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Migration data from the National Health Service Central Register and the 1981 Census: further comparative analysis

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Abstract

Two sources provide data on internal migration within the United Kingdom. The Census provides spatially detailed information on migrants (transitions) over the year preceding the Census at ten year intervals. The National Health Serice Central Register provides information on patient re-registrations (movements) for Family Practitioner Committee (FPC) Areas for each year. To develop a time series of spatially detailed migration data for use in preparing current population estimates and projections requires a combination of data from these two sources. This paper carries out a comparison of the two sources for a common period (April 1980 to March 1981). Overall levels of migration are compared; outflow, inflow and netflow NHSCR/Census ratios at three spatial scales are examined; NHSCR/Census ratios are examined within a metropolitan/non metropolitan area framework. The inter-area matrices of migration from the two sources are compared using statistical and interaction model indices. Finally, the comparison reviews differences between the two sources across the age range and between the two sexes.

The overall agreement between the two sources in terms of pattern is very close indeed. The differences at FPC area level are more variable, but explanations for these are put forward, following the work of Devis and Mills (1986), in terms of the differing populations at risk in the two sources, the differing role of underenumeration and sampling errors, and the differences in measurement concept between the two sources.

Acknowledgments

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OPCS have provided and are providing extensive data sets of NHSCR and Census migration for analysis, both as summary data and in the form of individual or detailed cell entry data. John Craig, Lak Bulusu and A.E. Hayman have been particularly helpful.

The maps displayed in the paper use digitized boundary information provided by the Department of the Environment. These data or other material remain the property and copyright of the Crown. Fuller details of the data are given in Rees, Stillwell and Boden (1987).

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1. INTRODUCTION

1.1 Sub-national migration forecasting and the need to compare data sets

Both short and long-term projections of sub-national population in Great Britain depend increasingly on our ability to predict inter-area migration, yet our knowledge of current trends in migration continues to be limited by inadequate data. The Census of Population provides the most reliable and comprehensive migration information but during intercensal periods, it is necessary to rely on other data sources, in particular, on the migration tables of National Health Service Central Register (NHSCR). It therefore becomes essential to identify the characteristics of both types of data and to establish the relationship between them so that when census data are unavailable, NHSCR data can be used and interpreted with a better understanding of its shortcomings.

Rees (1985) has outlined the underlying conceptual differences between census based 'transition' data and register based 'movement' data. The basic difference is that a register such as the NHSCR provides a count of every NHS patient re-registration or move occurring in each quarterly or annual period whereas migration data from the 1981 Census, for example, refers to a count of those persons whose usual residence on census date was different from that one year previously, regardless of how many moves or migrations there were between the two dates.

The identification of the major differences between these two migration data sources is essential if an accurate interpretation of migration patterns and trends is to be achieved and if methods and procedures for forecasting are to be devised which incorporate both types of data. Migration assumptions within the current official population forecasting methodology (Martin, Voorhees and Bates, 1981) for example, are based primarily on census-derived information although adjustments are made in response to trends inherent in NHSCR data.

This paper seeks to report the results of a preliminary comparative analysis of migration data from the two sources for 1980-81. Differences highlighted by the comparison can then be taken into account in formulating a forecasting methodology which utilizes NHSCR data associated with more recent time periods.

1.2 Aims of the comparative analysis

Although some excellent research comparing NHSCR movement data and census transition data for 1970-71 (Ogilvy, 1980) and 1980-81 (Devis and Mills, 1986) has been undertaken at a subnational scale, conceptual differences between the two measures of migration have not been the focus of attention and adjustments required to achieve greater consistency between the two data sets used in the comparison might have been improved in this respect. The aim of this analysis is, therefore, to provide a rigorous comparison of Census and NHSCR migration data taking into account some of the omissions of previous studies.

The comparative work is being undertaken in two stages. The first, reported in this paper, involves a comparison of summary tables of census and register migration statistics. The second, to be reported in a later paper, will involve a more precise disaggregated comparison of the two sets of migration data, made possible by use of "Primary Unit Data" from the NHSCR (records of individual patient transfers in Great Britain). A further aim of this research is to highlight the differences that occur between Census and NHSCR migration data at three alternative spatial scales using flow matrices disaggregated by age and sex. Thus, the work will seek not only to confirm some of the findings of previous studies but also to extend the analysis of these two types of data.

1.3 Structure of the paper

Section 2 of the paper outlines the characteristics of the two data sets and highlights the conceptual differences that exist between them. A review of previous comparative work is provided together with a discussion of the particular features of our own comparison.

Section 3 is designed to illustrate the procedures for matching the data sets. Initial data extraction is outlined together with the problems of age-time plan adjustment, and not-stated category assignment in the NHSCR data.

In Section 4 the ratios of NHSCR measured migration to Census measured migration are compared at three spatial scales and in Section 5, statistical and modelling methods are used to compare the two inter-zonal flow matrices. Age-disaggregated zonal out- and in-move totals for FPCAs are compared in Section 6.

Finally, some conclusions are drawn in Section 7 about the major differences that occur between the two types of data and the reasons for particular discrepancies. The paper finishes with some comments on how more accurate adjustment techniques can be adopted.

2. DATA CHARACTERISTICS AND PREVIOUS RESEARCH

2.1 Census transition data

Migrant (transition) data from the 1981 Census are based on the retrospective question 'where were you living one year ago?' A "migration" is bound to have occurred when a person's usual residence at census date is different from that one year previously. Transition data are measured in cohorts defined by end-of-period age-groups. The associated age-time plan of observation (Figure 1) illustrates that the cohort contains those in age group a at time t (Census date) who were in age group a-1 at time t-1. Although a one year migrant question has been included in every census since 1961, the transition dataset from the 1971 Census is based on a 10% sample, in contrast to the 1981 Census data which is a 100% count of migration between 6 April 1980 and 5 April 1981.

Census transition data suffer from a number of limitations. Some migrant subgroups such as infants are excluded from the tabulations of the Census. No tables are constructed of infants who are born during the year before Census date and who also move during that year. A second problem is that the census is unable to distinguish between single and multiple moves. The census question asks only for the address at enumeration and one-year previously and so does not take into account the possibility of a person making several moves or returning to his or her original place of usual residence. There is also the problem of the quality of the Census data. The extent of under-enumeration and mis-classification of migrants has been assessed from the 1981 Census Post Enumeration Survey (PES)(Britton and Birch, 1985)and suggests that the Census undercounted migrants to a significant extent in terms of origin not-stated, failure to fill in forms correctly and incorrect answers to census questions. The PES results indicate that, across all ages, inter-FPCA migration is undercounted in the Census by approximately 172,000 persons (Devis and Mills, 1986).

Certain migrants are unique to the Census. Moves by members of the Armed Forces and their dependants, for example, are recorded by the Census but not by the NHSCR. Service personnel register with a Service Medical Officer and are recorded in the NHSCR as being members of the Armed Forces but any resulting moves that they make will not incur an NHS reregistration. Similarly, moves by prisoners and long-term psychiatric patients will be recorded by the Census but not by the NHSCR. In the 1981 Census, inmates were classified as usual residents of an institution if they had been resident there for six months or more. A move was assigned if one-year previously the usual residence had been non-institutional and the reverse applies for moves out of institutions.

2.2 NHSCR movement data

Migration involves the event of moving from one place of usual residence to another. In countries where national registration systems exist, movement counts derive from the completion of change of address forms. Such registration systems tend to record moves taking place within a given time-period by age at the time of movement as the age-time plan for movement data in Figure 2 illustrates.

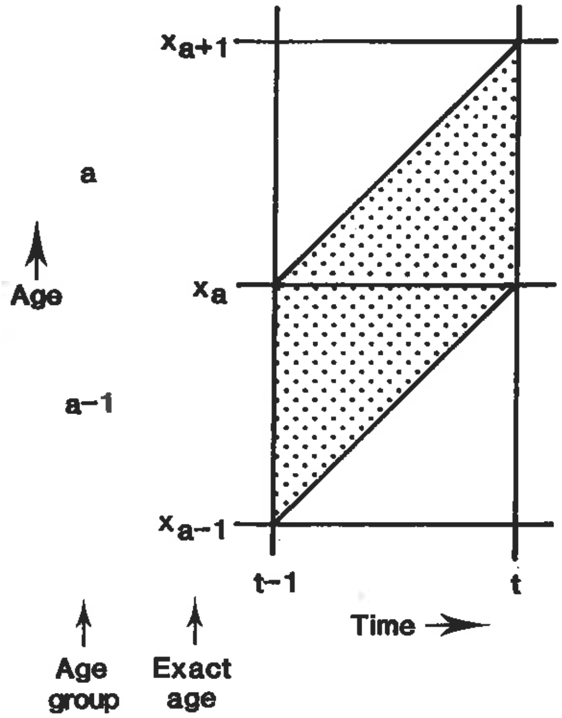


Figure 1. The age-time plan of observation for transition data

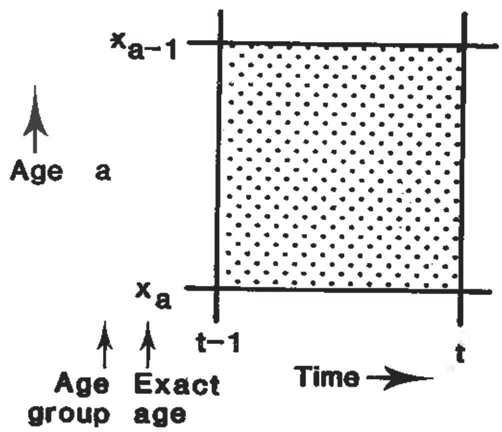


Figure 2. The age-time plan of observation for movement data

The National Health Service Central Register provides data on the re-registration of doctors' patients in Family Practitioner Committee Areas (FPCAs) in England and Wales and in Area Health Boards (AHBs) in Scotland. Between 1975 and 1984, OPCS obtained from the register a 10% sample of transfers classified by age, sex and by area of origin and destination. Since April 1984, the proportion of inter-FPCA re-registrations obtained by OPCS has increased to 100%.

There are a number of imperfections in these movement data. Firstly, the NHSCR does not record migrants who do not register with a doctor. Certain groups, such as the elderly or mothers with young children are more likely to register soon after a move has been made. Others, particularly young adults, may delay re-registration until treatment is required or may not bother to reregister at all.

Secondly, the assumption has usually been made that the estimated average time-lag between a move and its accompanying re-registration is three month. The implication is that moves recorded in a certain period refer to moves made, on average, three months earlier. Thirdly, there is the error involved in sampling prior to April 1984 which is relevant to our comparison.

As with the Census, certain flows are unique to the NHSCR. Students, for example, are recorded by the Census as living at home, so their moves to places of education are not recorded. However, the NHSCR will record student moves if the person registers with a doctor at the educational establishment concerned. It is important also to emphasize that the NHSCR will record every move made on the condition that the mover re-registers with a new FPC. Unlike the Census which records only the number of migrants, the NHSCR provides a count of each move that a migrant makes, and therefore includes multiple and return migrations. The NHSCR will also record moves made by non-surviving migrants who register before death. That is, persons who make a move, re-register and die before the end of the period and are consequently not enumerated in the Census. Finally infants who are born, move and are re-registered during the period will be included in the NHSCR but not the Census.

2.3 Previous comparisons of migration data from different sources

2.3.1 Ogilvy's analyses

Ogilvy (1980a) has compared NHSCR movement data with census transition data for periods close to the 1971 Census. Census migration was measured from 25/26 April 1970 to 25/26 April 1971, whereas the closest NHSCR dataset available was that associated with moves occurring between April 1st 1971 and March 31st 1972. This dataset, on the assumption of an average three-month lag in re-registration, corresponds to the calendar year 1971.

In the analysis, which is restricted to gross and net movement between the eight English regions and Wales, Ogilvy points out the obvious difficulties involved in such a comparison of migrants versus migrations and states that multiple movement is the main reason of the differences between the two sources. NHSCR gross flows were shown to be approximately 20% higher than those from the Census although there was a strong correlation (r=0.997) between the two data sets. The correlation proved to be only slightly weaker when net flows were compared. The transformation of flows into rates again produced a signiicant positive correlation coefficient. In a subsequent paper, Ogilvy (1980b) summarised the differences by age and sex, highlighting in particular a higher rate of NHSCR movement for children under 5 and people aged 15-19, a differentially higher recording of NHSCR moves by young women as compared to young men and a higher rate of NHSCR movement by persons aged 60 and over.

2.3.2. Thomson's analysis

Thomson (1984) has undertaken a comparative study based on age and sex-disaggregated 1981 Census data and NHSCR data for flows between metropolitan districts and shire counties in the West Midlands, and flows between these zones and the other standard regions. Thomson showed that there was a generally strong correlation between the two data sets but not for the 15-19 age-group. The possibility of student distortion was emphasised, with the application of a student correction factor producing a more satisfactory relationship in the 15-19 age-group. The estimated NHSCR: Census ratio for net flows was 1.04 although ratios for individual areas showed wide variation. The gross flow comparison produced ratios which were higher overall but more stable across age-bands. Like Ogilvy, Thomson states that the presence of multiple moves is the major reason for differences between Census and NHSCR figures but argues that although variation is apparent at the small area level, the NHSCR is a reasonable guide to migration at a more aggregate spatial scale.

2.3.3. The analysis of Devis and Mills

Devis and Mills (1986) have published a detailed comparison of the two alternative sources of migration data which analyses some of the differences that exist between them and illustrates the effect of adjusting for these differences. The comparison is based on rates of movement between FPCAs in England and Wales. The respective time-periods of observation for NHSCR and Census are more closely matched than those used by Ogilvy (1980a). NHSCR data, when lagged by three months, are associated with the twelve months ending March 31, 1981 whilst the Census data refer to the year prior to April 5th, 1981, the date of the 1981 Census.

The total NHSCR in- and out-transfers were shown to exceed the total census in- and out-flows by approximately 28%. When NHSCR moves by those with unstated age and sex were omitted, together with moves made by persons aged under one, the discrepancy fell to 24%. These crude discrepancies were greater for females than males and greater for moves between regions than for moves between FPCA's within regions. The difference was most significant for women aged 15-19 and boys aged 10-14.

Devis and Mills emphasize that there is no simple reason for these crude differences such as one source including multiple and return moves and the other not doing so, and they outline the main factors which require consideration when attempting to match the alternative data sets. The important types of move are those involving students, Armed Forces personnel and their dependants, non-survivors, prisoners and long-term psychiatric patients and those who move more than once. The quality of Census data is also an important factor. The effect of adjusting for these discrepancies is to reduce the total difference between the data sets to 3%.

The main aim of the analysis in Occasional Paper 35 (Devis and Mills, 1986) was to decompose NHSCR re-registrations and Census migrant figures into move or migrant types and to attempt a comparison of the lowest common denominator. Table 1 sets out the decompositions estimated by Devis and Mill although arranged differently from their tables on pages 1 and 54. Figure 3 sets out these components in diagram form. Essentially, component A.1 of the NHSCR re-registrations (1,301,306) is compared with component B.1 of the Census migrants plus component B.4 an estimate of missed migrants, which is 1,130,575 plus 172,000 = 1,302,575. The estimated numbers are thus in very close agreement.

The remaining components of both data sets can be divided into three groups:

(i) those that involve operational measurement problems in the two sources;

(ii) those that involve conceptual differences between the two sources; and

(iii) those that involve differences in the populations at risk captured in the two sources.

Under the first category, we can identify component A.6, moves of persons with sex not stated, component A.7 moves of persons with age not stated, component A.10, sampling error, and component A.11, moves not resulting in a re-registration, for NHSCR re-registration data. For Census migration data, the corresponding component is B.4, migrants with origin not stated, migrants with misreported migrations and migrants missed through underenumeration.

Under the second category fall components A.2, moves by migrants who die and component A.4, second and further moves for NHSCR re-registrations.

The third category comprises component A.3, moves by students, component A.5, moves by persons under 1 year of age, component A.8, moves between FPCAs by Armed Forces, A.9, moves between FPCAs by inmates of prisons or psychiatric establishments and the corresponding components B.2 Armed forces migrants, and B.3 prisoner and psychiatric migrants for Census data.

Much of the analysis by Devis and Mills (1986) focusses on whether at the FPCA scale the net migration estimates provided by the two sources were in agreement or not. This concern with net migration derives from its use in the final stage of current subnational population projections. The

Table 1. The decomposition of NHSCR re-registrations and Census migrants, 1980-81, estimated by Devis and Mills (1986): migration between FPCAs in England and Wales.

			Source in Devis & Mills (1986)
A.	**Decomposition of NHSCR re-registrations between FPCAs**		
A.1	First moves of non-student survivors who are one year of age or more and whose sex and age are stated.	1301306	Residual
A.2	Moves by migrants who die	4662	Table 3.8
A.3	Moves by students	100100	Table 3.2
A.4	Second and further moves (Multiple and return moves)	101672	Table 1.1 & p.16
A.5	Moves by persons under one year of age	17600	Table 2.2
A.6	Moves of persons with sex not-stated	25490	Table 2.2
A.7	Moves of persons with age not-stated	3300	Table 2.2
	Total NHSCR re-registrations	1554130	
	Additional components not measured directly		
A.8	Armed Forces moves between FPCAs	78600	Table 3.5
A.9	Moves between FPCAs by inmates of prisons or psychiatric establishments	7440	p.18
A.10	Sampling Error	+ or - 7330	Appendix C
A.11	Moves between FPCAs not resulting in a re-registration	unknown	
	Possible total NHSCR re-registrations	1647500 to 1632840	
B.	**Decomposition of Census migrants between FPCAs**		
B.1	Civilian, non-institutional surviving migrants, aged one or more	1130575	Residual
B.2	Armed Force migrants	78600	Table 3.5
B.3	Prisoners and psychiatric patients	7440	p.18
	Total Census migrants	1216615	
B.4	Migrants missed by the Census (origin not-stated,under-enumeration or mis-reporting as estimated by the Post Enumeration Survey)	172000	pp. 18-19
		1388615	

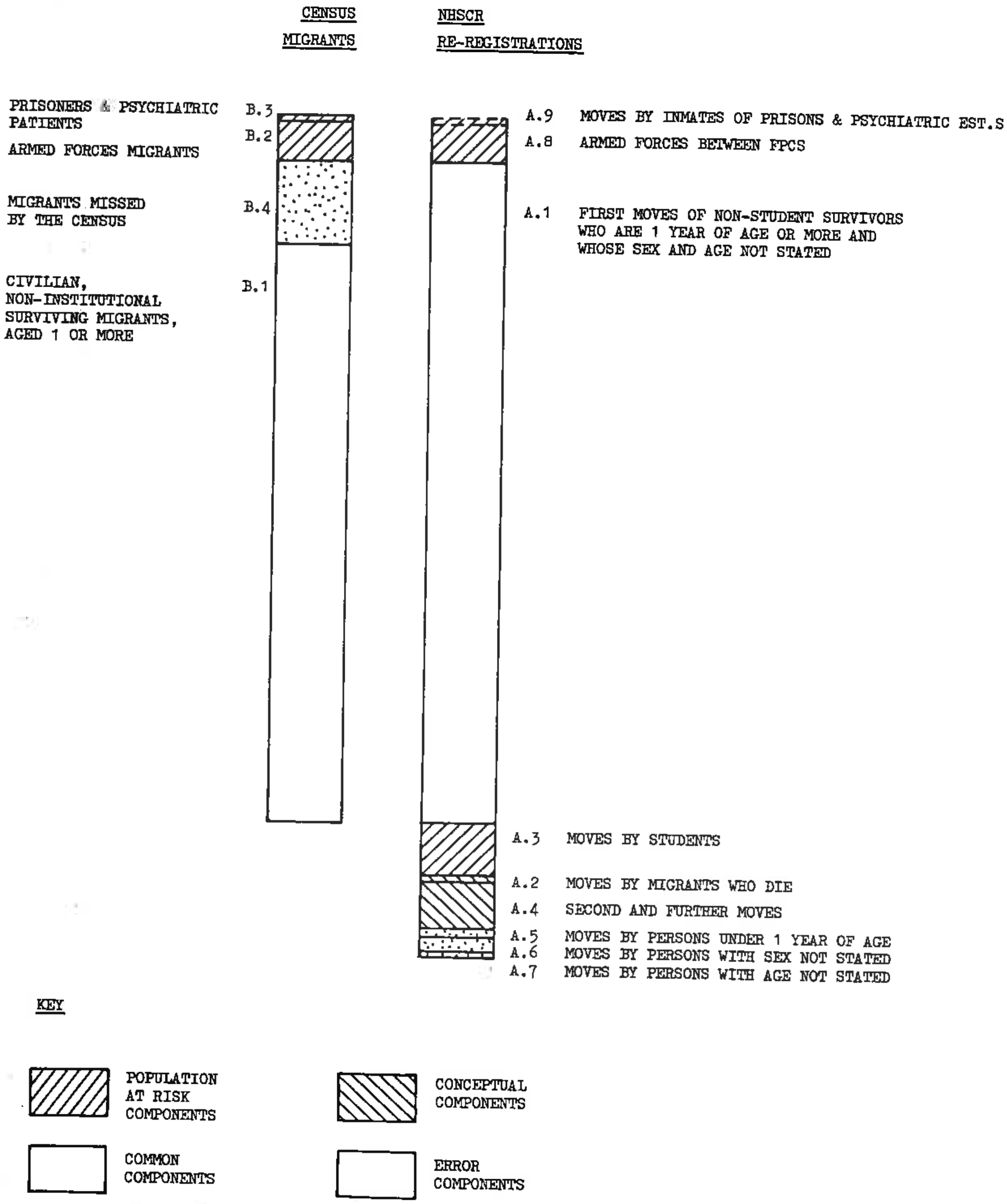


Figure 3. The components of NHSCR re-registrations and Census migrants, 1980-81, estimated by Devis and Mills (1986).

argument is that if the two sources are shown to be in agreement, then we can be confident in using NHSCR re-registration data for inter-censal years to provide data for trending the migration inputs to the subnational projections. However, in its earlier stages, the subnational population projection model utilizes gross migration by age and sex into and out of local authority areas, and gross migration for broad age groups between local authority areas (OPCS, 1984). Alternative projection models which might be explored also use gross migration stream data. Hence it is important to explore the goodness of fit between the NHSCR re-registrations data set and the Census migrant data set by looking at the matrix of inter FPCA flows at various spatial scales. This is done in later sections of the paper.

Our comparison takes a slightly different view of the components that make up the two types of migration measure. We aim to implement a multiregional population projection based on "movement" data, and so are concerned to use, not downwardly adjusted NHSCR re-registrations A.1 but upwardly adjusted NHSCR re-registrations - components A.1 to A.7 (total measured re-registrations) plus components not measured A.8, A.9 and A.11, adding to NHSCR re-registrations estimates of Armed Forces and institutional migration wherever possible. A study of the discrepancies between Census migration and NHSCR migration should help in this respect.

To summarize this review, it is clear that the analysis of Devis and Mills (1986) is crucial to an understanding of the differences between NHSCR re-registration data and Census migrant data at FPCA level. Devis and Mills emphasize the variety of reasons why differences occur between the two data sources, and adjust each data set successively in order to reduce the differences between them. However, they do conclude that

> "... although care should be taken in each area with the treatment of various sub-populations, NHSCR data can be an effective tool for the annual measurement of net population changes through migration." (Devis and Mills, 1986, p. 28).

2.4. Features of our comparison

This paper attempts to confirm earlier findings and to extend the comparative analysis. The clarification of the conceptual differences as well as the population differences between movement and transition data is essential. Sections 2.1 and 2.2 have introduced the problem and section 3.3 will explain in detail the adjustment techniques adopted for converting NHSCR movement data to a cohort basis, consistent with Census transition data.

The remainder of Section 3 is devoted to an explanation of further alignments and adjustments that are made to the data sets to make them more comparable and consistent.

Devis and Mills (1986) based their study on a comparison of rates of migration. Our analysis will attempt to confirm their findings using migration flows. The results from Devis and Mills' work will be extended by analysing, in detail, differences that exist betwen the two data sources at alternative spatial scales, together with a more systematic breakdown of individual inter-area flows at each level to examine the influence of contiguity and metropolitan status on the size of the NHSCR/Census ratio. The calibration of a doubly-contrained spatial interaction model for each inter-zonal array adds a further dimension to the analysis, comparing zone-specific distance decay parameters between data sets.

A statistical interpretation of the relationship between NHSCR and Census flows is introduced through the computation of goodness of fit statistics together with the use of regression techniques to establish a precise linear relationship between NHSCR and Census flows.

The final set of results presented are associated with the differences between age and sex disaggregated inflows into FPCAs. Statistical comparisons together with further breakdown of the data by metropolitan status isolate the age and sex groups responsible for the major differences highlighted in the analysis of aggregate inter-zonal flows.

3. SPATIAL SCALE, TIME PERIOD ALIGNMENT AND DATA ADJUSTMENT

3.1 The choice of spatial scales

In addition to reporting results at the national level, we use three alternative spatial scales for subnational analysis.

(i) Level 1, the standard region scale, consists of 8 English regions, Scotland, Wales, Northern Ireland and the Isle of Man. Out flows to Northern Ireland and the Isle of Man from other regions are not available from the Census and are therefore excluded from the inter-regional matrix of flows. The study zones at this spatial scale are outlined in Figure 4.

(ii) Level 2 consists of metropolitan counties, their region remainders and regions without metropolitan counties in England, together with Wales, Scotland, N. Ireland and the Isle of Man (Figure 5). No distinction is made between the Outer Metropolitan Area and the Outer South East - or between Central Clydeside and the rest of Scotland because NHSCR data is unavailable from the computer summaries for these spatial units. The absence of census data on migrants to Northern Ireland and the Isle of Man means that the system of interest has 19 origins and 17 destinations. This system of zones is equivalent to the European Community level 2 (EC2) region set.

(iii) Level 3 is the most disaggregate spatial level and involves Family Practitioner Committee Areas (FPCA's) in England and Wales together with Scotland, Northern Ireland and the Isle of Man. There are 97 origin zones and 95 destination zones since flows to Northern Ireland and the Isle of Man are not available. FPCAs in England and Wales correspond to metropolitan districts and counties without metropolitan districts, with one or two exceptions. Knowsley and St. Helens in Merseyside are combined to form one FPCA and 33 London boroughs are combined to form a total of twelve FPCAs within Greater London. Figure 6 illustrates the FPCA system of interest and Table 2 indicates the names of the coded zones.

3.2. Time-period alignment and initial data extraction

3.2.1 Time-period alignment

The results of Ogilvy's (1980a) analysis are made suspect by the poor alignment of the respective time-periods of observation. This study will use data from the Census which refers to the one-year period prior to 5/6 April 1981. This is matched most closely by the NHSCR movement data for the twelve-month period ending June 30 1981. This approximates to moves taking place between April 1st, 1980 and March 31st, 1981, assuming an average three-month lag between each move and re-registration.

3.2.2 Census data extraction

The comparative analyses will be undertaken using data aggregated from the 1981 Census district by district migration matrix supplied by OPCS on ten magnetic tapes, one each for the standard regions of England, one for Wales and one for Scotland.

Figure 4. The standard regions used in the analysis

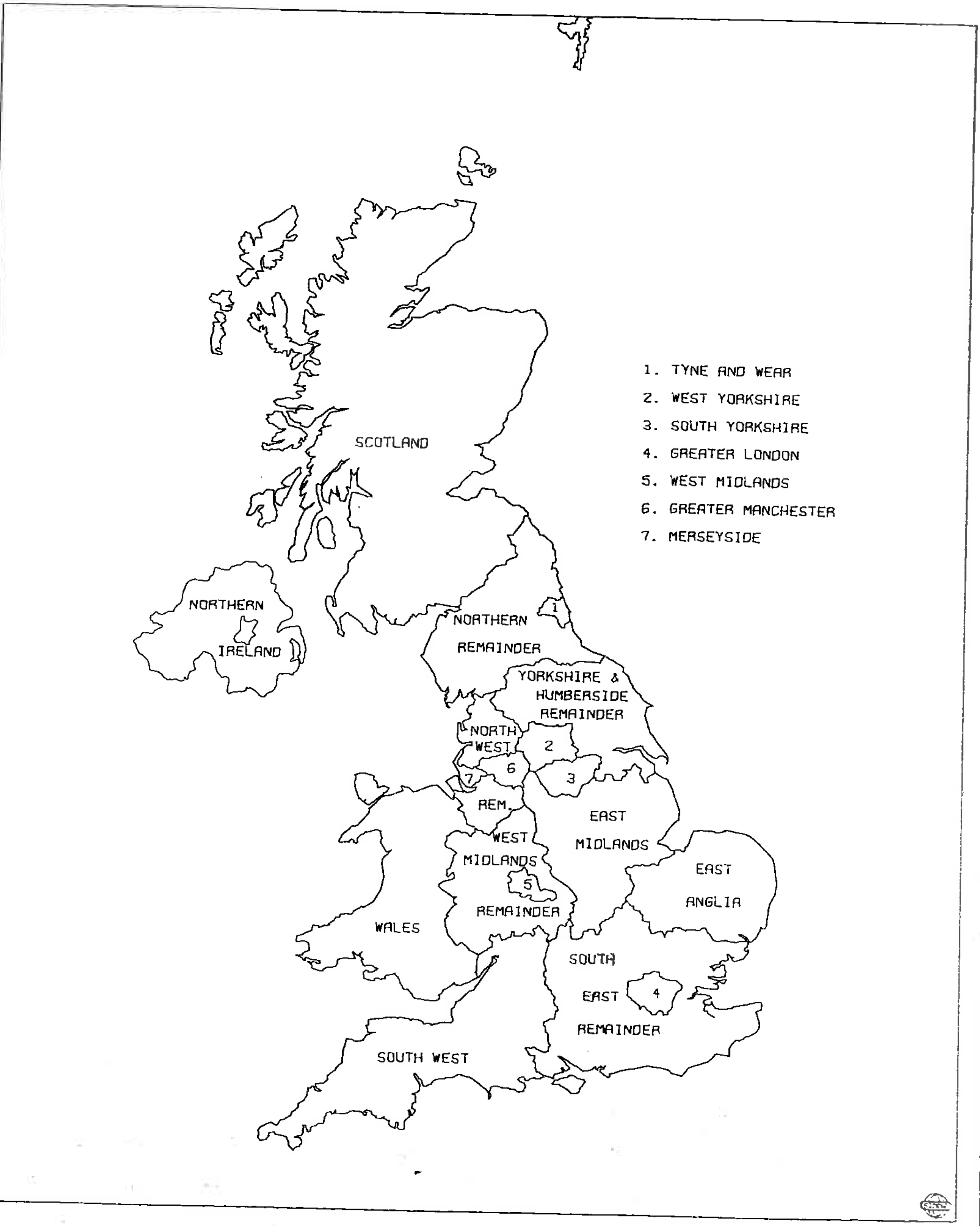


Figure 5. The European Community Level 2 regions used in the analysis

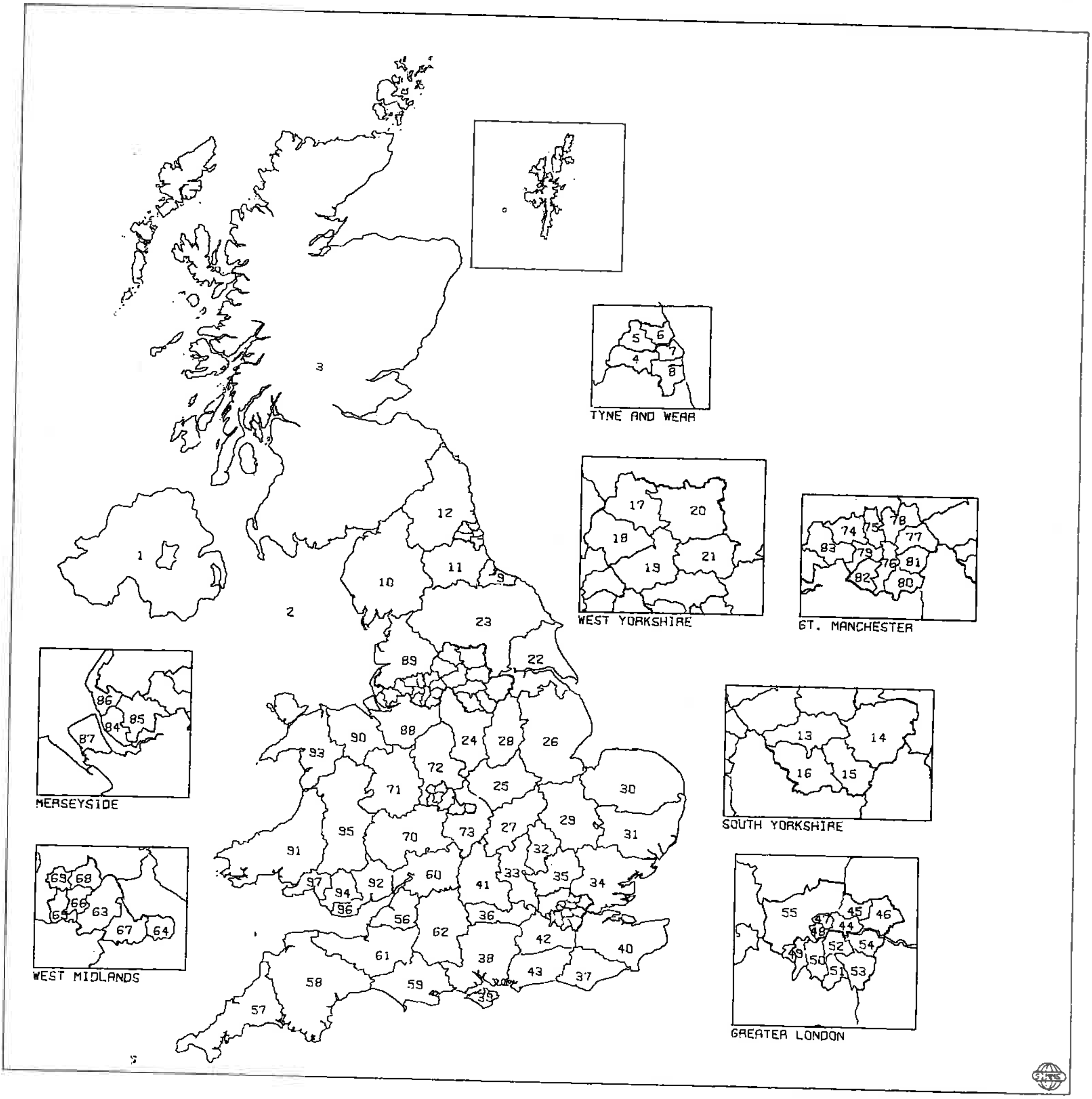


Figure 6. The Family Practitioner Committee Areas used in the analysis (See Table 2 for the names of the FPCAs)

Table 2. Names of the Family Practitioner Committee Areas

Code	FPCA name	Code	FPCA name	Code	FPCA name
1	Northern Ireland	37	East Sussex	63	Birmingham
2	Isle of Man	38	Hampshire	64	Coventry
3	Scotland	39	Isle of Wight	65	Dudley
4	Gateshead	40	Kent	66	Sandwell
5	Newcastle	41	Oxfordshire	67	Solihull
6	North-Tyneside	42	Surrey	68	Walsall
7	South-Tyneside	43	West Sussex	69	Wolverhampton
8	Sunderland	44	City, Hackney, Newham & Tower Hamlets	70	Hereford & Worcestershire
9	Cleveland	45	Redbridge & Waltham Forest	71	Shropshire
10	Cumbria	46	Barking & Havering	72	Staffordshire
11	Durham	47	Camden & Islington	73	Warwickshire
12	Northumberland	48	Kensington, Chelsea & Westminster	74	Bolton
13	Barnsley	49	Richmond & Kingston	75	Bury
14	Doncaster	50	Merton, Sutton & Wandsworth	76	Manchester
15	Rotherham	51	Croydon	77	Oldham
16	Sheffield	52	Lambeth, Southwark & Lewisham	78	Rochdale
17	Bradford	53	Bromley	79	Salford
18	Calderdale	54	Bexley & Greenwich	80	Stockport
19	Kirklees	55	Middlesex	81	Tameside
20	Leeds	56	Avon	82	Trafford
21	Wakefield	57	Cornwall	83	Wigan
22	Humberside	58	Devon	84	Liverpool
23	North-Yorkshire	59	Dorset	85	St. Helens & Knowsley
24	Derbyshire	60	Gloucestershire	86	Sefton
25	Leicestershire	61	Somerset	87	Wirral
26	Lincolnshire	62	Wiltshire	88	Chesire
27	Northamptonshire			89	Lancashire
28	Nottinghamshire			90	Clwyd
29	Cambridgeshire			91	Dyfed
30	Norfolk			92	Gwent
31	Suffolk			93	Gwynedd
32	Bedfordshire			94	Mid-Glamorgan
33	Buckinghamshire			95	Powys
34	Essex			96	South Glamorgan
35	Hertfordshire			97	West Glamorgan
36	Berkshire				

Note:
Middlesex consists of the London Boroughs of Barnet, Brent, Harrow, Ealing, Hammersmith, Hounslow, Enfield, Haringey and Hillingdon.

Each record of a tape file contains seven fields of coded information: the origin, destination, age, sex, record-type, type of move and migrant count. The count is recorded in binary form. Each individual is recorded twice within the complete data set, once as an in-migrant and once as an out-migrant for each transfer where the origin is in Great Britain. For each transfer into Great Britain from external zones there is only an in-migrant record. Each record has a 'TYMO' field to indicate whether the type of move is within district or not and this facilitates the exclusion of intra-district flows from any analysis. Data extraction involved the development of a procedure to read the coded data from each tape into two separate output files containing:

(i) the matrix of migrants between the 97 origin and 95 destination zones; and
(ii) in-migration totals for each zone disaggregated by five-year age-group and sex.

The data processing was carried out via a FORTRAN program containing an assembler routine. This routine converted all fields within an individual record read from tape, from ICL 1900 code to EBCDIC code and the binary integer in the count field to an EBCDIC integer variable. The processing was restricted to the in-migrant records on the tape files and ignored any intra-zone transfers.

The conversion of the Census district destination and origin codes to our study zone codes was performed using look-up tables - a method whereby each district code is assigned an integer value corresponding to its study zone code. This method was also used to reduce the 108 single year age-groups to 16 five-year age groups (1-4,...,75+).

Each record was read individually, passed through the assembler routine and output as a series of integer variables which were then used to increment the individual elements of the two arrays. When the reading of records from one tape was complete the contents of the arrays were written to disk and then read as the initial arrays for the next run. Each tape was processed separately with complete arrays output after running the program with the tenth tape. The data obtained from the tapes was checked against OPCS published figures.

3.2.3. NHSCR data extraction

This preliminary comparative analysis has been undertaken using NHSCR data obtained from OPCS in the form of computer summaries of data (Stillwell, 1986) aggregated from the Primary Unit Data which consists of a series of records containing coded information about origin, destination, age, sex, year of birth and type of move.

The NHSCR data available from these summaries consists of a matrix of person transfers between FPCAs, and gross out and in-movement totals for each FPCA disaggregated by five-year age-group for males and females. Age and sex-disaggregated outflows from the NHSCR include flows to Northern Ireland and the Isle of Man. However, these are excluded from the comparative analysis given the absence of an equivalent set of flows in the Census data.

An important discrepancy between the two data sets is the inclusion of moves made by infants in the NHSCR data. For this reason the NHSCR inter-zonal flows are reduced in volume by a constant which corresponds to the proportion of infant moves within the system as a whole. Figures from Devis and Mills (1986, Table 2.2) suggest a constant, c defined as:

$$c = \frac{\text{Total moves made by persons aged under 1}}{\text{Total moves made by persons of all ages}} = 0.011 \qquad (1)$$

This adjustment, which is applied both here and in Devis and Mills (1986), is slightly in error, because the under 1 category in the NHSCR data refers to a "period-age group" whereas the missing under 1 category in the Census data refers to a "period-cohort". In the second stage analysis, this error will be corrected.

3.3 Age-time plan (A.T.P) adjustment

Section 2 described some of the conceptual differences that exist between Census and NHSCR data. To make the age disaggregated data sets more comparable it is necessary to convert NHSCR movement data for five-year age groups to Census five year period-cohort data, (or vice versa). The diagrams in Figure 7 illustrate the way estimation techniques are adopted to convert NHSCR data to a cohort basis consistent with Census flows.

3.3.1 The first age group

The NHSCR records moves made by all persons in age groups 0 to 4 years during the one year period (Figure 7a). The Census records transitions made by persons in the period-cohort defined by the 1-4 age-group at the end of the period. The census therefore does not include migrants aged less than 1 year of age.

The NHSCR inmove data for the first age group can be estimated, for both sexes, as:

$$M_{*j}^{1(c)} = 0.8\ M_{*j}^{1(n)} \qquad (2)$$

where

M = NHSCR re-registrations or moves

$M_{*j}^{1(c)}$ = total moves into zone j recorded in age group 1 used in the Census migration data

$M_{*j}^{1(n)}$ = total moves into zone j recorded in age group 1 used in the NHSCR re-registration data.

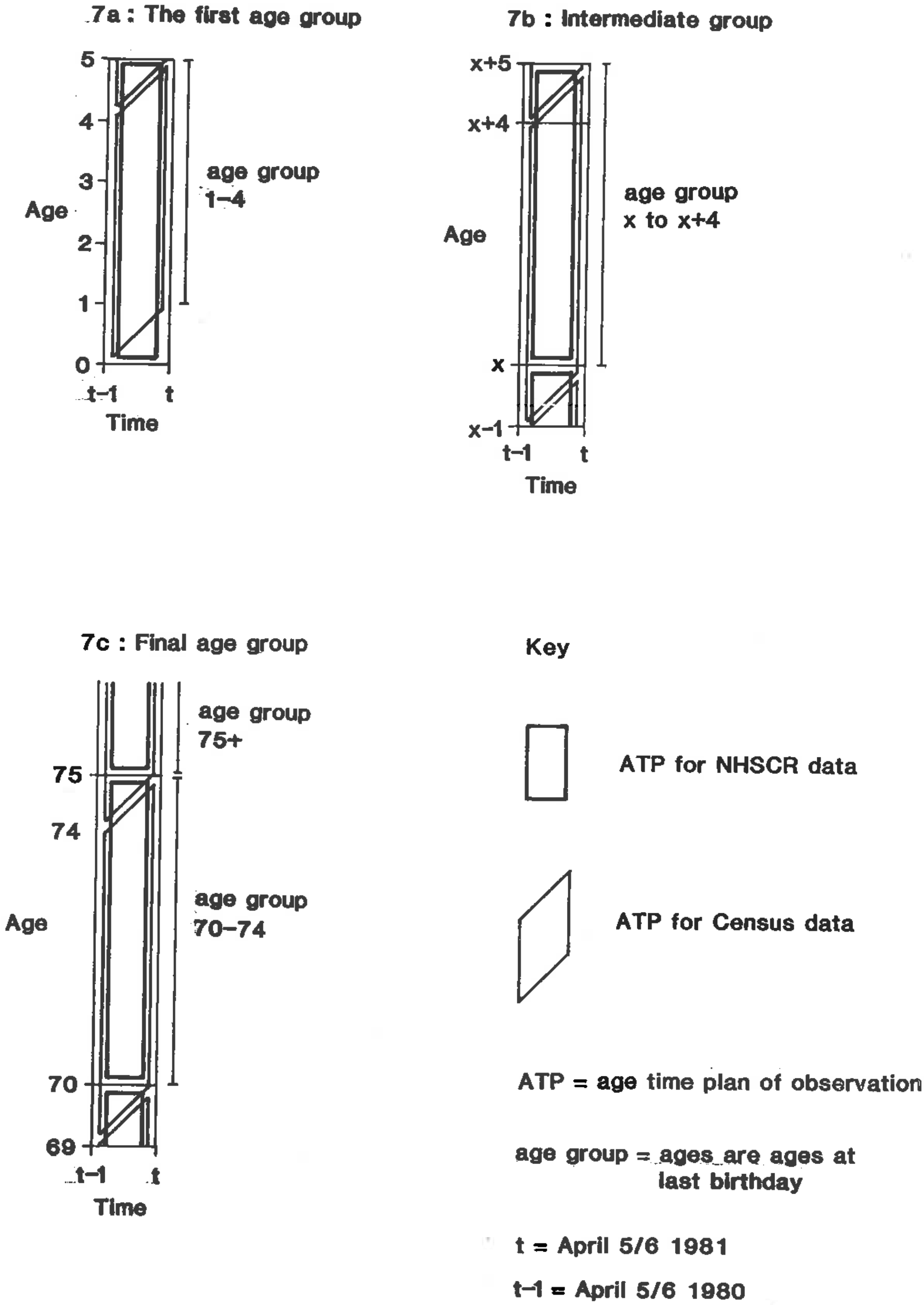


Figure 7. Age-time plan adjustments required to covert movement to transition data in first, intermediate and final age groups

3.3.2 The final age-group

For the purposes of comparison the final age-group was defined as those aged 75 or over. The penultimate census period-cohort contains all transfers made by those in the 70-74 age-group at the end of the year (Figure 7c). So, to match the movement data in this way, a proportion of the penultimate NHSCR age-group must be combined with the final NHSCR age-group, using the equation:

$$M_{*j}^{16(c)} = 0.1\ M_{*j}^{15(n)} + M_{*j}^{16(n)} \qquad (3)$$

where 0.1 is the proportion of the penultimate age group total to be included. The 15th age group is 70-74 years of age and the 16th refers to 75 or more years of age.

3.3.3. The intermediate age-groups

The inmove totals for intermediate age groups (Figure 7b) can be adjusted as follows:

$$M_{*j}^{a(c)} = 0.1\ M_{*j}^{a-1(n)} + 0.9\ M_{*j}^{a(n)} \text{ for } 1<a<16 \qquad (4)$$

where a-1(n) and a(n) are consecutive age groups used in the NHSCR re-registration dataset.

3.4 Not-stated categories

This initial analysis is based upon the comparison of two arrays - the inter-FPCA array of person transfers and the inflow totals by age by sex. The Census figures include only one not-stated category, that of origin not-stated. Therefore reassignment of these flows is important only for the inter-zonal matrix. Those Census flows with unknown origin were assigned as follows (age and sex subscripts omitted):

$$T_{ij}(2)= T_{ij}(1) + T_{?j} \times \ (T_{ij}(1))/(\sum_{j=i} T_{ij}(1)) \qquad (5)$$

where

T = Census migrant transitions

$T_{ij}(2)$ = adjusted Census migrant flow between origin i and destination j

$T_{ij}(1)$ = recorded Census migrant flow between origin i and destination j

$T_{?j}$ = Census migrants to zone j with origin not stated

Because the NHSCR inter-FPCA array used in this analysis includes no origin or destination not-stated categories, no reassignment is required.

The second array used is that of flows to all destinations disaggregated by age and sex. Within this array there is a not-stated age and a not-stated sex category. To make the array more comparable with that of the census the not-stated flows were assigned as follows.

$$
\begin{aligned}
M_{*j}^{as}(2) = {} & M_{*j}^{as}(1) \\
& + M_{*j}^{?s} \times \left(M_{*j}^{as}(1) / \sum_{a} M_{*j}^{as}(1)\right) \\
& + M_{*j}^{a?} \times \left(M_{*j}^{as}(1) / \sum_{s} M_{*j}^{as}(1)\right) \\
& + M_{*j}^{??} \times \left(M_{*j}^{as}(1) / \sum_{as}\sum M_{*j}^{as}(1)\right)
\end{aligned}
\qquad (6)
$$

where

$M_{*j}^{as}(2)$ = adjusted NHSCR moves to destination j for age group a and sex s

$M_{*j}^{as}(1)$ = recorded NHSCR moves to destination j for age group a and sex s

$M_{*j}^{?s}$ = NHSCR moves to destination j for sex s of unknown age

$M_{*j}^{a?}$ = NHSCR moves to destination j for age group a of unknown sex

$M_{*j}^{??}$ = NHSCR moves to destination j for unknown age group and unknown sex

4. THE COMPARISON OF ALL-AGE MIGRATION DATA SETS USING FLOWS AND RATIOS

4.1 Overall levels of NHSCR and Census migration

Table 3 illustrates the differences that exist between NHSCR and Census migration flows at different spatial scales. The first row in the table includes only inter-FPCA flows that cross standard region boundaries. The second row includes all inter- FPCA flows that cross the boundaries of EC2 regions. The third row involves those flows between EC2 level regions that fall within standard regions, the fourth row accounts for those inter-FPCA flows that remain within EC2 regions, and the bottom row refers to all inter-FPCA migration flows.

Overall, there are 24.5% more NHSCR re-registrations than Census migrants (the ratio is 1.2446). This figure compares with the 23.9% obtained by Devis and Mills (1986). The slight difference is because Devis and Mills omit all NHSCR re-registration with unstated age and sex and consider inter-FPCA flows within England and Wales only.

The figures in the final column of Table 3 show clearly that the ratio of NHSCR re-registration to Census migrants varies systematically with the spatial scale. The highest ratios are for the longest distance flows and the ratios decline systematically as the average distance of migration shrinks.

How should this observation be explained? For an explanation, we must refer to the components of each migration data set that are different (as set out in Table 1 and Figure 3.)

The differences in populations at risk between the NHSCR and Census measurement systems might make some contribution. Students, for example,are known to be heavily involved in inter-regional migration; on the other hand, migrants within the Armed Forces also migrate over long distances. The 100,000 student movers per year are balanced by 86,000 migrants in the Armed Forces and institutional populations. Infant migrants (those under 1 year of age), however, do not contribute as we have excluded them from NHSCR flows.

It is unlikely that the error components of either data set differ in a systematic way related to spatial scale. The chances are that both sources undercount short distance migration more severely than long distance migration. The errors of age not stated, sex not stated or origin not stated cannot contribute to the effect observed in Table 3 because the relevant totals have been proportionally allocated over flows for which all characteristics are known.

The most likely culprits are therefore the conceptual components. However, non-surviving migrants, whose migrations are recorded in the NHSCR but not in the Census, are too few in number to produce such a substantial effect. We are left therefore, with the component "multiple or return moves".

Table 3. NHSCR and Census migration flows and ratios at various spatial scales.

Migration flows between FPCAs	Total moves (NHSCR)	Total transitions (Census)	Difference	Ratio
(1) Between standard regions	838501	629915	208586	1.331
(2) Between EC2 regions	1148990	881826	267164	1.303
(3) Between EC2 regions, within standard regions	310489	251911	58578	1.233
(4) Within EC2 regions	499757	442918	56839	1.128
(5) All flows	1648747	1324744	324003	1.245

Source: unpublished NHSCR and Census data supplied by the Office of Population Census and Surveys.

Notes:
Relationship between row items:-

row(3) = row(2) - row(1)
row(4) = row(5) - row(2)
row(5) = row(1) + row(3) + row(4)

It is probably useful to consider exactly what is meant by the terms "multiple moves" and "return moves", and consider the consequences for our comparison of NHSCR re-registrations and Census migrants. Persons can make many moves during their lifetime (perhaps 8 to 10 in the UK on average). Within any one year the number made is fewer, and if only moves between FPCAs are considered the number will be smaller still.

Devis and Mills (1986, Table 3.6 p.16) report on the number of multiple and return moves by Longitudinal Study members between FPCAs recorded in the NHSCR over the years 1972-73. A return move was one with the same FPCA as origin of the first move and destination of the last. They report that 95.5% of movers made only 1 inter-FPCA move in a year; 4.5% made 2 or more moves (4.3% just 2 moves, 0.2% more). Of the 4.5%, some 1.8% made return moves.

Herein lies a possible explanation for the scale effect observed in Table 3. If moves were randomly distributed with respect to chances of returning to the origin area, then we should expect Census-recorded migration to consist of longer distance displacements than NHSCR recorded migration, since the displacement in Census migration would be the average distance between origin 1 and destination 2 whereas in NHSCR migration the mean distance would be the average of the displacements of origin 1 and destination 1 and of origin 2 (alias destination 1) and destination 2. If Census- recorded migrations are longer distance on average than NHSCR migration, we should observe the reverse of the relation between scale and NHSCR/Census ratio shown in Table 3.

However, if return moves are a very important phenomenon and the statistics quoted by Devis and Mills suggest that 40% of second or higher order moves in a year are return moves, then the Census migrations will tend to show much shorter displacements between origin and destination than NHSCR moves. If this is the case, then we should observe the kind of ratio gradient with scale observed in Table 3.

So, our hypothesis concerning the relationship between scale of migration and NHSCR/Census migration ratio is that part of it may be due to the inclusion of longer distance student migrants in the former but not in the latter, an effect not fully compensated for by the exclusion of large distance migrants from the Armed Forces. The greater part, however, is likely to be due to a combination of the conceptual difference between the two methods of measuring migration (NHSCR picking up multiple moves, the Census not) and the greater significance of return migration for multiple movers.

4.2. Outflow, inflow and netflow ratios: detailed patterns

The aggregate figures considered so far give an indication of the effect of scale upon the NHSCR-Census ratio, but they hide the considerable variations that exist at a more disaggregate level.

Disaggregation of the total figures into zonal outflow, inflow and netflow categories at each spatial scale reveals a number of interesting characteristics. Table 4 illustrates in rank order the outflow, inflow and

Table 4. Outflow, inflow and netflow totals, differences and ratios for NHSCR and Census migration for standard regions

Region	NHSCR	Census (1000's)	Difference	Ratio
		OUTFLOWS		
NORTHWEST	96.4	68.2	28.3	1.41
NORTH	49.3	35.1	14.2	1.40
ISLE OF MAN	1.3	1.0	0.4	1.37
WEST MIDLANDS	80.2	58.8	21.4	1.36
SOUTH EAST	222.0	165.2	56.8	1.34
YORKS. & HUMB.	76.4	57.0	19.3	1.34
WALES	43.5	33.5	10.1	1.30
EAST ANGLIA	72.3	55.6	16.8	1.30
EAST MIDLANDS	43.7	33.7	10.1	1.30
SOUTH WEST	89.7	69.9	19.8	1.28
SCOTLAND	52.8	41.9	10.9	1.26
NORTHERN IRELAND	10.7	10.0	0.7	1.07
		INFLOWS		
NORTHWEST	78.6	52.0	26.6	1.51
NORTH	40.8	27.7	13.1	1.47
YORKS. & HUMB.	73.2	51.3	22.0	1.43
WEST MIDLANDS	71.6	50.5	21.1	1.42
WALES	46.2	34.5	11.7	1.34
SOUTH EAST	227.6	172.5	55.0	1.32
EAST MIDLANDS	56.9	45.0	11.9	1.26
EAST ANGLIA	81.9	64.9	17.0	1.26
SCOTLAND	47.9	38.6	9.2	1.24
SOUTH WEST	113.8	92.9	21.0	1.23
ALL REGIONS	838.5	629.9	208.6	1.33
		NETFLOWS		
WALES	2.7	1.0	1.6	2.56
SCOTLAND	-5.0	-3.3	-1.7	1.50
ISLE OF MAN	-1.3	-1.0	-0.4	1.37
EAST MIDLANDS	13.2	11.4	1.8	1.16
NORTH	-8.5	-7.4	-1.1	1.15
NORTHWEST	-17.8	-16.1	-1.6	1.10
NORTHERN IRELAND	-10.7	-10.0	-0.7	1.07
SOUTH WEST	24.1	23.0	1.2	1.05
WEST MIDLANDS	-8.6	-8.3	-0.3	1.03
EAST ANGLIA	9.5	9.3	0.3	1.03
SOUTH EAST	5.5	7.3	-1.8	0.76
YORKS. & HUMB.	-3.1	-5.8	2.6	0.54

netflow ratios that exist at the standard region scale. The greatest outflow ratios are exhibited by the North West and North regions with the South East, West Midlands and the Isle of Man figures also above the mean ratio. By far the lowest ratio between NHSCR and Census data is for Northern Ireland, with Scotland, and the South West also having relatively low ratios. Wales, East Anglia and the East Midlands all have ratios below the UK average.

For the ten destinations at the regional level, the greatest inflow ratios are exhibited by those regions outside the South East containing a metropolitan county: the North West, the North, Yorkshire and Humberside, and West Midlands. Scotland and the South West have the lowest inflow ratios at this spatial scale.

The distribution of net flow ratios at the standard region scale indicates that whilst several regions have ratios close to unity, the range of values is greater than with either the outflows or inflows. The NHSCR value of net inmigration to Wales is 150% higher than the Census figure, whereas NHSCR net outmigration from Yorkshire and Humberside is only about half that indicated by the Census data.

At the scale of metropolitan counties, region remainders and regions without metropolitan counties, outflow ratios vary around the mean figure of 1.303 (Table 5). West Yorkshire flows show the greatest discrepancy with the Northern region remainder, North West remainder, Greater Manchester and Merseyside also having relatively large ratios. Apart from Northern Ireland, which has a very low ratio, the smallest ratios are found for outflows from the region remainders of the West Midlands and Yorkshire and Humberside.

The most striking feature of the inflow figures at this level are the large NHSCR/Census ratios shown for inflows to metropolitan counties, excluding Greater London. Tyne and Wear, West Yorkshire, Greater Manchester, Merseyside, West Midlands and South Yorkshire all have ratios well above the mean figure and above the largest outflow ratio. The South East remainder also exhibits a relatively high figure. Inflow ratios are again smallest for the West Midlands region remainder, and also for the South West and Greater London.

Once again the variation in the netflow ratios at the EC2 scale is accentuated at the extremes, whilst 10 out of 17 regions have ratios which represent a difference of less than ±10%. Another feature which emerges more clearly at this scale is that a significant proportion of zone netflow ratios are below unity, indicating that the absolute value of the NHSCR netflow is less than the corresponding Census figure. In the case of South Yorkshire, the NHSCR net outflow is only 13% of the Census net outflow. This situation arises simply as a result of differences in the NHSCR/Census ratios for the gross flows involved. The absolute differences between the NHSCR and Census data on net migration remain within ± 3,000.

Figures 8 and 9 illustrate the variation in inflow and outflow ratios for FPCAs in Great Britain (Northern Ireland and the Isle of Man are excluded) on a quartile basis. The majority of outflow ratios for FPCAs

Table 5. Outflow, inflow and netflow totals, differences and ratios for NHSCR and Census migration for EC2 regions

EC2 Region	NHSCR	Census (1000's)	Difference	Ratio
		OUTFLOWS		
WEST YORKSHIRE	40.2	28.0	12.2	1.44
NORTH REM.	40.3	29.3	11.0	1.38
NORTH WEST REM.	57.2	41.9	15.3	1.36
GREATER MANCHESTER	51.2	37.8	13.4	1.35
MERSEYSIDE	34.4	25.4	9.0	1.35
WEST MIDLANDS C.	58.1	44.3	13.8	1.31
SOUTH EAST REM.	193.6	148.5	45.1	1.30
EAST ANGLIA	72.3	55.6	16.8	1.30
WALES	43.5	33.5	10.1	1.30
EAST MIDLANDS	43.7	33.7	10.1	1.30
TYNE AND WEAR	24.8	19.1	5.7	1.30
GREATER LONDON	216.5	166.9	49.5	1.30
SOUTH WEST	89.7	69.9	19.8	1.28
SOUTH YORKSHIRE	22.4	17.7	4.7	1.27
SCOTLAND	52.8	41.9	10.9	1.26
YORKS. & HUMB. REM.	36.3	28.9	7.4	1.25
WEST MIDLANDS REM.	59.8	48.4	11.4	1.24
		INFLOWS		
TYNE & WEAR	20.2	12.8	7.4	1.58
WEST YORKSHIRE	35.8	23.1	12.6	1.55
GREATER MANCHESTER	40.2	26.2	14.0	1.53
MERSEYSIDE	23.7	15.7	8.0	1.51
WEST MIDLANDS C.	42.5	28.7	13.7	1.48
SOUTH YORKSHIRE	22.1	15.2	6.9	1.46
SOUTH EAST REM.	155.5	111.5	44.0	1.39
WALES	46.2	34.5	11.7	1.34
NORTH WEST REM.	61.0	47.1	14.0	1.30
NORTH REM.	36.4	28.2	8.3	1.29
EAST MIDLANDS	56.9	45.0	11.9	1.26
EAST ANGLIA	81.9	64.9	17.0	1.26
YORKS. & HUMB. REM.	37.9	30.5	7.4	1.24
SCOTLAND	47.9	38.6	9.2	1.24
GREATER LONDON	260.1	211.3	48.8	1.23
SOUTH WEST	113.8	92.9	21.0	1.23
WEST MIDLANDS REM.	66.9	55.6	11.2	1.20
ALL REGIONS	1149.0	881.8	267.2	1.30

Table 5. Continued

EC2 Region	NHSCR	Census	Difference	Ratio
		NETFLOWS		
NORTH REM.	-3.9	-1.1	-2.8	3.51
WALES	2.7	1.0	1.6	2.56
SCOTLAND	-5.0	-3.3	-1.7	1.50
EAST MIDLANDS	13.2	11.4	1.8	1.16
MERSEYSIDE	-10.7	-9.7	-0.9	1.10
SOUTH WEST	24.1	23.0	1.2	1.05
SOUTH EAST REM.	-38.1	-37.0	-1.1	1.03
EAST ANGLIA	9.5	9.3	0.3	1.03
WEST MIDLANDS C.	-15.6	-15.6	-0.1	1.01
YORKS. & HUMB. REM.	1.6	1.6	0.0	1.00
GREATER LONDON	43.6	44.3	-0.7	0.98
WEST MIDLANDS REM.	7.1	7.3	-0.2	0.97
GREATER MANCHESTER	-10.9	-11.5	-0.6	0.95
WEST YORKSHIRE	-4.4	-4.8	-0.4	0.92
NORTH WEST REM.	3.8	5.1	-1.3	0.75
TYNE & WEAR	-4.6	-6.3	1.7	0.73
SOUTH YORKSHIRE	-.3	-2.6	2.2	0.13

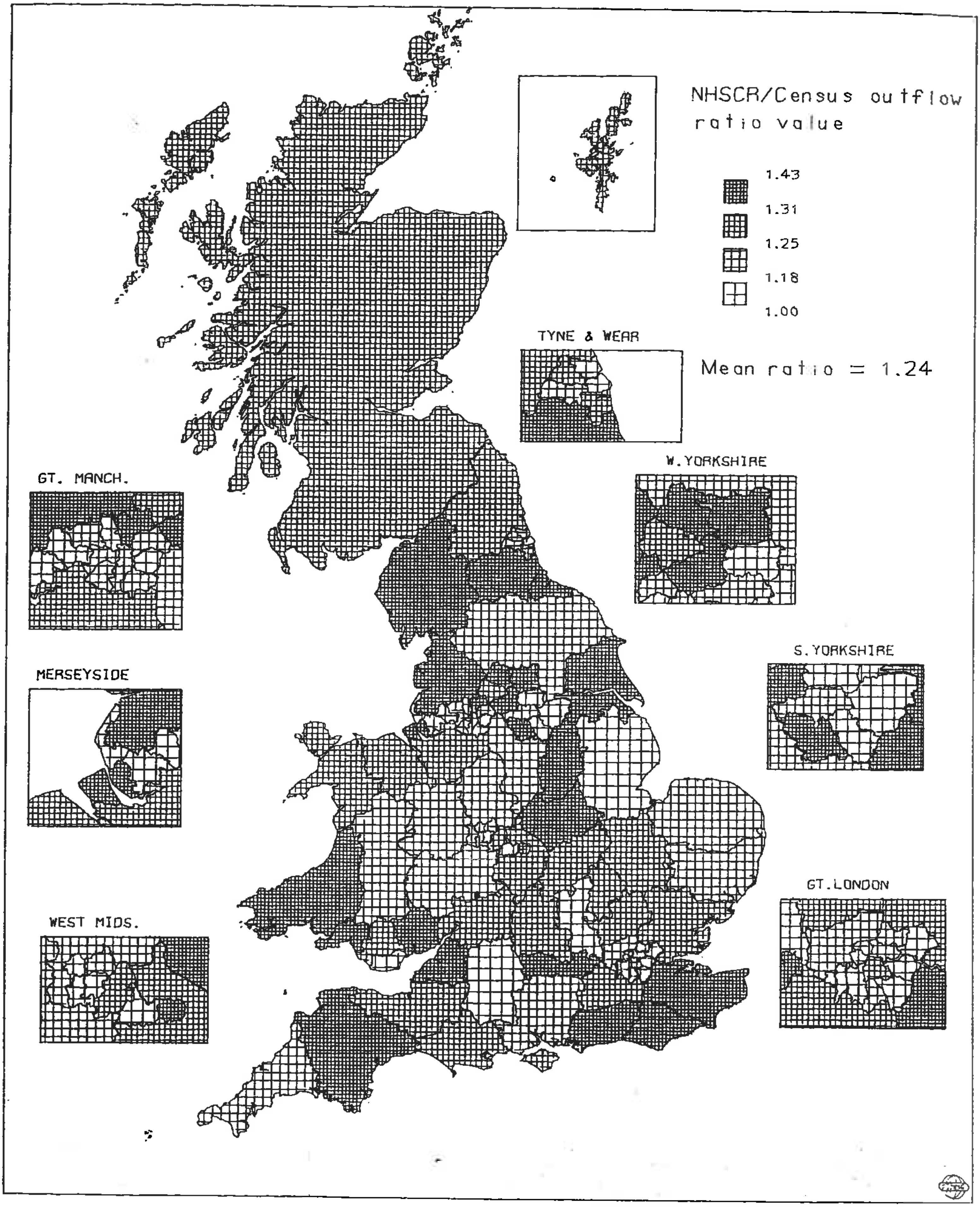


Figure 8. NHSCR/Census migration ratios for FPCAS: outflows

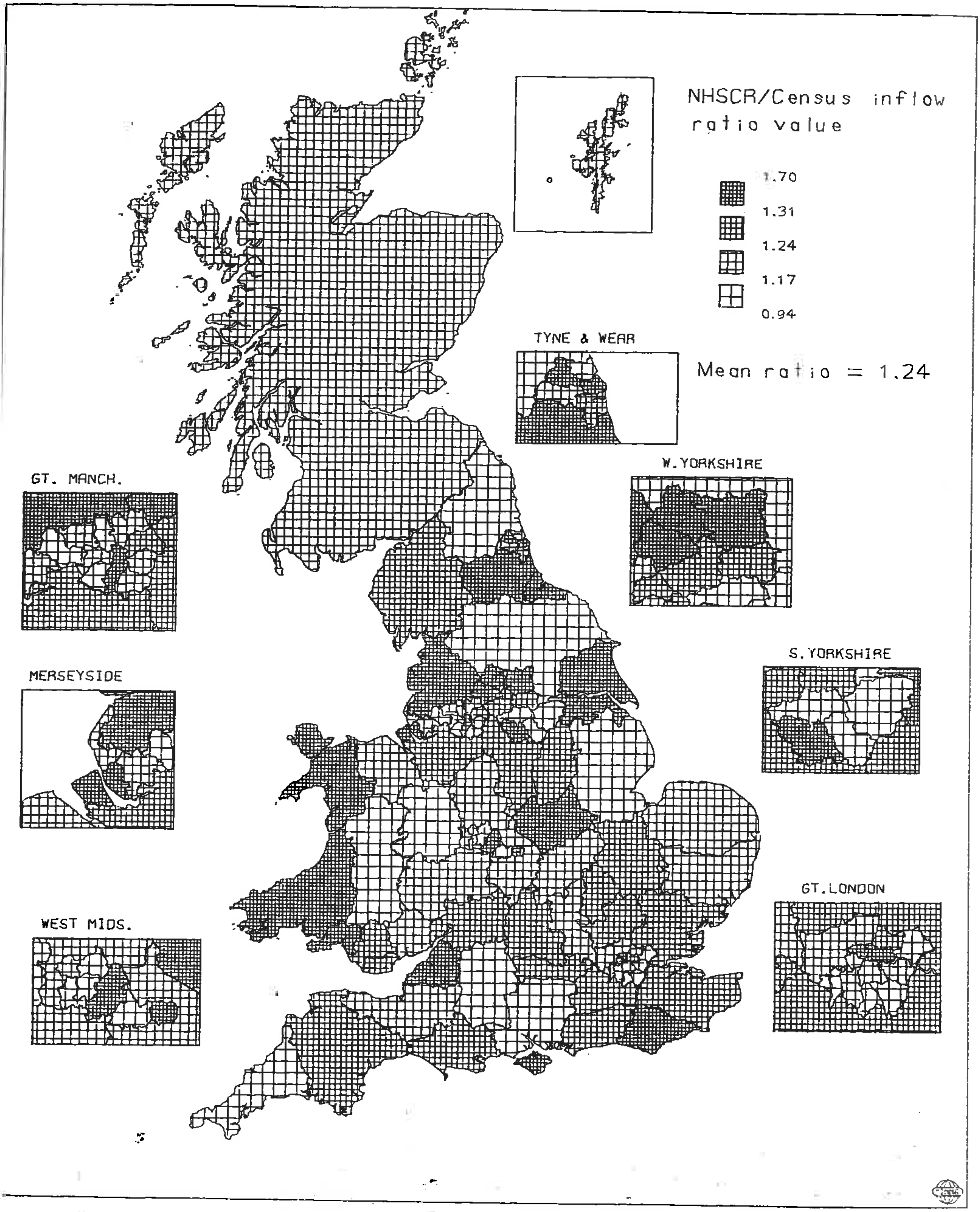


Figure 9. NHSCR/Census migration ratios for FPCAs: inflows

within metropolitan counties are below the national figure of 1.24 although West Yorkshire and Merseyside are exceptional in containing some FPCAs with relatively high ratios.

Ratios for flows from FPCAs within Greater London are all below the national figure with the one exception of the FPCA of Lambeth, Southwark and Lewisham. The highest ratios between the two data sets are found in East Sussex (1.43), Lancashire (1.43), West Glamorgan (1.40) and Durham (1.40) - all outside of metropolitan counties.

The inflow ratios at this scale further emphasise the discrepancies that exist between data for inflows to metropolitan zones. Although the range of ratios within each metropolitan county is substantial, certain FPCAs do exhibit relatively high ratios, such as, Coventry (1.70), Sheffield (1.64), Newcastle (1.56), Leeds (1.52) and Manchester (1.51). The FPCAs of West Glamorgan (1.65) and Cleveland (1.58) also have high ratio values. The FPCAs of Greater London show relatively low ratio values compared to other metropolitan zones. Those FPCAs with the lowest inflow ratios include the non-metropolitan counties of Lincolnshire (0.94), Wiltshire (0.99), Hampshire (1.03) and Northumberland (1.60) together with the metropolitan FPCAs of Dudley (0.99) and Sandwell (1.05). A list of inflow and outflow ratios at the FPCA scale is given in the appendix (Table A.1).

This tabulation also lists the NHSCR/Census netflow ratios for FPCAs. Considerable variation in the netflow ratio is illustrated for FPCAs. Leicestershire (86.6), Warwickshire (0.02) and Bromley (0.08) represent those FPCAs showing the greatest discrepancy between NHSCR and Census net flows.

Although the 19 overall NHSCR/Census migrant ratio has been shown to decrease as the scale becomes more refined (Table 3), the variation in the ratio is greatest at the FPCA level. At each spatial scale inflow discrepancies generally exceed those of outflows, with inflows to metropolitan zones (regions containing a metropolitan zone in the standard region case) having the greatest ratios. The largest discrepancy between NHSCR and Census inflows increases as the number of the metropolitan zone increases.

The analysis of inflow ratios at the FPCA scale highlights certain metropolitan zones as having extreme ratio values. It is possible to hypothesize that the movement of students might have a significant influence on the NHSCR/Census ratio in those metropolitan FPCAs containing a major educational establishment as will the importance of multiple and return moves. In Sections 4.4 and 4.5 we examine more closely how the ratio varies according to metropolitan status and zone contiguity at different spatial scales and attempt to provide some explanation for the differences that occur. However, in the following section, the relationship between the two types of data is quantified using correlation and regression analysis based on zone-specific, gross and net migration rates, as in Ogilvy (1980a).

4.3. The relationship between NHSCR re-registrations and Census migrant data at different scales

The relationship between migration derived from the NHSCR and Census can be quantified at standard region, EC2 region and FPCA scales using migration rates calculated using usually resident population from the 1981 Census. Out-, in- and net-migration rate correlation coefficients (Figure 10) are relatively high (above 0.9) at each spatial scale although the coefficient decreases as the mumber of zones in the system increases. Correlation coefficients for outmigration are generally higher than those for inmigration at each spatial scale, and the least significant correlation is found between net migration rates at the FPCA level (r=0.913). When least squares regression parameters are computed, intercept values appear to be largest at the smaller spatial scales although they are close to zero at all scales. The regression coefficient should reflect the overall NHSCR/Census ratio as long as the intercept is close to zero. However, as the spatial scale decreases, the slope of the regression also reduces and intercept increases. This is the case for outmigration and net migration rates but for inmigration rates, the slope value is lower at the EC2 region scale than at the FPCA scale. The slope value is smallest for net rates and falls below one for NHSCR and Census net rates at the EC2 and FPCA scales. The positive intercepts in all the regressions suggest that when Census-recorded migration is nil, there would still be NHSCR-registered migration, reflecting the additional population group, students, covered in part in NHSCR re-registrations, but not in the Census. The Figure 10 results suggest that the correlation between the aggregate migration data sets from the two sources at all three spatial scales is strong but they are likely to conceal considerable variations which will emerge when data is disaggregated further.

4.4. Ratios for metropolitan and non-metropolitan areas

It is interesting to group the gross flows at the EC2 and FPCA scales according to whether they involve metropolitan or non-metropolitan zones (Table 6). At the metropolitan county/region remainder level, aggregate ratios involving metropolitan zones are higher than ratios for non-metropolitan zones with NHSCR data exceeding census data for metropolitan inflows by 33.5%. At the FPCA level the lowest aggregate ratio is 1.207 for metropolitan outflows and the highest is 1.272 for non metropolitan outflows.

The change in the relative differences between ratios as the spatial scale becomes more refined is illustrated further in Table 7, which presents the ratios between the two data sets for flows between the sets of metropolitan and non-metropolitan origins and destinations. At the EC2 scale the NHSCR/Census ratio is 1.524 for inter-metropolitan flows and 1.298 for flows from non-metropolitan to metropolitan zones. However, at the more disaggregate FPCA scale the inter-metropolitan ratio decreases considerably to 1.144 whilst the ratio for non-metropolitan to metropolitan zone flows increases to 1.413. These variations contrast with much smaller variations at different spatial scales between ratios involving flows from metropolitan to non-metropolitan zones and flows between non-metropolitan

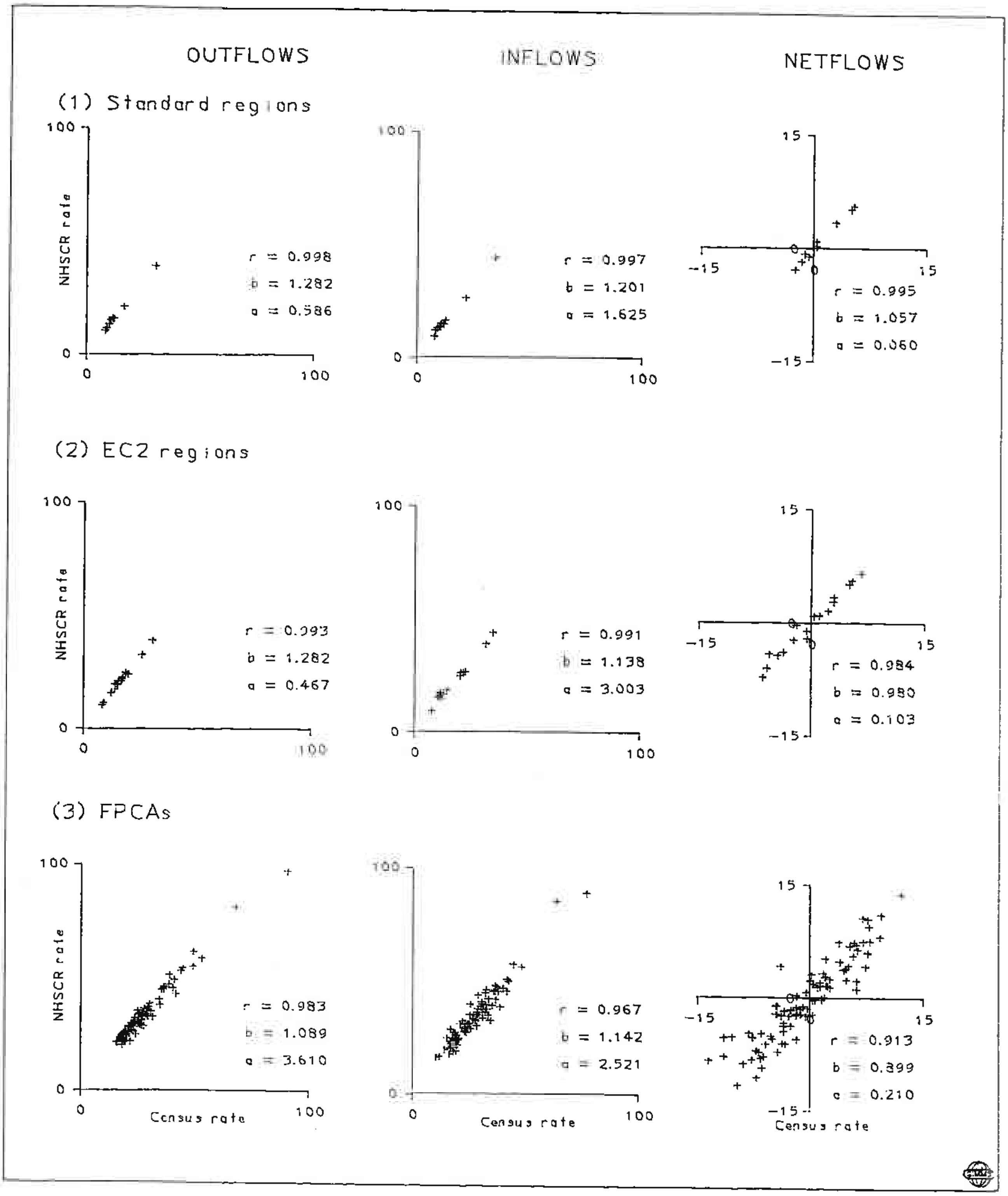


Figure 10. Scatterplots of HNSCR re-registrations against Census migrants at three spatial scales

Table 6. Aggregate ratios between NHSCR and Census inflows to and outflows from metropolitan and non-metropolitan zones

Type of flow	Spatial scale EC2 regions	FPCAs
Metropolitan inflows ratio	1.335	1.250
Metropolitan outflows ratio	1.319	1.207
Non-metropolitan inflows ratio	1.284	1.241
Non-metropolitan outflows ratio	1.293	1.272

Table 7. Aggregate ratios between NHSCR and Census data on flows between metropolitan and non-metropolitan zones.

Origins	Destinations Metropolitan	Non-metropolitan	Total
Metropolitan zones:			
EC2 regions	1.524	1.280	1.319
FPCAs	1.144	1.272	1.207
Non-metropolitan zones:			
EC2 regions	1.298	1.287	1.293
FPCAs	1.413	1.226	1.272
Totals:			
EC2 regions	1.335	1.284	1.303
FPCAs	1.250	1.241	1.245

zones.

Are the observations set out in Tables 6 and 7 consistent with our earlier interpretation (Section 4.1) of the differences between NHSCR and Census derived migration counts? The scale effect interpreted earlier is present in both Tables 6 and 7. In Table 6 all EC2 scale ratios are higher than the FPCA scale ratios in the corresponding row. In Table 7 all entries in the EC2 region rows are higher than the ratios reported for FPCAs in the corresponding columns.

Table 6 shows an interesting reversal when in- and out-flow ratios are compared. The metropolitan inflow ratios exceed the metropolitan out-flow ratios at both scales; the non-metropolitan inflow ratios are, however, smaller than the non-metropolitan out-flow ratios at both scales. These observations are consistent if we regard non-metropolitan zones as consistently more favoured by migrants than metropolitan. The inflow ratios for metropolitan zones are high because more return migration out of these unattractive zones takes place and this depresses the Census count. Conversely, the outflow ratios for metropolitan zones are lower because more migrants stay out once they have left (i.e. there is less return migration); the Census count is thus less depressed vis a vis the Register count than in the inflow case. Exactly, the reverse arguments apply when inflow and outflow ratios for the more attractive non-metropolitan zones are considered.

This interpretation is consistent with the inter-zonal flow ratios recorded in Table 7, except for the flows from metropolitan FPCAs, where the NHSCR/Census ratio is higher for non-metropolitan destination.

4.5. Inter-zonal flow ratios based on zone contiguity and status

Extensive comparison of the Census and NHSCR arrays can be undertaken by analysing individual flow ratios at the three alternative spatial scales. However, the grouping of flows into categories based on zone contiguity and metropolitan or non-metropolitan status has presentation advantages. In this section the analysis of metropolitan and non-metropolitan ratios is limited to data for the EC2 and FPCA levels whereas the analyses based on zone contiguity applies to all three spatial scales.

Table 8 illustrates that the overall ratios for flows between contiguous zones and between non-contiguous zones diverge as the number of zones increases. At the standard region scale, the contiguous zone flow ratio exceeds that for flows between non-contiguous zones. At the EC2 region and FPCA level, the reverse is true with the ratio between contiguous zone flows being considerably lower than that involving non-contiguous zone flows. Thus, there appears to be greater consistency for Census and NHSCR flows between zones which are adjacent at both the more refined spatial scales.

Table 7 in section 4.4 illustrated the breakdown of flow ratios into metropolitan and non-metropolitan categories. Table 9 takes the classification a stage further by subdividing the flows involved on the basis of zone contiguity. At the EC2 region scale, the greatest ratio

Table 8. Aggregate ratios between NHSCR and Census data on flows between contiguous zones and between non-contiguous zones.

	Spatial scale		
	Standard Region	EC2 region	FPCA
Inter-contiguous zone flow ratio	1.34	1.26	1.17
Inter non-contiguous zone flow ratio	1.32	1.33	1.26

Table 9. Ratios between NHSCR and Census flows involving contiguous and non-contiguous metropolitan and non-metropolitan zones.

	Spatial scale	
	EC2 Regions	FPCA
Contiguous:		
Metropolitan inflows	1.256	1.142
Metropolitan outflows	1.252	1.124
Non-metropolitan inflows	1.272	1.197
Non-metropolitan outflows	1.272	1.227
Non-contiguous:		
Metropolitan inflows	1.396	1.283
Metropolitan outflows	1.360	1.230
Non-metropolitan inflows	1.293	1.248
Non-metropolitan outflows	1.312	1.280

differential is found between inflows and outflows involving non-contiguous metropolitan zones. Little variation between ratios is exhibited for flows between contiguous zones at this scale. At the more disaggregate scale, all the ratios are smaller with the greatest values now shown by inflows to and outflows from non-contiguous metropolitan zones. Greatest consistency at this level is exhibited by ratios involving inflows to and outflows from contiguous metropolitan zones.

Table 10 illustrates the classification of individual inter-zonal flow ratios based on ratio size. The figures refer to percentage distributions. Once again, these individual size categories can be sub-divided on the basis of contiguity and metropolitan status. Figure 11 uses bar charts to illustrate the proportion of ratios in each size category which involve flows between contiguous and non-contiguous zones. At the regional level the extreme ratio values (i.e. <1 and 1.6+) consist entirely of flows between non-contiguous zones. Flows between contiguous zones are of greatest importance in the 1.4-1.6 size category where they comprise 50% of the ratios.

Again at the EC2 region scale, flows between non-contiguous zones are responsible for the majority of extreme ratio values, with contiguous zone flow ratios of most importance in the 1.2-1.4 category. At the FPCA scale, flows between non-contiguous zones are dominant throughout with less than 5% in each ratio category attributable to contiguous flows.

Classification of the ratios by size and metropolitan status (Figure 12) indicates that, at the EC2 scale, those ratios with a value of less than one relate entirely to flows from non-metropolitan zones. For the largest ratio category (1.6+), the majority of ratios relate to flows to metropolitan zones with approximately 35% being between metropolitan zones and 45% from non-metropolitan to metropolitan zones. At the FPCA level, the first three ratio categories show fairly similar proportions in each status-group. In the 3-4 and 4+ ratio size categories, flows between metropolitan zones begin to assume greater importance with approximately 50% of the largest ratios being in this group. Flows from non-metropolitan to metropolitan zones have little significance in the highest category in this case.

A double classification of the ratio categories based upon contiguity and metropolitan status produces the bar charts in Figure 13. At the EC2 scale all flows between contiguous zones in the highest ratio category are to metropolitan zones with the lower categories consisting mainly of flows between non-metropolitan zones. Flows between non-contiguous zones at this level are dominated again by inter-non-metropolitan zone transfers in the lower ratio categories with flows to metropolitan zones being of greatest importance in the 1.6+ category. At the FPCA level the most striking feature of the inter-contiguous zone flows is the dominance of inter-metropolitan zone flows in the highest ratio category. Non-contiguous zone flows into metropolitan zones are of the greatest importance in the higher ratio categories.

Table 10. Percentage classification of inter-zonal flow ratios by ratio size.

NHSCR/Census inter-zonal flow ratio r	Spatial scale Standard regions	EC2 regions	FPCA
$r<1.0$	7.4	3.9	19.8
$1.0\leq r<1.2$	12.7	16.1	14.8
$1.2\leq r<1.4$	50.0	33.6	14.8
$1.4\leq r<1.6$	24.5	22.2	12.7
$1.6\leq r<1.8$	3.6	14.1	8.5
$1.8\leq r<2.0$	0.9	5.2	5.6
$2.0\leq r<3.0$	0.9	4.9	15.2
$3.0\leq r<4.0$	0.0	0.0	4.1
4.0 +	0.0	0.0	4.5
Totals	100.0	100.0	100.0

Table 11. Statistics comparing NHSCR and Census inter-zonal flows

Statistic	Spatial Scale Standard regions	EC2 regions	FPCAs
Information Gain	0.005	0.009	0.053
Mean Absolute Deviation	25.08	23.68	25.84
Index of Dissimilarity	3.7	4.7	11.1
Correlation Coefficient	0.996	0.995	0.980

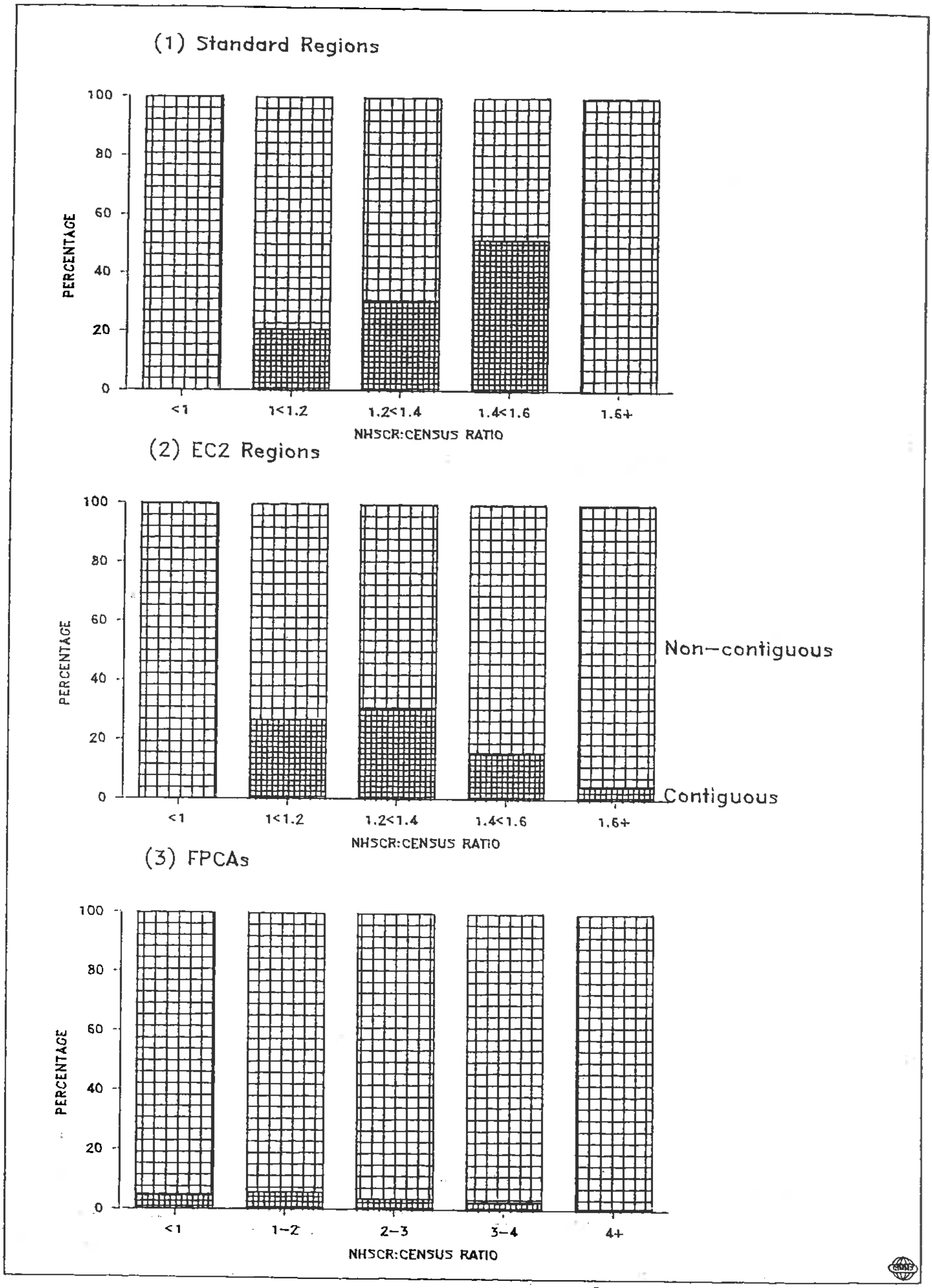


Figure 11. Inter-zonal flow ratios at different scales: percentages contiguous and non-contiguous

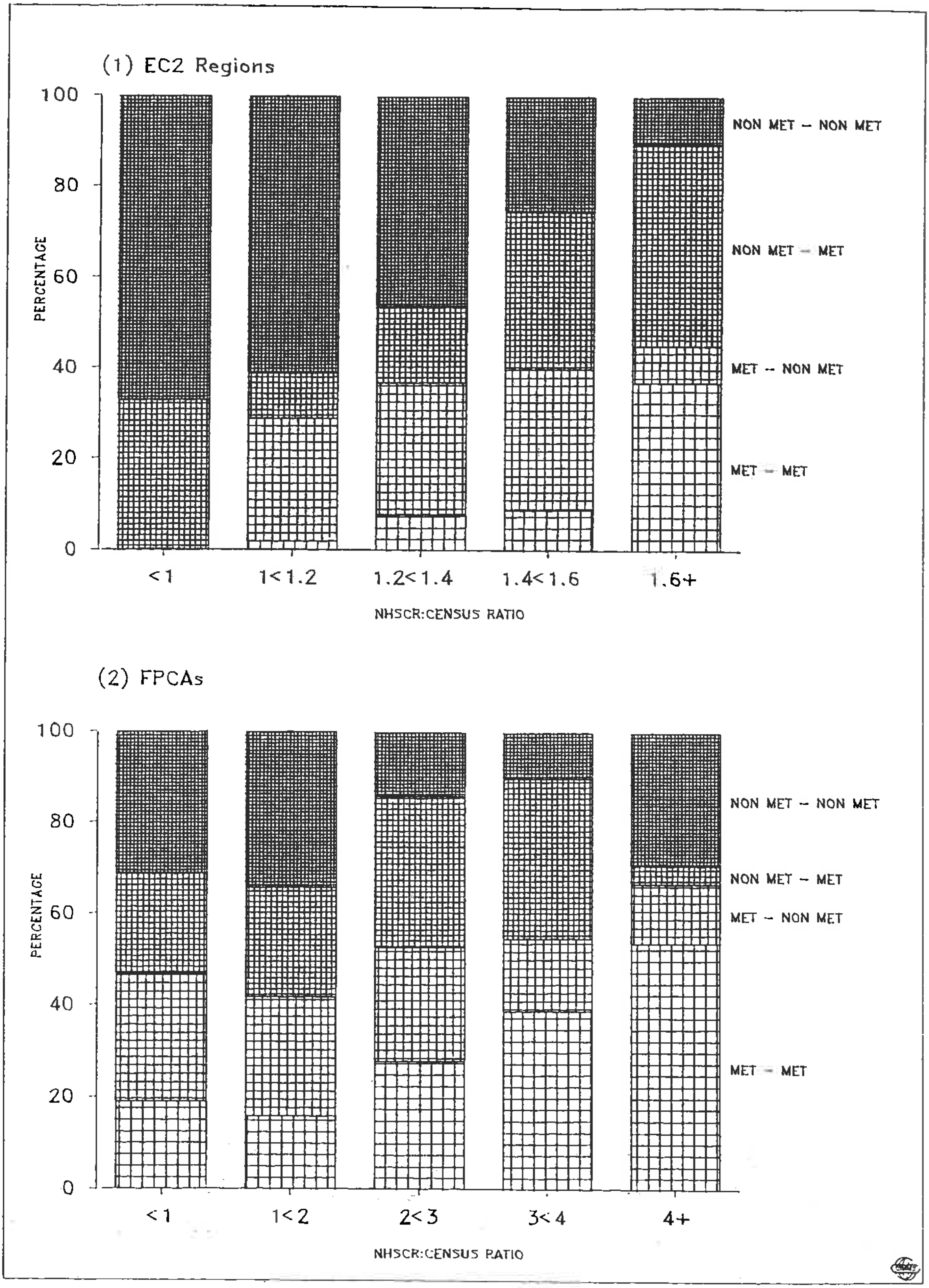


Figure 12. Inter-zonal flow ratios by size and zone status

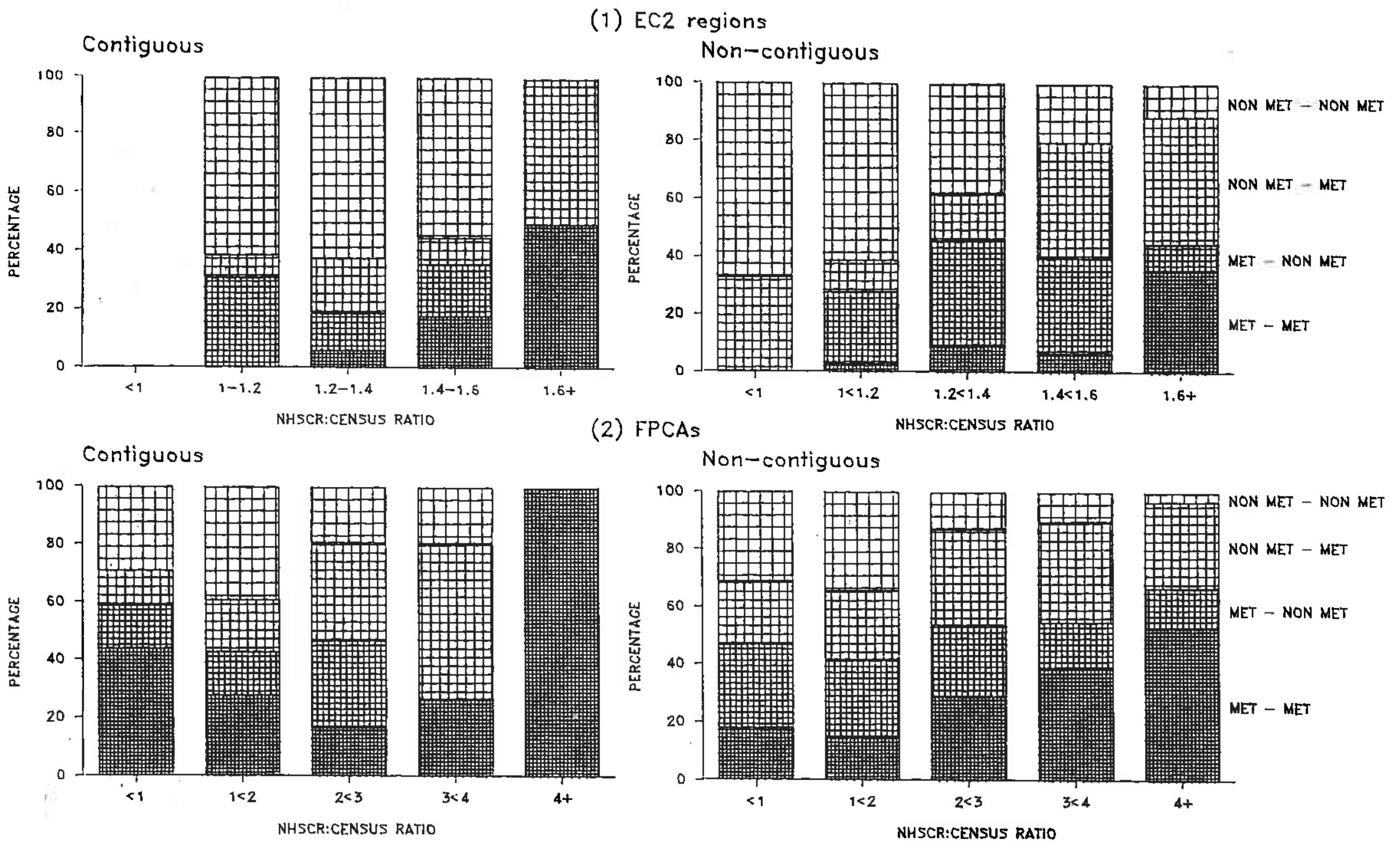


Figure 13. Inter-zonal flow ratios by size, zone status and zone contiguity

4.6. Conclusions

The preceding sections have highlighted the relatively large discrepancies that exist between certain NHSCR and Census flows at all three spatial scales. Flows to metropolitan zones at the EC2 and FPCA scale exhibit the largest ratios. At EC2 level, NHSCR and Census inflows to metropolitan zones differ by 33.5% and by 52.4% when considering only flows from other metropolitan zones. The ratio is greater when metropolitan zones are non-contiguous. At the FPCA level, relatively large ratios between NHSCR and Census metropolitan inflows (1.25) are again in evidence, however in this instance, ratios involving flows from non-metropolitan to metropolitan zones have the greatest discrepancy (41.3%) with the lowest ratio (14.4%) being recorded for inter-metropolitan flows. Again at the FPCA level it is the non-contiguous metropolitan inflows and non-metropolitan outflows which show the greatest discrepancies. The effect of disaggregation has, therefore, been to reduce the metropolitan inflow ratio by including flows within EC2 regions in the analysis and increasing the proportion of inter-metropolitan flows, and reducing the importance of multiple and return moves. The identification of the largest ratios involving flows to certain metropolitan FPCAs needs to be taken a step further by analysing age and sex disaggregated NHSCR and Census inflows to these zones. The movement of students from domicile region to place of education will have an important effect on the NHSCR/Census discrepancy, and it is the analysis of NHSCR and Census flows in the most mobile age-groups (10-24) which will provide further explanation of the major differences that have been highlighted. The issue is taken up again in section 6 after a comparison of the NHSCR and Census flow matrices using techniques of goodness of fit measurement developed in spatial interaction modelling.

5. STATISTICAL AND MODEL BASED COMPARISONS OF INTER-ZONAL MIGRATION

5.1. A Statistical comparison of the NHSCR and Census inter-zonal flow matrices

In this section, summary statistics are computed which provide an indication of the overall relationship between the NHSCR and Census inter-zonal flow matrices at the three alternative spatial scales. Knudsen and Fotheringham (1986) have classified alternative 'goodness-of-fit' statistics into three categories: information based statistics, general distance statistics and traditional statistics; and four appropriate examples from these three categories are presented in Table 11.

The information gain statistic is the basis of all information-based statistics. The formula for computation here is:

$$IGS = I(P:Q) = \sum_{i=1}^{m} \sum_{j=1}^{n} p_{ij} \ln (p_{ij}/q_{ij}) \qquad (15)$$

where,

m,n are matrix dimensions or number of origin and destination zones respectively.

p_{ij}, q_{ij} are elements of discrete probability distributions P and Q, where

$$p_{ij} = M_{ij} / \sum_{i=1}^{m} \sum_{j=1}^{n} M_{ij} \qquad (16)$$

$$q_{ij} = T_{ij} / \sum_{i=1}^{m} \sum_{j=1}^{n} T_{ij} \qquad (17)$$

where M_{ij} is the observed NHSCR inter-zonal migration and T_{ij} is the observed Census inter-zonal migration. The information gain statistic has a minimum of zero when P = Q and a maximum of positive infinity when $p_{ij}>0$ and $q_{ij} = 0$ for any i,j combination. The statistic is used here to analyse non-zero elements of the respective arrays. The information gain is low in all three cases showing a strong relationship between NHSCR and Census flows at each spatial scale, although the statistic increases as the scale becomes more disaggregate.

Two general distance statistics are computed - the mean absolute deviation and the index of dissimilarity. The MAD statistic, represented in Table 11 as a percentage, has the following computational formula:

$$MAD = \frac{\sum_{i}^{n} \sum_{j}^{m} |M_{ij} - T_{ij}|}{\sum_{i}^{n} \sum_{j}^{m} Mij} \cdot 100 \qquad (18)$$

where the sum of the absolute deviations is divided by the sum of the NHSCR inter-zonal transfers. The mean deviation is lowest at the EC2 scale at 23.7% in contrast to the regional scale where it is 25.1% and the FPCA scale where it is highest. When interpreting the MAD statistic it must be noted that the values in Table 11 incorporate the general difference between NHSCR and Census levels as well as the individual flow differences which contrasts to a statistic such as the IGS which measures relative variation between the data sets. For this reason the MAD statistics must be assessed in the light of the overall discrepancies illustrated in Table 3.

The index of dissimilarity is an index which compares two distributions by calculating the sum of deviations between cell proportions in the two matrices. The IOD ranges from 0 to 100 with zero indicating perfect correspondence and 100 indicating complete dissimilarity. The formula for computation is:

$$IOD = \sum_{i}^{n} \sum_{j}^{m} \left| (M_{ij} / \sum_{i}^{n} \sum_{j}^{m} M_{ij}) - (T_{ij} / \sum_{i}^{n} \sum_{j}^{m} T_{ij}) \right| 50 \qquad (19)$$

The degree of dissimilarity is relatively low at all three spatial scales with the IOD value of 11.1 at the FPCA level being the greatest illustrating a greater distance between NHSCR and Census flows at this scale. The three index values are in conformity with the IGS over the three spatial scales.

The correlation coefficient is representative of what Knudsen and Fotheringham refer to as traditional statistics. r can have a value between zero, indicating no correspondence between the two arrays and one, indicating perfect correlation. It is defined as

$$r = \{\sum_{i}^{n} \sum_{j}^{m} (M_{ij} - \bar{M})(T_{ij} - \bar{T}) / (\sum_{i}^{n} \sum_{j}^{m} (M_{ij} - \bar{M})^2 - \sum_{i}^{n} \sum_{j}^{m} (T_{ij} - \bar{T})^2\}^{0.5} \qquad (20)$$

The r coefficient indicates strong correlation between the Census and NHSCR arrays at all three spatial scales with the strength of correlation decreasing as the spatial scale becomes finer. If the MAD statistic is interpreted correctly then all the measures computed highlight a strong relationship between NHSCR and Census flows at all three levels with the strength of the statistical relationship decreasing as the level of disaggregation increases.

The scatterplots of values from the NHSCR and Census matrices are illustrated in Figure 14 and emphasize the strong correlation between NHSCR and Census inter-zonal flows at the three spatial scales. The regression parameters computed for each data set indicate that the intercept value is smallest at the FPCA scale (19.59) and largest at the EC2 scale (195.3) The slope of the regression line reflects the positive relationship between NHSCR and census flows and decreases as the degree of spatial disaggregation increases, in line with the decline in the size of the

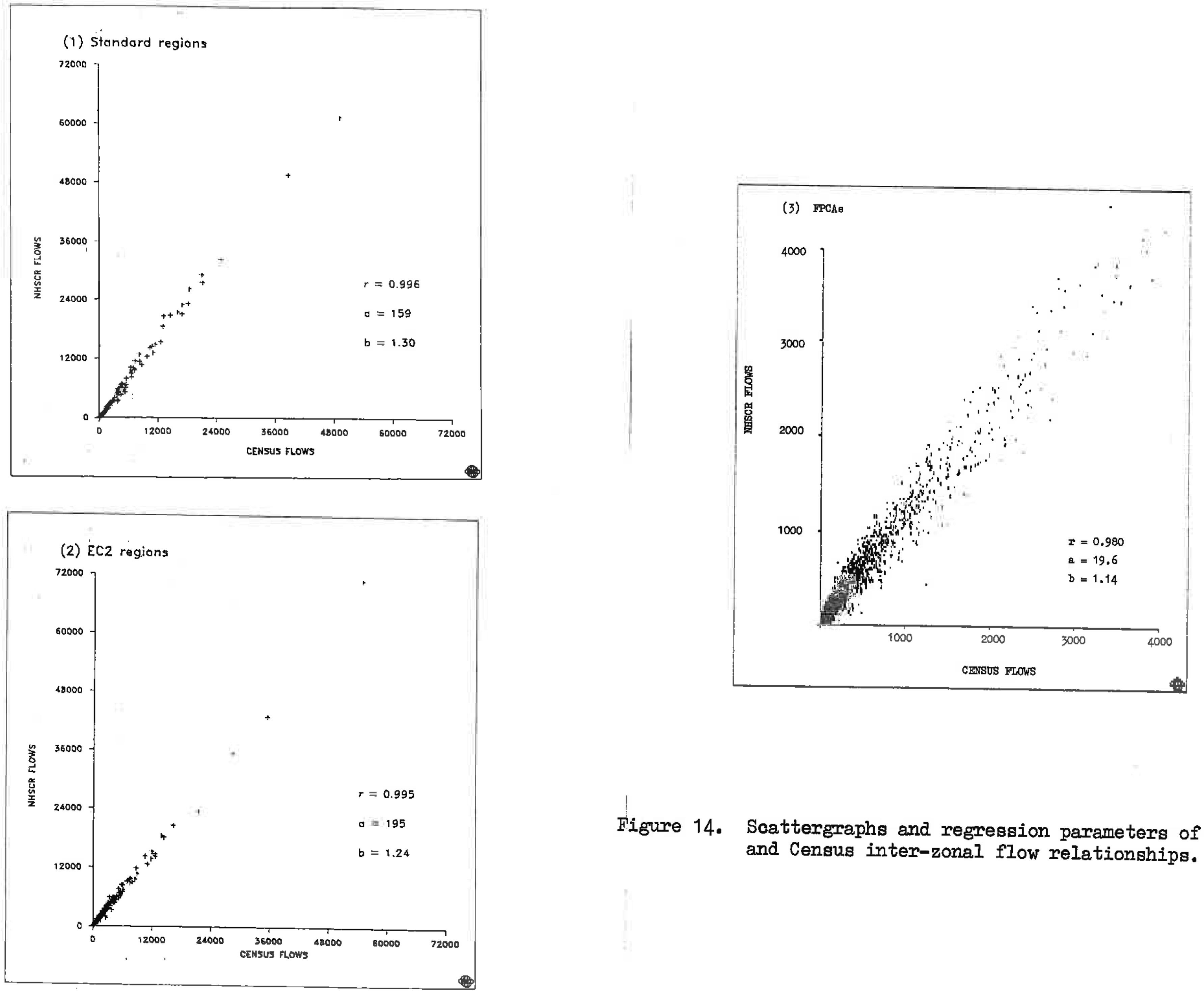


Figure 14. Scattergraphs and regression parameters of NHSCR and Census inter-zonal flow relationships.

overall ratio.

5.2. A comparison of inter-zonal flows using a spatial interaction model

The inter-zonal movement and transition arrays can be compared using a doubly-constrained spatial-interaction model which establishes the relationship between distance moved and either migration in the system as a whole or migration from individual origins or to individual destinations, following Stillwell (1984). A doubly constrained spatial interaction model can be defined for migration between zone i and zone j, M_{ij}, as:

$$M_{ij} = A_i B_j O_i D_j f(d_{ij}) \qquad (21)$$

where

O_i is the total outmigration from zone i
D_j is the total inmigration to zone j

$f(d_{ij})$ is a function of the distance between the centroid of zone i and that of zone j

and A_i and B_j are balancing factors defined as:

$$A_i = 1/\sum_j B_j D_j f(d_{ij}) \qquad (22)$$

$$B_j = 1/\sum_i A_i O_i f(d_{ij}) \qquad (23)$$

which are used to ensure that the constraints

$$O^i = \sum_j M_{ij} \quad (24) \qquad \text{and } D_j = \sum_i M_{ij} \qquad (25)$$

are satisfied.

The analysis reported here refers only to migration at the FPCA scale and inter-zonal distances have been measured in kilometres between centres of population of individual FPCAs (OPCS, 1984). Glasgow has been chosen as the zone centroid of Scotland, and Northern Ireland and the Isle of Man have been excluded from the analysis partly because only Census in-migration data from these two zones is available, and partly because of difficulties involved in measuring distances between these zones and other zones in the system. The negative power distance function (d_{ij} ⁻beta) has been utilized in preference to the negative exponential function and the optimum decay parameter, beta, which is estimated using a Newton Raphson iterative routine in the IMP package (Stillwell, 1984) can be interpreted as a measure of the propensity to migrate over distance, so that higher beta values indicate a more significant friction of distance effect on migration.

Initial fits of the doubly constrained model to the two arrays produced a generalized decay parameter value of 1.295 with an observed mean migration distance of 124 kilometres for the Census data and a lower beta value of 1.194, with a higher mean movement distance of 130 kilometres, for the NHSCR data. The friction of distance effect appears, therefore, to be greater for the Census data and migrant transitions occur over shorter distances, on average, than NHSCR moves. These findings are consistent with the hypothesis about the influence of return migration on the scale effect put forward in Section 4.1. The average distance recorded for Census transitions will be lower than the mean distance for NHSCR moves (all other things being equal) if there is a tendency for persons making second moves in the year to return to their origin areas at the start of the year.

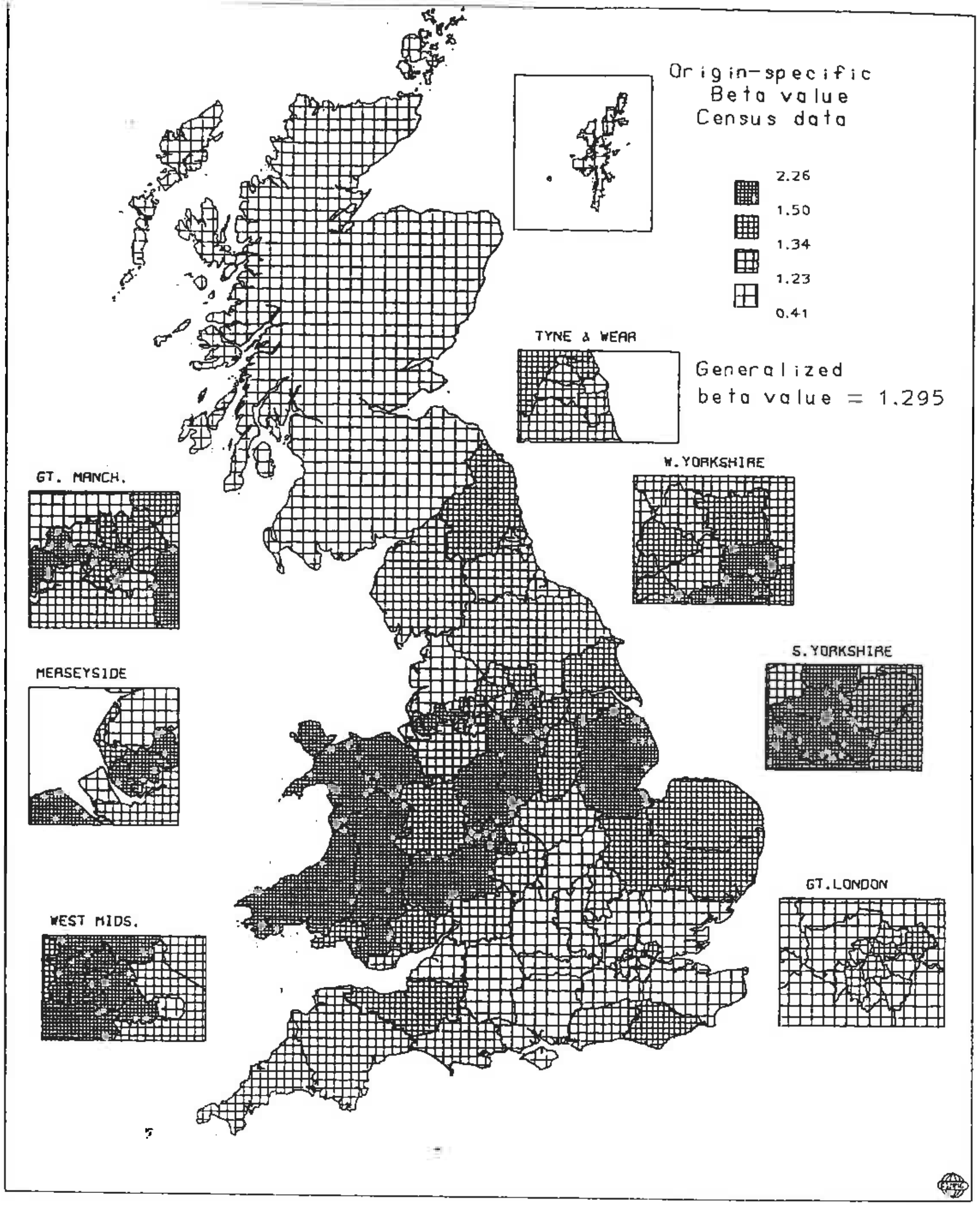
To assess the spatial variation in the effect of distance upon migration, origin and destination-specific parameters have been calibrated on data from both sources. These illustrate variations in the perception of distance as a deterrent to movement to and from individual zones in the system. Figures 15 and 16 illustrate the origin- and destination-specific parameters calibrated using each type of data and Table 12 lists the highest and lowest values in each case.

The origin-specific parameters reveal that Census migrants from the non-metropolitan counties of Powys, Gwynedd and Hereford and Worcester together with migrants from the metropolitan districts of Sandwell, Rotherham, Walsall, Wolverhampton and Dudley perceive distance to have the greatest influence on their movement whilst the former are also high in the list based on NHSCR data. Lincolnshire and Dyfed also appear with high values.

Census outmigrants least affected by distance originate from Scotland and from non-metropolitan FPCAs in the South-West and South-East regions whilst NHSCR movers least effected by distance are those from Scotland, non-metropolitan FPCAs in the South-East, Northamptonshire and also a number of FPCAs within Greater London.

The highest Census and NHSCR-based destination-specific parameters are found again in Powys and Gwynedd and those FPCAs exhibiting the lowest destination-specific values are Scotland and certain Greater London FPCAs, showing that in both cases persons moving to the South-East as well as away from it are least affected by the friction of distance.

Census and NHSCR origin-specific parameters exhibit a generally strong relationship as indicated by a correlation coefficient (r) of 0.924. The coefficient value for destination-specific parameters is greater with a value of 0.938.



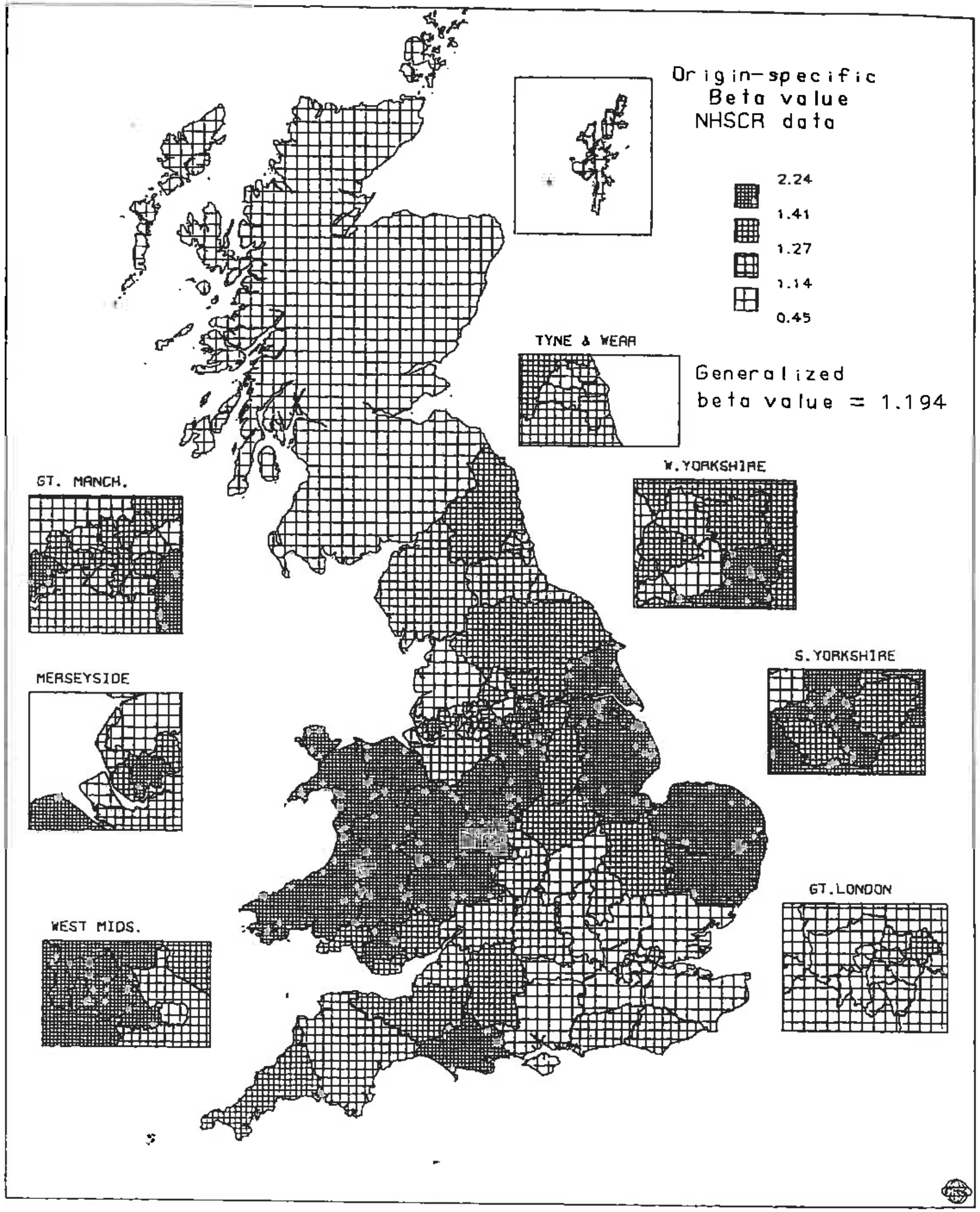
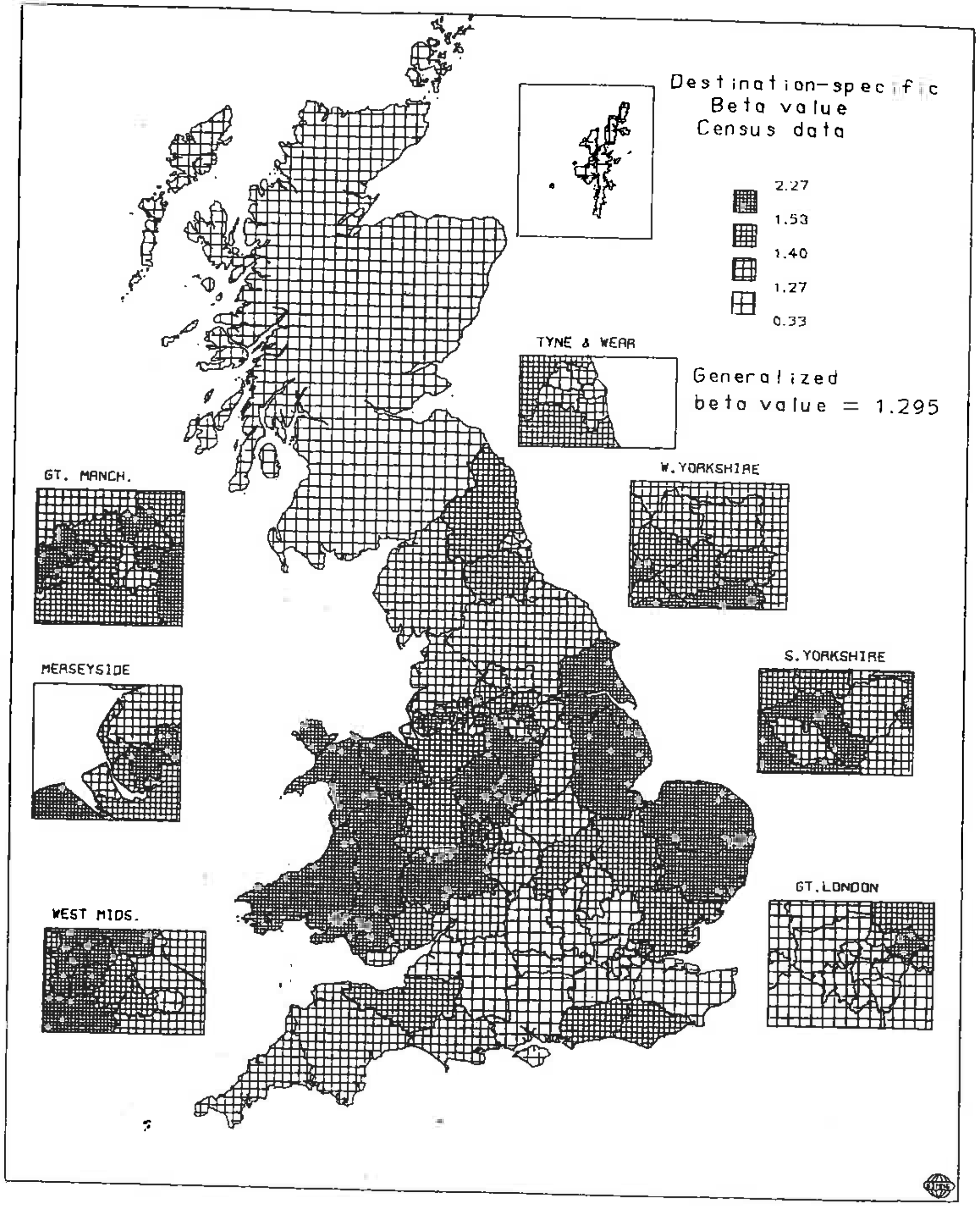


Figure 15. Origin-specific decay parameters for FPCA's using NHSCR and Census data.



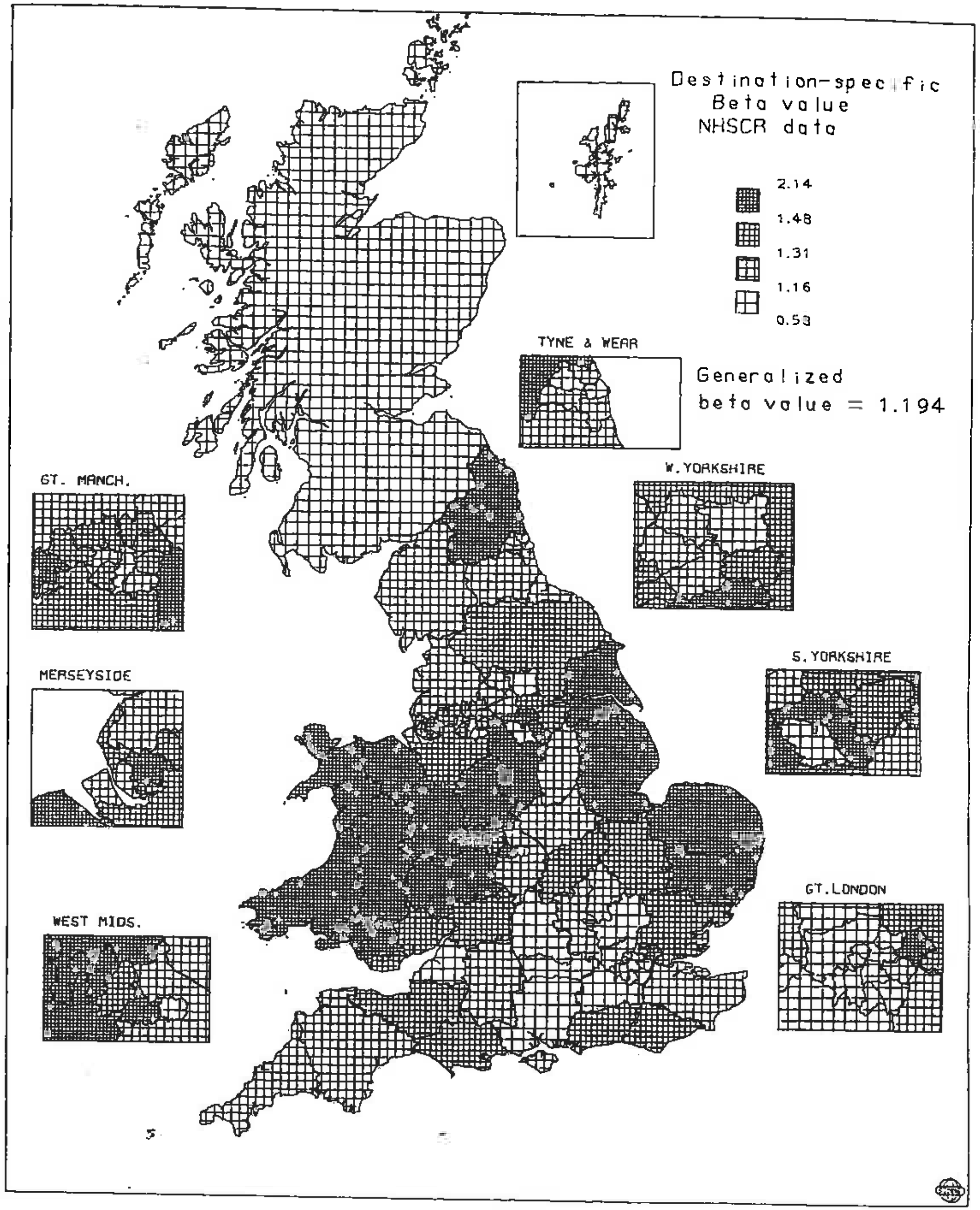


Figure 16. Destination-specific decay parameters for FPCA's using NHSCR and Census data.

Table 12. <u>FPCAs with highest and lowest origin and destination-specific decay parameters.</u>

Rank	Census	Origin-specific beta value	NHSCR	Origin-specific beta value
1	Powys	2.260	Powys	2.243
2	Gwynedd	1.899	Gwynedd	1.918
3	H'ford & Worcs	1.776	Lincolnshire	1.690
4	Sandwell	1.734	Dyfed	1.662
5	Rotherham	1.730	H'ford & Worcs	1.597
6	Walsall	1.722	Dudley	1.592
89	Buckinghamshire	1.113	Berkshire	1.024
90	Isle of Wight	1.100	Surrey	1.012
91	Kent	1.083	R'mond & K'ston	0.985
92	Wiltshire	1.050	Northamptonshire	0.973
93	Hampshire	0.940	Hertfordshire	0.973
94	Scotland	0.412	Scotland	0.446
		Destination specific beta value		Destination specific beta value
1	Powys	2.279	Powys	2.144
2	Gwynedd	2.017	Gwynedd	2.008
3	Staffordshire	1.946	Staffordshire	1.785
4	H'ford & Worcs	1.852	H'ford & Worcs	1.753
5	Walsall	1.820	Lincolnshire	1.689
6	West Glamorgan	1.778	Dyfed	1.686
89	Lambeth, Southwark Lewisham	1.050	Merton, Sutton Wandsworth	0.977
90	Middlesex	1.013	Lambeth, Southwark Lewisham	0.898
91	Hampshire	0.997	Middlesex	0.889
92	Camden & Islington	0.946	Camden & Islington	0.787
93	K'ton, Chelsea Westminster	0.807	K'ton, Chelsea Westminster	0.655
94	Scotland	0.333	Scotland	0.582

6. THE COMPARISON OF AGE AND SEX-DISAGREGGATED DATA SETS AT THE FPCA SCALE

6.1. Total inflow ratios by age and sex

This section takes the comparative analysis a step further by examining differences between two age and sex disaggregated data sets which consist of inflows to all FPCAs disaggregated by 5 year age-groups from 5-9 to 70-74 together with the 1-4 and 75+ groups and by sex. The conversion and estimation routines applied to the data have been discussed in section 3.

Table 13 illustrates the breakdown of total inflow ratios by five-year age-group and sex. The greatest discrepancies between ratios for persons are found in the 15-19 and 70-74 age groups. There are also significant differences between the data sets for persons aged 10-14 and 35-39. Ratios in the 40-44 age-group show the greatest comparability, with the 20-24 group also exhibiting a relatively low discrepancy.

The overall NHSCR Census ratio of 1.266 hides the considerable variation that exists between the sexes. At the level of FPCA, female ratios show a far higher discrepancy (1.34) than the male ratios (1.19). Analysis of individual age-groups indicates that the greatest ratio between female flows is found in the 15-19 age-group (1.95) with large values also being found in the 70-74 (1.62) and the 35-39 (1.51) age-groups. Female and male flows in the 40-44 age-group exhibit a ratio value of almost unity as do male flows in the 20-24 and 25-29 age-groups. The 70-74, and the 10-14 groups in particular have the largest discrepancies between male flows.

Figure 17 gives a graphical illustration of the variation in ratio size by sex and age-group (cf Devis and Mills, 1986, Figure 2.1). The three peaks emphasize the inconsistency between NHSCR and Census flows in the 10-19 age-range, the 35-39 age-group and the 70-74 age-group. In the 10-19 age range male flows have the larger ratio value in the 10-14 group but the female discrepancy is predominant in the 15-19 age-group. The female ratio is greatest again in the late thirties age-range but the male flow ratio is greater for 70-74. Both male and female ratios exhibit a low point in the 40-44 age-range but it is only male flow ratios that have a relatively low value in the 20-29 age-range.

6.2 Age and sex disaggregated inflow ratios for FPCAs

The total inflow ratio for each FPCA, disaggregated by age and sex can be categorised on the basis of ratio size (Table14), emphasising the relatively large discrepancies that exist between data on flows in the 15-19 age-group and also in the 70-74 age-group for certain FPCAs. 30% of NHSCR flows in the 15-19 age-group are more than twice the size of the corresponding census figure, with 12% being more than 3 times larger. Similar percentages for the 70- 74 age-group are 25% and 5%.

The greatest number of ratios in the lowest size category is found in the 40-44 age-group, where approximately 43% of census zonal inflows have values greater than the corresponding NHSCR inflows. Statistical indices

Table 13. Overall NHSCR/Census FPCA inflow ratios by age and sex

Age-group	Persons	Males	Females
1-4	1.185	1.194	1.176
5-9	1.279	1.290	1.266
10-14	1.489	1.569	1.404
15-19	1.663	1.405	1.947
20-24	1.149	1.003	1.281
25-29	1.168	1.066	1.285
30-34	1.213	1.148	1.291
35-39	1.446	1.393	1.513
40-44	1.016	1.011	1.022
45-49	1.301	1.283	1.324
50-54	1.263	1.266	1.261
55-59	1.285	1.283	1.287
60-64	1.267	1.276	1.260
65-69	1.273	1.255	1.291
70-74	1.651	1.695	1.619
75+	1.273	1.259	1.280
TOTALS	1.266	1.192	1.342

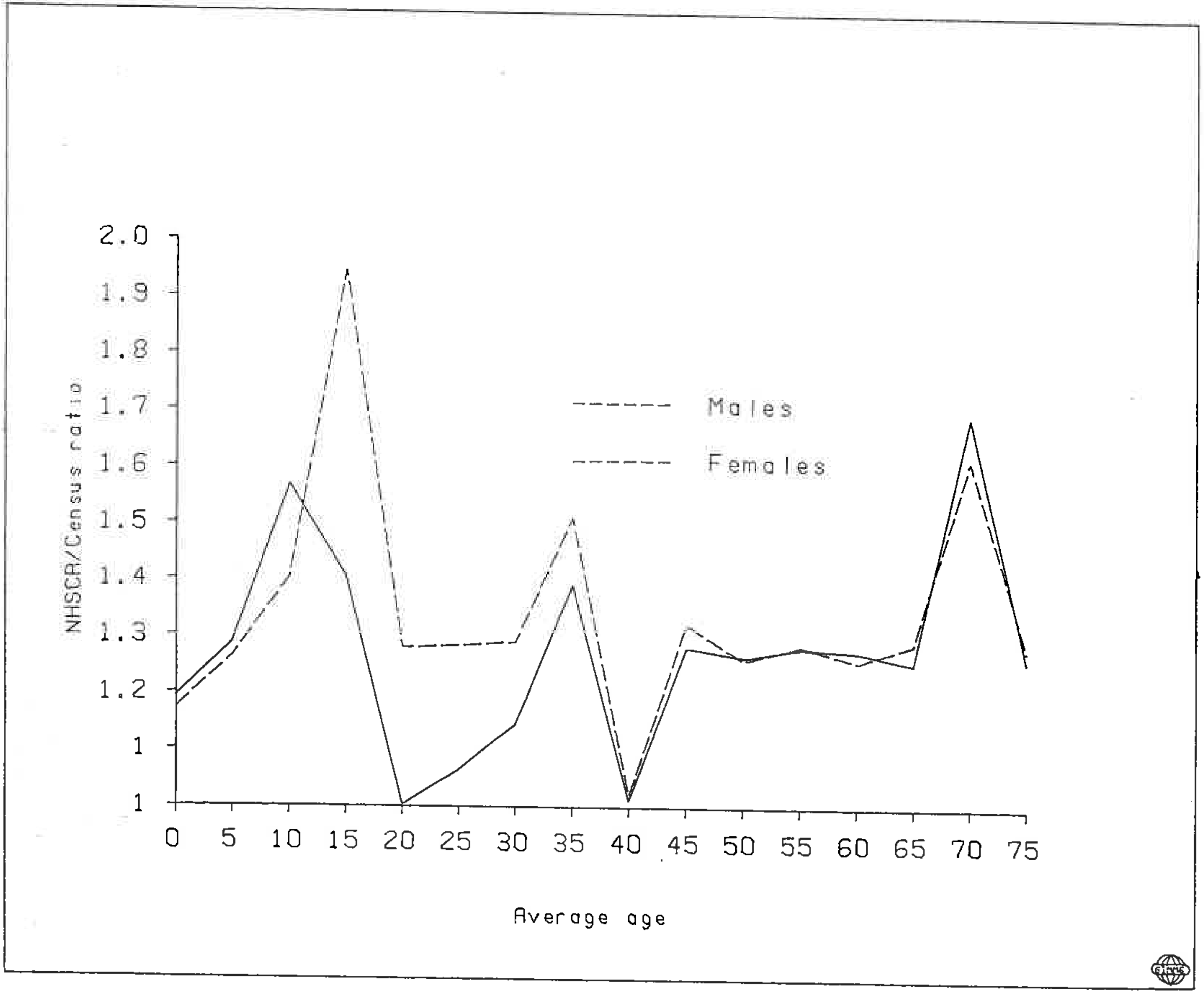


Figure 17. NHSCR/Census inflow ratios by age and sex.

Table 14. <u>Age and sex-disaggregated NHSCR/Census FPCA inflow ratios by ratio size</u>

Age-group	Males				Females			
	Ratio Value							
	1	1 2	2 3	3+	1	1 2	2 3	3+
1-4	18	77	0	0	18	76	1	0
5-9	7	87	1	0	15	80	0	0
10-14	4	85	6	0	8	81	6	0
15-19	16	53	16	10	2	62	18	13
20-24	40	55	0	0	2	93	0	0
25-29	29	66	0	0	4	91	0	0
30-34	19	76	0	0	10	85	0	0
35-39	2	87	6	0	3	90	2	0
40-44	42	53	0	0	40	55	0	0
45-49	12	83	0	0	15	77	3	0
50-54	13	78	4	0	20	72	3	0
55-59	21	69	5	0	17	73	5	0
60-64	18	73	4	0	16	76	3	0
65-69	22	67	6	0	20	70	5	0
70-74	6	62	21	6	4	70	17	4
75+	27	65	3	0	18	76	1	0

for individual age and sex groups further emphasise the variation in the relationship between NHSCR and census data (Table 15). Section 5.1 gives an explanation of the statistics used here. The overall correlation between the sexes is reasonably strong with female flows exhibiting a higher 'r' value than males but having a slightly higher mean absolute percentage deviation. The dominant feature of the table is the poor correlation between flows in the 15-19 age-group with an r value of 0.67 for males and 0.84 for females. The relatively large 'distances' between flows in this age-group are emphasised by the MAD figures which are approaching 50% for both males and females. MAD figures are also relatively high in the 70-74 age-group although correlation between the flows is a lot stronger. Male flows in the 10-14 and 75+ age-groups exhibit a poor relationship in comparison as do female flows in the 10-14 and 70-74 age-groups. The IOD values for males (23.9) and females (12.7) in the 15-19 age-group further emphasize the degree of dissimilarity between the data sets, relative to other age groups.

Table 16 illustrates the variation in the NHSCR-census ratio value that exists between metropolitan and non-metropolitan inflows. Total female metropolitan and non-metropolitan ratios are almost identical whereas the male ratio, although considerably lower than the female figure is greatest for metropolitan inflows. A striking difference is apparent between male metropolitan and non-metropolitan inflows in the 15-19 age-group. The discrepancy for male metropolitan inflows is 1.98 compared to 1.21 for non-metropolitan flows. Female ratios in the 15-19 age-group are high for both metropolitan and non-metropolitan flows although flows to non-metropolitan zones exhibit the larger discrepancy.

The 70-74 age-group ratios are relatively high for both metropolitan and non-metropolitan male and female inflows although in both cases the metropolitan inflow ratios are the greater. The same is true in the 35-39 age-group where again ratio values are relatively high. Young males (10-14) moving to non-metropolitan zones also exhibit a large discrepancy.

The greatest degree of consistency between census and NHSCR is found in the 40-44 age-group where all inflow ratios (male and female) have a value close to unity. Male metropolitan and non-metropolitan inflows in the 20-29 age-range also have ratio values approaching one.

Those FPCAs having the largest male and female inflow ratios in the 15-19 age-group are illustrated in Table 17. The male ratio is proportionately higher in these selected zones although overall the female figure is greater. The table shows that inflows to major metropolitan zones exhibit the highest ratios together with inflows to West Glamorgan, Durham, Leicestershire, Dyfed, Nottinghamshire and Oxfordshire.

Table 18 gives a similar indication of the smallest ratio values. The smallest male ratios in this 15-19 age-group are much lower than the female with only two of the female ratios being below unity. The lowest male ratios are all found for inflows to non-metropolitan FPCAs.

Although the overall ratio between female NHSCR and Census inflows is higher than the male ratio it is individual male inflows in the 15-19 age-

Table 15. Goodness of fit statistics for individual age-groups

Age-group	Correlation coefficient		Mean Absolute Deviation		Index of Dissimilarity		Information Gain	
	male	female	male	female	male	female	male	female
1-4	0.970	0.958	18.0	17.7	6.76	7.19	0.014	0.017
5-9	0.978	0.974	23.6	22.9	5.56	6.10	0.011	0.013
10-14	0.946	0.964	36.5	29.3	8.66	7.49	0.022	0.018
15-19	0.672	0.897	49.6	48.7	23.97	12.74	0.189	0.049
20-24	0.969	0.989	15.5	22.0	7.74	4.77	0.018	0.007
25-29	0.990	0.991	10.3	22.3	4.39	4.31	0.007	0.006
30-34	0.986	0.984	14.7	23.1	4.87	5.41	0.008	0.009
35-39	0.975	0.979	28.4	34.0	6.34	5.82	0.014	0.010
40-44	0.975	0.971	11.6	12.7	5.74	6.20	0.013	0.015
45-49	0.965	0.966	24.0	26.9	7.67	7.59	0.019	0.022
50-54	0.967	0.959	23.0	23.4	6.95	8.26	0.019	0.023
55-59	0.959	0.977	24.8	24.4	8.72	7.03	0.027	0.021
60-64	0.976	0.971	25.7	22.4	8.28	7.77	0.027	0.020
65-69	0.976	0.970	23.1	24.8	8.05	8.11	0.025	0.020
70-74	0.966	0.956	41.5	38.6	8.58	9.20	0.030	0.029
75+	0.960	0.981	24.5	24.7	8.93	6.23	0.029	0.016
Totals	0.948	0.956	22.6	26.6	10.14	7.96	0.041	0.025

Note: The goodness of fit statistics are computed for inflows to FPCAs.

Table 16. Metropolitan and non-metropolitan inflow ratios by age and sex

Age-group	Males Metrop.	Males Non-met.	Females Metrop.	Females Non-met.
1-4	1.281	1.155	1.286	1.126
5-9	1.358	1.264	1.333	1.239
10-14	1.408	1.634	1.392	1.409
15-19	1.975	1.205	1.849	2.018
20-24	0.984	1.018	1.217	1.337
25-29	1.040	1.085	1.280	1.288
30-34	1.160	1.141	1.365	1.252
35-39	1.443	1.368	1.578	1.485
40-44	1.100	0.965	1.079	0.997
45-49	1.326	1.261	1.301	1.334
50-54	1.335	1.233	1.334	1.231
55-59	1.353	1.255	1.361	1.264
60-64	1.346	1.256	1.378	1.228
65-69	1.395	1.220	1.336	1.277
70-74	1.839	1.649	1.673	1.600
75+	1.370	1.220	1.242	1.295
TOTAL	1.212	1.181	1.346	1.341

Table 17. Extreme high ratios for inflows to FPCAs in the 15-19 age-group.

Males		Females	
Zone	Ratio	Zone	Ratio
Coventry	6.5373	Sheffield	4.4124
Newcastle	5.1994	Leeds	3.9387
Sheffield	4.9695	Coventry	3.7762
Leeds	4.6457	Newcastle	3.3884
W.Glamorgan	3.6787	W.Glamorgan	3.2366
Birmingham	3.6003	Durham	3.2091
Manchester	3.4294	Dyfed	3.2488
Liverpool	3.3059	Nottinghams	3.1369
Durham	3.3700	Liverpool	3.0820
Leicesters	3.3481	Oxon	3.0688

Table 18. Extreme low ratios for inflows to FPCAs in the 15-19 age-group.

Males		Females	
Zone	Ratio	Zone	Ratio
Cornwall	0.2394	Powys	0.9576
Lincolns	0.3929	Lon-Croy	0.9821
Northumb	0.4089	Sandwell	1.0203
Powys	0.5209	Trafford	1.0242
Wiltshire	0.5612	Dudley	1.1447
Hampshire	0.5693	Wiltshire	1.1878
Salop	0.5906	Northumb	1.1931
N.Yorks	0.6406		
Northants	0.6600		
Somerset	0.7576		

group that exhibit the greatest variation and contain the greatest and smallest ratio values.

The extreme ratio values outlined in this section for the 15-19 age-group can be explained by a number of factors. The effect of multiple and return moves upon the NHSCR/Census ration will be of greatest importance in the most mobile age-groups (15-24) but is by no means totally responsible for the large ratios that are in evidence for certain FPCAs. The movement of students to places of education is also likely to be major importance to the discrepancies that are outlined in Table 17. All those FPCAs with extreme high ratios contain major educational establishments where the inflow of students is likely to be of greater importance than the presence of multiple or return moves.

Also important in the younger age-groups will be the movement of members of the Armed Forces. Such migration is less common for females than males - giving a possible explanation for the stronger correlation between female flows in the 15-19 age-group and an explanation for the extreme low male ratio vlaues that are observed in certain FPCAs in this age-group (Table 18).

7. CONCLUSIONS

In the preceding sections of the paper, both the similarities and the dissimilarities between migration measured by NHSCR re-registrations and Census tabulation have been highlighted at several different aggregations (total flows, total inflows, total outflows, total netflows, total flows by age and sex, inter-zone flows), at several different spatial scales (standard regions, EC2 regions, FPCAs) and using two classifications (metropolitan/non-metropolitan and contiguous/non-contiguous). Here we attempt to summarize our findings and then re-interpret them in terms of the components identified by Devis and Mills (1986).

7.1 Similarities

When we compare the two datasets at the highest level of aggregation (standard region flow totals), correlation coefficients of over 0.99 are observed. The coefficients drop to 0.98 when we break up these totals into zone to zone flows for FPCAs. It is only when the netflows are considered that the correlation drops to any degree - to 0.91 in the case of net migration at the FPCA level. The patterns of migration captured by these two measuring instruments are very similar indeed, as evidenced by correlations of 0.92 and 0.94 between friction of distance parameters for FPCA origins and FPCA destinations respectively.

7.2 Differences

However, NHSCR and Census migration measures are not perfect replicas of each other by any means. The correlation of FPCA inflows for males in the 15-19 year old age group is only 0.672, and the mean absolute deviations of NHSCR and Census inter-zonal flows vary between 23 and 26% depending on spatial scale.

Overall the NHSCR re-registration count is 24.5% greater than the Census migrant count. However, Devis and Mills (1986) have demonstrated that if non-comparable elements are stripped out of the NHSCR and Census counts, the resultant "lowest common denominators" are very close indeed numerically. Recalling Table 1, we see that component A.1 of the NHSCR count is 1.301 millions and components B.1 and B.4 of the Census count together sum to 1.303 millions. The difference is less than one tenth of one percent!

7.3 Systematic patterns in NHSCR/Census differences

When we compare the "raw" NHSCR and Census counts across spatial zones, we observe substantial differences. In interpreting these differences we must needs refer to the non-common components of both measures for an explanation. At the moment this interpretation is qualitative: we hope to make a quantitative estimate of the influence of each non-common component in a subsequent paper. The non-common components consist of three sets: operational measurement problems, conceptual differences and differences in the populations captured in the two sources (section 2.3.3).

Taking the last set first, we note that our map (and those of Devis and Mills, 1986) of NHSCR/Census ratios for inflows to FPCAs (Figure 9) places in the lowest category (ratios just above or just below unity) those counties with substantial Armed Forces establishments (Cornwall, Wiltshire, Hampshire, Powys, Salop, Lincolnshire, Northumberland, North Yorkshire) and therefore systematic migration directed by the recruitment, promotion and tour of duty systems of the military. Armed forces migrants are "picked up" by the Census question but not by the NHSCR re-registration process.

Conversely, the highest ratios on that map (Figure 9) appear in metropolitan districts (Newcastle, Leeds, Manchester, Liverpool, Birmingham) and non-metropolitan counties (Durham, Leicester, Avon,) with large institutions of higher education that import and export substantial numbers of student migrants year in and year out.

It was observed that the NHSCR/Census ratio increased with scale of migration considered, and that mean migration distance for NHSCR derived migration was 6 kilometres greater than that for Census measured migration. The hypothesis was proposed that only the return migration element of additional NHSCR recorded moves that could account for such observations. Similarly, return migration was held to play some part in the higher NHSCR/Census ratios observed for inflows to metropolitan areas as a whole: areas unattractive to migrants were associated with returns to more attractive zones (non-metropolitan areas). Such return flows depressed the observed Census count while not affecting the NHSCR count.

7.4 Lines of further research

However, these non-common components of the two migration measures clearly act together. The observed NHSCR/Census differences for any one area or any one inter-area flow are the net outcome of the various effects discussed above. In our comments we have merely selected areas in which one effect was clearly dominant.

It is necessary therefore to expand our simple regression equations relating NHSCR and Census migration from two variable equations to multivariable equations, incorporating as independent variables the number of the Armed Forces migrants, the estimated number of student migrants (Devis and Mills 1986), Appendix Table 2), the attractiveness of areas and, in the case of inter-area flows, the distance between areas. In addition, to establish more clearly the role of return migration, it would be valuable to construct a set of simulation experiments. We hope to incorporate these lines of further research in a follow up paper that employs NHSCR migration data extracted from the individual movement records.

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APPENDIX

Table A.1 Outflow, inflow and netflow totals, differences and ratios for NHSCR and Census migration for FPCAs

FPCA	OUTFLOWS				INFLOWS				NETFLOWS			
	NHSCR	Census	Diff.	Ratio	NHSCR	Census	Diff.	Ratio	NHSCR	Census	Diff.	Ratio
SCOTLAND	52.8	41.9	10.9	1.26	47.9	38.6	9.2	1.24	-5.0	-3.3	-1.7	1.50
GATESHED	6.4	5.3	1.0	1.20	4.7	3.9	.8	1.19	-1.7	-1.4	-.3	1.21
NEWCSTLE	12.3	9.8	2.5	1.25	10.9	7.0	3.9	1.56	-1.4	-2.8	1.4	.50
N-TYNESD	5.7	5.2	.4	1.08	5.4	4.7	.6	1.14	-.3	-.5	.2	.60
S-TYNESD	3.5	3.1	.4	1.14	2.7	1.9	.8	1.43	-.8	-1.2	.4	.68
SUNDRLND	6.8	5.3	1.4	1.26	6.3	5.0	1.4	1.28	-.4	-.4	.0	1.07
CLEVELND	12.2	8.9	3.3	1.38	9.3	5.9	3.4	1.58	-2.9	-3.0	.1	.97
CUMBRIA	10.2	7.4	2.8	1.38	10.1	8.1	2.0	1.24	-.1	.8	-.8	-.11
DURHAM	14.7	10.5	4.2	1.40	13.4	9.7	3.7	1.38	-1.3	-.7	-.5	1.70
NTHMBLND	8.6	6.6	2.0	1.30	8.9	8.5	.5	1.06	.3	1.8	-1.5	.19
BARNSLEY	4.1	3.4	.7	1.20	3.8	3.4	.4	1.11	-.3	.0	-.3	17.00
DONCASTR	6.2	6.2	.0	1.00	6.3	5.7	.6	1.11	.1	-.5	.6	-.19
ROTHERHM	5.1	4.5	.6	1.14	5.5	4.8	.7	1.14	.4	.3	.1	1.15
SHEFFELD	13.7	10.4	3.3	1.31	13.2	8.0	5.2	1.64	-.5	-2.4	1.9	.21
BRADFORD	12.6	9.6	3.0	1.32	10.6	8.0	2.6	1.33	-2.0	-1.6	-.4	1.25
CALDERDL	5.1	3.9	1.2	1.30	4.9	3.8	1.2	1.31	-.2	-.2	.0	1.20
KIRKLEES	9.7	7.1	2.6	1.37	8.8	6.9	1.9	1.28	-.9	-.2	-.7	4.03
LEEDS	20.8	15.3	5.5	1.36	19.2	12.6	6.6	1.52	-1.6	-2.7	1.1	.59
WAKEFELD	7.3	6.2	1.1	1.18	7.6	6.0	1.5	1.25	.3	-.2	.4	-1.67
HUMBERSD	17.8	13.4	4.4	1.33	16.8	11.9	5.0	1.42	-1.0	-1.5	.5	.65
N-YORKS	22.1	18.5	3.6	1.19	24.7	21.7	3.0	1.14	2.6	3.1	-.5	.83
DERBYSHR	19.1	15.5	3.6	1.23	21.6	17.3	4.3	1.25	2.5	1.8	.7	1.40
LEICS	20.8	15.7	5.1	1.32	22.8	15.8	7.0	1.45	2.0	.0	2.0	86.57
LINCS	15.5	14.9	.7	1.04	17.8	18.9	-1.1	.94	2.3	4.0	-1.8	.57
NTHANTS	15.7	12.0	3.7	1.30	18.6	15.0	3.6	1.24	3.0	3.0	-.1	.98
NOTTS	22.6	16.9	5.6	1.33	22.3	17.3	5.0	1.29	-.2	.4	-.6	-.66
CAMBS	22.0	17.1	4.9	1.29	26.0	20.6	5.3	1.26	4.0	3.5	.5	1.13
NORFOLK	16.6	13.7	2.9	1.21	21.4	17.4	4.0	1.23	4.8	3.6	1.1	1.31
SUFFOLK	15.1	12.4	2.7	1.22	19.5	16.5	2.9	1.18	4.4	4.2	.2	1.05
BEDFORDS	18.0	14.4	3.6	1.25	19.0	14.6	4.4	1.30	.9	.2	.7	4.33
BUCKS	23.7	20.6	3.1	1.15	30.7	25.8	4.9	1.19	7.1	5.2	1.9	1.35
ESSEX	38.6	30.2	8.3	1.28	45.7	36.1	9.6	1.27	7.1	5.8	1.3	1.22
HERTS	35.1	27.7	7.5	1.27	37.1	29.0	8.1	1.28	1.9	1.3	.7	1.51
BERKS	28.6	21.5	7.1	1.33	32.1	25.1	7.1	1.28	3.6	3.6	.0	1.00
E-SUSSEX	22.7	15.8	6.8	1.43	28.8	20.9	7.9	1.38	6.1	5.1	1.0	1.20
HANTS	47.1	39.8	7.3	1.18	50.4	48.7	1.6	1.03	3.3	9.0	-5.7	.37
IOWIGHT	3.5	2.7	.8	1.28	4.7	3.5	1.2	1.33	1.2	.8	.4	1.51
KENT	41.1	30.2	10.9	1.36	43.2	34.1	9.1	1.27	2.1	3.9	-1.8	.54
OXFORDSH	22.7	17.8	4.9	1.27	24.4	18.7	5.7	1.30	1.7	.9	.8	1.88
SURREY	45.7	35.8	9.9	1.28	45.5	36.5	9.0	1.25	-.2	.7	-.9	-.32
W-SUSSEX	22.0	16.5	5.5	1.33	30.9	24.5	6.5	1.26	8.9	7.9	1.0	1.12
LON-CHNT	29.0	23.7	5.3	1.22	24.8	17.5	7.3	1.42	-4.1	-6.1	2.0	.68
LON-RWF	20.7	16.8	3.9	1.23	17.6	13.7	3.9	1.29	-3.1	-3.1	.1	.98
LON-BH	12.8	11.2	1.6	1.15	10.7	9.2	1.5	1.16	-2.1	-2.0	-.1	1.07
LON-CI	25.9	21.6	4.3	1.20	27.3	20.3	6.9	1.34	1.3	-1.2	2.6	-1.09
LON-KCW	28.2	26.3	1.9	1.07	25.8	22.4	3.4	1.15	-2.4	-3.9	1.5	.61
LON-RK	16.9	15.3	1.7	1.11	16.3	14.0	2.3	1.17	-.6	-1.3	.7	.48
LON-MSW	32.2	28.7	3.4	1.12	29.4	24.9	4.5	1.18	-2.7	-3.8	1.0	.73

Table A.1 <u>Continued</u>

FPCA	OUTFLOWS				INFLOWS				NETFLOWS			
	NHSCR	Census	Diff.	Ratio	NHSCR	Census	Diff.	Ratio	NHSCR	Census	Diff.	Ratio
LON-CROY	16.8	13.8	3.0	1.22	14.9	12.8	2.1	1.16	-1.9	-1.0	-.9	1.86
LON-LSL	42.2	33.6	8.6	1.26	34.9	28.7	6.2	1.22	-7.2	-4.9	-2.4	1.49
LON-BROM	13.4	11.8	1.6	1.14	13.5	12.4	1.1	1.09	.0	.6	-.5	.08
LON-BG	16.1	14.6	1.5	1.10	15.4	13.2	2.2	1.17	-.7	-1.5	.7	.49
LON-MIDD	91.6	73.8	17.9	1.24	77.1	64.9	12.2	1.19	-14.5	-8.8	-5.7	1.65
AVON	25.2	18.8	6.4	1.34	28.0	19.0	9.0	1.48	2.8	.2	2.6	14.48
CORNWALL	13.1	11.0	2.1	1.19	16.5	14.9	1.6	1.11	3.4	3.9	-.5	.87
DEVON	30.0	21.9	8.1	1.37	33.9	26.7	7.2	1.27	4.0	4.8	-.8	.83
DORSET	18.1	14.2	3.9	1.28	24.5	19.7	4.8	1.24	6.4	5.5	.9	1.16
GLOUCS	14.0	10.7	3.3	1.31	15.3	12.0	3.2	1.27	1.3	1.3	.0	.97
SOMERSET	13.4	10.4	3.0	1.29	16.6	13.7	2.9	1.21	3.2	3.3	-.2	.95
WILTS	16.7	16.0	.7	1.04	19.8	20.0	-.2	.99	3.1	4.0	-.9	.78
BIRMINGH	34.3	26.7	7.6	1.29	26.2	19.0	7.3	1.38	-8.1	-7.7	-.4	1.05
COVENTRY	10.4	7.8	2.6	1.34	8.9	5.3	3.7	1.70	-1.4	-2.5	1.1	.57
DUDLEY	6.4	5.7	.7	1.12	5.7	5.8	.0	.99	-.6	.1	-.7	-6.61
SANDWELL	7.6	7.3	.3	1.04	5.8	5.5	.3	1.05	-1.9	-1.8	-.1	1.03
SOLIHULL	8.5	8.2	.3	1.04	8.3	7.3	1.0	1.13	-.2	-.9	.7	.23
WALSALL	7.1	6.0	1.1	1.19	5.5	5.0	.5	1.11	-1.6	-1.0	-.6	1.60
WOLVERHN	7.4	6.3	1.1	1.17	5.6	4.6	1.0	1.22	-1.8	-1.7	-.1	1.04
HEREFORD	17.5	14.4	3.1	1.21	22.1	18.1	4.0	1.22	4.6	3.7	.9	1.25
SALOP	11.6	9.8	1.8	1.19	12.5	11.6	.9	1.08	.9	1.8	-.9	.51
STAFFS	22.8	18.7	4.1	1.22	24.3	19.8	4.5	1.23	1.5	1.0	.5	1.47
WARWICKS	16.2	12.6	3.6	1.29	16.3	13.3	2.9	1.22	.0	.7	-.7	.02
BOLTON	6.4	5.1	1.3	1.25	6.1	5.0	1.0	1.20	-.3	-.1	-.3	4.17
BURY	5.7	5.1	.6	1.11	5.1	4.5	.6	1.12	-.6	-.6	.0	1.07
MANCHSTR	21.6	17.8	3.7	1.21	19.3	12.8	6.5	1.51	-2.3	-5.0	2.8	.45
OLDHAM	5.4	4.4	1.0	1.22	4.9	3.8	1.1	1.28	-.5	-.6	.1	.83
ROCHDALE	7.1	5.3	1.8	1.34	5.9	4.9	1.1	1.21	-1.1	-.4	-.8	3.07
SALFORD	8.0	6.4	1.6	1.25	5.8	4.9	.9	1.18	-2.2	-1.5	-.7	1.45
STOCKPRT	10.7	8.6	2.1	1.25	9.6	7.8	1.8	1.23	-1.1	-.7	-.3	1.44
TAMESIDE	5.7	5.0	.7	1.13	5.4	4.4	.9	1.21	-.3	-.6	.2	.57
TRAFFORD	8.9	7.6	1.4	1.18	7.2	6.2	1.0	1.17	-1.7	-1.4	-.3	1.24
WIGAN	6.2	5.5	.6	1.11	5.5	5.0	.5	1.11	-.7	-.6	-.1	1.18
LVERPOOL	18.3	13.9	4.4	1.32	12.5	9.0	3.5	1.39	-5.8	-4.9	-1.0	1.20
ST-HELEN	10.6	9.3	1.3	1.14	7.4	6.1	1.3	1.22	-3.2	-3.2	.1	.98
SEFTON	9.2	7.9	1.3	1.17	8.3	6.9	1.4	1.21	-1.0	-1.0	.1	.94
WIRRAL	8.7	6.3	2.4	1.37	8.0	5.7	2.2	1.39	-.7	-.6	-.1	1.19
CHESIRE	27.5	21.2	6.3	1.30	29.0	23.3	5.7	1.24	1.5	2.1	-.6	.71
LANCS	32.1	22.5	9.6	1.43	34.4	25.5	8.9	1.35	2.3	3.0	-.7	.78
CLWYD	9.5	7.3	2.2	1.30	10.9	9.0	1.9	1.21	1.4	1.7	-.3	.83
DYFED	8.1	5.9	2.2	1.37	10.5	7.2	3.3	1.46	2.4	1.2	1.1	1.92
GWENT	8.7	6.4	2.3	1.36	7.8	6.4	1.5	1.23	-.9	-.1	-.9	15.63
GWYNEDD	6.7	5.2	1.4	1.27	7.8	5.7	2.1	1.37	1.2	.5	.7	2.49
MID-GLAM	9.8	7.6	2.2	1.28	8.7	6.7	2.0	1.30	-1.1	-.9	-.2	1.18
POWYS	3.3	2.7	.6	1.21	3.9	3.5	.4	1.11	.6	.8	-.2	.77
S-GLAM	11.6	10.0	1.6	1.16	11.0	8.7	2.2	1.26	-.6	-1.3	.7	.49
W-GLAM	7.2	5.1	2.0	1.40	6.8	4.2	2.7	1.65	-.3	-1.0	.6	.33