WORKING PAPER 510

INTERNAL MIGRATION CHANGE IN THE UK: TRENDS BASED ON NHSCR MOVEMENT DATA, 1975-6 TO 1985-6

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ABSTRACT

In this paper, trends in internal migration in the United Kingdom are examined using annual data on the movement of NHS patients between FPCAs from 1975-6 to 1985-6. In absolute terms, the pattern of population redistribution has been influenced in particular by changes in the balance of movement to and from Greater London. At a broader spatial scale, the net loss of total migrants from the North to the South of the country has continued to increase. Areas of the North classified as having lower densities have, as a group, experienced increased net losses or reduced marginal net gains, whilst in the South, areas of similar density have continued to register high inflows, largely as a result of continuing counterurbanization.

The isolation of separate components of inter-area movement is undertaken using time series indices of change in the overall level of movement and in probabilities of movement generated from each origin, attracted to each destination, and taking place between each origin-destination pair. Spatial interaction models are calibrated in a comparative static analysis of the changing frictional effect of distance on movement, and the results of a selection of migration projection models are evaluated.

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1. INTRODUCTION

The National Health Service Central Register (NHSCR) has become an important source of data on recent population redistribution in the United Kingdom, providing important evidence of how the volume and pattern of internal movement, measured by NHS patient reregistrations in different Family Practitioner Committee Areas (FPCAs), has changed during the 1970's and the first half of the 1980's. The value of the NHSCR has been recognized by the Office of Population Censuses and Surveys (OPCS) and the Department of the Environment (DOE) who use reregistration information to update 1981 Census migration data in order to generate net migration assumptions for the official subnational population forecasting model. In the absence of alternative sources, the NHSCR will become increasingly important in the years up to the publication of migration data from the 1991 Census. Although there are certain shortcomings associated with the NHSCR data which have been documented in the literature by Ogilvy (1980), Devis (1984) and others, recent research at OPCS (Devis and Mills 1986) and at the University of Leeds (Boden, Stillwell and Rees 1987, 1988) has shown that quite close agreement between the two types of data exists and that differences which arise do so due to the differing populations at risk in the two sources, the differing role of underenumeration and sampling errors, and the different measurement concepts employed in each case.

A key attribute of the NHSCR transfer data is its availability on a continuous basis and in this paper we use annual time series information to investigate trends in internal migration from the mid-1970s to the mid-1980s. The analysis is divided into three parts. Firstly, the major characteristics of the changing redistribution of the population through net migration are identified at different spatial scales and with reference to north-south and metropolitan-nonmetropolitan divisions (Section 3). Secondly, following work in the USA by Frey (1983,1984) and in the Netherlands by Baydar (1983) and Willekens and Baydar (1986), aggregate inter-area migration is decomposed into its component levels and probabilities in order to separate out different trends and patterns (Section 4). Level, generation, attraction and distribution components are identified and changes over time are examined using time series indices. Finally, the changing frictional effect of distance on migration is investigated using doubly constrained spatial interaction models and some evaluation of alternative distribution projection methods is reported (Section 5). However, before embarking on this analysis it is necessary to describe the data sets and the spatial systems of interest in more detail.

2. DATA SETS AND ZONE SYSTEMS

Whenever a NHS patient reregisters with a doctor in a new FPCA, details of age, sex and origin FPCA are recorded and this information about each transfer or move is maintained in a central register. The spatial units defined as FPCAs in England and Wales are illustrated in Figure 1 and comprise 49 nonmetropolitan or shire counties, 35 metropolitan districts which together represent the pre-abolition provincial metropolitan counties, and 12 zones in Greater London based on borough aggregations. During the period from 1975 to April 1984, OPCS extracted a 10% sample of moves from the NHSCR and every three months produced two computer summaries of the transfers taking place during the previous 12 months. One of the summaries contained total numbers of moves between each FPCA and all other FPCAs in England and Wales together with transfers between these FPCAs and the three additional regions of Scotland, Northern Ireland and the Isle of Man. The other summary contained the number of moves into and out of each of the zones, disaggregated by sex and into 5 year age groups. Since April 1984, however, OPCS have obtained 100% counts of movements from the NHSCR which are available on a quarterly basis in the form of coded Primary Unit Data (PUD).

OPCS estimate an average time lag of about three months between a move and a subsequent reregistration and it is therefore assumed that transfers recorded between one September and the next are appropriate for mid-year to mid-year analysis. The eleven year time series of NHSCR data upon which this paper is based has been obtained from the first of the computer summaries for the eight years commencing mid-1975, and from the Primary Unit Data for the years 1983-4, 1984-5 and 1985-6. The data for 1983-84 is a mixture of 10% and 100% PUD information. The analysis is confined primarily to aggregate inter-area movement although data from the PUD files for the last three years have been obtained in age disaggregated form (16 age groups: 0-4, ... 70-74, 75+) and are employed in section 5. Time series data for 12 monthly periods are used to avoid seasonal variations which are apparent in quarterly series, and the adoption of mid-year as a beginning and end point for each period is consistent with the availability of population data.

Mid-year population estimates have been obtained from OPCS and are used for migration rate calculations. Since the NHSCR movement data is recorded as a count of all changes of residence between two mid-year points in time (as opposed to the Census transition count of those whose residence at the end of the period was different from that at the beginning), rates of movement for a particular year have been calculated using the average of the initial and final mid-year populations.

Although FPCAs are the basic spatial units of the data set, it is useful to be able to observe what trends are occurring at more aggregate spatial scales and therefore results are presented for three further systems of interest. One of these is a system of metropolitan counties, their region remainders, and other standard regions (Figure 1) which has been used extensively in previous work (Rees and Stillwell 1984, Stillwell 1986, Stillwell and Boden 1986), although no distinction is drawn between the Outer Metropolitan Area and the Outer South East in this paper. The second system is a set of coarse regional divisions similar to that used by Champion et al. for recent work on population change (Champion et al. 1987). Four macro-regions are defined in this set (Figure 1): the periphery, the industrial heartland, the capital and the remainder of the South. Finally, FPCAs have been classified into four categories on the basis of a ranking of their 1981 Census usually resident population densities (Table 1). FPCAs in each category which are located in the North and the South of the country are grouped to form a further regionalization of eight categories which is used to examine net migration trends in the next section.

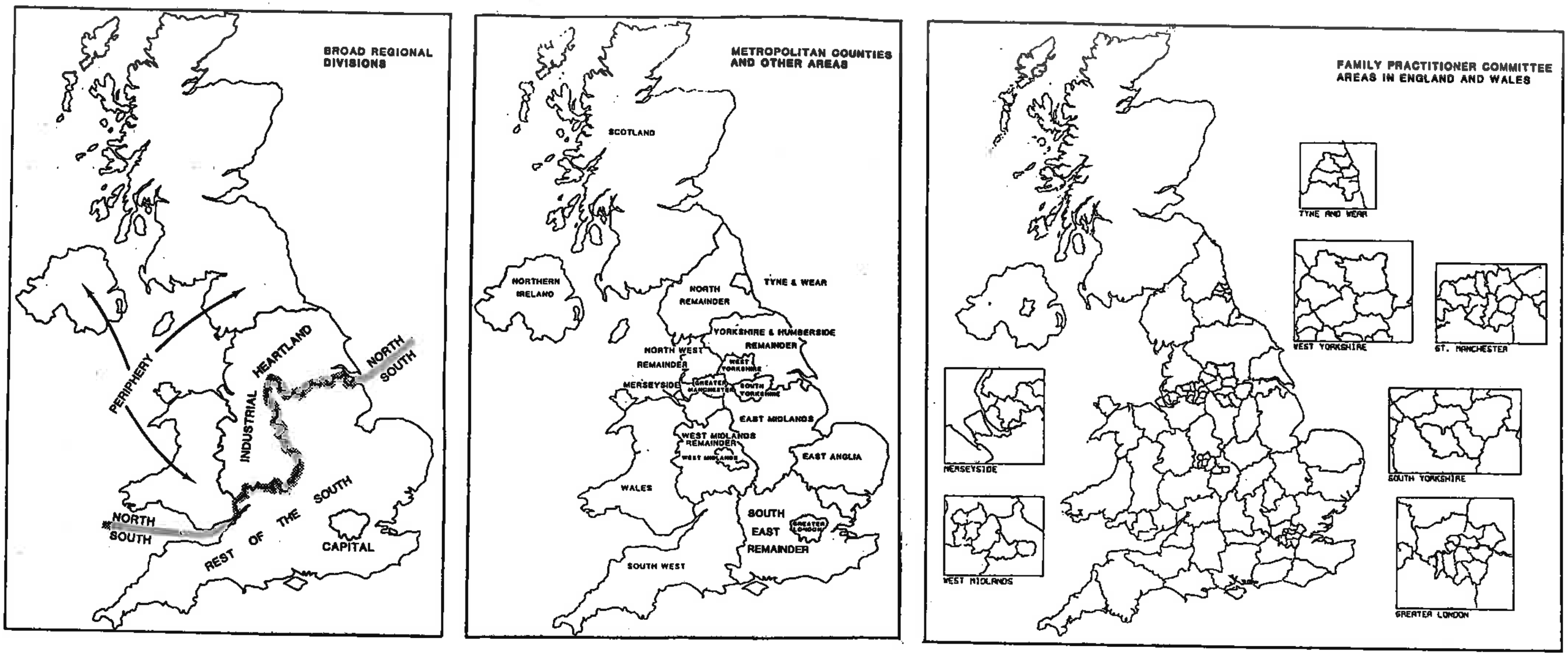


Figure 1: Three systems of spatial units used for the analysis of NHSCR moves in the UK

Table 1: Classification of FPCAs into population density categories

Population Density Category (persons per hectare)							
High (>22.9)		Medium/High (22.9-6.6)		Medium/Low (6.5-2.4)		Low (<2.4)	
Lon - CI	GL	* Wirral	IH	Surrey	RS	* Warwickshire	IH
Lon - KCW	GL	* Sunderland	PR	Herts	RS	Northants.	RS
Lon - LSL	GL	* Tameside	IH	Mid-Glam.	PR	Dorset	RS
Lon - CHNT	GL	* Trafford	IH	* Calderdale	IH	Oxfordshire	RS
Lon - MSW	GL	* Sefton	IH	Berkshire	RS	Gloucs	RS
Lon - RWF	GL	Lon - Brom	GL	* Doncaster	IH	Cambs.	RS
* Liverpool	IH	* Bolton	IH	Notts.	RS	* Hereford	IH
Lon - BG	GL	* Bury	IH	W. Glam.	PR	* Clwyd	PR
Lon - Midd	GL	* St Helens	IH	* Lancashire	IH	Suffolk	RS
* Birmingham	IH	* Oldham	IH	Bedfords.	RS	Wiltshire	RS
* Manchester	IH	* Wigan	IH	Essex	RS	Devon	RS
* Wolverhamp.	IH	* Gateshead	PR	* Cheshire	IH	Norfolk	RS
Lon - Croy	GL	* Sheffield	IH	Kent	RS	Somerset	RS
* Sandwell	IH	* Rochdale	IH	Hampshire	RS	Cornwall	RS
* Coventry	IH	* Leeds	IH	* Staffs.	IH	* Salop	IH
Lon - RK	GL	* Bradford	IH	E. Sussex	RS	* N. Ireland	PR
* Dudley	IH	* Solihull	IH	Derbyshire	RS	Lincs.	RS
Lon - BH	GL	* Cleveland	PR	Bucks	RS	* N. Yorkshire	IH
* S. Tyneside	PR	* Wakefield	IH	Leics.	RS	* Cumbria	PR
* Walsall	IH	* S. Glam.	PR	W. Sussex	RS	* Scotland	PR
* Salford	IH	* Kirklees	IH	* Gwent	PR	* Northd.	PR
* Newcastle	PR	* Rotherham	IH	I of Wight	RS	* Gwynedd	PR
* N. Tyneside	PR	* Barnsley	IH	* Durham	PR	* Dyfed	PR
* Stockport	IH	Avon	RS	* Humberside	IH	* Powys	PR

Notes: (i) * represents an FPCA in the North

(ii) Broad regional divisions:

GL	Greater London	IH	Industrial Heartland
RS	Remainder of South	PR	Periphery

(iii) Greater London FPCAs:

CI	Camden and Islington	Midd	Middlesex
KCW	Kensington/Chelsea/Westminster	Croy	Croydon
LSL	Lambeth/Southwark/Lewisham	RK	Richmond/ Kingston
CHNT	City/Hackney/Newham/Tower Hamlets		
MSW	Merton/Sutton/Wandsworth	BH	Barking/ Havering
RWF	Redbridge/Waltham Forest		
BG	Bexley/Greenwich	Brom	Bromley

(iv) Density categories are quartile groups

3. SPATIAL PATTERNS OF NET GAINS AND LOSSES

Although the population of the UK has experienced very low rates of growth over the last fifteen years, with declines occurring in some years, the subnational redistribution of the population has been very substantial. In certain regions and local areas, population change has been influenced significantly by higher fertility, mortality or external migration, but most of the population redistribution has been the result of internal migration flows. The net effects of internal migration as a component of subnational population change can be examined at different spatial scales.

3.1. Changes at the macro-region scale

The pattern of net migration at this scale during the period is characterized by substantial gains of around 100 thousand transfers per year in the South, excluding Greater London, and losses from the periphery, industrial heartland and the capital. Figure 2 shows that in the first year of the time series, the periphery was also gaining in net terms, whereas London and the heartland lost over 80 and 30 thousand respectively. By 1981-2, net losses from the capital had fallen by over 50%, the industrial heartland was losing more migrants in net terms than Greater London, and the periphery was also losing around 10 thousand migrants per year. Consequently the gains by the rest of the South had been reduced. The second half of the period saw increasing net losses from the periphery and heartland regions at the same time as losses from Greater London were rising, resulting in further gains

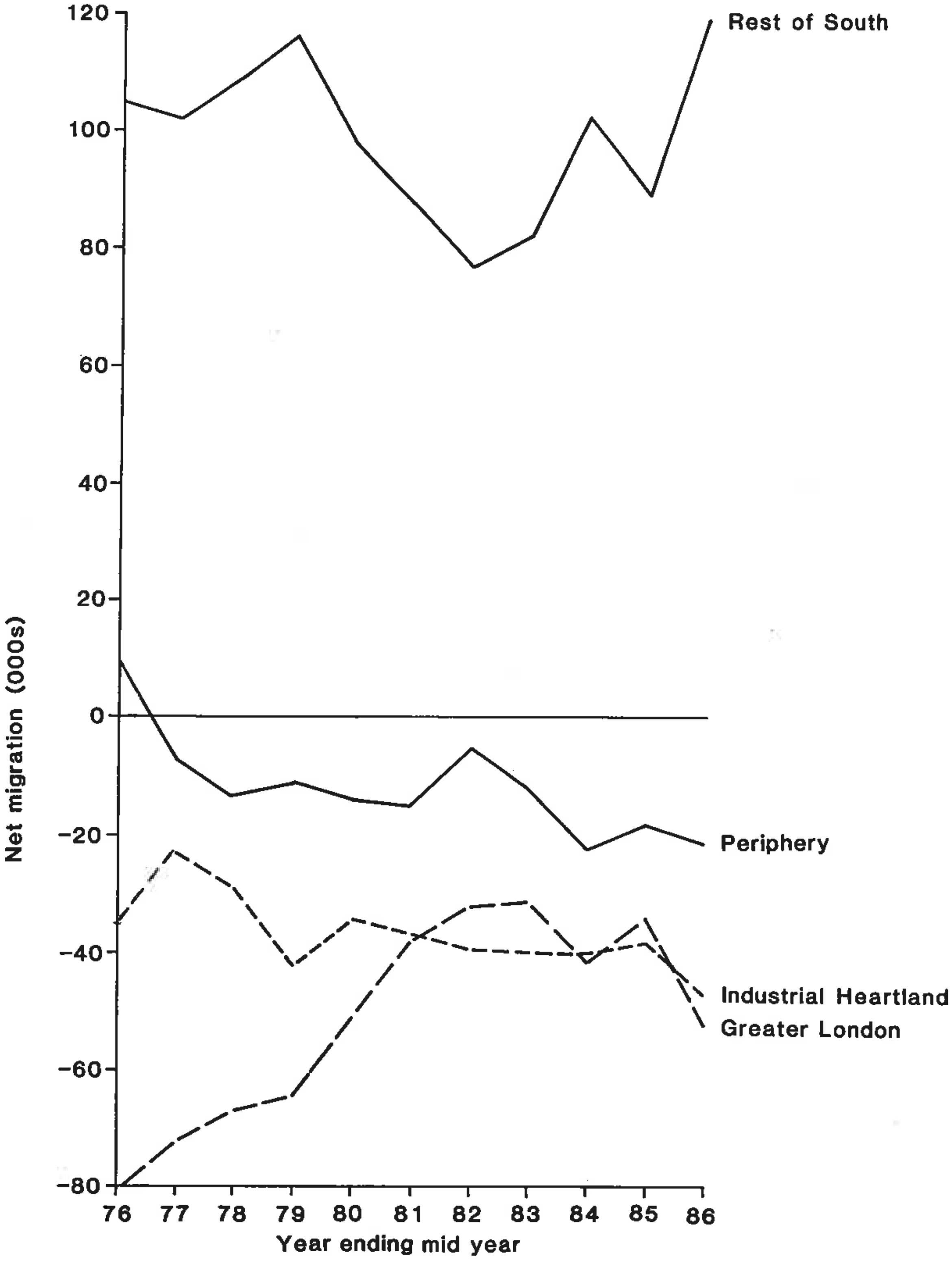


Figure 2: Net migration balances, broad regional divisions, 1975-6 to 1985-6

in the South Remainder which reached 120 thousand by 1985-6. Variations in the level of net inmigration to the rest of the South clearly reflect the fluctuations in net outmovement from London.

3.2. Metropolitan losses and nonmetropolitan gains

The spatial system of metropolitan counties and nonmetropolitan regions has been used in previous research by the authors to demonstrate the dominant pattern of losses from the conurbations and gains in their surrounding hinterlands during the 1960s and 1970s, reflecting processes of population decentralization and counterurbanization (Fielding 1982). Changes in regional net movement between 1971 and 1979 (Ogilvy 1982) confirm this pattern and the important role of the South East in the migration system of the whole country, but what changes have occurred since then?

The graphs depicted in Figure 3 illustrate the net migration rates for each of the regions concerned. Within England and Wales, the contrast between metropolitan losses and nonmetropolitan gains has continued but some fluctuations in rates have taken place. The most consistent rates of net loss are found in Tyne and Wear, West Yorkshire and Greater Manchester, whereas South Yorkshire experienced an increase in rates of net outmovement in the second half of the 1975-86 period, having achieved a net gain in 1979-80. Merseyside has suffered higher rates of loss than the other northern conurbations and there is as yet no evidence that this situation is changing. The most significant changes in rates are associated with Greater London and, to a lesser extent, the West Midlands, both of which were experiencing

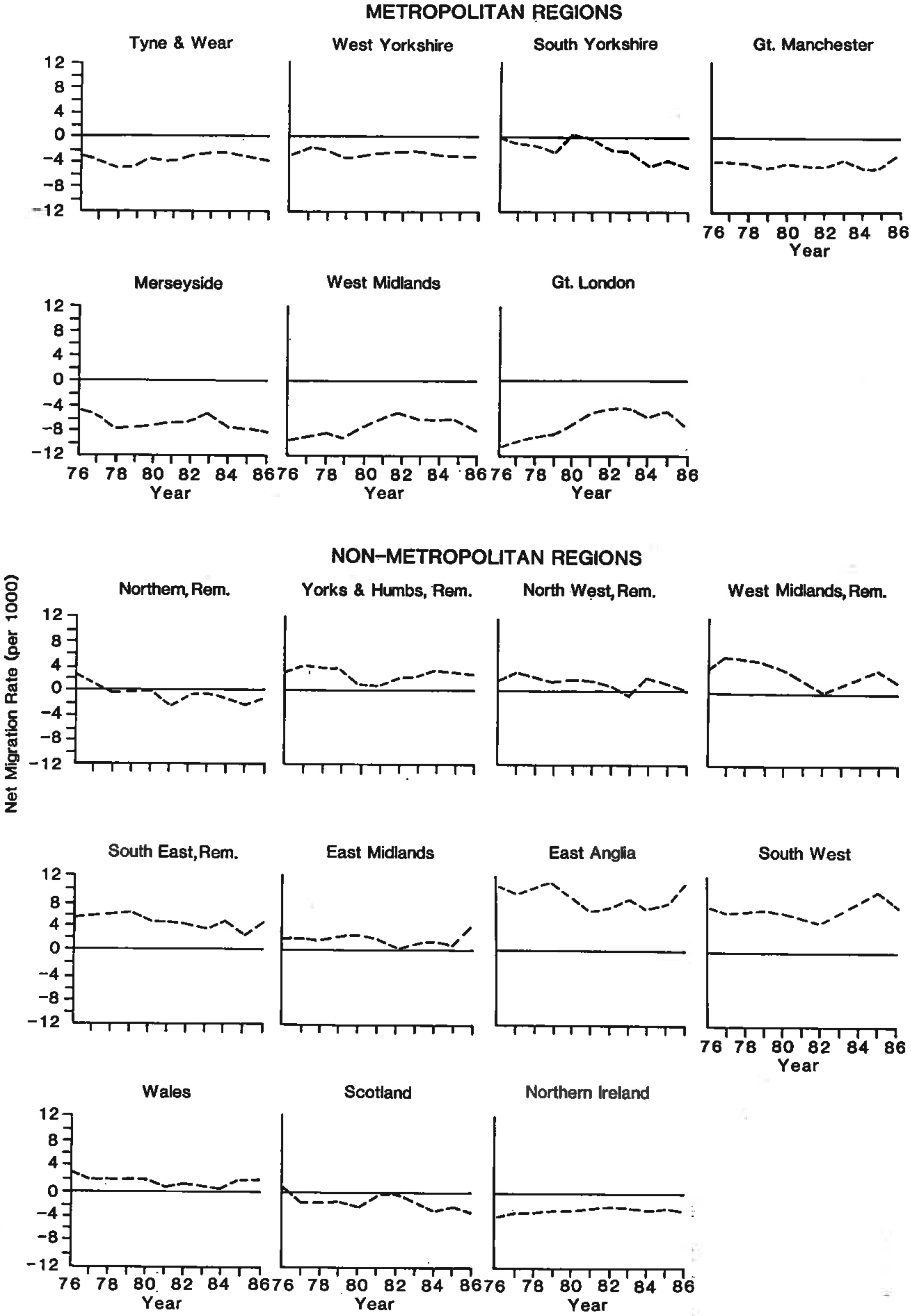


Figure 3: Net migration rates, metropolitan and non-metropolitan regions, 1975-6 to 1985-6

very high rates of net loss in 1975-6. Rates of net outmigration in these two regions dropped during the first half of the period but the declines appear to have levelled out and rates have begun to increase again since 1983-4.

In contrast to these patterns of loss net balances in most nonmetropolitan regions have remained positive. The exception is the Remainder of the North, where gains in 1975-7 have been replaced with losses during the rest of the period. The highest rates of net inmigration are found in East Anglia and the South West, where most fluctuation has also taken place. Rates of net gain in East Anglia dropped between 1979-80 and 1981-82 in response to declines in outmovement from the capital, but maintained a level of around 8 per thousand until 1985-6 when a substantial increase occurred. Parallel rises in the net inmigration rate in this year were also evident in the Remainder of the South East and in the East Midlands, but these regions appear to have been less affected by changes in Londons outmigration earlier in period. In the South West, however, the final year of the period saw a downturn in the rate of net inmovement which had been rising since 1981-2. A similar fluctuation also occurred in the Remainder of the West Midlands, although this region experienced a significant decline in its inmigration rate between 1976-7 and 1981-2, in line with the reduction in outmigration from its inner metropolitan core. Net rates schedules for Scotland and Northern Ireland have also been included in Figure 3 which indicate relatively stable patterns of net loss in each case.

3.3. Net migration rates for FPCAs

In aggregate terms, UK metropolitan FPCAs maintained rates of net loss of around 6 per thousand throughout the period whereas nonmetropolitan FPCAs experienced gains of around 2.5 per thousand on average. More detail is provided when the time series schedules for shire county and metropolitan district FPCAs are considered. Figure 4 illustrates the net migration rate profiles for metropolitan FPCAs and a cursory glance at the set is sufficient to indicate that most fluctuations have occurred in various parts of Greater London. The FPCAs most responsible for the reduction in the capitals net loss up to 1981-2 appear to be Camden and Islington (which had a positive balance between 1979-80 and 1984-5), Kensington, Chelsea and Westminster (after 1978-79) and Lambeth, Southwark and Lewisham. Smaller declines in the rate of net loss were experienced by City/Hackney/Newham/Tower Hamlets and by Redbridge and Waltham Forest. In the provinces, metropolitan net migration rates have generally been more constant over time with certain notable exceptions such as Manchester, whose rate of net loss declined appreciably during the period, or Solihull, where net gains have been registered since 1981-2.

The net migration rate time series schedules for shire counties in England and Wales are depicted in Figure 5. Whilst the majority of FPCAs show continuous net gains, several have profiles which fluctuate around zero: Cumbria, Humberside, Derbyshire, Leicestershire, Nottinghamshire, Avon, Staffordshire, Lancashire, Gwent, S. and W. Glamorgan. Cleveland is exceptional in having an increasingly negative net migration rate. The FPCAs which experience most net rate fluctuation appear to be located in the

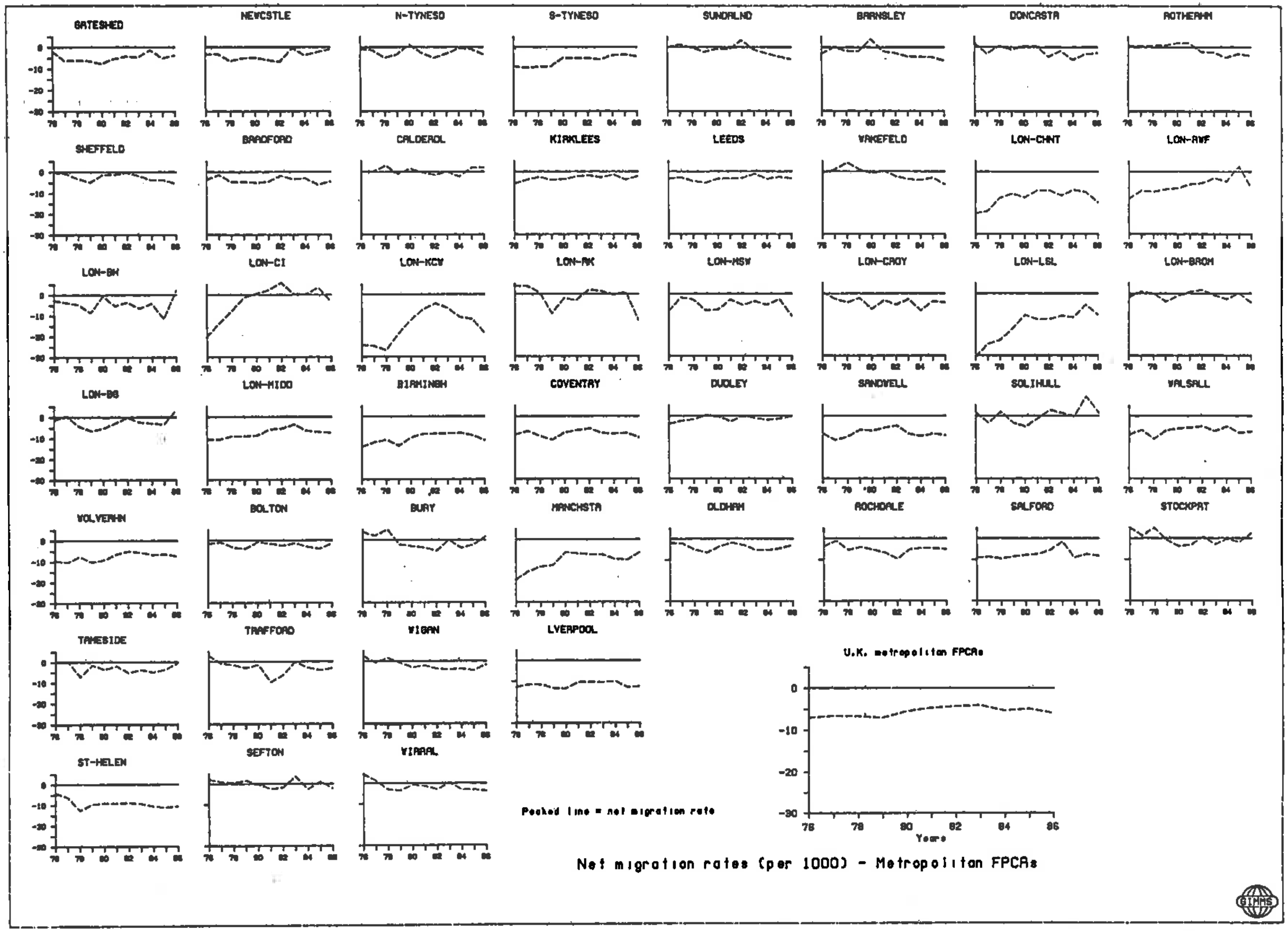


Figure 4: Net migration rates, metropolitan FPCAs, 1975-6 to 1985-6

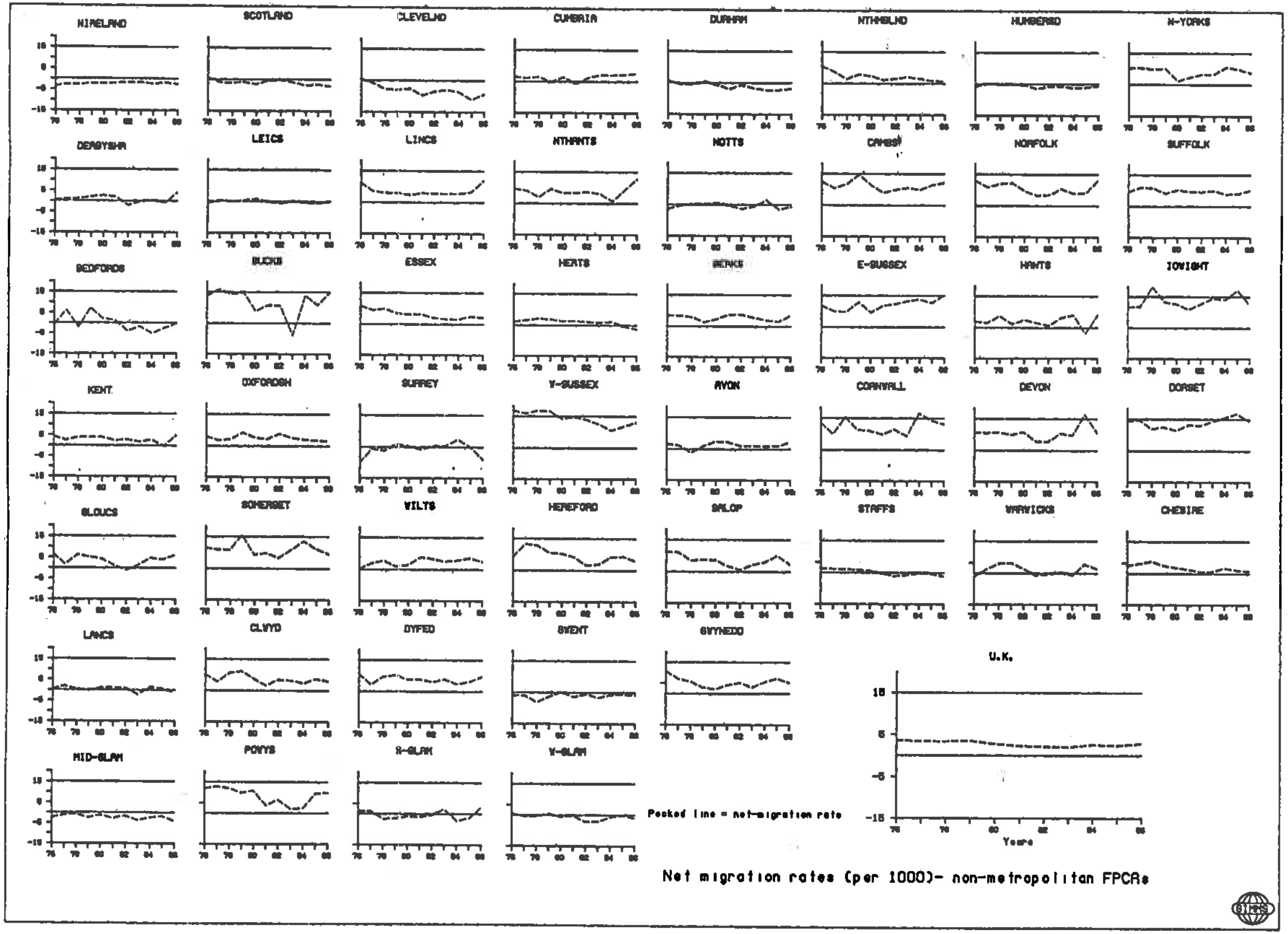


Figure 5: Net migration rates, non-metropolitan FPCAs, 1975-6 to 1985-6

South. Buckinghamshire, for example, had a positive net migration rate of nearly 15 per thousand at the beginning and end of the period yet actually lost migrants in 1983-3. Four years of net gain in Bedfordshire in the first half of the period were followed by net losses thereafter. The highest inmigration rates were found to occur in the FPCAs along the South coast: E. and W. Sussex, Isle of Wight, Dorset, Devon and Cornwall, certain of which had particularly high rates in 1984-5. Other nonmetropolitan FPCAs with fluctuating schedules include North Yorkshire, Northamptonshire, Cambridgeshire, Norfolk, Somerset, Hereford and Worcester, Salop, Clywd, Gwynedd and Powys.

3.4. Net migration trends and the North-South divide

This section examines the net migration balances of FPCAs in the North and the South grouped on the basis of their density characteristics. Density is considered as a proxy for level of urbanization and Figure 6 provides further evidence of how the processes of migration have resulted in increasing net migration losses from the North and gains by the South. In the North, there have been significant net losses from FPCAs in both high and medium/high density categories without the compensating gains by FPCAs in the medium/low and low density FPCAs that have occurred in the South. The group of Northern FPCAs in the medium/low class has actually suffered net losses since 1980-1 and the low density FPCAs also recorded a negative balance overall in 1985-6. Northern urban areas have therefore experienced considerable net losses during the period but the consequent outflows have not resulted in corresponding gains in the less urbanized areas of the North.

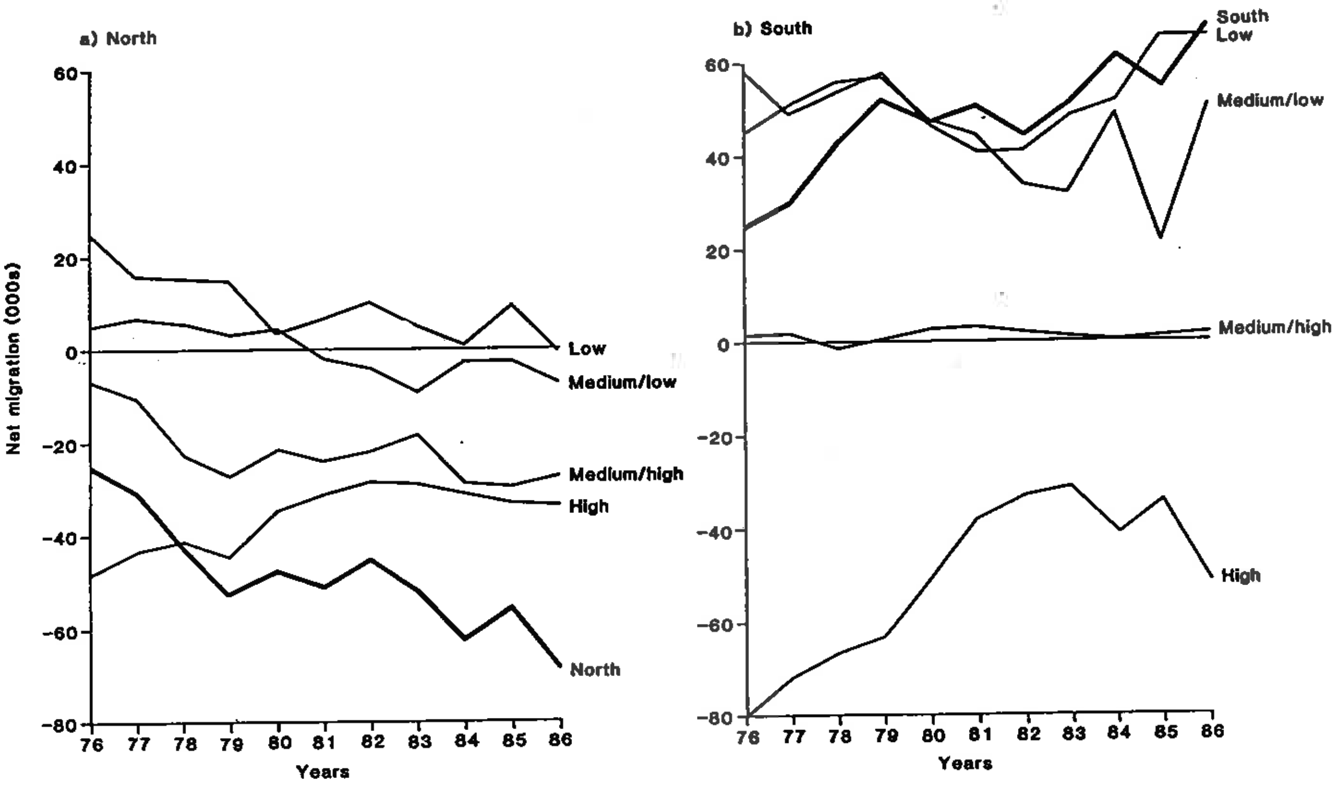


Figure 6: Net migration flows, FPCA density categories in the North and South, 1975-6 to 1985-6

Counterurbanization appears to have been less important than the movement of people to the South from the North.

In the South, the net migration schedule for the high density London FPCAs indicates a deceleration in the volume of loss up to 1982-3 which is reflected in the schedules of the medium/low and low density FPCAs. Although the medium/low density category has shown fluctuation in recent years (with gains of 50,000 in 1983-4 and 1985-6), the low density areas have undergone a more sustained increase in the level of net inmigration since 1981-2, reaching 68,000 by the final year. Counterurbanization has extended to the most rural areas in the southern half of Britain whereas outmovement to FPCAs surrounding Greater London (FPCAs in the medium/low density category), is still important but has shown more fluctuation over time.

4. TRENDS IN THE COMPONENTS OF INTER-AREA MOVEMENT

The examination of changes in the spatial patterns of net migration does provide a summary of where population redistribution has resulted in gains or losses, but it also conceals a great deal of information about the gross volumes of migration that are occurring between the zones in the system. Although much research in the UK has been focused on gross or directional movement of different types at various scales for particular time periods, few attempts have been made to decompose internal migration into its component levels and probabilities and to explore the temporal stability of the components defined.

4.1. The components defined

The aggregate migration flow between origin zone i and destination zone j can be separated into four components: (1) a level component; (2) a generation component; (3) an attraction component; and (4) a distribution component. The level component measures the overall level of migration in the system:

$$L(t) = \sum_i \sum_j M_{ij}(t) \qquad (1)$$

The generation component measures the relative importance of each origin zone as a generator of outmovement. It is calculated as the proportion of total migration which originates from zone i:

$$g_i(t) = \sum_j M_{ij}(t) \,/\, \sum_i \sum_j M_{ij}(t) \qquad (2)$$

The attraction component measures the importance of different destinations to migrants and is defined as the proportion of total migration which is attracted to destination j:

$$a_j(t) = \sum_i M_{ij}(t) \,/\, \sum_i \sum_j M_{ij}(t) \qquad (3)$$

Finally there is the distribution component which can be defined in one of two ways. It measures either the way in which migrants from origin zones choose different destinations or the way destination zones attract migrants from different origins. In the first case, the component is defined as the proportion of outmovement from zone i that arrives at zone j:

$$t_{ij}(t) = M_{ij}(t) \,/\, \sum_j M_{ij}(t) \qquad (4)$$

Alternatively, it can be defined as the proportion of inmovement to zone j which originated from zone i:

$$K_{ij}(t) = M_{ij}(t) / \sum_{i} M_{ij}(t) \qquad (5)$$

The distribution component is a conditional probability which gives the relative weight of each inter-area migration flow within the system and the dynamics of the migration pattern is a function of the relative stability or instability of each of the components and the way they interact. At this stage in our analysis, a formal mathematical model is not proposed. Each component of migration and its variation over time is examined using an index which take the value 100 for the base year, 1975-6.

4.2. The level component

Previous research on intercensal change in levels of migration within Britain has identified a significant shift from an increase of 15% in the volume of migration during the 1960s to a substantial decline of nearly 20% during the 1970s (Stillwell and Boden 1986, Table 1). The decline in the 1970s has been confirmed for migration between regions and between FPCAs using data from the NHSCR. What has happened since the beginning of the current decade?

The total number of moves per annum expressed as a percentage of the base year level has been computed for moves between metropolitan/nonmetropolitan regions and between FPCAs (Figure 7). In 1975-6, over 1.93 million moves were made between the FPCAs and 1.33 million moves between the more aggregate regions, but by 1981-2, the level of movement in both systems had

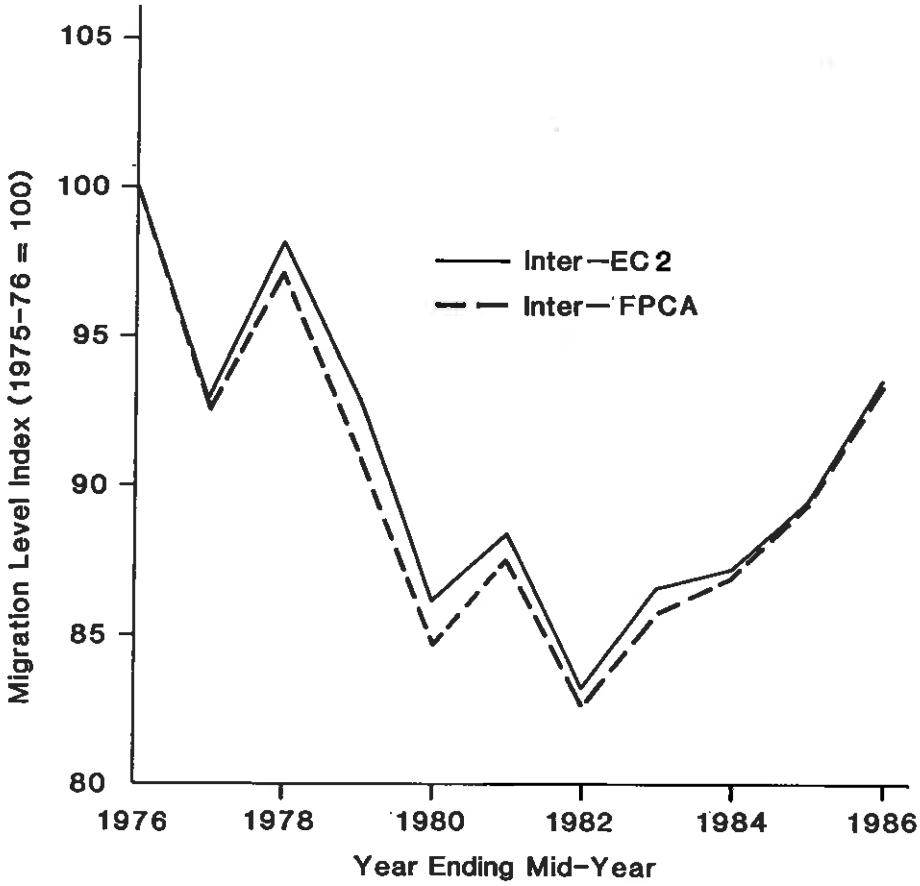


Figure 7: Changes in total movement between FPCAs, and between metropolitan/non-metropolitan regions, 1975-6 to 1985-6

fallen by about 17%. Approximately 222 thousand fewer moves were made between the metropolitan/nonmetropolitan regions in 1981-2 than in the base year and 337 thousand fewer reregistrations between FPCAs were recorded. Since this low point, the levels of movement have increased steadily and reached just over 93% of the 1975-6 level in 1985-6. Comparison of the two schedules suggests that shorter distance inter-FPCA movement declined marginally more than longer distance inter-region migration.

4.3. Generation and attraction components

In this section generation and attraction components of the movement from and to metropolitan/nonmetropolitan regions and from and to FPCAs grouped according to density are considered. Figure 8 illustrates that whilst many of the metropolitan/ nonmetropolitan regions have stable generation and attraction components, there are some notable exceptions. The time series index for Northern Ireland shows the regions declining share of total outmigration but with considerable annual fluctuation parallelled by changes in its share of total inmigration. The index of change in the attraction component of movement to Scotland shows significant declines in the earlier and later years of the period and a downward trend is also apparent in the attraction components of migration to the Remainder of the North and Merseyside. In contrast, Greater London attracted a share of total inmigration which increased by over 10% between 1979-80 and 1980-1 and has only declined to less than 10% of the base level in the last three years of the period. With the exception of Northern Ireland, the capital city is the only region where the generation

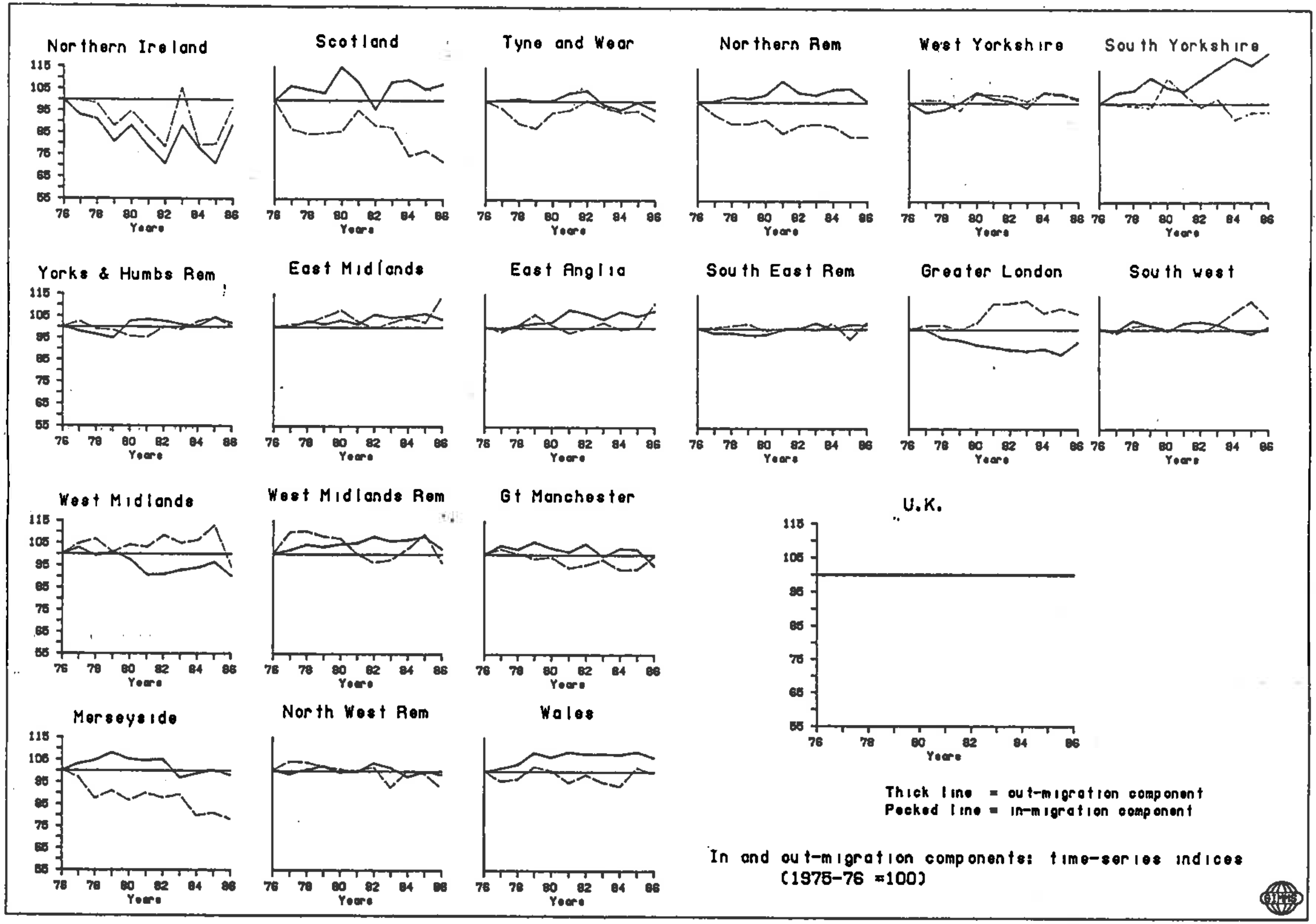


Figure 8: Changes in generation and attraction components, metropolitan and non-metropolitan regions, 1975-6 to 1985-6

component of total migration has fallen and remained below the base level throughout the period, although the proportion of total outmigration originating from the West Midlands metropolitan area also declined by 10% of its 1975-6 level between 1978-9 and 1980-1. The most dramatic change in the generation component schedules appears to have occurred in South Yorkshire, where the outmigration proportion in 1985-6 had increased by 20% of its 1975-6 level. Generally speaking, the attraction components appear to be less stable than the generation components over time.

The schedules depicted in Figure 9 illustrate changes in the generation and attraction components of migration from and to FPCAs grouped according to regional location and density. In the North, the generation component of migration from high density FPCAs has fallen relative to its 1975-6 level, whilst the attraction component has fluctuated only marginally. In the other three density categories the generation component has remained above the base year proportion whilst the attraction component has declined. The picture of change is rather different in the South, primarily because annual attraction components of migration to FPCAs in the two lowest density categories have tended to remain above the 1975-6 proportions (with the two exceptions) and since 1980-1, the rise in the proportion of inmigration into FPCAs in the lowest density, least urbanized category has been pronounced.

4.4. The distribution component

Since there is a distribution component associated with each origin-destination flow in the inter-region matrix, variation in the component over time is illustrated firstly with the example

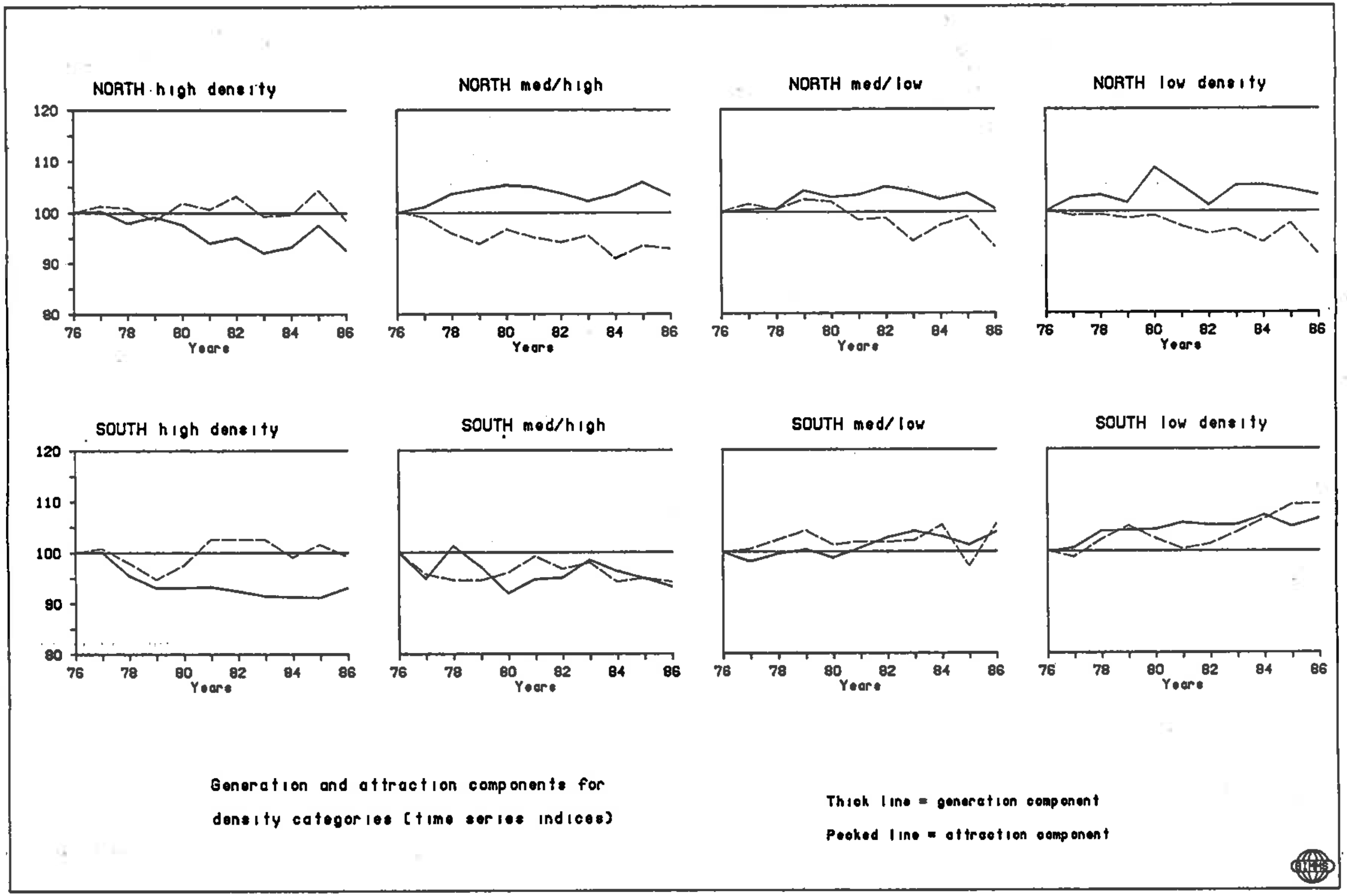
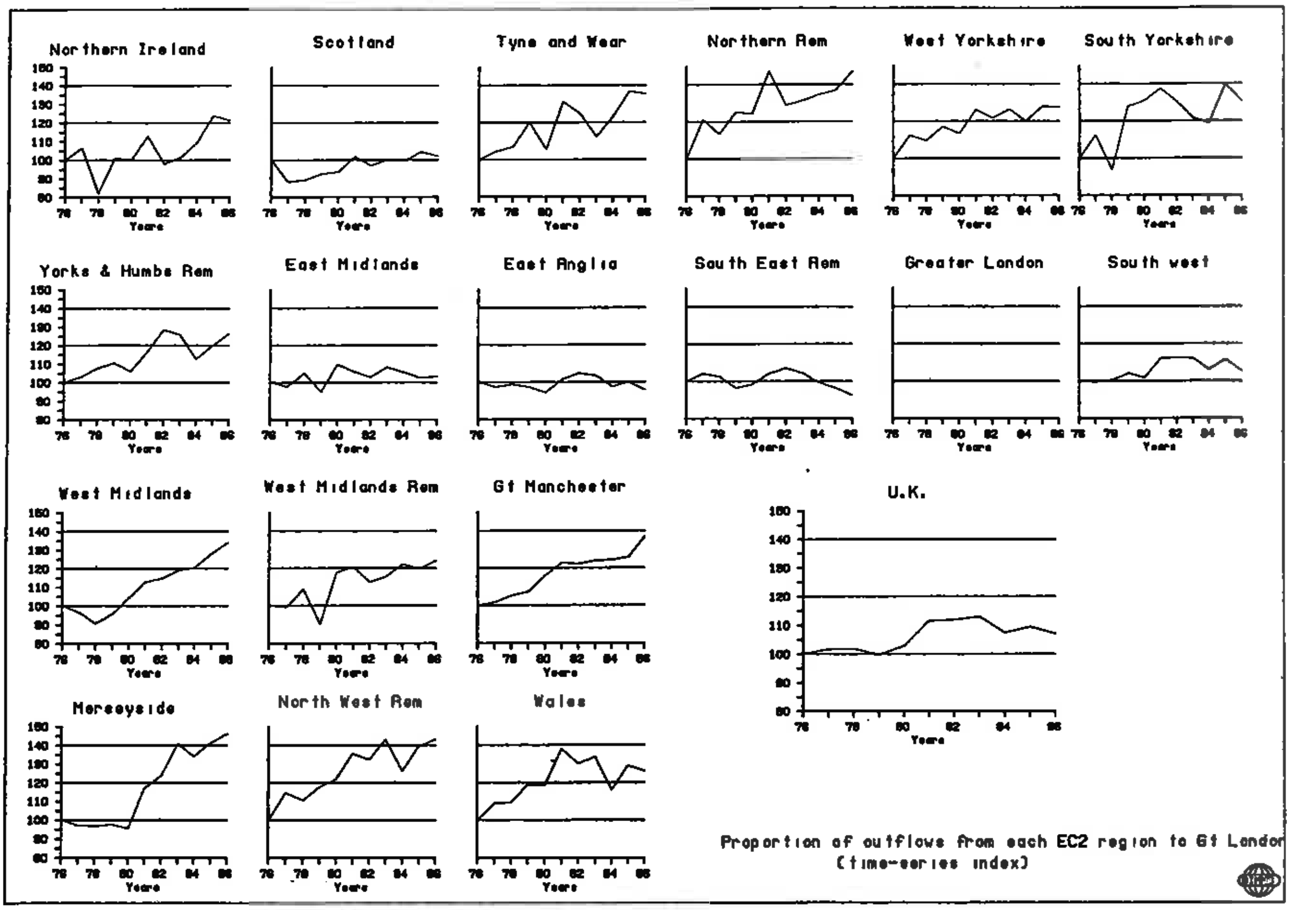


Figure 9: Changes in generation and attraction components, FPCAs by density category, 1975-6 to 1985-6

of Greater London. The dominant feature of the time series indices of the proportion of outmoves from each origin for which Greater London is the destination (Figure 10), is the increasing attractiveness of the capital to migrants from outside the South. Virtually all metropolitan and nonmetropolitan regions in the industrial heartland and the periphery have experienced significant increases in the proportion of their outmoves which involve Greater London. In certain cases the increase in the London-bound share has been over 40% of the 1975-6 component. In contrast, the proportions leaving the East Midlands, the Remainder of the South East, East Anglia and the South West for Greater London have remained relatively stable. The counterstreams of movement from London to the other regions, expressed as proportions of total outmigration from Greater London (Figure 11) show quite different trends. The most stable distribution component has been that from Greater London to its region remainder and proportions of outmovement to other regions in the South have experienced relatively little fluctuation. There is some evidence of a trend towards an increasing proportion of outmovement from London to the West Midlands and Manchester metropolitan areas and a declining proportion of movement to Scotland, but otherwise, fluctuations are considerable and trends more difficult to discern.

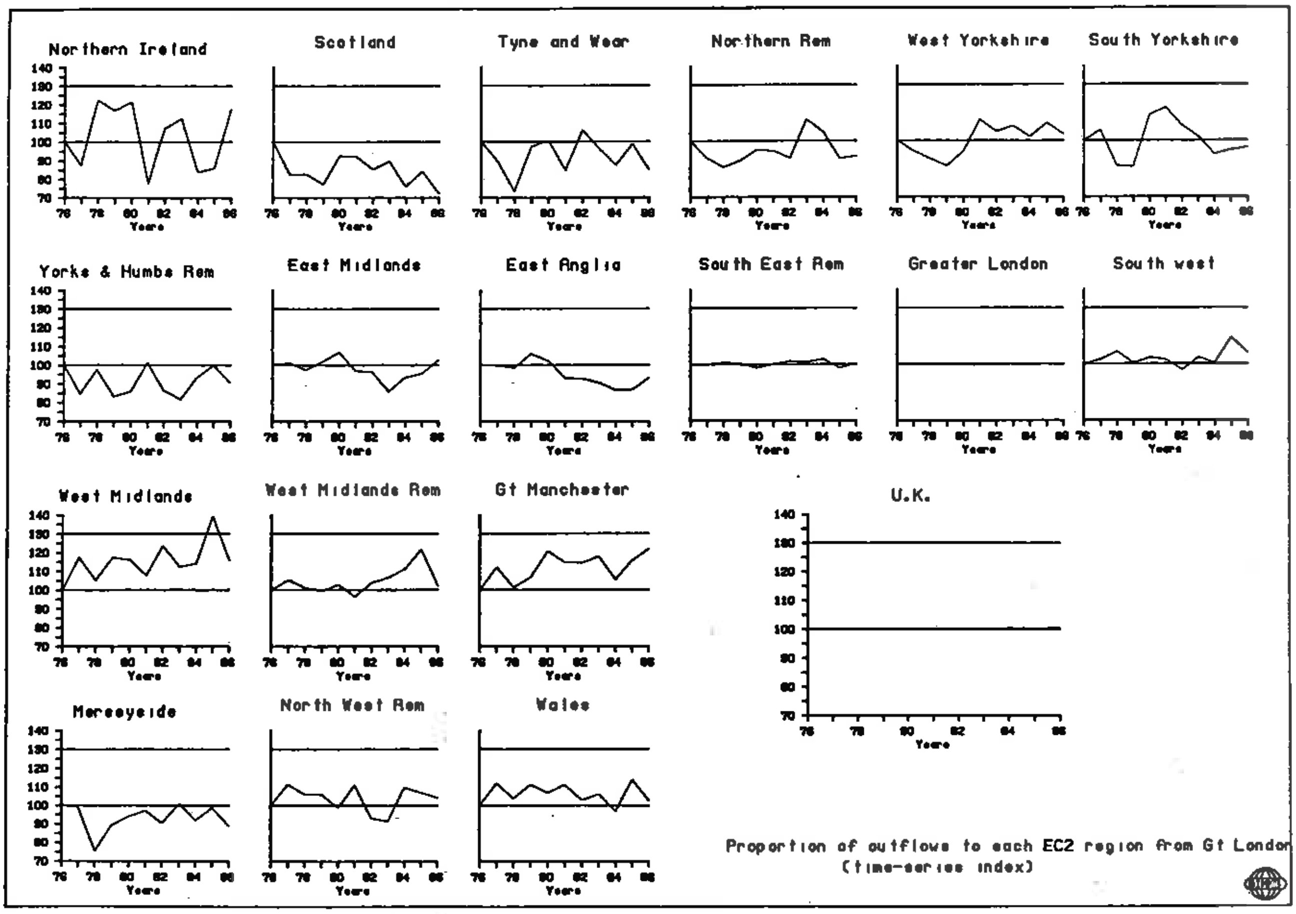
The general conclusion which emerges from examining the complete set of distribution components is that they show much less temporal stability than the generation and attraction components. This is confirmed when we observe changes in the distribution components of movement between FPCAs in the North and in the South, grouped according to density. Most outmoves from high density



Northern Ireland, Scotland, Tyne and Wear, Northern Rem, West Yorkshire, South Yorkshire, Yorks & Humbs Rem, East Midlands, East Anglia, South East Rem, Greater London, South west, West Midlands, West Midlands Rem, Gt Manchester, U.K., Merseyside, North West Rem, Wales

Proportion of outflows from each EC2 region to Gt Londo
(time-series index)

Figure 10: Changes in the distribution components (proportion of outflows from each region to Greater London), 1975-6 to 1985-6



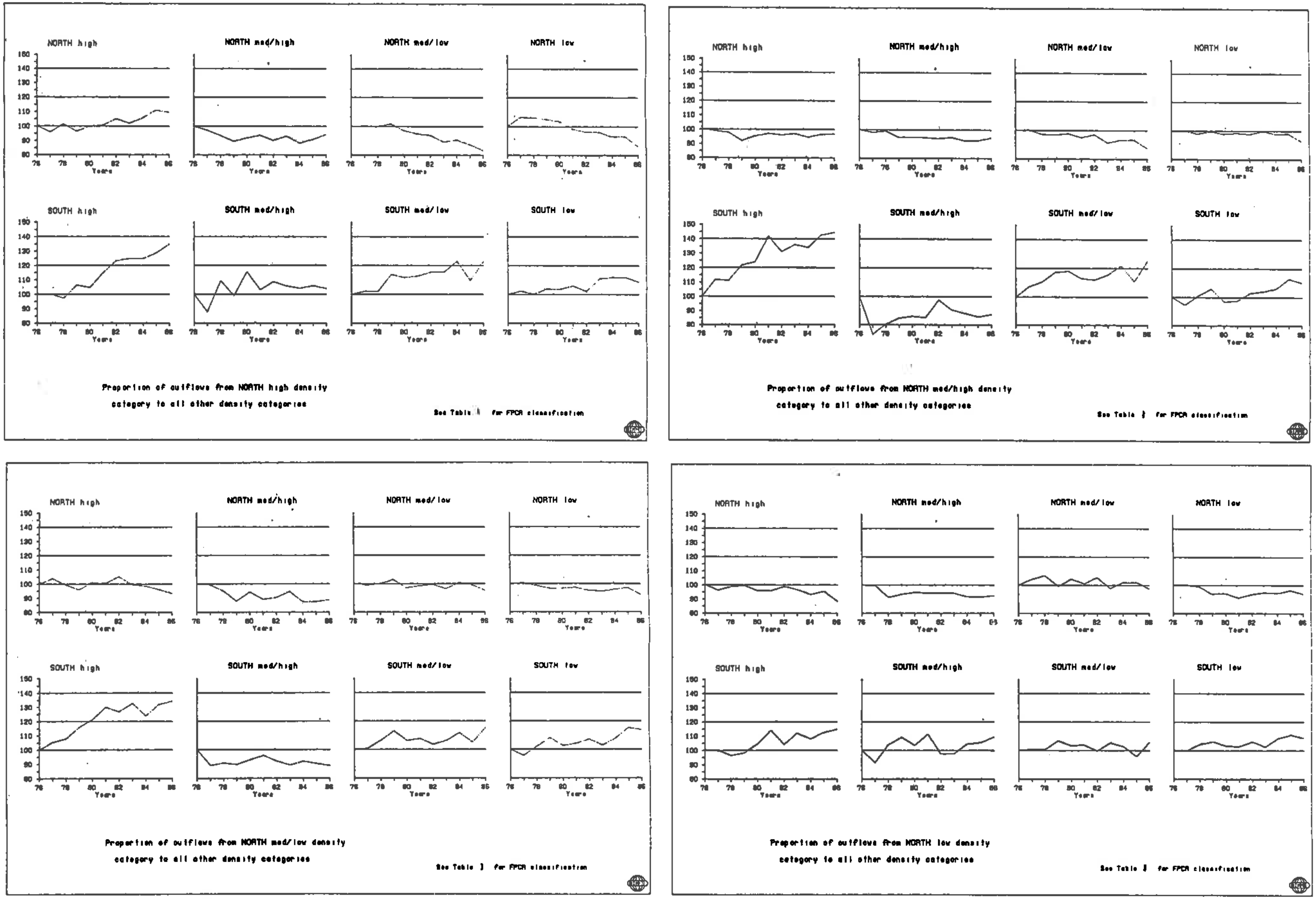
Northern Ireland, Scotland, Tyne and Wear, Northern Rem, West Yorkshire, South Yorkshire, Yorks & Humbs Rem, East Midlands, East Anglia, South East Rem, Greater London, South west, West Midlands, West Midlands Rem, Gt Manchester, U.K., Merseyside, North West Rem, Wales

Proportion of outflows to each EC2 region from Gt Londo
(time-series index)

Figure 11: Changes in the distribution components (proportion of outflows from Greater London to each region), 1975-6 to 1985-6

FPCAs in the North (Figure 12) are relatively short distance to other high density FPCAs in the North, but there has been a relative decline in the proportion moving to FPCAs of lower density in the North. On the other hand, the proportion of moves from these areas to FPCAs in the South, particularly those of high density in Greater London, has increased. The same general pattern exists for northern FPCAs in high/medium and medium/low density categories. Even the distribution component of migration from low density FPCAs in the North to high density FPCAs in the South has an upward trend.

Most outmovement from FPCAs in the South occurs between FPCAs in high and medium/low density categories. However there appears to be an increasing proportion of movement from high density areas in the South to high density FPCAs in the North (Figure 13). The distribution components of migration from high/medium density FPCAs in the South show most annual fluctuation but there are only two FPCAs in this group. FPCAs in the two lower density categories in the South have more stable distribution components. Movement proportions out of areas of medium/low density to areas of medium/high density in the South and North and to areas of low density in the North have declined below the 1975-6 base and distribution components of migration from medium/low and low density FPCAs to low density FPCAs in the South have increased since 1981-2.



Proportion of outflows from NORTH high density category to all other density categories

See Table 3 for FPCA classification

Proportion of outflows from NORTH med/high density category to all other density categories

See Table 3 for FPCA classification

Proportion of outflows from NORTH med/low density category to all other density categories

See Table 3 for FPCA classification

Proportion of outflows from NORTH low density category to all other density categories

See Table 3 for FPCA classification

Figure 12: Changes in the distribution components of migration from Northern FPCAs in four density categories, 1975-6 to 1985-6

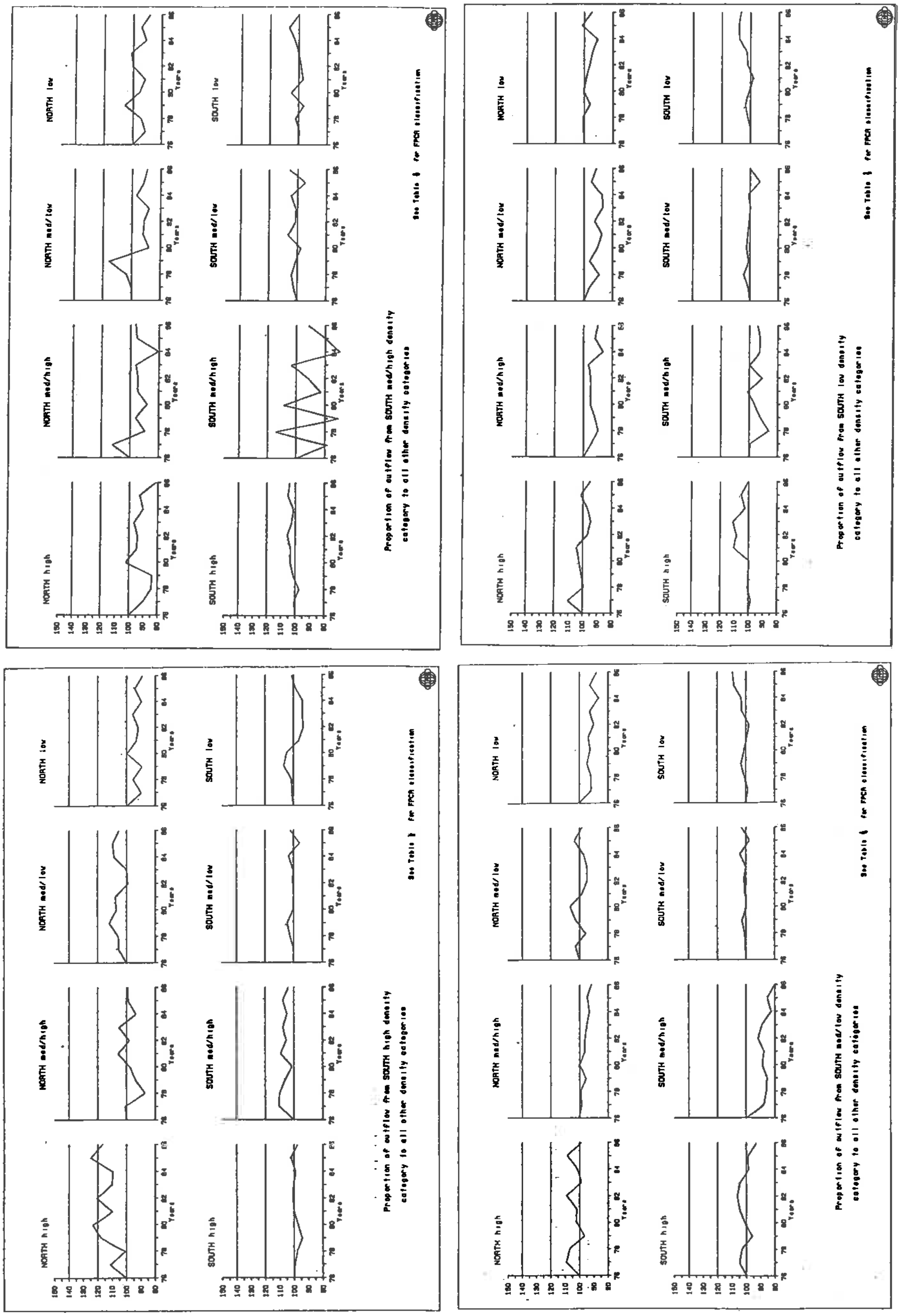


Figure 13: Changes in the distribution components of migration from Southern FPCAs in four density categories, 1975-6 to 1985-6

5. MIGRATION DISTRIBUTION MODELLING

Empirical analysis of annual NHSCR reregistration data provides a fairly reliable indication of the volume and direction of longer distance internal migration in the UK, and the extent to which migration components and spatial patterns have changed in more recent years. Modelling provides a means through which migration analysis may be extended to identify, for example, relevant influences on or consequences of historical migration behaviour, to estimate unknown migration characteristics of subgroups of the population, or to project migration in the future.

Common amongst the plethora of models that have been proposed are those attempting to identify the significance of particular explanatory factors using multivariate regression techniques, where independent variables are selected according to how the dependent variable is defined. Models seeking to explain the causal mechanisms behind changes in the overall propensity to migrate within a particular system of interest are likely to employ variables of a different nature to those that might be chosen to investigate reasons for the pattern of net losses and gains in the metropolitan/nonmetropolitan system or to investigate the motives for specific flows such as the movement of male migrants aged 20-24 from West Yorkshire to Greater London. Causal modelling of aggregate flows, such as those available from the NHSCR and described in Sections 3 and 4, is unlikely to be satisfactory because of the wide variety of reasons behind the decisions of those individuals involved to change their place of usual residence. It is possible to distinguish at least three life course groups whose motivations for migration will differ and who will respond to different pushes and pulls. The movement of those who are economically active and without family responsibilities may result from the need to find a (new) job or take up a place in an educational institution. The movement of families where one or both parents are working may also be motivated by work opportunities but other factors relating to housing or the location of schools may be significant. Movement associated with retirement, on the other hand, occurs when ties to the labour market are severed and may be motivated by residential, environmental or social factors.

In order to construct satisfactory migration models for these life course groups, it is really necessary to use data disaggregated into single or five year age groups and by sex, although various attempts have been made to separate aggregate migration flows into motivation-specific streams (eg job-based distinguished from home-based migration) by Stillwell (1978) and Gordon (1982). In deciding where to move, a potential migrant has to select from among the set of competing opportunities and in this situation, the availability of information and the geographical proximity of likely destinations are important influences. In this section of the paper we focus on the role of distance and attempt to investigate its changing influence on the distribution of migration between metropolitan and nonmetropolitan regions using spatial interaction models.

5.1. Spatial interaction models

Gravity models are based on the assumption that migration occurring between any pair of zones varies according to the sizes of the origin and destination and the distance between the two zones concerned. The negative relationship between distance and migration recognized by Ravenstein (1885) has been examined in numerous studies using regression techniques. More recently, the use of spatial interaction models derived by entropy maximising methods (Wilson 1974) has allowed additional knowledge about gross zonal outmovement and inmovement to be incorporated in the form of constraints and zone-specific distance decay parameters to be calibrated (Stillwell 1978, Fotheringham 1981, 1983).

A doubly constrained spatial interaction model for aggregate movements between the seventeen zones of the metropolitan/nonmetropolitan region system (Northern Ireland excluded) can be written as:

$$M_{ij} = A_i B_j O_i D_j d_{ij}^{-\beta} \qquad (6)$$

where O_i = total outmigration from zone i;

D_j = total inmigration to zone j;

$d_{ij}^{-\beta}$ = a linear function representing the inverse relationship between migration and distance from zone i to zone j, where β is the calibrated parameter;

and where A_i and B_j are balancing factors defined endogenously which ensure that outmigration and inmigration constraints are satisfied.

Interzonal distances have been calculated using national grid references for centres of local authority districts, counties and regions (OPCS 1984) as follows:

$$d_{ij} = \sqrt{(e_i - e_j)^2 + (n_i - n_j)^2} \qquad (7)$$

where e_i and e_j are easting coordinates of origin i and destination j;

and n_i and n_j are northing coordinates of origin i and destination j.

Where a study zone contains more than one FPCA, the population centre is determined as the weighted average of the easting and northing coordinates of the FPCAs involved:

$$d_{ij} = \sqrt{\left(\frac{\sum_{k \in i} e_k P_k}{\sum_{k \in i} P_k} - \frac{\sum_{l \in j} e_l P_l}{\sum_{l \in j} P_l} \right)^2 + \left(\frac{\sum_{k \in i} n_k P_k}{\sum_{k \in i} P_k} - \frac{\sum_{l \in j} n_l P_l}{\sum_{l \in j} P_l} \right)^2} \quad (8)$$

where P_k and P_l are the populations of the constituent FPCAs of zones i and j used for weighting.

The optimum generalized decay parameter, β^*, has been estimated with a Newton Raphson iterative search routine using a software package developed at Leeds (Stillwell 1984) and can be interpreted as a measure of the general propensity to migrate over distance. Higher parameter values indicate that distance has a more pronounced effect on migration. When a doubly constrained model is fitted to each of the 11 interregional movement matrices, the results show that the propensity to migrate over distance has fallen gradually from 1975-6 to 1985-6 (the value of the parameter has decreased from 0.81 to 0.74). The average distance over which migration has taken place increased from 162.8km in 1975-6 to 166.3km in 1981-2, declined to 163.2km in 1982-3 but then increased to 165.7km by the final year of the period.

5.2. Zone-specific decay parameters

The generalized decay parameters give an indication of change in the overall propensity to migrate but it is very likely that aggregate movement from specific origins and to specific destinations will show spatial and temporal variation. Models with origin- and destination-specific parameters have been calibrated which demonstrate the extent of this variation. The influence of distance on outmovement (Figure 14) and on inmovement (Figure 15) does vary even between zones in the same broad regional division. Of the four regions defined as constituting the periphery, migrants to and from Scotland appear relatively unaffected by distance whereas migrants to and from Tyne and Wear and the Remainder of the North have much higher parameter values. Wales has intermediate decay values although inmigrants to Wales are more affected by distance than outmigrants from the Principality, despite moving over similar distances.

Zones in the industrial heartland appear to be more clustered in terms of the propensities of their out- and inmigrants to move over distance. The general trend of decline in the frictional effect of distance is reflected in the outmigration parameter schedules for all the metropolitan regions apart from West Yorkshire, and in the inmigrant parameter schedules for Merseyside and Greater Manchester. Declines in parameter values over the period are more apparent for inmigrants to the region Remainders of the West Midlands and the North West than outmigrants from these regions but the influence of distance of inmovement propensities to Yorkshire and Humberside, Remainder appears to have been increased over time.

In the South of the country, there is again considerable variation in decay parameter values. Greater London and the Remainder of the South East have relatively low parameters whereas distance has a much greater effect on migrants to and from East Anglia and the South West. As expected, the destination-specific parameter is higher than the origin-specific parameter for Greater

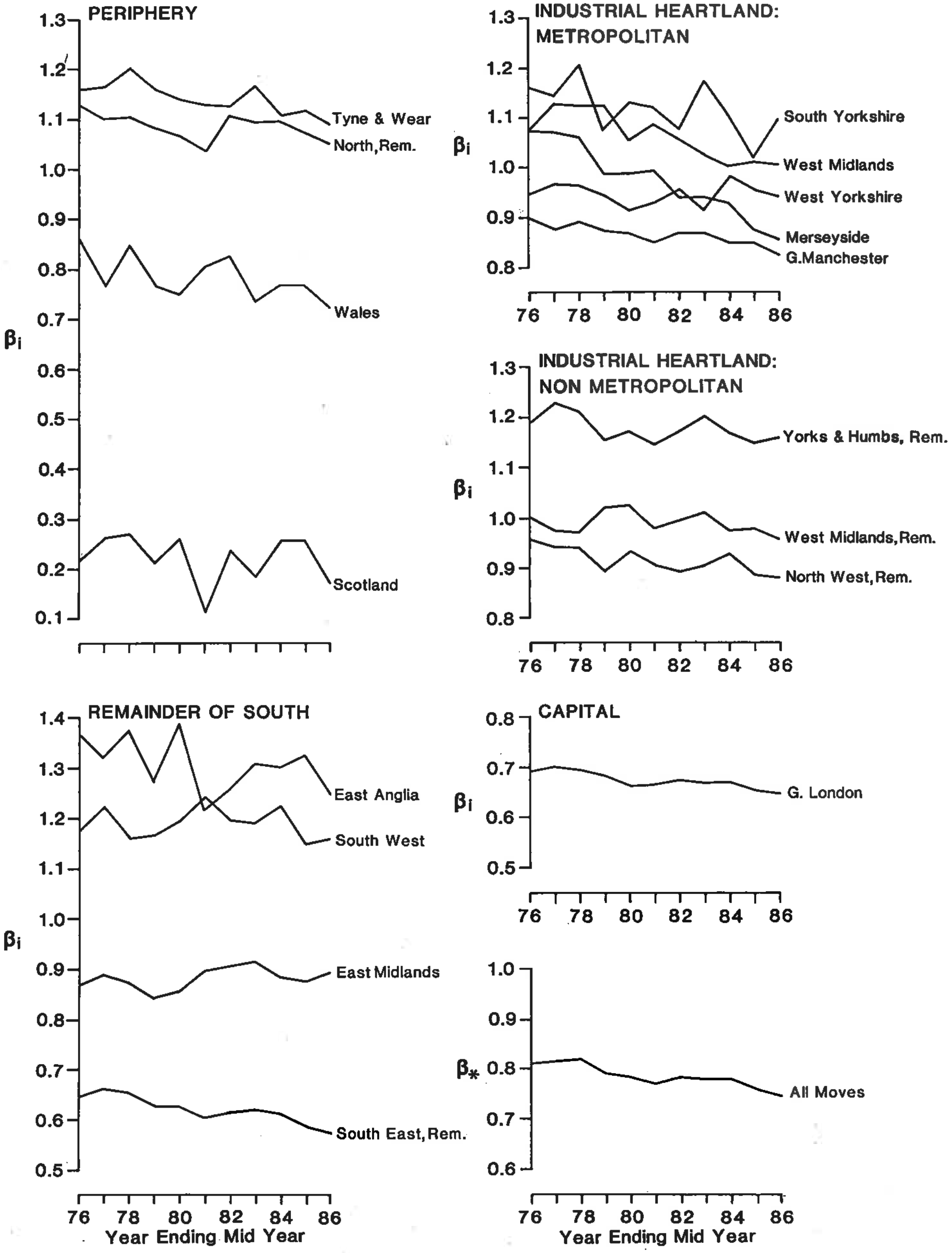


Figure 14: Origin-specific distance decay parameters, metropolitan and non-metropolitan, 1975-6 to 1985-6

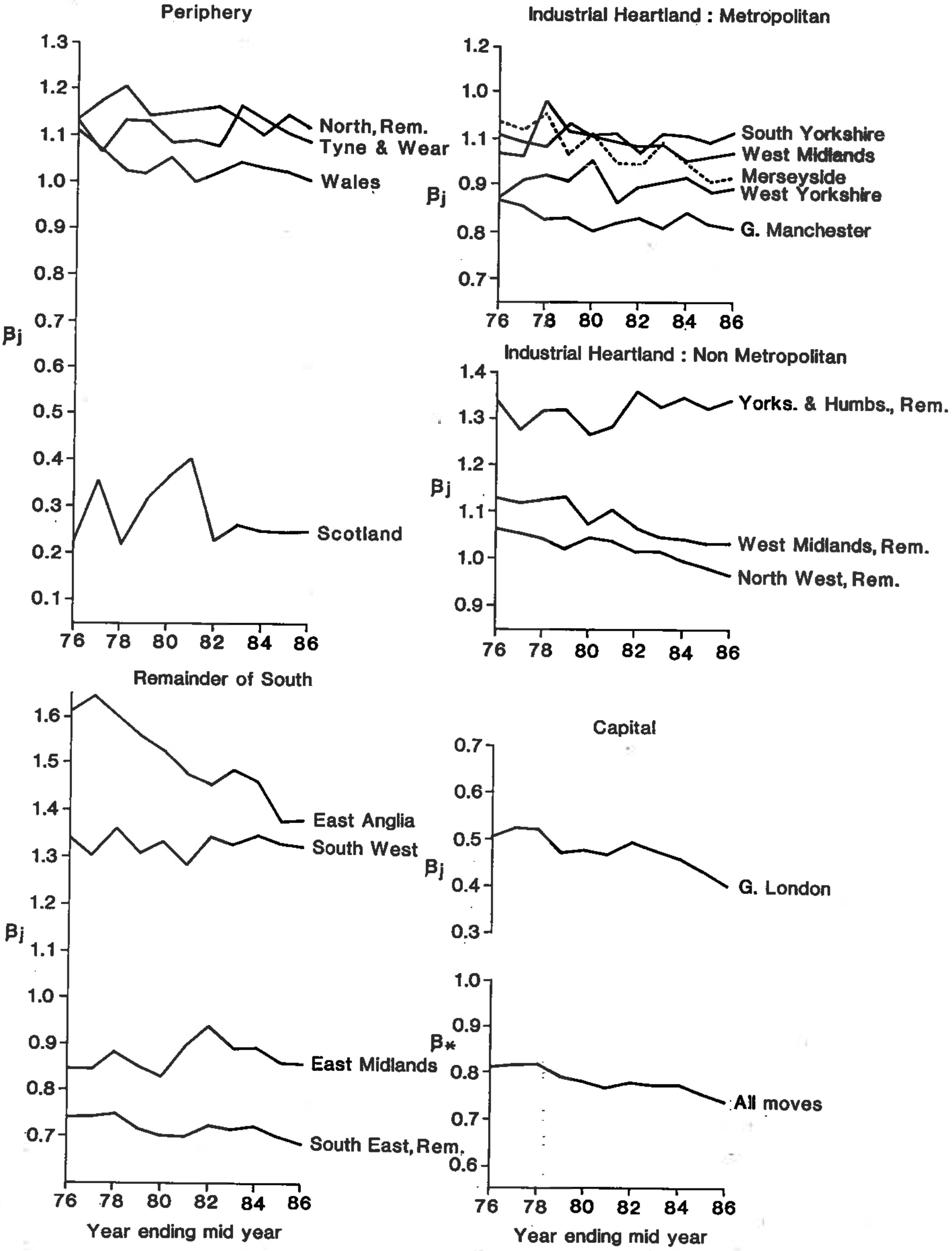


Figure 15: Destination-specific decay parameters, metropolitan and non-metropolitan regions, 1975-6 to 1985-6

London and vice versa for the Remainder of the South East. The most significant decline over time in the frictional effect of distance is that associated with inmovement to East Anglia but this trend is not apparent for movement to or from the South West or the East Midlands where perhaps upward trends are discernible.

5.3. Age-specific decay parameters

It can be argued that the propensity to migrate over distance depends as much on age as on region of origin or destination. Figure 16 illustrates generalized decay parameters and mean movement distances for interregion migrants in 16 age groups (0-4, .. 70-74, 75+) for two 12 month periods: 1983-4 and 1985-6. The profiles reflect some of the characteristics of individuals in particular life course groups. In the early age groups, distance exerts most influence on migrants aged 10-14 and least influence on those aged 20-24. Thereafter the influence of distance increases steadily to around retirement age before levelling off. Mean distances of migration tend also to decline with age but there are three peaks in the profile associated with movers aged 5-9, 20-24 and 35-44. A comparison of the figures for 1983-4 with those for 1985-6 indicates that the friction of distance became less important for all age groups up to 60-64, but more important for those aged over 65. This has not necessarily resulted in increased distances of movement in the non-elderly age groups. Movers aged 5-9, 35-39 and 50-54 travelled shorter distances in 1985-6 than in 1983-4.

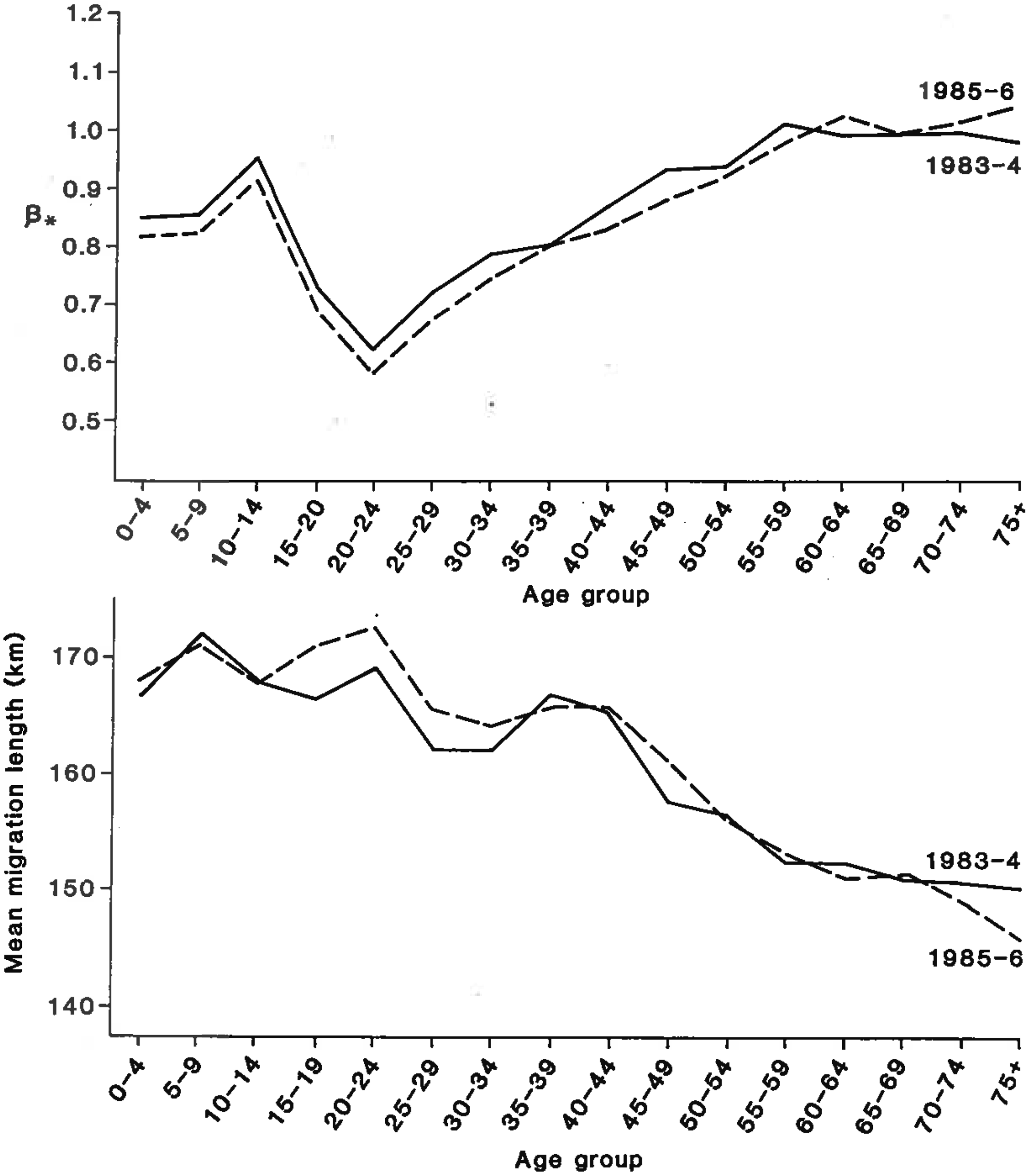


Figure 16: Generalized distance decay parameters and mean migration lengths, metropolitan and non-metropolitan regions, 1983-4 and 1985-6

5.4. Model evaluation

Two further questions are addressed briefly in this section. Firstly, how well do spatial interaction models of this type fit aggregate NHSCR data sets in a historical context?; and secondly, in the context of projection, how do spatial interaction models compare with alternative types of distribution model, given the availability of differing amounts of information?

Goodness of model fit can be measured using a variety of statistical indices which compare matrices of predicted with observed migration (Knudsen and Fotheringham 1986). Two commonly computed measures, the mean absolute (percentage) deviation (MAD) and the coefficient of determination (R2), have been selected to illustrate the accuracy with which observed flows can be predicted in historical and projection contexts. No attempt has been made to improve spatial interaction model fits by adjustment of distance values. The computed statistics in Table 2 illustrate relatively little fluctuation from year to year in historical models and demonstrate that origin-specific parameter calibration reduces the average deviation from around 28% to 20%. Further improvements in fit are obtained when destination-specific parameters are calibrated and the MAD falls to 17%. Further examination of the results is required to identify variations in fit between zones or distance categories to establish precisely where over or underprediction is predominant. Fitting the generalized parameter model to age-specific migration matrices indicates that best fits are obtained with data for those aged under 40. Minimum mean deviations of around 23% are computed for those aged 20-24 over 1983-6, compared with 35% for those aged 55-59.

Table 2: Goodness of fit statistics for spatial interaction models of historical migration between 17 study zones, 1975-86

	Type of Spatial Interaction Model					
YEAR	Generalized		Origin-specific		Destination-specific	
	Type of fit statistic					
	MAD	R2	MAD	R2	MAD	R2
1975-76	28.12	0.9453	19.95	0.9717	16.85	0.9832
1976-77	28.21	0.9454	19.73	0.9722	17.48	0.9817
1977-78	28.50	0.9403	19.93	0.9696	17.32	0.9803
1978-79	28.87	0.9347	20.91	0.9661	17.17	0.9809
1979-80	28.27	0.9332	20.45	0.9640	17.09	0.9794
1980-81	27.97	0.9353	20.07	0.9663	16.73	0.9810
1981-82	27.71	0.9402	19.73	0.9688	16.92	0.9813
1982-83	27.63	0.9366	19.80	0.9653	16.68	0.9810
1983-84	27.08	0.9355	19.42	0.9645	16.40	0.9813
1984-85	27.60	0.9268	19.86	0.9606	16.44	0.9803
1985-86	27.74	0.9324	20.14	0.9630	16.21	0.9826

Notes: (i) MAD is the mean absolute % deviation for the total number of non-zero cells defined as:

$$100 \left(\left(\sum_{i} \sum_{j} \left| \left(M^{Obs}_{ij} - M^{Pred}_{ij} \right) / M^{Obs}_{ij} \right| \right) / \left(N^{2} - N \right) \right)$$

where N = the number of zones in the system

(ii) R2 is the coefficient of determination which measures proportion of total variation in the observed matrix which is explained by the predicted matrix

The construction of a model for migration projection is usually undertaken as part of the development of a population forecasting system (Martin, Voorhees and Bates 1981, Rees and Stillwell 1984) and different population projection models require different migration inputs. The official OPCS model for population projection requires net migration assumptions, for example, whereas multiregional accounts-based models can incorporate inter-zonal transitions or moves. It is possible to envisage a number of alternative methods that might be used to project inter-zonal flows in the future, the choice of which would depend on factors such as the type of data available, the level of disaggregation of the flow to be forecast, and the purpose of the projection exercise. The desire to project interzonal flows either directly or through stages involving intermediate projection of overall levels, or zonal gross migraproduction, outmigration or inmigration rates is a further consideration. The incorporation of non-demographic data is feasible with certain methods but forecasts of explanatory variables are frequently unreliable or even more difficult to generate than migration.

It would be convenient to develop a system based on a set of different types of projection model with the facility to adopt whichever distribution model was most suitable under differing assumptions about data provision. This would also enable projections by different methods to be compared and evaluated. This approach is illustrated in the remainder of this section , where a selection of alternative projection models have been used to project aggregate interregional movement for 1985-6 based on rates, probabilities or parameters computed from base data for either

1980-1 or 1984-5. The adoption of a particular model depends on the type of data available for the projection period and the accuracy of different models can be evaluated by comparing projected with observed flow matrices. Seven models have been selected. The first and simplest type of distribution model applies historical inter-zonal rates to initial populations for the projection period which are assumed known. The second model is based on the theoretical structure introduced in Section 4, where the origin-destination flow is assumed to be composed of a level component, a generation component and a distribution component. The level of movement in the system during the projection period is assumed to be known and each flow from zone i to zone j is estimated by applying (a) the historical probability of migration occuring from origin i, and (b) the historical probability of migration to destination j given that the move originated from zone i. The third and fourth models are both singly constrained spatial interaction models whose parameters have been calibrated on historical data. The production constrained model assumes that total moves from each origin have been projected exogenously whereas the attraction constrained model assumes that total moves to each destination are known. The remaining set of projections are all based on the assumption that both zonal outmigration and inmigration totals are known. Two doubly constrained spatial interaction models are proposed; one with a generalized decay parameter, the other with a set of origin-specific parameters. A final doubly constrained model is included in which a growth factor is used to distribute the totals on the basis of the migration pattern for the historical period. The growth factor for each inter-zonal flow is the product of the ratio of projected to historical gross outmovement from each origin and the ratio of projected to historical inmovement to each destination.

Summary goodness of fit statistics associated with each of the models selected are presented in Table 3. The results of the rates model can be considered as a benchmark against which to compare other projections. There is a mean deviation of 10.1% between projected and observed flows when 1980-1 rates are applied and this deviation is reduced to 7.7% when more recent rates are utilized, reflecting changes in the pattern of population redistribution in the intervening period. However, if total movement in the system is known, the historical probability model provides more accurate projections, as indicated by the MAD and R2 statistics. The results of using spatial interaction models for projection purposes reflect the magnitude of deviation which arises when the information carried forward from the historical period is reduced to a single parameter or parameter set describing the relationship between distance and migration. An attraction constrained model appears to generate more accurate projections than a production constrained model, but the improvement of fit when using a doubly constrained model is only significant when zone-specific parameters are introduced. The mean deviation is around 20% for the doubly constrained spatial interaction model with origin-specific parameters calibrated on either base year. Finally, if a doubly constrained growth factor model is adopted which contains no explicit distance function and where the historical migration matrix is simply adjusted to comply with new row and column totals using balancing factors, the mean deviation

Table 3: Goodness of fit statistics for selected migration projection models

Information available for projection period (1985-6)	Type of model	Fit statistic	
		MAD	R2
Initial populations	Movement rates model based on (a) 1980-1	10.11	0.9922
	(b) 1984-5	7.66	0.9938
Total moves	Conditional probability model based on (a) 1980-1	8.59	0.9935
	(b) 1984-5	7.44	0.9939
Moves from each origin	Production constrained model based on (a) 1980-1	34.23	0.8423
	(b) 1984-5	34.23	0.8422
Moves to each destination	Attraction constrained model based on (a) 1980-1	29.58	0.9251
	(b) 1984-5	29.63	0.9247
Moves from each origin and to each destination	Doubly constrained generalized parameter model based on (a) 1980-1	28.06	0.9303
	(b) 1984-5	27.93	0.9310
	Doubly constrained origin-specific parameter model based on (a) 1980-1	20.28	0.9598
	(b) 1984-5	20.33	0.9614
	Doubly constrained growth factor model based on (a) 1980-1	5.14	0.9982
	(b) 1984-5	2.65	0.9996

See notes with Table 2

falls to below 3% when the 1984-5 matrix is utilized.

6. CONCLUSION

In this paper we have attempted to identify and illustrate some of the recent trends in the redistribution of the population of the UK through aggregate internal migration using time series data on NHS patient transfers.

The analysis of net migration underlines the significant effect, in absolute and relative terms, of the changing balance between outmovement from and inmovement to Greater London. Net losses from the capital declined in the late 70s and early 80s, slowing down growth elsewhere, but this deceleration was not sustained and losses began to increase again after 1982-3, with gains occurring in areas of low and medium/low density in the South. The evidence of counterurbanization is less apparent in the North. Despite metropolitan regions continuing to lose migrants, net gains in low density areas have remained below 5,000 and net losses have been recorded in medium/low density areas since 1980-1. Movement away from the North has continued during the 1980s, resulting in a widening of the net migration 'gap' between North and South. Decomposition of inter-area movement into its level, generation, attraction and distribution components has allowed these trends to be investigated in more detail. When constrained spatial interaction models are applied to each of the inter-regional movement matrices, the generalized parameters suggest an overall decline in the propensity to migrate over distance. There are significant variations in the parameter by age group and the calibration of zone-specific decay parameters indicates a wide range of parameter values with increases in the frictional effect of distance over time in certain cases. In the context of projection, the results generated by models of this type, in comparison with others, reflect the level of accuracy which occurs when information about the historical period is reduced to a single parameter or parameter set.

Spatial interaction modelling has been used in this paper as a method of assessing change through a comparative static analysis. However, patterns of change in each of the components of migration can be quantified in a dynamic analysis by treating migration patterns for different years simultaneously, and by adopting a parameterization method based on log-linear modelling (Baydar 1983). The time-related parameters of such a model would enable further assessment of the stability of each component of migration over time and it is our intention to explore this approach with both aggregate and age-sex disaggregated data in subsequent research.

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