ranking (Isle of Wight) (Table 2). The counties with the smallest percentages in this young adult age group are peripheral, coastal and less densely populated.

4.4.   The younger middle aged: ages 30-44

Several shifts have occurred in this map (Figure 7) compared with the previous. The metropolitan counties outside London that house Universities (Greater Manchester, South Yorkshire, Nottinghamshire, West Midlands) are no longer in the top third of the distribution. Both Inner London and Lothian remain in the top sextile as attractive, job providing locations. But the most striking feature is the concentration of top sextile counties in

9

% 5-15 1991

▓	16.0
▨	14.3
⊠	13.9
⊠	13.6
⊠	13.3
⊠	12.9
⊠	11.5
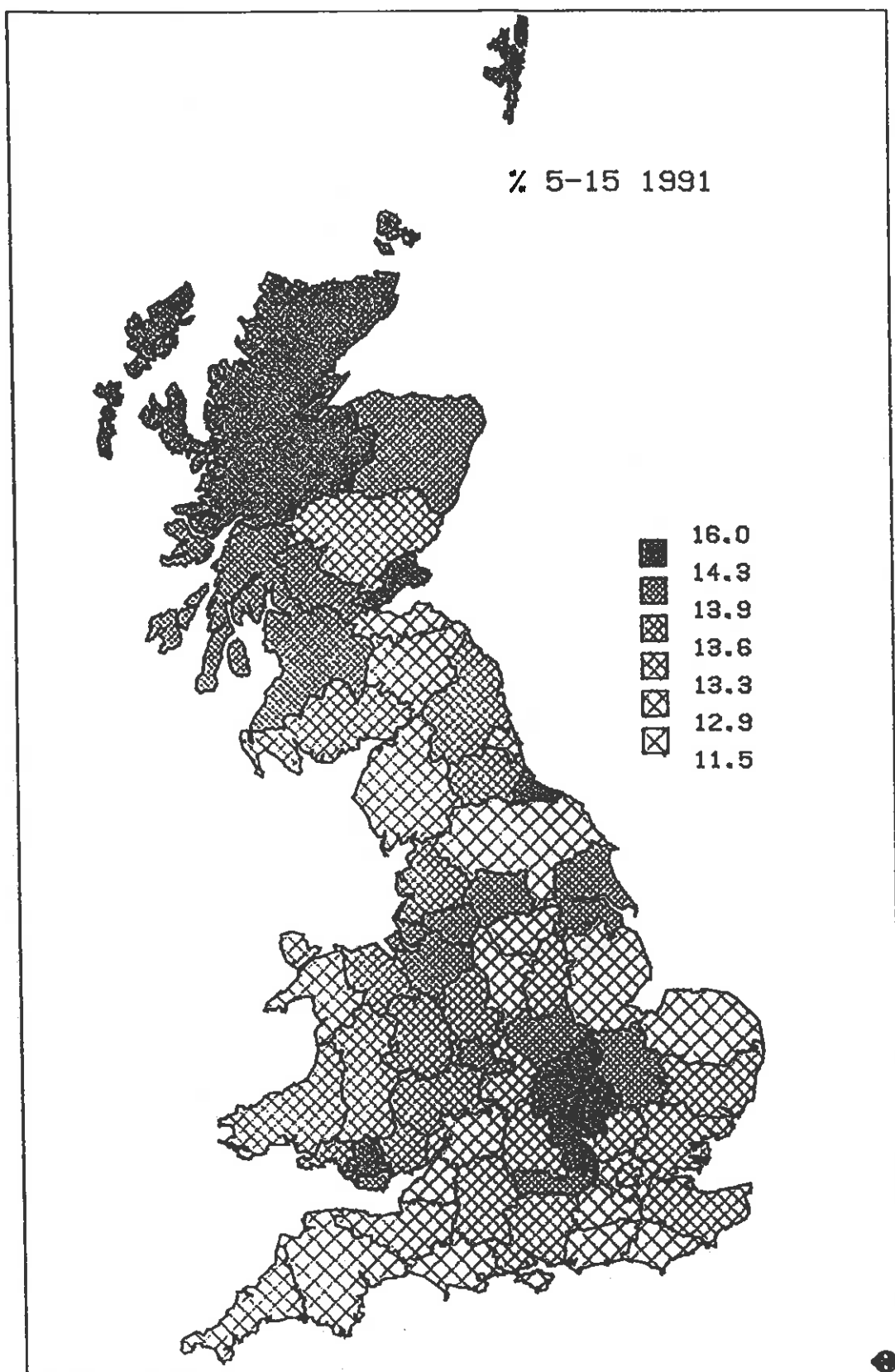
Figure 4. Percentage aged 5-15, GB counties/regions, 1991 Census

% 16-17 1991

■	3.0
▦	2.7
▨	2.7
▧	2.6
▧	2.6
⊠	2.5
◇	2.0
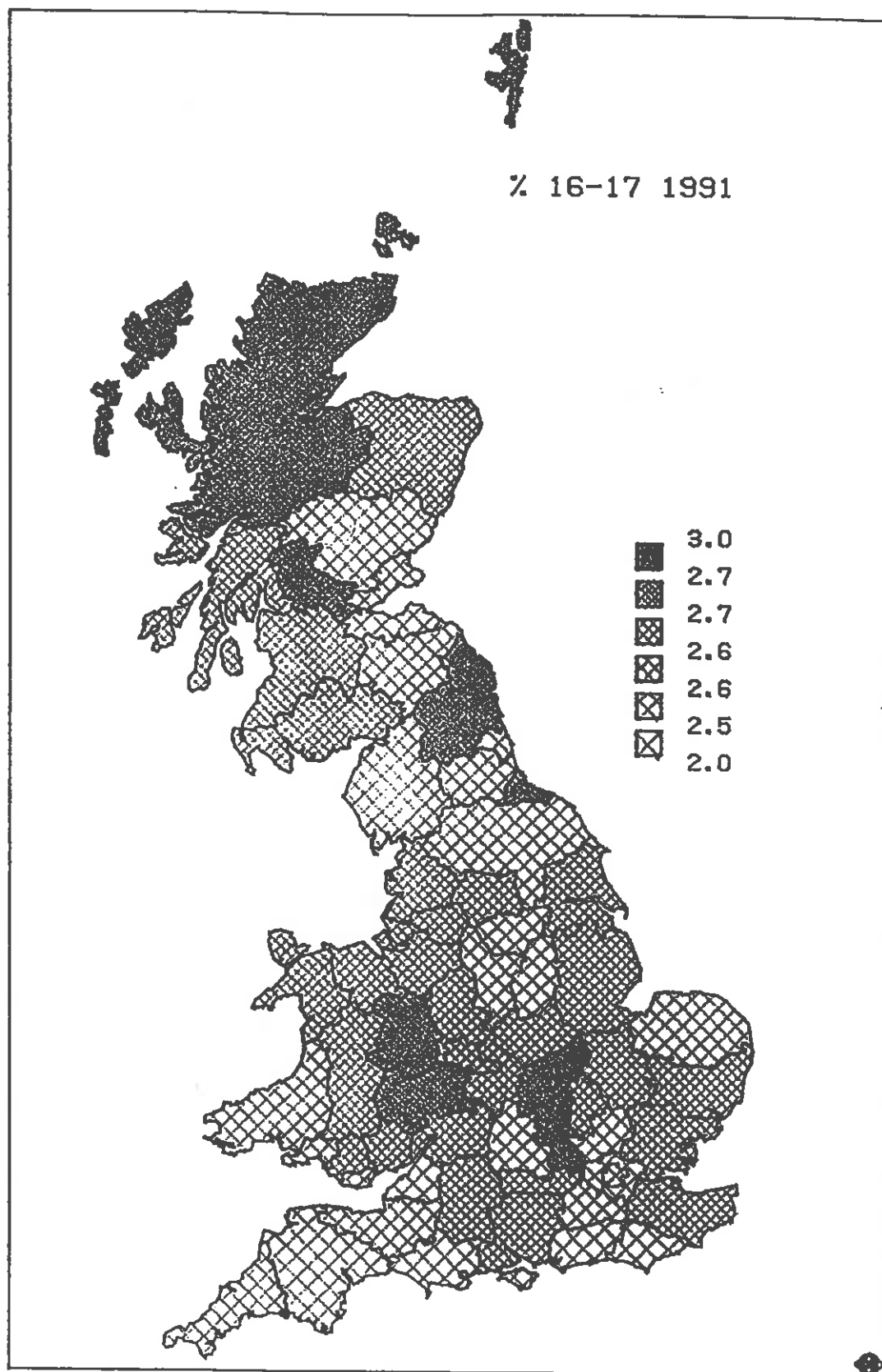
Figure 5. Percentage aged 16-17, GB counties/regions, 1991 Census
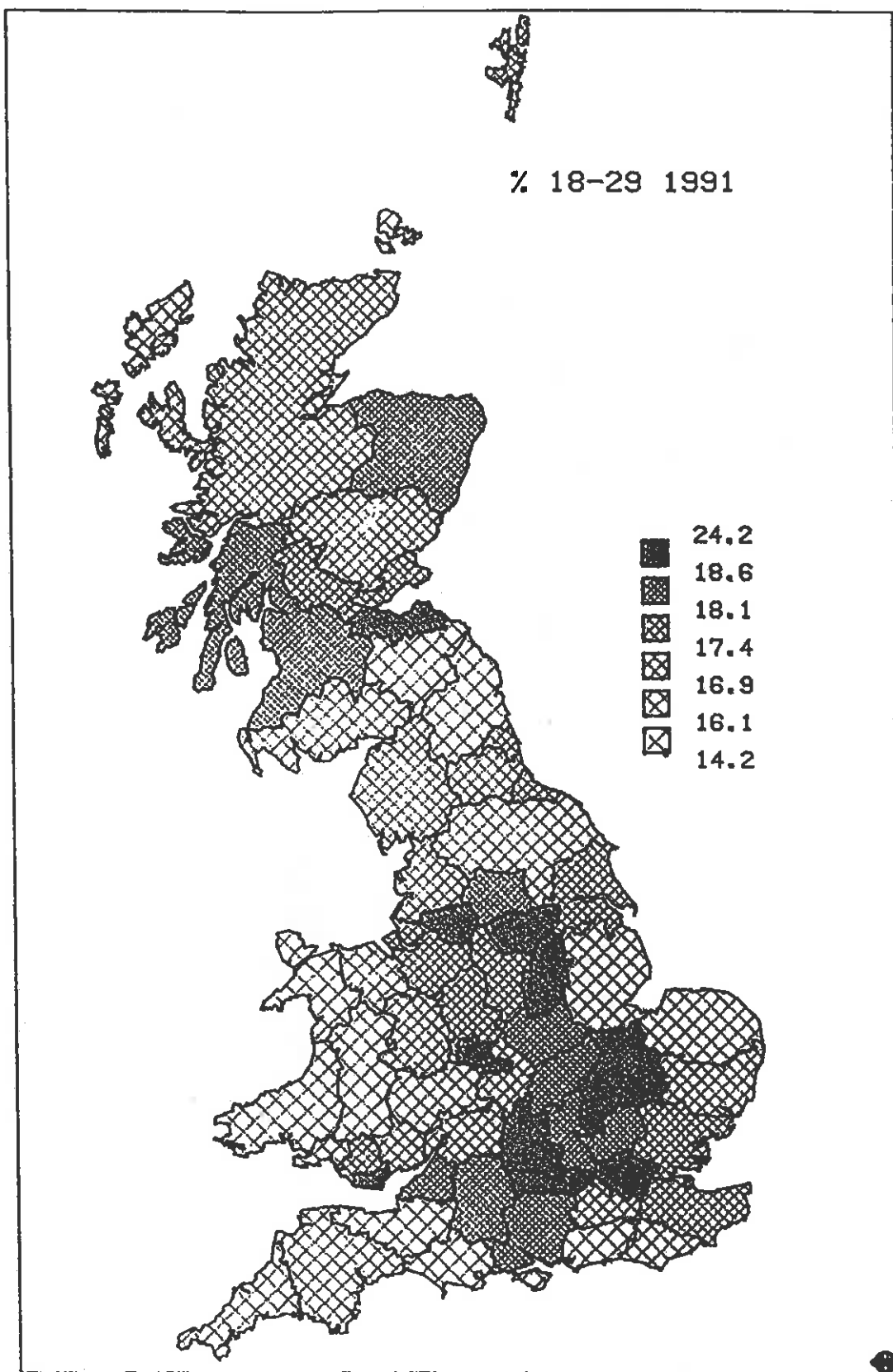
Figure 6. Percentage aged 18-29, GB counties/regions, 1991
Census

Table 2.

Dispersion statistics for age group percentages,
Great Britain, counties/regions, 1991 Census

Age Group	Lowest	Median	Highest	Range	As a % of median
0-4	5.5	6.5	7.4	1.9	29
5-15	11.5	13.6	16.0	4.5	33
16-17	2.0	2.6	3.0	1.0	38
18-29	14.2	17.4	24.2	10.0	57
30-44	18.9	21.2	23.4	4.5	21
45-pen	16.6	19.6	20.9	4.3	22
pen-74	9.1	12.0	15.5	6.4	53
75-84	4.3	5.5	9.0	4.7	85
85+	1.1	1.5	2.9	1.8	120

i

% 30-44 1991

▓	23.4
▨	22.3
▩	21.7
▩	21.2
▩	20.7
▩	20.3
▨	18.9
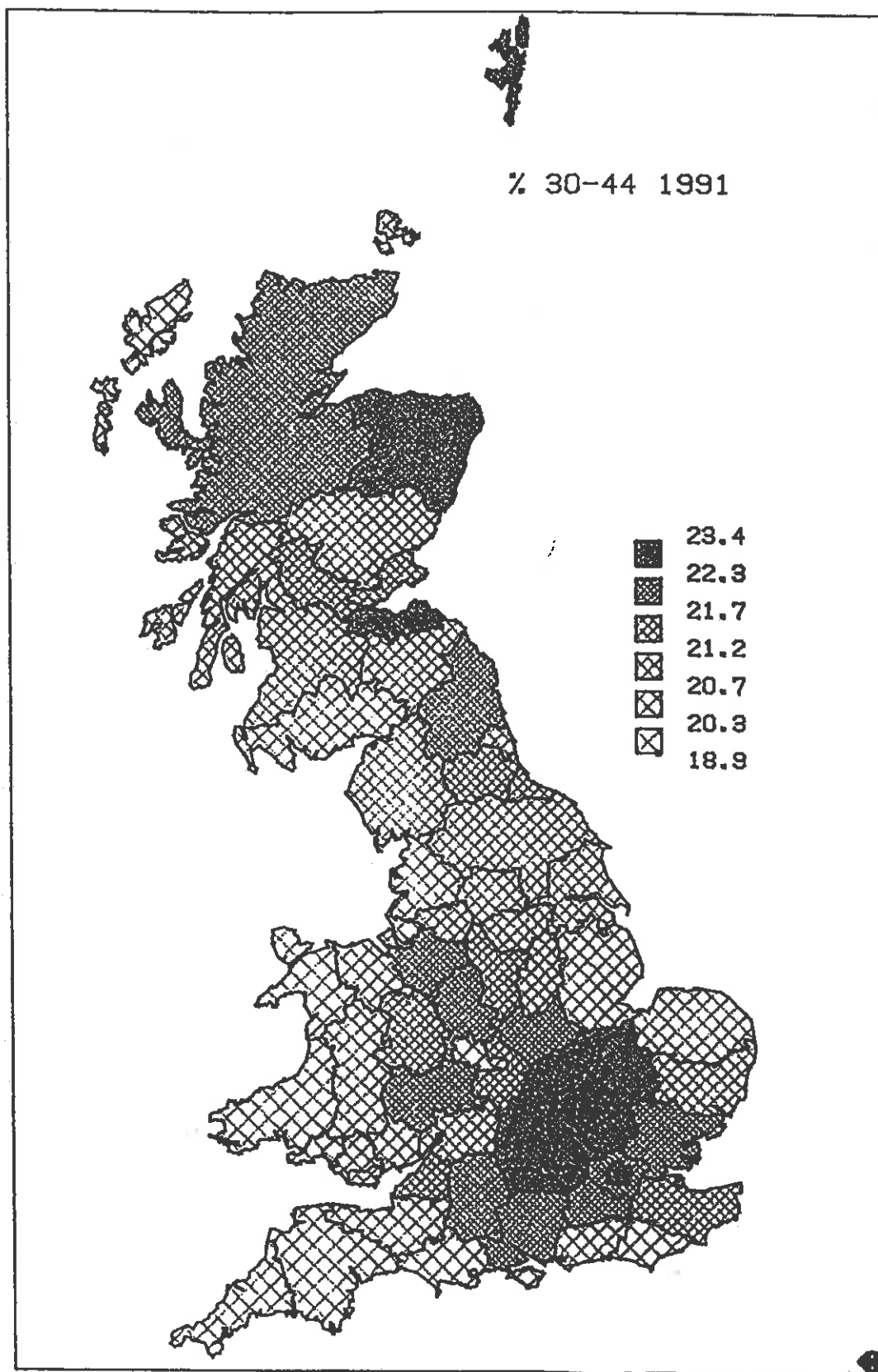
Figure 7. Percentage aged 30-44, GB counties/regions, 1991 Census

the region to the North West of London where the industrial
success stories of 1980s Britain were located: Oxford, Cambridge,
Northampton, Buckinghamshire, Bedfordshire and Berkshire - the
heart of Britain's high tech and research and development
activity.

Note the position of Grampian region in Scotland, where oil
related developments (servicing the offshire oil industry in the
North Sea) have created employment opportunities for persons in
this age group. The Scottish capital region, but not the Welsh,
also places in the top sextile.

4.5   The older middle aged: ages 45 to pensionable age

Figure 8 maps the percentage distributions for the age group from
45 to pensionable age (65 for men, 60 for women). It is clear
that a radical shift in the pattern has occurred compared with
the two previous age groups, although the range and variability
for these ages is relatively low. Interpretation of the map is
made difficult because the age group mixes two populations: those
still in work and those who have taken retirement earlier than
the statutory pensionable age. The former group are relatively
immobile and have probably aged in place after previous
migrations when younger, while the latter will have begun to
participate in the distinctive retirement migration.

Of the counties in the highest sextile, those in the West
Midlands together with Surrey probably contain aged-in-place
concentrations of suburbanised migrants from prior decades, while
the peripheral counties (in Wales, in Northern England, Cornwall)
probably receive early retirers.

At the other end of the distribution with low percentages in this
age group are the northern metropolitan counties (from whence
earlier retirees may have left) and the southern counties with
high concentrations of the younger middle aged.

4.6   The retired pensionable age to 74

Once the retirement age threshold is crossed, a completely new
pattern (Figure 9) emerges which is the reverse image of previous
maps of the 18-29 and 30-44 age groups. The counties in the top
sextile house 50% more persons in this age group in relative
terms (15% versus 10%) than do counties in the bottom sextile.
The pattern shift is undoubtedly the product of migration around

15

% 45-pen 1991

▓	20.9
▓	20.3
▨	20.1
▨	19.6
⊠	19.3
⊠	18.8
⊠	16.6
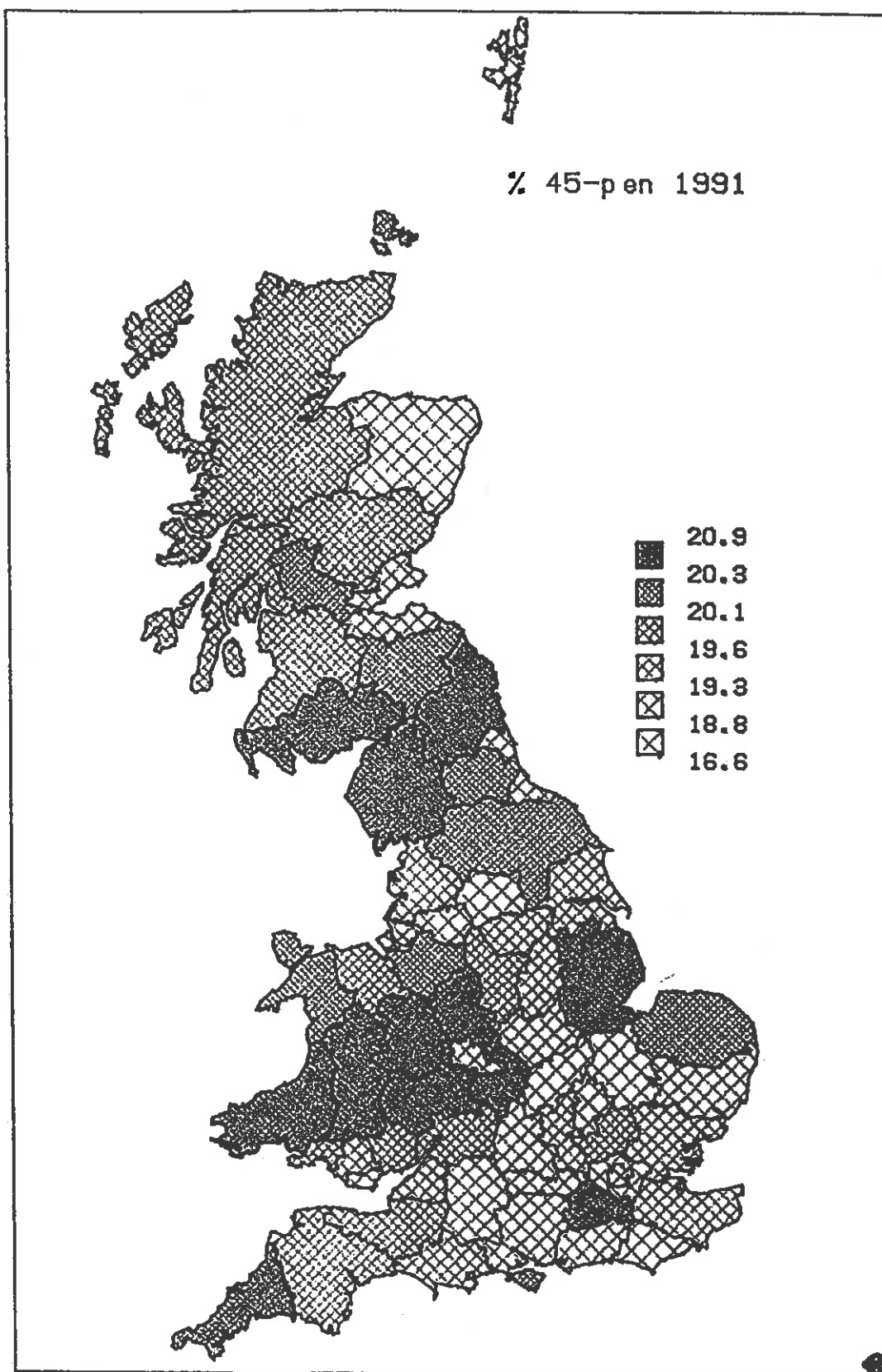
Figure 8. Percentage aged 45-pensionable age, GB counties/regions, 1991 Census

% p en-74 1991

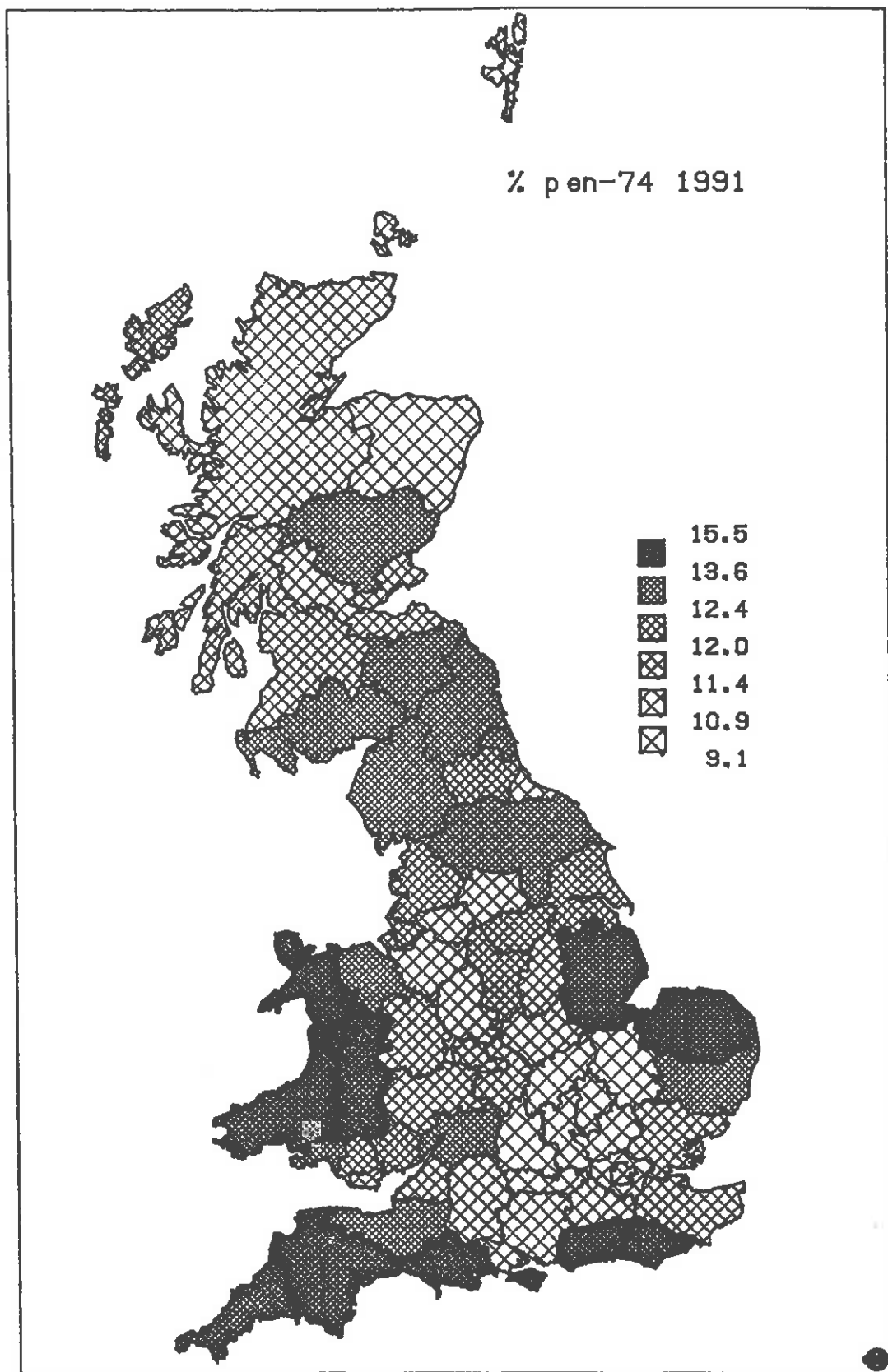|	
■	15.5
▨	13.6
▨	12.4
▨	12.0
▨	11.4
▨	10.9
▨	9.1

Figure 9. Percentage aged pensionable age to 74, GB counties/regions, 1991 Census

retirement from the counties of work (Central England, Scotland, South East Wales) to the counties of leisure (Southern and Eastern coastal England, North and West Wales), the England/Scotland border area). Previous research using 1981 Census and 1980s National Health Service Central Register (NHSCR) migration data (Rees, Stillwell and Boden 1989; Stillwell, Rees and Boden 1992) has shown that although the upturn in migration activity at retirement is not very marked in overall terms, it is extraordinarily efficient in effecting population redistribution. Retirees migrate from the work counties to the leisure counties, but rather few make the return trip, whereas there are always substantial counterstreams in the working age migration traffic.

It has been suggested in previous research that the counties/regions with retirement age concentrations are closely linked with the closest metropolitan region exporting retirement age migrants. That is, that around retirement counties are well defined in-migration fields. Use of the inter-area migration data (between Family Health Service Authorities) derived from the NHSCR and the inter-district data contained with the Special Migration Statistics (SMS) from the 1991 Census should make the testing of these interpretations.

4.7   The elderly: ages 75 to 84 and 85 and over

There is a very high correlation between the maps (Figures 10 and 11) of the elderly (aged 75 or over) and the retirement age group. However, the interpretation does need modification. Migration activity falls off at these ages and there is some return migration to work counties, mainly for family or health reasons (these suggestions will need detailed verification through analysis of the NHSCR and SMS datasets). The alternative interpretation is that the concentrations of the elderly represent ageing-in-place of cohorts previously redistributed around retirement some 10 to 20 years earlier.

However, one additional factor needs to be taken into account in interpreting the spatial distributions of the elderly, that of mortality. There are strong differentials in mortality both on a South-East-North West gradient and between metropolitan and non-metropolitan counties. The chances of a 65 year old in Dorset surviving 10 years are much higher than the same aged person living in Strathclyde, for example.

18

% 75-84 1991

■	9.0
	6.6
	5.9
	5.5
	5.2
	5.0
	4.3
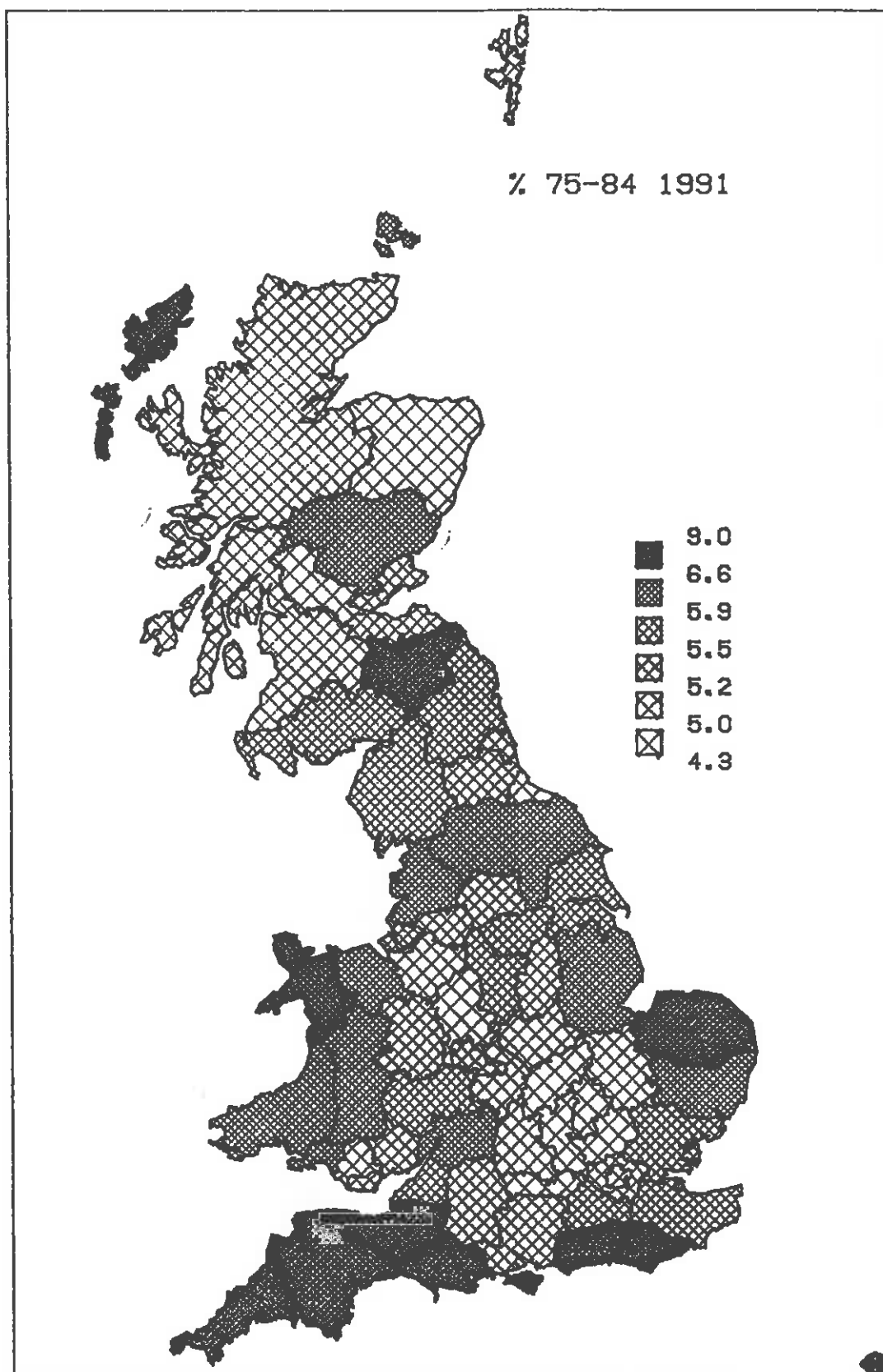
Figure 10.   Percentage aged 75-84, GB counties/regions, 1991
Census

19

% 85+ 1991

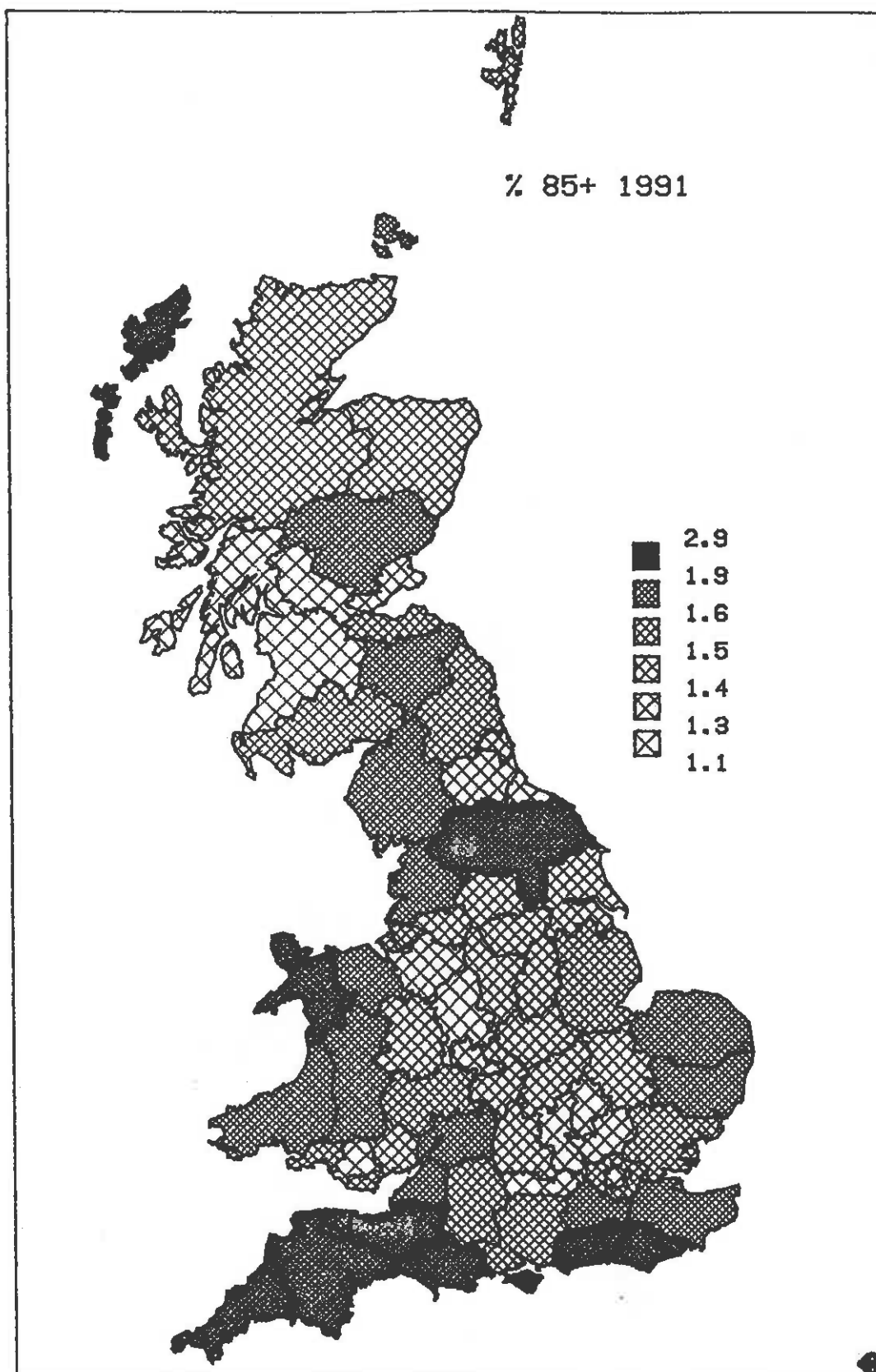|	
■	2.9
▨	1.9
▨	1.6
▨	1.5
▨	1.4
▨	1.3
▨	1.1

Figure 11.   Percentage aged 85+, GB counties/regions, 1991
                 Census

20

Whether this general interpretation applies to the elderly concentration in the Western Isles (in the top sextile in Figures 10 and 11) needs investigation because it is not linked to either a high percentage in the retirement age group nor to particular favourable mortality. Here we may be observing a rural population left behind as a result of decades of emigration by younger generations.

4.8   Towards a general model?

In this part of the paper we have looked at the spatial patterns of age groups at a particular cross-section in time. The age composition of any county's population in 1991 is a complex palimpsest of demographic events over the 20th Century. Each age group receives its initial input through birth in the county or region, and then in each time interval since birth there will be further inputs to the birth cohort from in-migration and further subtractions from the birth cohort through death and out-migration.

The birth cohort histories may differ radically in terms of initial size and subsequent events. As is established in the next section of the paper, identification of of these sources of variation even for one time period is a complex task. The following story must therefore be regarded as a very preliminary hypothesis.

(1)   The life course begins with a concentration of independent adults, new households and recently formed couples and families in the larger metropolitan areas and work counties of the country.

(2)   The concentration of young children in these areas is linked to the distribution of young parents.

(3)   Two factors cause young adults and families to move away from the metropolitan centres: the job opportunities offered in more dynamic local economies in the work counties outside the metropoli and a desire for a more suburban life style.

(4)   The families will then age in place into later middle years at their favoured niches. The differences between the younger and older working age distributions reflect the

changes in job opportunities in the respective periods of career establishment.

(5) At retirement (between 55 and 70) the couple, already freed from family responsibilities, is freed from workplace ties, reevaluates the current residential location and moves to better amenity locations.

(6) The life course winds down with a period of ageing in place in the location chosen for retirement and ends with death.

There are many objections to the model as presented. It takes a very middle class view of the migration process over the life course; it makes assumptions about a family life course that is less and less typical; it constructs a dynamic time-space-age model of population evolution on very partial, single time point data.

However, the maps of the different age groups reveal sufficient evidence of such a systematic evolution of the geography of population with the life course that further investigation of this model is justified.

5. LIMITING LONG-TERM ILLNESS: A NEW MAP

The Census Monitors report in the same table (Table E) as the age variables the percentage of the population reporting limiting long-term illness. The question producing these statistics was asked for the first time in the 1991 Census. This variable is intended to aid Local Authorities in planning provision of home based services in 1993 under the new "Care in the Community" initiative in which overall responsibility for care of the chronic ill and disabled moves to Local Authority departments of Social Services. The question has been used previously in the General Household Survey. In successive GHS reports in the 1970s and 1980s the percentages reporting limiting long-term illness rose steadily. This should probably be interpreted as an indicating increasing awareness of illness and a reduction in acceptance of illness as a necessary correlate of increasing age.

Figure 12 plots the percentage for counties and regions while Figure 13 provides finer detail for districts. The map patterns closes resembles those for mortality reported in an unpublished study by the author (Rees 1989) and by Howe (1963) in his cartographic work on mortality. Figure 14 displays life expectancy and standardised mortality ratios

22

% ill 1991

20.5
15.4
13.9
13.1
11.8
10.8
8.9
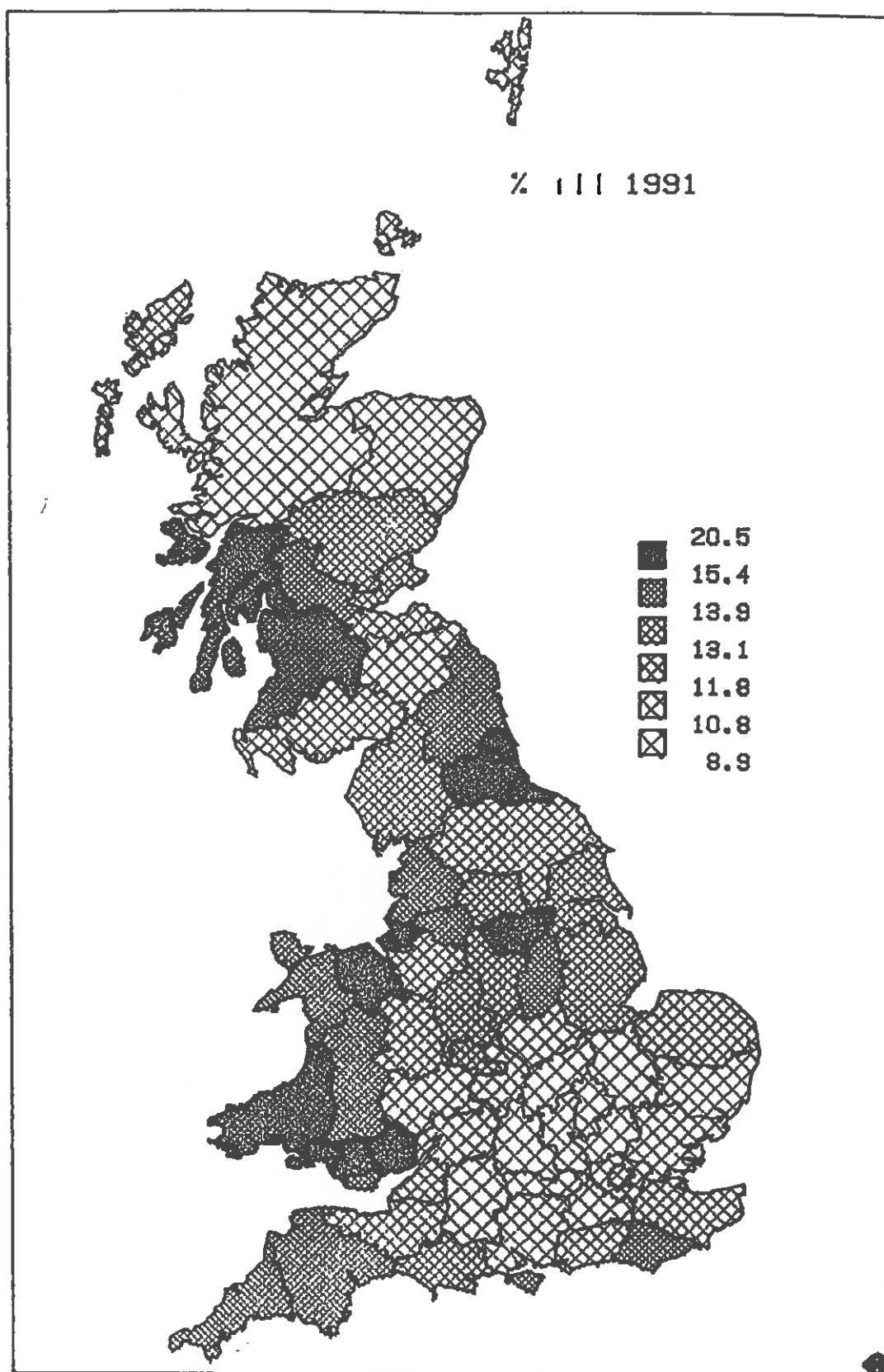
Figure 12.   Percentage reporting limiting long-term illness,
GB counties/regions, 1991 Census

23

% ill 1991

26.2
15.5
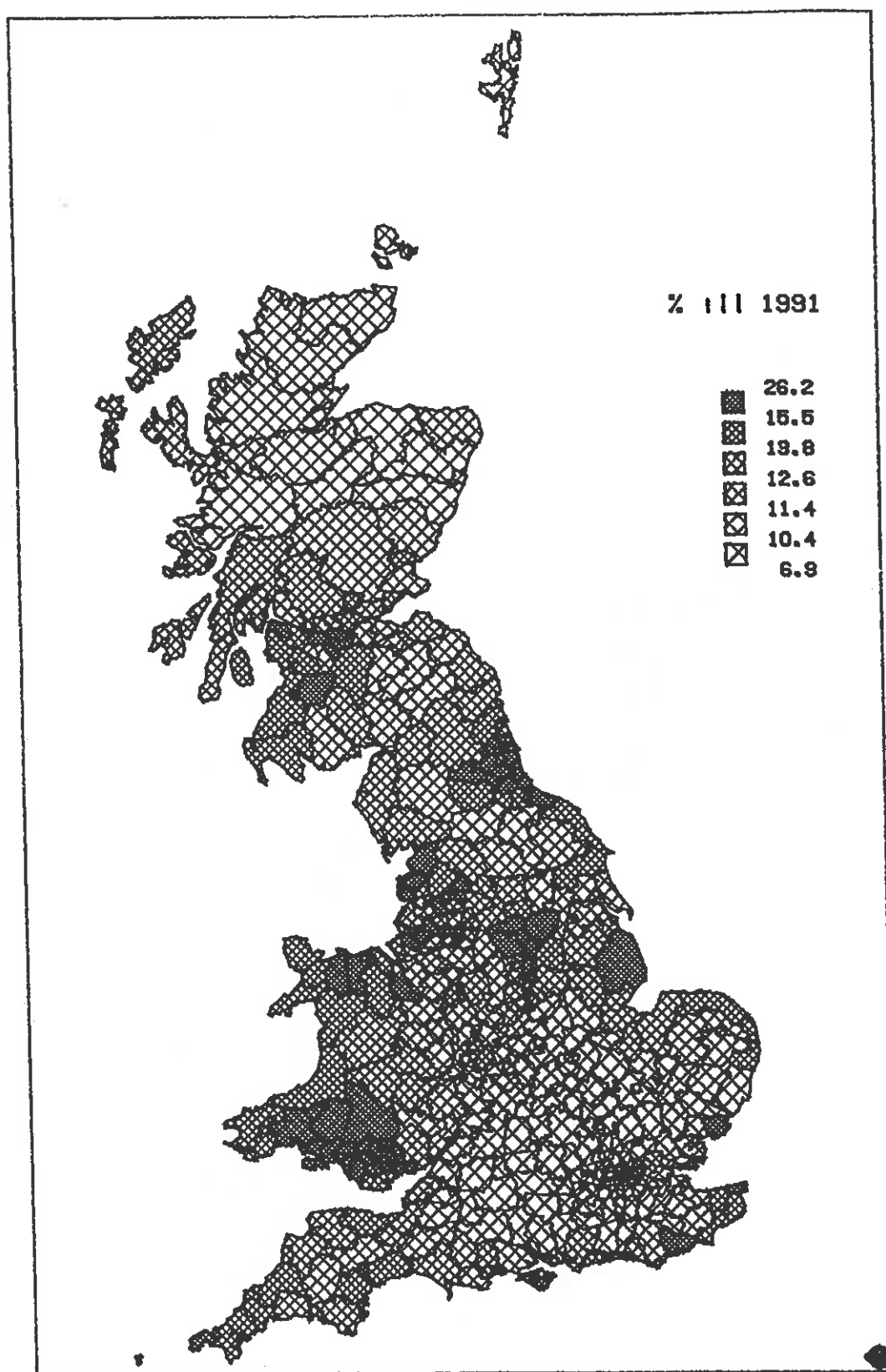19.8
12.6
11.4
10.4
6.9

Figure 13.   Percentage reporting limiting long-term illness,
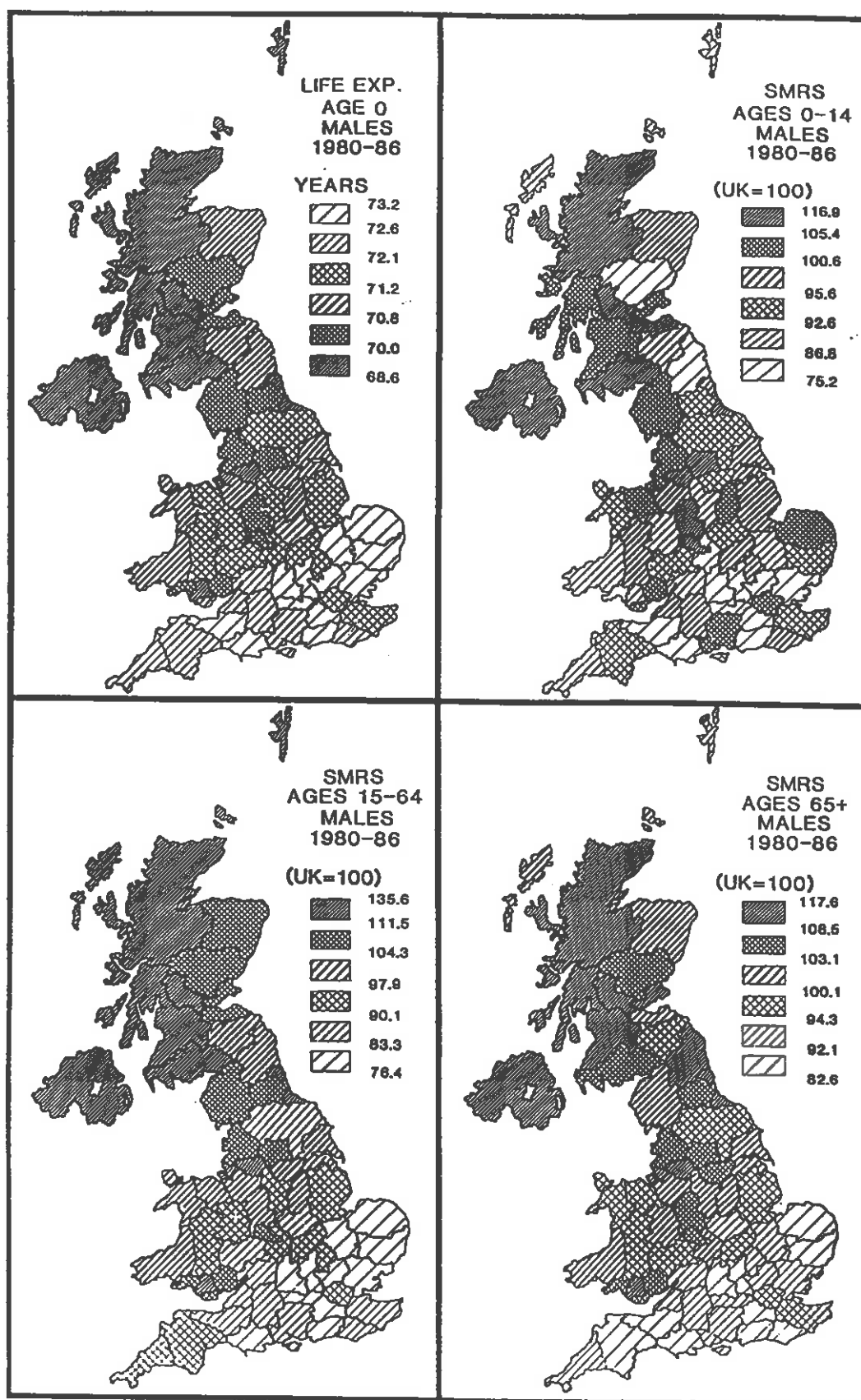   GB districts, 1991 Census

24

Figure 14.   Life expectancy at birth for males, UK counties/regions, 1980-86

for 1980-86. Both the morbidity maps and the mortality maps show simultaneously:

(1)   a gradient from the south and east towards the north and west from low to high mortality.

(2)   some differences between the most densely populated areas more illness, more mortality) and less densely populated areas (less illness, less mortality); and

(3)   particularly high levels of illness and of mortality from lung conditions (pneumoconiosis, silicosis, emphysena, bronchitis, lung cancer) in coalfield counties (Durham, South Yorkshire, Nottinghamshire, Gwent, Mid Glamorgan and West Glamorgan)

Two differences stand out between the morbidity and mortality maps. The first is that the Highlands and Island Areas fall in the highest mortality category (less than 70 years life expectancy, over 111.5 SMR for males aged 15-64) but report low percentages of limiting long-term illness. The second anomaly applies to the counties of north and west Wales which fall in the upper third of the illness distribution but in the middle third of the mortality distribution.

The links of the limiting long-term illness maps with the age pattern are weak, although an elderly age structure may account for the higher position of counties such as Cornwall, Devon, Dorset and East Sussex in the illness map than in the mortality map.

Testing of these suggested hypotheses through use of the better Local Base Statistics and through connection to the county and district mortality indicators is indicated.

6.   CHANGES, 1981-91

6.1   The under-enumeration problem

So far, it has been assumed that the 1991 Census statistics, as reported in the Census Monitors can be regarded as reliable statistics. However, detailed investigation by the Census Offices (OPCS 1992) has revealed about 2 per cent under-enumeration. Table 3 sets out the sources of the error, as reported for England and Wales. Some 59% of the under-enumeration estimated by OPCS must be attributed to the failure of young persons to provide information on returned Census forms or to provide those forms at all. OPCS (1992b) provides detailed advice on "What users of census data should do":

Table 3. Level and source of under-enumeration in the 1991 Census, England and Wales

Source	Number added to obtain estimate		% of under-enumeration
1991 Census Count of usual residents (Table D of Census Monitors)	49,890		
Net student balance	+ 58		
Changes 21 April to mid 1991	+ 43		
Natural change		+ 34	
Net migration		+ 9	
Under-enumeration in Census	+ 965		100
Census Validation Survey adjustments		+292	30
Over-imputation		- 85	- 9
Missed/Misclassified dwellings		+200	21
Persons in responding households		+177	18
Enhancement of Census count of infants		+ 21	2
Enhancement of Census count of Armed Forces		+ 79	8
Enhancement of persons aged 1-44 and 85+		+572	59
Provisional rebased mid-1991 population estimate for England and Wales	50,955		

Source: OPCS (1992c), p.5.

Notes: population figure are in 1,000s

"There are two circumstances, however, in which the user
might find it beneficial to take special action. The first
is where the user requires absolute numbers by age and sex
for a particular area. Here, users may wish to use the
mid-year population estimates. If so, they should take
into account the definitional differences, particularly for
students.

The second circumstance is where the user is studying
census characteristics which depend strongly on sex and age
and where comparisons might be slightly distorted by the
known sex/age bias in the missing 2 per cent. The user can
check this distortion and, if necessary, correct for it, by
making some adjustments for the relevant sex and age groups
by using boost factors ..."
OPCS (1992b), pp.10-11

These boost factors are set out in Table 4.

These factors are derived from a comparison of the rolled forward 1991
population estimates based on the 1981 Census with the 1991 Census
figures. The Census data report male minorities in some of the young
adult ages, whereas most demographic evidence (birth and death
registration, and previous censuses) points to male majorities in all
the younger ages stemming from a 6% surplus of boys over girls at birth
which is steadily whittled away by ages 45-50 through higher male
mortality.

In the analysis of section 4, these boost factors were not applied
(though they will be in future analysis). Would this have made a
significant difference to the maps and interpretation, bearing in mind
that OPCS provide no area specific estimates for the boost factors?

Table 5 reports some sample computations for North Yorkshire. The
table reports three alternative estimates of the county age
distribution: that given in Table E of the Census Monitor (Column 1),
that produced by applying OPCS's boost factors to the implied
populations of Table E (column 5) and that calculated from the mid-year
population estimates. The boosted Census figures give a distribution
close to the estimate percentages but there is relatively little
alteration in the overall distribution. The largest change is, as
expected, for the 18-29 age group which increases its share by 0.6%,
while the age groups above 30 lose 0.1% or 0.2%. Bearing in mind that
these sort of changes would occur in all counties, we can be confident

Table 4. Factors of census counts/population estimates for estimated under-enumeration

Age	Persons	Males	Females
All ages	1.02	1.03	1.01
0- 4	1.03	1.04	1.03
5- 9	1.03	1.03	1.02
10-14	1.02	1.02	1.01
15-19	1.02	1.03	1.01
20-24	1.06	1.09	1.02
25-29	1.06	1.08	1.03
30-34	1.02	1.03	1.01
35-39	1.01	1.02	1.00
40-44	1.01	1.01	1.01
45-84	1.00	1.00	1.00
85+	1.05	1.10	1.04

Source: OPCS (1992b), p.10

TABLE 5.   A comparison of Census adjusted Census and mid-year population age distribution for North Yorkshire, 1991

Age Group	Census Monitor Table E (1)	Implied population (2)	Interpolated inflation factor (3)	Inflated population (4)	Inflated % (5)	Mid-1991 estimate (1000s) (6)	% (7)
0- 4	6.0	42,130	1.030	43,394	6.1	43.3	6.0
5-15	12.6	88,472	1.025	90,684	12.7	92.3	12.8
16-17	2.5	17,554	1.020	17,905	2.5	17.9	2.5
18-29	16.8	117,963	1.053	124,215	17.4	125.6	17.4
30-44	21.1	148,156	1.013	150,082	21.0	152.0	21.1
45-pen	20.2	141,837	1.000	141,837	19.8	143.8	19.9
pen-74	12.6	88,472	1.000	88,472	12.4	88.6	12.3
75-84	6.3	44,236	1.000	44,236	6.2	44.6	6.2
85+	1.9	13,341	1.050	14,008	2.0	13.9	1.9
Total	100.0	702,161	1.020	£714,833	100.0	720.9	100.0

Sources by column:

(1)   Table E in the Census Monitors. Crown Copyright

(2)   Total population for county in Table E x column ¾ ÷ 100

(3)   OPCS 1992b, P.10

(4)   Column (2) x Column (3)

(5)   Column (4) as % of sum of Column age group totals

(6)   Estimated from OPCS's file of provisional population estimates of district populations for mid-1991. The national age distribution by single years of age (OPCS 1992c) is used to estimate 15, 16-17 and 18-19 year olds for use with the five year age group data provided.

that our maps derived from Census Monitors show the real geography of age in Britain.

6.2 The measurement of change

Table E in the Census Monitors reports the percentage age distributions for the 1981 and 1991 Census populations using a 1981 usually resident population base. This excludes any imputation for absent households. Direct comparison of the percentages provides some useful information but doesn't report directly on changes in age group sizes. To estimate these changes the following computations were carried out on the 1981 base versions of the statistics:

$p91$ = implied population in age group in 1991
     = total population in 1991 x (% in age group/100)

$p81$ = implied population in age group in 1981
     = total population in 1981 x (% in age group/100)

% change, 1981-91 = 100 x $(p91-p81)/p81$

Ideally, OPCS's boost factors (from Table 4) should have been applied to the 1991 Census populations and other boost factors applied also to the 1981 Census populations where underenumeration for England and Wales was estimated to be 215,000 or 0.45 per cent (OPCS 1990, Table 1, p61), though no age breakdown is provided. On average we should expect percentage change figures from comparison of unadjusted Census data to be 2.0-0.45 = 1.55 per cent too low.

Table 6 provides some sample comparisons for the County of North Yorkshire in which the percentage change in each Census Monitor age group is compared with the corresponding percentage changes based on mid-year estimates. The table shows that the two sources report the same direction and level of change, and that they are on average 1.7% apart (total row). However, the differences are a good deal larger than those reported for 1991 above in Table 5.

Caution therefore must be exercised in interpreting the maps of age group change which are now presented. On average, the percentage changes will be about 1½% too low. However, such an adjustment is relatively small in relation to the range of percentage changes reported, and, in any case could only be

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Table 6. Population change, 1981-91, using Census Monitor and population estimate data, North Yorkshire

Age groups (County Monitor Table E)	Percentage change 1981-91 using Table E 1981 base population	Percentage change 1981-91 using 1981 mid-year and 1991 provisional mid-year estimates
0-4	16.5	17.7
5-15	-14.5	-11.6
16-17	-19.8	-27.5
18-29	9.4	10.9
30-44	12.3	15.1
45-pen	7.0	9.8
pen-74	- 1.6	- 0.2
75-84	18.2	19.6
85+	66.0	59.8
Total	4.8	6.5

Source: Census Monitors and Mid-Year Estimates. Crown Copyright

applied uniformly across the country. Attention therefore will be confined to major rather than minor differences when the maps of change are interpreted.

6.3   The general geography of change

Whereas the maps of age structure show several different patterns, the patterns of age change are much more uniform, as the correlations reported in Table 7 testify. All of the age group change variables are positively correlated with change in the all age population and all but two show positive correlation coefficients above 0.5.

Figures 15 shows the map of total population change. The overall pattern of change is dominated by high growth in a belt of counties in an arc to the north and west of London running from Norfolk in the East to Cornwall in the West. Outside of this arc are the two western counties of the West Midlands region and the Highland region of Scotland. Counties in the second sextile lie adjacent to the southern belt except for Grampian region and the county of North Yorkshire.

Figures 16 to 18 put together the maps of change for the nine age groups. These composite diagrams shows the similarity of age group change patterns. However, they also makes clear that the directions and amounts of change in the age groups differ greatly. The average direction of county/region change reflects the cohort replacement process described for the national age structure in section 2 (see Table 8). However, around this mean level of change is considerable variation produced by migration differences between counties/regions and, in the older age groups, mortality differences. The county/region differences mean that the direction of change in some age groups can have the opposite sign to national change. This happens in the 0-4, 18-29, 45-pensionable age, pensionable age to 74 and 75 to 84 age groups (Table 8).

Overall change in county/region populations is rather moderate (+or-10% around 2% growth), changes in individual age groups can be very high indeed in either loss or gain terms. For example, East Sussex posts a 30% gain in 0-4 year olds while the Western Isles show a 16% loss. Cambridgeshire limits the loss for the school ages (5-15) to 7% while Strathclyde loses a quarter in this age group. Cambridgeshire records a 16% gain in young adults (18-29) while Merseyside manages a 12% loss. Lincolnshire

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Table 7. Correlations between overall population change and change in the age group populations

Age Group	Pearson correlation coefficient with percentage change in total population
0- 4	0.45
5-15	0.73
16-17	0.77
18-29	0.84
30-44	0.72
45-pen	0.85
pen-74	0.51
75-84	0.65
85+	0.39

Notes:

1. Pearson's r is computed for the 67 counties/regions of Great Britain.

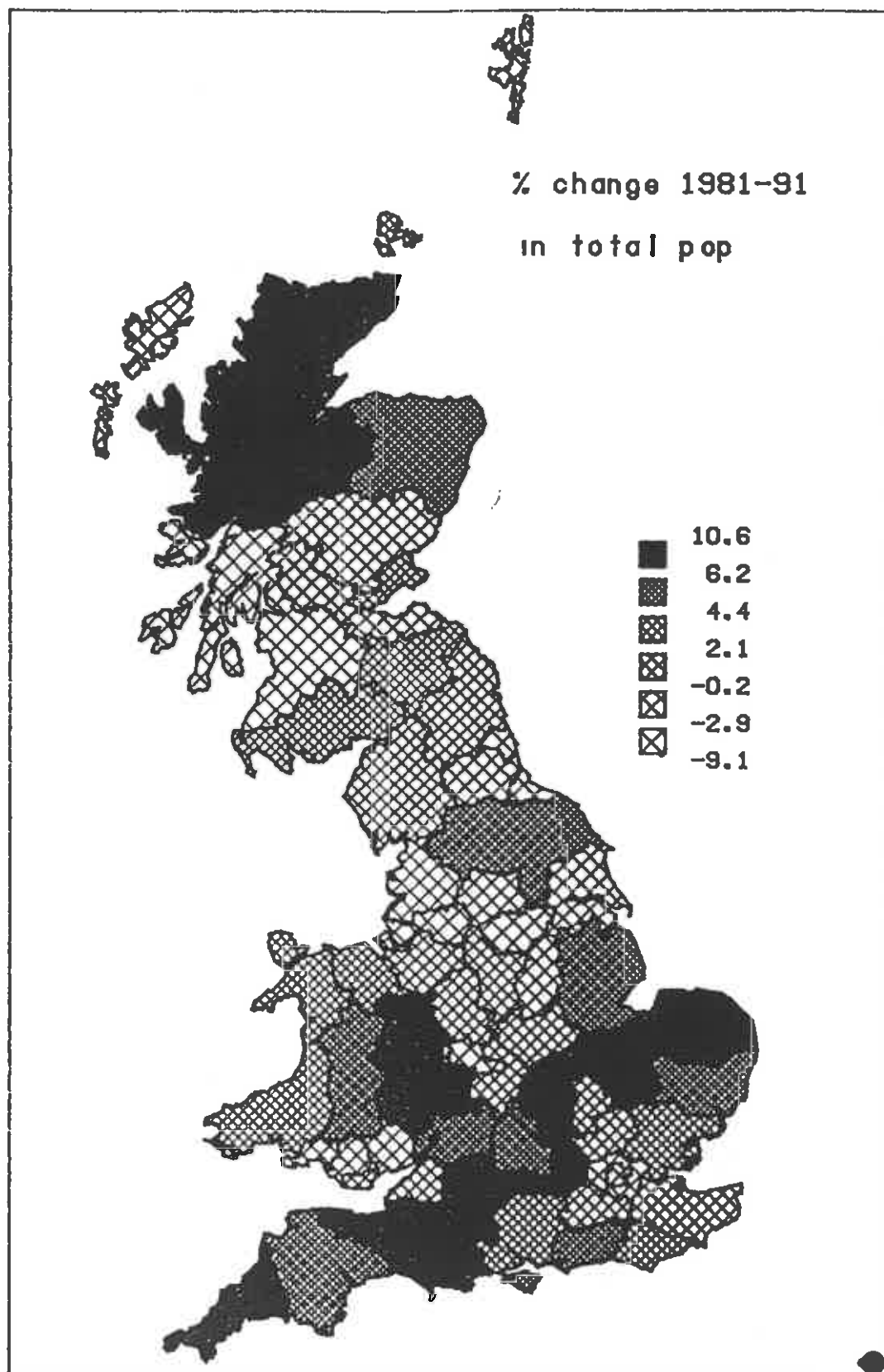% change 1981-91
in total pop

10.6
6.2
4.4
2.1
-0.2
-2.9
-9.1

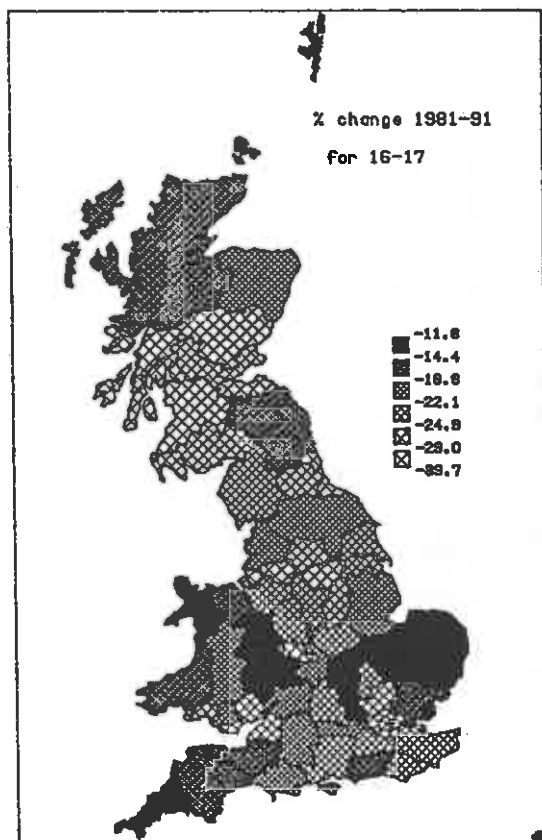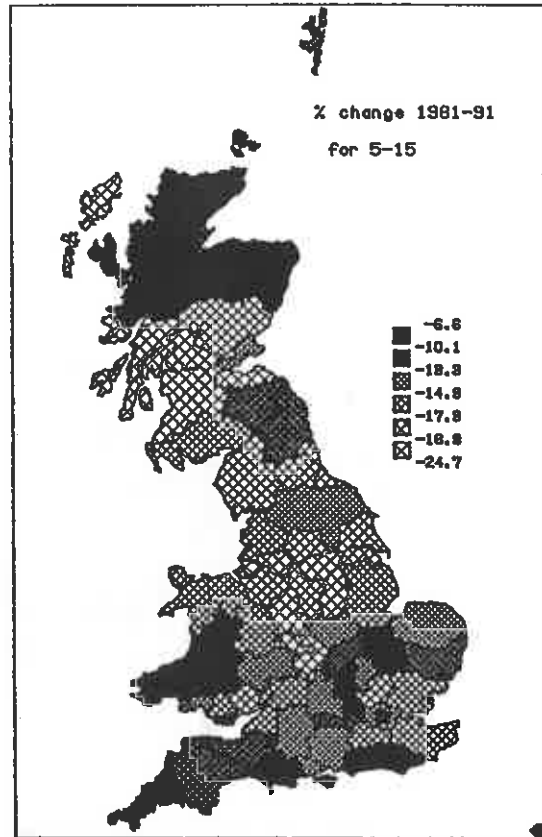Figure 15.   Percentage change, 1981-91, GB counties/regions,
total populations

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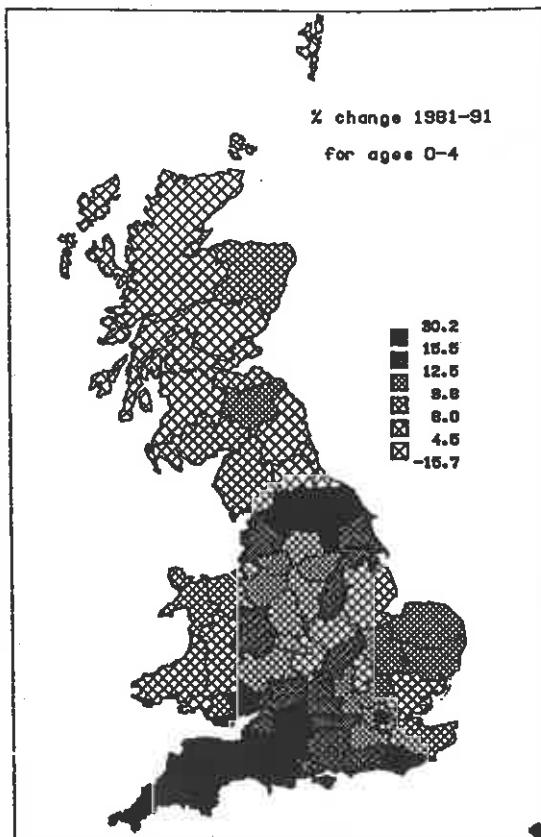Figure 16.   Percentage change, 1981–91, GB counties/regions, age groups 0-4, 5-15 and 16-17

% change 1981-91
for 18-29

15.6
11.8
7.8
5.4
2.8
-0.8
-12.1

% change 1981-91
for 30-44

21.8
15.2
11.6
9.2
7.4
5.2
-0.0

% change 1981-91
for 45-pen

16.8
9.4
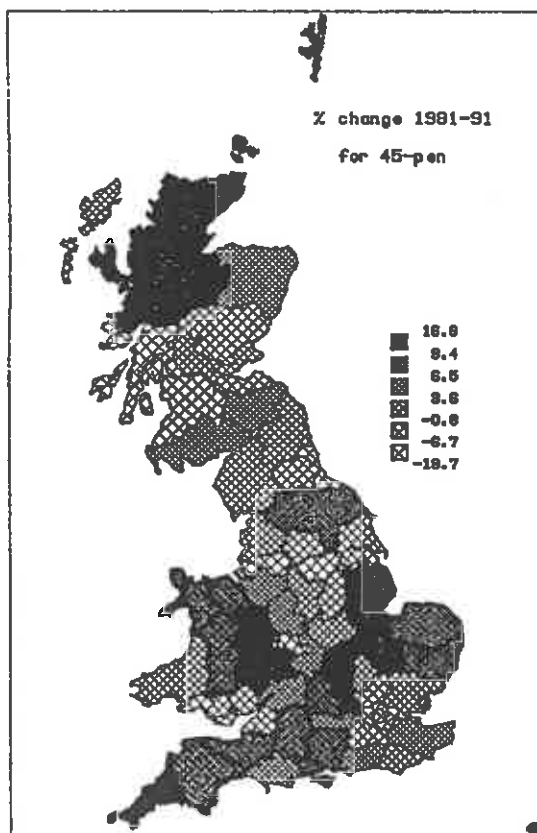6.5
3.6
-0.6
-6.7
-19.7
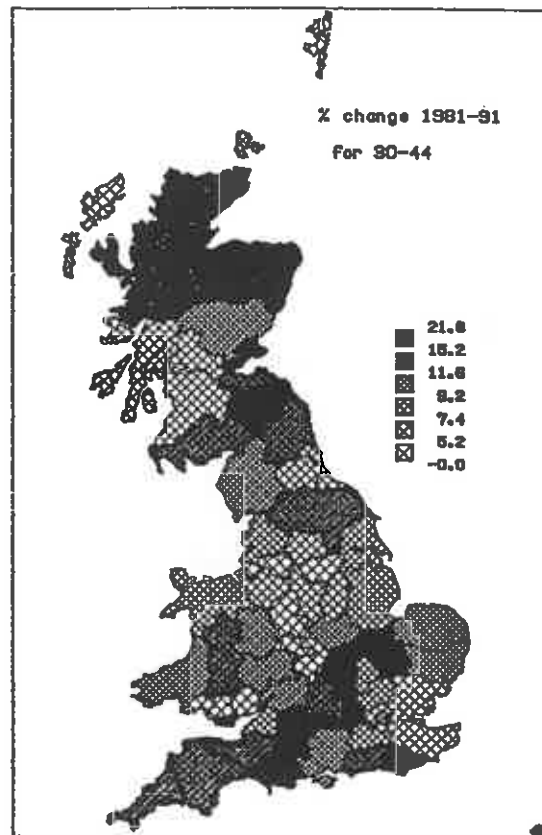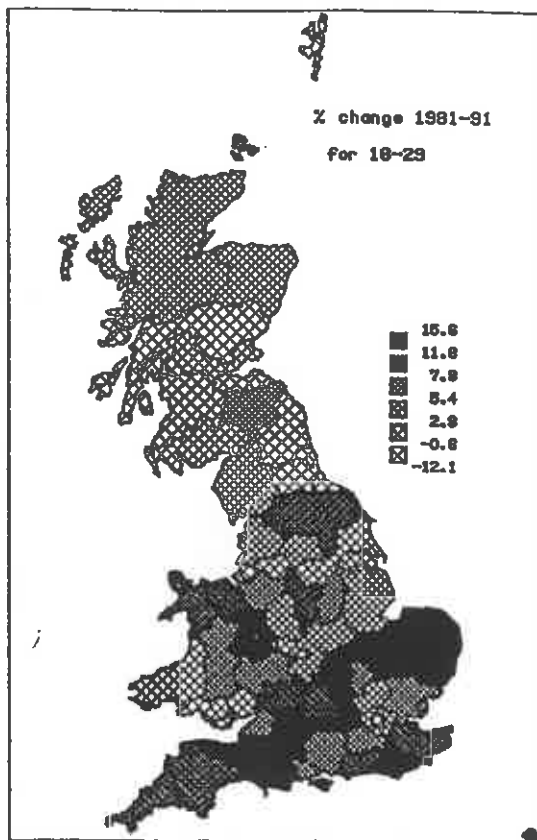
Figure 17.   Percentage change 1981-91, GB counties/regions,
                  age groups 18-29, 30-44 and 45-pensionable age

% change 1981-91
for pen-74

■ 12.1
▓ 5.3
▓ 2.2
▓ 0.6
▓ -2.5
▓ -6.1
▓ -25.3

% change 1981-91
for 75-84

■ 32.4
▓ 28.3
▓ 24.5
▓ 19.2
▓ 16.4
▓ 11.1
▓ -5.7

% change 1981-91
for 85+

■ 74.3
▓ 61.6
▓ 55.0
▓ 50.5
▓ 46.6
▓ 41.6
▓ 10.4

Figure 18.   Percentage change 1981-91, GB counties/regions,
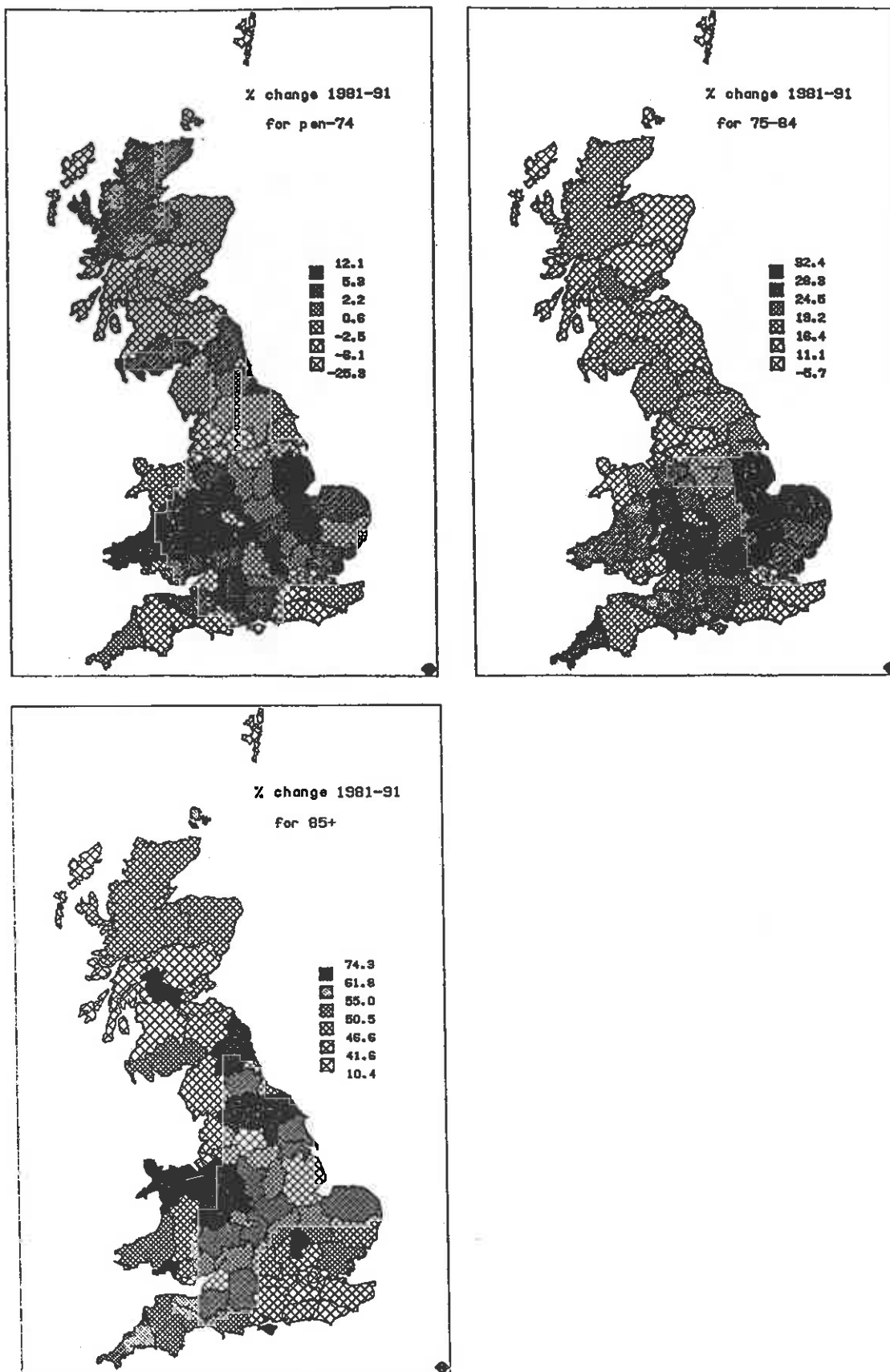   age groups pensionable age-74, 75-84 and 85+

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Table 8. Descriptive statistics for percentage change 1981-91 in age group population, GB counties/regions

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Age Group	Mean	Std.Dev	Minimum	Maximum	England & Wales (Table 1)
0-4	9.5	7.0	-15.7	30.2	14.0
5-15	-15.1	4.4	-24.7	- 6.6	-13.1
16-17	-22.4	6.5	-39.7	-11.8	-25.2
18-29	5.1	6.3	-12.1	15.6	9.3
30-44	9.7	4.9	0.0	21.8	10.8
45-pen	2.0	7.7	-19.7	16.8	- 0.1
pen-74	- 1.2	6.8	-25.3	12.1	- 2.7
75-84	19.2	8.4	- 5.7	32.4	16.6
85+	50.8	11.5	10.4	74.3	50.1
Total	1.65	4.61	- 9.06	10.62	2.7

sees a 12% gain in the retirement age group while Inner London sees a 25% loss. Finally, we can point to Bedfordshire's 74% gain in the oldest age group (85+) compared with only 10% in Inner London.

7. A FRAMEWORK FOR DECOMPOSING AGE GROUP CHANGE

Comparison of population stocks at two points in time provides only a partial picture of change. It is necessary to decompose that change into its demographic components before trying to relate the component change to other factors. To carry out such a decomposition using the age groups provided in the Census Monitors would be extremely problematic because of the variety of age intervals employed: these are successively 5, 11, 2, 12, 15, 20/15, 10, and undetermined. It is essential to employ regular age intervals (one year, five year or ten years) in order that the same birth cohort can clearly be identified in both the 1981 and 1991 age groups. The decomposition of age group change therefore will need to employ either population estimates for mid-1981 and mid-1991 (the final revised version becoming available only in mid-(1993) or adjusted Local Base Statistics for counties/regions which should all be available in January 1993.

It is, however, worth developing the methodology for such a decomposition in anticipation of the data. This methodology provides the means of estimating age disaggregated net migration over the inter-censal interval.

Figure 19 shows the Lexis (age-time) diagram that would be involved for age groups of ten years in interval (the simplest case), in which one age group in 1981 survives wholly into the next in 1991 (allowing for a little discrepancy between the two dates).

The following notation for the variables involved is adopted:

P   =   population
D   =   deaths
M   =   migrations
M^I =   in-migrations
M^O =   out-migrations
N   =   net in-migrations = $M^I - M^O$
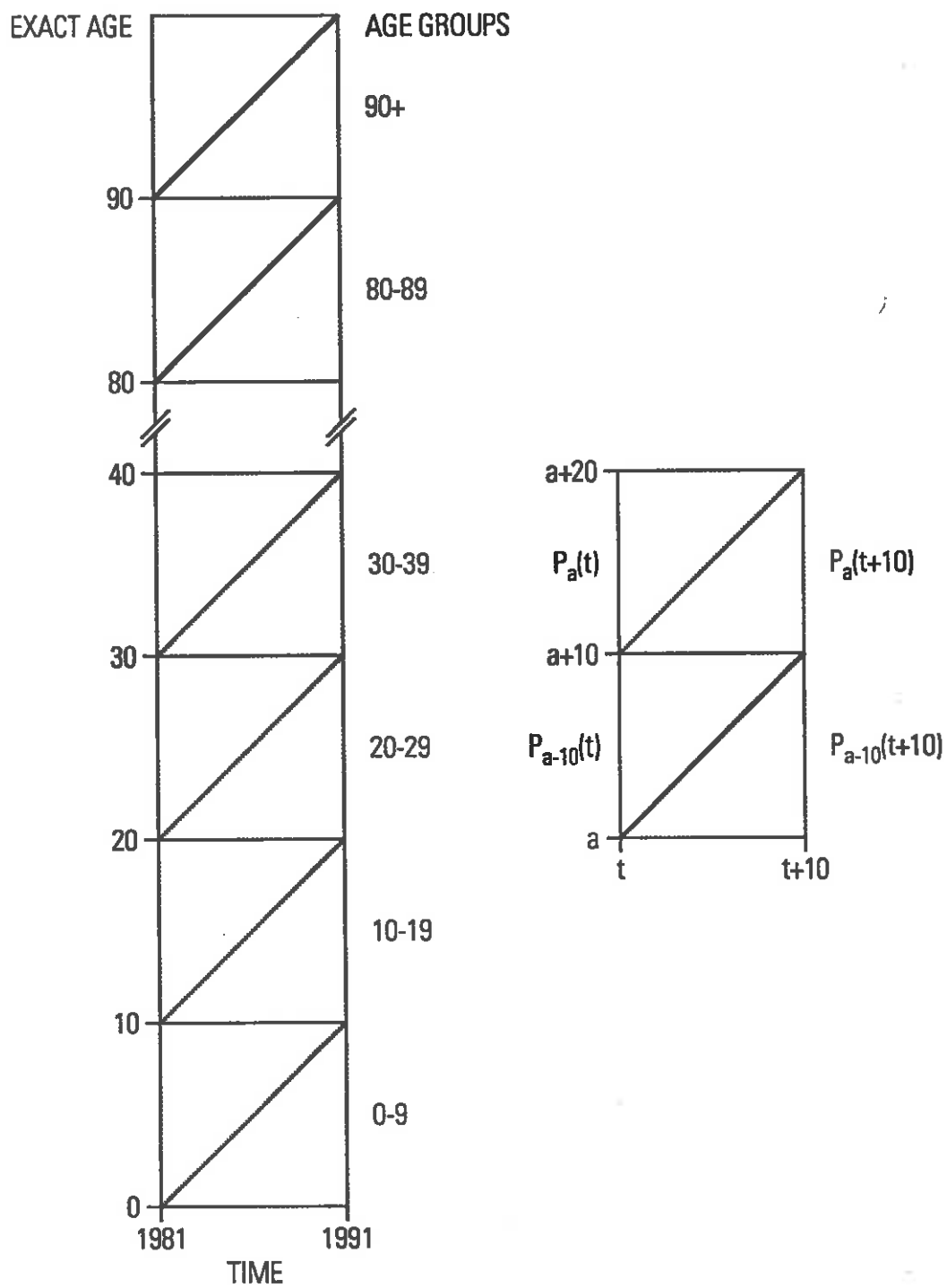B   =   births
a   =   age
t   =   time

Figure 19.   Age-time diagrams for intercensal comparisons

The population stocks and flows all apply to one geographical unit such as a county or region.

Combining the notational building blocks we obtain:

$_{10}P_a(t)$ = population aged a to a+10 at time t (start)

$_{10}P_a(t+10)$ = population aged a to a+10 at time t+10 (end)

$_{10}P_{a+10}(t)$ = population aged a+10 to a+20 at time t (start)

$_{10}P_{a+10}(t+10)$ = population aged a+10 to a+20 at time t+10 (end)

$_{10}D_a$ = deaths to persons aged a to a+10 at time t that occur over the 10 year interval

$_{10}M_a$ = migrations to persons aged a to a+10 at time t that occur over the 10 year interval.

To measure change in section 6.2 we employed the difference, C_a between the same age group at successive Censuses:

$$_{10}C_a = {}_{10}P_a(t+10) - {}_{10}P_a(t) \tag{1}$$

The end of interval population is built forward from the start of interval population in the same birth cohort by adding or subtracting components of change:

$$_{10}P_a(t+10) = {}_{10}P_{a-10}(t) - {}_{10}D_{a-10} + {}_{10}M^I_{a-10} - {}_{10}M^O_{a-10} \tag{2}$$

Substitute the RH side of equation (2) into the $P_a(t+10)$ term in equation (1)

$$_{10}C_a = {}_{10}P_{a-10}(t) - {}_{10}D_{a-10} + {}_{10}M^I_{a-10} - {}_{10}M^O_{a-10} \tag{3}$$

Group together terms and replace gross migration by net:

$$_{10}C_a = ({}_{10}P_{a-10}(t) - {}_{10}P_a(t)) - {}_{10}D_{a-10} + {}_{10}N_{a-10} \tag{4}$$

The population terms in brackets represent the difference between successive ten year birth cohorts as at time t; the difference between age group populations is that difference minus deaths in the cohort that ends the interval in age a plus the net in-migration in the same period-cohort.

Since mortality can be directly estimated from inter-censal statistics on deaths by county/region, we can use equations (1) and (4) to derive the means of inferring net migration

$$P_a(t+10) - P_a(t) \tag{5}$$

$$= (P_{a-10}(t) - P_a(t)) - {}_{10}D_{a-10} + {}_{10}N_{a-10}$$

Move all terms except ${}_{10}N_{a-10}$ to the LH side and then swap sides obtaining:-

$$_{10}N_{a-10} = P_a(t+10) - P_a(t) - (P_{a-10}(t) - P_a(t)) + {}_{10}D_{a-10} \tag{6}$$

which simplifies to

$$_{10}N_{a-10} = P_a(t+10) - P_{a-10}(t) + {}_{10}D_{a-10} \tag{7}$$

Modifications of these equations are needed for the first and last ages, or for other regular age intervals, but the principles are the same.

County mortality data is readily available but needs age group adjustment and some interpolation.

A check on these decompositions can be obtained by consolidating the continuous migration data available from the NHS Central Register (Stillwell, Rees and Boden 1992).

8.   CONCLUDING REMARKS

This paper has taken a first look at the demographic results from the 1991 Census, using information published in the Census Monitors. These first results give rise to a whole series of fruitful hypotheses and methodological questions about Britain's population which can be explored with the more extensive datasets about to become available.

The descriptions produced can be refined by:

(1)   extending the study area fully to the whole of the United Kingdom by adding data for Northern Ireland

(2)   examining spatial patterns at the finer spatial scale of district and ward

(3)   linkage of the Census datasets to other information about vital
      and migration events in the intercensal period in order to
      decompose change into cohort replacement, mortality and migration
      components and

(4)   investigation of the association of migration change so exposed
      with economic change.

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Abbreviations

CONI   = Census Office Northern Ireland

GRO(S)= General Register Office (Scotland)

HMSO   = Her Majesty's Stationery Office

OPCS   = Office of Population Censuses and Surveys