DRAFT

MIGRATION AND SETTLEMENT IN THE UNITED KINGDOM: DYNAMICS AND POLICY

P.H. Rees*

September 1978 WP-78-36

*School of Geography
University of Leeds

2361
Laxenburg
Austria

International Institute for Applied Systems Analysis

Preface

To promote international scientific cooperation and to disseminate research results, the Migration and Settlement Task of the Human Settlements and Services Area at IIASA initiated a comparative analysis of patterns of interregional migration and spatial population growth in National Member Organization countries. To carry out the study, a network of national scholars was established, an integrated methodology for multiregional demographic analysis was developed and a package of computer programs to implement this methodology was written. The contributors were invited to prepare reports on migration and settlement in their respective countries. An outline was provided and computer analysis was done by IIASA. The results of the various case studies will be discussed at a conference to be held at IIASA in September 1978.

In this paper, Dr. Philip Rees of the University of Leeds, investigates the spatial population dynamics and policies in the United Kingdom. The "standard" regions constitute the framework for the analysis. Both conventional methods and multiregional techniques are used in a comparative way to explore the impact of recent demographic changes.

Frans Willekens
Leader
Migration and
Settlement Task

August 1978

Abstract

The pattern of population change in U.K. regions is explored using both conventional single region methods and new multi-regional techniques. Current patterns of spatial population growth are outlined using components of growth tabulations, multi-regional population accounts tables, and an analysis of the age specific patterns of fertility, mortality and migration. The first British multi-regional life table, spatial fertility expectancy table, and multi-regional migraproduction table are described, and summary measures from these tables are compared with their single region equivalents. Population projections are carried out using a multi-regional survivorship matrix for British regions and the results are compared with official and accounts based projections. The paper concludes with speculations about the causes underlying the patterns observed and assesses the role of governmental policy in shaping those patterns.

Acknowledgments

Andrei Rogers deserves my thanks for leading the way in the field of multi-regional population analysis in such an innovative fashion. Frans Willekens earns my gratitude and thanks for running my rough and ready British data through his elegantly written computer programs. Rosanna Whitehead and Susan Hughes did an excellent job in converting my original manuscript into typed form and Gordon Bryant and John Dixon skilfully translated my draft figures into finished illustrations. The blame for the paper, however, lies solely with me.

Philip Rees
August 1978

Contents

Continued/

List of tables

List of tables continued

List of figures

1. Introduction

1.1 Prior work and new work proposed

The distribution of population in the United Kingdom of Great Britain and Northern Ireland (or U.K. for short) has long been of interest to social scientists and this interest has been coupled with a concern for understanding how migration patterns affect population distribution. Thus, Ravenstein (1885) analyses the pattern of migratory flows into and out of the counties of the British Isles (then one country). More recently, several workers have reviewed the pattern of population change (Eversley, 1971; Lawton, 1973, 1977; Champion, 1976) and a major study by the Department of the Environment has reported on regional change in the period 1951 to 1969 (Department of the Environment, 1971).

In this paper, an attempt is made to build on those previous reviews in two ways. The picture of migration and settlement is extended well into the 1970s in terms of time series data, and a long look into the future is taken using models developed by Rogers (1975) and Rees and Wilson (1977) that enable the multi-regional dynamics of population change to be studied.

Current patterns of spatial population growth are reviewed in Section 2 of the paper, and the multi-regional analysis is described in Section 3. Section 4 reviews the extent to which a population distribution policy has existed and to what degree it has been effective. In the remainder of this first section of the paper, the broad historical picture of population change in the regions of the U.K. is described, after a brief consideration of the way in which the set of British regions have been defined over time.

1.2 Definition of the set of regions

Regions are divisions of national territories that share common characteristics of one kind or another. In the U.K. they have not in modern times been governmental units (with a few exceptions) but have rather been created for statistical or analytic purposes. Since the Second World War "standard" regions have been defined for which many governmental statistical series are published, and for which advisory Economic Planning Councils have been set up. The

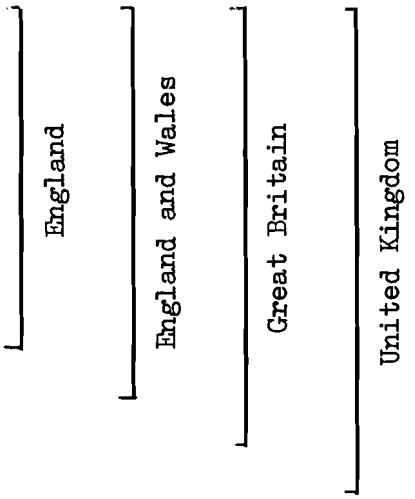
intention has been that the regional boundaries of dispersed offices of central government departments and nationalised industries follow those of the standard set, though this has rarely been achieved in practice.

The number of regions defined has in this period fluctuated around 11. There seems to be broad agreement that such a number provides sufficient variation across the country to be interesting without involving excess detail and problems of statistical variability characteristic of very small areas. Such a number is also convenient from a population modelling point.

Unfortunately, in their relatively short history the standard regions have changed shape and size rather drastically, as Figure 1 reveals. Prior to 1st April 1965 there were some 10 standard regions in England and Wales to which we have added the two "national" units of Scotland and Northern Ireland, making twelve in number. After 1st April 1965 the number reduces to eleven with the reogranisation of the Eastern, London and South Eastern and Southern regions into the South East and East Anglia regions, and with further boundary changes elsewhere. These were the regions current at the Census of 1971, the source of much of the migration data analysed in Section 3. After 1st April 1974 the regional boundaries were further adjusted to accord with the reorganisation of the local government county and district boundaries in England and Wales.

The region set used here is as follows:

1. North
2. Yorkshire and Humberside
3. North West
4. East Midlands
5. West Midlands
6. East Anglia
7. South East
8. South West
9. Wales
10. Scotland
11. Northern Ireland



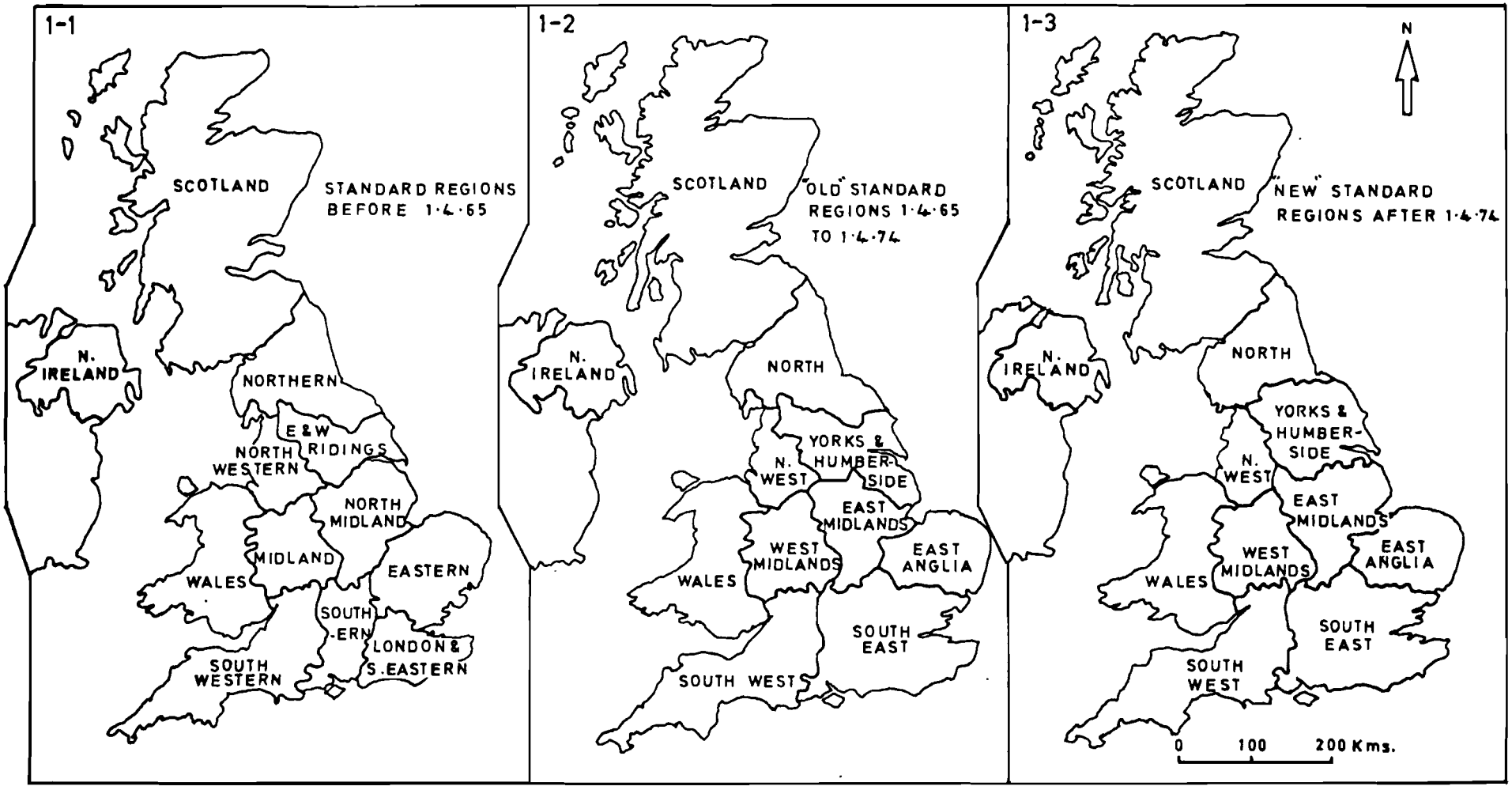


Figure.1. The changing regional definitions, U.K.

Some analyses that follow refer to the regional boundaries current from 1st April 1965 to 1st April 1974 and some to the post 1st April 1974 boundaries. The first set is referred to as the "old" regions (Figure 1.2) and the second set as the "new" regions. Some analyses include Northern Ireland, and hence are truly analyses of the U.K. Others exclude Northern Ireland and refer only to the ten regions of Great Britain. The four national units (England, Wales, Scotland, Northern Ireland) retain constant regional boundaries throughout, but, of the English regions only the West Midlands (called the "Midlands" prior to 1st April 1965) is as fortunate. Table 1 sets out the approximate probability matrices that convert one set of regional data to another.

1.3 Broad historical trends

Table 2 sets out the estimated regional breakdown of the population in absolute numbers and percentage shares (using the "old" region definitions) from 1801 (the year of the first Great Britain census) to 1971 (the year of the latest U.K. census). The final column of the table gives the mid-1971 estimate of the regional population under the "new" region definitions. Figure 2 plots the percentage shares on a graph against the relevant year. It is worth considering the trends in some detail - they reveal the rise and fall of the fortunes of the various regions and also warn us about not expecting trends in population to continue indefinitely.

The largest region throughout the period was the South East, containing the capital London. Its share of the national population expanded continuously from 22 per cent in 1801 to 31 per cent in 1971, although 1801-1851 saw little change. Conversely, throughout the period the second largest region in 1801, Scotland, suffered continuous decline from just over 14 per cent of the U.K. population to just above 9 per cent. Of the other "Celtic" fringe countries, Wales saw its share of the national population cake hover around 5 per cent throughout the period, whereas Northern Ireland saw substantial relative loss, particularly in connection with the Potato Famine of 1848 and its aftermath. In fact, Northern Ireland has yet to regain its peak population recorded in 1841. High volume emigration has been characteristic of this region.

Table 1 Regional conversion matrices showing the proportional distribution of the population of "before" regions into "after" regions

REGIONS BEFORE 1.4.65

AFTER / BEFORE	REGIONS 1.4.65 to 1.4.74 ("OLD" REGIONS)											
	N	YH	NW	EM	WM	EA	SE	SW	W	S	NI	Total
Northern	1											1
East & West Ridings		1										1
North Western			1									1
North Midland		.1404		.8492		.0104						1
Midland					1							1
Eastern						.3714	.6286					1
London & South Eastern							1					1
Southern							1					1
South Western								1				1
Wales									1			1
Scotland										1		1
Northern Ireland											1	1

REGIONS 1.4.65 TO 1.4.74

AFTER / BEFORE	REGIONS AFTER 1.4.74 ("NEW" REGIONS)											
	N	YH	NW	EM	WM	EA	SE	SW	W	S	NI	Total
North	.9184	.0816										1
Yorkshire & Humberside		.9656		.0344								1
North West	.0152		.9734	.0115								1
East Midlands		.0029		.9971								1
West Midlands					1							1
East Anglia						1						1
South East							.9898	.0107				1
South West								1				1
Wales									1			1
Scotland										1		1
Northern Ireland											1	1

Table 2 Population at selected censuses 1801-1971, regions[a], United Kingdom

			POPULATION (1000's)								
			1801	1851	1891	1911	1931	1951	1961	1971	1971[b]
REGIONS	1.	N	634	1161	2215	2815	3038	3137	3250	3296	3137
	2.	YH	809	1794	3115	3877	4285	4522	4635	4479	4868
	3.	NW	885	2531	4714	5796	6197	6447	6567	6743	6602
	4.	EM	651	1166	1776	2263	2531	2893	3100	3390	3635
	5.	WM	854	1705	2664	3277	3743	4423	4758	5110	5121
	6.	EA	625	1049	1105	1192	1232	1382	1470	1669	1686
	7.	SE	2499	5102	9171	11744	13539	15127	16271	17230	16994
	8.	SW	1349	2255	2471	2687	2794	3229	3411	3781	4088
	9.	W	587	1163	1771	2421	2593	2599	2644	2731	2723
	10.	S	1608	2889	4026	4761	4843	5096	5179	5229	5217
	11.	NI	(1649)[c]	1443	1236	1251	1243	1371	1425	1528	1538
TOTALS	U.K.		(20183)[c]	22259	34264	42082	46038	50225	52709	55507	55610
		EW	8893	17927	29002	36070	39952	43758	46105	48750	48854
		GB	10501	20816	33028	40831	44795	48854	51284	53979	54071
			SHARES OF THE U.K. POPULATION								
			1801[d]	1851	1891	1911	1931	1951	1961	1971	1971[b]
REGIONS	1.	N	5.49	5.22	6.46	6.69	6.60	6.25	6.17	5.94	5.64
	2.	YH	7.02	8.06	9.09	9.21	9.31	9.00	8.79	8.65	8.75
	3.	NW	7.68	11.37	13.76	13.77	13.46	12.84	12.46	12.15	11.87
	4.	EM	5.65	5.24	5.18	5.38	5.50	5.76	5.88	6.11	6.54
	5.	WM	7.40	7.66	7.77	7.79	8.13	8.81	9.03	9.21	9.21
	6.	EA	5.42	4.71	3.22	2.83	2.68	2.75	2.79	3.01	3.03
	7.	SE	21.67	22.92	26.77	27.91	29.41	30.12	30.87	31.04	30.56
	8.	SW	11.70	10.13	7.21	6.39	6.07	6.43	6.47	6.81	7.35
	9.	W	5.09	5.22	5.17	5.75	5.63	5.10	5.02	4.92	4.90
	10.	S	13.95	12.98	11.75	11.31	10.52	10.15	9.83	9.42	9.38
	11.	NI	8.92	6.48	3.61	2.97	2.70	2.73	2.70	2.75	2.77
TOTALS	UK		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		EW	77.13	80.54	84.64	85.71	86.78	87.12	87.47	87.83	87.85
		GB	91.08	93.52	96.39	97.03	97.30	97.27	97.30	97.25	97.23

Notes

a. The regions are the "old" standard regions, current at the 1971 Census.

b. These are the populations and shares of the "new" standard regions (post 1st April 1974) as at mid-year 1971.

c. These are 1841 populations.

d. The shares of the U.K. are estimated for 1801.

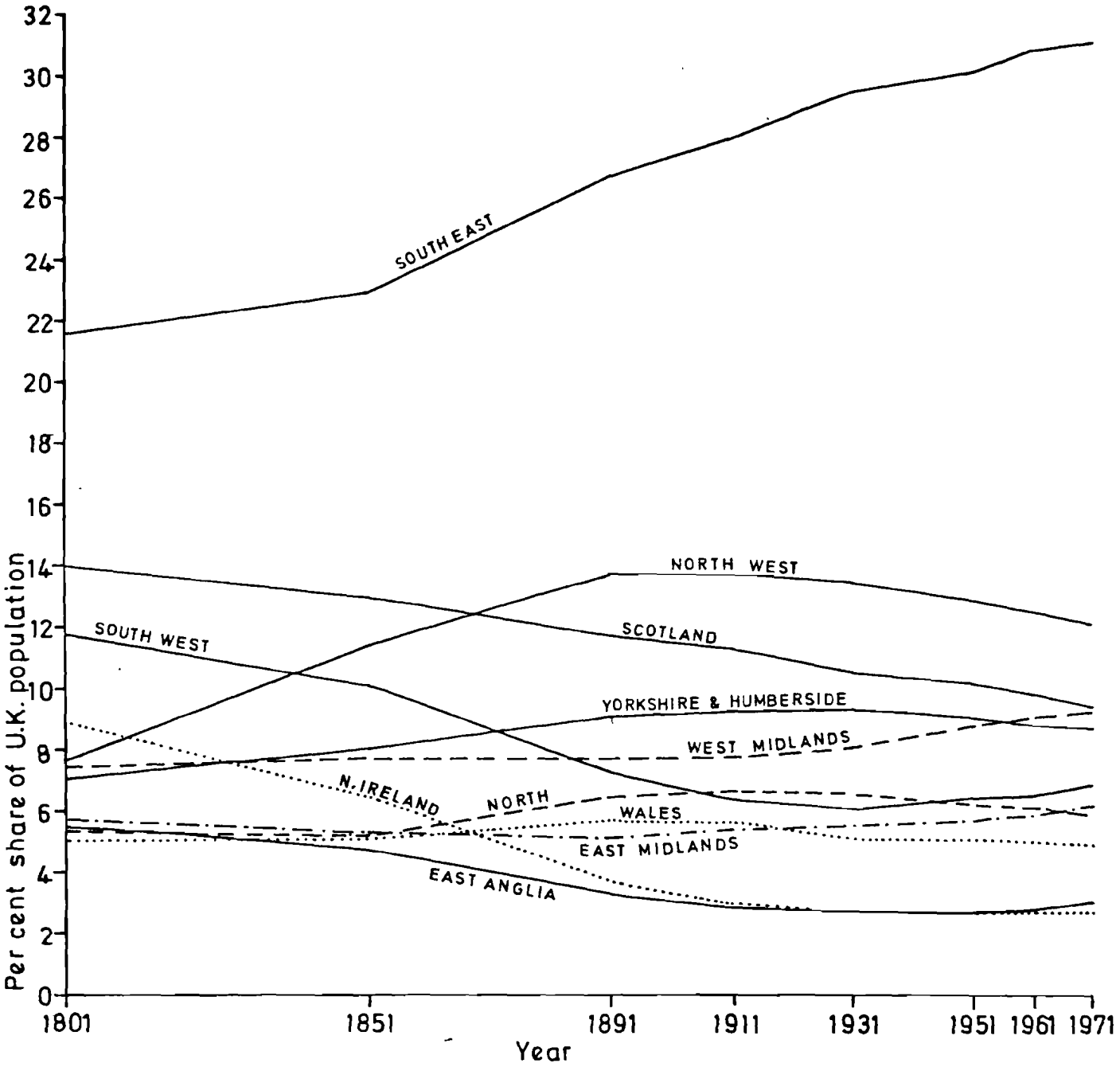


Figure 2. Regional shares of the U.K. population, 1801-1971

Table 3 Average annual growth rates, U.K. regions, 1801-1971

Region	1801-51	1851-91	1891-1911	1911-31	1931-51	1951-61	1961-71
1. N	12.1	16.1	12.0	3.8	1.6	3.5	1.4
2. YH	15.9	13.8	10.9	5.0	2.7	2.5	3.5
3. NW	21.0	15.5	10.3	3.3	2.0	1.8	2.6
4. EM	11.7	10.5	12.1	5.6	6.7	6.9	8.9
5. WM	13.8	11.2	10.4	6.6	8.3	7.3	7.1
6. EA	10.4	1.3	3.8	1.7	5.7	6.2	12.7
7. SE	14.3	14.7	12.4	7.1	5.5	7.3	5.7
8. SW	10.3	2.3	4.2	2.0	7.2	5.5	10.3
9. W	13.7	10.5	15.6	3.4	0.1	1.7	3.2
10. S	11.7	8.3	8.4	0.9	2.5	1.6	1.0
11. NI	-13.3	-3.9	0.6	-0.3	4.9	3.9	7.0
UK	9.8	10.8	10.3	4.5	4.4	4.8	5.2
EW	14.0	12.0	10.9	5.1	4.5	5.2	5.6
GB	13.7	11.5	10.6	4.6	4.3	4.9	5.1

Notes

1. Derived from Table 2 using the formula

$$g = \frac{1}{n} \ln (P(t+n)/P(t)) \times 1000$$

where n = number of years in period
P(t) = initial population
P(t+n) = final population

rate of 1 or below) was attained by 1915-20. The fall in mortality paralleled that of fertility until 1911-15, after which it slowed, and only thereafter did natural increase rates fall below 10 per thousand per annum. Zero natural increase was almost achieved in the 1930s. The post-Second World War period saw fluctuating fertility levels, higher on average than the 1930s, until the post-1964 decline had continued far enough for zero natural increase (or slight decrease) to be achieved in 1976 and 1977. The net migration component of population change played a relatively minor role at the national level for England and Wales, though it played a very important part in Scotland and Northern Ireland.

Detailed data for the components of growth for the regional level are not available, although a reworking of the county level information and the census tabulations of Ravenstein (1885) and Friedlander and Roshier (1966) would yield the required figures; some indication of regional general fertility and child mortality trends is, however, provided by Brass (1977). Table 4 compares general fertility rate levels (livebirths in a year divided by number of women aged 15 to 44 at mid-year) in 1876, 1928 and 1974 drawing on Tables 2A and 3 in Brass (1977) and regional statistics in O.P.C.S. (1977b). Although the comparison between the two sets of regions (those in Figure 1.1 and Figure 1.3 respectively) cannot be exact, and although the general fertility rate is rather influenced by the sex and age structure of the population, we can make some broad generalisations. In the period of the demographic transition between 1876 and 1928 the regions exhibited parallel decline in fertility with little change in rank order. The rank correlation between the 1876 and 1928 general fertility rates was high (0.76). In the period of fluctuating fertility after 1928 the rank order of regions changed quite a bit and the correlations between successive years in the table are low. East Anglia, for example, changes from being the lowest ranked region in 1965 to being the highest in 1974. Scotland changes from a number 1 rank in 1965 to a number 7 rank in 1974.

The variation amongst regions (within Great Britain, at least) in fertility levels has never been great and Table 4's maximum-minimum ratio and coefficient of variation rows show that it has declined to virtually nothing. Fertility differentials have some influence on

Table 4 General fertility rates for regions

Brass's regions	General Fertility Rates 1876	1928	1965	1970	1974	Current regions
1. London and S.E.	139	59	89.6	79.3	64.8	South East[c]
2. Eastern	152	66	88.5	81.9	71.1	East Anglia
3. Midland	174	74	93.0	87.4	69.2	West Midlands
4. North Western	163	67	94.6	88.6	69.6	North West
5. North Midland	165	70	92.5	85.9	69.9	East Midlands
6. Northern	193	85	89.7	79.9	66.0	North
7. South Western	137	63	92.4	81.1	67.4	South West
8. East/West Ridings	170	68	92.3	89.0	68.5	Yorkshire & Humberside
9. Southern	144	67	89.6	79.3	64.8	South East[c]
10. Wales	170	77	88.7	82.8	70.0	Wales
11. Scotland	149[a]	80[b]	96.6	86.6	68.0	Scotland
England and Wales	157	68	91.8	83.6	67.6	Great Britain
Regional map	Figure	1.1	Figure	1.2	Fig. 1.3	
Max/Min	1.40	1.33	1.09	1.12	1.10	
Coefficient of variation	10.7	10.9	2.89	4.35	2.84	
	Ranks					
1. London and S.E.	10	11	8=	10=	10=	South East[c]
2. Eastern	7	9	11	7	1	East Anglia
3. Midland	2	4	3	3	5	West Midlands
4. North Western	6	7	2	2	4	North West
5. North Midland	5	5	4	5	3	East Midlands
6. Northern	1	1	7	9	9	North
7. South Western	11	10	5	8	8	South West
8. East/West Ridings	4	6	6	1	6	Yorkshire & Humberside
9. Southern	9	8	8=	10=	10=	South East[c]
10. Wales	3	3	10	5	2	Wales
11. Scotland	8	2	1	4	7	Scotland
Correlation[d]		0.76	0.31	0.58	0.41	

Notes

a. Scottish GFR for 1870-72 (average).

b. Scottish GFR for 1930-32 (average).

c. The South East is not included in post-1965 comparisons.

d. Spearman's rho, r_s, is used

$$r_s = 1 - 6 \sum_{i=1} d_i^2/(N^3-N)$$

where d_i is the difference in rank on the two measures for the ith region.

N = 11 for $r_{1876,1928}$, $r_{1928,1965}$;

N = 10 for $r_{1965,1970}$, $r_{1970,1975}$

e. Sources: Brass (1977); O.P.C.S. (1967), (1972b), (1977b).

the pattern of population growth in 1876: the correlation (Pearson's r) between Table 3 "1851-91" column and Table 4's 1876 column is +0.55. This influence disappears for later years (the correlation between the 1911-31 column of Table 3 and the 1928 column of Table 4 is -0.25) and we show in the next section of the paper that most of the variation amongst regions in rates of growth in the recent past is due to migration. Natural increase levels (determined after 1921 predominantly by fertility levels) for the nation set the overall growth levels for the regions but the variation amongst regions is controlled by the patterns of migration from one region to another.

To sum up, the regions of the U.K. entered the 1970s characterised by low rates of growth, the general level of which was set by low and declining fertility, the variation among which was governed by migration. The established population trends were relative losses in the Northern and Celtic regions, and relative gains in the Midland and Southern regions. In the next section of the paper, the components of U.K. multi-regional demographic growth are examined in detail for the past decade and a half with particular attention focussed on the 1970-71 period when the most recent data on multi-regional migration is available.

2. Current patterns of spatial population growth

2.1 Population change, 1965-76

The focus in this section of the paper is on the last decade for which a full spectrum of regional data is available, for either "old" standard regions (Figure 1.2) or "new" standard regions (Figure 1.3). Particular attention will be paid to the pattern of population change around 1970-71 for two reasons. This is the period for which census data on population and migration is last available; the population and migration data from 1972 to 1976 are imperfect estimates rather than totally reliable statistics. The second reason is that this is the period at which the patterns of migration and settlement can be compared cross-nationally in the I.I.A.S.A. Comparative National Project (Rogers, 1976a; Willekens, 1978).

Within the last decade population growth has ceased in the United Kingdom and in seven out of eleven regions (Table 5). The full statistics of population change are set out in the form of aggregate population, components of change accounts in Appendix 1 and the corresponding rates are set out in Appendix 2. Table 5 extracts figures for selected years from Appendix 1. All figures in Appendices 1 and 2 are for the "new" regions (Figure 1.3) and so are not directly comparable with the figures in Table 2.

Some three patterns of change among the eleven regions can be discerned.

(1) The populations of Scotland, the North, Yorkshire and Humberside and the North West all peak in the early 1970s. The four regions were characterised by falling shares of the U.K. population throughout the 1965-76 period (Figures 4 and 5).

(2) The populations of Northern Ireland, the South East and the West Midlands also peaked in the period (in 1973, 1972 and 1974 respectively) and thereafter the regions were characterised by falling shares. In the first part of the period (to 1972, 1968 and 1972 respectively), however, these regions were still gaining in terms of U.K. population shares.

Table 5 Population and shares of U.K. regions, 1965, 1970, 1976

Region (NR)	Population (1000's) 1965	1970	1976	Share (per cent) 1965	1970	1976
1. North	3126	3134	3121.6	5.77	5.65	5.58
2. Yorkshire & Humberside	4790	4853	4891.9	8.83	8.76	8.75
3. North West	6519	6589	6553.4	12.02	11.89	11.72
4. East Midlands	3468	3606	3734.5	6.40	6.51	6.68
5. West Midlands	4910	5094	5164.5	9.06	9.19	9.23
6. East Anglia	1553	1686	1802.7	2.86	3.04	3.22
7. South East	16609	16965	16893.7	30.63	30.61	30.21
8. South West	3879	4059	4256.4	7.15	7.32	7.61
9. Wales	2686.3	2717.0	2766.1	4.95	4.90	4.95
10. Scotland	5209.9	5213.7	5205.1	9.61	9.41	9.31
11. Northern Ireland	1468.2	1527.4	1538.1	2.71	2.76	2.75
U.K.	54218.4	55421.1	55928.0	100.00	100.00	100.00
England and Wales	47540.3	48680.0	49184.8	87.68	87.84	87.94
Great Britain	52750.2	53893.7	54389.9	97.29	97.24	97.25

Region (NR)	Year of peak population 1801-61	1965-76	Year of peak share 1801-61	1965-76
1. North	1961	1972	1911	1965
2. Yorkshire & Humberside	1961	1975	1931	1965
3. North West	1961	1973	1891	1965
4. East Midlands	1961	1976	1961	1976
5. West Midlands	1961	1974	1961	1972
6. East Anglia	1961	1976	1801	1976
7. South East	1961	1972	1961	1968
8. South West	1961	1976	1801	1976
9. Wales	1961	1976	1911	1965
10. Scotland	1961	1971	1801	1965
11. Northern Ireland	1841	1973	1801	1972
U.K.	1961	1974	--	--

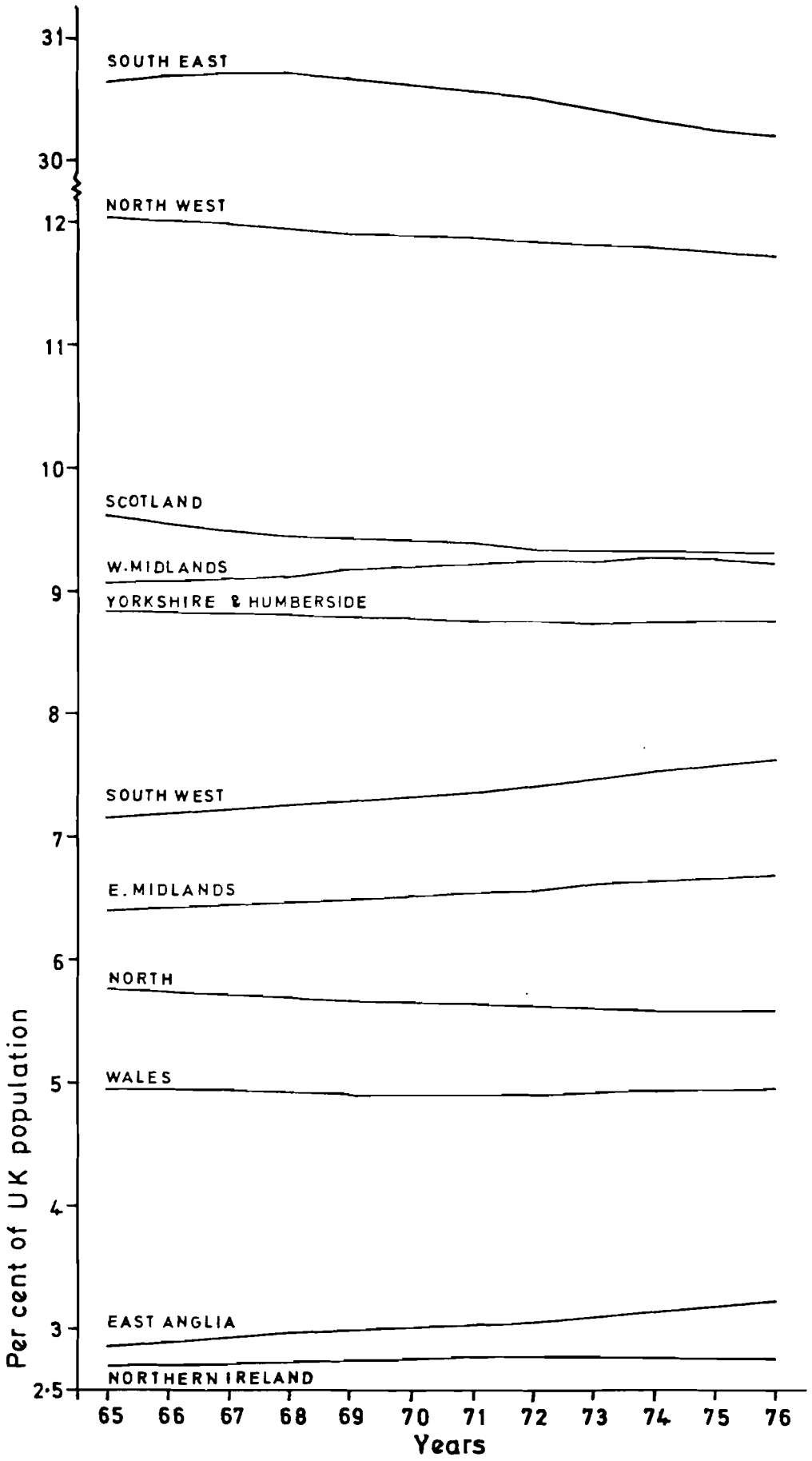


Figure 4· Regional shares of UK population, 1965-76

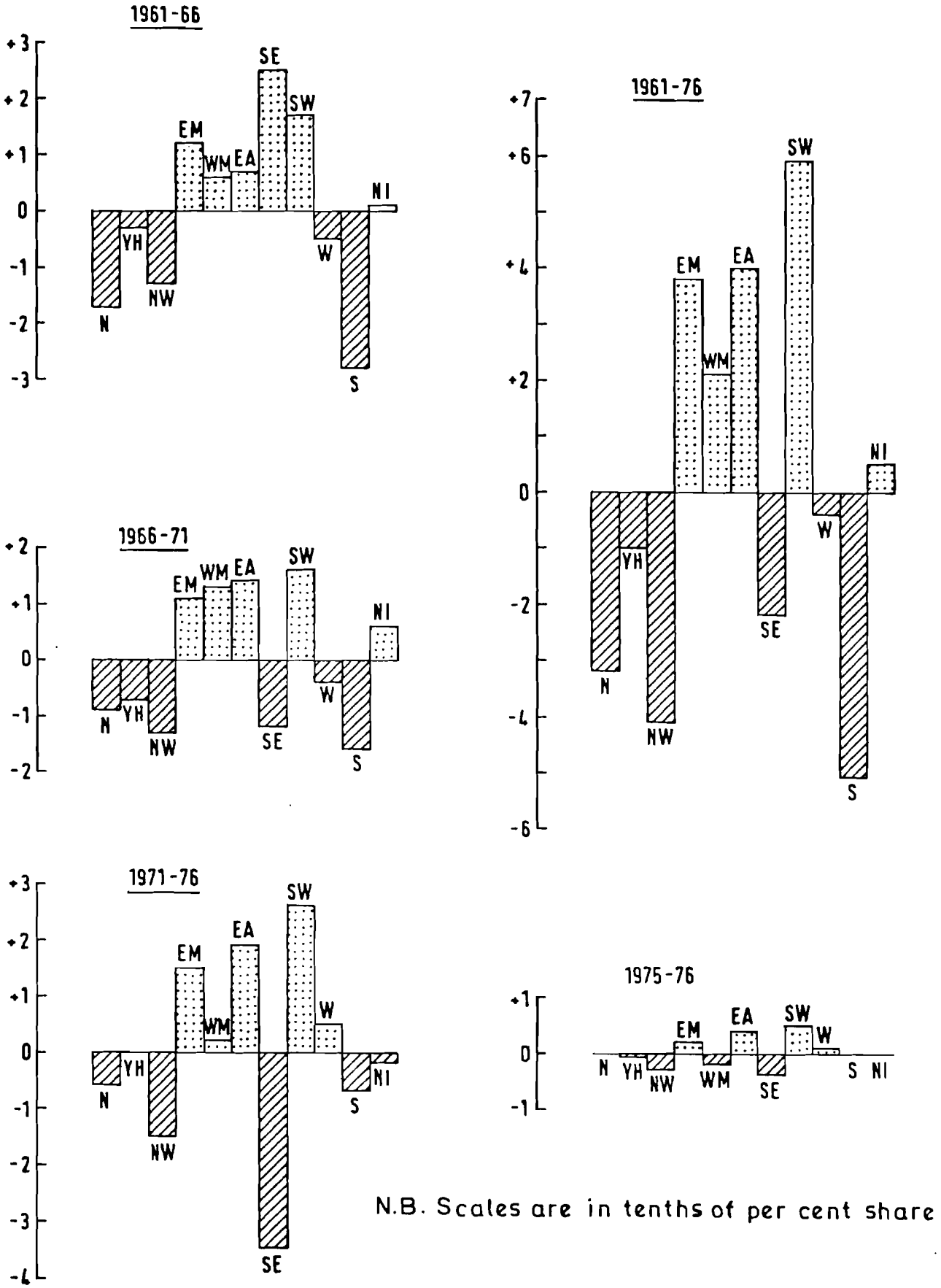


Figure 5: Shifts in population shares for U.K. regions, 1961-1976

(3) Four regions continued to show population growth - namely, East Anglia, the South West, the East Midlands and Wales. The first three showed gains in shares throughout the period; Wales joined the regions gaining shares after 1969 (Figures 4 and 5).

The most dramatic reversal of fortunes evident in Figures 4 and 5 is that of the South East region. The continuous population growth and accretion of population shares over the 1901-1971 period changes to first, loss of shares, and second, absolute loss of population. Underlying these population shifts is the decentralisation of population out of London. Greater London experienced large net outflows of migrants of 75-100,000 each year and the Rest of South East gained slightly smaller net inflows of 12-100,000 each year (figures from Appendix 1). There is evidence, however, of a marked slow-down in the growth of the Rest of the South East, and a considerable reduction in the rate of net immigration into the sub-region towards the end of the period (see the appropriate table in Appendix 2).

2.2 Simple components of population change, 1965-76

It is possible to reconstruct, in part from published statistics and in part by estimation, a time series for the new regions (Figure 1.3) of the components of population change (Appendix 1). From these simplest of "accounts", population change, natural increase and net migration rates were computed and plotted for each region on a time series graph (Figure 6). It is clear from these graphs that the variation amongst regions in terms of natural increase is very low, and that the pattern of change is very uniform. Natural increase reaches a peak in 1964-65 of between 5 and 9 per 1,000 per annum, falls to a level of between 2 and 7 per 1,000 by 1970-71, and reaches a range of -2 to 2 per 1,000 in 1975-76. Northern Ireland's natural increase rates remain about 5 per 1,000 above the range on the British mainland but show parallel decline, at least from 1966-67.

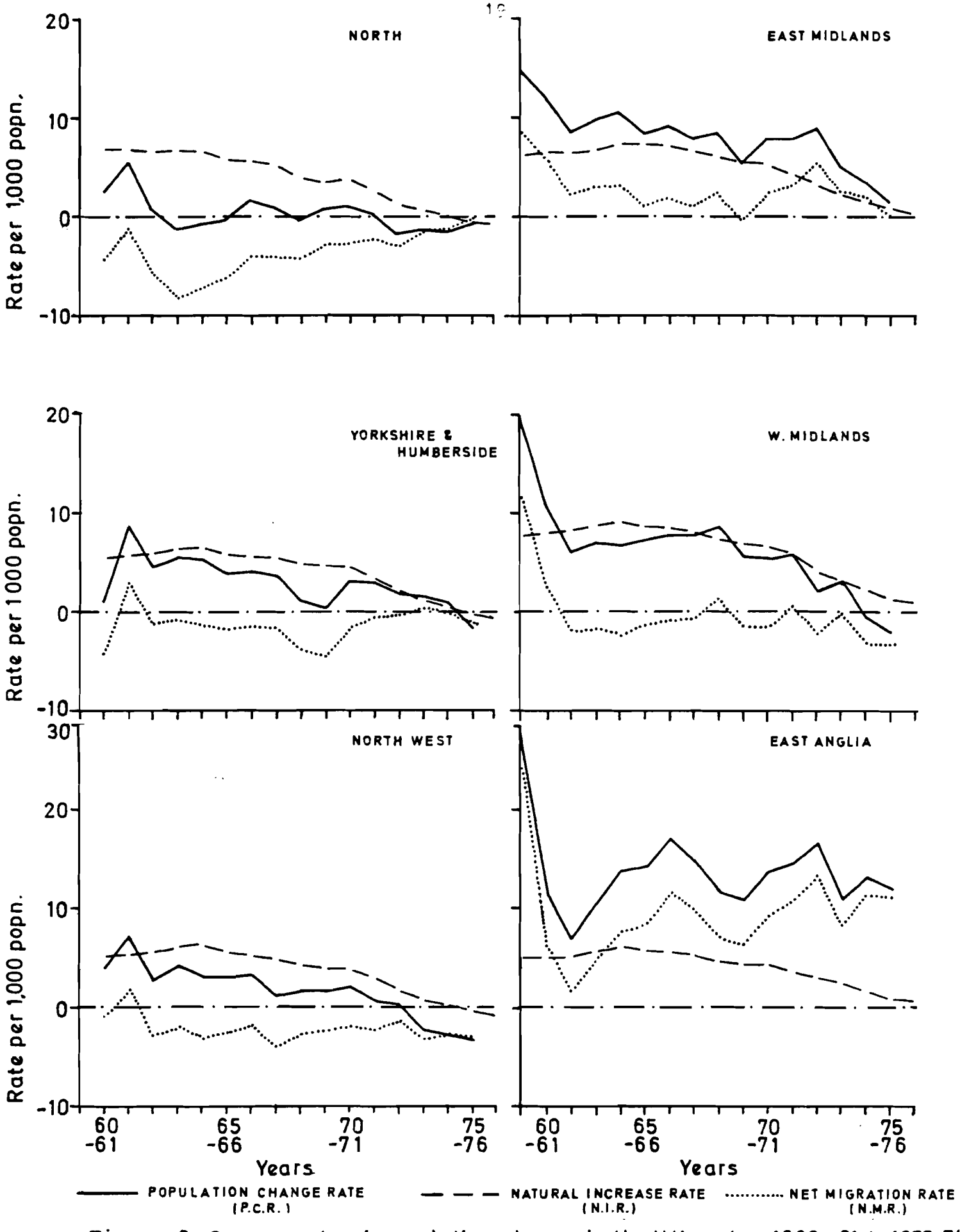


Figure 6. Components of population change in the UK : rates, 1960 - 61 to 1975-7

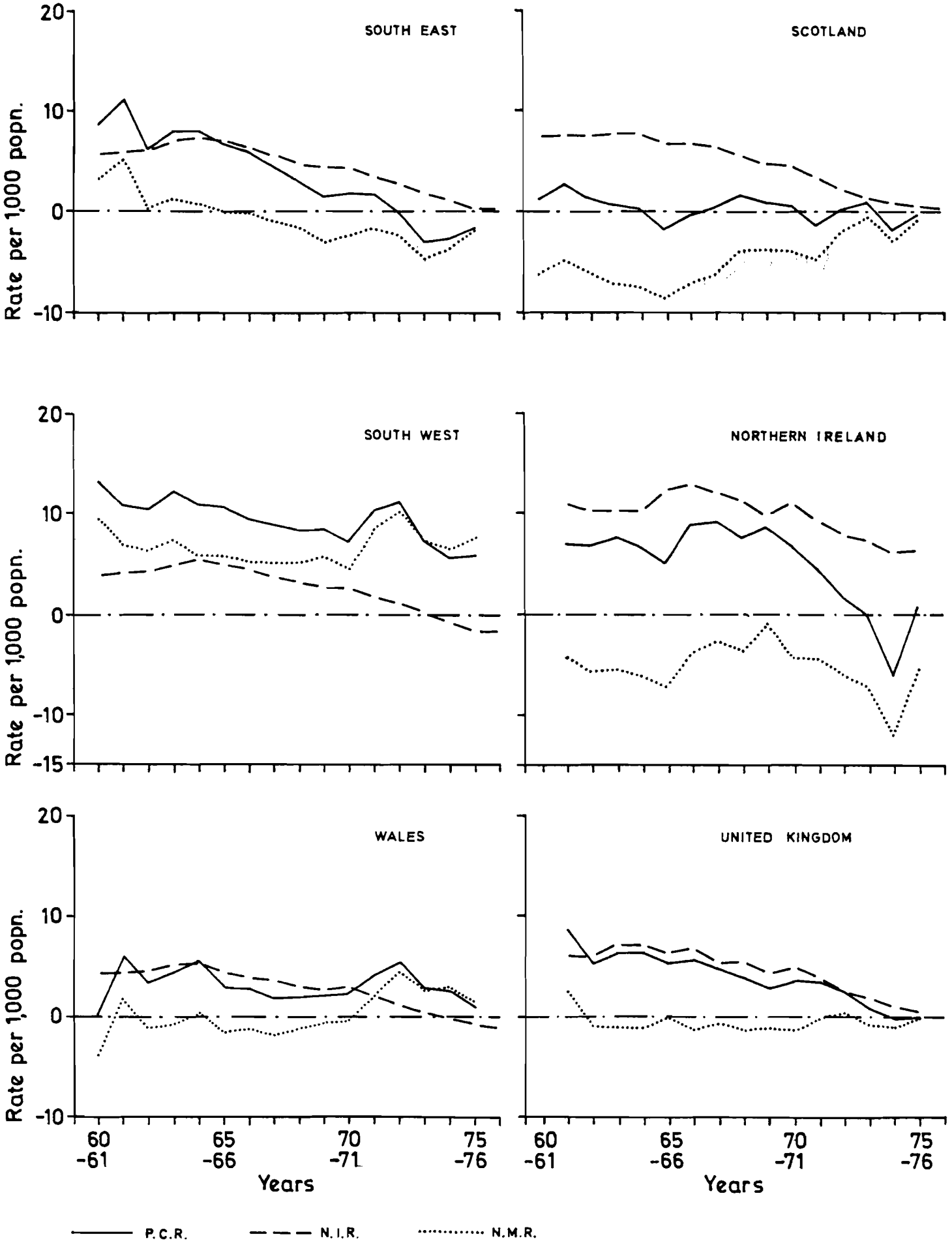


Figure 6 (Continued)

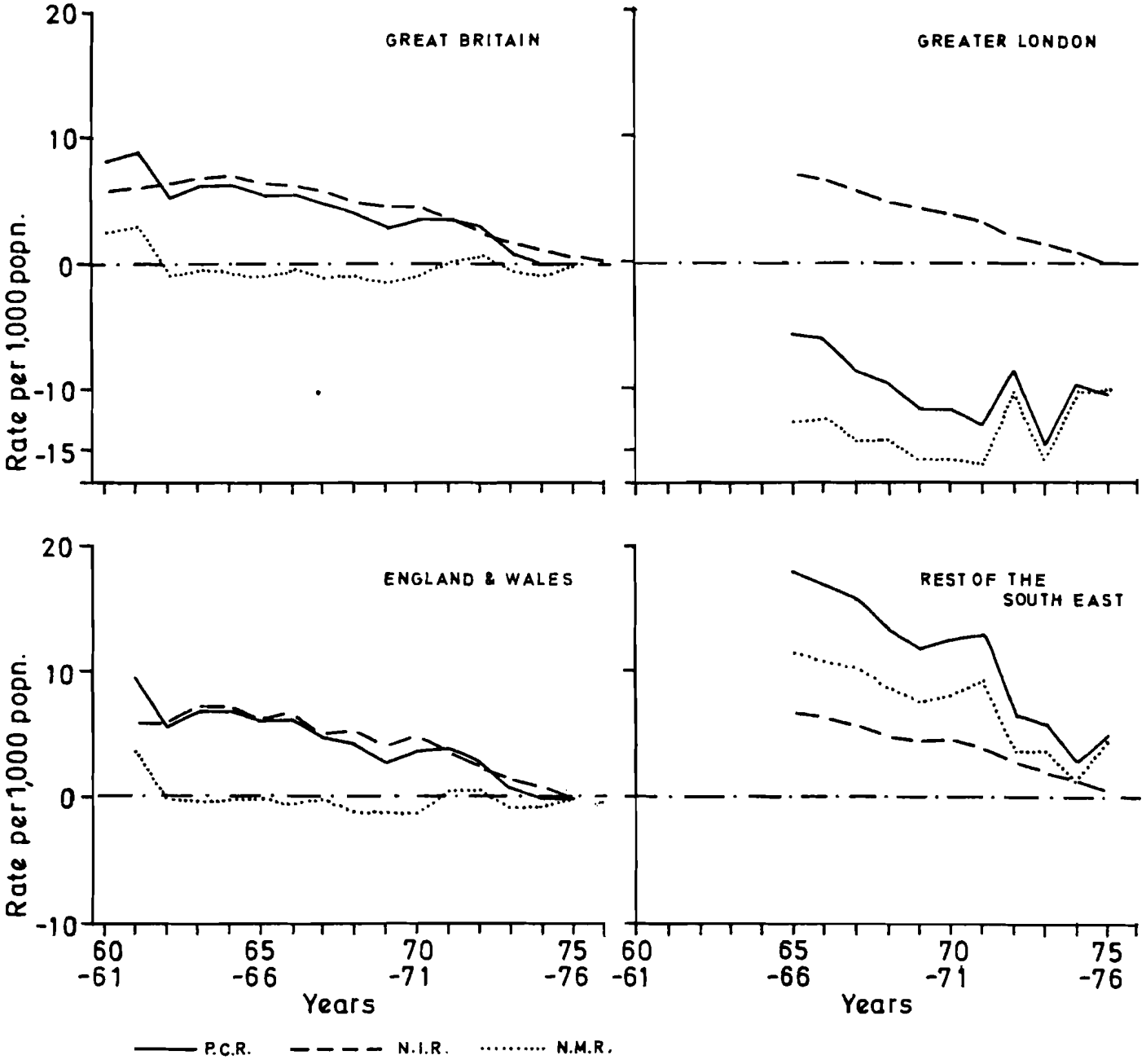


Figure 6.(Continued)

Net migration, on the other hand, shows no such uniform pattern over time over all regions. However, it is clear from the graphs that the patterns of population change discussed above stem very largely from the levels and direction of net migration. This influence is confirmed by calculation of the coefficients of correlation among the variables population change rate, natural increase rate and net migration rate for the regions taken as a set in each mid-year to mid-year period (Table 6). The simple correlation between regional rate of population change and regional natural increase averages only +0.20 whereas the equivalent average correlation between rate of population change and net migration rate is +0.96.

(1) The four regions losing relative shares throughout the period and absolute numbers in the latter part of the period - the North, Yorkshire and Humberside, the North West and Scotland - all experience net migration losses. The relative size of the losses (as measured by the net migration rate) decreases over the period, however, for all but the North West.

(2) The change in the status of the South East from a relative gainer to a relative loser in 1968 (Table 5) was anticipated by a conversion of a net migration gain to a loss in 1965-66 and thereafter. This change in relative migration position of the region is due mainly to declining net migration to the South East outside Greater London. Greater London itself experienced a slightly lower net out-migration rate in the latter part of the 1965-76 period (Figure 6).

Northern Ireland was characterised by fairly high net out-migration rates with a marked change in direction of change in 1969-70 (with the onset of "the troubles" perhaps). From 1965-66 to 1969-70 net migration was becoming less negative; since 1969-70 it has become more negative.

(3) Three of the gaining regions - East Midlands, East Anglia, South West - showed net in-migration almost throughout the period, and they were joined by Wales after 1970-71.

Table 6 Association of the components of population change

Period	Correlation coefficients			
	PCR vs NIR	PCR vs NMR	NIR vs NMR	PCR vs NIR, NMR
65-66	0.16	0.96	-0.13	1.00
66-67	0.22	0.96	-0.07	1.00
67-68	0.22	0.95	-0.09	1.00
68-69	0.38	0.95	0.07	1.00
69-70	0.12	0.94	-0.23	1.00
70-71	0.20	0.95	-0.11	1.00
71-72	0.15	0.97	-0.10	1.00
72-73	0.22	0.98	0.04	1.00
73-74	0.32	0.97	0.09	1.00
74-75	0.16	0.98	-0.05	1.00
75-76	0.01	0.98	-0.19	1.00
Average	0.20	0.96	-0.07	1.00

Notes

1. PCR = population change rate
   NIR = natural increase rate
   NMR = net migration rate
2. Correlation coefficients = Pearson's coefficients.
3. The correlations are calculated for the regions of Great Britain only.

These patterns are summarised in four maps (Figure 7). Net migration rates are plotted on a base map derived by Craig (1977) in which the area of a region is proportional to its population. The first map shows why the early 1960s were an era of concern about "the drift to the South East". By 1965-66 both the South East and the West Midlands had entered the migration loss regions. The 1970-71 pattern is very close to that of 1965-66, but by 1975-76 the ranking of regions within the loss column had changed with the North and Scotland improving their position. Wales in the meantime had moved into the migration gain column. In Section 4 of the paper the association between these shifts and regional policy will be examined.

2.3 Multi-regional components of population change, 1965-66

The simple accounts discussed in the preceding section give only a single region view of the components of population change. The net migration flow statistic for each region consists, in fact, of two sets of migration flows from other regions to each region, and from each region to the other regions. A multi-regional view of the components of population change is provided by sets of population accounts for the U.K. regions.

Tables 7, 8, 9 and 10 present a selection from a time series of population accounts developed by the author. Tables 7 and 8 are extracted from Rees (1976); Tables 9 and 10 from Rees (1978). The theory underlying the definition and estimation of "closed demographic accounts" is described in detail in Rees and Wilson (1977). Here the accounts tables are regarded as the best estimate of the transitions of the population from origin regions to destination regions. The bulk of the transitions are for people who exist at the start of the period and who survive at its end. These people are located in the top left quadrant of the table. Additions to the population through births are represented in the bottom left quadrant. Subtractions from the regional populations through death are represented in the right hand half of the table with infant deaths in the bottom right quadrant and deaths to people already in existence at the start of the period in the top right quadrant.

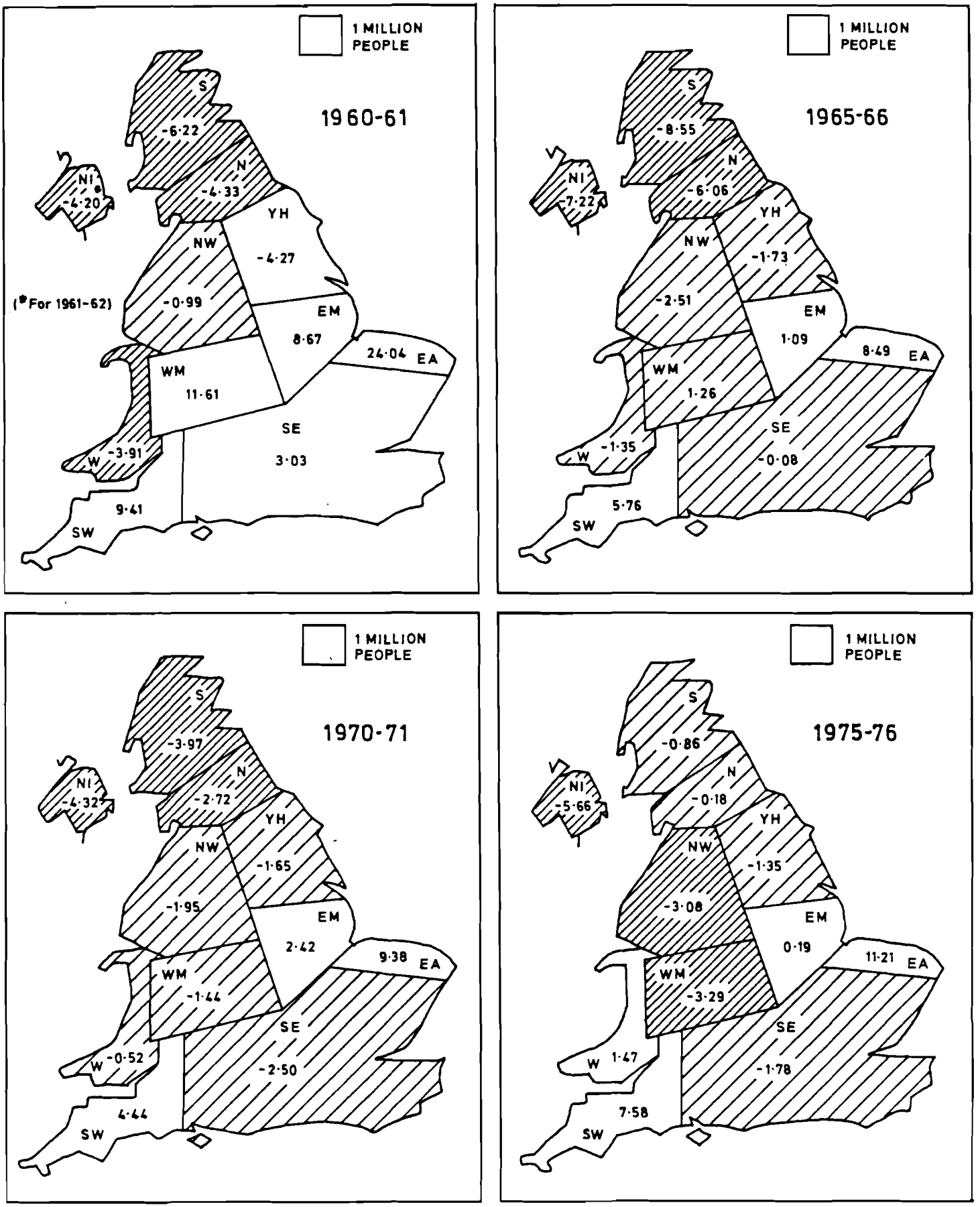


Figure 7: Net migration rates in U.K. regions, selected years

Initial State \ Final State	Survival at C.D. 1966											Death in 1965–66												
	1 N	2 YH	3 NW	4 EM	5 WM	6 EA	7 SE	8 SW	9 W	10 S	11 RTW	Sub Totals	1 N	2 YH	3 NW	4 EM	5 WM	6 EA	7 SE	8 SW	9 W	10 S	11 RTW	Sub Totals	TOTALS
1. North	3195207	10024	6118	3997	5468	1633	13412	2638	1288	4170	24964	3268919	38603	61	38	22	29	9	79	17	8	27	149	39042	3307961
2. Yorkshire & Humberside	10856	4556799	10774	13057	4089	2800	15259	4545	2171	3419	27624	4651393	65	55902	68	72	21	16	90	30	14	22	167	56467	4707860
3. North West	6057	10815	6496139	6392	7913	2252	21732	6513	8411	3825	44797	6614886	36	65	82752	35	41	13	128	42	55	25	282	83476	6698360
4. East Midlands	2739	12499	5479	3151580	8279	4231	15654	3774	1400	2394	23247	3231276	16	76	34	35102	43	24	92	25	9	15	127	35565	3266839
5. West Midlands	3247	4961	9978	9918	4812591	2424	21368	11176	5750	2009	31307	4915429	19	30	62	54	51089	14	126	73	38	18	164	51688	4967116
6. East Anglia	1521	2870	2180	4665	2322	1473695	17656	3337	781	1268	26319	1536614	9	17	14	26	12	17341	104	22	5	8	151	17709	1554323
7. South East	12018	15435	20547	19664	19705	30141	16347869	53740	11338	14938	189199	16734594	72	93	129	108	103	173	196043	349	75	96	1118	198359	16932953
8. South West	2789	4036	4554	3874	7363	2992	40201	3424762	4909	2890	34449	3532009	17	24	29	21	39	17	238	45346	32	19	224	46005	3578815
9. Wales	1167	1927	5192	1978	6288	710	12038	5405	2610280	1795	9315	2656115	7	12	33	11	33	4	71	35	34815	12	61	35093	2691209
10. Scotland	5497	4756	6754	4787	5558	1633	19786	3438	1187	5037917	48865	5140178	33	29	42	26	29	9	117	22	8	65498	313	66127	5206304
11. Rest of the world	13052	17636	25263	13742	23569	17170	175073	25902	7332	21662	0	340401	78	107	159	75	123	99	1034	168	48	139	0	2031	342431
Sub totals	3254210	4641758	6592869	3233654	4903145	1535681	16700048	3545230	2654847	5097087	460086	52628614	38954	56416	83361	35552	51563	17720	198124	46129	35109	65870	2757	631562	53254171
1. North	57463	89	54	35	48	14	119	23	11	37	221	58114	344	0	0	0	0	0	0	0	0	1	345	58459	
2. Yorkshire & Humberside	98	83558	97	118	37	25	138	41	20	31	249	84412	0	508	0	0	0	0	0	0	0	1	509	84921	
3. North West	56	99	120374	58	72	21	198	59	77	35	409	121458	0	0	761	0	0	0	1	0	0	1	763	122221	
4. East Midlands	25	114	50	58751	76	39	143	35	13	22	213	59481	0	0	0	324	0	0	0	0	0	1	325	59806	
5. West Midlands	31	47	94	95	93292	23	204	107	55	27	299	94274	0	0	0	0	491	0	1	0	0	1	493	94767	
6. East Anglia	13	24	19	40	20	25711	150	28	7	11	223	26246	0	0	0	0	0	149	0	0	0	1	150	26396	
7. South East	108	138	184	176	177	270	298182	481	102	134	1695	301547	0	0	1	0	0	1	1772	2	0	5	1781	303428	
8. South West	24	35	39	33	63	26	347	60400	42	25	297	61331	0	0	0	0	0	0	1	395	0	1	397	61728	
9. Wales	10	16	44	17	53	6	102	46	45089	15	79	45477	0	0	0	0	0	0	0	0	298	0	0	298	45775
10. Scotland	52	45	64	46	53	16	189	33	11	97603	466	98578	0	0	0	0	0	0	1	0	0	629	1	631	99209
11. Rest of the world	227	307	440	239	410	299	3047	451	128	377	0	5925	1	1	1	1	1	1	9	1	0	1	0	17	5942
Sub totals	58107	84472	121459	59608	94301	26450	302819	61704	45555	98317	4151	956943	345	509	763	325	492	151	1785	398	298	630	13	5709	962652
TOTAL	3312317	4726230	6714327	3293262	4997446	1562131	17002867	3606934	2700402	5195404	464237	53585482	39300	56925	84123	35877	52054	17870	199907	46527	35405	66509	2769	637271	54216823

Table 7. Aggregate population accounts for British regions, 1965-66 (one year) C.D. = Census Date

Initial State \ Final State	Survival at C.D. 1971												Death in 1970-71											
	1 N	2 YH	3 NW	4 EM	5 WM	6 EA	7 SE	8 SW	9 W	10 S	11 RTW	Sub Totals	1 N	2 YH	3 NW	4 EM	5 WM	6 EA	7 SE	8 SW	9 W	10 S	11 RTW	Sub Totals	TOTALS
Existence at C.D. 1970																								
1. North	3241941	9290	7370	3630	3790	2190	15040	3870	1220	4910	25275	3318526	38271	55	46	20	19	12	83	24	8	29	147	38714	3357240
2. Yorkshire & Humberside	12790	4644500	13290	13190	5970	4320	21580	5610	2570	3470	27886	4755176	74	55831	83	72	31	24	119	34	16	21	165	56470	4811646
3. North West	6790	10650	6567400	6320	9750	2980	29210	8950	10370	5200	43952	6701572	39	63	82920	35	50	17	161	55	65	31	274	83710	6785282
4. East Midlands	4200	12170	5300	3229569	9610	6030	19110	6680	2330	3100	25545	3323644	24	72	33	36111	49	33	106	41	15	18	140	36642	3360286
5. West Midlands	3550	5400	9750	12600	5009250	3040	25630	12590	6350	3340	27877	5119377	21	32	61	69	52000	17	142	77	40	20	143	52622	5171999
6. East Anglia	1150	2510	1970	4490	2540	1584217	20460	3820	1170	1650	28194	1652171	7	15	12	25	13	17982	113	23	7	10	156	18363	1670534
7. South East	12070	16570	22920	26390	21410	35410	16697512	66570	12050	17610	193299	17121811	70	98	143	145	110	196	187508	409	76	105	1069	189929	17311740
8. South West	2970	4600	4860	4230	8680	3390	49030	3589220	4730	4810	35450	3711970	17	27	30	23	44	19	271	45000	30	29	218	45708	3757678
9. Wales	1450	2040	6390	2420	5650	1280	13160	7000	2647069	1650	10185	2698294	8	12	40	13	29	7	73	43	33607	10	64	33906	2732200
10. Scotland	5540	4810	7220	4910	4630	2070	23790	5330	1700	5033830	57612	5151442	32	28	45	27	24	11	132	33	11	60633	342	61318	5212760
11. Rest of the world	14570	19630	27330	16650	23140	20280	197220	29390	8840	28160	0	385210	85	116	170	91	118	112	1090	181	55	167	0	2185	387395
Sub totals	3307021	4732170	6673800	3324399	5104420	1665207	17111742	3739030	2698399	5107730	475275	53939193	38648	56349	83583	36631	52487	18430	189798	45920	33930	60906	2718	619567	54558760
Birth in 1970-71																								
1. North	52151	73	58	29	30	17	119	31	10	39	200	52757	305	0	0	0	0	0	0	0	0	0	1	306	53063
2. Yorkshire & Humberside	109	80569	113	112	51	37	184	48	22	30	238	81513	0	480	0	0	0	0	1	0	0	0	1	482	81995
3. North West	57	90	112263	53	82	25	246	75	87	44	370	113392	0	0	703	0	0	0	1	0	0	0	1	705	114097
4. East Midlands	35	103	45	55667	81	51	161	56	20	26	216	56461	0	0	0	308	0	0	0	0	0	0	1	309	56770
5. West Midlands	31	47	85	110	88686	26	223	110	55	29	243	89645	0	0	0	0	457	0	1	0	0	0	1	459	90104
6. East Anglia	9	20	16	36	20	25873	163	30	9	13	224	26413	0	0	0	0	0	145	0	0	0	0	1	146	26559
7. South East	94	129	179	206	167	277	265676	520	94	138	1510	268990	0	0	1	1	0	1	1478	2	0	0	4	1487	270477
8. South West	23	35	37	32	66	26	376	56279	36	37	272	57219	0	0	0	0	0	0	1	349	0	0	1	351	57570
9. Wales	11	16	51	19	45	10	104	55	42533	13	81	42938	0	0	0	0	0	0	0	0	268	0	0	268	43206
10. Scotland	47	41	61	42	39	18	201	45	14	86708	488	87704	0	0	0	0	0	0	1	0	0	518	1	520	88224
11. Rest of the world	256	344	479	292	406	356	3459	515	155	494	0	6756	1	1	1	1	1	1	10	2	0	1	0	19	6775
Sub totals	52823	81467	113387	56598	89673	26716	270912	57764	43035	87571	3842	883788	306	481	705	310	458	147	1493	353	268	519	12	5052	888840
TOTALS	3359844	4813637	6787187	3380997	5194093	1691023	17382654	3796794	2741434	5195301	479117	54822981	38954	56830	84288	36941	52945	18577	191291	46273	34198	61592	2730	624619	55447600

Table 2 Aggregate population accounts for British regions, 1970-71 (one year)

Table 9 Multi-regional population accounts, G.B., "new" regions 1970-71

REGION OF EXISTENCE M.Y. 1970 / ORIGIN STATE	REGION OF SURVIVAL M.Y. 1971											REGION OF DEATH 1970-71											TOTALS
	N	YH	NW	EM	WM	EA	SE	SW	W	S	NW	N	YH	NW	EM	WM	EA	SE	SW	W	S	NW	
North	3034.8	10.1	6.8	3.5	3.2	1.6	12.1	2.9	1.1	4.9	15.3	37.4	62	43	20	17	9	68	17	7	29	93	3134.0
Yorkshire and Humberside	8.5	4689.7	12.4	13.0	5.8	3.8	19.2	5.4	2.6	3.7	30.4	51	58.0	79	73	30	21	108	33	17	22	185	4853.0
North West	6.8	9.7	6385.2	8.2	9.4	2.7	24.8	8.1	9.9	5.2	36.3	42	59	82.0	46	50	16	141	51	64	31	230	6589.0
East Midlands	3.7	12.3	6.9	3468.6	10.1	6.6	18.3	6.9	2.5	3.5	26.4	23	75	44	39.6	54	37	104	44	16	21	149	3606.0
West Midlands	3.1	5.5	9.9	13.5	4935.9	2.9	22.6	12.1	6.3	3.6	25.0	19	34	63	77	52.9	17	128	76	41	22	133	5094.0
East Anglia	1.0	2.8	2.0	5.0	2.6	1578.0	19.2	3.8	1.2	1.8	26.9	6	16	13	28	14	18.3	108	24	8	11	153	1663.0
South East	11.3	19.8	24.7	30.4	23.1	37.2	16343.6	68.5	13.0	20.3	182.8	69	120	157	171	123	211	187.9	428	83	122	1.0	16965.0
South West	2.5	6.1	5.7	6.0	10.0	3.8	51.2	3876.9	5.4	6.0	35.1	15	38	36	34	53	21	290	49.4	35	36	220	4059.0
Wales	1.2	2.1	6.6	2.8	5.7	1.2	11.9	6.6	2628.0	1.8	14.5	7	13	42	15	30	7	67	41	34.3	10	94	2717.0
Scotland	5.2	4.9	6.7	4.9	4.4	1.9	20.1	4.8	1.6	5052.5	44.6	32	30	43	28	24	11	114	31	11	61.6	268	5213.7
Rest of World	9.8	23.5	26.8	18.6	23.0	20.0	189.7	30.4	9.6	27.9	0	59	143	170	105	122	113	1.1	190	62	168	0	381.4
North	49.1	80	54	28	26	12	96	23	9	39	121	300	0	0	0	0	0	0	0	0	0	0	49.9
Yorkshire and Humberside	72	80.7	105	109	50	32	163	46	21	32	256	0	495	0	0	0	0	0	0	0	0	1	82.1
North West	57	81	107.9	68	78	23	207	68	36	53	303	0	0	688	0	0	0	1	0	0	0	1	109.6
East Midlands	31	102	57	59.3	84	54	153	58	21	29	220	0	0	0	335	0	0	0	0	0	0	1	60.4
West Midlands	27	48	86	118	87.4	26	197	106	56	31	218	0	0	0	0	465	0	1	0	0	0	1	88.8
East Anglia	7	22	16	40	21	25.7	153	29	9	14	212	0	0	0	0	0	147	0	0	0	0	1	26.4
South East	86	153	191	235	180	289	257.5	529	100	158	1.4	0	0	1	1	0	1	1.5	2	0	0	4	262.3
South West	20	46	42	45	76	29	388	60.1	41	45	265	0	0	0	0	0	0	1	378	0	0	1	61.4
Wales	9	16	52	21	44	10	94	51	42.1	14	114	0	0	0	0	0	0	0	0	272	0	0	42.8
Scotland	43	41	55	41	36	16	168	40	13	85.6	372	0	0	0	0	0	0	0	0	0	518	1	87.0
Rest of World	78	198	222	155	200	157	1.4	229	75	233	0	0	1	1	0	1	0	4	1	0	1	0	3.0
TOTALS	3137.4	4868.0	6602.3	3634.6	5121.5	1686.0	16993.3	4087.7	2723.6	5217.4	440.7	38.0	59.1	83.4	40.5	53.9	18.9	191.6	50.7	34.9	62.6	2.6	55148.8

REGION OF BIRTH 1970-71

Notes

1. Numbers greater than or equal to 1000 are expressed in 1000's. Numbers less than 1000 are reproduced as they stand. This is done in order to display conveniently numbers of different orders of magnitude in the four quadrants of the table.
2. The period is from 30th June/1st July 1970 to 30th June/1st July 1971.

Table 10 Multi-regional population accounts, G.B. "new" regions 1975-76

ORIGIN STATE / DESTINATION STATE	REGION OF SURVIVAL M.Y. 1976											REGION OF DEATH 1975-76											TOTALS
	N	YH	NW	EM	WM	EA	SE	SW	W	S	RW	N	YH	NW	EM	WM	EA	SE	SW	W	S	RW	
REGION OF EXISTENCE M.Y. 1975																							
North	3029.8	9.3	5.9	3.1	2.8	1.5	11.1	2.9	1.1	4.9	13.2	38.8	57	36	17	16	9	66	19	7	31	84	3124.7
Yorkshire and Humberside	9.4	4736.6	11.5	12.5	5.6	3.8	19.4	6.0	2.8	4.1	28.6	59	58.9	72	70	31	22	115	39	18	25	175	4899.8
North West	7.9	10.3	6374.9	8.3	9.5	2.9	26.4	9.5	11.3	6.0	27.1	50	63	80.0	46	53	16	156	62	74	37	168	6574.7
East Midlands	4.4	13.3	7.0	3588.1	10.4	7.1	19.9	8.3	2.9	4.2	21.2	28	82	43	40.8	59	41	118	54	19	26	119	3728.0
West Midlands	3.6	5.9	9.9	13.9	5012.1	3.1	24.3	14.3	7.3	4.2	19.4	23	36	62	77	57.3	17	144	93	48	26	109	5175.9
East Anglia	1.1	3.0	2.0	5.2	2.7	1695.0	20.7	4.5	1.4	2.2	23.4	7	18	13	29	16	19.9	122	29	9	14	134	1781.4
South East	12.2	19.7	23.1	28.9	21.8	37.0	16321.9	75.2	13.9	22.1	146.6	77	121	143	161	123	212	196.2	490	91	136	869	16921.2
South West	2.5	5.8	5.0	5.5	9.0	3.6	48.7	4046.2	5.5	6.2	36.8	16	36	31	30	51	21	288	53.7	36	38	240	4229.4
Wales	1.2	2.0	5.9	2.5	5.1	1.2	11.3	6.9	2675.1	1.8	15.6	7	13	37	14	29	7	66	44	35.4	11	102	2764.3
Scotland	5.2	4.5	5.7	4.3	3.8	1.7	18.5	4.9	1.6	5054.6	37.8	32	28	36	24	21	10	109	32	10	63.1	233	5206.2
Rest of World	7.6	23.3	23.0	15.2	18.5	23.9	170.9	27.7	9.8	28.0	0	48	143	143	85	104	137	1.0	180	63	173	0	349.8
REGION OF BIRTH 1975																							
North	36.7	74	47	25	24	11	88	23	9	40	79	234	0	0	0	0	0	0	0	0	0	0	37.4
Yorkshire and Humberside	78	57.9	98	107	46	32	164	50	23	34	172	0	358	0	0	0	0	0	0	0	0	1	59.1
North West	66	86	79.3	70	79	23	218	80	40	62	167	0	0	494	0	0	0	1	0	0	0	1	80.7
East Midlands	35	111	56	45.3	87	57	166	69	24	34	132	0	0	0	255	0	0	0	0	0	0	0	46.3
West Midlands	30	51	84	121	63.2	27	212	125	63	35	121	0	0	0	0	359	0	1	0	0	0	0	64.4
East Anglia	7	22	16	43	19	21.6	163	33	9	16	145	0	0	0	0	0	125	0	0	0	0	0	22.2
South East	94	153	178	222	170	286	198.0	581	108	172	876	0	0	1	1	1	1	1.2	2	0	1	3	202.0
South West	20	42	37	39	70	27	369	46.3	40	45	206	0	0	0	0	0	0	1	305	0	0	1	47.5
Wales	9	16	46	18	40	10	89	53	33.8	15	97	0	0	0	0	0	0	0	0	221	0	0	34.4
Scotland	42	37	47	36	31	14	154	41	12	66.3	244	0	0	0	0	0	0	0	0	0	411	1	67.4
Rest of World	46	140	142	94	115	149	1.0	154	60	181	0	0	0	0	0	0	0	3	0	0	1	0	2.1
TOTALS	3122.1	4892.4	6554.0	3733.4	5165.1	1803.1	16893.6	4253.9	2766.8	5205.1	371.9	39.4	59.9	81.1	41.6	58.2	20.5	199.6	55.1	36.0	64.0	2.2	55418.9

Notes

1. Numbers greater than or equal to 1000 are expressed in 1000's. Numbers less than 1000 are reproduced as they stand. This is done in order to display conveniently numbers of different orders of magnitude in the four quadrants of the table.

2. The period is from 30th June/1st July 1975 to 30th June/1st July 1976.

Each table contains a great deal of interacting information on fertility, mortality and migration. Here we concentrate on the information on spatial relocation. The first impression from Tables 7 through 10 is of the importance of external migration. The migrant flows to and from the rest of the world are the largest movements. Only the exchange of migrants between the South East and South West regions approach the scale of the external flows. This is unfortunate from the point of view of population accounting and of population projection since emigration flows, in particular, are difficult to estimate, and there is considerable discrepancy between the various statistical sources (Rees, 1978, gives more details).

This point is further emphasised if we cumulate the migrant flows of the exist-survive quadrant of the accounts tables into the totals of internal and external in-, out- and net-migrants (Tables 11 and 12). In-migrants from outside Great Britain make up 32 per cent of total inter-regional in-migrants and emigrants account for 39 per cent of total inter-regional out-migrants in 1965-66. The comparable figures for 1970-71 are 32 and 36 per cent ("old" regions), 31 and 34 per cent ("new" regions), and for 1975-76 are 29 and 30 per cent. In other words about one third of all inter-region migrants enter or leave Great Britain in a year. The slight decline in the relative importance by 1975-76 can be attributed to an overall increase in the level of internal migration between the regions, and a decrease in external emigration. This decrease in the 1970s is a function of the greater difficulty of emigration of Britons to traditional destinations such as Australia, New Zealand, Canada and America, and the reduced job opportunities there. Immigration into Britain has not declined as much between 1970-71 and 1975-76.

The pattern of gains and losses through internal and external migration is summarised in Figure 8. Regions are classified as having either positive migration (gain) or negative migration (loss) balances for both internal and external migration. Regions with positive gains from one set of flows and negative from the other are further classified by whether they gain or lose overall through

Table 11 Total inflows and outflows of exist-survive migrants in the population accounts of 1965-66, 1970-71, "old" regions

	In-migrants			Out-migrants			Net-migrants		
	Internal	External	Total	Internal	External	Total	Internal	External	Total
	1965-66, "old" regions								
N	45.9	13.1	59.0	48.7	25.0	73.7	-2.8	-11.9	-14.7
YH	67.4	17.6	85.0	67.0	27.6	94.6	0.4	-10.0	-9.6
NW	71.4	25.3	96.7	73.9	44.8	118.7	-2.5	-19.5	-22.0
EM	68.4	13.7	82.1	56.5	23.2	79.7	11.9	-9.5	2.4
WM	67.0	23.6	90.6	71.5	31.3	102.8	-4.5	-7.7	-12.2
EA	48.8	17.2	66.0	36.6	26.3	62.9	12.2	-9.1	3.1
SE	177.1	175.1	352.2	197.5	189.2	386.7	-20.4	-14.1	-34.5
SW	94.6	25.9	120.5	73.6	34.4	108.0	21.0	-8.5	12.5
W	37.3	7.3	44.6	36.5	9.3	45.8	0.8	-2.0	-1.2
S	37.5	21.7	59.2	53.4	48.9	102.3	-15.9	-27.2	-43.1
Total	715.4	340.5	1055.9	715.2	460.0	1175.2	0.2	-119.5	-119.3
	1970-71, "old" regions								
N	50.5	14.6	65.1	51.3	25.3	76.6	-0.8	-10.7	-11.5
YH	68.1	19.6	87.7	82.8	27.9	110.7	-14.7	-8.3	-23.0
NW	79.1	27.3	106.4	90.2	44.0	134.2	-11.1	-16.7	-27.8
EM	78.1	16.7	94.8	68.6	25.5	94.1	9.5	-8.8	0.7
WM	72.1	23.1	95.2	82.2	27.9	110.1	-10.1	-4.8	-14.9
EA	60.7	20.3	81.0	39.8	28.2	68.0	20.9	-7.9	13.0
SE	217.0	197.2	414.2	231.0	193.3	424.3	-14.0	3.9	-10.1
SW	120.4	29.4	149.8	87.4	35.4	122.8	33.0	-6.0	27.0
W	42.5	8.8	51.3	41.0	10.2	51.2	1.5	-1.4	0.1
S	45.7	28.2	73.9	60.0	57.6	117.6	-14.3	-29.4	-43.7
Total	834.2	385.2	1219.4	834.3	475.3	1309.6	-0.1	-90.1	-90.2

Notes

1. Due to slight rounding errors the totals of the internal in- and out-migrants columns do not quite tally.

Table 12 Total inflows and outflows of exist-survive migrants in the population accounts of 1970-71, 1975-76, "new" regions

	In-migrants			Out-migrants			Net migrants		
	Internal	External	Total	Internal	External	Total	Internal	External	Total
	1970-71, "new" regions								
N	43.3	9.8	53.1	46.2	15.3	61.5	-2.9	-5.5	-8.4
YH	73.3	23.5	96.8	74.4	30.4	104.8	-1.1	-6.9	-8.0
NW	81.7	26.8	108.5	84.8	36.3	121.1	-3.1	-9.5	-12.6
EM	87.3	18.6	105.9	70.8	26.4	97.2	16.5	-7.8	8.7
WM	74.3	23.0	97.3	79.5	25.0	104.5	-5.2	-2.0	-7.2
EA	61.7	20.0	81.7	39.4	26.9	66.3	22.3	-6.9	15.4
SE	199.4	189.7	389.1	248.3	182.8	431.1	-48.9	6.9	-42.0
SW	119.1	30.4	149.5	96.7	35.1	131.8	22.4	-4.7	17.7
W	43.6	9.6	53.2	39.9	14.5	54.4	3.7	-4.9	-1.2
S	50.8	27.9	78.7	54.5	44.6	99.1	-3.7	-16.7	-20.4
Total	834.5	379.3	1213.8	834.5	437.3	1271.8	0.0	-58.0	-58.0
	1975-76, "new" regions								
N	47.5	7.6	55.1	42.6	13.2	55.8	4.9	-5.6	-0.7
YH	73.8	23.3	97.1	75.1	28.6	103.7	-1.3	-5.3	-6.6
NW	76.0	23.0	99.0	92.1	27.1	119.2	-16.1	-4.1	-20.2
EM	84.2	15.2	99.4	77.5	21.2	98.7	6.7	-6.0	0.7
WM	70.7	18.5	89.2	86.5	19.4	105.9	-15.8	-0.9	-16.7
EA	61.9	23.9	85.8	42.8	23.4	66.2	19.1	0.5	19.6
SE	200.3	170.9	371.2	253.9	146.6	400.5	-53.6	24.3	-29.3
SW	132.5	27.7	160.2	91.8	36.8	128.6	40.7	-9.1	31.6
W	47.8	9.8	57.6	37.9	15.6	53.5	9.9	-5.8	4.1
S	55.7	28.0	83.7	50.2	37.8	88.0	5.5	-9.8	-4.3
Total	850.4	347.9	1198.3	850.4	369.7	1220.1	0.0	-21.8	-21.8

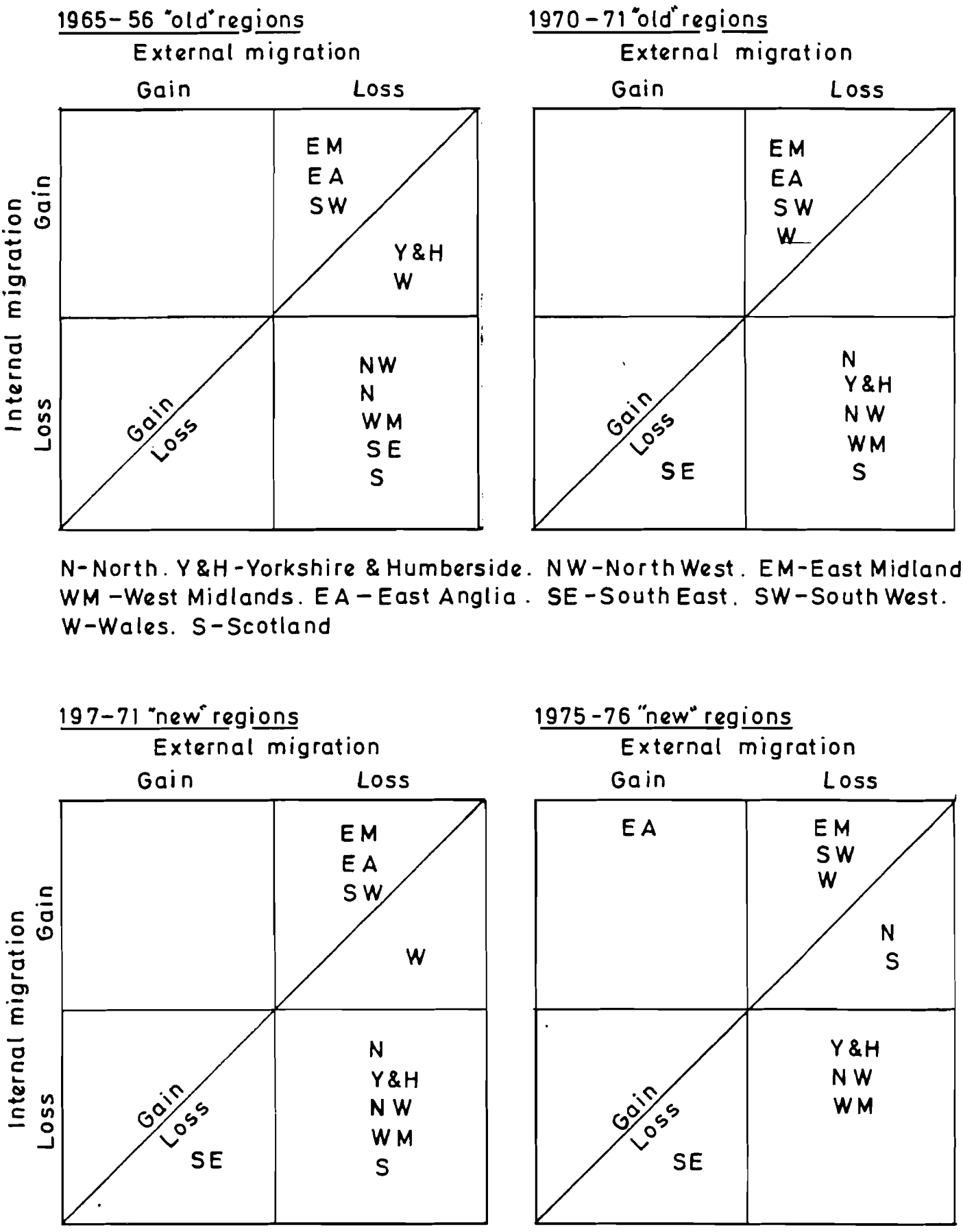


Figure 8. The pattern of regional internal & external migration balances

migration. Four regions maintain their class through the three periods: the East Midlands and the South West gain through internal migration, lose through external migration but gain overall. The North West and West Midlands lose population through both internal and external migration in 1965-66, 1970-71 and 1975-76. Two regions, East Anglia and the South East, change their position vis à vis external migration. East Anglia in 1965-66 and in 1970-71 gains through internal migration only, but in 1975-76 gains from both sources, the only region to do so. The external immigration and emigration rates for this region are very high, in fact, and this is probably a reflection of the relatively large size of the foreign student and U.S. Airforce populations in the region. Both populations are subject to continuous turnover.

The South East in 1965-66 loses through both internal and external migration streams; in 1970-71 and 1975-76 the region gains through external migration. In fact, the South East in 1975-76 attracted 49 per cent of the immigrants to Great Britain from abroad but contributed only 40 per cent of the external emigrants.

The North and Scotland show a shift in 1975-76 to gains from internal migration whereas previously they had lost through both internal and external migration. Wales exhibited losses through external migration but gains through internal with variable total outcome. Yorkshire and Humberside showed a gain from internal migration in 1965-66 but otherwise experienced losses from both migration streams.

In discussing the patterns of total internal and external in- and out-migration, the role of change has been stressed. However, it is clear that to a great measure the time series of accounts shows great stability in the overall pattern of large and small flows. In Figure 9 are plotted the most important flows (roughly a third of all flows) in the exist-survive quadrant of the 1965-66, 1970-71 and 1975-76 accounts. The maps are virtually identical, and the changes marginal.

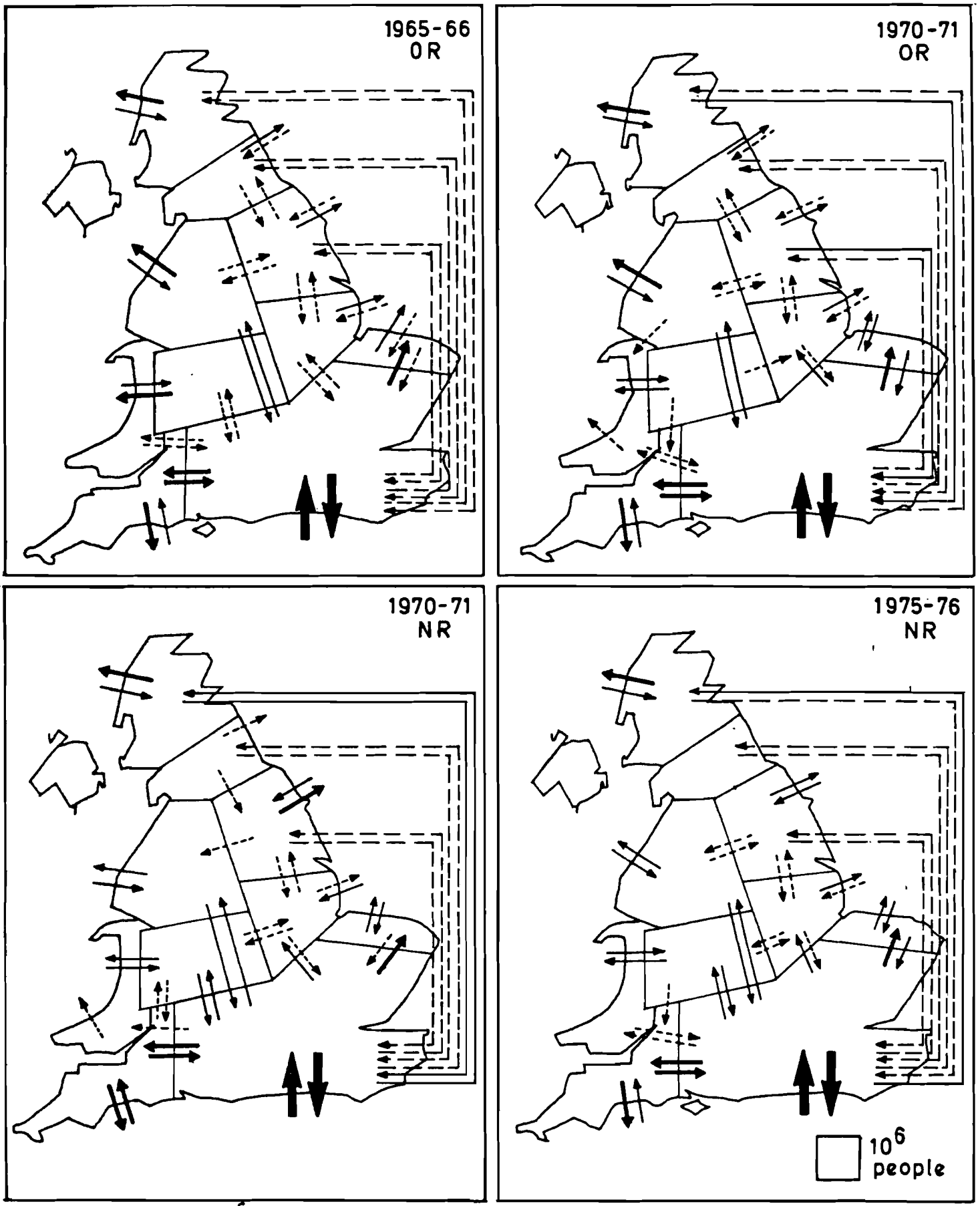


Figure 9. Migrant flow patterns, GB regions

Detailed examination of the processes underlying the inter-regional migration flows matrix is beyond the scope of this paper except that we should note that substantial and continuing attention has been paid to the problem of "explaining" migration via various forms of gravity, intervening opportunity, entropy maximising, kinetic and probabilistic models (see Stillwell, 1976, for a review; Gleave and Hyman, 1978; Cordey Hayes and Gleave, 1978; Weeden, 1973; Hart, 1970; Masser, 1970; Stillwell, 1977a, 1977b; Stillwell, 1978). Integration of this kind of predictive and potentially policy-connected model with the demographic models discussed later in this paper is clearly an important research task, foreshadowed as always by the work of Rogers (1968).

It is difficult to show what effect shifts in migration pattern have had on the future by using the information in the accounts directly in a set of projections of the population because of the compounding effect of mortality and fertility differentials (see Section 3, however, for a description of the projection consequences of the patterns of population change shown in Tables 7 to 10). Transition rates calculated by dividing each element in the accounts matrix by its row total reflect the influence of mortality as well as migration. Growth rates making up the components of growth model of Rogers (1968) include the effect of both mortality and fertility.

It is, however, possible to compare the "pure" effect of migration by dividing each element in the exist-survive quadrant by the total of survivors in its row (shown in the middle of the accounts table) to yield probabilities of relocation conditional on survival. Figure 10 graphs these probabilities for each transition in the first ten rows of the accounts matrix. Two separate lines are shown in each graph. The first connects the 1965-66 value with the 1970-71 value for the "old" regions; the second connects the 1970-71 value for the "new" regions to the 1975-76 value. Reference to a column of graphs yields the picture of change in the out-migration transitions that will produce the in-migrant flows to the region whose name heads the column. Reference to a row shows how the transition probabilities of out-migration from a region have shifted.

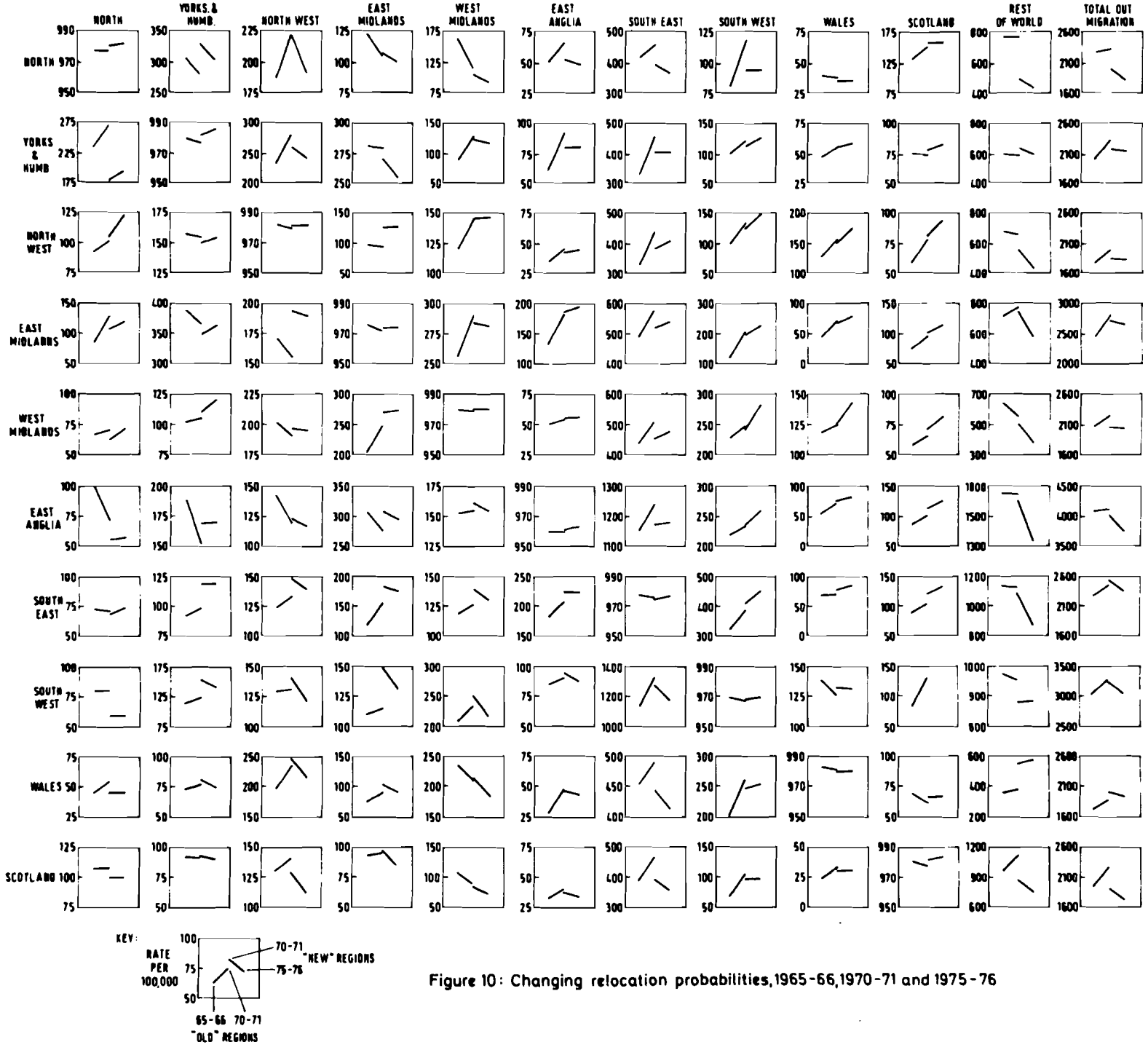


Figure 10: Changing relocation probabilities, 1965-66, 1970-71 and 1975-76

Looking at the graph, the following conclusions can be suggested:

(1) The trends in the transition probabilities suggest a shift over the period in favour of the North, East Anglia, the South West, Wales and Scotland.

(2) They suggest a shift in the opposite direction for Yorkshire and Humberside, the North West, the East Midlands and the West Midlands.

(3) The picture for the South East is ambiguous. The exact implications of these shifts in migration pattern for the future populations and future shares of the regions will be discussed in Section 3 of the paper.

2.4 Regional fertility

So far the discussion has focused on the total population of U.K. regions without regard for age and sex, and on the aggregate components of population change. Attention is now devoted to the detailed age-specific patterns for the regions, beginning first with fertility.

Earlier evidence (Figure 3, Table 4, Figure 6) showed that the recent past in the U.K. (1965-76) was a period of falling natural increase, a result of sharply declining fertility rates (since 1964) and gradually declining mortality rates. As with migration the detailed regional and age-specific pattern is examined for three calendar years - 1965, 1970, 1975 - at the beginning, middle and end of the 1965-76 period. The relevant age-specific fertility rates, total period fertility, general fertility, crude birth and net reproduction rates for 1965, 1970 and 1975 are given in Table 13.

The experience of Northern Ireland clearly stands apart from that of the rest of the U.K. The fertility levels there are considerably higher than in Great Britain: 1,029 per 1,000 higher in 1965 in total period fertility rate terms, 914 higher in 1970 and 823 higher in 1975. The differences have been narrowing, and are likely to continue to do so. The higher fertility is, in part, accounted for by the high fertility of the Catholic minority in Northern Ireland, although the fertility of the Protestant majority is also high relative to the British population as a whole (Compton, 1978).

Table 13 Fertility rates, U.K. regions, 1965, 1970, 1975

	Age-specific fertility rates (per 1000 women)							Summary rates			
	15-19	20-24	25-29	30-34	35-39	40-44	45-49	TPFR	GFR	CBR	NRR
1965 ("old" regions)											
North	42.5	171.5	173.3	98.2	50.7	13.9	1.0	2756	89.7	18.12	1291
Yorks. & Humb.	46.8	181.8	180.0	99.7	48.2	12.5	1.0	2850	92.3	18.03	1336
North West	47.8	182.7	183.1	104.4	53.1	14.1	0.9	2931	94.6	18.48	1373
East Midlands	46.2	187.8	176.8	98.9	47.9	13.0	1.0	2858	92.5	18.54	1339
West Midlands	42.9	180.9	181.5	105.9	52.1	13.6	0.9	2889	93.0	19.39	1354
East Anglia	46.3	178.4	169.2	92.7	40.5	11.5	0.9	2698	88.5	17.05	1264
South East	43.1	166.2	177.5	102.4	46.5	11.4	0.9	2740	89.6	18.05	1284
South West	45.0	189.7	180.9	100.3	46.3	12.5	0.9	2878	92.4	17.30	1349
Wales	48.2	182.7	169.2	97.8	47.2	12.4	0.9	2792	88.7	17.23	1308
Scotland	40.9	181.0	191.0	112.3	56.0	13.9	1.0	2981	96.6	19.32	1397
Northern Ireland	9.3	92.4	241.4	241.3	127.6	47.3	12.5	3859	121.9	23.57	1808
Great Britain	44.4	176.7	179.4	102.6	49.2	12.7	0.9	2830	91.8	18.26	1326
United Kingdom	43.4	174.5	181.0	106.4	51.3	13.5	1.2	2857	92.6	18.41	1339
1970 ("old" regions)											
North	48.2	167.0	137.4	73.9	31.0	8.2	0.4	2331	79.9	15.89	1110
Yorks. & Humb.	57.3	177.6	151.8	78.5	36.3	9.6	0.6	2559	89.0	16.97	1212
North West	55.7	167.7	153.0	83.7	38.4	10.0	0.6	2546	88.6	16.78	1196
East Midlands	53.9	161.7	158.4	76.7	31.6	8.4	0.6	2457	85.9	16.57	1160
West Midlands	54.0	153.3	156.7	84.3	39.6	10.4	0.8	2496	87.4	17.54	1180
East Anglia	48.7	158.9	152.4	68.4	28.8	7.2	0.4	2324	81.9	15.65	1103
South East	43.0	135.9	150.2	79.3	33.3	8.1	0.5	2252	79.3	15.50	1067
South West	48.4	155.1	152.3	72.3	29.8	7.4	0.5	2329	81.1	15.05	1111
Wales	53.1	164.8	147.4	75.5	33.0	8.1	0.5	2412	82.8	15.64	1133
Scotland	47.3	155.7	159.2	89.7	39.6	9.9	0.6	2510	86.6	16.75	1181
Northern Ireland	23.5	123.4	215.3	178.4	93.3	33.4	6.5	3369	108.7	21.01	1579
Great Britain	49.4	153.6	152.0	79.7	34.8	8.8	0.6	2395	83.6	16.18	1133
United Kingdom	48.6	152.8	153.7	82.3	36.3	9.4	0.7	2419	84.3	16.31	1144
1975 ("new" regions)											
North	42.8	123.3	124.0	49.7	17.1	3.8	0.3	1805	62.9	12.17	857
Yorks. & Humb.	41.4	122.9	122.8	53.2	19.3	5.1	0.5	1826	64.2	12.26	867
North West	42.2	121.3	123.8	57.0	21.7	5.3	0.4	1859	65.3	12.47	883
East Midlands	38.5	122.6	125.6	55.8	18.8	4.5	0.4	1831	65.0	12.63	869
West Midlands	38.7	119.4	120.0	59.7	21.8	6.3	0.7	1833	64.5	12.65	870
East Anglia	35.3	128.3	131.2	54.6	16.4	4.1	0.4	1852	66.5	12.70	879
South East	30.4	101.9	122.7	63.0	20.7	4.7	0.3	1719	61.4	12.14	816
South West	32.2	115.6	124.0	55.8	17.7	4.2	0.3	1749	61.8	11.41	830
Wales	41.8	126.4	119.6	59.0	19.2	4.1	0.3	1852	65.0	12.29	879
Scotland	40	124	129	60	21	5	0	1895	65.9	12.47	900
Northern Ireland	36	145	173	102	52	17	0	2625	88.8	17.20	1246
Great Britain	36.8	115.7	123.7	58.7	20.1	4.9	0.4	1802	63.6	12.35	856
United Kingdom	36.8	116.5	124.9	59.8	20.9	5.2	0.3	1822	64.3	12.48	865

Notes

1. Rates: Age specific rate = 1000 x(births in calendar year to women in age group/women in age group at mid-year)
TPFR = total period fertility rate = (sum of age specific rates) x 5; GFR = 1000 x (births/women aged 15-44 at mid year);
CBR = 1000 x (births/population at mid-year); NRR = net reproduction rate. 1965 & 1975 NRRs are based on division of each TPFR by the TPFR for England & Wales that yields an NRR of 1. 1970 NRRs are based on use of life table survival rates using method of Shyrock, Siegel & Stockwell (1976).

The variation among the other regions is relatively small compared with the Great Britain-Northern Ireland difference. The range between maximum and minimum value is 283 in 1965 in total period fertility rate terms, 307 in 1970 and 176 in 1975 (some 10 per cent, 13 per cent and 10 per cent of the Great Britain mean in each of the years).

The fall in fertility over the 1965-75 decade is sustained and substantial in every region. The 1965 fertility rates are the second highest since World War One (see Figure 3), just below those of the previous year. By 1975 fertility rates had fallen to 64 per cent of the 1965 high level, just over the equivalent of 1.8 children per woman over her childbearing age span, and well below replacement level.

Some regions made relative gains in the period such as East Anglia or Wales, and others lost in relative position such as the South West or South East. Figure 11 maps the crude birth rate and total period fertility rates for the regions. Fertility rates in the Northern part of the U.K. tend to be higher than those in the Southern, though the North region tends to have lower fertility and is included in the "lowest three regions" group in the 1975 maps. The correlation between different fertility indices for the same year is not perfect (Table 14), and of the same order of magnitude as the correlation between successive years on the same index. The picture is then one of minor change over a small range producing changes in rankings for the regions intermediate between the high fertility of Northern Ireland, Scotland and the North West, and the low fertility of the South East and South West.

Fertility in all regions is concentrated in the 20-24 and 25-29 age groups with the one exception of Northern Ireland where high fertility persists into the 30-34 and 35-39 age groups. The teens and twenties are the ages experiencing least fall in fertility rates in the 1965-75 period (83, 65 and 69 per cent for Great Britain, respectively) with more substantial falls in the older age groups. In Northern Ireland fertility rates in the 15-19 and 20-24 age groups rose substantially from relatively low levels as the fertility pattern shifted to that of the regions in Great Britain. This shift stands

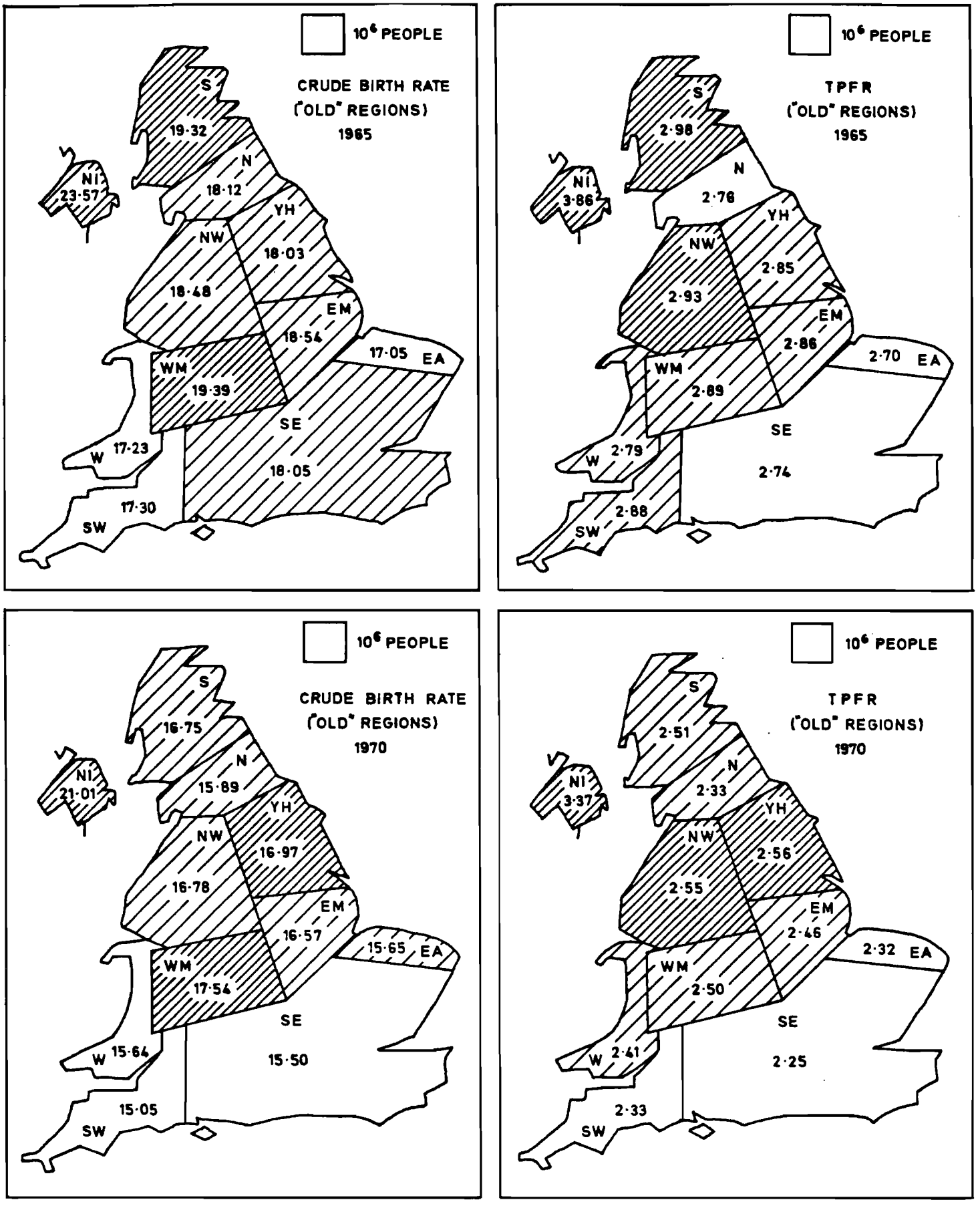


Figure 11: Regional fertility rates, U.K., 1965, 1970 and 1975

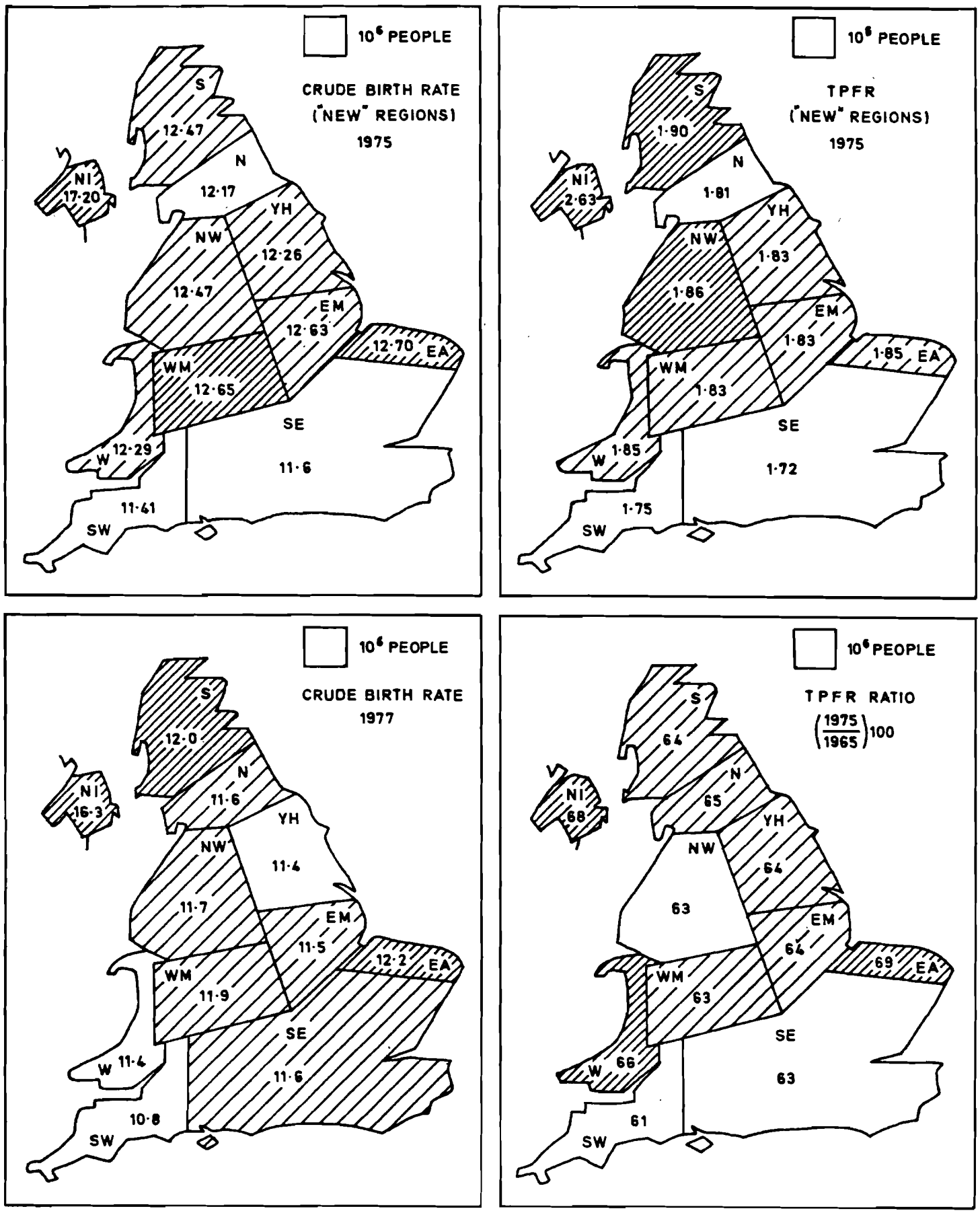

10⁶ PEOPLE
CRUDE BIRTH RATE
("NEW" REGIONS)
1975
S 12·47
N 12·17
NI 17·20
YH 12·26
NW 12·47
EM 12·63
WM 12·65
EA 12·70
SE 11·6
W 12·29
SW 11·41
10⁶ PEOPLE
TPFR
("NEW" REGIONS)
1975
S 1·90
N 1·81
NI 2·63
YH 1·83
NW 1·86
EM 1·83
WM 1·83
EA 1·85
SE 1·72
W 1·85
SW 1·75
10⁶ PEOPLE
CRUDE BIRTH RATE
1977
S 12·0
N 11·6
NI 16·3
YH 11·4
NW 11·7
EM 11·5
WM 11·9
EA 12·2
SE 11·6
W 11·4
SW 10·8
10⁶ PEOPLE
TPFR RATIO
(1975/1965)100
S 64
N 65
NI 68
YH 64
NW 63
EM 64
WM 63
EA 69
SE 63
W 66
SW 61
HIGHEST ← FERTILITY → LOWEST
TOP THREE REGIONS
MIDDLE FIVE REGIONS
BOTTOM THREE REGIONS
TPFR = TOTAL PERIOD FERTILITY RATE

Table 14 Correlation of fertility rates

		CBR			TPFR		
		1965	1970	1975	1965	1970	1975
Crude birth rate (CBR)	1965		.962	.921	.948		
	1970			.930		.967	
	1975						.984
Total period fertility rates (TPFR)	1965	.948				.975	.966
	1970		.967				.969
	1975			.984			

Notes

1. Pearson's correlation coefficient between the variables in the table derived from the data for 11 regions given in Table 13 and displayed in Figure 10.

out clearly when the rates are graphed cumulatively against age. (Figure 12): the Northern Ireland curve for 1975 shows the features which characterised those of the South East in 1965.

Net reproduction rates are shown in the last column of Table 13. These were well above replacement level (NRR=1) in 1965 but had by 1975 decreased to levels well below replacement (again with the exception of Northern Ireland). The regional patterns of fertility are not substantailly altered by the NRR calculation (the 1970 correlation between the TPFRs and NRRs is .999), but given an inverse correlation between TPFRs and female life expectancies (-.565) the variability of the NRRs amongst the regions is less than the TPFRs (coefficient of variations are .1167 and .1209 respectively).

2.5 Regional mortality

The picture provided by crude death rates for the region (Table 15) is one of rising mortality! Of course, this surprising trend results not from the greater depredations of disease but from the rising age of the population and the falling fertility. The low rates for the West Midlands and Northern Ireland are a result of their younger than average age structure rather than any better intrinsic mortality experience. The regional pattern over time is a little more stable than that for the crude birth rate.

If instead, mortality measures based on the age-specific death rates for the regions and for the country are examined a rather happier picture emerges. Life expectancy figures, calculated on a single region basis in various sources, are collected together in the bottom part of Table 16. The table reveals that slight improvement in life expectancy still continued in the recent past. An improvement of 0.6 years was effected on average for both males and females in England and Wales, between 1970 and 1974-75.

The range between highest and lowest regional life expectancy values is 3.5 for males and 3.2 for females (for the 1970 figures for all U.K. regions given in Table 17). This range is comparable to the range of life expectancy values among the countries of the

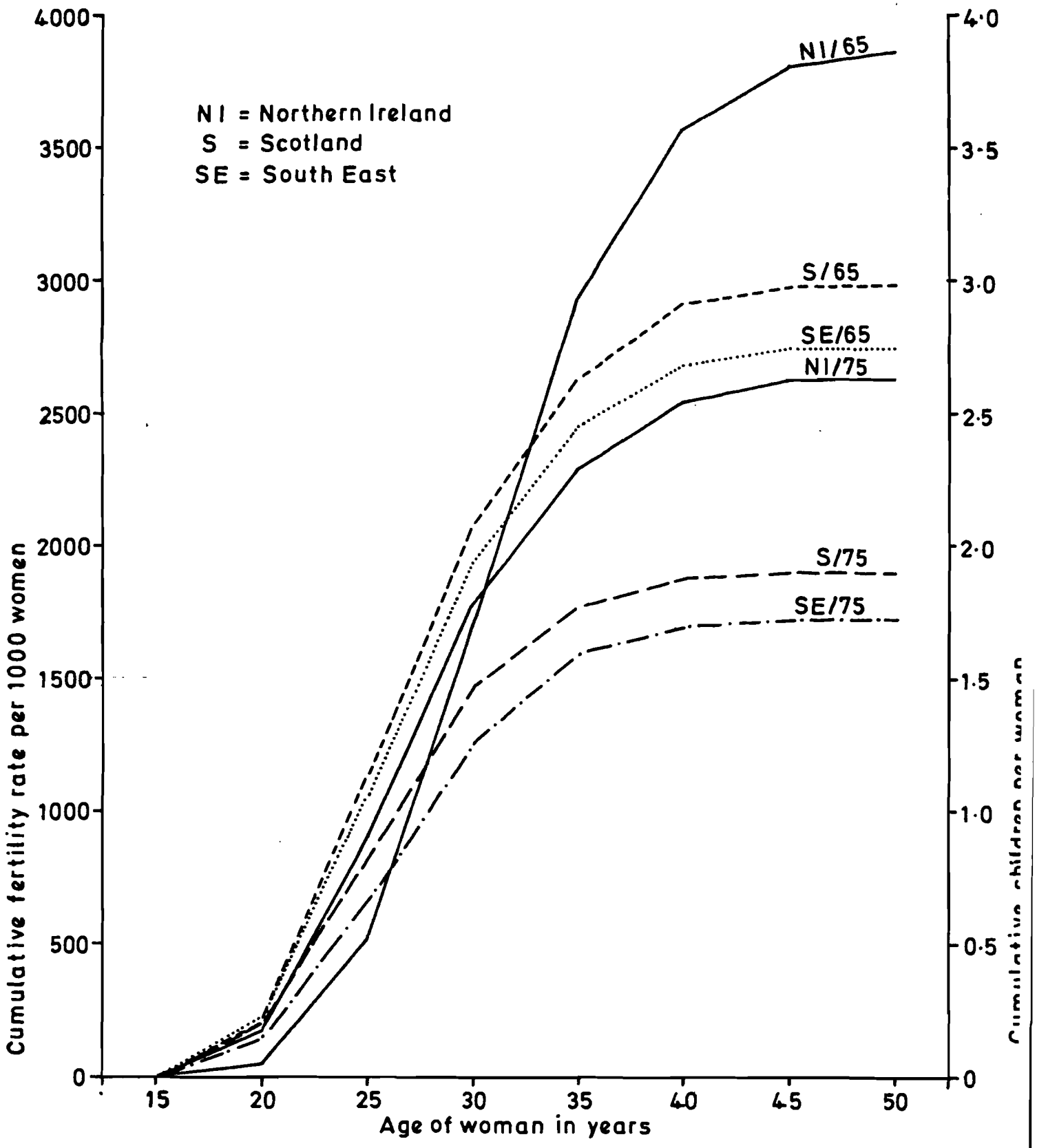


Figure 12. Cumulative fertility rates for selected regions

Table 15 Crude death rate, selected years, "new" regions

Region	1965	1970	1975	1977	Regression coefficient
North	12.2	12.3	12.3	12	.005
Yorkshire & Humberside	11.9	12.2	12.1	12	.007
North West	12.5	12.8	12.6	13	.028
East Midlands	11.0	11.3	11.3	11	.005
West Midlands	10.5	10.7	10.7	11	.033
East Anglia	11.6	11.4	11.4	11	-.039
South East	11.2	11.4	11.4	11	-.009
South West	12.0	12.5	12.7	13	.077
Wales	12.3	12.9	12.9	13	.052
Scotland	12.1	12.2	12.4	12.5	.033
Northern Ireland	10.6	10.9	10.7	11.1	.028
United Kingdom	11.5	11.8	11.9	12	.039
Great Britain	11.5	11.9	11.9	12	.037
England and Wales	11.5	11.8	11.8	12	.035
Correlation coefficient	.962	.979	.933		

Notes

1. The regression coefficient is calculated by regressing the crude death rate against time starting at 1965.

2. The correlation coefficient is Pearson's r.

Table 16 Selected morality indicators, England and Wales regions, 1969-75

Region	SMR (OR) 1969-73		RMR (OR) 1969-73	SMR (NR) 1975	
	Males	Females	Infants	Males	Females
North	109	108	107	111	108
Yorkshire & Humberside	105	104	112	104	103
North West	112	109	113	111	108
East Midlands	98	100	101	97	100
West Midlands	104	102	104	103	102
East Anglia	89	93	88	88	93
South East	93	95	90	94	95
South West	93	96	94	90	94
Wales	107	104	103	109	105
England and Wales	100	100	100	100	100

Region	LE (OR) 1970		LE (NR) 1974-75		GAIN IN LE 1970 to 74-75	
	Males	Females	Males	Females	Males	Females
North	68.1	74.1	68.2	74.4	0.1	0.3
Yorkshire and Humberside	68.0	74.4	68.9	75.2	0.9	0.8
North West	67.2	73.8	68.1	74.4	0.9	0.4
East Midlands	68.8	75.2	69.4	75.4	0.6	0.2
West Midlands	68.4	74.8	69.1	75.4	0.7	0.6
East Anglia	70.5	76.5	71.3	76.9	0.8	0.4
South East	69.9	76.1	70.6	76.6	0.7	0.5
South West	69.6	75.9	70.6	76.8	1.0	0.9
Wales	68.0	74.2	68.5	75.1	0.5	0.9
England and Wales	68.9	75.1	69.5	75.7	0.6	0.6

Notes

1. Definitions
   SMR = standardised mortality ratio or the ratio of actual deaths in the region to deaths expected by applying the England and Wales mortality rates to the regional population at risk.
   RMR = relative mortality ratio or the ratio of the infant mortality rate to the infant mortality rate for England and Wales.
   LE = average life expectancy
   OR = "old" regions
   NR = "new" regions

2. Sources

SMR (OR) 1969-73) RMR (OR) 1969-73)	Chilvers (1978)
SMR (NR) 1975	O.P.C.S. (1977c)
LE (OR) 1970	Table 17
LE (NR) 1974-75	Gardner and Donnan (1977)

Table 17 Regional life expectancies, U.K., 1970

"Old" Region	Average $_0e$				Median $_0e$			
	Persons	Males	Females	Difference	Persons	Males	Females	Difference
North	71.1	68.1	74.1	6.0	74.4	71.2	77.6	6.4
Yorkshire & Humberside	71.2	68.0	74.4	6.4	74.5	71.2	77.9	6.7
North West	70.5	67.2	73.8	6.6	73.8	70.4	77.4	7.0
East Midlands	72.0	68.8	75.2	6.4	75.2	71.8	78.6	6.8
West Midlands	71.6	68.4	74.8	6.4	74.9	71.4	78.4	7.0
East Anglia	73.5	70.5	76.5	6.0	76.6	73.5	79.9	6.4
South East	73.1	69.9	76.1	6.3	76.3	72.8	79.6	6.8
South West	72.8	69.6	75.9	6.3	76.0	72.7	79.1	6.4
Wales	71.1	68.0	74.2	6.2	74.4	71.1	77.8	6.7
Scotland	70.2	67.0	73.3	6.3	73.6	70.3	76.9	6.6
Northern Ireland	70.7	67.9	73.5	5.6	74.0	71.0	77.0	6.0

Notes

1. Deaths data for five year age groups 0, 1-4, 5-9, ..., 85+ estimated from data available for 0, 1-4, 5-14, 15-24,..., 75+ for standard regions in England and Wales using national deaths data and mid-year population broken down by five year age groups 0, 1-4, 5-9,..., 85+. The estimation equations are

$$D_r^{jx} = A_s^{jx} \, d_r^{EWx} \, P_r^{jx} \quad , \quad r \epsilon s$$

$$A_s^{jx} = D_s^{jx} \Big/ \sum_{r \epsilon s} d_r^{EWx} \, P_r^{jx}$$

where D_r^{jx} are deaths in region j for sex x in detailed age group r, P_r^{jx} is the population of sex x in region j in detailed age group r, d_r^{EWx} is the death rate for sex x and age group r in England and Wales, A^{jx} is a balancing factor for sex x in region j that adjusts estimated r age group deaths so that they equal observed s (more aggregated) age group deaths, D_s^{jx}.

2. Deaths data for Scotland and Northern Ireland were directly available.

3. The life expectancies were calculated using a version of the LIFE computer program given in Keyfitz and Flieger (1971) adapted for an ICL 1906A with integer variables converted to reals.

4. Median life expectancies are the age at which half the population has died (that is, that x for which e(x)=.5). They are found by interpolation.

Table 18 Life table survivors out of 10,000 births from the abridged life tables for 1970

Region	Age in years							
	0	1	20	40	50	60	70	80
MALES								
North	10000	9792	9680	9444	9007	7829	5395	2196
Yorks. & Humb.	10000	9765	9645	9418	9021	7908	5407	2148
North West	10000	9751	9635	9405	8950	7712	5126	1973
East Midlands	10000	9792	9681	9453	9078	8036	5621	2379
West Midlands	10000	9792	9677	9457	9062	7943	5473	2276
East Anglia	10000	9818	9691	9506	9180	8289	6127	2842
South East	10000	9813	9705	9500	9163	8189	5896	2659
South West	10000	9807	9695	9499	9163	8157	5864	2564
Wales	10000	9796	9689	9470	9038	7832	5348	2137
Scotland	10000	9775	9652	9356	8875	7626	5101	2018
Northern Ireland	10000	9762	9654	9402	8952	7808	5319	2256
FEMALES								
North	10000	9827	9762	9628	9324	8662	7193	4203
Yorks. & Humb.	10000	9820	9753	9611	9326	8693	7237	4334
North West	10000	9824	9749	9602	9300	8601	7093	4154
East Midlands	10000	9852	9786	9657	9387	8779	7394	4541
West Midlands	10000	9828	9754	9622	9361	8776	7379	4459
East Anglia	10000	9861	9793	9671	9442	8925	7654	4958
South East	10000	9856	9791	9655	9409	8858	7584	4861
South West	10000	9853	9798	9676	9443	8887	7557	4740
Wales	10000	9825	9759	9613	9314	8658	7202	4279
Scotland	10000	9833	9756	9581	9241	8494	6947	3982
Northern Ireland	10000	9800	9730	9576	9285	8584	7036	3972
PERSONS								
North	10000	9809	9720	9535	9162	8242	6280	3208
Yorks. & Humb.	10000	9791	9698	9512	9169	8296	6319	3266
North West	10000	9786	9691	9501	9122	8158	6124	3103
East Midlands	10000	9821	9732	9552	9227	8400	6488	3469
West Midlands	10000	9810	9714	9537	9206	8350	6407	3380
East Anglia	10000	9839	9741	9585	9306	8604	6884	3926
South East	10000	9834	9747	9576	9285	8526	6760	3844
South West	10000	9829	9745	9585	9301	8523	6720	3690
Wales	10000	9810	9723	9540	9174	8246	6270	3216
Scotland	10000	9803	9703	9467	9058	8067	6036	3030
Northern Ireland	10000	9780	9691	9488	9119	8199	6187	3114

Common Market (4.76 for males and 3.51 for females for 1966 from statistics given in Keyfitz and Flieger, 1971). The most favoured region in 1970, East Anglia, enjoys mortality conditions nearly as favourable as the Netherlands or Denmark; Scotland on the other hand suffers from less favourable mortality levels, comparable to those of Luxembourg.

Tables 17 and 18 and Figure 13 provide a more detailed picture of life expectancy as of 1970. These tables will be used later to compare the information available on a single region basis with that available from multi-regional analysis. The pattern is one of higher mortality in the Northern and Western regions than in the Southern and Eastern (Figure 12). Scotland and the North West are particularly disadvantaged compared with the other regions in terms of male life expectancy and East Anglia and the South East particularly advantaged. The regional variability of female life expectancy is a little lower than that of males. Table 18 extracts from the individual life tables the $\ell(x)$ survival statistics for males, females and persons, and makes possible an examination of regional differences in survival to particular ages. The rank ordering shown in Figure 13 is maintained at most ages, give or take a rank per region, with only one or two exceptions. The Northern Ireland male populations shows a higher survival propensity at the oldest ages than its overall life expectancy position suggestions. Similarly, Scotland has a much higher survival value at age 1 than its overall position suggests.

2.6 Inter-regional migration: patterns and rates by age

The examination of age-specific patterns of mortality and fertility is a long standing concern. However, data of good quality on age-specific migration has only recently become available in the U.K. with the Censuses of 1961, 1966 and 1971. Published data for detailed age groups for inter-regional migration up to 75 and over is available only in the Census 1971, although Joseph (1975) has used unpublished special tabulations from the Sample Census 1966. The regions to which the data apply are our "old" regions (Figure 1.2). Unpublished tabulations of inter-regional migration on a uniform five year age group basis are

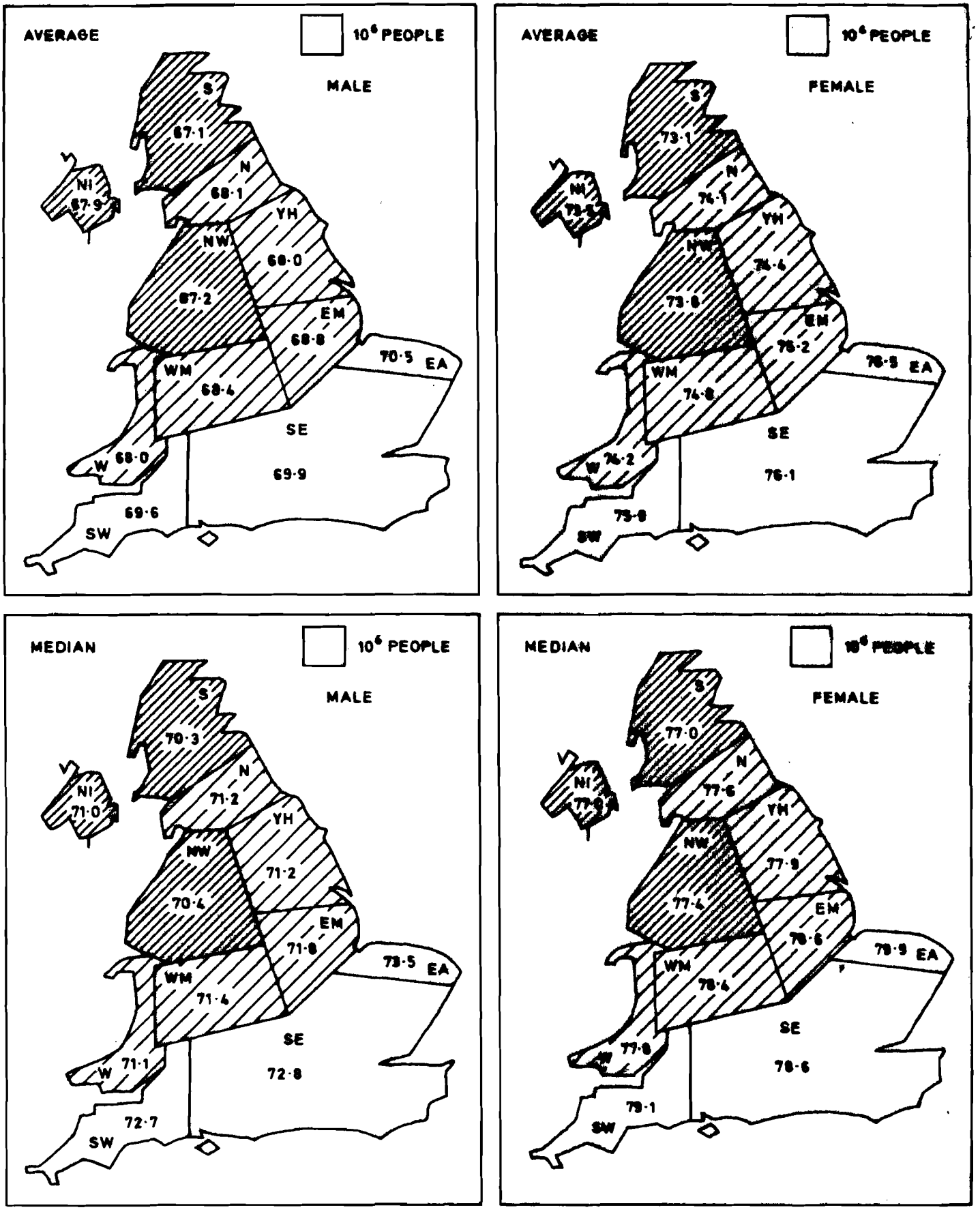


Figure 13. Life expectancies, single region method, 1970

also available for "new" regions (Figure 1.3). Selected data from these various sources are used to investigate the relationship between inter-regional migration and age.

Net migrant flows are examined first. Table 19 sets out a crude age disaggregation of the net internal migrant columns of Table 11 for the 1965-66 and 1970-71 period and adds a comparison with the earlier 1960-61 period (data derived from the Department of the Environment, 1971). Some individual age groups display distinctive patterns that differ from the overall ones already discussed in an earlier section. For example, although the South East moves from positive net immigration in the early sixties to net outflow later both overall and for all but one age group, migration of 15-24 year olds remains positive throughout the period. The bright lights of the capital attract the nation's young like moths to a lamp at night. At older ages the attractions diminish and net out-migration occurs. By 1970-71, three regions show consistent losses in all age groups, that is, Yorkshire and Humberside, the North West and West Midlands. Two show a mixed pattern of mainly losses and some gains (the South East as already noted, and Scotland). Two show a pattern of losses in the 15-24 year age group but mostly gains otherwise - the North and Wales. Three regions, East Midlands, East Anglia and the South West, exhibit consistent gains in all age groups in 1970-71 (and in 1965-66). Figure 14 shows these patterns for five year age groups in 1970-71. The picture remains the same with one or two minor deviations such as East Midlands' 15-19 year olds.

Of course, net migrants as such do not actually exist: they are simply an arithmetic concept. To obtain a better idea of the age-specific pattern of migration, the migrant data need to be examined through the computation of rates that relate migrants to population at risk. A detailed matrix of inter-regional migrants by five year age group was assembled for 1970-71 (the methods of estimation are described in Section 3 of the paper), and migration rates were calculated using the Willekens and Rogers (1976) computer program run at I.I.A.S.A.

$$ {}^{i}M_{x}^{j} = \frac{{}^{i}D_{x}^{j}}{K_{x}^{i}} \qquad \text{for } i,j=1,\ldots,10,\ j\neq i \qquad (1) $$

Table 19 Net inter-regional internal migrants, 1960-61, 1965-66, 1970-71

	North	Yorks. & Humb.	North West	East Midlands	West Midlands	East Anglia	South East	South West	Wales	Scotland
1960-61										
Age group										
1-14	-2340	-260	-1200	2770	1390	940	1370	4970	-450	-7190
15-24	-3330	-1900	-1470	1520	80	-290	14540	1310	-4380	-6080
25-44	-3920	-2680	-1640	3080	2390	1530	6020	5850	-1280	-9350
45-64	-350	-1860	-2010	-90	-1130	1180	-90	4640	1100	-1390
65+	250	-680	-700	10	-690	850	-1670	2550	240	-160
Total	-9690	-7380	-7020	7290	2040	4210	20170	19320	-4770	-24170
1965-66										
Age group										
1-14	-1190	1060	1240	3750	-30	2350	-7350	3150	660	-3640
15-24	-1980	80	-2270	3170	-1530	1090	9140	1150	-2570	-6280
25-44	80	770	790	3550	-710	3880	-9710	4910	700	-4360
45-59	-200	-640	-1080	850	-1020	1920	-3890	4250	1110	-1300
60+	440	-910	-1100	410	-1200	2800	-8350	7200	800	-90
Total	-2750	360	-2420	11730	-4990	12040	-20160	20660	700	-15670
1970-71										
Age group										
1-14	660	-3110	-1210	2620	-1820	5210	-4370	6320	170	-4470
15-24	-2000	-6270	-5690	1540	-1350	3660	14910	3970	-2660	-6110
25-44	60	-3870	-650	4040	-2750	5850	-5830	6790	770	-4410
45-59	-30	-590	-1820	680	-1440	2590	-7710	6060	1950	310
60+	510	-910	-1780	770	-2860	2640	-14810	9980	1220	420
Total	-800	-14750	-11150	9650	-10220	20950	-13990	33120	1450	-14260

Sources:

1. 1960-61 and 1965-66 migrant figures are taken from Department of the Environment (1971), Appendix 2. The data are originally derived from the relevant census 1961 and Sample Census 1966 tabulations.
2. 1970-71 migrant figures derive from Table 3A in O.P.C.S. (1974).
3. The age groups are those at the end of the one year period of measurement, that is, at census dates in 1961, 1965 and 1971.

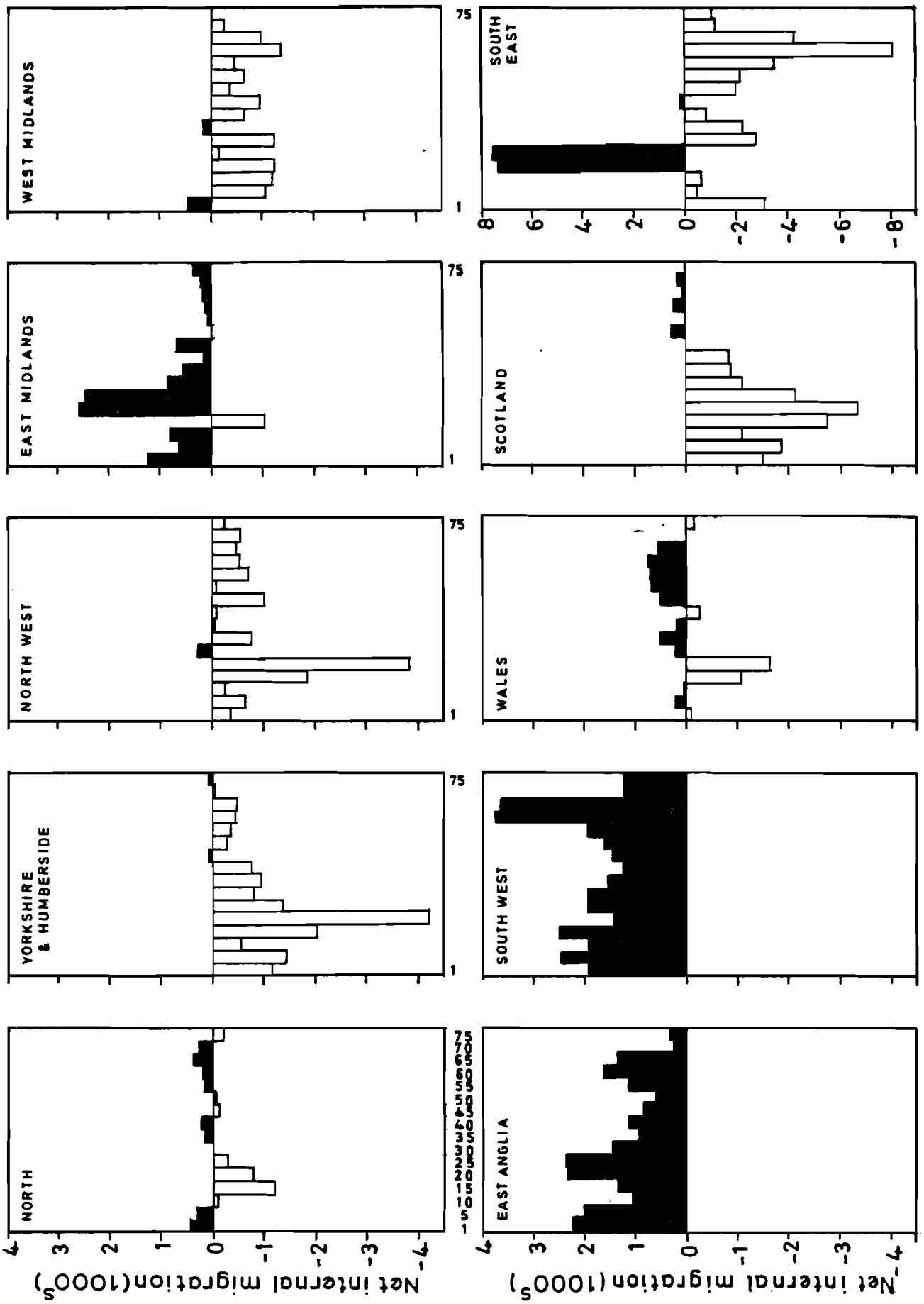


Figure 14. Net internal migration patterns

where

${}^{i}M_{x}^{j}$ is the observed rate of migration (transition) from region i at the start of the year to region j at the end of the year for persons making the transition between age x and age x+5

${}^{i}D_{x}^{j}$ is the estimated number of migrants (of both sexes) making the transition from region i at the start of the year to region j at the end of the year for persons making the transition between age x and x+5

K_{x}^{i} is the estimated number of people (of both sexes) in region i in age group x to x+5 (whole years x to x+4 at last birthday) mid-way through the year.

The ${}^{i}D_{x}^{j}$ for the calendar year 1970 were assumed to be equal to the ${}^{i}D_{x}^{j}$ measured in the pre-Census 24th/25th April 1970 to 24th/25th April 1971 period. The K_{x}^{i} apply to mid-year (30th June/1st July) 1970. When the ${}^{i}M_{x}^{j}$ are plotted against age x, on a graph it should be remembered that the average age of migration is approximately $x+\frac{5}{2}$, and this approximation is used in computing mean age of the migrants or the migration schedule (Willekens and Rogers, 1976).

Figure 15 displays the age pattern of total internal out-migration for each of the ten regions. The characteristic profile was described over a decade ago by Lowry (1966), and more recently by Plessis-Fraissard (1977), and has been modelled by Rogers and Castro (1976), Rogers, Raquillet and Castro (1977) and Pittenger (1978). This profile is displayed in all regions. Each age-specific profile is characterised by a fall from age group 0-4 to age group 10-14, a sharp rise from age group 10-14 to age group 20-24, and a decline from the peak (at age group 20-24 in all cases) to a levelling out at age groups 45-49 and beyond at about 40 per cent of the crude rate. There is evidence of a third local maximum at retirement ages in some of the schedules, in those for the East Midlands, West Midlands and South East.

These general observations can be repeated for a selection of inter-regional migration rates displayed in Figure 16, for the rates of immigration to the regions from outside G.B. shown in Figure 17, for selected emigration rates taken from Rees (1977a) in Figure 18 and for selected classes of all migrants resident in Great Britain

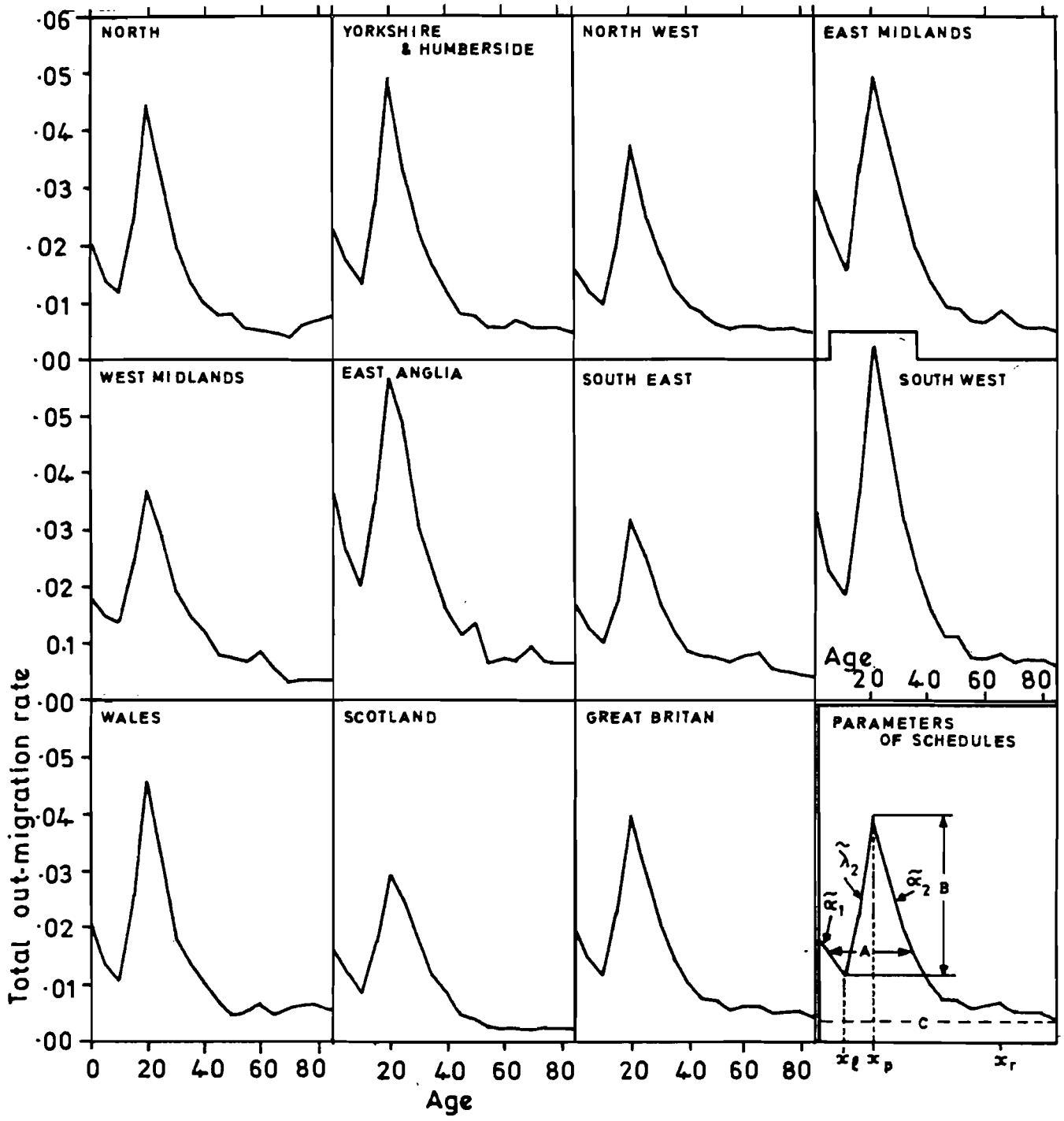


Figure 15. Total internal out-migration rates, 1970

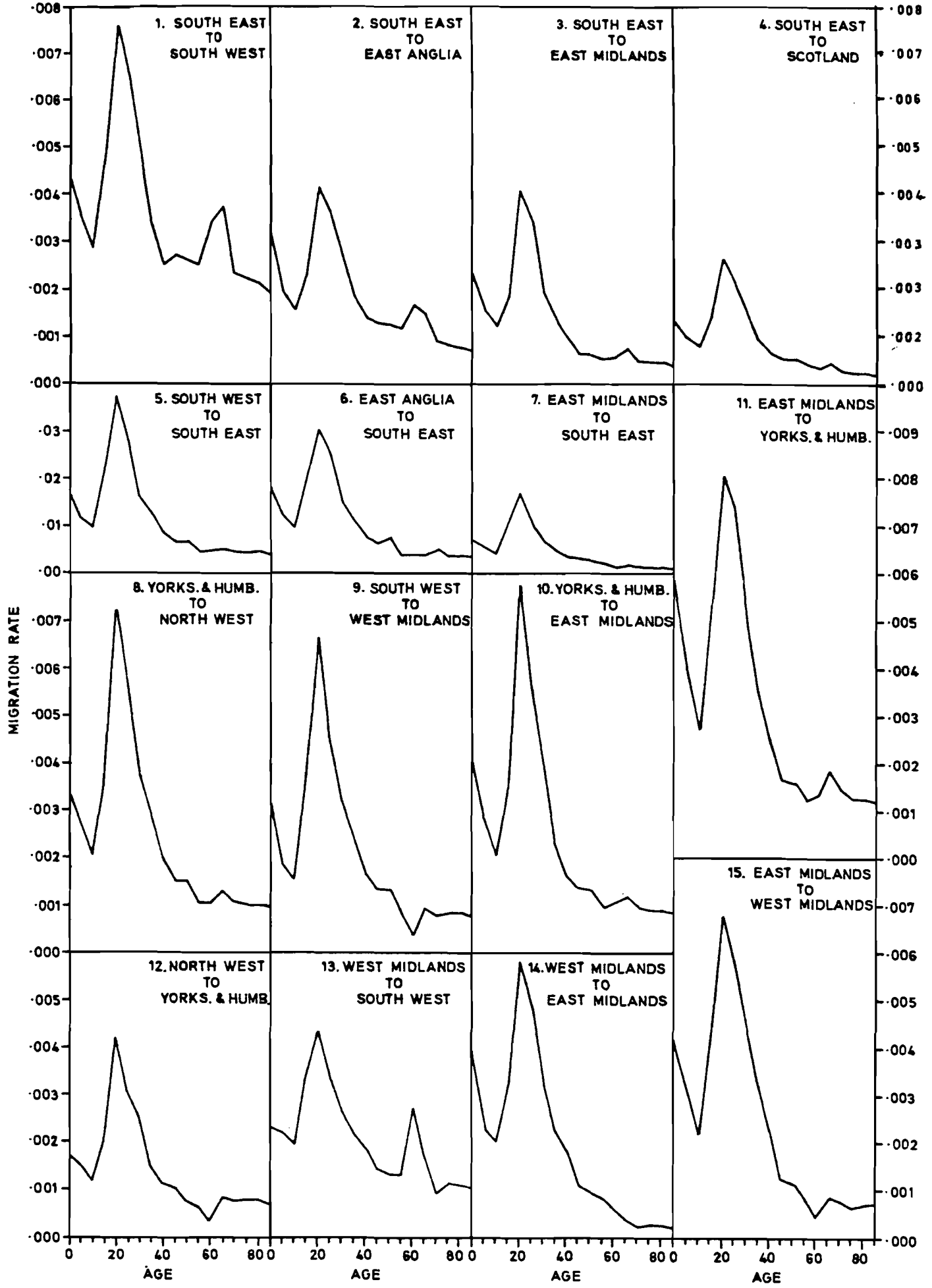


Figure 16. Selected inter-regional migration profiles (internal migration) 1970

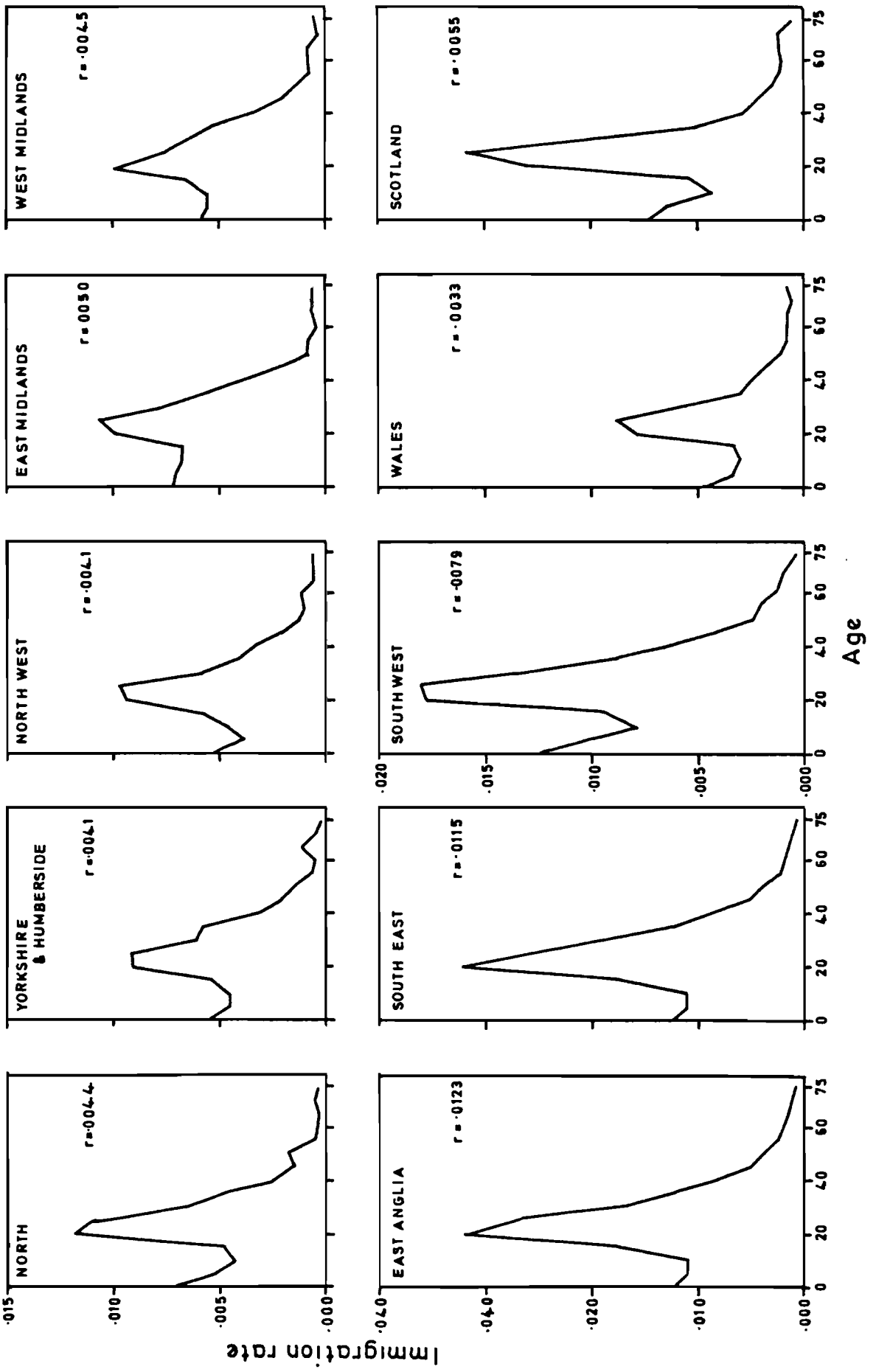


Figure 17. External immigration rate profiles, 1970

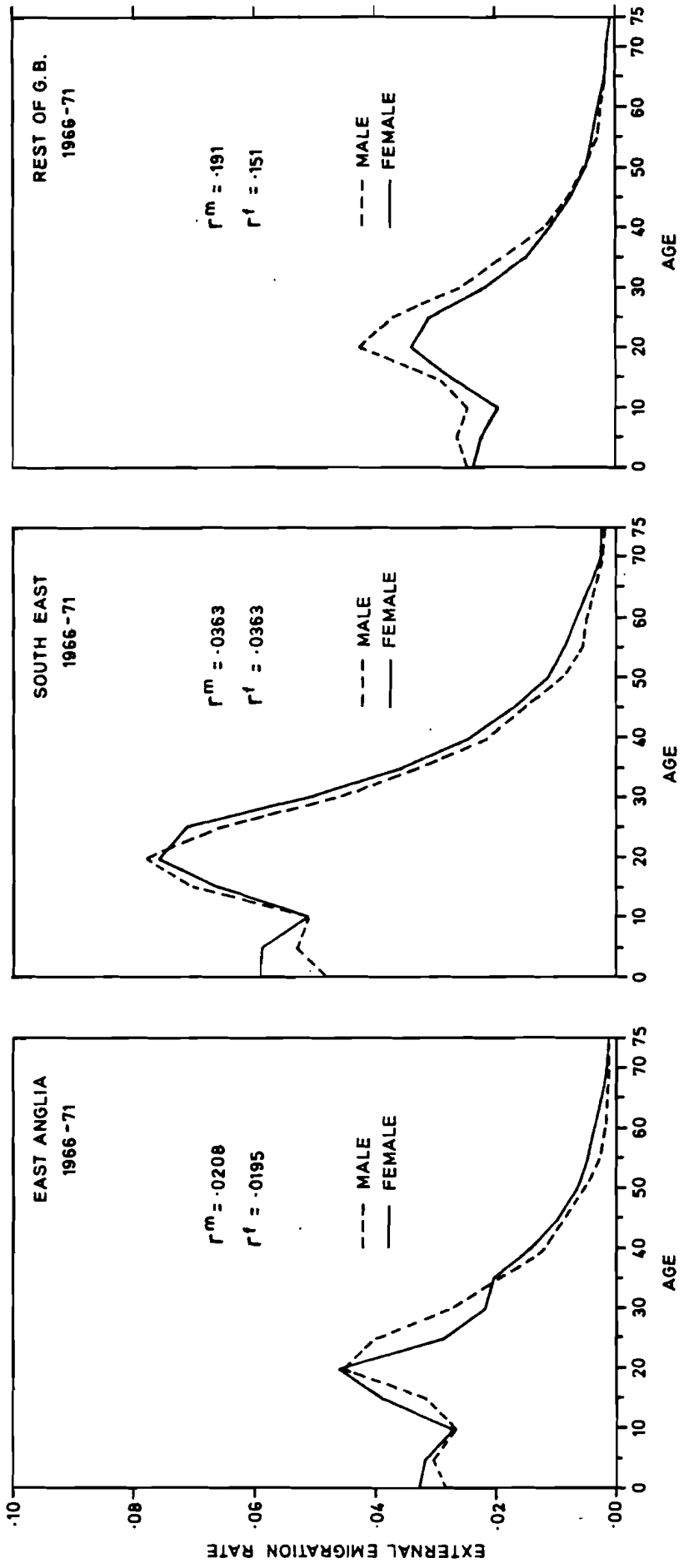


Figure 18. External emigration profiles, 1966-71

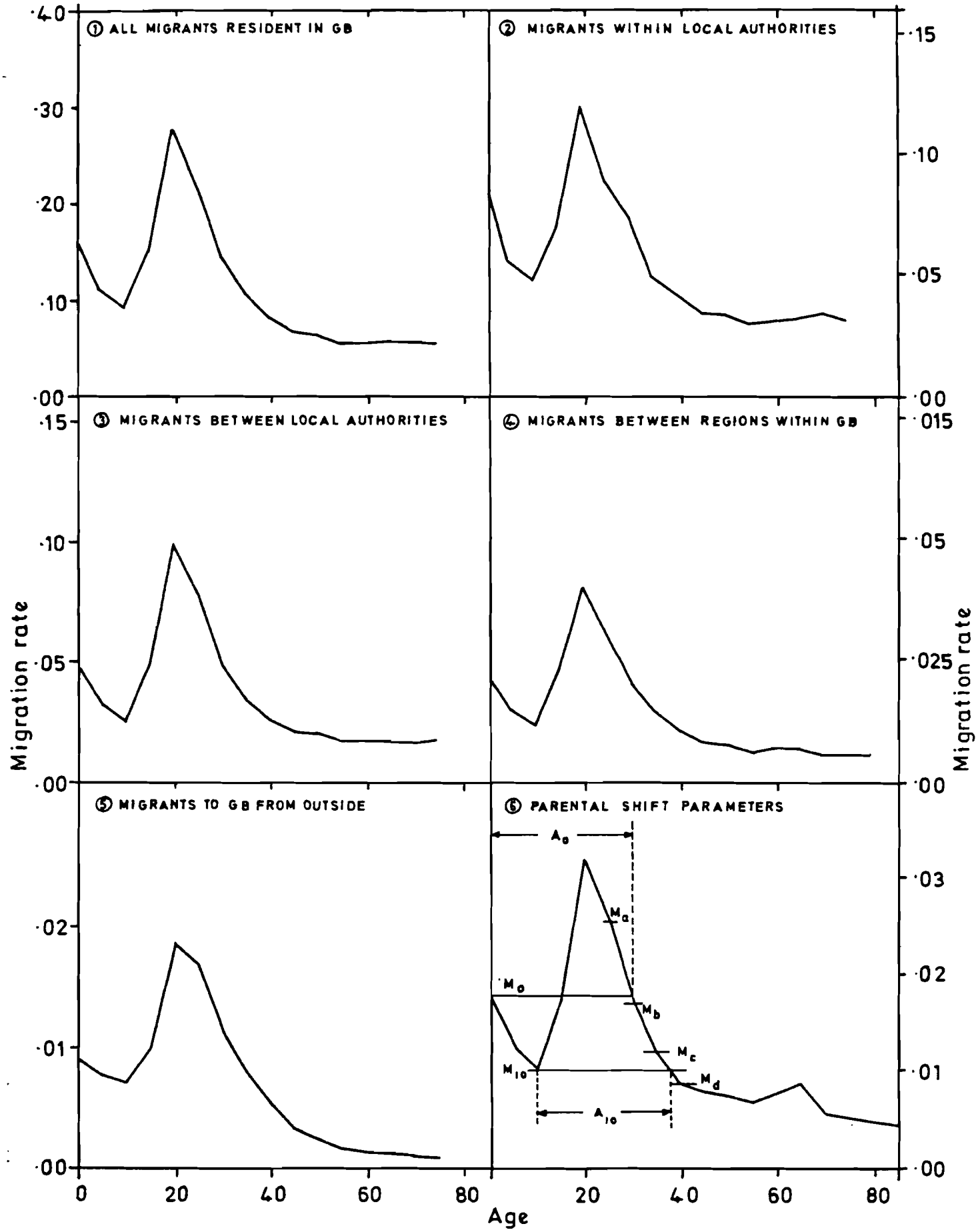


Figure 19. Migration profiles for various classes of migrant G.B., 1970

in Figure 19. Although the migration schedules have the same general shape there are a number of interesting differences in detail. In order to pinpoint these differences rough approximations to the model migration schedule parameters developed by Rogers, Racquillet and Castro (1977) have been calculated for the Figure 15 and Figure 19 schedules and recorded in Table 20. Comparisons of the regional or migration class schedules can be made, in particular, with the all migrants schedule (Figure 19,1).

The absolute levels of out-migration in the various regions or migration classes (first column of Table 20) differ so much that the schedule parameters (bottom half of Table 20) have all been normalised by division by the crude rate. The average age of migration schedules of the various classes differ little, although the variation among regions is substantial. The North West, West Midlands, South East and Wales stand out as having "older" schedules. A detailed tabulation (Table 21) of the average ages of the migration schedules of inter-regional migrants reveals that destination regions tend to be more homogeneous than origin regions in this respect, and that the oldest schedules involve flows to the South West, Wales and East Anglia. These regions are the principal destinations of retirement migrants from the South East and South West in particular. Retirement peaks in the migration schedules show up only at muted scale in total out- or in-migration flows (7 out of 10 regions). They are pronounced features of only selected migration streams such as South East to South West (Figure 16.1), West Midlands to South West (Figure 16.13), South East to East Anglia (Figure 16.2), East Midlands to Yorkshire and Humberside (Figure 16.11). The corresponding migration counter-streams (Figures 16.5, 16.6 and 16.10) fail to show marked retirement peaks.

The constant column ($C/\overline{M}$) reveals that there is, in fact, a systematic relationship between levels of migration rates at the older ages and spatial scale. For the external migrant flows there are very low rates beyond age 50; for inter-regional migrations the rates remain moderate and for within region, inter-local authority and intra-local authority migration the rates remain quite high in relation to the mean rate.

Table 20 Parameters of the observed out-migration schedules, 1970

Region or Migrant Class	Crude rate $\bar{M}$	Av. age of schedule $\bar{x}$	Age at low point x_ℓ	Age at high peak x_p	Age at retirement peak x_r	The parental shift at x=0 A_0	The parental shift at x=10 A_{10}	The parental shift average A
North	.0155	29.9	12.5	22.5	-	29.3	26.5	27.9
Yorkshire & Humberside	.0174	29.7	12.5	22.5	67.5	29.3	28.4	28.8
North West	.0134	31.6	12.5	22.5	-	31.6	29.3	30.4
East Midlands	.0206	29.6	12.5	22.5	67.5	29.3	27.8	28.5
West Midlands	.0151	30.1	12.5	22.5	62.5	31.0	27.1	29.1
East Anglia	.0241	29.4	12.5	22.5	72.5	27.8	27.2	27.5
South East	.0135	32.8	12.5	22.5	67.5	29.7	28.1	28.9
South West	.0235	29.8	12.5	22.5	67.5	29.8	28.3	29.0
Wales	.0152	30.4	12.5	22.5	62.5	28.8	28.9	28.8
Scotland	.0117	27.7	12.5	22.5	-	30.4	29.6	30.0
G.B.:								
1) All migrants	.1168	31.2	12.5	22.5	-	28.6	27.6	28.1
2) Within LAs	.0563	32.2	12.5	22.5	-	26.0	25.7	25.8
3) Between LAs within regions	.0378		12.5	22.5	-	29.8	29.9	29.8
4) Between regions	.0155	32.0	12.5	22.5	65.0	29.8	28.2	29.0
5) From outside G.B.	.0072		12.5	22.6	-	33.2	26.1	29.7

Region or Migrant Class	Gradients $\alpha_1/\bar{M}$	Gradients $\alpha_2/\bar{M}$	Gradients $\lambda_2/\bar{M}$	Constant $C/\bar{M}$	Jump $B/\bar{M}$	Peakedness ratio $M_{xp}/M_{x\ell}$
North	-.0600	-.1123	.2084	.2471	2.08	2.9
Yorkshire & Humberside	-.0603	-.1080	.2063	.2874	2.06	2.8
North West	-.0485	-.1052	.2075	.3604	2.07	2.8
East Midlands	-.0655	-.0888	.1650	.2757	1.65	2.4
West Midlands	-.0301	-.0795	.1494	.1942	1.94	2.4
East Anglia	-.0759	-.0851	.1515	.2805	2.80	2.3
South East	-.0578	-.0859	.1622	.3311	1.62	2.4
South West	-.0600	-.1034	.1953	.2966	1.95	2.7
Wales	-.0664	-.1164	.2289	.3072	2.29	3.0
Scotland	-.0718	-.0923	.1812	.1718	1.81	2.5
G.B.:						
1) All migrants	-.0599	-.0837	.1580	.4687	1.58	3.0
2) Within LAs	-.0637	-.0704	.1271	.5575	1.27	2.5
3) Between LAs within regions	-.0620	-.0974	.1945	.4177	1.94	3.8
4) Between regions	-.0574	-.0948	.1806	.3168	1.81	2.6
5) From outside G.B.	-.0244	-.0933	.1591	.0874	1.59	2.6

Table 20

Notes: definitions of parameters

These are cruder versions of the parameters of model migration schedules developed by Rogers, Racquillet and Castro (1977).

$\bar{M}$ = average or crude migration rate (as defined in Equation (1))

$\bar{x}$ = average age of schedule of migration rates

x_e = average age of low point in schedule in teens

x_p = average age of high point in schedule in twenties

x_r = average age of high point at retirement (if present)

A_0 = parental shift at x=0 (age group 0-4)

A_{10} = parental shift at x=10 (age group 10-14)

A = average parental shift = $(A_0+A_{10})/2$

$$A_0 = \left[M_a + 5(M_a-M_0)/(M_a-M_b)\right]$$

$$A_{10} = \left[M_c + 5(M_c-M_{10})/(M_c-M_d)\right]$$

M_a, M_b, M_c, M_d: migration rates as defined in Figure 16.6

α_1 = rate of descent of pre-labour curve = $(M_{x_\ell}-M_0)/(x_\ell-0)$

α_2 = rate of descent of labour force curve = $(M_{40}-M_{x_p})/(40-x_p)$

λ_2 = rate of ascent of labour force curve = $(M_{x_p}-M_{x_\ell})/(x_p-x_\ell)$

= minimum M_x

c = constant

B = jump in migration rates on labour force entry = $(M_{x_p}-M_{x_\ell})$

All these parameters are normalised by division by M_ℓ.

Table 21 Mean age of migrants and migration rate schedules, 1970

Origin region	Destination region N	YH	NW	WM	EM	EA	SE	SW	W	S	Total
A. Mean age of migrants											
North	--	26.4	26.7	27.2	24.4	25.1	25.8	26.6	24.2	26.3	
Yorks. & Humb.	26.7	--	27.5	26.3	25.0	24.0	24.6	27.7	26.6	26.8	
North West	27.8	28.2	--	27.9	26.6	26.5	26.5	28.5	30.6	25.5	
East Midlands	23.8	26.3	25.9	--	25.1	26.4	25.6	27.6	27.2	22.5	
West Midlands	24.6	24.7	26.2	24.2	--	25.6	25.5	30.3	29.7	27.8	
East Anglia	31.1	26.1	23.5	26.7	24.4	--	26.4	25.3	27.6	23.0	
South East	27.3	26.4	27.5	26.4	26.7	29.4	--	32.0	29.7	27.2	
South West	24.5	25.0	27.3	25.1	27.0	27.4	27.1	--	27.4	24.1	
Wales	22.9	27.8	26.7	25.0	27.7	26.9	26.2	28.1	--	24.4	
Scotland	24.4	22.3	24.8	22.6	22.7	25.3	24.1	23.4	27.8	--	
B. Mean age of schedule											
North	--	30.2	30.8	31.5	27.5	29.3	29.3	31.4	27.4	30.6	30.0
Yorks. & Humb.	30.0	--	31.6	30.2	28.2	27.1	27.7	32.2	30.2	30.2	29.7
North West	32.0	32.8	--	32.6	30.7	30.4	30.1	33.0	35.1	28.9	31.7
East Midlands	26.5	30.6	29.4	--	28.5	30.9	28.8	32.9	32.4	25.5	29.6
West Midlands	28.2	27.2	30.0	26.8	--	28.9	28.1	35.8	34.9	32.2	30.1
East Anglia	35.8	29.3	25.3	30.2	27.6	--	29.7	29.1	30.5	25.7	29.4
South East	30.6	29.6	30.6	29.8	29.7	33.6	--	36.9	33.5	30.4	32.8
South West	26.5	28.3	30.4	28.2	30.4	31.0	30.3	--	30.6	26.4	29.8
Wales	25.0	32.3	31.2	27.8	32.4	31.7	29.2	32.3	--	27.2	30.4
Scotland	28.4	25.5	29.3	26.2	26.2	29.5	27.6	27.5	31.8	--	27.7
Total (unweighted)	29.3	29.5	29.8	29.3	29.3	30.3	29.0	32.3	31.8	28.6	--

Notes

1. Source: output from Willekens and Rogers (1976) program with G.B. region data described in Section 3.1.

When we look at the younger parts of the migration schedules our initial impression is that the rate of pre-labour force decline, α_1, is very close to the equivalent parameter, α_2, for the labour force curve. Rogers, Racquillet and Castro (1977) suggest that their α_1 and α_2 values are so close for the U.S., Poland and Sweden that in a simplified model α_1 can be assumed equal to α_2. In their results (Table 7, p. 45) α_1 is sometimes greater than α_2 (indicating a steeper decline) and sometimes less than α_2. Although the α_1 and α_2 measures in Table 20 are cruder than those of Rogers, Racquillet and Castro (1977) they show that in all regions and in all migrants classes that α_1 is less than α_2, that is that the pre-labour force decline is less steep than the labour force decline in migration rates. This finding is confirmed when the two parental shift parameters are examined: in almost all cases the age 0 shift is greater than the age 10 shift. The gap between the two sections of the curve narrows as parental age increases. The α_1 slope varies systematically with scale of migration: the longer distance the migration the shallower the slope. The same relation does not appear to hold for the α_2 slope. Migrants within local authorities (intra-urban migrants) exhibit less steep α_2 values than other migrants, and α_2 values closest to the α_1 values for their schedules.

Interpretation of these findings (and their difference from those of Rogers, Racquillet and Castro) is difficult. A possible explanation is that the mean age of childbearing has shifted over time so that younger adult migrants are further away on the age scale from their children than are older adult migrants. However, this interpretation is not supported by knowledge of historical shifts in mean age of childbearing for England and Wales. In 1970 the mean age at childbirth (all maternities) of women was 26.2 years (corresponding to an A_0 for all migrants in G.B. of 28.6) whereas 10 years earlier (1960) it had been 27.7 (corresponding to an A_{10} of 27.6). The two sets of statistics move in opposite directions.

Thus it appears that not only is migration of various scales selective of adults by age but it also selects families with different generation spans. Further investigation is undoubtedly needed.

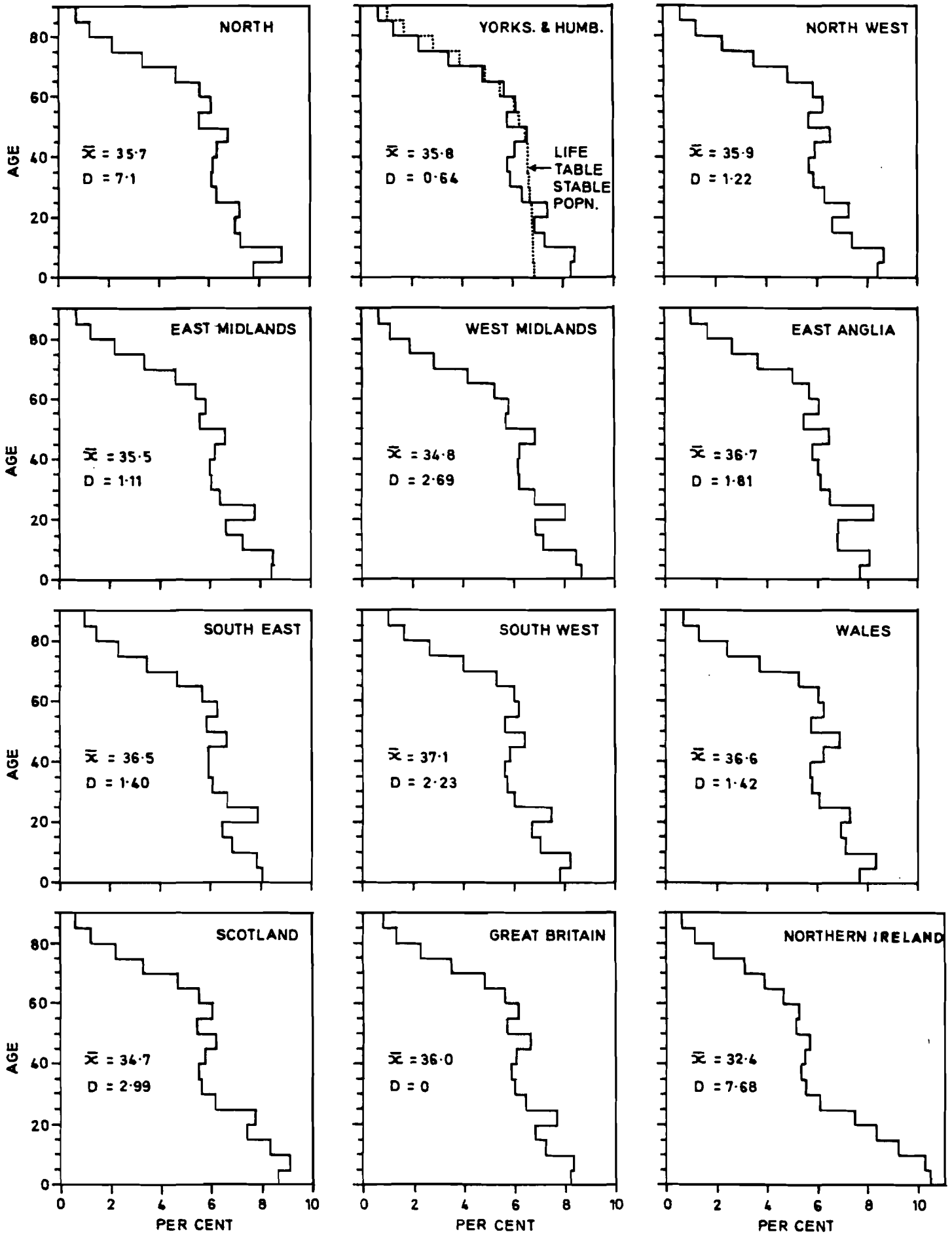
2.7 Population composition by age

The simultaneous operation of fertility, mortality and migration processes determines the age and regional composition of the national population. Section 2 of the paper began with a consideration of evolving regional shares, followed with an examination of the aggregate components of population change and an analysis of those components on an age-specific basis. Here the age compositions of regional populations are briefly described for 1970.

The population pyramids for the ten British regions, Great Britain and Northern Ireland are set out in Figure 20. The average age and index of dissimilarity values (D) indicate that the regions differ little from the national profile. The notable exception is Northern Ireland with its much higher numbers in younger age groups, a function of its substantially higher than average fertility which was described in Section 2.4.

The general shape of the population pyramids correspond to that predicted by the single region life table model as the stable population profile plotted for Yorkshire and Humberside. This stable population profile is disturbed at the younger ages by the fluctuations in fertility experienced in each quinquennia (see Figure 3) and these are reproduced in all pyramids except that for Northern Ireland, and in a muted form in Scotland's pyramid. The influence of migration on the regional age structures is more difficult to detect directly. The South West has more than its "fair" share of the elderly (60 and over) whereas the Northern and Midland regions have less than their "fair" share.

To understand in full how the components of population change interact to determine the changing dynamic of regional and age composition of the population it is necessary to integrate all three processes in one multi-regional model and look at the results of running such a model with the input data on fertility, mortality and migration that have been described in this section of the paper.



KEY x̄ = MEAN AGE D = INDEX OF DISSIMILARITY FROM G.B.

Figure 20. Age composition of regional populations, U.K., 1970

3. Multi-regional population analysis

3.1 The theory and the computer programs

Multi-regional population analysis has been developed to answer a number of demographic questions which single region analysis leaves unanswered.

(1) Consider the traditional life table. Applied at the regional scale this assumes that people die in their region of birth experiencing the region's death rates throughout their lives. This is what was done in Table 17. But how many of the 73.1 years of life expected by the population of the South East are actually spent in the region given the substantial out-migration experienced by the population (and documented in Section 2.3)?

(2) Consider the traditional vectors of net reproduction rates for the regions listed in Table 13. If potential mothers born in a region migrate then the children they are likely to have will be born in a region different from that in which their mothers were born.

(3) Consider the conventional method of single region population projection with allowance for migration via net migrant or net migration rate assumptions. This can lead to substantial errors in projection (Rogers, 1976; Rees, 1977a).

Multi-regional disaggregation of population projection models, of life table analysis and of fertility analysis has been pioneered by Rogers (1968, 1971, 1975) and his fellow workers (Rogers and Willekens, 1976a; Rogers and Ledent, 1976; Rogers and Willekens, 1976b; Rogers and Willekens, 1976c; Willekens, 1977; Ledent, 1978). The methods and models employed have been summarised in two sets of computer programs (Willekens and Rogers, 1976b; Willekens and Rogers, 1977).

The first set of computer programs (Willekens and Rogers, 1976) has been used to investigate the dynamics of population and migration patterns in a variety of countries (Rogers, 1976b; Willekens, 1978): data from each participant country have been input to the Spatial Demographic Analysis programs at I.I.A.S.A. and the results analysed by participating national investigators. In this section of the paper the data and the results of a spatial demographic analysis of Great Britain's population at the standard region scale are described.

3.2 A brief note on data: current and potential

The data requirements of the spatial demographic analysis programs (Willekens and Rogers, 1976) were selected from the information available in the census and vital statistics time series for the U.K. described in Section 2.

(1) The regions chosen were the "old" standard regions of Great Britain, as defined at the time of the 1971 Census, as mapped in Figure 1.2. These were the most practical choice at time of data preparation (1976).for the calendar year 1970. Northern Ireland was not included in the set of regions because, although migration data on the flow from Northern Ireland to G.B. regions were available, the reverse flows were not.

In future analysis, it should be possible to use the new standard regions of G.B. as unpublished, reworked migration data became available in 1977, and to make an estimate of the migration flows from G.B. regions to Northern Ireland using a combination of model migration schedules and an estimate of gross flows based on accounting and spatial interaction methods.

(2) The period chosen was the calendar year, 1970. This was the calendar year closest to the one year period for which the latest migrant data were available, that is, for 24th/25th April 1970 to 24th/25th April 1971. No more recent detailed age-sex disaggregated migrant data exists, unfortunately.

In future analysis, it should be possible to use constrained accounting methods (as in Rees, 1977a) to update sets of spatial population accounts, and perhaps to integrate unpublished inter-region migrant flow data generated by O.P.C.S. from the National Health Register change of address file. Vital statistics data are more readily available for more recent years.

(3) Data on both sexes were assembled but aggregated before input to the Willekens and Rogers, 1976 program. In a future analysis this step could be avoided if the necessary program modifications were made to deal with the usual female dominant fertility analysis.

(4) Population data were extracted from Table A4 in O.P.C.S. (1972b) for "the estimated home population by sex and age, as at 30th June 1970" for regions in England and Wales, and from Table N2.1 in Registrar General, Scotland (1971b) for Scotland. The home population concept - "the population, of all types, actually in England and Wales, distributed by area according to residence" - is the most appropriate and available for regional purposes, although the "total" population concept - "the home population plus members of H.M. Forces belonging to England and Wales/Scotland/Northern Ireland and serving overseas but minus the Forces of the other countries temporarily resident in England and Wales" - is used for the national projections.

Population numbers are provided in the mid-year estimates for five year age groups up to 75 and over. Population in this latter age group was broken down further into age groups 75-79, 80-84 and 85 and over by applying deconsolidation proportions derived from the more detailed breakdown for each region in England and Wales given in the 1971 Census. The full range of age group information was available for Scotland.

These data correspond with the time series displayed in Table 2 in Section 1, and have been described in Figure 20 and Section 2.8.

(5) Births data were extracted from Table GG of O.P.C.S. (1972b) and Table S2.5 of Registrar General, Scotland (1971b). The fertility rates derived from dividing births by the relevant female population have been analysed in Section 2.4.

(6) Deaths data were derived from Table 19 O.P.C.S. (1972a) and Table C2.1 in Registrar General, Scotland (1971a). For the regions of England and Wales data were provided for the following age groups only: under 1, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74 and 75 and over. Death rates for the missing five year age groups were computed for England and Wales as a whole and applied in the following equation:

$$\hat{D}_r^{i\delta} = A_v^i \, M_r^{EW\delta} \, K_r^i \quad , \; r \varepsilon v \qquad (2)$$

for age group r=3,...,18 referring to age groups 5-9, 10-14,..., 80-84, 85+, and for both sexes separately. The $\hat{D}_r^{i\delta}$ are the estimated number of deaths in region i in age group r; $M_r^{EW\delta}$ is the death rate for age group r in England and Wales; and K_r^i is the mid year 1970 population of region i in age group r; and A_v^i is a balancing factor that ensures the estimated deaths are properly constrained to known information.

$$\sum_{r \epsilon v} \hat{D}_r^{i\delta} = D_v^{i\delta} \tag{3}$$

so that substituting the R.H. side of Equation (2) in the L.H. side of Equation (3) yields

$$\sum_{r \epsilon v} A_v^i M_r^{EW\delta} K_r^i = D_v^{i\delta} \tag{4}$$

and

$$A_v^i = D_v^{i\delta} \Big/ \sum_{r \epsilon v} M_r^{EW\delta} K_r^i \tag{5}$$

These deaths data were employed as input to the single region life table analysis described in Section 2.6 of the paper and summarised in Tables 17 and 18.

(7) Migrant data were estimated from the partial tabulations provided in O.P.C.S. (1974b, 1975). The estimation problem involved the age disaggregation available in the various tables and was solved using a crude version of the Willekens (1977) method but with better, more constrained data.

Required in the Willekens and Rogers (1976) program is the variable:

$^{i}D_x^j(1970)$ - the number of moves between region i and j in age group x to x+5 (exact ages) or x to x+4 (single ages) at last birthday over a single year, 1970.

The regions are the 10 in our system; the age groups are five year ones from 0-4 through 85+.

Available from the 1971 Census are the following variables:

K^{ij}_{*v} - the number of persons existing in region i at the start of the year who survive in region j at the end of the year. They are classified by age groups v at the end of the year. The v age groups are 1-4, 5-14, 15-19, 20-24, 25-29, 30-34, 35-44, 45-59, 60-64 and 65 and over,

$\sum_{j\varepsilon GB,\ j\neq i} K^{ij}_{*s}$ - the number of persons existing in region i who out-migrate to another region j in Great Britain over the year. These total internal out-migrants are classified by age groups s at the end of the year. The s age groups are 1-4, 5-9, 10-14,..., 70-74, 75 and over.

$\sum_{j\varepsilon GB,\ j\neq i} K^{ji}_{*s}$ - the number of persons existing in all regions j (born region i) at the start of the year who migrate to and survive in region i in age group s at the end of the year. These are the total internal in-migrants into the region i.

K^{*i}_{*s} - the total population in region i in five year age groups s. Age groups s=16,17,18 are the quinquennial age groups 75-79, 80-84, and 85+.

Four steps, portrayed diagramatically in Figure 21, are employed in the estimation method.

(1) Deconsolidation The v age group data are deconsolidated into age group data using

$$\hat{K}^{ij}_{*s} = P(s|v,i)\ K^{ij}_{*v} \qquad s\varepsilon v \tag{6}$$

where $P(s|v,i)$ is the probability of a migrant from origin region i classified in aggregated age group v (at time t+1) being in five year age groups. This is given by

$$P(s|v,i) = \sum_{j\varepsilon GB,\ j\neq i} K^{ij}_{*s} \Big/ \sum_{s\varepsilon v} \sum_{j\varepsilon GB,\ j\neq i} K^{ij}_{*s} \tag{7}$$

where $s\varepsilon v$ means that the five year age group is embedded in the larger age group. Estimating Equation (6) needs to be applied to age groups 5-9, 10-14, 35-39, 40-44, 45-59, 60-64, 65-69, 70-74 and 75+.

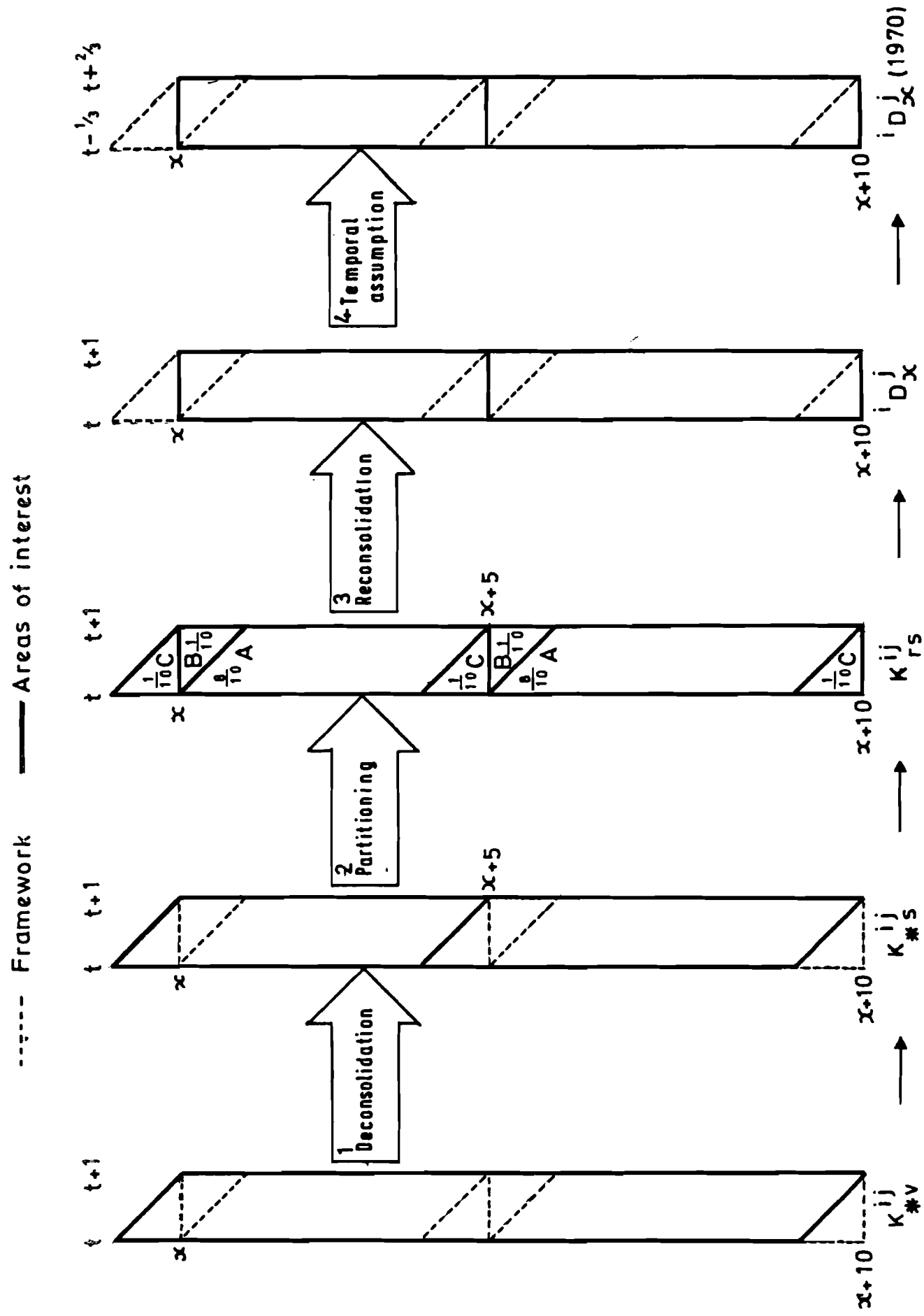


Figure 21. The steps in the estimation process for migrant data

The final age group for which migrant data is available is broken up using population proportions

$$P(s|v,i) = K^{*i}_{*s} \Big/ \sum_{s\varepsilon v} K^{*i}_{*s} \qquad (8)$$

for v=age group 75+, s=age groups 75-79, 80-84 and 85+. Unfortunately this means that the assumption has been made that the migration rate in these post-retirement age groups is equal to the mean for the group together, whereas it is more likely that the migration rate falls off with age. Unfortunately no published data, even at national level, disaggregate migrants in this 75+ age group. One possible solution in future analysis might be to use model migration schedules to estimate the likely rate and to use them in a constrained equation

$$\hat{K}^{ij}_{*s} = A^{ij}_{v}\, \hat{M}^{ij}_{*s}\, K^{i*}_{*s} \qquad s\varepsilon v \qquad (9)$$

v refers to 75+

where $\hat{M}^{ij}_{*s}$ is the model schedule estimated migration rate (fitted to previously estimated data), K^{i*}_{*s} the population at risk and A^{ij}_{v} is a simple balancing factor

$$A^{ij}_{v} = K^{ij}_{*v} \Big/ \sum_{s\varepsilon v} \hat{M}^{ij}_{*s}\, K^{i*}_{*s} \qquad (10)$$

The estimation could have been improved through employment of a doubly constrained model

$$\hat{K}^{ij}_{*s} = A^{j}_{*s}\, B^{i}_{*s}\, P(s|v,i)\, K^{ij}_{*v} \qquad (11)$$

where

$$A^{j}_{*s} = \sum_{\substack{j\varepsilon GB \\ j\neq i}} K^{ji}_{*s} \Big/ \sum_{\substack{j\varepsilon GB \\ j\neq i}} B^{i}_{*s}\, P(s|v,v)\, K^{ij}_{*v} \qquad (11)$$

and

$$B^{i}_{*s} = \sum_{\substack{j\varepsilon GB \\ j\neq i}} K^{ij}_{*s} \Big/ \sum_{\substack{j\varepsilon GB \\ j\neq i}} A^{j}_{*s}\, P(s|v,i)\, K^{ij}_{*v} \qquad (12)$$

but the gain in accuracy was not felt to outweigh the costs of developing the computer program. Comparison of the estimated migrant figures with

fully disaggregated migrant vectors more recently available from O.P.C.S. (1977e) for "new" regions for interactions unchanged by regional re-organisation suggests that the differences are fairly minor.

(2) Partitioning Migrant figures by quinquennial age groups were then partitioned into three components: those who were in the same five year age group one year earlier, those who were in the previous age group one year earlier but who migrated when in the age group they achieved at the end of the period, and those who were in the previous age group one year earlier and migrated while still in it. These components are labelled A, B and C respectively in Figure 21's middle Lexis diagram. Simple geometrical weights were used to partition the migrant figures

$$K^{ij}_{sss} = 0.8\ K^{ij}_{*s} \qquad \text{(Component A)} \qquad (14)$$

$$K^{ij}_{s-1\ ss} = 0.1\ K^{ij}_{*s} \qquad \text{(Component B)} \qquad (15)$$

$$K^{ij}_{s-1\ s-1\ s} = 0.1\ K^{ij}_{*s} \qquad \text{(Component C)} \qquad (16)$$

where the first age group label applies to age group at time t, the second to the age at which the migration between region i and j took place and the third age group label applies to the age group of migrants at t+1. In case of the first age group no K^{ij}_{011} figures for infant migrants (0 being a label for birth during period t to t+1) were available so these were estimated as

$$K^{ij}_{011} = 0.125\ K^{ij}_{*1} \qquad (17)$$

(3) Resorting The migrant components were then added together again to yield migrant estimates for the age groups required in the Willekens and Rogers (1976) program

$${}_iD^j_x = K^{ij}_{s-1ss} + K^{ij}_{sss} + K^{ij}_{sss+1} \qquad 0<x<w \qquad (18)$$

$${}_iD^j_0 = K^{ij}_{011} + K^{ij}_{111} + K^{ij}_{112} \qquad (19)$$

$${}_iD^j_\omega = K^{ij}_{R-1RR} + K^{ij}_{RRR} \qquad (20)$$

where ω is last age used in the I.I.A.S.A. program (85), R is the last discrete age group (85+), and x and s are appropriately related.

(4) Temporal assumption The final assumption made is that the migrants observed over the year before 24th/25th April 1971 Census were equal in number to the slightly earlier calendar year 1970.

$$ {}^{i}D_{x}^{j}(1970) = {}^{i}D_{x}^{j}(1970\text{-}71) \qquad (21) $$

This was felt to be a reasonable assumption.

The migration rates derived from these estimates have been described in Section 2.8.

3.3 Estimation of the multi-regional migration and death probability matrix

Key steps in the multi-regional analysis of population have always been the definition of the matrix of survival and migration probabilities for use in generating multi-regional life table and the definition of the matrix of survivorship rates for use in population projection. Considerable debate has been generated concerning the proper methods (Schoen, 1975; Rogers and Ledent, 1976, 1977; Schoen, 1977; Rees, 1978). Ledent (1978) has discussed the problems and various alternatives in depth, and his findings have some bearing on the results reported here.

The purpose behind the adjustments to the migrant data was to convert the "cohort" census migration data to the "age group" mobility basis required in the Willekens and Rogers (1976) program. However, the data still remains "transitions" data rather than "moves" data in the sense defined by Ledent (1978). Ledent (1978) suggests that for five year periods treatment of transitions data as if it were moves data does not lead to serious bias. Similarly, Rees (1978) suggests that for five year periods use the Willekens and Rogers (1976) probability estimation equation does not lead to much empirical bias compared with accounting based estimates. So, it would appear that using the migrant data from the 1971 Census as if it were "moves" data is acceptable.

The problem is, however, that the probability matrices for multi-regional life table analysis and for multi-regional projection are based on "transitions" between exact ages five years apart (in life table analysis) or between five year age groups over five year periods. The rates for one year are multiplied by five to yield estimates of the five year rates in the probability estimation equation

$$\underset{\sim}{P}(x) = \left[\underset{\sim}{I} + \tfrac{5}{2}\,\underset{\sim}{M}\right]^{-1}\left[\underset{\sim}{I} - \tfrac{5}{2}\,\underset{\sim}{M}\right] \qquad (22)$$

employed in the Willekens and Rogers (1976) program. Death rates (and fertility rates) can be treated in this fashion but not transition rates (Ledent, 1978). The matrix of one year transition rates must be raised to the power five to yield a proper estimate of the five year matrix (Rees, 1977b) although the exact procedure still needs to be explored*. Or five year transitions data must be employed from the start of the analysis (as in Ledent, 1978).

This point can be illustrated drawing from the probability matrix generated using Equation (22), and from a probability matrix derived from a set of multi-regional accounts (Rees, 1977a) using Equation (16.45), from Rees and Wilson (1977)

$$\underset{\sim}{P}(x) = \left[\underset{\sim}{H}(r_{x-T}) + \underset{\sim}{H}(r_x)\right]^{\frac{1}{2}} \qquad (23)$$

for $0<x<\omega-T$, with slightly different techniques used for the $x=0$ and $x=\omega-T$, and ω cases. Life table surivival rates are interpolated between corresponding accounts based survivorship rates. Figure 22 shows the probabilities of migration and survival by age for the East Anglia to South East transitions. The shape of the profiles are similar but the Equation (22) probabilities are clearly over-estimates of the corresponding five year rates.

---

* This should involve deconsolidation of the five year age group, one year time period data to single year data, estimation of a single year matrix of probabilities, running of a population model for five years and then extracting from the results the five year age group, five year period matrix.

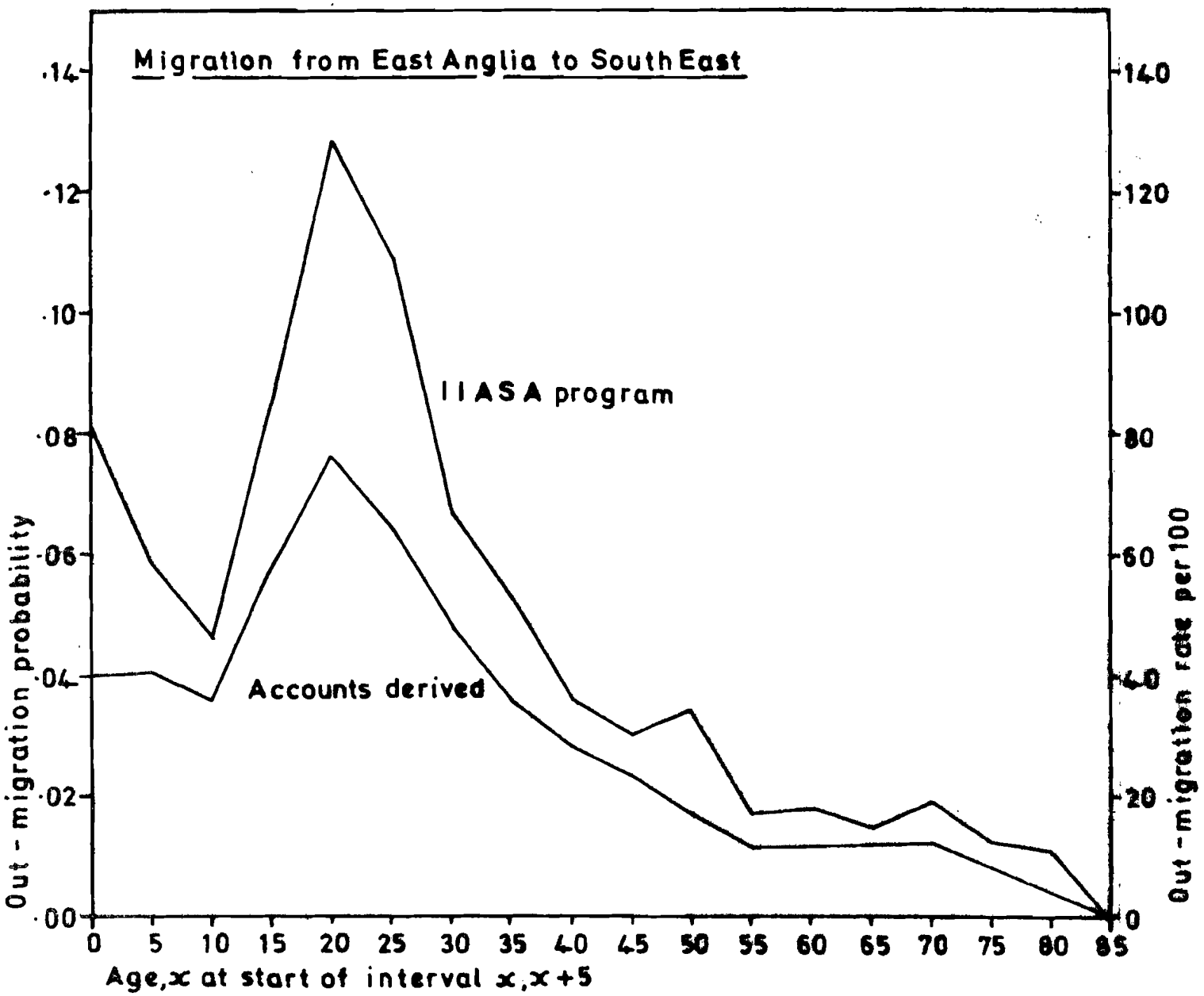


Figure 22. A comparison of selected multi-regional life table out-migration probabilites estimated by different methods

The multi-regional population analysis reported here uses one year data and Equation (22) to generate the probability matrix, and so must be regarded as a preliminary exploration only, justified as being the first attempt to answer the questions posed at the beginning of this section of the paper. The likely biases introduced will be suggested as each part of the analysis is considered*.

3.4 The multi-regional life table

3.4.1 Life history of the initial cohorts

The recursive application of the age-specific probabilities of dying and out-migrating to regional radices generates the life histories of cohorts born in each region. The life history consists of two tables: the first specifies the location of the deaths of the initial cohort, the second the number of inter-regional transitions made between regions at the various ages by members of the initial cohort.

Since full specification of the life history of cohorts in a 10 region system requires 10 sets of 11 tables (1 for deaths, 10 for inter-regional transitions) with 18 rows and 10 columns, only a sample can be reproduced here. In Table 22 the life history of the initial cohort born in Yorkshire and Humberside is traced out in terms of the locations at which people die. Although the amount of migration recorded in the table is probably over-estimated by about 60 per cent, even the approximate adjusted totals for deaths suggest that 42 per cent of the initial cohort will die outside the region in which they were born, some 12 per cent of them in the South East and between 4 and 6 per cent of them in adjacent English regions. Note that no migrants are allowed to die within the period of migration - hence the zeros in the first row - although this would be fairly easy to add to the multi-regional life table model.

---

* The descriptions of the 1970 migration, fertility and mortality rates still stand as these are based on the components of the $\underset{\sim}{M}(x)$ matrices rather than the $\underset{\sim}{P}(x)$ matrices.

Table 22 Initial region of cohort, Yorkshire and Humberside: number of deaths in each region of residence

Age	N	YH	NW	EM	WM	EA	SE	SW	W	S	Total
0	0	2332	0	0	0	0	0	0	0	0	2332
5	3	150	3	3	2	1	4	1	1	1	169
10	4	123	5	4	2	2	6	2	1	1	150
15	11	247	11	11	5	5	19	5	2	4	320
20	15	240	16	14	9	7	33	7	4	6	351
25	21	188	23	21	13	6	50	10	6	9	347
30	29	206	35	30	20	9	73	16	9	17	444
35	50	293	62	47	33	17	106	24	19	29	677
40	96	504	122	89	66	34	207	47	31	49	1245
45	170	788	216	149	116	55	355	89	60	91	2089
50	272	1207	345	239	188	90	570	150	100	145	3306
55	404	1861	544	379	298	144	932	257	154	222	5195
60	601	2738	806	580	453	229	1415	408	239	341	7810
65	863	3867	1115	865	643	375	2050	639	347	462	11231
70	1113	4707	1406	1085	821	503	2622	881	454	591	14183
75	1263	5024	1510	1216	925	588	3033	1092	514	657	15822
80	1205	4740	1452	1208	922	610	3172	1117	496	622	15544
85	1307	5307	1607	1486	1118	865	4392	1458	559	689	18788
Tot.	7432	34522	9278	7426	5634	3540	19039	6203	2993	3936	100003
Adj. Tot.	4738	58258	5915	4734	3592	2257	12138	3954	1908	2509	100003

Notes

1. The total, 100003, is 3 above the initial cohort radix due to rounding error.
2. In the output of the Willekens and Rogers (1976) program the variables ${}_{jo}\ell_{k\delta}(85)$ for $k \neq j$ are not calculated (as they should be), and they are inserted in the table above using the relationships:

$$ {}_{jo}\ell_{k}(85) = \sum_{i} {}_{jo}\ell_{ik}(80) \qquad \text{all } k, k \neq j $$

$$ {}_{jo}\ell_{k\delta}(85) = {}_{jo}\ell_{k}(85)\ q_{k}(85) $$

$$ q_{k}(85) = 1 $$

3. Adjusted totals are computed by multiplying all column totals except that for Yorkshire and Humberside by the ratio of the 5 year out-migration rate to 5 times the 1 year out-migration (for 1966-71 and 1970-71 respectively) given in Rees (1977): that is, by (.3382)/(5x.1061) = .637512. Stayers were worked out as a residual.

If the totals of tables similar to Table 22 are gathered together, then a complete picture of the life-time migration history of the initial cohorts in our ten regions is obtained (Table 23). This table is the multi-regional equivalent to the D(x) column in single region life tables showing how deaths to a cohort are distributed by age at death. Table 23 resembles the right hand side of the accounts tables presented earlier (Tables 7 to 10) in showing migration and death flows, but over a life-time rather than a period. It also serves to emphasise that any population model is a model of deaths as well as survivors - perhaps funeral directors might benefit as well as planners from such analysis.

The second component of the life history of a regional cohort is the specification of the inter-regional transfers experienced over a life-time. Table 24 extracts 1 of the 10 tables of inter-regional transitions for persons born in Yorkshire and Humberside, and records all the transitions out of the South East to other regions at each exact age x to exact age x+5 interval. Note that there are no entries in the first row as persons born in Yorkshire and Humberside have first to migrate out of Yorkshire and Humberside before they can subsequently migrate out of another region.

Given the earlier conclusion about the equation that generates the probabilities of migration, the results can be regarded as illustrative only. Rather than 192,000 transitions, more like 108,000 probably take place.

The word "transitions" or "transfers" has been used instead of either "migrants" or "moves" here. The numbers do refer to persons in hypothetical regional cohorts but when counted up columnwise persons are counted perhaps several times. Since there are only 100,000 persons in the initial radix, the 192,000 total in Table 24 must refer to their actions - the action of transferring from being located in the South East at age x to being located in the South East or another region at age x+5. In fact, 181,000 out of the 192,000 are acts of staying put.

Table 23 Lifetime migration and death matrix

A. Original	Region of death										Total
Region of Birth	N	YH	NW	EM	WM	EA	SE	SW	W	S	
North	37314	8190	8302	4871	5134	3078	18800	6006	2565	5739	100000
Yorkshire & Humberside	7432	34521	9278	7427	5634	3541	19036	6203	2992	3936	100000
North West	4093	5781	43319	4278	5943	2652	18240	6361	5231	3922	100000
East Midlands	4712	9093	6979	28914	8443	4801	21706	7627	3332	4394	100000
West Midlands	3255	4719	7294	6782	38880	3040	19817	8169	4440	3604	100000
East Anglia	3411	5537	6079	7043	6238	23233	31538	8869	3381	4669	100000
South East	3371	4580	6141	5484	5691	5535	50434	10742	3360	4661	100000
South West	3606	4961	6267	5007	7369	4140	32577	26502	4328	5245	100000
Wales	2968	4037	8541	4252	7411	2852	20333	8611	37384	3611	100000
Scotland	4239	4276	6264	4114	4465	2578	18564	5578	2302	47622	100000

B. Adjusted	Region of death										Total
Region of Birth	N	YH	NW	EM	WM	EA	SE	SW	W	S	
North	61455	5036	5105	2995	3157	1893	11560	3693	1577	3529	100000
Yorkshire & Humberside	4738	58257	5915	4735	3592	2257	12136	3954	1907	2509	100000
North West	2506	3540	65294	2619	3639	1624	11279	3895	3203	2401	100000
East Midlands	2839	5479	4205	57164	5088	2893	13080	4596	2008	2648	100000
West Midlands	2001	2902	4485	4170	62419	1869	12185	5023	2730	2216	100000
East Anglia	1876	3044	3343	3873	3430	57790	17341	4877	1859	2567	100000
South East	1904	2587	3469	3098	3215	3126	72002	6068	1898	2633	100000
South West	2052	2823	3566	2849	4193	2356	18537	58176	2463	2985	100000
Wales	1843	2507	5305	2641	4603	1771	12629	5348	61110	2243	100000
Scotland	2503	2525	3698	2429	2636	1522	10960	3293	1359	69073	100000

Notes

1. Adjustments (Part B of Table) carried out as in Table 22. The ratios of 5 year migration rates to 5 times one year migration rates were used.

Table 24 Life history of initial cohort, Yorkshire and Humberside: migrants

Location at age x SOUTH E. TO Age	Location at age x+5										Total migrants
	N	YH	NW	EM	WM	EA	SE	SW	W	S	
x = 0	0	0	0	0	0	0	0	0	0	0	0
5	8	11	16	18	14	23	2346	41	7	12	2496
10	11	15	22	26	20	32	4185	59	10	17	4397
15	26	34	44	50	49	59	5380	131	30	39	5842
20	79	113	158	167	150	160	7947	290	74	111	9249
25	101	138	186	221	165	226	12674	391	93	142	14337
30	80	100	132	147	141	192	14876	347	66	113	16194
35	47	70	112	109	98	152	16253	268	53	77	17239
40	35	53	84	82	73	119	17138	215	40	58	17897
45	31	42	61	56	63	110	17398	235	40	49	18085
50	29	39	57	53	52	103	17051	222	38	46	17690
55	25	33	48	45	35	97	16372	206	33	39	16933
60	24	22	42	44	26	123	14898	253	30	26	15488
65	23	27	37	49	33	93	12705	239	29	30	13265
70	12	14	19	25	17	47	10234	122	15	15	10520
75	7	10	13	17	12	31	7326	82	10	10	7518
80	4	6	8	10	7	18	4260	49	6	6	4374
85	0	0	0	0	0	0	0	0	0	0	0
Total	543	727	1038	1118	955	1585	181046	3148	574	790	191524

However, conversely the numbers in Table 24 are not migrations or moves. Several inter-regional moves may be made in an age interval x to x+5 by a migrant making only one transition. In fact, even stayers may make moves. So "transitions" are under-estimates of "moves". This would be true even if single year age intervals were used with a one year period, though the under-counting would be far less serious, particularly at the inter-regional level. In order to count moves made it would be necessary to adopt a time interval within which it could be assumed that only one move took place. A year might be reasonable for inter-region migration. One would then construct a one year of age, one year of time population model, and count transitions as moves. Otherwise a mobility measure is very difficult to extract from a model embodying transitions.

3.4.2 Expected numbers of survivors

At each age x the expected number of survivors is calculated. In the multi-regional life table this involves subtracting the decrements of death and out-migrants in the interval x-5 to x from the expected number of survivors at age x-5 and adding the increments through in-migration in the interval. Survivors from each regional cohort are now spread over all regions and these from 10 sets of tables such as that for Yorkshire and Humberside (Table 25).

Again Table 25 carries forward the earlier over-estimation of migration and rather too many of the initial cohort find themselves in other regions. However, something quite useful can be learned from a comparison of Table 25 with the single region results presented earlier (Table 18). The variance of the single region $\ell(x)$ vectors is over twice that of the multi-region $\ell(x)$ vectors. There is thus significant regression towards the mean when multi-region statistics are substituted for single region: the gap between the maximum and minimum survival proportions of regional populations under single region assumptions widens to 896/10,000 by age 80 compared with only 332/10,000 for regional cohorts under multi-region assumptions. The effect of migration is to smooth out the spatial differences in survival chances within the U.K. This conclusion should continue

Table 25 Expected numbers of survivors: initial region of cohort, Yorkshire and Humberside

Region	0	5	20	40	50	60	70	80
North	0	179	457	673	672	616	485	252
Yorks. & Humb.	10000	8673	6542	3704	3192	2824	2046	1017
North West	0	160	455	833	835	771	592	305
East Midlands	0	177	420	695	687	636	496	269
West Midlands	0	89	250	516	520	478	367	202
East Anglia	0	71	176	300	308	296	255	147
South East	0	250	928	1810	1826	1690	1314	755
South West	0	79	222	444	475	474	431	254
Wales	0	34	104	231	244	239	198	105
Scotland	0	55	149	316	330	315	249	130
Total	10000	9767	9703	9521	9188	8338	6433	3433

Table 26 Expected numbers of survivors: initial region of cohort, all regions, total

Region	0	5	20	40	50	60	70	80
North	10000	9789	9727	9545	9199	8329	6421	3410
Yorks. & Humb.	10000	9769	9703	9521	9188	8338	6433	3433
North West	10000	9767	9701	9517	9169	8283	6354	3365
East Midlands	10000	9799	9738	9559	9234	8401	6517	3520
West Midlands	10000	9787	9721	9543	9216	8376	6485	3489
East Anglia	10000	9810	9744	9572	9262	8464	6633	3653
South East	10000	9814	9754	9580	9269	8463	6627	3653
South West	10000	9810	9752	9579	9266	8450	6601	3610
Wales	10000	9788	9728	9548	9208	8341	6437	3436
Scotland	10000	9778	9712	9503	9139	8238	6305	3321
Max-min	---	--	51	77	130	226	328	332
Max-min (Table 18)	---	--	44	118	248	537	848	896

to hold even when reduced migration probabilities are substituted in the analysis, and it is, in effect, a consequence of the Markovian assumption inherent in the multi-regional life table model that migrants experience the death rates of their current region of residence. Use of any alternative assumption or relation would necessitate sophisticated life history data.

3.4.3 Numbers of years lived in each region

From the life history of the initial cohorts (deaths and transitions table) tables giving the number of years lived in each region in each age interval, the $\underline{L}(x)$ vectors, are generated.for each initial region, and these numbers are then summed "backwards" cumulatively starting at age 85 to yield the $\underline{T}(x)$ vectors for each region of origin of years of life lived beyond age x.

3.4.4 Expectations of life

If the $\underline{T}(x)$ vectors are divided by the $\underline{\ell}(x)$ vectors scaled to unity (to yield probabilities of survival to age x) then expectations of life are obtained. Again the statistics for the initial cohort born in Yorkshire and Humberside are produced in Table 27, and in Table 28 the expectations of life at age 0 for all regions are consolidated together.

It should be emphasised that Table 27 is only a partial multi-regional analogue of the single region life expectation vector: given birth in Yorkshire and Humberside these are the expectations of life in the 10 regions beyond the ages noted in the rows. Thus, at age 50 persons born in Yorkshire and Humberside can expect a further 25.5 years of life, 8.4 of them in Yorkshire and Humberside, 5.3 in the South East, and so on. What would also be interesting to know would be what the expectation of life was beyond age x in region i, given you were located there at age x. The value of migration in life expectancy terms would then be revealed.

Table 27 Expectations of life in the regions beyond age x for initial region of cohort, Yorkshire and Humberside

	Region of residence										
Age, x	N	YH	NW	EM	WM	EA	SE	SW	W	S	Total
0	4.1	36.7	4.9	4.2	3.0	1.9	10.6	2.9	1.4	1.9	71.6
5	4.2	32.8	5.0	4.3	3.0	1.9	10.8	2.9	1.4	1.9	68.3
10	4.1	28.6	4.9	4.2	3.0	1.9	10.7	2.9	1.4	1.9	63.4
15	3.9	24.7	4.7	4.0	2.9	1.8	10.4	2.8	1.4	1.8	58.5
20	3.7	21.2	4.5	3.8	2.8	1.8	10.1	2.7	1.3	1.8	53.7
25	3.5	18.2	4.3	3.6	2.6	1.7	9.5	2.6	1.3	1.7	48.9
30	3.2	15.8	3.9	3.3	2.4	1.5	8.7	2.4	1.2	1.6	44.0
35	2.9	13.6	3.5	3.0	2.2	1.4	7.9	2.2	1.1	1.4	39.2
40	2.5	11.7	3.1	2.6	2.0	1.3	7.0	2.0	1.0	1.3	34.5
45	2.2	10.0	2.7	2.3	1.7	1.1	6.1	1.8	0.9	1.1	29.9
50	1.9	8.4	2.3	2.0	1.5	1.0	5.3	1.6	0.7	1.0	25.5
55	1.6	6.9	1.9	1.6	1.2	0.8	4.5	1.4	0.6	0.8	21.4
60	1.3	5.5	1.6	1.4	1.0	0.7	3.7	1.2	0.5	0.6	17.6
65	1.0	4.4	1.3	1.1	0.8	0.6	3.0	1.0	0.4	0.5	14.1
70	0.8	3.4	1.0	0.9	0.6	0.5	2.4	0.8	0.3	0.4	11.1
75	0.6	2.5	0.7	0.7	0.5	0.4	1.9	0.6	0.3	0.3	8.6
80	0.4	1.8	0.5	0.5	0.4	0.3	1.5	0.5	0.2	0.2	6.4
85	0.3	1.3	0.4	0.4	0.3	0.2	1.2	0.4	0.1	0.2	4.6

Table 28 gives a very convenient overview of the effects of migration on life expectancy (again with the caveat that the values of off-diagonal terms are over-estimated). The table indicates that very large proportions of a person's life are likely to be spent outside his region of birth, and that for all regions of birth a great deal of the regional cohort's lives will be spent in the country's metropolitan region, the South East.

Figure 23 compares the row totals of Table 28 - the life expectancies of the regional birth cohorts with the earlier single region life expectancies. The latter can be regarded as measuring the "mortality environment" of the region, whereas the former measure the actual experience of the region's sons and daughters given that they migrate. The two measures have an almost identical pattern when mapped (Figure 23) and correlated (r=.986), but the variance of the multi-region measure is much lower than the single region. There is classic regression towards the mean: those regions with high single region expectations of life have lower multi-regional values; those regions with low single region expectations have higher multi-regional values. Migration thus has the effect of reducing regional mortality differentials for birth cohorts.

Finally, to conclude the consideration of the multi-regional life table, Table 29 summarises succinctly the effect of migration on the distribution of life in a multi-regional system by dividing each element in Table 28 by the relevant row total. Again with revised probabilities input to the analysis, the allocations in the diagonal would increase and in the off-diagonal decrease.

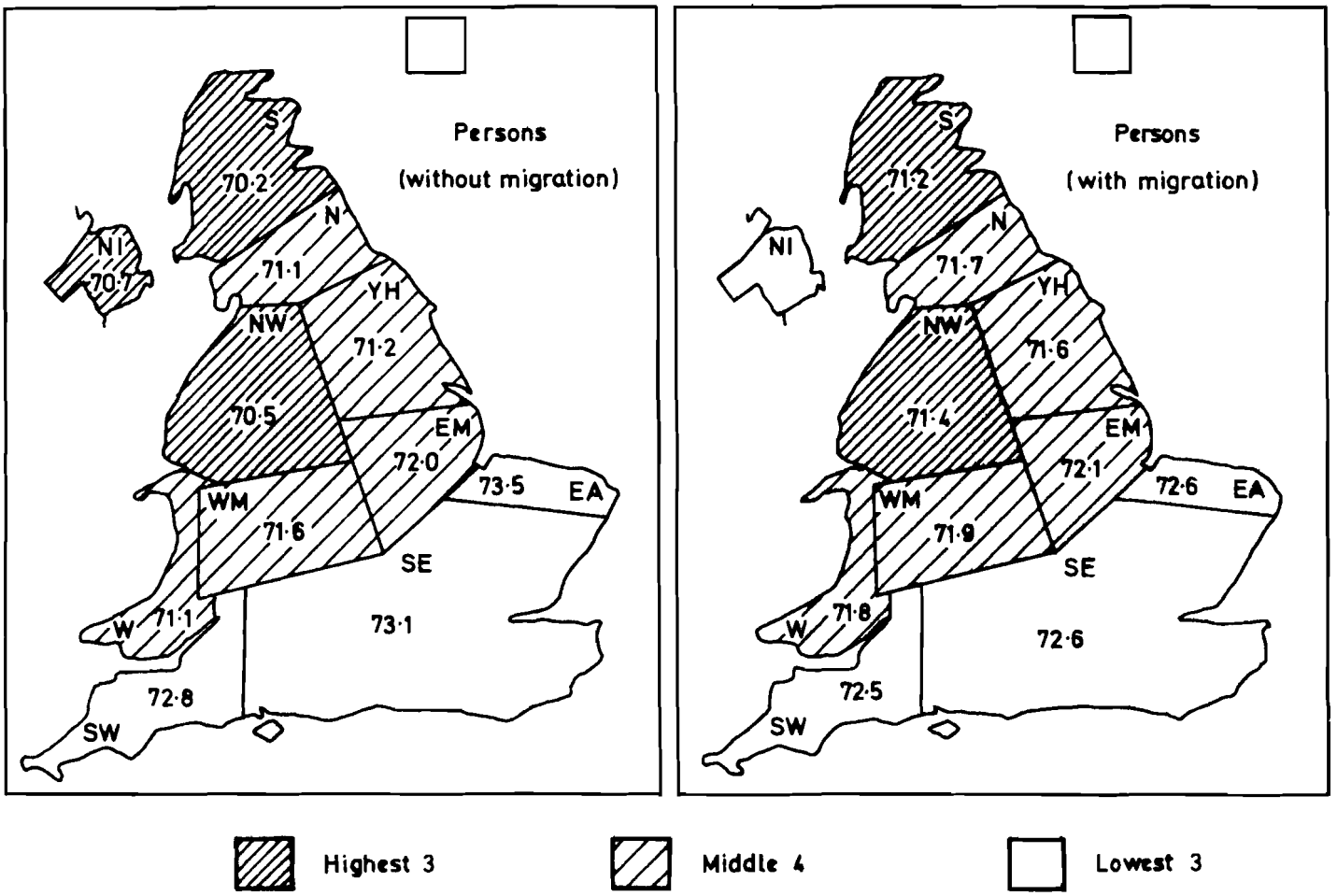
3.5 Multi-regional fertility analysis

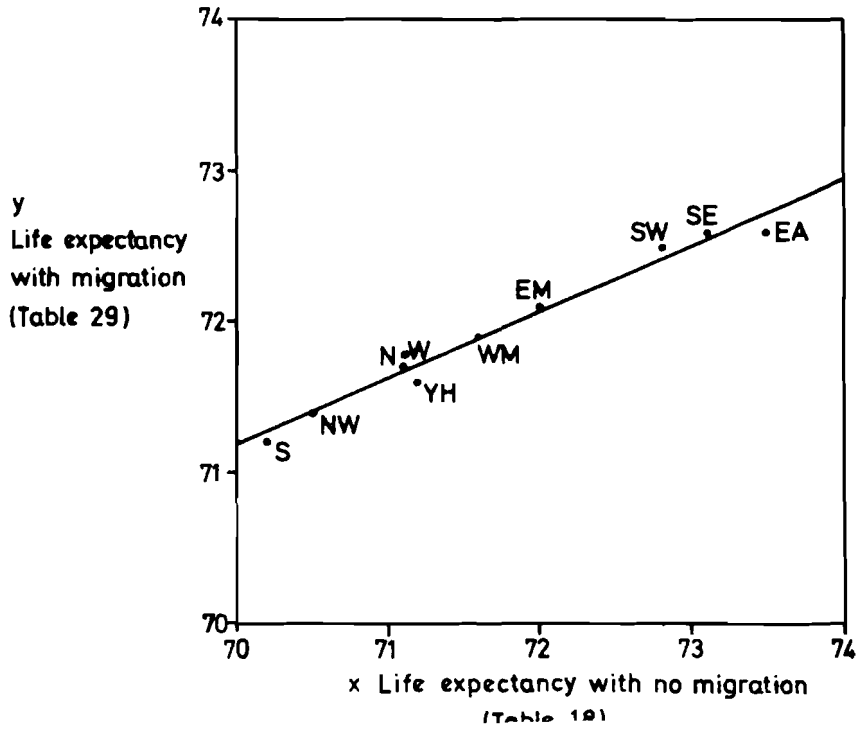
In the same way as the multi-regional life table generated tables of deaths and transitions (as illustrated by Tables 22, 23 and 24) so the equivalent tables of births can be calculated: these are births in all regions to mothers classified by region of origin (birth). The assumption is made that the mothers who migrate to another region experience the fertility rates of that region. Then the results are consolidated to yield a matrix of spatial fertility

Table 28 Expectations of life at birth by regions of birth and regions of residence, ${}_{i}0^{e}_{j}$

Region of birth	Region of residence										Total
	N	YH	NW	EM	WM	EA	SE	SW	W	S	
North	38.6	4.5	4.3	2.5	2.7	1.6	10.4	2.8	1.2	2.9	71.7
Yorkshire & Humberside	4.1	36.7	4.9	4.2	3.0	1.9	10.6	2.9	1.4	1.9	71.6
North West	2.1	3.0	42.3	2.2	3.1	1.3	10.1	3.0	2.6	1.9	71.4
East Midlands	2.5	5.2	3.5	33.5	4.8	2.7	12.2	3.8	1.6	2.3	72.1
West Midlands	1.6	2.4	3.8	3.9	40.1	1.5	10.9	3.9	2.1	1.7	71.9
East Anglia	1.6	2.9	3.1	4.0	3.4	29.8	19.1	4.5	1.6	2.4	72.6
South East	1.7	2.3	3.0	3.0	2.9	3.0	47.4	5.4	1.6	2.8	72.6
South West	1.8	2.6	3.1	2.7	4.1	2.1	19.7	31.4	2.2	2.7	72.5
Wales	1.5	2.0	4.6	2.2	4.0	1.4	11.2	4.4	38.7	1.7	71.8
Scotland	2.2	2.3	3.2	2.2	2.4	1.2	10.4	2.7	1.0	43.6	71.2

Figure 23. Life expectancy, persons, 1970: single region and multi-region values





STATISTICS OF REGRESSION

r	=	0·9860
b	=	0·4419
a	=	40·2487
$\bar{y}$	=	71·94
$\bar{x}$	=	71·71
σ_y	=	0·4993
σ_x	=	1·1140

Table 29 Net allocations of the expectations of life ${}_i\theta_j$

Region of birth	Region of residence										Total
	N	YH	NW	EM	WM	EA	SE	SW	W	S	
North	.5390	.0631	.0605	.0353	.0378	.0221	.1453	.0395	.0166	.0408	1.0000
Yorkshire & Humberside	.0577	.5127	.0682	.0591	.0414	.0266	.1485	.0401	.0195	.0262	1.0000
North West	.0289	.0415	.5925	.0304	.0436	.0179	.1409	.0415	.0360	.0268	1.0000
East Midlands	.0350	.0723	.0491	.4645	.0665	.0379	.1694	.0521	.0221	.0312	1.0000
West Midlands	.0228	.0334	.0522	.0543	.5577	.0209	.1515	.0542	.0298	.0233	1.0000
East Anglia	.0223	.0406	.0427	.0556	.0468	.4108	.2637	.0619	.0224	.0332	1.0000
South East	.0229	.0318	.0420	.0408	.0404	.0418	.6532	.0741	.0215	.0313	1.0000
South West	.0254	.0362	.0427	.0368	.0559	.0289	.2725	.4340	.0306	.0371	1.0000
Wales	.0209	.0276	.0637	.0310	.0556	.0193	.1567	.0612	.5397	.0242	1.0000
Scotland	.0312	.0316	.0449	.0311	.0331	.0174	.1466	.0373	.0142	.6125	1.0000

expectancies. The theory underlying the calculation and the program used are described in Willekens and Rogers, 1977 (Section 2.1)

$$\underset{\sim}{\phi}(x) = \underset{\sim}{F}(x)\ \underset{\sim}{L}(x) \tag{23}$$

where $\underset{\sim}{\phi}(x)$ is the matrix of ${}_i\phi_j(x)$ values of the expected number of children to be born during a unit time T, in a region j to a woman of age x to x+T, who is part of the stationary life table population, $\underset{\sim}{L}(x)$. The net maternity values are summed over age

$$\underset{\sim}{NRR} = \sum_x \underset{\sim}{\phi}(x) \tag{24}$$

to yield the generalised net maternity or spatial fertility expectancy matrix.

The results for Great Britain are shown in Table 30 and in Table 31 in net allocation form (in which the elements of Table 30 are divided by their row elements). Once again the caveat that the diagonal elements are under-estimated and the off-diagonal elements are over-estimated applies. The table gives some indication, however, of the likely genetic mixture across regions of a nation's population. For example, parents born in East Anglia will have, under the conditions of mortality and migration in the multi-regional life table model described above, only 41 per cent of their children in the region itself, just under 22 per cent in the South East and between about 2 and 6 per cent in the other regions. These children will themselves migrate amongst the regions resulting in even greater genetic mixture after two generations.

Another way of looking at the regional mixture of the parental origins of births is to generate an origin allocations matrix by pre-multiplying the net allocations matrix by a row vector containing the proportions of national births in the regions and then dividing each column by the relevant column total. The observed 1970 proportions were used to calculate Table 32, although the stable population proportions would be more general. The table shows how the offspring of those born in 1970 would be distributed in fifty years time (at the end of the reproductive age span) in terms of

Table 30 Spatial fertility expectancies, G.B. regions, 1970

Region of birth of parent	Region of birth of child										
	N	YH	NW	EM	WM	EA	SE	SW	W	S	Total
North	.640	.077	.070	.037	.042	.020	.153	.037	.015	.048	1.140
Yorks. & Humb.	.065	.659	.080	.069	.046	.025	.157	.037	.019	.028	1.185
North West	.030	.046	.768	.032	.048	.016	.144	.038	.037	.030	1.188
East Midlands	.038	.089	.055	.571	.078	.039	.181	.052	.022	.037	1.161
West Midlands	.023	.037	.059	.062	.691	.019	.158	.052	.030	.026	1.158
East Anglia	.022	.046	.047	.065	.054	.459	.296	.064	.022	.039	1.113
South East	.023	.035	.047	.045	.044	.042	.736	.076	.021	.036	1.106
South West	.026	.041	.047	.040	.065	.027	.310	.495	.033	.045	1.128
Wales	.021	.029	.076	.033	.064	.017	.167	.063	.654	.027	1.150
Scotland	.031	.035	.048	.032	.036	.015	.152	.035	.013	.786	1.182

Table 31 Net allocations of fertility expectancies, G.B. regions, 1970

Region of birth of parent	Region of birth of child										
	N	YH	NW	EM	WM	EA	SE	SW	W	S	Total
North	.5609	.0678	.0616	.0326	.0367	.0179	.1345	.0325	.0135	.0422	1.0000
Yorks. & Humb.	.0548	.5564	.0674	.0580	.0385	.0215	.1324	.0310	.0159	.0240	1.0000
North West	.0249	.0388	.6467	.0266	.0403	.0134	.1212	.0324	.0308	.0249	1.0000
East Midlands	.0325	.0764	.0475	.4914	.0671	.0339	.1558	.0447	.0192	.0316	1.0000
West Midlands	.0199	.0317	.0514	.0590	.5971	.0165	.1361	.0452	.0259	.0221	1.0000
East Anglia	.0194	.0417	.0425	.0583	.0483	.4124	.2658	.0571	.0198	.0350	1.0000
South East	.0207	.0316	.0421	.0411	.0401	.0379	.6659	.0685	.0192	.0329	1.0000
South West	.0230	.0364	.0414	.0353	.0580	.0238	.2744	.4389	.0291	.0396	1.0000
Wales	.0181	.0255	.0658	.0783	.0560	.0145	.1453	.0551	.5683	.0231	1.0000
Scotland	.0264	.0293	.0410	.0274	.0302	.0125	.1284	.0294	.0106	.6658	1.0000

Table 32 Regional births by origin cohort

Region of birth of parent	Region of birth of child									
	N	YH	NW	EM	WM	EA	SE	SW	W	S
North	.5793	.0473	.0293	.0292	.0221	.0324	.0261	.0259	.0169	.0267
Yorks. & Humb.	.0879	.6005	.0499	.0789	.0361	.0590	.0400	.0396	.0316	.0235
North West	.0552	.0577	.6635	.0497	.0522	.0501	.0506	.0573	.0844	.0342
East Midlands	.0362	.0566	.0238	.4591	.0431	.0649	.0322	.0396	.0253	.0213
West Midlands	.0345	.0370	.0420	.0804	.6138	.0501	.0451	.0587	.0570	.0245
East Anglia	.0103	.0139	.0103	.0249	.0140	.3628	.0255	.0232	.0127	.0107
South East	.1103	.1120	.1021	.1842	.1234	.3422	.6587	.2865	.1245	.1078
South West	.0259	.0277	.0214	.0336	.0381	.0442	.0574	.3888	.0401	.0277
Wales	.0155	.0139	.0253	.0205	.0271	.0206	.0229	.0368	.5844	.0117
Scotland	.0448	.0335	.0325	.0395	.0301	.0383	.0416	.0396	.0232	.7118
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

the regional birth origins of their parents. The rank ordering of the regions in the diagonal elements in Tables 31 and 32 gives some indication of the degree of "endogamy" involved over a generation. The regions which retain their offspring to the greatest extent are the South East, Scotland and the North West with values above 0.6 in the diagonal (Figure 24); the most open regions are East Anglia, the South West and the East Midlands, with the other regions in between. The same classification applies to the admission proportions except Scotland receives less migrants than the South East and so takes the first rank in "endogamy".

A comparison similar to that for life expectancy can be made between the total multi-regional values (Table 30) and the single region values (Table 13) for the regional net reproduction rates. The graph of the two sets of statistics (Figure 25) reveals the same "regression to the mean" effect. Variance in the fertility of regional cohorts is reduced compared with the variance in regional fertility with now allowance for migration. The regression is not quite as pronounced in the fertility case as in the life expectancy instance (b=.59 as opposed to .44), and the correlation is lower (r=.95 as opposed to .99). The higher regression coefficient is the result of the lesser age span over which the fertility process takes place compared with mortality, whereas the lower correlation is probably due to the fact that the multi-regional calculation involved both sexes whereas only females are used in the single region calculation.

This fertility expectancy finding is dependent on the assumption, in common with the similar life expectancy finding, that people adopt the mortality and migration behaviour of their current residence. In the U.K., data to test such an assumption are absent, although Long (1975) has analysed the relevant U.S. data with respect to the probability of return migration. However, there is some evidence concerning the second assumption embodied in spatial fertility expectancy calculation, namely, that people adopt the fertility behaviour of the region they move to. King (1974) reports fertility rates for immigrants to Leeds and the Immigrants Statistics Unit (1978)

Figure 24. Net allocation of spatial fertility expectancies: retention probabilities

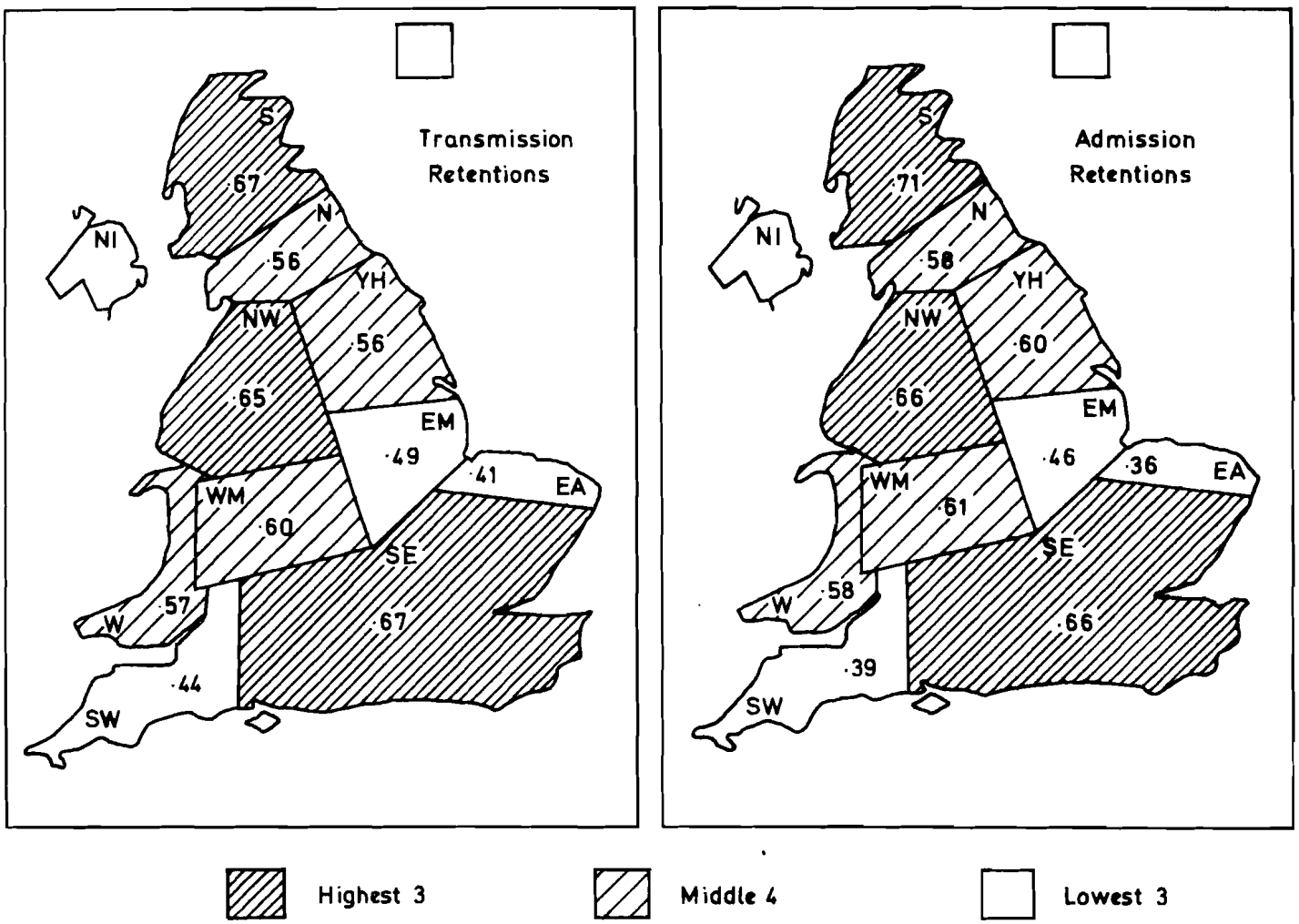
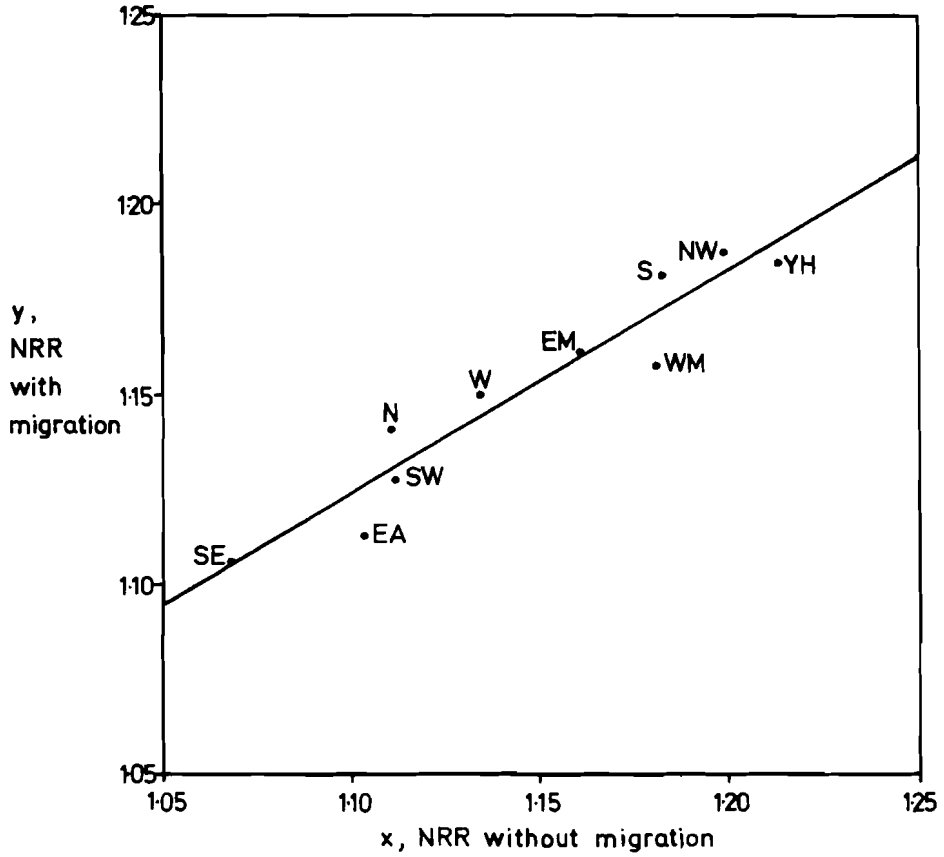


Figure 25. Spatial fertility expectancies: single region and multi-region values



STATISTICS OF REGRESSION

r	=	0·9539
b	=	0·5901
a	=	0·4753
$\bar{y}$	=	1·1512
$\bar{x}$	=	1·1453
σ_y	=	0·0293
σ_x	=	0·0474

report fertility rates for the New Commonwealth and Pakistani immigrant population in England and Wales. The fertility rates fall between those of the origin country and the host country, and show fairly rapid convergence over time. The differences in fertility rates between regions are, of course, much lower but it would be surprising if the same effect did not occur. It would be instructive to substitute fertility rates interpolated between origin and destination region according to length of stay in the spatial fertility expectancy calculation.

3.6 Multi-regional mobility analysis

In the previous section the events analysed were births. The acts of migration or moves can be analysed in a similar fashion (Willekens and Rogers, 1977) and a net migra-production matrix, $\underset{\sim}{NMR}$, defined. This matrix contains the expected number of out-migrations that an individual makes during his life-time:

$$\underset{\sim}{NMR} = \sum_{x} \underset{\sim}{\bar{Y}}(x) \tag{25}$$

where

$$\underset{\sim}{\bar{Y}}(x) = \underset{\sim}{M}^{O}(x)\ \underset{\sim}{L}(x) \tag{26}$$

where $\underset{\sim}{M}^{O}(x)$ is diagonalised matrix of out-migration rates for the age interval x to x+5. In principle, this kind of calculation could be extended to cover inter-regional migrations.

The net migra-production matrix for the regions of Great Britain is shown in Table 33 and the corresponding net allocations matrix in Table 34. To what extent are the values in this matrix correct given our earlier comments on the probability matrix calculation? As estimates of the expected number of inter-regional transitions over five year periods they are clearly over-estimates in the light of our earlier comments. As estimates of the expected number of inter-regional transitions over one year they may be better since the latter are closer to the definition of moves. Further analysis is undoubtedly indicated here (as suggested in Ledent, 1978).

Table 33 Net migraproduction matrix

Region of birth	Region from which out-migration takes place										
	N	YH	NW	EM	WM	EA	SE	SW	W	S	Total
North	.6630	.0678	.0507	.0414	.0343	.0297	.1215	.0532	.0140	.0277	1.1033
Yorks. & Humb.	.0561	.7084	.0574	.0739	.0376	.0367	.1244	.0531	.0167	.0167	1.1811
North West	.0261	.0420	.6134	.0350	.0395	.0231	.1161	.0552	.0322	.0173	0.9998
East Midlands	.0330	.0794	.0406	.7719	.0635	.0549	.1434	.0731	.0196	.0213	1.3007
West Midlands	.0207	.0337	.0435	.0678	.6591	.0276	.1262	.0744	.0265	.0148	1.0941
East Anglia	.0195	.0427	.0353	.0705	.0441	.8250	.2320	.0891	.0199	.0228	1.4018
South East	.0206	.0323	.0344	.0499	.0368	.0599	.6572	.1061	.0188	.0208	1.0367
South West	.0232	.0377	.0347	.0442	.0530	.0390	.2399	.8430	.0284	.0254	1.3687
Wales	.0188	.0273	.0544	.0362	.0520	.0249	.1314	.0874	.6587	.0155	1.1065
Scotland	.0281	.0322	.0362	.0367	.0297	.0220	.1214	.0499	.0116	.5493	0.9172

Table 34 Allocations matrix, migraproduction

Region of birth	Region from which out-migration takes place										
	N	YH	NW	EM	WM	EA	SE	SW	W	S	Total
North	.6009	.0615	.0460	.0376	.0311	.0269	.1101	.0482	.0127	.0251	1.0000
Yorks. & Humb.	.0475	.5998	.0486	.0626	.0318	.0311	.1053	.0450	.0142	.0141	1.0000
North West	.0261	.0420	.6135	.0350	.0395	.0231	.1161	.0552	.0322	.0173	1.0000
East Midlands	.0254	.0610	.0312	.5935	.0488	.0422	.1103	.0562	.0151	.0163	1.0000
West Midlands	.0189	.0308	.0397	.0620	.6024	.0252	.1154	.0680	.0242	.0135	1.0000
East Anglia	.0139	.0304	.0252	.0503	.0314	.5892	.1655	.0636	.0142	.0162	1.0000
South East	.0198	.0311	.0332	.0482	.0355	.0578	.6399	.1023	.0181	.0201	1.0000
South West	.0170	.0276	.0254	.0323	.0387	.0285	.1753	.6160	.0208	.0185	1.0000
Wales	.0170	.0247	.0492	.0328	.0470	.0225	.1187	.0790	.5953	.0140	1.0000
Scotland	.0307	.0351	.0395	.0400	.0324	.0240	.1324	.0544	.0126	.5989	1.0000

Table 33 suggests that inter-regional migrations are events only slightly less frequent than children! The figures in the column totals in Table 33 range from 0.92 migrations per person for Scottish cohorts to 1.40 for East Anglia cohorts. Table 30's totals for fertility are just a little higher, although the earlier Table 13 data indicate that children in recent years are less frequent an event than inter-regional migration.

What is the single region equivalent of the net migra-production rate? The gross migra-production rate GMR (Willekens and Rogers, 1977) is one equivalent

$$\underset{\sim}{GMR} \doteq \sum_{x} \underset{\sim}{M}^{o}(x) \qquad (27)$$

where $\underset{\sim}{M}^{o}(x)$ is a matrix with out-migration rates from the regions in the diagonal and zeros elsewhere. The GMRs are the mobility equivalents of the total period fertility rates or gross fertility rates. A true single region equivalent would involve applying single region stationary life table populations to the schedule of out-migration rates (as in Long and Boertlan, 1974). A convenient approximation to this is to multiply the total out-migration rate by the single region life expectancy value. This enables us to compare mobility rates at a number of spatial scales quite easily and a range of mobility measures for the British regions has been accumulated in Table 35.

Column (2) of Table 35 contains the total internal out-migration rate of residents of the 10 regions. This rate includes all intra-region as well as inter-region transitions in the 1970-71 one year period. Column (3) gives the total numbers of "moves" (equated here with one year transitions*) expected in a life-time by this method. The Southern regions of the country - East Anglia, the South East and South West - stand out as having the most mobile

---

* Evidence from the General Household Survey of O.P.C.S. (1973) suggests that persons who migrate in Britain make an average of 1.274 moves per year rather than the one assumed here. This would shift the range in Column (3) from 8.5 moves per life-time for Wales to 11.99 moves per life-time for East Anglia.

Table 35 Various migraproduction calculations

Region	Life expectancy (Table 17) (1)	Total O.M.R. (Rees, 1977) (2)	Total "moves" (3)	Regional O.M.R. (Table 20) (4)	Regional "moves" (5)	G.M.R. (6)	N.M.R. (Table 33) (7)
North	71.1	.1101	7.2281	.0155	1.1021	1.2143	1.1033
Yorks. & Humb.	71.2	.1061	7.5543	.0174	1.2389	1.3370	1.1811
North West	70.5	.1056	7.4448	.0134	0.9447	1.0599	0.9998
East Midlands	72.0	.1080	7.7760	.0206	1.4832	1.5674	1.3007
West Midlands	71.6	.1074	7.6898	.0151	1.0812	1.1561	1.0941
East Anglia	73.5	.1280	9.4080	.0241	1.7714	1.8435	1.4018
South East	73.1	.1269	9.2764	.0135	0.9869	1.0590	1.0367
South West	72.8	.1266	9.2165	.0235	1.7108	1.8417	1.3687
Wales	71.1	.0938	6.6692	.0152	1.0807	1.2063	1.1065
Scotland	70.2	.1187	8.3327	.0117	0.8213	0.8677	0.9172

Region	Regional I.O.M.R. (Table 8) (8)	Regional internal "moves" (9)	Regional E.R. (Table 8) (10)	Emigrations (11)	Regional T.O.M.R. (Table 8) (12)	Regional total "moves" (13)	Grand total "moves" (14)
North	.0153	1.0878	.0075	.5333	.0228	1.6211	7.7614
Yorks. & Humb.	.0172	1.2246	.0058	.4130	.0230	1.6376	7.9673
North West	.0133	0.9377	.0065	.4583	.0198	1.3960	7.9031
East Midlands	.0204	1.4688	.0076	.5472	.0280	2.0160	8.3232
West Midlands	.0159	1.1384	.0054	.3866	.0213	1.5250	8.0764
East Anglia	.0238	1.7493	.0169	1.2422	.0407	2.9915	10.6502
South East	.0133	0.9722	.0112	.8187	.0245	1.7909	10.0951
South West	.0232	1.6890	.0094	.6843	.0327	2.3733	9.9008
Wales	.0150	1.0665	.0037	.2631	.0187	1.3296	6.9323
Scotland	.0115	0.8073	.0111	.7792	.0226	1.5865	9.1119

Notes

1. Column (3) = Column (1) x Column (2)
2. Column (5) = Column (1) x Column (4)
3. Column (6): GMR = gross migraproduction rate
4. Column (7): NMR = net migraproduction rate
5. Column (8): IOMR = internal out-migration rate
6. Column (9) = Column (1) x Column (8)
7. Column (10): ER = emigration rate (external out-migration)
8. Column (11) = Column (1) x Column (10)
9. Column (12): TOMR = total out-migration rate
   = Column (8) + Column (10)
10. Column (13) = Column (9) + Column (11)
    = Column (1) x Column (12)
11. Column (14) = Column (3) + Column (11)

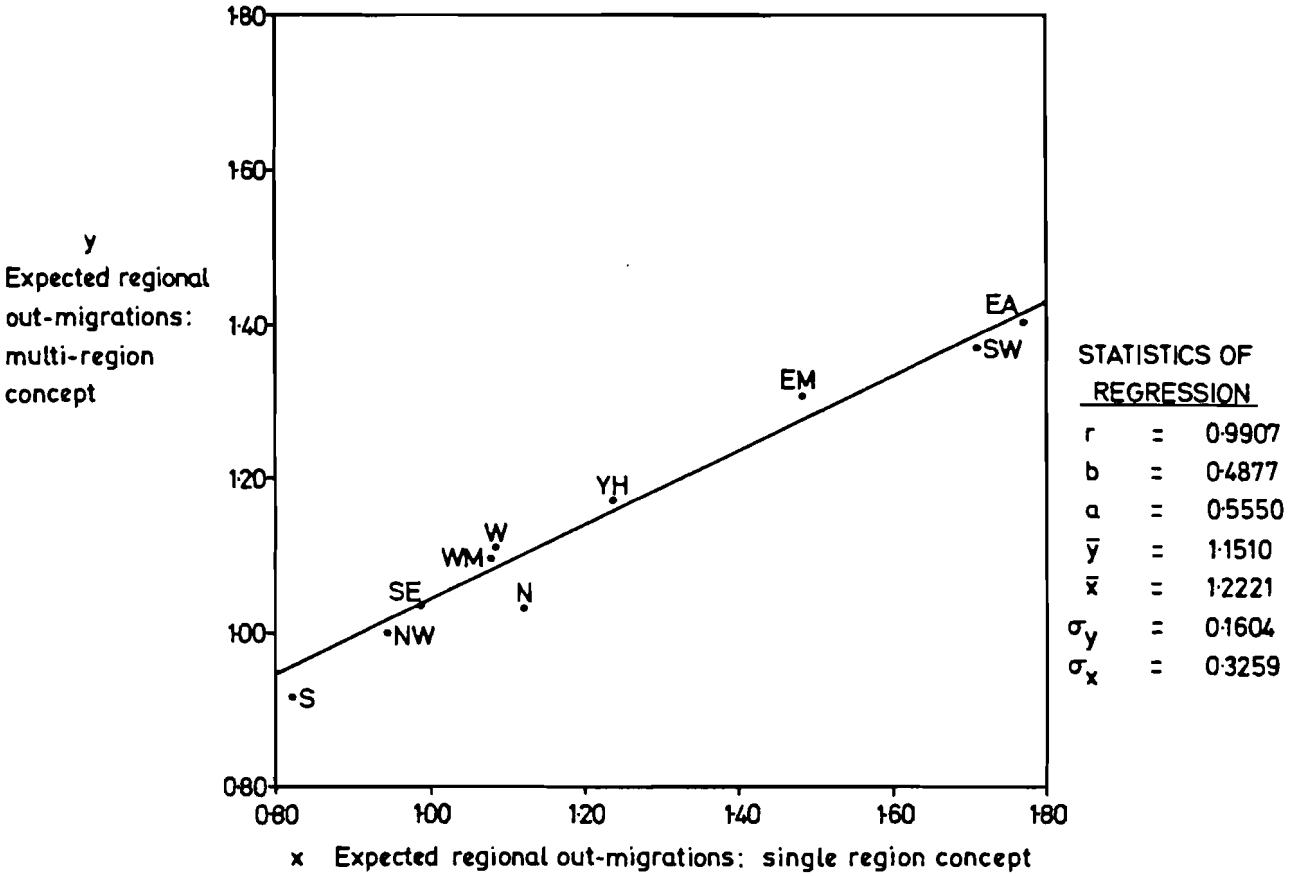
population, followed by Scotland, the Midlands regions, the Northern regions and Wales exhibit the lowest mobility with the Welsh population likely to make almost 3 less moves in an average life-time than the East Anglian.

If the same calculation is applied to regional out-migrants (to other British regions) then a single region estimate of regional "moves" is obtained (Column (5) of Table 35). This can be compared with the Net Migra-production Rates derived from the multi-regional analysis (Column (7) of Table 35) in a graph (Figure 26). Precisely the same kind of "regression to the mean" relationship shows up as in the life expectancy and fertility cases. The variance in the migratory behaviour of birth cohorts is reduced by the very act of migration!

The bottom half of Table 35 reports similar calculations based on the accounting data of Table 8 which contains the multi-regional population accounts for the mid-year 1970 to mid-year 1971 period. The regional internal out-migration rate is computed by dividing the total of such migrants by the initial period population. This is a slightly different procedure from that for the Column (4) rates, but the results (Columns (8) and (9)) are very little different. What the accounts table does add, however, is the possibility of calculating the life-time number of emigrations expected in each regional population (Columns (10) and (11)) and these turn out to be surprisingly high. In fact, one might suppose that such figures would lead to the disappearance of the British population! In reality, a very large proportion of emigrations are balanced by immigrations (as shown in Tables 11 and 12) and a very large proportion of immigrants are, in fact, returning British citizens.

The final columns of Table 35 record the sum of internal and external "moves" for the regions and the grand total of residential mobility (Column (14)). The ranking of the regions remains fairly stable as the migration scale changes - compare Columns (3), (7), (11) and (13)-with the exceptions of Scotland and the South East.

Figure 26. Migraproduction expectations: single region vs multi-regional values



The Scottish population and the Scottish birth cohort have the lowest inter-regional migra-production rate, probably because Scotland is the region least accessible to the British population system. However, residential mobility in general and emigration mobility are fairly high for Scotland leading to a seventh rank in regional total "moves" and a fourth rank in grand total "moves". Similarly, the South East has a low ranking on inter-regional mobility, in this case probably because of its large size, a second place in the emigration moves column, a second place in the total "moves" category and a second place overall in the grand total "moves". These differences emphasise the difficulty of explaining the patterns of inter-regional migration without adopting a proper spatial interaction perspective (Stillwell, 1977).

3.7 Multi-regional population projections

3.7.1 Theory and caveats

One of the most useful products of multi-regional population analysis is the projection of regional populations utilising the survivorship matrix $\underset{\sim}{S}(x)$, generated from the multi-regional life table

$$\underset{\sim}{S}(x) = \underset{\sim}{L}(x+5)\ \underset{\sim}{L}^{-1}(x) \qquad (28)$$

(Willekens and Rogers, 1976, p. 31) where $\underset{\sim}{L}(x)$ refers to the stationary multi-regional life table population. The survivorship proportions are used to project the existing population

$$\{\underset{\sim}{K}^{(t+5)}\ (x+5)\} = \underset{\sim}{S}(x)\ \{\underset{\sim}{K}^{(t)}\ (x)\} \text{ for } 5 \leqslant x \leqslant z-5 \qquad (29)$$

where $\{\underset{\sim}{K}^{(t)}\ (x)\}$ is a vector of regional populations aged x to x+5 at time t, and $\{\underset{\sim}{K}^{(t+5)}\ (x+5)\}$ is equivalent vector at time t+5, now aged x+5 to x+10.

Births are computed by applying a fertility and survivorship matrix $\underset{\sim}{B}(x)$ to the potentially fertile population

$$\{\underset{\sim}{K}^{(t+5)}\ (0)\} = \sum_{\alpha-5}^{\beta-5} \underset{\sim}{B}(x)\ \{\underset{\sim}{K}^{(t)}\ (x)\} \qquad (30)$$

(Willekens and Rogers, 1976, p. 41) where

$$\underset{\sim}{B}(x) = \tfrac{1}{2}\ \underset{\sim}{L}(0)\ \underset{\sim}{\ell}^{-1}(0)\ [\underset{\sim}{F}(x) + \underset{\sim}{F}(x+5)\ \underset{\sim}{S}(x)] \qquad (31)$$

where $\underset{\sim}{F}(x)$ is a diagonal matrix of regional fertility rates for persons aged x to x+5 at time t, $\underset{\sim}{\ell}(0)$ is the value of the life table radix, and $\underset{\sim}{L}(0)\ \underset{\sim}{\ell}^{-1}(0) = \underset{\sim}{S}(0)$, the survivorship matrix for persons born in the period.

This projection procedure replicates for a multi-regional system the method of deriving survivorship rates used in connection with the conventional life table (Keyfitz, 1968; Keyfitz and Flieger, 1971), but contrasts with more direct derivation in other multi-regional projection models (Rogers, 1968; Gilje and Campbell, 1973) from migrant and death statistics, or from spatial population accounts (Rees and Wilson, 1977; Rees, 1977a).

In this section, the results of applying the Equations (28) through (31) model to the 1970 British regions system described in Section 3.2, using the Willekens and Rogers, 1976, program, are described. A number of caveats apply to these projections which make them unsuitable as forecasts*, but they are worth examination as the one of the few multi-regional population projections of the regional populations of Britain**. The caveats are listed below.

---

* The terms "projection" and "forecast" are used as follows. Projections of the population are explorations of the future development of various categories of the population using particular models and assumptions. Forecasts are judgmentally selected or adjusted projections that the author(s) of the projection consider as the best available view of the demographic future.

**See Joseph (1974, 1975) for earlier attempts, Rees (1976) for an aggregate projection, Rees (1977a) for a three region projection.

(i) The point made earlier about the likely over-estimation of the multi-regional migration and death probability matrix applies with equal force to the multi-regional survivorship matrix. Such an over-estimation is likely to speed up whatever redistribution of the population is taking place, other things being equal, though it is not, of itself, likely to affect the overall system population since the death probabilities and fertility rates are correctly determined.

(ii) The effect of external migration, which was shown to be of such importance in Section 2.3, is unrepresented in the projections reported here.

(iii) The situation with respect to fertility has changed dramatically since 1970 (as was shown in Section 2.4), and that of mortality marginally since 1970 so that updating to a more recent year would be desirable.

(iv) Similarly, the internal migration picture reques updating since in Section 2.2 the net migration picture was shown to have changed substantially in a number of respects.

Caveat (i) requires the solution of a technical problem in multi-regional population analysis that should soon be overcome. Caveat (ii) requires the estimation of emigration vectors for the regions (the immigration vectors are readily available) and inclusion of net emigration rates, disaggregated by age in an unpublished simulation version of the Willekens and Rogers, 1976 programs (Willekens, 1978, personal communication). The simulation version of the programs could readily accept updated fertility and mortality data (Caveat (iii)). Caveat (iv) is more difficult to remove as migration data is available only at the periodic censuses (5 or 10 years apart). However, using a combination of official net migration estimates, external migration data (O.P.C.S., 1978c) and accounting techniques an estimate of the annual inter-region migration matrices has been prepared as part of larger accounts matrices (the accounts table for 1975-76 given in Table 10 is one example). These estimations could be disaggregated fairly straightforwardly by age and sex using improved versions of the methods employed in Rees (1977a).

3.7.2 The population projection

Selected results from the population projection are presented in Table 36: the total populations in the ten regions, their shares of the national population and one measure of their age structure, the per cent of the population in the potentially active age groups 15 to 64. A second table, Table 37, gives details of the way the components of growth change over time under the regime of unchanging mortality, fertility and migration rates.

The first point to make is that the absolute sizes of the populations are greater than most other projections (discussed later) would have them. In 1970 fertility was high relative to overall post-1918 British experience (Figure 3B), higher than subsequently in the 1970s, and higher than the long term fertility rates assumed by O.P.C.S. in recent projections. Generally, a T.P.F.R. of 2.2 was assumed for England and Wales by O.P.C.S. from 1971 through 1975 with a reduction to 2.1in 1976 based projections (O.P.C.S., 1978).

Of more interest are the relative shares of the G.B. population projected. Shares for the North, Yorkshire and Humberside, the North West, Wales and Scotland are projected to fall throughout the projection time horizon to 2020. Shares for the East Midlands, East Anglia and the South West grow continuously in this period. The West Midlands' share at first increases and then decreases; the South East's share declines through the rest of the twentieth century but recovers slightly in the twenty-first.

These share projections can be compared with projections (Table 38) based on input of the 1970-71 accounts matrix (Table 9) into a simpler aggregate model

$$\underset{\sim}{K}^{(t+1)} = \underset{\sim}{G}^{(t,t+1)} \underset{\sim}{K}^{(t)} + \underset{\sim}{I}^{(t,t+1)} \qquad (32)$$

where $\underset{\sim}{K}$ are vectors of regional populations, $\underset{\sim}{G}^{(t,t+1)}$ is a matrix of survivorship and birth and survivorship rates for a one year period and $\underset{\sim}{I}^{(t,t+1)}$ is a vector of regional immigrants (not net immigrants

Table 36. Multi-regional population projection: G.B. regions, 1970 base

Region	1970	1975	1980	1985	1990	2000	2010	2020
	POPULATION NUMBERS (1000s)							
N	3360	3413	3463	3518	3579	3710	3870	4056
YH	4812	4850	4884	4925	4981	5123	5320	5568
NW	6789	6863	6938	7032	7151	7439	7806	8237
EM	3363	3499	3628	3757	3894	4173	4469	4783
WM	5178	5307	5423	5538	5661	5922	6217	6555
EA	1674	1811	1937	2058	2177	2404	2628	2852
SE	17316	17612	17909	18248	18633	19495	20530	21722
SW	3764	3968	4158	4340	4519	4867	5233	5618
W	2734	2777	2818	2860	2909	3020	3161	3327
S	5199	5250	5306	5371	5448	5616	5836	6096
GB	54187	55349	56463	57646	58951	61769	65070	68814
	POPULATION SHARES (PER CENT OF G.B. POPULATION)							
N	6.20	6.17	6.13	6.10	6.07	6.01	5.95	5.89
YH	8.88	8.76	8.65	8.54	8.45	8.29	8.18	8.09
NW	12.53	12.40	12.29	12.20	12.13	12.04	12.00	11.97
EM	6.21	6.32	6.42	6.52	6.61	6.76	6.87	6.95
WM	9.56	9.59	9.60	9.61	9.60	9.59	9.55	9.53
EA	3.09	3.27	3.43	3.57	3.69	3.89	4.04	4.14
SE	31.96	31.82	31.72	31.66	31.61	31.56	31.55	31.57
SW	6.95	7.17	7.36	7.53	7.67	7.88	8.04	8.16
W	5.05	5.02	4.99	4.96	4.93	4.89	4.86	4.83
S	9.59	9.48	9.40	9.32	9.24	9.09	8.97	8.86
GB	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	PER CENT OF POPULATION ACTIVE							
N	63.5	62.5	63.2	63.5	63.0	63.7	64.7	64.4
YH	63.1	61.8	61.9	62.2	61.8	62.6	63.6	63.4
NW	62.5	61.5	61.8	62.3	61.9	63.0	64.0	63.8
EM	63.2	62.4	62.6	63.1	62.8	63.6	64.6	64.1
WM	64.5	63.1	63.0	63.3	62.8	63.4	64.2	63.9
EA	63.4	62.2	62.3	62.9	62.8	63.9	64.6	63.8
SE	63.9	62.8	62.8	63.4	63.2	64.3	65.3	65.0
SW	62.0	61.0	61.3	61.8	61.5	62.6	63.7	63.1
W	63.1	62.0	62.5	62.8	62.3	63.3	64.4	64.0
S	61.7	61.5	61.9	62.1	61.7	63.0	64.2	63.6
GB	63.2	62.2	62.4	62.9	62.5	63.5	64.5	64.1

Notes

1. The regions are the "old" regions (Figure 1.2).

Table 37 Aggregate components of growth rates, G.B. regions, 1970 base

Region	1970	1975	1980	1985	1990	2000	2010	2020
NATURAL INCREASE RATE (PER 1000, ANNUAL EQUIVALENT)								
N	3.6	3.2	3.1	3.6	3.6	3.8	4.3	4.5
YH	4.8	4.1	3.9	4.4	4.6	5.2	6.0	6.4
NW	3.9	3.6	3.8	4.6	5.2	5.9	6.7	7.0
EM	5.3	5.2	4.9	5.4	5.7	5.9	6.3	6.4
WM	6.7	5.9	5.2	5.3	5.4	5.6	6.0	6.3
EA	4.2	4.0	3.6	3.8	3.9	3.9	4.1	3.9
SE	4.1	4.0	3.8	4.0	4.4	4.8	5.4	5.7
SW	2.5	2.4	2.1	2.3	2.5	2.7	3.2	3.3
W	2.7	2.4	2.1	2.5	2.6	3.1	3.7	4.0
S	4.6	4.7	5.0	5.4	5.5	5.7	6.4	6.5
GB	4.3	4.0	3.9	4.2	4.5	4.8	5.4	5.7
INTERNAL NET MIGRATION RATE (PER 1000, ANNUAL EQUIVALENT)								
N	-0.3	-0.3	-0.3	-0.3	-0.1	0.0	0.1	0.3
YH	-3.1	-2.8	-2.6	-2.4	-2.2	-2.0	-1.8	-1.6
NW	-1.7	-1.5	-1.6	-1.6	-1.6	-1.5	-1.6	-1.5
EM	2.9	2.4	1.9	1.7	1.4	0.9	0.6	0.3
WM	-1.6	-1.4	-1.2	-1.1	-1.1	-1.0	-0.9	-0.9
EA	12.6	10.4	8.9	7.8	6.8	5.2	4.5	3.8
SE	-0.9	-0.7	-0.4	-0.2	-0.2	-0.0	0.0	0.1
SW	8.7	7.6	6.7	5.9	5.3	4.5	4.1	3.7
W	0.5	0.6	0.6	0.6	0.8	1.0	1.1	1.3
S	-2.7	-2.8	-2.8	-2.8	-2.6	-2.4	-2.2	-2.0
GB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GROWTH RATES (PER 1000, ANNUAL EQUIVALENT)								
N	3.22	2.90	2.78	3.29	3.43	3.79	4.46	4.82
YH	1.69	1.35	1.31	1.92	2.41	3.23	4.22	4.81
NW	2.17	2.06	2.21	3.01	3.59	4.36	5.16	5.47
EM	8.17	7.53	6.82	7.01	7.11	6.77	6.82	6.71
WM	5.18	4.54	4.05	4.19	4.38	4.62	5.03	5.48
EA	16.77	14.42	12.49	11.53	10.66	9.17	8.51	7.72
SE	3.27	3.31	3.36	3.82	4.22	4.75	5.45	5.74
SW	11.18	9.91	8.73	8.21	7.78	7.18	7.26	6.97
W	3.20	2.98	2.72	3.08	3.41	4.12	4.86	5.27
S	1.79	1.99	2.15	2.64	2.85	3.34	4.22	4.42
GB	4.30	4.04	3.86	4.23	4.49	4.85	5.44	5.66

because emigration rates are implicitly included in the $\underline{G}$ matrix). The total numbers projected are, of course, rather different because of aggregation error in the simpler model, and because no emigration losses allowed in the more complex model. The share trends (Table 40) are, however, quite similar.

Table 38 also reports the results of a growth matrix or components of growth model based on the 1975-76 accounts (Table 10), and Table 39 gives details of the latest (1976 based) official national projections (O.P.C.S., 1978d) prepared by the Government Actuary in collaboration with the Office of Population Censuses and Surveys, and the latest (1974 based) regional projections. Both sets of projections show that expectations of the future population have fallen dramatically from 1970 based levels. Whereas the 1970 based projection (Table 36) had a figure of 61.8 millions projected for Great Britain in 2000, the official projections based on 1976 show a figure of only 55.9 millions in 2001, and the components of growth projection (in which fertility is not assumed to recover to replacement levels) gives a figure of 54.0 millions only, slightly less than the figure in 1970.

The pattern of changes in regional shares does not appear very different from that of the 1970 based projections (Table 40) except that Wales is projected to gain in share terms and the West Midlands to lose, reversing the 1970 projected pattern.

These comparisons have not provided a precise evaluation of the influence of a multi-regional approach as opposed to a single region approach because there are many causes for the differences in projection - both in model and in data input and assumptions. Evaluation of the influence of model construction requires the kind of experimentation with same data base that Rogers (1976) has carried out so successfully, and evaluation of the influence of data input and assumptions requires systematic simulation of a variety of possible scenarios (as in Rees, 1977a).

This study of migration and population dynamics in U.K. regions concludes with a brief review of relevant policy.

Table 38 Multi-regional population projections, G.B. regions, aggregate growth matrix model based on 1970-71 and 1975-76 accounts

Region	1970	1975	1980	1985	1990	1995	2000
POPULATION SHARES (PER CENT) 1970-71 GM model							
N	5.82	5.75	5.70	5.65	5.61	5.58	5.54
YH	9.00	9.00	8.99	8.99	8.99	9.00	9.00
NW	12.23	12.15	12.09	12.03	11.98	11.94	11.91
EM	6.69	6.84	6.97	7.09	7.19	7.29	7.37
WM	9.45	9.55	9.64	9.73	9.81	9.89	9.97
EA	3.09	3.23	3.36	3.45	3.53	3.59	3.64
SE	31.48	31.24	31.03	30.85	30.69	30.55	30.43
SW	7.53	7.66	7.77	7.86	7.94	8.00	8.05
W	5.04	5.02	5.01	4.99	4.98	4.98	4.97
S	9.67	9.55	9.45	9.35	9.26	9.18	9.11
GB	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Popn GB	54072	54777	55643	56493	57327	58145	58949
POPULATION SHARES (PER CENT) 1975-76 GM model							
N	5.82	5.74	5.73	5.71	5.70	5.69	5.68
YH	9.00	9.00	8.95	8.91	8.87	8.84	8.81
NW	12.23	12.09	11.92	11.77	11.63	11.51	11.40
EM	6.69	6.85	6.91	6.96	7.00	7.04	7.08
WM	9.45	9.51	9.43	9.36	9.30	9.25	9.20
EA	3.09	3.27	3.46	3.62	3.75	3.86	3.95
SE	31.48	31.10	30.91	30.77	30.65	30.57	30.51
SW	7.53	7.77	7.99	8.18	8.34	8.47	8.58
W	5.04	5.08	5.11	5.14	5.16	5.18	5.20
S	9.67	9.57	9.57	9.58	9.59	9.59	9.60
GB	100.0	100.00	100.00	100.00	100.00	100.00	100.00
Popn GB	54072	54405	54324	54239	54153	54065	53977

Notes

1. 1970-71 GM model: growth matrix (aggregate population) computed based on Table 9 accounts and used to project the population. See Rees and Wilson, 1977, Chapter 6 for details of method. The program used is described in Jenkins and Rees (1977).
2. 1975-76 GM model: growth matrix (aggregate population) computed based on Table 10 accounts and used to project the population. The program used is described in Jenkins and Rees (1977).
3. The regions are "new" regions (Figure 1.3).

Table 39. Official single region population projections, regions (1974 based) and countries (1976 based)

Region	1974	1976	1981	1986	1991	1996	2001	2016
	POPULATIONS (1000s): HOME POPULATION OF THE ENGLISH REGIONS							
N	3127	3110	3068	3071	3082			
YH	4897	4883	4841	4864	4910			
NW	6593	6554	6447	6437	6465			
EM	3719	3758	3851	3981	4128			
WM	5181	5183	5191	5256	5339			
EA	1758	1802	1921	2053	2191			
SE	16955	16911	16842	16954	17110			
SW	4206	4249	4369	4543	4730			
E	46436	46448	46528	47159	47956			
	POPULATIONS (1000s): TOTAL POPULATION OF THE U.K. COUNTRIES							
W	2765	2773	2790	2832	2893	2945	2979	3090
S	5242	5225	5188	5223	5304	5362	5378	5427
NI	1535	1528	1532	1545	1566	1587	1600	1625
UK	56053	56002	55697	55962	56712	57325	57535	58201
GB	54518	54472	54165	54418	55147	55738	55935	56576
EW	49276	49247	48977	49195	49844	50376	50557	51148
E	46511	46474	46187	46363	46951	47431	47578	48058
	POPULATION SHARES (OF G.B. POPULATION)							
N	5.74	5.72	5.62	5.55	5.47			
YH	9.00	8.97	8.87	8.78	8.72			
NW	12.11	12.04	11.82	11.63	11.48			
EM	6.83	6.90	7.06	7.19	7.33			
WM	9.52	9.52	9.52	9.50	9.48			
EA	3.23	3.31	3.52	3.71	3.89			
SE	31.15	31.06	30.87	30.63	30.38			
SW	7.73	7.81	8.01	8.20	8.39			
E	85.31	85.32	85.27	85.20	85.14			
W	5.07	5.09	5.15	5.20	5.25	5.28	5.33	5.46
S	9.62	9.59	9.58	9.60	9.62	9.62	9.61	9.59
NI	2.82	2.81	2.83	2.84	2.84	2.85	2.86	2.87
UK	102.82	102.81	102.83	102.84	102.84	102.85	102.86	102.87
GB	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
EW	90.38	90.41	90.42	90.40	90.38	90.38	90.39	90.41
E	85.31	85.32	85.27	85.20	85.14	85.10	85.06	84.94

Notes

1. Sources: English region projections - O.P.C.S. (1977d)
U.K. countries projections - O.P.C.S. (1978d).

Table 40. Shifts in population shares in the projections

Region	Projection model			
	Multi-regional cohort survival 1970 base Table 36	Growth matrix 1970-71 base Table 38	Growth matrix 1975-76 base Table 38	Cohort survival with net migration 1974/76 base Table 39
CHANGE IN PER CENT SHARE 1970-1990				
North	-0.13	-0.21	-0.08	-0.35
Yorks. & Humb.	-0.33	-0.01	-0.13	-0.28
North West	-0.40	-0.25	-0.60	-0.75
East Midlands	+0.40	+0.50	+0.31	+0.64
West Midlands	+0.04	+0.36	-0.15	+0.03
East Anglia	+0.60	+0.42	+0.66	+0.80
South East	-0.35	-0.79	-0.83	-1.10
South West	+0.72	+0.41	+0.81	+0.86
Wales	-0.08	-0.06	+0.12	+0.21
Scotland	-0.35	-0.41	-0.08	-0.05
CHANGE IN PER CENT SHARE 1970-2000				
North	-0.19	-0.28	-0.14	
Yorks. & Humb.	-0.58	0.00	-0.19	
North West	-0.49	-0.32	-0.83	
East Midlands	+0.55	+0.68	+0.39	
West Midlands	+0.03	+0.52	-0.25	
East Anglia	+0.80	+0.55	+0.86	
South East	-0.40	-1.05	-0.97	
South West	+0.93	+0.52	+1.05	
Wales	-0.16	-0.07	+0.16	
Scotland	-0.50	-0.56	-0.07	

4. Population distribution policy

4.1 Introduction

In the first three sections of this paper, the aim has been to describe, in as thorough a fashion as possible, the population dynamics of U.K. regions. Clearly, it would be satisfying to combine with this descriptive account an explanation of why regional populations differed in their mortality experience, fertility behaviour and migration propensity. This explanation would seek to determine the role, direct or indirect, that explicit public policy played in influencing those differences. Scope for a thorough exploration is not here available, but the subject is important enough to warrant a short review of the findings of others and some speculation. For more careful and detailed descriptions of various aspects of population distribution policy in the U.K. reference should be made to McCrone (1969), the Department of the Environment (1971, Chapter 5), House (1973), Lawton (1973), and Lawton (1977).

The regions used in the analysis are not governmental units in the sense of having an elected governing council or equivalent body. They are rather statistical amalgamations of the upper tier of local governmental units: counties in England and Wales, and "regions and areas" in Scotland. These are the units which could be said to have population distribution policies, and are charged with preparing Structure Plans that embody population forecasts and distribution strategies. However, since there are some 68 of these local government units (Greater London, 7 Metropolitan counties, and 39 non-metropolitan counties in England; 8 counties in Wales; 12 regions and areas in Scotland; and Northern Ireland), multi-regional analysis of the kind carried out at the regional scale is too large a task at the local scale at present, although use might be made of the aggregated or decomposed models suggested by Rogers (1976). Similarly, multi-regional analysis for the city-regions which represent the fundamental units of the spatial economy would require extensive resources and explorations. The Urban Change Project (Drewett, Spence and Goddard, 1975) has measured population and employment trends, components of change and migration patterns for

about 360 city-region zones (circa 120 metropolitan labour markets divided into core, outer and peripheral zones) but little in the way of model based analysis has yet been attempted.

However, the standard regions or approximate equivalents do serve as units in the administrative structure of national government departments. The National Health Service, for example, is divided into fifteen Regional Health Authorities, the boundaries of six of which coincide with standard regions while others aggregate to standard regions. There has always been a regional dimension to most national policies, particularly those concerned with employment. In some cases, as in national policy concerning the location of manufacturing employment, the regional element in policy has been explicit: attempts have been made to force or to lure jobs away from low unemployment regions (South East, West Midlands) towards high unemployment regions (Northern Ireland, Scotland, the North) with consequent effects on migration patterns. In other cases, the effect of policy has been indirect: the distribution of finance to the regional hospital authorities has been very uneven in the past and may have contributed to the mortality differences highlighted in Section 2.6.

Explanations for the regional patterns and policy influence on each of the elements in population dynamics are discussed in turn: stocks, births, deaths, internal migrants and external migrants.

4.2 The direction of population

People are not told where they should live in the U.K. Almost all of them choose, subject to various employment, income and family constraints, where to live. The exceptions are those bound in one fashion or another to institutions: the Armed Forces and the prisons are the principal examples. The differences between total, home and civilian population distributions, for example, are entirely a matter for the Ministry of Defence since the Armed Forces make up the differences.

4.3 Explanations of fertility patterns

National fertility trends have been analysed in detail by official demographers (O.P.C.S., 1978d) and academics (Simons, 1977). Principal explanations for the declining trend since 1964 include lowered family size goals stemming from a perception of worsened life chances for offspring and from a more careerist orientation of women, the availability of legal abortions since 1968 eliminating many unwanted potential children, and the use of safer contraceptives such as the Pill.

Less attention has been paid to regional fertility variation. Jones (1975) has related birth rates in local areas in Scotland to the degree to which women in the childbearing ages participate in the labour force and to the proportion of higher fertility Catholics in the population, once the effect of the age-sex structure of the population had been eliminated. Compton (1977) has analysed the variation in fertility within Northern Ireland, and has shown that the sectarian (Protestant/Catholic) composition of local populations is the main, though not exclusive, explanation. Lawton (1973) points to the effect of migration in selecting more fertile couples. Migrants in the fertile age ranges who move into "suburbanising" areas do so in order to have children, whereas those who stay behind in the city are more likely to have decided to have smaller families or no children. Finally, given a fair degree of difference in family size between families headed by men in different social Classes (Lawton, 1973; Pearce and Britton, 1977), it is likely that the social class composition of the regions, which given their different industrial structures will differ quite a bit, contributes to an explanation of the fertility variations. Thus, female workforce participation, religious composition, social class composition and life-cycle related migration all go to make up a multivariate explanation of fertility patterns.

Policy, such as it is, on family planning is to maximise people's freedom of choice in the number and spacing of the children they have. Income supplementation for families with children (formerly through family allowances, currently through child benefit), although differentiating in a pro-natalist fashion between the first and subsequent children, has probably had little or no effect on

fertility. The measures have been enacted for welfare reasons, not in order to achieve particular population goals.

4.4 Reasons for mortality variation

Lawton (1973) and Coates and Rawstron (1971) suggest that the highest mortality rates are found in association with poor housing and urban environments and higher-than-average incidence of social and economic problems. The low rank for Scotland, Northern Ireland and the North West on the life expectancy maps supports this interpretation: these are the regions of poorest housing and worst urban environments (Glasgow, Belfast, Liverpool). In Scotland, in particular, there is the added problem of higher-than-average incidence of alcoholism. The poor environment influences the infant mortality rate in particular (see Coates and Rawstron, 1971, Figure 9.2), both amongst the regions and within them with the inner city areas suffering most. The influence of social class (correlated with quality of environment) on infant mortality, child mortality and adult mortality has been shown (Fox, 1977) to be quite marked, and thus if the regions differ in terms of occupations and industries (House, 1973, Figure 1.2) they will show variation in infant mortality. The South East, East Anglia, and the South West have much higher concentrations of workers in the lower mortality risk professional and managerial occupations, and the West Midlands and Northern regions a greater concentration in the higher mortality risk industrial occupations. Those industries themselves undoubtedly affect mortality incidence from respiratory disease through air pollution. Happily, the pollution from coalburning has been reduced in recent years through the operation of Smoke Control orders.

Public policy has an effect on the variation in mortality among regions through the very great per capita differences in National Health Service expenditure among the hospital regions, and in expenditure on general practice and the dental service (Coates and Rawstron, 1971, Chapters 7 and 8). These differences in public provision certainly account for part of the better than average life expectancy in the South East where there is a particular concentration of teaching hospitals, hospital beds, medical practioners and dentists,

(particularly those with higher qualifications). The Department of Health and Social Security has in the present Labour administration begun to redistribute financial resources among the hospital regions.

4.5 The factors influencing inter-regional migration

Of the 7 to 11 migrations that a person is likely to make in a lifetime only 1 to 2 (see Table 35 for the precise statistics) are likely to be between the regions, while 5 to 10 will be within the regions. Migrations between regions will be primarily those for job-related reasons whereas those within regions will be for residence related reasons (Harris and Clausen, 1966; Stillwell, 1978; Gleave and Hyman, 1978), although the correspondence is by no means perfect. Selected inter-regional migration streams (as was shown in Section 2.7) also involve migrants moving to retirement homes.

Local planning and housing policy will affect intra-regional migrations in the main, and this applies also to the planned migrations to the U.K.'s new towns. These new towns and agreed town expansion schemes (see Figure 19 in Department of the Environment, 1971) have as their purpose the decanting of industry and population from the crowded inner zones of the major metropolises (London, Birmingham, Liverpool, Newcastle and Glasgow) to the outer areas of the region. The only planned migrations that cross regional boundaries to any large extent are those into the East Midlands from the South East and Scotland (Corby and Northampton new towns; Daventry and Wellingborough town expansion schemes), into East Anglia from the South East (Peterborough new town; King's Lynn, Huntingdon, St. Neots, Mildenhall, Thetford, Bury St. Edmonds, Haverhill Ipswich and Sudbury-Melford town expansion schemes), and into Wales from the West Midlands (Newtown new town). Even in the South East to East Anglia case planned migrations are exceeded by voluntary moves, so that the direct effect of policy on inter-regional migration is small.

The influence of the gravity model variables - distance, size of originating population, and size of destination opportunities or some surrogate measure - have been extensively studied, as was mentioned in Section 2.3, together with variables such as unemployment rate and regional per capita income. The gravity model variables

account for 91 to 96 per cent of the variation in inter-county migration in Stillwell's (1977) study, leaving relatively little primary role for socio-economic indicators. However, these do play an important role in determining destination region opportunities and attractiveness (Weeden, 1973). The clearest link has been established, in fact, between net migration and employment change in the American situation (Lowry, 1966). In the British situation a similar relationship probably holds.

A regional policy concerning the distribution of manufacturing employment has existed since 1934 (McCrone, 1969). Through investment grants and loans, through tax incentives such as the Regional Employment Premium and Selective Employment Tax and through controls such as the Industrial Development Certificates limiting expansion in low unemployment regions, manufacturing employment has been redirected to various categories of assisted areas. Most assistance has gone to Northern Ireland, Scotland, the North and Wales. In the North West the Liverpool area has received most such redirected employment and the remote western districts of the South West have also benefited. The North West and Yorkshire and Humberside were included as Intermediate Areas only from 1971 (Figure 1.4 in House, 1973).

The national government has also acted to redistribute state controlled office employment to peripheral regions, to limit office development in Central London at various times and to encourage private office employment to move out of the metropolis (until very recently) through the Location of Offices Bureau although most of the shifts were to locations in the Outer South East.

The Figure 6 graphs of net migration trends suggest that perhaps regional policy has indeed since 1970 begun to have the desired effects. Those regions benefiting most from regional policy - Wales, Scotland and the North - certainly show much less net out-migration after 1970 than in the 1960s. Of course, Northern Ireland is an exception in that although the incentives for relocation of employment there were at a maximum, employees were reluctant to stay there or move there because of "the Troubles". After 1969 the net migration rate declined sharply. Conversely, the net migration rate for the South East has become more negative.

4.6 The factors influencing international migration

Of all demographic flows, international migration is the one most closely regulated by legislation and government action. The effect of such legislation is to set ceilings on the flows generated by the demand for labour in the destination country and the need for employment in the origin country.

Successive Immigration Acts (1962, 1968, 1973) have sought to limit the right of New Commonwealth citizens to migrate to the U.K. Very small quotas of work permits are now allowed, and the migration stream is principally one of dependents. There has as a consequence been a fall in the total number of immigrants since the early 1960s. The flows from other destinations (the Old Commonwealth, Foreign Countries) have, however, remained at their earlier levels (O.P.C.S., 1978c). One characteristic of immigration not commonly recognised is that the largest group by citizenship has always been U.K. citizens returning from sojourns abroad.

Similar legislative action has affected emigrants from the U.K. going to other countries - particularly Australia, New Zealand, Canada and the United States, and the 1970s saw reduced numbers compared with earlier years because of the greater restrictions imposed by those countries, worried by rising domestic unemployment (particularly after 1973).

Immigrants and emigrants have been very concentrated in their distribution within the U.K. with the South East being the destination of almost one half of the G.B. immigrants in 1975-76 and the origin of 40 per cent of the emigrants (Table 12). New Commonwealth immigrants tend to be concentrated in the inner areas of major metropolises and particularly in Greater London; other immigrants are more widely spread in the major cities and across the regions (see Coates and Rawstron, 1971, Chapter 6). The opportunities for employment in the service and industrial sectors in the jobs being vacated by the native population determined the metropolitan concentration of New Commonwealth immigrants. Once established concentrations have tended to persist, although there has been some dispersion as socio-economic improvement is achieved by immigrant families. Policy (on race relations, on discrimination and so on) has been reactive to the facts of distribution in this area rather than a determining factor.

5. Conclusion

A number of tentative conclusions, empirical, conceptual and technical, can be drawn from the analysis of the population dynamics of U.K. regions.

The dominant pattern across the regions in terms of fertility and mortality, whether measured by single region or multi-regional methods, was one of a gradient of demographic development from a low mortality, low fertility south and east to a high mortality, high fertility north and west. At the start of the 1960s this was also a gradient from conditions of net in-migration to those of heavy net outflows.

In the recent past fertility has declined steadily in all regions and life expectancy has improved uniformly but only marginally. Dramatic reductions in the projected populations of regions resulted from the necessity to adopt ever lower fertility scenarios. The pattern of migration has shifted in kind from one of "drift to the South East" from the northern and western regions to one of loss from the nation's core, the South East, gain to the margins of the core, the South West, East Anglia, East Midlands and Wales, and lesser losses in the northern, western and West Midlands regions. Some would see the shift in migration and population trends as the product of policy; others might view it as the natural course of decentralisation from the national metropolis.

Detailed examination of the age pattern of those migration streams revealed regularity of behaviour on a par with the more well known fertility and mortality curves, which would repay further model-based analysis. The crude measures fitted, however, did reveal that the age pattern of migration varied systematically with length of move, and that for inter-regional migration at least the relationship between parent and child migration was of a form different from that reported for other countries.

The feasibility of multi-regional population analysis with British population data was demonstrated through use of the set of models and computer programs developed by Andrei Rogers and his fellow workers at I.I.A.S.A. A first multi-regional life table was produced for British regions together with linked spatial

fertility expectancies and multi-regional migraproduction expectancies. Comparison of single region and multi-region life expectancy, net reproduction and migraproduction measures revealed that they were not alternative measures of the same concept, but related measures of different concepts. The single region measures applied to a regional population unchanged by the flux of migrants through the population over time; the multi-region measures applied to regional cohorts moving through time and space. Since these regional cohorts were assumed to adopt instantaneously the behaviour of their destination region, the multi-region measures were regressions of the single region measures towards the national mean. There is probably a strong case for relaxing this assumption to allow cohorts to carry some information about their birthplace with them on their travels, although empirical calibration of any relationships would be very difficult.

Multi-regional age-sex disaggregated population projections were carried out using the I.I.A.S.A. programs and compared with official single region projections and multi-regional all age and sex accounts based projections. Again feasibility with British data was demonstrated though a number of drawbacks, some technical, some empirical, still need to be overcome before official demographers in the U.K. are likely to contemplate a move to this superior methodology.

Finally, a rough attempt was made to speculate about the likely explanations for the regional demographic structure and dynamics described. Much has been learnt about "migration and settlement in the U.K.", but much has still to be discovered.

References

O.P.C.S. = Office of Population Censuses and Surveys

Bogue, D.J. (1969). The principles of demography. Wiley, New York.

Brass, W. (1977). Regional variations in fertility and child mortality during the demographic transition in England and Wales. In British Regional Populations. Papers presented at the Joint Meetings of the British Society for Population Studies and the Population Geography Study Group at the University of Liverpool, 21-23 Sept. 1977.

Champion, T. (1976). Evolving patterns of population distribution in England and Wales, 1951-71. Transactions, Institute of British Geographers, New Series, 1, Part 4.

Chilvers, C. (1978). Regional mortality 1969-73. Population Trends, 11, Spring 1978, 16-20.

Coates, D. and Rawstron, E.M. (1971). Regional variations in Britain. Batsford, London.

Compton, P. (1978). Fertility differentials and their impact on population distribution and composition in Northern Ireland. Environment and Planning A, forthcoming.

Craig, J. (1977). Population scale mapping. Population Trends, 8, Summer 1977, 18-19.

Department of the Environment (1971). Long term population distribution in Great Britain - a study. Report by an inter-departmental study group. H.M.S.O., London.

Drewett, J.R., Goddard, J.B., Spence, N. (1975). British cities: urban population and employment trends, 1951-71. Department of the Environment, London.

Eversley, D.E.C. (1971). Population changes and regional policies since the War. Regional Studies, 5, 221-228.

Fox, J. (1977). Occupational mortality 1970-72. Population Trends, 9, 8-15.

Friedlander, D. and Roshier, R.J. (1966). A study of internal migration in England and Wales. Population Studies, 20, 45-59.

Gardner, M. and Donnan, S. (1977). Life expectancy: variations among regional health authorities. Population Trends, 10, Winter 1977, 10-12.

Gleave, D. and Cordey-Hayes, M. (1977). Migration dynamics and labour market turnover. Progress in Planning, 8, Part 1.

Harris, A.I. and Clausen, R. (1966). Labour mobility in Great Britain, 1953-63. H.M.S.O., London.

Hart, R. (1970). A model of interregional migration in England and Wales. Regional Studies, 4, 279-296.

House, J.W. (1973). Regions and the system. In J.W. House (ed.) The U.K. space: resources, environment and the future. Weidenfeld and Nicolson, London.

Hyman, G. and Gleave, D. (1978). A reasonable theory of migration. Transactions of the Institute of British Geographers, New Series, Vol. 3, No. 2, 179-201.

Immigrant Statistics Unit, O.P.C.S. (1978). Marriage and birth patterns among the New Commonwealth and Pakistani population. Population Trends, 11, Spring 1978, 5-9.

Jenkins, J.C. and Rees, P.H. (1977). Computer programmes for aggregate accounts-based and associated forecasting models of population. Working Paper 205, School of Geography, University of Leeds.

Jones, H. (1975). Spatial analysis of human fertility in Scotland. Scottish Geographical Magazine, 91, 102-113.

Joseph, G. (1974). Interregional population distribution and growth in Britain - a projection exercise. Scottish Journal of Political Economy, 21, 159-170.

Joseph, G. (1975). A Markov analysis of age/sex differences in inter-regional migration in Great Britain. Regional Studies, 9, 69-78.

Keyfitz, N. (1968). Introduction to the mathematics of population. Addison-Wesley, Reading, Massachusetts.

Keyfitz, N. and Flieger, W. (1971). Population: facts and methods of demography. Freeman, San Francisco.

King, J.R. (1974). Immigrant fertility trends and population growth in Leeds. Environment and Planning A, 6, 509-546.

Lawton, R. (1973). People and work. In J.W. House (ed.) The U.K. space: resources, environment and the future. Weidenfeld and Nicolson, London.

Lawton, R. (1977). Regional population trends in England and Wales in the 19th and 20th centuries. In British Regional Populations. Papers presented at the Joint Meetings of the British Society for Population Studies and the Population Geography Study Group at the University of Liverpool, 21-23 Sept. 1977.

Ledent, J. (1978). Some methodological and empirical considerations in the construction of increment-decrement life tables. Research Memorandum, RM-78-25, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Long, L.H. (1975). Trends in return migration to the South. Demography, 12, 601-614.

Long, L.H. and Boertlein, C.G. (1975). The geographical mobility of Americans: an international comparison. Current Population Reports, Special Studies, Series P-23, No. 64, Bureau of the Census, U.S. Department of Commerce.

Lowry, I.S. (1966). Migration and metropolitan growth: two analytical models. Chandler, San Francisco.

Masser, I. (1970). A test of some models for predicting inter-metropolitan movement of population in England and Wales. University Working Paper 9, Centre for Environmental Studies, London.

McCrone, G. (1969). Regional policy in Britain. George Allen and Unwin, London.

O.P.C.S. (1967). The Registrar General's Statistical Review of England and Wales for 1965. Part II. Tables, Population. H.M.S.O., London.

O.P.C.S. (1972a). The Registrar General's Statistical Review of England and Wales for 1970. Part I. Tables, Medical. H.M.S.O., London.

O.P.C.S. (1972b). The Registrar General's Statistical Review of England and Wales for 1970. Part II. Tables, Population. H.M.S.O., London.

O.P.C.S. (1973). General household survey. H.M.S.O., London.

O.P.C.S. (1974a). The Registrar General's Statistical Review of England and Wales for 1972. Part II. Tables, Population. H.M.S.O., London.

O.P.C.S. (1974b). Census 1971. Great Britain. Migration Tables. Part I (10% Sample). H.M.S.O., London.

O.P.C.S. (1975). Migration Regional Reports. H.M.S.O., London.

O.P.C.S. (1977a). Population Trends 8. H.M.S.O., London.

O.P.C.S. (1977b). Birth statistics, 1974. England and Wales. Series FM1. No. 1. H.M.S.O., London.

O.P.C.S. (1977c). Mortality statistics: area. 1975. Series DH5. No. 2. H.M.S.O., London.

O.P.C.S. (1977d). Population projections: area. 1974-1991. England. Series PP3. No. 1. H.M.S.O., London.

O.P.C.S. (1977e). Table DT4312. Migrants within one year preceding census by area of former usual residence by area of usual residence at census by sex by age. O.P.C.S., Titchfield, Hants.

O.P.C.S. (1978a). Birth statistics, 1975. England and Wales. Series FM1. No. 2. H.M.S.O., London.

O.P.C.S. (1978b). Mortality statistics. 1975. England and Wales. Series DH1. No. 2. H.M.S.O., London.

O.P.C.S. (1978c). International migration. 1975. United Kingdom. England and Wales. Series MN. No. 2. H.M.S.O., London.

O.P.C.S. (1978d). Population projections. 1976-2016. Series PP2. No. 8. H.M.S.O., London.

Pearce, D. and Britton, M. (1977). The decline in births: some socio-economic aspects. Population Trends, 7, Spring 1977.

Pittenger, D. (1978). On making flexible projections of age-specific net migration. Environment and Planning A, forthcoming.

Plessis-Fraissard, M. (1977). Age, duree de sejour et probabilite de migrer. In Centre National de Recherche Scientifique, Ve Collogue National de Demographie, No. 934. L'analyse demographique et ses applications. Pp. 193-211. Editions du Centre National de la Recherche Scientifique, Paris.

Ravenstein, E.G. (1885). The laws of migration. Journal of the Royal Statistical Society 48, 167-235.

Rees, P.H. (1976). Modelling the regional system: the population component. Working Paper 148, School of Geography, University of Leeds. To be published in the Revue de Geographie de Lyons.

Rees, P.H. (1977a). The future population of East Anglia and its constituent counties (Cambridge, Norfolk and Suffolk). A report prepared for the East Anglian Economic Planning Council by the University of Leeds Industrial Services Ltd. under Department of the Environment Contract number DGR/461/23.

Rees, P.H. (1977b). The measurement of migration from census data and other sources. Environment and Planning A, 9, 247-272.

Rees, P.H. (1978a). Increment-decrement life tables: some further comments from a demographic-accounting point of view. Environment and Planning A, 10, 705-726.

Rees, P.H. (1978b). Spatial demographic growth in British regions. Final report on S.S.R.C. project HR/2904, in preparation.

Rees, P.H. and Wilson, A.G. (1977). Spatial population analysis. Edward Arnold, London.

Registrar General, Scotland (1971a). Annual report of the Registrar General for Scotland 1970. Part I - Mortality Statistics. H.M.S.O., Edinburgh.

Registrar General, Scotland (1971b). Annual report of the Registrar General for Scotland 1970. Part II - Population and Vital Statistics. H.M.S.O., Edinburgh.

Rogers, A. (1968). Matrix analysis of inter-regional population growth and distribution. University of California Press, Berkeley and Los Angeles.

Rogers, A. (1971). Matrix methods in urban and regional analysis. Holden-Day, San Francisco.

Rogers, A. (1975). Introduction to multiregional mathematical demography. Wiley, New York.

Rogers, A. (1976a). The comparative migration and settlement study: a summary of workshop proceedings and conclusions. Research Memorandum, RM-76-01. International Institute for Applied Systems Analysis, Austria.

Rogers, A. (1976b). Shrinking large scale population projection models. Environment and Planning A, 8, 515-541.

Rogers, A. and Castro, L.J. (1976). Model multiregional life tables and stable populations. Research Report RR-76-09. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Rogers, A. and Ledent, J. (1976a). Increment-decrement life tables: a comment. Demography, 13, 287-290.

Rogers, A. and Ledent, J. (1976b). Multiregional population projection. In J. Cea (ed.) Optimization techniques: modelling and optimization in the service of man. Springer Verlag, Berlin.

Rogers, A. and Ledent, J. (1977). Increment-decrement life tables: rejoinder. Demography, 14, 593.

Rogers, A., Racquillet, R. and Castro, L.J. (1977). Model migration schedules and their applications. Research Memorandum, RM-77-57. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Rogers, A. and Willekens, F. (1976a). Spatial population dynamics. Papers, Regional Science Association, 36, 3-34.

Rogers, A. and Willekens, F. (1976b). Spatial zero population growth. Research Memorandum, RM-76-25. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Rogers, A. and Willekens, F. (1976c). The spatial reproductive value and the spatial momentum of zero population growth. Research Memorandum, RM-76-81, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Schoen, R. (1975). Constructing increment-decrement life tables. Demography, 12, 313-324.

Schoen, R. (1977). Increment-decrement life tables: further reactions to Rogers' and Ledent's comment. Demography, 14, 591-592.

Simons, J. (1977). An interpretation of recent fertility trends in England and Wales. In British Regional Populations. Papers presented at the Joint Meetings of the British Society for Population Studies and the Population Geography Study Group at the University of Liverpool, 21-23 Sept. 1977.

Stillwell, J.C.H. (1975). Models of inter-regional migration: a review. Working Paper 100, School of Geography, University of Leeds.

Stillwell, J.C.H. (1977a). Some historical tests of spatial interaction models for inter-area migration. Part I - Inter-county models. Working Paper 185, School of Geography, University of Leeds.

Stillwell, J.C.H. (1977b). Some historical tests of spatial interaction models for inter-area migration. Part II - Inter-region migration. Working Paper 199, School of Geography, University of Leeds.

Stillwell, J.C.H. (1978). Interzonal migration: some historical tests of spatial interaction models. Environment and Planning A, forthcoming.

Weeden, R. (1973). Inter-regional migration models and their application to Great Britain. National Institute of Economic and Social Research. Paper II. Cambridge University Press, Cambridge.

Willekens, F. (1977). The recovery of detailed migration patterns from aggregate data: an entropy maximizing approach. Research Memorandum, RM-77-58. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Willekens, F. (1978). The comparative migration and settlement study: background paper for the 1978 September conference. Working Paper, WP-78-10. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Willekens, F. and Rogers, A. (1976). Computer programs for spatial demographic analysis. Research Memorandum, RM-76-58. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Willekens, F. and Rogers, A. (1977). More computer programs for spatial demographic analysis. Research Memorandum, RM-77-30. International Institute for Applied Systems Analysis, Laxenburg, Austria.

APPENDIX 1. Components of population change, U.K. regions, 1965-76: stocks and flows in 1000s

Period	Final Population	Initial Population	Population Change	Births	Deaths	Natural Increase	Net Migration
	NORTH						
65-66	3125	3126	-1	56.2	38.3	17.9	-18.9
66-67	3130	3125	5	54.6	37.1	17.5	-12.5
67-68	3133	3130	3	53.1	37.0	16.0	-13.0
68-69	3132	3133	-1	50.8	38.7	12.2	-13.2
69-70	3134	3132	2	49.6	38.8	10.9	-8.9
70-71	3137.4	3134	3.4	49.9	38.0	11.9	-8.5
71-72	3137.8	3137.4	0.4	47.7	38.7	9.0	-8.6
72-73	3132.3	3137.8	-5.5	43.6	39.8	3.8	-9.3
73-74	3128.7	3132.3	-3.6	40.8	39.4	1.4	-5.0
74-75	3124.7	3128.7	-4.0	38.9	38.7	0.2	-4.2
75-76	3121.6	3124.7	-2.6	37.4	39.4	-2.0	-0.6
	YORKSHIRE AND HUMBERSIDE						
65-66	4809	4790	19	85.5	58.2	27.3	-8.3
66-67	4829	4809	20	84.8	57.6	27.2	-7.2
67-68	4847	4829	18	84.3	57.7	26.6	-8.6
68-69	4852	4847	5	83.2	59.8	23.4	-18.4
69-70	4853	4852	1	82.6	59.8	22.8	-21.8
70-71	4868.0	4853	15.0	82.1	59.1	23.0	-8.0
71-72	4882.1	4868.0	14.1	77.7	60.5	17.3	-3.2
72-73	4890.8	4882.1	8.7	71.1	61.2	9.9	-1.2
73-74	4897.4	4890.8	6.6	65.8	59.9	5.9	-0.7
74-75	4899.8	4897.4	2.4	61.8	59.4	2.4	-0.0
75-76	4891.9	4899.8	-7.9	59.1	59.9	-0.8	-6.6
	NORTH WEST						
65-66	6539	6519	20	118.7	82.4	36.4	-16.3
66-67	6561	6539	22	116.7	82.5	34.2	-12.2
67-68	6568	6561	7	114.9	82.2	32.7	-25.7
68-69	6579	6568	11	112.5	83.7	28.8	-17.8
69-70	6589	6579	10	110.5	84.5	26.1	-16.1
70-71	6602.3	6589	13.3	109.6	83.4	26.2	-12.9
71-72	6607.3	6602.3	5.0	104.5	84.0	20.5	-15.5
72-73	6609.2	6607.3	1.9	95.7	84.7	11.0	-9.1
73-74	6592.9	6609.2	-16.3	89.1	84.3	4.8	-21.1
74-75	6574.7	6592.9	-18.2	84.4	83.8	0.6	-18.8
75-76	6553.4	6574.7	-21.3	80.7	81.1	-0.5	-20.2

APPENDIX 1 (Continued)

Period	Final Population	Initial Population	Population Change	Births	Deaths	Natural Increase	Net Migration
	EAST MIDLANDS						
65-66	3497	3468	29	64.3	39.0	25.2	3.8
66-67	3529	3497	32	63.4	38.4	25.0	7.0
67-68	3557	3529	28	62.9	38.9	24.0	4.0
68-69	3587	3557	30	62.2	40.8	21.3	8.7
69-70	3606	3587	19	60.7	41.0	19.7	-0.7
70-71	3634.6	3606	28.6	60.4	40.5	19.9	8.7
71-72	3663.1	3634.6	28.5	58.5	41.2	17.3	11.2
72-73	3696.0	3663.1	32.9	54.8	41.9	12.9	20.0
73-74	3714.7	3696.0	18.7	51.6	42.1	9.6	9.1
74-75	3728.0	3714.7	13.3	48.5	42.3	6.2	7.1
75-76	3734.5	3728.0	6.5	46.3	41.6	4.7	0.7
	WEST MIDLANDS						
65-66	4946	4910	36	94.7	52.5	42.2	-6.2
66-67	4984	4946	38	94.2	52.0	42.2	-4.2
67-68	5022	4984	38	93.6	52.6	40.9	-2.9
68-69	5066	5022	44	92.1	54.8	37.3	6.7
69-70	5094	5066	28	90.2	54.9	35.3	-7.3
70-71	5121.5	5094	27.5	88.8	53.9	34.8	-7.3
71-72	5152.1	5121.5	30.6	84.5	55.0	29.5	1.1
72-73	5163.2	5152.1	11.1	77.8	56.3	21.5	-10.4
73-74	5179.4	5163.2	16.2	72.4	56.0	16.4	-0.2
74-75	5175.9	5179.4	-3.5	67.7	55.6	12.1	-15.6
75-76	5164.5	5175.9	-11.4	64.4	58.2	6.2	-17.0
	EAST ANGLIA						
65-66	1575	1553	22	26.7	17.8	8.8	13.2
66-67	1602	1575	27	26.7	17.6	9.0	18.0
67-68	1626	1602	24	27.0	18.5	8.4	15.6
68-69	1645	1626	19	26.6	19.1	7.5	11.5
69-70	1663	1645	18	26.1	18.9	7.2	10.8
70-71	1686	1663	23.0	26.4	18.9	7.4	15.6
71-72	1710.7	1686	24.7	26.2	19.4	6.8	17.9
72-73	1739.0	1710.7	28.3	25.4	20.0	5.5	22.8
73-74	1758.2	1739.0	19.2	24.5	19.9	4.5	14.7
74-75	1781.4	1758.2	23.2	23.2	20.0	3.2	20.0
75-76	1802.7	1781.4	21.3	22.2	20.5	1.7	20.0

APPENDIX 1 (Continued)

Period	Final Population	Initial Population	Population Change	Births	Deaths	Natural Increase	Net Migration
	SOUTH EAST						
65-66	16719	16609	110	298.4	187.0	111.3	-1.3
66-67	16820	16719	101	291.6	186.0	105.6	-4.6
67-68	16895	16820	75	283.2	190.7	92.5	-17.5
68-69	16943	16895	48	274.7	195.6	79.1	-31.1
69-70	16965	16943	22	266.3	193.5	72.8	-50.8
70-71	16993.3	16965	28.3	262.3	191.6	70.7	-42.4
71-72	17020.4	16993.3	27.1	252.6	193.5	59.1	-32.0
72-73	17018.5	17020.4	-1.9	235.3	195.5	39.9	-41.8
73-74	16966.5	17018.5	-5.2	221.8	193.8	28.0	-80.0
74-75	16921.2	16966.5	-45.3	210.9	193.0	17.9	-63.2
75-76	16893.7	16921.2	-27.5	202.0	199.6	2.5	-30.1
	SOUTH WEST						
65-66	3920	3879	41	66.3	47.7	18.7	22.3
66-67	3957	3920	37	64.7	47.5	17.3	19.7
67-68	3992	3957	35	63.2	48.5	14.6	20.4
68-69	4025	3992	33	62.4	50.2	12.2	20.8
69-70	4059	4025	34	61.7	50.4	11.3	22.7
70-71	4087.7	4059	28.7	61.4	50.7	10.7	18.0
71-72	4130.2	4087.7	42.5	59.9	51.6	8.3	34.2
72-73	4176.3	4130.2	46.1	57.0	52.7	4.2	41.9
73-74	4206.2	4176.3	29.9	53.8	53.4	0.4	29.5
74-75	4229.4	4206.3	23.2	50.1	53.8	-3.7	26.9
75-76	4256.4	4229.4	27.0	47.5	55.1	-7.6	32.1
	WALES						
65-66	2693.8	2686.3	7.5	45.6	33.9	11.7	-4.2
66-67	2701.2	2693.8	7.4	44.3	33.9	10.4	-3.0
67-68	2706.2	2701.2	5.0	44.0	34.1	9.9	-4.9
68-69	2711.4	2706.2	5.2	43.6	35.5	8.2	-3.0
69-70	2717.0	2711.4	5.6	42.8	35.5	7.3	-1.7
70-71	2723.6	2717.0	6.6	42.8	34.9	8.0	-1.4
71-72	2734.6	2723.6	11.0	41.5	35.4	6.1	4.9
72-73	2749.3	2734.6	14.7	38.8	35.9	2.9	11.8
73-74	2757.2	2749.3	7.9	36.9	35.7	1.2	6.7
74-75	2764.3	2757.2	7.1	35.1	35.6	-0.5	7.6
75-76	2766.1	2764.3	1.8	34.4	36.0	-1.6	4.1

APPENDIX 1 (Continued)

Period	Final Population	Initial Population	Population Change	Births	Deaths	Natural Increase	Net Migration
	SCOTLAND						
65-66	5200.6	5209.9	-9.3	97,5	63.3	35.2	-44.5
66-67	5198.3	5200.6	-2.3	98.1	61.5	34.8	-37.1
67-68	5200.2	5198.3	1.9	94.9	61.5	34.0	-32.1
68-69	5208.5	5200.2	6.3	92.9	63.6	28.9	-20.6
69-70	5213.7	5208.5	5.2	87.9	63.7	25.1	-19.9
70-71	5217.4	5213.7	3.7	87.0	62.6	24.4	-20.7
71-72	5210.4	5217.4	-7.0	82.5	63.4	19.2	-26.2
72-73	5211.7	5210.4	1.3	76.4	64.7	11.7	-10.4
73-74	5216.6	5211.7	4.9	72.2	64.6	7.6	-2.7
74-75	5206.2	5216.6	-10.4	69.0	63.8	5.1	-15.5
75-76	5205.1	5206.2	-1.1	67.4	64.0	3.4	-4.5
	NORTHERN IRELAND						
65-66	1475.6	1468.2	7.4	34	16	18	-10.6
66-67	1488.8	1475.6	13.2	34	15	19	-5.8
67-68	1502.6	1488.8	13.8	33	15	18	-4.2
68-69	1514.1	1502.6	11.5	33	16	17	-5.5
69-70	1527.4	1514.1	13.3	32	17	15	-1.7
70-71	1537.8	1527.4	10.4	33	16	17	-6.6
71-72	1544.7	1537.8	6.9	30.7	16.8	13.9	-7.0
72-73	1547.1	15 4.7	2.4	29.5	17.6	11.9	-9.5
73-74	1546.8	1547.1	-0.3	28.2	17.1	11.1	-11.4
74-75	1537.2	1546.8	-9.6	26.4	17.1	9.3	-18.9
75-76	1538.1	1537.2	0.9	26.4	16.8	9.6	-8.7
	UNITED KINGDOM						
65-66	54500.0	54218.4	281.6	987	648	339	-57.4
66-67	54800.3	54500.0	300.3	982	609	373	-72.7
67-68	55049.0	54800.3	248.7	948	658	289	-40.3
68-69	55263.0	55049.0	214.0	943	646	296	-82.0
69-70	55421.1	55263.0	158.1	899	667	232	-73.9
70-71	55609.6	55421.1	188.5	915	639	276	-87.5
71-72	55793.4	55609.6	183.8	862.3	660.8	201.5	-17.7
72-73	55933.4	55793.4	140.0	807.6	671.9	135.8	4.2
73-74	55964.6	55933.4	31.2	751.7	664.0	87.7	-56.5
74-75	55942.8	55964.6	-21.8	720.7	671.1	49.6	-71.4
75-76	55928.0	55942.8	-14.8	688.6	681.0	7.6	-22.4

APPENDIX 1 (Continued)

Period	Final Population	Initial Population	Population Change	Births	Deaths	Natural Increase	Net Migration
	ENGLAND AND WALES						
65-66	47823.6	47540.3	283.3	856	567	289	-5.7
66-67	48113.2	47823.6	289.6	850	534	316	-26.4
67-68	48346.2	48113.2	233.0	820	580	240	-7.0
68-69	48540.4	48346.2	194.2	817	568	249	-54.8
69-70	48680.0	48540.4	139.6	779	586	193	-56.4
70-71	48854.4	48680.0	174.4	795	562	233	-58.6
71-72	49038.3	48854.4	183.9	748.6	579.9	168.8	15.1
72-73	49174.6	49038.3	136.3	701.8	590.4	111.4	24.9
73-74	49201.2	49174.6	26.6	652.5	582.7	69.8	-43.2
74-75	49199.4	49201.2	-1.8	625.0	589.2	35.8	-37.6
75-76	49184.8	49199.4	-14.6	594.6	599.3	-4.7	-9.9
	GREAT BRITAIN						
65-66	53024.4	52750.2	274.2	953.9	620.0	334.8	-60.6
66-67	53311.5	53024.4	287.1	939.1	614.0	323.3	-36.2
67-68	53546.4	53311.5	234.9	921.1	621.8	299.6	-64.7
68-69	53748.9	53546.4	202.5	901.0	641.7	259.0	-56.5
69-70	53893.7	53748.9	144.8	878.4	641.0	238.4	-93.6
70-71	54071.8	53893.7	178.1	870.6	633.7	237.0	-58.9
71-72	54248.7	54071.8	176.9	835.7	642.7	193.0	-16.1
72-73	54386.3	54248.7	137.6	775.9	652.6	123.3	14.3
73-74	54417.8	54386.3	31.5	728.9	649.2	79.8	-48.3
74-75	54405.6	54417.8	-12.2	689.5	646.0	43.5	-55.7
75-76	54389.9	54405.6	-15.7	661.4	655.3	6.1	-22.2
	GREATER LONDON						
65-66	7810	7857	-47	141.6	87.4	54.2	-101.2
66-67	7761	7810	-49	136.0	86.0	50.0	-99.0
67-68	7693	7761	-68	129.7	87.2	42.5	-110.5
68-69	7619	7693	-74	123.5	88.4	35.1	-109.1
69-70	7530	7619	-89	117.5	86.5	31.0	-120.0
70-71	7441.3	7530	-88.7	114.5	85.5	29.0	-117.7
71-72	7344.8	7441.3	-96.5	108.2	85.8	22.4	-119.9
72-73	7281.1	7344.8	-63.7	99.1	85.2	13.9	-77.6
73-74	7173.9	7281.1	-107.2	92.7	83.8	8.8	-116.0
74-75	7102.8	7173.9	-71.1	88.1	83.6	4.5	-75.6
75-76	7027.6	7102.8	-75.2	84.2	86.2	-1.9	-73.3

APPENDIX 1 (Continued)

Period	Final Population	Initial Population	Population Change	Births	Deaths	Natural Increase	Net Migration
	REST OF THE SOUTH EAST						
65-66	8909	8752	157	156.7	99.6	57.1	99.9
66-67	9059	8909	150	155.6	100.0	55.6	94.4
67-68	9202	9059	143	153.5	103.5	50.0	93.0
68-69	9324	9202	122	151.2	107.2	44.1	77.9
69-70	9435	9324	111	148.9	107.0	41.8	69.2
70-71	9552	9435	117	147.8	106.1	41.8	75.2
71-72	9675.6	9552	123.6	144.5	107.7	36.7	86.9
72-73	9737.4	9675.6	61.8	136.2	110.3	25.9	35.9
73-74	9792.6	9737.4	55.2	129.1	109.9	19.2	36.0
74-75	9818.4	9792.6	25.8	122.7	109.4	13.4	12.4
75-76	9866.1	9818.4	47.7	117.8	113.4	4.4	43.3

Notes

1. Definitions

Regions: "new" regions (post 1.4.74) as defined in Figure 1.3.
Periods: July 1st in year to June 30th in the next year.
Final population: home population estimate as of June 30th of next year.
Initial population: home population estimate of June 30th of year.
Net migration: population change less natural increase.

2. Sources

Population, births and deaths figures given in O.P.C.S. Population Trends with some estimates made of missing data from "old" region data.

APPENDIX 2. Components of population change, U.K. regions, 1965-76, rates per 1000 population

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	NORTH				
65-66	-0.32	17.98	12.24	5.74	-6.06
66-67	1.60	17.47	11.87	5.60	-4.00
67-68	0.96	16.95	11.83	5.12	-4.16
68-69	-0.32	16.22	12.34	3.89	-4.20
69-70	0.64	15.85	12.38	3.47	-2.83
70-71	1.08	15.92	12.12	3.80	-2.72
71-72	0.13	15.21	12.34	2.88	-2.75
72-73	-1.75	13.91	12.68	1.23	-2.98
73-74	-1.15	13.03	12.59	0.44	-1.59
74-75	-1.28	12.42	12.36	0.06	-1.34
75-76	-0.83	11.96	12.61	-0.65	-0.18
	NORTH WEST				
65-66	3.07	18.21	12.64	5.57	-2.51
66-67	3.36	17.85	12.61	5.24	-1.87
67-68	1.07	17.52	12.53	4.98	-3.91
68-69	1.67	17.13	12.74	4.39	-2.71
69-70	1.52	16.80	12.84	3.96	-2.44
70-71	2.02	16.63	12.66	3.97	-1.95
71-72	0.76	15.83	12.72	3.11	-2.35
72-73	0.29	14.48	12.81	1.66	-1.38
73-74	-2.47	13.48	12.75	0.73	-3.19
74-75	-2.76	12.80	12.71	0.09	-2.85
75-76	-3.15	12.27	12.34	-0.07	-3.08

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	YORKSHIRE AND HUMBERSIDE				
65-66	3.97	17.85	12.15	5.70	-1.73
66-67	4.16	17.63	11.97	5.66	-1.50
67-68	3.73	17.46	11.95	5.51	-1.78
68-69	1.03	17.18	12.34	4.83	-3.80
69-70	0.21	17.03	12.33	4.70	-4.49
70-71	3.09	16.91	12.18	4.74	-1.65
71-72	2.90	15.97	12.42	3.55	-0.65
72-73	1.78	14.55	12.53	2.03	-0.24
73-74	1.35	13.46	12.25	1.21	0.14
74-75	0.49	12.63	12.13	0.50	-0.01
75-76	-1.51	12.06	12.22	-0.16	-1.35
	EAST MIDLANDS				
65-66	8.36	18.53	11.25	7.28	1.09
66-67	9.15	18.14	10.98	7.16	1.99
67-68	7.93	17.82	11.01	6.81	1.13
68-69	8.43	17.48	11.48	6.00	2.44
69-70	5.30	16.91	11.43	5.48	-0.19
70-71	7.93	16.75	11.24	5.51	2.42
71-72	7.84	16.10	11.35	4.76	3.09
72-73	8.98	14.96	11.43	3.53	5.46
73-74	5.06	13.97	11.38	2.59	2.47
74-75	3.58	13.06	11.40	1.66	1.92
75-76	1.45	12.43	11.17	1.26	0.19

APPENDIX 2 (Continued).

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	WEST MIDLANDS				
65-66	7.33	19.29	10.70	8.59	-1.26
66-67	7.68	19.04	10.52	8.53	-0.85
67-68	7.62	18.77	10.56	8.21	-0.59
68-69	8.76	18.34	10.91	7.43	1.34
69-70	5.53	17.81	10.83	6.97	-1.45
70-71	5.40	17.43	10.59	6.84	-1.44
71-72	5.97	16.50	10.73	5.76	0.21
72-73	2.15	15.10	10.94	4.17	-2.01
73-74	3.14	14.03	10.85	3.17	-0.04
74-75	-0.68	13.08	10.74	2.33	-3.01
75-76	-2.09	12.45	11.24	1.21	-3.29
	SOUTH EAST				
65-66	6.62	17.96	11.26	6.70	-0.08
66-67	6.04	17.44	11.12	6.32	-0.27
67-68	4.46	16.84	11.34	5.50	-1.04
68-69	2.84	16.26	11.58	4.68	-1.84
69-70	1.30	15.72	11.42	4.30	-3.00
70-71	1.67	15.46	11.29	4.17	-2.50
71-72	1.59	14.87	11.39	3.48	-1.88
72-73	-0.11	13.83	11.48	2.34	-2.45
73-74	-3.06	13.03	11.38	1.65	-4.70
74-75	-2.67	12.43	11.37	1.06	-3.73
75-76	-1.63	11.94	11.79	0.15	-1.78

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	EAST ANGLIA				
65-66	14.17	17.17	11.49	5.68	8.49
66-67	17.14	16.93	11.19	5.74	11.40
67-68	14.98	16.83	11.56	5.27	9.71
68-69	11.69	16.35	11.74	4.61	7.07
69-70	10.94	15.89	11.49	4.40	6.54
70-71	13.83	15.85	11.39	4.45	9.38
71-72	14.65	15.53	11.49	4.04	10.61
72-73	16.54	14.87	11.67	3.21	13.34
73-74	11.04	14.08	11.47	2.61	8.43
74-75	13.20	13.18	11.38	1.80	11.39
75-76	12.18	12.48	11.51	0.97	11.21
	SOUTH WEST				
65-66	10.57	17.10	12.29	4.81	5.76
66-67	9.44	16.51	12.11	4.41	5.03
67-68	8.85	15.96	12.26	3.69	5.15
68-69	8.27	15.64	12.58	3.06	5.20
69-70	8.45	15.34	12.53	2.81	5.64
70-71	7.07	15.14	12.50	2.64	4.44
71-72	10.40	14.65	12.63	2.02	8.38
72-73	11.16	13.79	12.76	1.03	10.13
73-74	7.16	12.89	12.79	0.10	7.06
74-75	5.52	11.91	12.79	-0.88	6.40
75-76	5.79	11.23	13.02	-1.79	7.58

APPENDIX 2 (Continued).

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	WALES				
65-66	2.79	16.96	12.62	4.34	-1.55
66-67	2.75	16.43	12.57	3.86	-1.11
67-68	1.85	16.27	12.61	3.66	-1.81
68-69	1.92	16.13	13.11	3.03	-1.11
69-70	2.07	15.78	13.08	2.69	-0.63
70-71	2.43	15.75	12.80	2.95	-0.52
71-72	4.04	15.24	13.01	2.23	1.81
72-73	5.38	14.17	13.13	1.05	4.33
73-74	2.87	13.41	12.98	0.43	2.44
74-75	2.58	12.72	12.91	-0.19	2.77
75-76	0.90	12.44	13.01	-0.57	1.47
	NORTHERN IRELAND				
65-66	5.04	23.16	10.90	12.26	-7.22
66-67	8.95	23.04	10.17	12.88	-3.93
67-68	9.27	22.17	10.08	12.09	-2.82
68-69	7.65	21.96	10.65	11.31	-3.66
69-70	8.78	21.13	11.23	9.91	-1.12
70-71	6.81	21.61	10.48	11.13	-4.32
71-72	4.49	19.96	10.92	9.04	-4.55
72-73	1.55	19.10	11.39	7.70	-6.15
73-74	-0.19	18.23	11.05	7.17	-7.37
74-75	-6.21	17.07	11.06	6.01	-12.22
75-76	0.59	17.17	10.93	6.25	-5.66

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	SCOTLAND				
65-66	-1.79	18.91	12.15	6.76	-8.55
66-67	-0.44	18.53	11.83	6.70	-7.14
67-68	0.37	18.37	11.83	6.53	-6.17
68-69	1.60	17.78	12.23	5.55	-3.96
69-70	1.00	17.04	12.23	4.81	-3.81
70-71	0.71	16.68	12.00	4.68	-3.97
71-72	-1.34	15.82	12.15	3.67	-5.01
72-73	0.25	14.67	12.42	2.24	-1.99
73-74	0.94	13.85	12.40	1.45	-0.51
74-75	-1.99	13.22	12.23	0.99	-2.98
75-76	-0.21	12.94	12.29	0.65	-0.86
	UNITED KINGDOM				
65-66	5.19	18.20	11.95	6.25	-0.11
66-67	5.51	18.02	11.17	6.84	-1.33
67-68	4.54	17.30	12.01	5.27	-0.74
68-69	3.89	17.13	11.73	5.38	-1.49
69-70	2.86	16.27	12.07	4.20	-1.34
70-71	3.40	16.51	11.53	4.98	-1.58
71-72	3.31	15.51	11.89	3.62	-0.32
72-73	2.51	14.47	12.04	2.43	0.08
73-74	0.56	13.44	11.87	1.57	-1.01
74-75	-0.38	12.88	11.99	0.89	-1.28
75-76	-0.26	12.31	12.17	0.14	-0.40

APPENDIX 2 (Continued)

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	ENGLAND AND WALES				
65-66	5.96	18.01	11.93	6.08	-0.12
66-67	6.06	17.77	11.17	6.61	-0.55
67-68	4.84	17.04	12.05	4.99	-0.15
68-69	4.02	16.90	11.75	5.15	-1.13
69-70	2.88	16.05	12.07	3.98	-1.16
70-71	3.58	16.33	11.54	4.79	-1.20
71-72	3.76	15.32	11.87	3.46	0.71
72-73	2.78	14.31	12.04	2.27	0.51
73-74	0.54	13.27	11.85	1.42	-0.88
74-75	-0.04	12.70	11.98	0.73	-0.76
75-76	-0.30	12.09	12.18	-0.10	-0.20
	GREATER LONDON				
65-66	-5.98	18.03	11.13	6.90	-12.88
66-67	-6.27	17.41	11.01	6.40	-12.67
67-68	-8.84	16.85	11.33	5.52	-14.36
68-69	-9.71	16.21	11.60	4.60	-14.32
69-70	-11.82	15.60	11.48	4.12	-15.94
70-71	-11.92	15.39	11.49	3.89	-15.81
71-72	-13.14	14.73	11.68	3.05	-16.18
72-73	-8.75	13.61	11.70	1.91	-10.66
73-74	-14.72	12.73	11.52	1.21	-15.94
74-75	-9.91	12.28	11.65	0.63	-10.54
75-76	-10.59	11.86	12.13	-0.27	-10.32

Period	Population Change Rate	Birth Rate	Death Rate	Natural Increase Rate	Net Migration Rate
	GREAT BRITAIN				
65-66	5.20	18.10	11.75	6.35	-1.15
66-67	5.41	17.68	11.58	6.10	-0.68
67-68	4.41	17.28	11.66	5.62	-1.21
68-69	3.78	16.82	11.98	4.84	-1.05
69-70	2.69	16.36	11.93	4.44	-1.74
70-71	3.30	16.15	11.76	4.40	-1.09
71-72	3.27	15.46	11.89	3.57	-0.30
72-73	2.54	14.30	12.03	2.27	0.26
73-74	0.58	13.40	11.94	1.47	-0.89
74-75	-0.22	12.67	11.87	0.80	-1.02
75-76	-0.30	12.16	12.05	0.11	-0.41
	REST OF THE SOUTH EAST				
65-66	17.94	17.91	11.38	6.53	11.41
66-67	16.84	17.47	11.22	6.24	10.59
67-68	15.79	16.94	11.43	5.52	10.27
68-69	13.26	16.43	11.65	4.79	8.47
69-70	11.90	15.96	11.48	4.48	7.42
70-71	12.40	15.67	11.24	4.43	7.97
71-72	12.94	15.12	11.28	3.84	9.10
72-73	6.39	14.08	11.40	2.68	3.71
73-74	5.67	13.26	11.29	1.97	3.70
74-75	2.64	12.57	11.20	1.37	1.27
75-76	4.86	12.00	11.55	0.45	4.41

Notes

1. Definitions: all rates are defined as the flow term from Appendix 1 divided by the initial population.
2. Sources: Appendix 1.