

Chapter 1

Interaction Data: Definitions, Concepts and Sources

John Stillwell, *University of Leeds, United Kingdom*
Adam Dennett, *University of Leeds, United Kingdom*
Oliver Duke-Williams, *University of Leeds, United Kingdom*

ABSTRACT

This initial chapter has two aims. Firstly, it seeks to clarify definitional and conceptual issues relating to the key interaction phenomena, migration and commuting, on which we concentrate in this book and for which we strive to obtain information to enhance our understanding of the processes that are taking place in the real world. The chapter explains the conceptual distinction between migrants and migrations, the importance of which becomes clear when the difference between transition and movement data is outlined, and it considers the alternative units of migrant measurement that are used such as individuals, wholly moving households and moving groups. Whilst migration tends to be measured over a period of time, typically a year, commuting is an activity that occurs on a much more frequent basis and consequently is usually measured as the numbers making a journey on one day. The chapter indicates how commuting to work and commuting to study are defined and measured.

Secondly, the chapter contains the summary of an audit of interaction data sources, outlining the characteristics of the different types of data that are available from censuses, registers and surveys. Particular emphasis is placed on the former, the Census of Population, for which there are a number of data products providing migration and commuting counts at different spatial scales and disaggregated by various attributes; micro data are distinguished from macro data. However, the chapter also introduces a range of other interaction data sources such as the registers of National Health Service patients, the Pupil Level Annual School Census, the databases of the Higher Education Statistics Agency, various national level surveys such as the Labour Force Survey and the International Passenger Survey. In some cases, the data are exemplified using tables or maps. The chapter concludes with a reflection on the importance of the census as a key data source for small area analysis and a plea that, in a post-census world, sufficient steps be taken by central government to ensure the creation and provision of information systems for monitoring migration and commuting in an effective way, providing accurate and reliable intelligence on trends and creating opportunities for new research projects that develop explanations.

INTRODUCTION

Interaction data refer to counts of flows between geographical origins and destinations. They may be measured by different units and they can be extracted from a range of sources. Whilst flows of commodities, finance, vehicles, telephone calls and email are all typical examples of what constitutes a wide spectrum of flow data, our focus here is on the people whose movement is part of two common geographical phenomena, migration or commuting, whose volumes and patterns are of considerable importance to researchers of human behaviour as

well as to planners and policy makers tasked to ensure adequate housing provision and improve traffic congestion.

Different types of interaction data are available from population *censuses*, administrative *registers* and social *surveys*, and we shall explore examples of each of these sources in detail in later sections of the chapter. Some data are cross-sectional whilst other sources provide continuous time series flow statistics useful for sub-national population estimation or projection. Some interaction data are currently available online from internet web sites whilst others are much less accessible, are limited because of disclosure control, or need skilled/experienced staff and extensive effort to ensure accurate extraction or estimation.

In Britain, in the absence of an official population registration system, *censuses* are accepted as providing the most comprehensive and most reliable migration and commuting data, particularly for flows within and between small areas. Several of the potential non-census interaction data sets originate from *administrative sources* and involve the collection of records arising from some transaction, or registration, or as a record of service delivery. They are collected for administrative rather than research purposes and many are based in government departments. A selected audit of administrative data sets (Jones and Elias, 2006) shows that most are used to provide stock information, but some include variables that provide information about flows of migrants or commuters such as NHS patients, school pupils, university students, workers and those attending hospital. In some cases, registration data have much simpler structure than census data and are only available at a relatively aggregate spatial scale but are particularly valuable because they are produced on a regular temporal basis. In other cases, the information on migration or commuting has to be generated from the primary unit data using time-consuming data matching and manipulation algorithms.

Surveys are the other main source of interaction data and, in many cases, surveys such as the Labour Force Survey (LFS) or the International Passenger Survey (IPS) provide reasonably detailed data in response to migration questions but are of limited value because their sample sizes allow only restricted spatial coverage. The IPS data on immigrants and emigrants are only published at regional scale and even then, users are advised to smooth out irregularities in the data by calculating three year averages. In most cases, survey data are particularly valuable because of the cross-classification possibilities that are available with primary unit data, even though the geographical dimension may be limited.

This chapter provides a review of the sources of interaction data that exist in the UK together with information about their characteristics, estimation methods, attributes, limitations and availability. Separate sections deal respectively with different census, administrative and survey data sources and we conclude with some reflections on the value of the census as a key data source for small area analysis and a plea to central government to ensure the creation and provision of information systems for monitoring these critical processes of migration and commuting in an effective way in the post-2011 era. However, we begin in the next section with an introduction to certain definitions and concepts.

DEFINITIONS AND CONCEPTS

Those who undertake secondary research on spatial interaction phenomena depend on a relatively limited number of data sources from which information can be gleaned on flows that are defined and measured in particular ways. Whilst migration has been defined as a permanent change of usual residence (Rees, 1977), this definition is restrictive because not all migrations are permanent; they may be temporary or cyclical. Higher education students move between parental home and college accommodation on a temporary basis whereas casual labourers frequently return to the same workplaces on a seasonal basis. The difficulty is in establishing the time period spent by an individual at one location for that usual residence to become permanent. Moreover, those with second or more homes may have temporary residence in different places of usual residence. Similarly, there are problems in defining what constitutes the commute to work, particularly when individuals may have multiple work locations or when travel to work involves a long-distance commute once a week to temporary accommodation and short-distance daily commutes. Familiar definitions of migration and commuting are found in the census, where, according to the 2001 Census

Glossary (online), “a migrant is a person with a different address one year before the Census to that on Census day” and “the migrant status of children under age one is determined by that of their next of kin”. Commuting in England, Wales and Northern Ireland involves “the means of travel used for the longest part, by distance, of the usual journey to work”, whereas in Scotland only, commuting involves “travel to main place of work or study (including school)”. Counts of migrants and commuters are derived from the two census questions shown in Figure 1.1.

14 What was your address one year ago?

◆ If you were boarding school or a student one year ago, give the address at which you were living during the school/college/university term.

◆ For a child born after 29 April 2000, ✓ No usual address one year ago .

The address shown on the front of the form

No usual address one year ago

Elsewhere, please write in below

_____ Postcode _____

33 What is the address of the place where you work in your main job?

◆ If you report to a depot, write in the depot address.

_____ Postcode _____

Mainly work at or from home

Offshore installation

No fixed place

a Migration question

b Commuting question

Figure 1.1: Census questions on place of former usual residence and place of work

Compared with the treatment of the migrant as an individual, the migration event is somewhat harder to measure accurately than the vital events of birth and death that occur once only to each person, and in Britain are recorded in official registers, classified by the time and the place at which they occurred. Migration, in contrast, is a process that happens once, more than once, or never for each individual over the course a lifetime. When it does occur, it is frequently difficult to pinpoint precisely in time; transfer between two residential locations may in fact occur in stages over several days or weeks. Definitions of migration help us to distinguish initially between migrants and non-migrants, and thereafter, to distinguish between different categories of migrant. Recurrent themes in both cases concern the distance over which moves are made, the frequency with which cyclical moves are repeated, and the intended degree of permanence of the move. Some definitions of migration are more inclusive than others over the question of which individuals should be counted as migrants. Lee (1966) for example, includes all changes in usual residence as migration, regardless of the distance of the move, whereas Bogue (1959) seeks to separate longer-distance movers from local movers, the latter not being considered as migrants.

The distinction between ‘migrants’ and ‘migrations’, as identified by Courgeau (1973; 1976), is particularly important because it is at the heart of the difference between the two major types of data: *transition data* and *event or movement data*. Transition data are recorded by the census, involving a comparison of individuals’ locations at the start and end of a (transitional) time period. They may be termed ‘exist-survive’ data, as it is necessary for an individual to exist at the start of a time period (12 months in the case of the 2001 Census) and to survive until the end for inclusion within the measured results. Whilst the census measures migrants, event data are those that attempt to record all migration events that occur, usually as they happen. A typical example of event data are the re-registrations that are recorded centrally for National Health Service patients whenever they change doctor. These data are held by NHS central registers and provide a useful indicator of time series trends, as demonstrated by Stillwell *et al.* (1992).

In order to clarify the difference between migrants and migrations, we can use a graphical device known as a Lexis diagram (Vandeschrick, 1993; 2001) which illustrates the relationship between three related demographic dimensions: age (group), time (period), and birth cohort, on a two dimensional plane. The horizontal axis of the Lexis diagram in Figure 1.2 shows time, marked in units of five years from 1986 to 2011 whilst the vertical axis shows age in completed years from 0 to 25. The spaces between tick marks on the horizontal

axis can be used to define both time periods and birth cohorts, the latter being those persons born during a given time period. The tick marks on the vertical axis can indicate age groups. A fuller diagram might extend upwards to a final open ended age group (e.g. '90+'), and may cover a variable number of time periods on the x axis, depending on the amount of data available and era to which they refer.

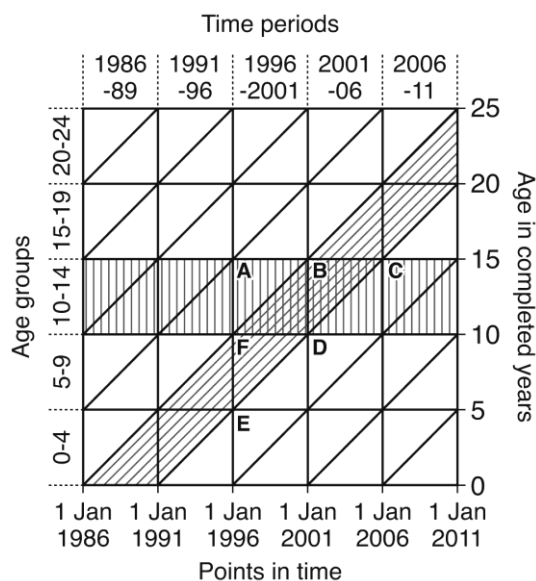


Figure 1.2: Lexis diagram indicating different migration concepts

Figure 1.1 is composed of a lattice of triangular components, and these elements are the smallest areas that can be defined on the diagram given known values of birth cohort, time period and age group. Thus, in Figure 1.2, the left-most birth cohort on the x axis includes all persons born between 1 January 1986 and 31 December 1991 inclusive and is labelled 1988-91, whilst the second birth cohort starts on 1 January 1991 and is labelled 1991-96. Similarly, the lowest age group runs from birth to the day before the fifth birthday and is labelled 0-4, and the second age group runs from the day of the fifth birthday to the day before the tenth birthday, and is labelled 5-9. The diagonal lines on the diagram track birth cohorts over time whereas the horizontal lines indicate the numbers in each age group, period by period. Figure 1.2 shows the path of the 1986-91 birth cohort (stippled) and the counts of those aged 10-14 in each period (shaded). We observe the triangle marked by the points ABCDEF. The area defined by the points FBDE includes persons from the 1986-91 birth cohort who were all aged 5-9 in 2001 and 10-14 in 2006; these are the exist-survive migrants over the five year period as recorded by the census. In contrast, the area defined by the points ABDF includes those aged 10-14 during the period 1996-01, including half those from the 1986-91 birth cohort and half those from the previous cohort, although it would not be possible to tell which was which from the data; these correspond to the administrative NHS event data. Finally, the area marked FBCD includes those from the 1986-91 cohort when they were aged 10-14 in either 1996-01 or 2001-06. Data of this type may be generated from a cohort survey that asked members at a particular age whether they had migrated when aged 10-14 but did not ask precisely how old they were when the event took place.

So far, we have assumed that the migration process involves an individual migrant. However, the individual is not necessarily the most rational unit of observation for migration, especially when the reasons for moving or staying are being considered. It may be more useful in certain contexts to consider the family or the household as a more suitable unit since residential location decisions are often based on a variety of factors such as employment, commuting possibilities and educational opportunities that affect different members of a single household. This is the reason why, in the 1991 Census, a distinction was drawn between 'all migrants' and those that were resident in 'wholly moving households'. Out of a total of 4.7 million migrants during 1990-91, 65.8% were resident in wholly moving households, defined in the Census as households in which all members indicate that they had a common different address one year previously.

The use of households as the fundamental observational units is not problem free. Recent British censuses in 1981, 1991 and 2001 have defined a household as being either a person living alone or a group of people (not necessarily related) who live at the same address and share common housekeeping, share at least one meal a day or share some accommodation such as a living room (Denham and Rhind, 1983; OPCS/GROS, 1992; ONS, 2001a). Whilst this definition may cover many cases, it is unlikely that it covers every case of persons who consider themselves to be 'a household', although it is perhaps impossible to find a definition suitable to be completely inclusive. Those who migrate as individuals have a non-uniform age distribution - heavily skewed to young adults. It is ironic that one of the largest groups of persons making migration decisions as individuals – students going to a higher education institution – are one of the most poorly recorded groups.

Some authors, including Flowerdew (1997), suggested the use of 'moving units' for the measurement of migration at both individual and non-individual levels. Most households would contain zero, one or two moving units, although any number would be possible. These moving units group together all persons who have moved from the same origin address, as determined by responses on the census form. Thus, if a particular household had five resident occupants, of which two had migrated from a common address A, another two had migrated from common address B and the fifth person had migrated from a third common address C, then it would be identified as containing three moving units. These ideas were incorporated into the 2001 Census with the measurement of the *moving group*, a person or group of people within a household or communal establishment who moved together from the same usual address one year before the census. Stillwell and Duke-Williams (2007) show that in 2000-01 there were approximately 5.8 million persons migrating within the UK in 3.5 million groups, of which 48% were wholly moving households and the remainder were 'other moving groups'. A very high percentage of those in the latter category were in fact individual movers (85%) and amongst those moving in households, over half involved 3 or more persons moving together, 28.3% in two person households and 20% as single people.

In addition to the new concept of moving groups, the 2001 Census also required the specification in certain tables (e.g. economic position) of a *moving group reference person* (MGRP). This is straightforward when there is only one person but may be less so when groups comprise more than one person. Consequently, rules are required to distinguish the MGRP. A detailed study of migration and socioeconomic change in Britain's larger cities, based on data from 2001 SMS Table MG109 on moving group migration by National Statistics Socioeconomic Classification (NS-SEC), has been produced by Champion *et al.* (2007).

Consideration of the meaning of usual residence, and the phenomena of multiple usual residences, links migration with commuting behaviour. This is because many persons with more than one usual residence will have a cyclic residential behaviour due to their interaction with the labour market. Relatively little research has been done on multiple home ownership because of the lack of data, but some evidence to suggest the presence of multiple usual residences may be found in the Special Workplace Statistics from the 1991 Census. These data were generated for a 10% sample of economically active persons, cross-classified by variables including place of enumeration, place of work and mode of transport to work. When analysed at the regional scale, the mode of transport is sometimes inconsistent with the distance between the residence and the workplace; for example, mode of transport may be 'by foot', despite the fact that the residence and workplace may be separated by a large distance. There are a number of possible reasons for such inconsistencies: either the responses given on the Census form may have been incorrect or they may have been incorrectly coded during the data processing stage. Alternatively, the data may be correct and the explanation may be because the Census was conducted on a Sunday, with responses being collated for places of residence at the weekend. If the place of residence on weekdays was close to the place of work, then the respondent may correctly indicate 'by foot' as their method of transport to work. The figures for travel to work by foot and by bicycle – which may be expected to be short trips – average around 4.5% of the overall total, with many of the larger (proportional) flows being between non-contiguous standard regions (Duke-Williams, 2004).

Whilst the commuting data provide some evidence that individuals have more than one usual residence, several research studies have explored the relationships between migration and commuting behaviour. Green (1997a), for example, has focused on the trade-offs

between migrating and not migrating, and between migrating and commuting longer distances, and Green *et al.* (1999) have identified the emergence of ‘dual location households’ as being a response to conflicts between a rise in the number of dual earner or dual career households and a concomitant rise in insecurities related to housing and labour markets. McHugh *et al.* (1995) offer a framework for studying cyclical migration and multiple residences, and provide a useful review of the literature relating to the limitations of conventional definitions of migration with respect to these phenomena. We now consider the sources from which these data are extracted in more detail.

CENSUS INTERACTION DATA SOURCES

The results of UK population censuses represent a massive collection of demographic and socioeconomic data accessible from published volumes or in digital form (Rees *et al.*, 2002). The various census products from which migration or commuting data can be extracted include: main census tables; Special Migration, Workplace and Travel Statistics; commissioned tables; Samples of Anonymised Records; and the Longitudinal Studies. These sources are discussed in turn with particular reference to data available from the 2001 Census. Further details of the 1991 Census are provided by Dale and Marsh (1993) and Openshaw (1995).

Census tables

The Census Offices produce a range of data tables that are available online to members of the academic community through the Casweb interface (Harris *et al.*, 2002). The *Key Statistics (KS)* provide an overview and summary of the main topics of the 2001 Census in a limited number of simple univariate tables for output areas (OAs), the smallest geographical units of the 2001 Census outputs. The *Standard Tables (ST)* and *ST Theme Tables* provide the most detailed attribute breakdowns available in a large number of cross-tabulations but only down to ward level in England, Wales and Northern Ireland, and to postcode sector level in Scotland. The *Census Area Statistics (CAS)*, *CAS Theme Tables* and *CAS Univariate Tables* are similar to those covered in the ST data sets but are available at OA scale like the KS and are less detailed in order to protect the confidentiality of personal information. *Armed Forces tables* provide information on members of the Armed Forces and data are available down to local authority district (LAD) level for England and Wales only. Certain tables from amongst these contain migration data although the spatial definition of the origins of inflows or the destinations of outflows is very broad. *KS24: Migration (All people)*, for example, provides counts of migrants in various categories including those moving into an ‘area’ from elsewhere in the UK (in-migrants) and from outside the UK (immigrants), those moving within the area and those moving out of the area (out-migrants) during the previous 12 months. There is also a category for those recorded with no usual address one year ago, some of whom may be in-migrants or immigrants. Table 1.1 illustrates detail from Table KS24 at district level, showing this classification and its extension to include those ‘People in ethnic groups other than White’ who move.

	Who moved into the area from within the UK	Who moved into the area from outside the UK	No usual address one year ago	Who moved within the area	Who moved out of the area	All People in ethnic groups other than 'White'	People in ethnic groups other than 'White' who are migrants	Who moved into the area from within the UK	People in ethnic groups other than 'White' who moved into the area from outside the UK	People in ethnic groups other than 'White' with no usual address one year ago	People in ethnic groups other than 'White' who moved within the area	People in ethnic groups other than 'White' who moved out of the area
The North												
D33700 Accrington Urban Area	2,140	155	633	5,052	2,349	6,595	732	118	74	146	394	169
D33701 Accrington	1,429	89	364	2,112	1,854	5,300	565	99	51	121	294	132
D33703 Church	325	4	39	108	314	100	21	11	-	5	5	13
D33704 Clayton-le-moors	615	25	75	282	527	139	21	8	10	3	-	11
D33705 Great Harwood	644	23	74	515	530	856	104	33	12	16	43	22
D33702 Oswaldtwistle	674	14	81	488	670	200	21	10	-	-	9	34
E10200 Ackworth Moor Top	333	22	29	112	351	131	19	4	13	3	-	20
D40400 Addingham	212	10	18	60	238	40	3	3	-	-	-	-
D90300 Adlington	395	26	34	275	399	97	10	3	3	-	4	4
E11400 Adwick-le-Street	444	18	83	446	551	91	20	9	6	3	3	3
B10100 Alnwick	517	29	60	383	359	37	8	7	-	3	-	6
E82100 Alsager	1,156	34	66	616	894	210	49	36	-	3	10	25
B10200 Ambie	284	-	27	363	245	16	6	5	-	-	-	-
C90200 Ambleside	367	18	34	236	263	31	7	-	3	-	3	4
E17200 Anston/Dinnington	826	43	86	868	978	210	52	20	28	-	4	14
C10100 Appleby	151	6	17	101	135	18	-	-	-	-	-	-

Table 1.1: Detail from KS Table 24 at district level
Source: ONS website at <http://www.statistics.gov.uk/statbase/>

Table ST008: Resident type by age and sex and migration, in comparison, contains a spatial breakdown that is similar to that used in KS24 except that ‘areas’ are distinguished from ‘associated areas’ within the UK. Counts of migrant flows from individual areas to the aggregate spatial units generated from the following categories:

- Lived at same address
- Lived elsewhere one year ago within same area
- No usual address one year ago
- Inflow
 - Lived outside the area but within ‘associated area’ one year ago
 - Lived outside the ‘associated area’ but within the UK one year ago
 - Lived outside UK one year ago
- Outflow
 - Moved out of the area but within the ‘associated area’
 - Moved outside the ‘associated area’ but within the UK.

Similar categories to these are used for ST009: Age of household reference person (HRP) and number of dependent children by migration of households, ST010: Household composition by migration of households, and TT033: Migration (People): All people in the area and those who have moved from the area in the past year, within the UK. The term ‘area’ refers to the particular area level being shown in the table; in the case of an ST or CAS table for a ward, ‘area’ translates to the name of the ward. In England and Wales, the ‘associated area’ refers to LAD for tables at ward (electoral division in Wales); parish (community in Wales) or OA level. For all other geographical areas, the ‘associated area’ is England and Wales. These data can be extracted online Casweb at (<http://census.ac.uk/casweb/>), although KS Table 24 is not contained within Casweb and must be accessed directly from the ONS web site (<http://www.statistics.gov.uk>).

Whilst data derived from the 2001 Key Statistics and Standard Tables have been used in analyses of patterns of internal migration by Champion (2005b) and of international migration by Horsfield (2005), there are no tables that provide interaction data on commuting equivalent to those above relating to migration other than TT011 which provides flows from each area (OA) to aggregate areas based on the distance traveled to work (< 2km, 2-5km, 5-10km, 10-20km, 20-30km, 30-40km, 40-60km, and 60+km). It is clear that the interaction data in the main census tables are very limited; although flows from origins or to destinations are available at different spatial scales (local authorities, wards or output areas), flows *between* origins and destinations are not and for these data, it is necessary to use the Origin-Destination Statistics.

Origin-Destination Statistics

As in 1991, two major migration and commuting interaction data sets are available from the 2001 Census: the *Special Migration Statistics* (SMS) and the *Special Workplace Statistics* (SWS). However, in Scotland, the SWS in 2001 were replaced with a new set of *Special Travel Statistics* (STS) that include journeys to place of study as well as place of work. These data sets are also known collectively as the 2001 Census Origin-Destination Statistics, detailed specification of which is available in ONS/GROS/NISRA (2001). They are currently accessible to members of the academic community and data suppliers registered with the Census Registration Service via the Web-based Interface to Census Interaction data (WICID) (see Chapter 4). The 2001 data sets have been reviewed by Rees *et al.* (2002) and Cole *et al.* (2002). More recently, Stillwell and Duke-Williams (2007) have explained the structure of the 2001 interaction data sets, documenting the differences in the data sets between 2001 and 1991 and the problems associated with making comparisons between 1991 and 2001, and examining the impact of the small cell adjustment methods (SCAM) used to adjust flows in 2001 to ensure confidentiality and reduce the risk of disclosure.

A summary of the tables and counts from the 2001 and 1991 Censuses (Table 1.2) shows a similar number of tables but considerably more counts in 2001 than in 1991. Data are

available in 2001 for three sets of interaction zones: level 1 involves 426 ‘districts’ that include metropolitan districts, unitary authorities and other local authority areas in England and Wales, council areas in Scotland and parliamentary constituencies in Northern Ireland; level 2 includes 10,608 ‘interaction wards’; and level 3 contains 223,060 OAs throughout the UK. The STS for Scotland in 2001 contain counts for children aged under 16 and require additional categories in certain tables. The 1991 SWS data identified in Table 1.2 are the 10% sample of journey from home to work flows produced only at ward level and referred to as SWS Set C (Cole *et al.*, 2002). The data in each of these tables are available from WICID, together with data sets of flows adjusted for suppression in 1991, inflated for under-enumeration in 1991, or estimated from 1981 and 1991 data to be consistent with 2001 boundaries. The modelling methodology that underpins the latter estimation is explained in Boyle and Feng (2002) and in Chapter 13 of this book.

Table 1.2: Tables, counts and variables in the 2001 and 1991 special interaction data sets

Data sets	Level 1 (District)	Level 2 (Ward*)	Level 3 (OA)
2001 SMS	10 tables (996 counts) <i>Migrants</i> : age sex, family status, ethnicity, illness, economic activity <i>Moving groups</i> : tenure, economic activity, NS-SEC, knowledge of Gaelic/Welsh/Irish	5 tables (96 counts) <i>Migrants</i> : age, sex, ethnicity, <i>Moving groups</i> : NS-SEC, tenure	1 table (12 counts) <i>Migrants</i> : age, sex
	SMS Set 2 11 tables (94 counts) <i>Migrants</i> : age, marital status, ethnicity, illness, economic position <i>Wholly moving households</i> : residents, tenure, economic position of head, Gaelic/Welsh speakers	SMS Set 1 2 tables (12 counts) <i>Migrants</i> : age, sex <i>Wholly moving households</i> : residents	Not available
2001 SWS	7 tables (936 counts) <i>Employees and self-employed</i> : age, sex, living arrangements, employment status, mode of travel, NS-SEC, industry, ethnicity	6 tables (354 counts) <i>Employees and self-employed</i> : age, sex, family status, mode of travel, NS-SEC, occupation, employment status	1 table (36 counts) <i>Employees and self-employed</i> : mode of travel
	1991 SWS	9 tables (274 counts) <i>Employees and self-employed</i> : economic position, hours worked, family position, distance, mode of travel, cars available, occupation, social class, industry	Not available
2001 STS	7 tables (1,176 counts) <i>Persons**</i> : age, sex, family status, mode of travel, NS-SEC, industry, ethnicity, employment status	6 tables (478 counts) <i>Persons**</i> : age, sex, family status, mode of travel, NS-SEC, ethnicity, employment status	1 table (50 counts) <i>Persons**</i> : mode of travel

tor in Scotland; ** persons including those who do not work or study

These data allow detailed analysis of migration and commuting behaviour at each of the three spatial levels or aggregations thereof. Figure 1.3 exemplifies aggregate flows of in-migrants and in-commuters to Leeds from the 2001 Census, revealing how the catchment areas vary for the two phenomena. Recent examples of detailed spatial empirical analyses of migration using the 2001 SMS include those studies of age-specific flows (Dennett and Stillwell, 2008a; 2008b), of migration and socio-economic change (Champion *et al.*, 2007; Champion and Coombes, 2007) and of ethnic migration (Stillwell and Hussain, 2008). Recent studies of commuting that utilise the 2001 SWS/STS include those by Harland *et al.* (2006) and Nielson and Hovgesen (2007).

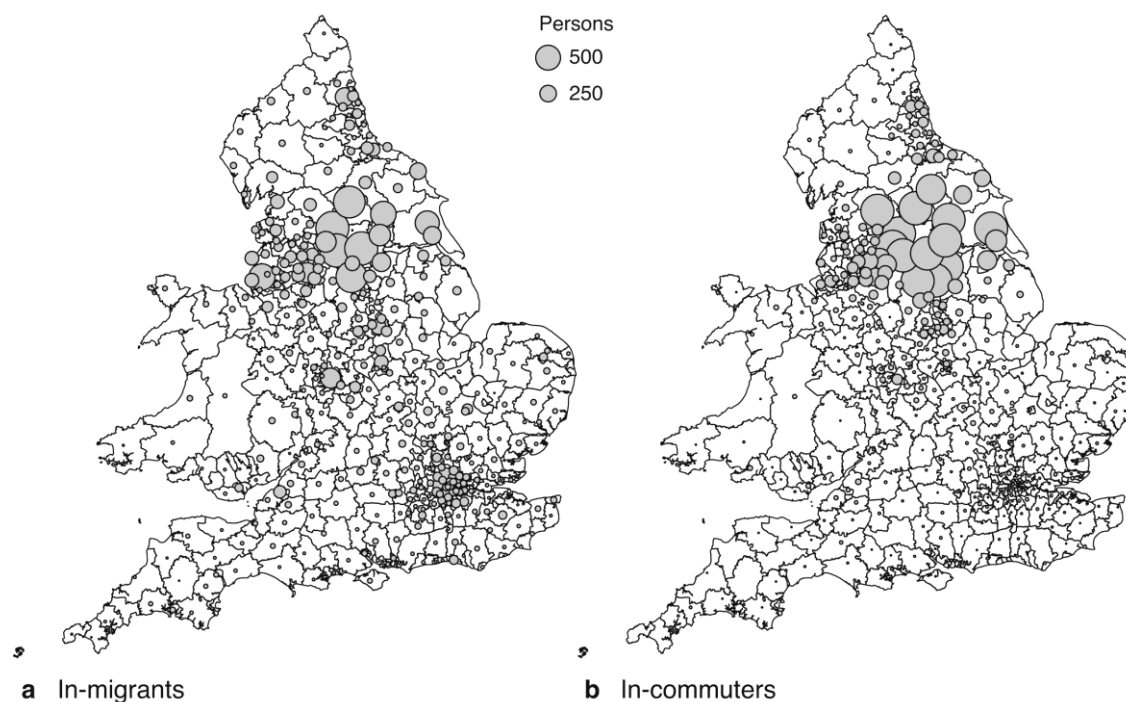


Figure 1.3: In-migrants (a) and in-commuters (b) to Leeds District

Commissioned Tables

Customised output from the 2001 Census may be commissioned from ONS Customer Services when particular cross-tabulations are not available from the standard tables, but commissioned tables incur charges to recover staff and material costs. Once a table has been delivered and paid for by a customer, it is listed on the ONS website and is available to all users free of charge on request from the Census Customer Services. All commissioned tables of 2001 data are subject to checks to ensure confidentiality. There is a function on the commissioned tables spreadsheet that allows the identification of tables of interest by entering the topics of interest. Each commissioned table is subject to SCAM procedures and consequently inconsistencies will appear when checking totals with data from other census sources. Hussain and Stillwell (2008) have used commissioned data from ONS to analyse district level ethnic migration trends in England and Wales cross-classified by age, whilst the Greater London Council Data Management and Analysis Group has produced a detailed briefing on ethnic migration in London (Mackintosh, 2005) based on commissioned data.

Samples of Anonymised Records

Samples of Anonymised Records (SARs) were introduced as a new innovation in the UK as one of the outputs of the 1991 Census, and offer a considerable degree of flexibility for multivariate analysis of individual records (Dale, 1998). These 'microdata' comprise a set of records relating to individuals and (where appropriate) households, with personal data such as names and addresses removed. However, there are spatial variables available, including residential location at the time of the census, location of address one year ago for migrants, and country of birth. In order to generate interaction flows, any two spatial references can be cross-tabulated, with possible disaggregation by any other chosen variable(s). A total of four

SAR files were generated from the 1991 Census; two relating to GB, and two relating to Northern Ireland. In both cases, the *Individual SAR* was a 2% sample of individuals in the Census and the *Household SAR*, a 1% sample of households with a record for each sampled household, followed by a set of records for each individual within the sampled household. Separate geographies were used for the primary reporting areas (i.e. the location at the time of the Census). Details of the type of geography and the numbers of areas for spatial variables are summarized in Dennett *et al.*, (2007). Migrant origin is limited to the standard region, and workplace location is only available as a broadly coded categorical variable, or as a broadly coded 'distance to workplace' observation. This limits the potential for use of the SAR as interaction data. However, because of their large sample size and the ability to cross-tabulate variables not available from the main census tables, the 1991 SARs have been used to identify the characteristics of migrants. One example is the migration of the elderly to join existing households by Al-Hamad *et al.* (1997). The 1991 SARs have also been used to assess the impacts of tenure on long-distance migration compared with short-distance migration by Boyle (1995), indicating that long-distance migrants are less likely to move into council housing than other tenures.

The range of SAR files was expanded to five with the 2001 Census: the *Individual SAR (Licensed)*, the *Individual Controlled Access Microdata Sample (Individual CAMS)*, the *Special License Household SAR*, the *Household Controlled Access Microdata Sample (Household CAMS)* and the *Small Area Microdata (SAM)*. The two CAMS files offer more detailed versions of the respective licensed files, and they are made available under more restrictive conditions. There are several potential locational variables which could be used to generate interaction data. For the Individual CAMS, a much more detailed residential geography is available than was the case with the 1991 SARs, based on the LAD but with much lower thresholds used for amalgamation. For other variables, the spatial geography is based on an expanded Government Office Region (GOR) geography that includes Wales, Scotland and Northern Ireland as additional regions, and splits London into Inner and Outer. Whilst the sample size for the Individual SAR has increased from 2% in 1991 to 3% in 2001, the value for use as interaction data is diminished due to the reduction in resolution of the primary geography from 278 regions (in GB) to 13 regions in 2001.

The Licensed Household SAR has the same sample size as in 1991, but has little or no potential for use as interaction data, due to the removal of the primary geography in order to reduce the risk of disclosure. The two CAMS files have more potential for use in interaction data analysis. The Individual CAMS has a LAD based geography for both migrant origins and destinations, thus offering similar spatial detail to 2001 SMS at Level 1. The data can be disaggregated by any chosen variable, although the sample size, coupled with the generally low incidence of one-year migrants in all Census data (around 12% of individuals were identified as migrants) will tend to restrict the ability to carry out multivariate analysis. The household CAMS file has a detailed primary geography, but only a categorical version of migrant origin. Both CAMS files feature very detailed versions of the country of birth variable, allowing spatially detailed analysis of life-time mobility.

The 2001 outputs also saw a new flavour of microdata: the Small Area Microdata (SAM), an individual sample (5%) which sacrifices attribute detail in order to permit greater spatial detail. For migration analysis, the SAM has the advantage of a detailed destination geography, although the origins remain as the expanded GOR geography. Thus, for the study of in-migrants, considerable detail can be discerned. However, as with all other 2001 SARs and the 1991 SARs, workplace address is provided solely as a movetype classification, meaning that the data are not suitable for use as origin-destination commuting data.

The 1991 SARs data, and the licensed versions of the 2001 SARs data are of limited use for spatially detailed analysis of interaction data. However, they retain the general advantage of microdata as an opportunity for flexible multivariate analysis, and thus have potential use for the aggregate study of characteristics of those involved in spatial interactions (i.e. migrants and commuters). A recent example of this is the study of the characteristics of ethnic migration by Finney and Simpson (2008). In general, the SARs are more useful for interaction data use with respect to migrants than to commuters, as there is no spatial coding of workplace location.

Longitudinal Studies

Longitudinal studies are data sources that contain multiple observations of a population of interest over a period of time. They include both surveys which are repeated at intervals for a known set of respondents, and more general instruments from which a sample is extracted, and externally linked to records for the same persons from earlier collection rounds. Examples of the former type of longitudinal study include the UK *cohort studies*, in which a selected sample are surveyed in multiple sweeps over the course of their lives. Examples of the latter type include the census based *Longitudinal Study*, which is derived from samples extracted from each decennial census. Data of these kind provide a valuable research resource, including the analysis of interaction flows.

There are three major longitudinal studies in the UK that are based on census data, with linked administrative records from other sources including vital events and registration data. These are: the ONS *Longitudinal Study of England and Wales* (LS) the *Scottish Longitudinal Study* (SLS) and the *Northern Ireland Longitudinal Study* (NILS). These differ in a variety of ways including the length of the time period covered, the sampling fraction used, and the types of other data linked into the study. The LS is the longest established of the three studies, containing linked data from the 1971, 1981, 1991 and 2001 Censuses. The sample is selected on the basis of four (undisclosed) birth dates, giving a sample fraction of around 1%. Persons born on one of these days are extracted from each Census and attempts are made to link them to established records from earlier Censuses or to administrative records. In addition to the core sample members, records are also extracted and added to the LS for other persons in the sample member's household, although these additional persons are not (unless they also happen to be a sample member) tracked in later censuses, unless they are still living in a sample member's household. The linked LS has enabled researchers to examine changing patterns of settlement and local geography as well as factors affecting long-term migration. The link between inter-regional migration and social mobility has been explored by Fielding (1992) to identify the South East region as an 'escalator'. The relationships between counterurbanisation and social mobility have been investigated by Fielding (1998) and various studies have tracked the spatial distribution of the population in different parts of the country (Williams, 2000; Davies *et al.*, 2006), migration relating to health and deprivation (Norman *et al.*, 2005) and the geographical and social dynamics of ethnic groups (Platt *et al.*, 2005).

The SLS is a continuous study, incorporating data from the 1991 and 2001 Censuses. It is a 5.5% sample, based on 20 birth dates providing linked information for approximately 274,000 individuals in Scotland. For each individual, the SLS has all the variables that can be extracted from the complete 1991 and 2001 census forms, including place of usual residence 12 months before the census and details relating to the journey to work or study. The NILS is the most recently started study, and contains data from the 2001 Census only. NILS members are selected on a total of 104 birth dates, giving a much larger sample size than the other two studies of around 28%. The linked administrative data include birth and death registrations, health service related migration data, and information about members' households from the Valuations and Land Agency. A new *UK Household Longitudinal Study* (UKLHS) is due to start its first wave of data collection in 2008 consisting of a wholly new sample of households, an ethnic minority boost sample, and a sample (up to 100%) drawn from the existing British Household Panel Survey (BHPS). It will yield a sample of at least 40,000 households, making it the largest type of study of its kind in the world, and will provide interaction flow data.

Whereas the longitudinal studies are based around linked census data, which contain, generally speaking, the same questions each time, birth cohort surveys use different questionnaires in each sweep. There are four significant birth cohort studies in the UK: the MRC National Survey of Health and Development (NSHD) (the British 1946 birth cohort study); the National Child Development Study (NCDS) (the 1958 birth cohort study, originally known as the Perinatal Mortality Survey); the 1970 British Cohort Study (BCS1970); and the Millennium Cohort Study (cohort born in 2000/2001). These tend to contain core questions that are asked at each sweep, plus additional questions that reflect changing interests and research priorities. Clearly, the questions that are asked to (the parents of) young children in the earliest waves of any birth cohort study will be very different to those asked as the survey members grow to adulthood and subsequently into retirement. Whilst adult members of the earlier cohort studies have been asked numerous questions in

each wave about employment and occupation related issues, it would appear from examination of the available data that specific questions about the location of members' workplaces have not been regularly asked. Thus, the potential for use as journey-to-work interaction data is very limited. In contrast, the very nature of the studies, which track individuals over time, means that a near complete record of residential history is maintained, giving rise to very rich migration based interaction data.

ADMINISTRATIVE INTERACTION DATA SOURCES

Whilst the Census provides the most comprehensive and reliable data on migration and commuting, particularly for smaller areas, its periodic nature means that researchers must look elsewhere for interaction data relating to inter-censal periods. A number of administrative registers provide useful information on a regular basis on both residential movement and commuting. In this section we introduce a selection of these sources and refer the reader to Dennett *et al.* (2007) for further detail.

NHSCR Data for England and Wales

One source of migration estimates is the registration system that records National Health Service (NHS) patients who migrate and change their doctor. The NHS Central Register (NHSCR) at Southport records movements of patients between Health Authority (HAs) areas in England and Wales and the Census Office has developed systems for capturing the reporting of re-registrations of patients between areas used to administer the general practitioner services of the NHS (Bulusu, 1991). These areas, initially known as Family Practitioner Committee Areas (FPCAs), became Family Health Service Areas (FSHAs) – groups of London boroughs, metropolitan districts and shire counties – in 1990 until late 1996 when HAs were introduced. Since the early 1980s, individual anonymised records from the NHSCR known as primary unit data (PUD) have been created by ONS (formerly OPCS) in quarterly data files. Entries in the NHSCR include the date of birth mentioned above together with the sex, the codes of the FHSA that the patient has been registered with in the past as well as the new FHSA code. The registration data available from the NHSCR are defined as ‘movement’ data and their measurement is conceptually different from that of ‘transition’ data available from the census, as explained earlier in the chapter. When compared for 1981, the NHSCR flows tend to be larger in volume than census counts because they capture multiple and return moves as well as student movements (Boden *et al.*, 1992).

Whilst researchers have highlighted many of the conceptual and definitional characteristics and shortcomings of the data (Stillwell *et al.*, 1992; Champion *et al.*, 1998), the NHSCR data has been used in a number of studies of time series trends (e.g. Bulusu, 1989; 1990; Devis, 1984; Rosenbaum and Bailey, 1991; Stillwell *et al.*, 1992; Stillwell, 1994; Stillwell *et al.*, 1996). Details of a time series of NHSCR data from 1975 to 1998 for a consistent set of areas (Duke-Williams and Rees, 1993) – used for a major migration modelling study commissioned by the Office of the Deputy Prime Minister (ODPM, 2002; Champion *et al.*, 2003; Fotheringham *et al.*, 2004) and for examining trends in internal migration by Kalogirou (2005) – are documented in Dennett *et al.* (2007).

Since 1998, NHSCR data sets have continued to be produced for a national geography of health-related administrative areas. The data are processed and tabulated for quarterly periods and matrices of origin-destination flows between GORs are available from ONS publications. Whilst NHSCR data aggregated into tables of gross inflows and outflows by broad age group (15 and under, 16-59, 16-64, 60+, 65+) are available for HAs from the ONS web site, origin-destination flows between HAs are available only on request.

Patient register data for England and Wales

The NHSCR system in England and Wales only records movements between HAs and, in the past, ONS has used information from electoral registers and the most recent census to apportion NHSCR inflows and outflows between constituent local authorities (LADs). The inadequacy of the electoral registers in the estimation of sub-HA flows led ONS to investigate the patient registers held by every HA in England and Wales (Scott and Kilbey,

1999; Chappell *et al.*, 2000). These registers contain the NHS number, gender, date of birth, date of acceptance at the HA and, importantly, the postcode of address, for each patient. With postcode unit information being available, it is possible theoretically to create aggregate migration matrices for any level of geography, a significant advantage over the FHSA/HA boundaries that previous NHSCR migration estimates were restricted to.

NHSCR and patient register data differ in their composition in that the NHSCR data are counts of moves from one area to another in a particular period of time whereas patient register data are counts of persons migrating and are, conceptually, equivalent to census transition data. With patient registration data only recording migrations if the address at the beginning of the period is different from the address at the end of the period (and if two addresses are present on the register), some categories of migrant are unaccounted for who would be identified by the NHSCR such as newborn infants born during the period, international immigrants, persons who have been discharged from the armed forces and other migrants who leave the register before the end through death, emigration or enlistment into the armed forces (Scott and Kilbey, 1999).

Acting on advice from extensive consultations about patient register data, ONS have used patient register and NHSCR data in combination to produce migration estimates for England and Wales since 1999. By obtaining a download from each patient register on an annual basis and by combining all the HA patient register extracts together, a total register for the whole of England and Wales has been created, the Patient Register Data System (PRDS). Comparing records in one year with those of the previous year by linking on NHS number enables identification of each person who changes their postcode. The download is taken at 31 July each year to enable migration estimates to be made for the year ending 30 June. This is consistent with the assumption that people delay registering with a new GP for a month after they move. Tables are created from the PRDS, combined with NHSCR data and used as an indicator of population movement (Migration Statistics Unit, 2007). A range of tables are available from the year ending mid-1998 onwards and cover inflows and outflows rounded to the nearest 100, disaggregated (in some cases) by age and gender for HAs and LADs. Recently, ONS have used the patient register data to produce origin-destination matrices from the year ending mid-1999. These tables include origin-destination matrices of flows between LADs in England and Wales by broad age group. Figure 1.4 illustrates net migration patterns in 2004-06 and changes since are different from those in 2000-01. As yet, despite the potential for estimating migration between areas from the postcode unit level upwards, no attempt has been made by ONS or anyone else to estimate migration for anything lower than LAD.

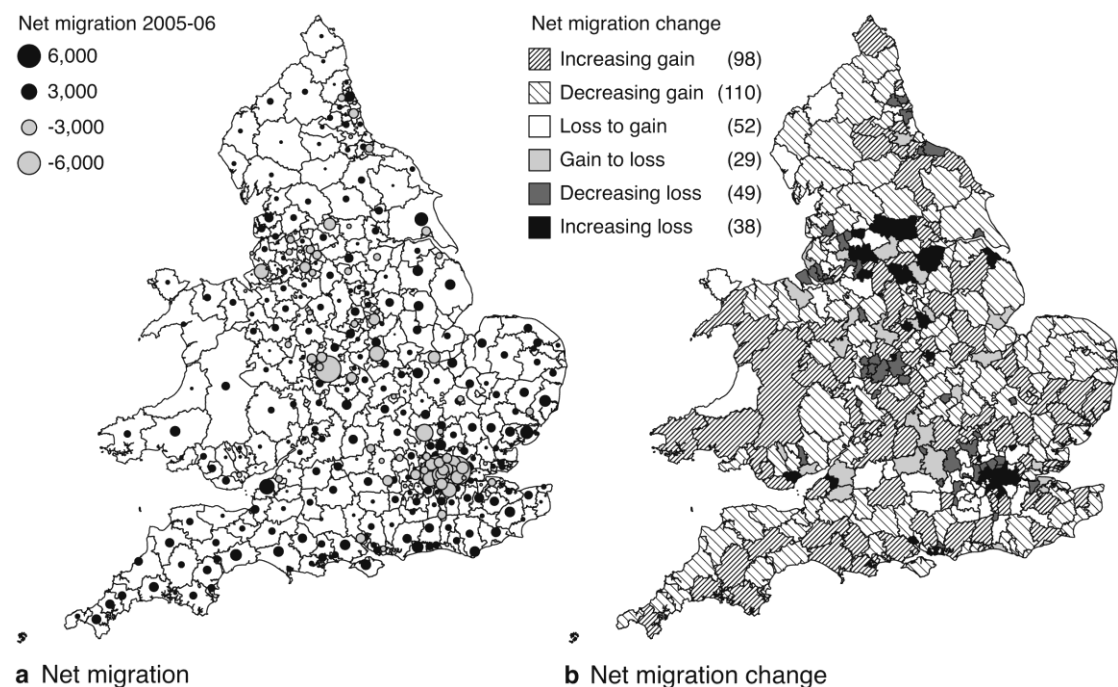


Figure 1.4: Net migration balances by local authority in England and Wales, 2005-06 (a) and changes since 2000-0 (b), based on patient registration estimates

Scotland and Northern Ireland

A similar combination of locally held patient register and NHSCR data is now in use in Scotland to estimate internal migration. In Scotland, patient register data is known as the Community Health Index (CHI) and includes information including postcode, date of birth, gender, details of registered GP and the date joined GP lists. It was not until 2002 that exactly the same method of constraining patient register estimates to NHSCR estimates was used in Scotland (GRO Scotland, 2006; 2007). And matrices of flows between council areas were created.

Patient register data in Northern Ireland is known as the Central Health Index (NI-CHI). In the late 1990s, CHI data in Northern Ireland underwent enhancement through more complete postcoding of the data, and through aggregate statistics being made available at local government district (LGD) and parliamentary constituency (PC) levels. A comparison has been carried out between the migration estimates obtained from the 2001 Census and NI-CHI data (NISRA, 2005) concluding that estimated migration flows between LGDs were sufficiently similar to justify the use of NI-CHI in estimating inter-censal migration flows within the country. Selected migration statistics are available from the NISRA website by LGD from 2001 to 2005. However, whilst it is possible to identify the net impacts of internal and external migration on LGD populations down to the single person, it is impossible to ascertain from where or to where migrants are coming from or where they are going to.

Pupil Level Annual School Census (PLASC)

Whilst the 2001 STS in Scotland provided details of the daily travel to study for students and children, similar data are not produced for England and Wales or Northern Ireland. However, the annual Pupil Level Annual School Census (PLASC) does collect data from each local education authority (LEA) in England and Wales on the location of pupils and the schools that they attend, providing a potentially useful source for data set on the journey to school, if confidentiality issues can be addressed.

Various data sets are collected and held by the Department for Education and Skills (DfES) within a centralised 'data warehouse'. These include the National Pupil Database (NPD), local authority data, school level data, school workforce data and geographical data (Ewens, 2005a; Jones and Elias, 2006). The NPD was established in 2002 and contains linked individual pupil records for all children in the state school system which is updated annually. Each pupil is given a unique pupil number (UPN) and has an associated set of attributes: age, gender, ethnicity, special educational needs, free school meal entitlement, key stage assessments, public exam results, home postcode and school attended. The NPD combines information from the PLASC with information on pupil attainment, reference data on schools and LEAs. PLASC is the foundation of the NPD, including variables such as ethnicity, a low-income marker, and information on Special Educational Needs (SENs). The linking of pupils from one year to the next using the UPN means that a longitudinal profile of each pupil is available whose extent depends on how long the pupil has been in the education system. Potentially, this means that pupils can be tracked over time and their transitions through the education system can be identified, including their movements between schools and between different home addresses (Harland and Stillwell, 2007a). PLASC data are therefore a potential source of data on commuting to school, on pupil mobility between schools and of child migration from one usual residence to another. At the moment, there is no indication of any system in place to process the data to generate this type of information. However, recent research based on PLASC includes studies of the mobility of English school children (Machin *et al.*, 2006) and moving home and changing school in Greater London (Ewens, 2005b), and work based on PLASC data for Leeds (Harland and Stillwell, 2007b), supplied by the LEA (Education Leeds), allows residential migration and movement between schools to be quantified as well as the movements from home to school that indicate how school territories vary in size and shape. Figure 1.5 shows two examples of the latter.

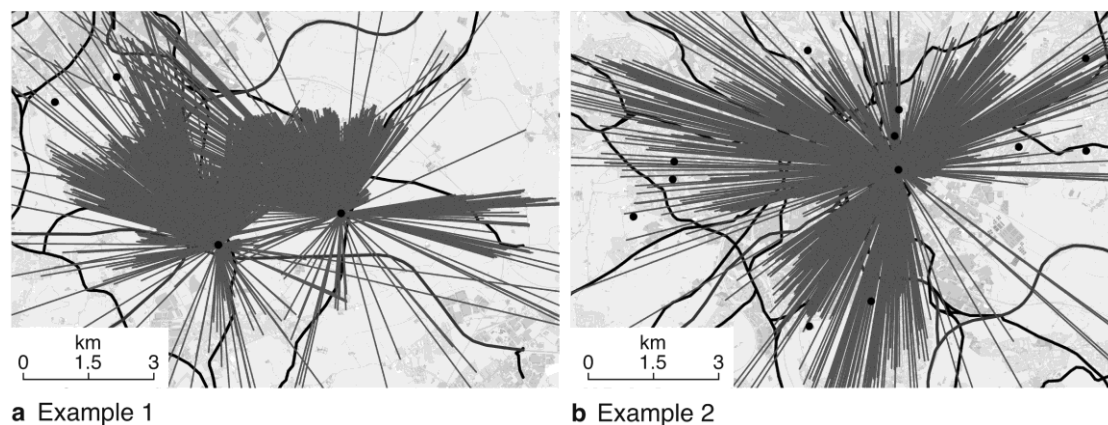


Figure 1.5: School territories based on data derived from the PLASC for Leeds

Hospital Episode Statistics Data

Another potential source of data on commuting is the Hospital Episode Statistics (HES) held by the NHS and providing data on the journey to hospital. These data include details of all patient admissions to NHS hospitals in England from 1989-90 (Liffen *et al.*, 1988). Data for NHS hospitals in Northern Ireland, Scotland and Wales are collected separately by respective national offices. Each record holds around 100 personal, medical and administrative details of each patient admitted to hospital in England, including geographical information about the location of treatment and where the patient lived. Around 12 million new records are added to the dataset each year, with most of the variables collected at point of contact from the Patient Administration System (PAS). Requests for this data in the form of database extracts or custom tabulations are currently made to the NHS Information Centre through their external data custodians, Northgate Information Solutions. If permission is granted by the relevant advisory groups, it should be possible to obtain data for patients relating to their residential location (which could be as detailed as postcode unit or OA) and their location of treatment (which in theory could be as detailed as hospital postcode). These interaction data can be further disaggregated by variables including gender, age, ethnicity, admission/discharge date, length of treatment spell and illness/diagnoses/operation type. Little, if any, research appears to have been done on the ‘commute to hospital’. This data set provides the potential to investigate hospital catchment areas for different types of operation and to compute average distances to hospital for different types of treatment across the country, for example.

Other sources

Whereas the Census and NHS patient registers provide interaction flow data for the population in aggregate terms, PLASC and HES statistics are examples of commuting data sets involving particular subgroups of the population: schoolchildren and hospital patients. There are many other sources of interaction data on particular sub-groups, some of which will be mentioned briefly in this section. One sub-group of particular importance are students whose migration flows were included in the census in 2001 but not formally in 1991. The *Higher Education Statistics Agency* (HESA) is the central source for HE statistics, collecting and providing data on students and staff in HEIs as well as destinations for HE graduates. There is a ‘student dataset’ that includes variables such as: A/AS level/Highers points scores, age, disability, gender, ethnicity (white/non-white), source of tuition fees, subject area of study together with domicile and location of HE institution. There is also a ‘first destination dataset’ that includes information on activity, qualification required for job, employer size, SIC, SOC and location of employment or institution of further study. HESA does not allow general access to microdata but flows at super output area level can be purchased on request.

There are a number of administrative sources of data on international migration flows. The *Worker Registration Scheme* (WRS), administered by the Home Office, provides a cumulative total of the number of nationals of the eight Central and Eastern European countries that joined the European Union (EU) who have registered to work in the UK. A National Insurance Number (NINo) is allocated to each overseas national entering the UK who wishes to work or claim benefits in the UK and is recorded on National Insurance

Recording System (NIRS). There are figures by 'year of arrival' that show arrivals subsequently allocated a NINo according to their reported arrival date into the UK. The figures by 'year of registration' are based on the date of registration onto NIRS i.e. after the NINo application and allocation process has been completed. NINo data are extracted each year in June and provide flows by local authority area. Boden and Stillwell (2006) have identified the variations in NINo registrations by Government Office region and explored the patterns by destination within Yorkshire and the Humber for Poles and Pakistanis, the two largest groups of labour inflows.

The *Immigration and Nationality Directorate of the Home Office* has responsibility for immigration control, applications for settlement, citizenship and asylum. Consequently, it produces statistics on immigration control, enforcement, citizenship and asylum. Asylum applications are identified as either 'port' or 'in-country'. Port asylum seekers are those who apply at port when entering the UK. They are relatively few in number and are usually not captured in the IPS since they are detained for separate interview on arrival. In-country asylum seekers are those entering the UK who do not apply for asylum on arrival but do so once in the UK. These individuals are also unlikely to be captured as migrants in the IPS (see later section). The Home Office also collects data on the dependents of asylum seekers (although this has not been done rigorously in the past) and these, together with the counts of principal asylum seekers and international migration data from the IPS, are used to produce estimates of Total International Migration (TIM). As with principal applicants, an allowance is made for those dependants who are not migrants because they are returned within a year. 'Visitor switchers' are visitors who enter or leave the UK intending to stay in the destination country for less than a year but who actually stay for a year or longer. For the years before 2001, estimates of visitor switcher inflows from the non-European Economic Area (non-EEA) were made from the Home Office database of after-entry applications to remain in the UK. IPS data on visitors for these years are only used to estimate visitor switcher data for individuals not covered by the available Home Office data. Since 2001, visitor switcher flows are estimated from IPS data relating to two categories of visitors: those who initially intend to stay for 6-11 months, and those who indicate that they may stay for longer than a year although intended length of stay is uncertain. The Home Office generates estimates of asylum seekers and visitor switchers by broad origin region and local authority area of destination (Stillwell *et al.*, 2002). At a more general level, the *United Nations Statistics Division* collects and disseminates, at the international level, official national data on international migration whereas *Eurostat* publishes tables on international migration and asylum by individual European country, the EU as it was constituted on 1 May 2004, the former EU15, the Economic Monetary Union, the European Economic Area and the European Free Trade Association. Inter-regional migration flows are also available from Eurostat but only for registered users with a userid and password.

Finally, data are available from specific administrative sources that relate to different types of mobility. For example, residential property transactions normally, though by no means exclusively, involve migration from one house to another and the previous addresses of new owner occupiers are held by estate agents, institutions operating in the housing market as well as the Land Registry. Likewise, changes of address are recorded at the Drivers and Vehicle Licensing Agency (DVLA) when vehicle owners move house. Council tax records are another important administrative source of migration data which are likely to be more reliable and more comprehensive than either of the previous two sources. Data on commuting flows to entertainment events such as football matches might be derived from details of season ticket holders held by the clubs or flows to public libraries might be extracted from the computerised library systems. Moreover, commercial organisations undertaking regular research surveys sometimes collect interaction data. An example of this is Axiom's annual research opinion poll that asks respondents where they lived previously and when they moved to their current residence. Clearly there are many sources that contain information about trip origins and destinations that can be geo-referenced either to a specific point or to a geographic area of some type. In various cases, the data that exist are inaccessible because of confidentiality constraints.

SURVEY INTERACTION DATA SOURCES

Surveys are the third major type of data source. The ESRC/JISC funded Economic and Social Data Service (ESDS) provides access to a range of archived UK survey data sources. Some of these data sources include information that can be used to measure population movements over different temporal and spatial scales, both within the UK and between the UK and other countries.

Labour Force Survey

The quarterly Labour Force Survey (LFS) is a continuous quarterly household survey of around 53,000 households, representing around 126,000 individuals (Madouros, 2006) whose main purpose is to provide information that can “*be used to develop, manage, evaluate and report on labour market policies*” (ONS, 2006a). The survey has been running since 1973, although the format has changed over the years. The more recent rounds of the LFS contain details of the residential and workplace movements of respondents, at the scale of GOR and Standard Region. For each respondent, their region of residence is recorded at the time of interview, as well as their region of residence three months and one year before. The region of place of work is also recorded for the main job and second job of each respondent, although the region of place of work three months or one year before the interview is *not* recorded. LFS data are available from the ESDS in individual respondent (primary unit data) form, which allows users to create their own flow matrices, either for residential or commuting flows, through a process of cross-tabulation, although it is apparent that regional definitions are not constant between the origin (region of residence one year ago) and destination (region of current residence). For respondents who were not born in the UK, information regarding their country of birth and origin is included, as well as the year of arrival in the UK. Country of residence three months ago and one year ago are also included, providing (in some cases) a timeframe in which to contextualise movements. A major change in the structure of the quarterly frequency of the survey occurred in 2006, when the seasonal quarterly basis (starting March-May) of collection which had been the norm since 1992, was changed to a calendar quarterly basis (starting January-March). From March-May 2005 quarter, a ‘special licence’ data set is also available, where the geographical scale of reference available for each individual is local authority district (LAD) for both residence and place of work. The Northern Ireland (NI) LFS is closely related to the GB LFS, with very similar variables included in the survey. It has been running for the same amount of time, with quarterly coverage from 1994 onwards. The sample size for the NI LFS is around 8,500-9,000 individuals. Primary unit data for the NI LFS are only available from 1995 to 2000 via the ESDS. Summary results for later dates are available through the Northern Ireland Statistics and Research Agency (NISRA).

Despite some difficulties with using the LFS to understand migration and commuting flows, a number of studies have used LFS data for this purpose. Forsythe (1992), Gordon (1995) and Bover (2002) have analysed inter-regional flows whilst Shields (1998), Dustmann and Faber (2005) and Dustmann *et al.* (2005) have looked at immigration.

International Passenger Survey

The International Passenger Survey (IPS) is a large, multipurpose sample survey of passengers arriving at, and departing from, the main UK airports and seaports as well as those passing through the Channel Tunnel. Details of the sampling methods are available in ONS (2006d). As a measure of migration, the IPS has three main limitations. Firstly, it does not cover all types of migration; flows along land routes between the UK and the Irish Republic are excluded as are most asylum seekers and some of their dependants. Secondly, it is subject to a degree of uncertainty, although ‘standard errors’ are estimated. Thirdly, migration estimates are based on respondents’ intentions, which may or may not become their final actions. Thus, some adjustments are required to account for ‘switchers’ who change their intentions.

The IPS has been described as the ‘richest’ source of information on international migration (ONS, 2005b), but the problems listed above have limited its utility. The annual ONS Total International Migration (TIM) publication (ONS, 2005b) outlines standard error calculations that need to be applied to the total flow estimates calculated from the sampled data. Furthermore, aggregate statistics provided by the ONS have been subjected to seasonal

adjustment (ONS, 2006a and Annex D, ONS, 2006b) to ‘smooth’ the effect of seasonal travel in the UK, and produce quarterly information that is directly comparable. Data available from the ESDS is available by quarter in annual packages. In addition, national estimates of international travel produced from the IPS have been created using complex variable weighting procedures for which little detailed information is provided, although a brief overview is given in Travel Trends (ONS, 2006a).

Whilst IPS data is the primary source used by the Government to produce estimates of international migration, the TIM estimates also include data on asylum seekers from the Home Office, as well as data from the Irish Central Statistics Office (ONS, 2006c). Annual publications produced by the ONS on international migration (ONS, 2003b; 2004b; 2005b; 2006c) have all made use of the TIM estimate and therefore the IPS. Other studies that have used the IPS to measure international migrations include Salt (2005) and Large and Ghosh (2006a; 2006b). Attention has been drawn to problems associated with the international migration figures in the wake of the revelation that the numbers of people coming into the UK from Eastern Europe in recent years have been significantly underestimated. The report for the inter-departmental task force on migration statistics (ONS, 2006d) reviews some of the current issues and shortcomings related to current international migration estimates.

General Household Survey and Northern Ireland Continuous Household Survey

The General Household Survey (GHS) has been in existence since 1971, and has been conducted on an annual basis since then, with the exception of two breaks – one in 1997/98 and another in 1999/2000. The sample size changes slightly year-on-year, but it is usually between 8,000-10,000 households, which comprise around 15,000-20,000 respondents. Results are published through the ONS in summary form and the ESDS in primary unit form on an annual basis. The main purpose of the study is to collect data on a range of core topics, covering household, family and individual information. The GHS has always asked a question relating, in some way, to the amount of time each respondent has lived at a current address. From this, it is possible to derive some indication of in-migration from somewhere else within Britain or immigration from outside Britain. A question relating to how many moves the respondent has made in the past five years is also included. Unfortunately, no question is included which could give a precise indication of the place of origin for internal migrants so it is only possible to determine whether an individual is currently living in a specific GOR, and that they either did or did not live there n years ago. The finest spatial unit of reference for any movement is the GOR/Standard Region scale. Information relating to the date of arrival in the UK for respondents born elsewhere is included, as is their country of birth. From this, it is possible to infer something about international immigration. However, country of residence before moving to GB is not included as a variable, thus casting some doubt on the real origin of the migrant and limiting any conclusions that can be drawn.

The Northern Ireland Continuous Household Survey (CHS) is related to (and indeed modelled on) the GHS in GB. However, the topics covered and continuity of the data are slightly different. Beginning in 1983, the CHS samples around 1% of the households in Northern Ireland. Covering similar general topics to the GHS, there are also variables which can be used to measure population migration. The spatial units used are of a ‘finer grain’ than those used in GB, with data aggregated by electoral ward as well as by district council area. However, variables allowing the monitoring of migration patterns are not included on the same regular basis as they are in the GHS and so migration analysis using the CHS is not possible.

National Travel Survey

First commissioned in 1965/66, the National Travel Survey (NTS) has, since then, provided periodic snapshots of British travel behaviour. Currently the NTS samples 16,000 addresses in Great Britain annually. Primary unit data are available to download for selected periods since 1972 from the ESDS and summary statistics and reports are also available through the ONS and the Department for Transport. The smallest geographical scale for which aggregate data are made available is the GOR, despite data being collected at postcode sector level. Origins and destinations that are published for each journey are referenced only by GOR. Additional data included for all cases includes variables such as distance and frequency of

journeys made on a given travel day, mode of transport, and average annual and weekly mileage. Standard socio-demographic identifier variables are also featured, including age, gender, marital status, socio-economic group and industry of employment. Interpretation of flow matrices from the NTS needs to be carried out carefully, as the flows represent all journeys carried out by the sample population in their given ‘travel week’ between origin and destination regions.

Table 1.3 is a summary of the interaction data that are available from social survey sources. The principal advantages of some of these surveys are that they publish results with high frequency – often annually, but in some cases quarterly, allowing the researcher to build a time series of migration data and to identify migration trends up to the most recent quarter or annual period, thus providing valuable information with which to complement data from the decennial census of population. However, the major drawback, shared by most of the social surveys covered here, is that the spatial resolution for published statistics tends to be the GOR. Such large spatial units mean that only very general patterns of movement can be observed, despite the rich variety of other attributes that can be ascribed to the individual respondents. Moreover, as a consequence of the detail inherent in many surveys, the sample size of the survey is often relatively small, with implications for accuracy.

Table 1.3: Summary of major survey data sources containing interaction data

Survey	LFS	LFS NI	IPS
Start date	1973	1973	1993
Current sample size	53,000 households, 126,000 individuals annually.	8500- 9000 individuals annually.	250,000 passengers annually.
Current timing	Calendar quarterly sampling and release.	Calendar quarterly sampling and release.	Continual sampling, quarterly compilation, annual release.
Main variable types covered (Variables flows can be disaggregated by).	Age, gender, ethnicity, level of education, marital status, religion, number of dependent children, employment type, sick days, socio-economic classification.	Age, gender, ethnicity, level of education, marital status, religion, number of dependent children, employment type, sick days, socio-economic classification.	Age, gender, UK port or route, type of vehicle, type of fare, purpose of visit, intended length of stay, money spent on beer, wine, spirits and cigarettes, overseas origin or destination.
Interaction data	GOR to GOR and International country to GOR interaction matrices possible. Disaggregation by any variable of choice. LAD to LAD with special permission.	GOR to GOR and International country to GOR interaction matrices possible. Disaggregation by any variable of choice. . LAD to LAD with special permission.	International country of origin to UK county matrices possible. Disaggregation by any variable of choice.
Survey	GHS	CHS	NTS
Start date	1971	1983	1965/66
Current sample size	8000-10,000 households, 15,000-20,000 individuals annually.	4,500 households (around 1% of Northern Ireland total).	16,000 households annually.
Current timing	Annual release.	Annual release.	Data collected on sample ‘travel week’ for study sample over course of a year. Annual release.
Main variable types covered	Household members, household and family information, household	Household members, household and family information, household	Accessibility of public transport, access to amenities, household

(Variables flows can be disaggregated by).	accommodation, housing tenure, consumer durables including vehicle ownership, employment, pensions, education, health and use of health services, income.	accommodation, housing tenure, consumer durables including vehicle ownership, employment, pensions, education, health and use of health services, income.	vehicle access, household composition and household socio-economic information, age, gender and marital status, employment, occupation and industry details, income, place of work and travel to work details.
Interaction data	Very little. GOR of destination is all that can be accurately measured. Origin is either current GOR or 'elsewhere.' There is no way of telling which.	Only for 1983. NI electoral ward or council area can be origin or destination. Immigration from GB or Eire also available for this year alone.	GOR to GOR commuting data is available readily for most recent years. This data should be available in theory for other years too, although in practice availability is variable.

CONCLUSIONS

This chapter demonstrates that origin-destination flow data are available from a wide-ranging set of census, administrative and survey sources, some of which were not specifically designed to provide statistical information to support research on migration or commuting directly, yet provide valuable insights into these patterns of behaviour for which there is a considerable paucity of reliable information. The most important data source for migration and commuting flow data is the Census and it is clear that the last three censuses have generated a number of products from which flow transition data can be extracted. In most cases, there are online interface and extraction systems or mechanisms of assistance already in place to allow users to access flow data; the WICID system giving access to the SMS, SWS and STS is explained in detail in Chapter 2.

An ONS consultation document looking forward to the 2011 Census (ONS, 2005a) indicates that migration and commuting questions similar to those asked in 2001 will be asked again in 2011 and it is likely that separate Origin-Destination Statistics will be produced once again. In order to maximise the success of the 2011 Census, the ONS carried out a test of the procedures to be used in England and Wales on 13 May 2007 on 100,000 households in five local authorities. It is interesting to observe that there were a number of questions on the ONS test questionnaire from which it would be possible to extract new interaction data. The first of these relates to visitors and simply asks for usual address, thus providing some indication of where visitors come from by age and sex. Secondly, there is the question about country of birth that allows a measure of lifetime migration to be derived but, in addition, there is a question for those born abroad about when they most recently arrived to live in England and Wales. In theory, this should enable the creation of matrices of those born overseas by origin and destination and year of entry. The familiar question relating to place of usual residence one year ago is asked, but there are also questions asking about other addresses at which an individual stays for part of the week or year. The second address is asked for together with information about the reason for staying at the second address. Reasons are categorised as 'to stay with another parent/guardian'; 'to stay when I work away from home'; 'to stay when not at university/boarding school'; 'my holiday/second home'; 'to stay when I'm on duty (armed forces)'; and 'other'. There is also a question about how long the individual stays at the second address: 'less than half the time', 'about half the time' or 'more than half the time'. These questions have the potential to generate a considerable amount of new interaction data relating to temporary mobility although they may not appear on the final census form and decisions on data released have yet to be made..

Amongst the administrative sources that have been considered in this chapter, the data source that seems to have been most exploited by practitioners and researchers hitherto has been the NHS patient re-registration system, as evidenced by the adoption of NHSCR data into the official population estimation methodology and the use of patient re-registration data for identifying changes in the magnitude and spatial patterns of movement between censuses, even though, as the audit carried out by Dennett *et al.* (2007) has demonstrated in detail, the data have their shortcomings and further work is required to develop a consistent set of patient register data for the UK as a whole.

The chapter indicates that there are other sources of administrative data that have the potential to provide valuable information on migration and commuting. The availability of time series of NHS hospital episode statistics and PLASC data on journey to school also have considerable potential for those seeking to better understand patterns of commuting, although, in the latter case, significant investment is required to ensure that the attributes of individual pupils are correct and consistent from year to year and algorithms would be required to produce the flows of children between particular geographical units. The analysis of HESA time series data on student flows to and after university would be particularly useful given the inconsistency of measuring students in the last two censuses. Administrative data sets containing flows of individuals entering the country from overseas, such as the NINo statistics and the Home Office data on asylum statistics and visitor switchers are extremely useful for helping to understand trends and patterns of immigration. There is a strong

argument for the development of what Rees and Boden (2006) refer to as a New Migrant Databank (NMD), a common framework within which to assemble counts and indicators of immigration derived from the various different sources

Surveys are the other major type of interaction data source and whilst there are several that provide information about migration, there are very few that contain any details of commuting flows. The main advantage of survey data, especially those which are available in primary unit data form such as the IPS, GHS or NTS is that the user can cross-classify different attributes and provide cross-tabulations that complement data from the decennial census of population, as well as providing more up-to-date information. However, one of the key constraints of survey data, due largely to the fact that the records are only a small sample of some population, is the implication for analysis at spatial scales below that of the GOR. In addition, there are problems with intermittent temporal coverage as well as limitations with some of the methods used for collecting the samples associated with particular surveys, e.g. IPS.

Finally, we should acknowledge that 2011 is likely to see the last census of population in the UK. Proposals have been formulated for an integrated population statistics system (IPSS) (ONS, 2003a) that combines census data at individual level into a single comprehensive statistics database with survey and administrative data and will underpin the country's population and social statistics. At the heart of these proposals is a high quality address register containing information on properties and characteristics of individuals associated with these properties together with a population register, which will provide the basis for linkage with data from other sources. The results of the 2011 Census will form the basis of the information contained in the proposed system that will subsequently be updated with data from further censuses, the proposed Integrated Household Survey and other administrative and registration systems. This system is likely to generate interaction data on a more regular basis and it will be very important to ensure that data release is maximised without the effects of disclosure control becoming too detrimental.

References

- Al-Hamad, A., Hayes, L. and Flowerdew, R. (1997) Migration of the elderly to join existing households: evidence from the Household SAR, *Environment and Planning A*, 29(7): 1243-55.
- Boden, P. and Stillwell, J. (2006) New migrant labour in Yorkshire and the Humber, *The Regional Review for Yorkshire and the Humber*, 16(3): 18-20.
- Boden, P., Stillwell, J. and Rees, P. (1992) How good are the NHSCR data?, in Stillwell, J., Rees, P.H. and Boden, P. (eds.) *Migration Processes and Patterns Volume 2 Population Redistribution in the United Kingdom*, Belhaven Press, London, pp. 13-27.
- Bogue, D. (1959) Internal migration, in Hauser, P. and Duncan, O.D. (eds.) *The Study of Population*, University of Chicago Press, Chicago, pp. 486-509.
- Bover, O.A.M. (2002) Learning about migration decisions from the migrants: Using complementary datasets to model intra-regional migrations in Spain, *Journal of Population Economics*, 15(2): 357-380.
- Boyle, P. (1995) Public housing as a barrier to long-distance migration, *International Journal of Population Geography*, 1: 147-64.
- Boyle, P. and Feng, G. (2002) A method for integrating the 1981 and 1991 GB census interaction data, *Computers, Environment and Urban Systems*, 26: 241-256.
- Bulusu, L. (1989) Migration in 1988, *Population Trends*, 58: 33-39
- Bulusu, L. (1990) Internal migration in the United Kingdom, 1989, *Population Trends*, 62: 33-36.
- Bulusu, L. (1991) Review of migration data sources, *OPCS Occasional Paper 39*, OPCS, London.

- Champion, A. (2005b) Population movement within the UK, Chapter 6 in Chappell, R. (ed) *Focus on People and Migration 2005 Edition*, Palgrave Macmillan, Basingstoke, pp. 91-113.
- Champion, A., Bramley, G., Fotheringham, A., Macgill, J. and Rees, P. (2003) A migration modelling system to support government decision making, Chapter 15 in Geertman, S. and Stillwell, J. (eds) *Planning Support Systems in Practice*, Springer, Heidelberg, pp. 269-290.
- Champion, A. and Coombes, M. (2007) using the 2001 census to study human capital movements affecting larger cities: insights and issues, *Journal of the Royal Statistical Society A*, 170(2): 447-467.
- Champion, A., Coombes, M., Raybould, S. and Wymer, C. (2007) *Migration and Socioeconomic Change A 2001 Census Analysis of Britain's Larger Cities*, Joseph Rowntree Foundation, York.
- Champion, A., Fotheringham, S., Boyle, P., Rees, P. and Stillwell, J. (1998) *The Determinants of Migration Flows in England: A Review of Existing Data and Evidence*, DETR, London.
- Chappell, R., Vickers, L. and Evans, H. (2000) The use of patient registers to estimate migration, *Population Trends*, 101: 19-24.
- Cole, K., Frost, M. and Thomas, R. (2002) Workplace data from the census, in Rees, P., Martin, D. and Williamson, P. (eds) *The Census Data System*, Wiley, Chichester, pp. 269-280.
- Courgeau, D. (1973) Migrants and migrations, *Population*, 1: 96-129.
- Courgeau, D. (1976) Quantitative, demographic, and geographic approaches to internal migration, *Environment and Planning A*, 8(3) : 261-269.
- Dale, A. (1998) The value of the SARs in spatial and area-level research, *Environment and Planning A*, 30, 767-774.
- Dale, A. and Marsh, C. (eds.) (1993) *The 1991 Census User's Guide*, HMSO Publications, London.
- Davies, E., Williamson, P. and Houldsworth, C. (2006) *The Leaving of Liverpool: An Examination into the Migratory Characteristics of Liverpool*, Mimeo, University of Liverpool.
- Denham, C. and Rhind, D. (1983) The 1981 census and its results, in Rhind, D. (ed.) *A Census User's Handbook*, Methuen, London, pp. 17-88.
- Dennett, A. and Stillwell, J. (2008a) Internal migration in Great Britain – a district level analysis using 2001 data, *Working Paper 08/1*, School of Geography, University of Leeds, Leeds.
- Dennett, A. and Stillwell, J. (2008b) Population turnover and churn - enhancing understanding of internal migration in Britain through measures of stability, *Population Trends*, 134: 24-41.
- Dennett, A., Stillwell, J. and Duke-Williams, O. (2007) Interaction data sets in the UK: an audit, *Working Paper 07/03*, School of Geography, University of Leeds, Leeds.
- Devis, T. (1984) Population movements measured by the NHSCR, *Population Trends*, 36: 15-20.
- Duke-Williams, O. (2004) The development and use of information systems for monitoring and analysing migration in Britain, *Unpublished PhD Thesis*, University of Leeds, Leeds.
- Duke-Williams, O. and Rees, P. (1993) TIMMIG: a program for extracting migration time series tables, *Working Paper 93/13*, School of Geography, University of Leeds, Leeds.
- Duke-Williams, O. and Stillwell, J. (2007) The effect of small cell adjustment on interaction data produced from the 2001 Census, *Environment and Planning A*, 39(5):1079-1100 .
- Dustmann, C. and Faber, F. (2005) Immigrants in the British labour market, *Fiscal Studies*, 26(4): 423-470.
- Dustmann, C., Fabbri, F. and Preston, I. (2005) The impact of immigration on the British labour market, *Economic Journal*, 115(507): 324-341.

- Ewens, D. (2005a) The National and London Pupil datasets: An introductory briefing for researchers and research users, Data management and Analysis Group, Greater London Authority.
- Ewens, D (2005b) Moving home and changing school: widening the analysis of pupil mobility, Data management and Analysis Group, Greater London Authority, London.
- Fielding, A. (1992) Migration and social mobility – South East England as an escalator region, *Regional Studies*, 26(1): 1-15.
- Fielding, A. (1998) Counterurbanisation and social class, in Boyle, P. and Halfacree, K. (eds) *Migration in Rural Areas: Theories and Issues*, John Wiley, Chichester.
- Finney, N. and Simpson, L. (2008) Internal migration and ethnic groups: evidence for Britain from the 2001 Census, *Population, Space and Place*, 14:63-83.
- Flowerdew, R. (1997) The potential use of moving units in British migration analysis, in Rees, P. (ed.) Third workshop: the 2001 Census - special datasets: what do we want?, *Working Paper 97/9*, School of Geography, University of Leeds, Leeds.
- Fotheringham, A., Rees, P., Champion, T., Kalogirou, S. and Tremayne, A. (2004) The development of a migration model for England and Wales: overview and modelling out-migration, *Environment and Planning A*, 36: 1633-1672.
- Forsythe, F. (1992) The nature of migration between Northern Ireland and Great Britain - a preliminary analysis based on the Labour Force Surveys, 1986-88, *Economic and Social Review*, 23(2): 105-127.
- Gordon, I. (1995) Migration in a segmented labour market, *Transactions of the Institute of British Geographers*, 20(2): 139-155.
- Green, A. (1997) A question of compromise? Case study evidence on the location and mobility strategies of dual career households, *Regional Studies*, 31(7): 641-657.
- Green, A.E., Hogarth, T. and Shackleton, R.E. (1999) *Long Distance Living: Dual Location Households*, Policy Press, Bristol.
- GRO Scotland (2006) <http://www.gro-scotland.gov.uk/statistics/publications-and-data/annual-report-publications/annrep/01sect5/estimating-migration.html>
- GRO Scotland (2007) <http://www.gro-scotland.gov.uk/statistics/migration/information-on-migration.html>
- Harland, K. Duke-Williams, O. and Stillwell, J. (2006) Commuting to school: an investigation of 2001 Census STS and PLASC data, Presentation at GISRUK'06, University of Nottingham, 10 April.
- Harland, K. and Stillwell, J. (2007a) Commuting to school in Leeds: how useful is the PLASC?, *Working Paper 07/02*, School of Geography, University of Leeds, Leeds.
- Harland, K. and Stillwell, J. (2007b) Using PLASC data to identify patterns of commuting to school, residential migration and movement between schools in Leeds, *Working Paper 07/03*, School of Geography, University of Leeds, Leeds.
- Harris, J., Hayes, J. and Cole, K. (2002) Disseminating census area statistics over the Web, Chapter 8 in Rees, P., Martin, D. and Williamson, P. (eds.) *The Census Data System*, Wiley, Chichester, pp. 113-121.
- Horsfield, G. (2005) International migration, Chapter 7 in Chappell, R. (ed) *Focus on People and Migration 2005 Edition*, Palgrave Macmillan, Basingstoke, pp. 114-129.
- Hussain, S. and Stillwell, J. (2008) Internal migration of ethnic groups in England and Wales by age and district type, Working Paper 08/xx), School of Geography, University of Leeds, Leeds.
- Jones, P. and Elias, P. (2006) Administrative data as research resources: a selected audit, Draft Paper, Warwick Institute for Employment Research.
- Kalogirou, S. (2005) Examining and presenting trends of internal migration flows within England and Wales, *Population, Space and Place*, 11(4): 283-297.
- Large, P. and Ghosh, K. (2006a) A methodology for estimating the population by ethnic group for areas within England. *Population Trends* 123, 21-31.
- Large, P. and Ghosh, K. (2006b) Estimates of the population by ethnic group for areas within England. *Population Trends* 124, 8-17
- Lee (1966) A theory of migration, *Demography*, 3(1): 47-57.

- Liffen, K., Maslen, S. and Price, S. (1988) *HES Book*, Department of Health, London.
- Madouros, V. (2006) Impact of the LFS switch from seasonal to calendar quarters: an overview of the switch of the LFS to calendar quarters and the potential effects of this change on users, ONS, London.
- Machin, S., Telhaj, S. and Wilson, J. (2006) The mobility of English school children, Discussion paper, Centre for Economic Performance.
- Mackintosh, M. (2005) 2001 Census: The migration patterns of London's ethnic groups, *DMAG Briefing Paper 2005/30*, Greater London Council Data Management and Analysis Group, Greater London Council, London.
- McHugh, K.E., Hogan, T.D. and Happel, S.K. (1995) Multiple residence and cyclical migration - a life-course perspective, *Professional Geographer*, 47(3): 251-267.
- Migration Statistics Unit (2007) Using patient registers to estimate internal migration, *Technical Guidance Notes*, Migration Statistics Unit, ONS, Titchfield.
- Nielson, T.A.S. and Hovgesen, H.H. (2007) Exploratory mapping of commuter flows in England and Wales, *Journal of Transport Geography*, 16: 90-91.
- NISRA (2005) Development of methods/sources to estimate population migration in Northern Ireland, NISRA Paper, http://www.nisra.gov.uk/archive/demography/publications/dev_est_mig.pdf (accessed 13/06/07).
- Norman, P., Boyle, P. and Rees, P. (2005) Selective migration, health and deprivation: a longitudinal analysis, *Social Science and Medicine*, 60(12): 2755-2771.
- Office of the Deputy Prime Minister (2002) *Development of a Migration Model*, ODPM, London.
- Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency (2006) *UK Statistical Disclosure Control Policy for 2011 Census Output*, November. <http://www.statistics.gov.uk/census/pdfs/SDCpolicy.pdf> (accessed 1/03/07)
- ONS (1999) 1996-based subnational population projections England, *ONS PP3 No 10*, The Stationery Office, London.
- ONS (2001) *Census 2001 Origin-destination Statistics (Final Specifications)*.
- ONS (2003a) Proposals for an Integrated Population Statistics System, *Discussion Paper*, ONS, October.
- ONS (2003b) International Migration: Migrants Entering or Leaving the United Kingdom and England and Wales, 2001. Series MN no.28. Office for National Statistics, London. http://www.statistics.gov.uk/downloads/theme_population/MN28.pdf (accessed 15/1/07)
- ONS (2004a) Proposals for a Continuous Population Survey, *Consultation Paper*, ONS, July.
- ONS (2004b) International Migration: Migrants Entering or Leaving the United Kingdom and England and Wales, 2002. Series MN no.29. Office for National Statistics, London. http://www.statistics.gov.uk/downloads/theme_population/MN_no_29_v3.pdf (accessed 15/1/07)
- ONS (2005a) *The 2011 Census: Initial View on Content for England and Wales*, Consultation Document, ONS, London.
- ONS (2005b) International Migration: Migrants Entering or Leaving the United Kingdom and England and Wales, 2003. Series MN no.30. Office for National Statistics, London. http://www.statistics.gov.uk/downloads/ihome_population/MN_No30_2003v3.pdf (accessed 15/1/07)
- ONS (2006a) Travel Trends. A report on the 2005 International Passenger Survey, Palgrave, Macmillan. http://www.statistics.gov.uk/downloads/theme_transport/traveltrends2005.pdf (accessed 15/1/07)
- ONS (2006b) Methodology for the experimental monthly index of services. http://www.statistics.gov.uk/iosmethodology/downloads/Whole_Report.pdf (accessed 15/1/07)

- ONS (2006c) International Migration: Migrants Entering or Leaving the United Kingdom and England and Wales, 2004. Series MN no.31. Office for National Statistics, London. http://www.statistics.gov.uk/downloads/theme_population/MN31.pdf (accessed 15/1/07)
- ONS (2006d) Report for the Inter-departmental Task Force on Migration Statistics. <http://www.national-statistics.org.uk/about/data/methodology/specific/population/future/imps/updates/downloads/TaskForceReport151206.pdf> (accessed 15/1/07)
- ONS/GROS/NISRA (2001) Census 2001 Origin-Destination Statistics (Final Specifications), London <http://www.statistics.gov.uk/census2001/pdfs/OriginDest4web.pdf> (accessed 15/05/08)
- OPCS/GROS (1992) *1991 Census, Definitions Great Britain*, HMSO, London.
- Openshaw, S. (ed.) (1995) *Census User's Handbook*, GeoInformation International, Cambridge.
- Platt, L., Simpson, L. and Akinwale, B. (2005) Stability and change in ethnic groups in England and Wales, *Population Trends*, 121: 35-46.
- Poulain, M. (1996) Confrontation des statistiques de migration intra-Européennes: vers plus d'harmonisation, *European Journal of Population*, 9(4): 353-81.
- Rees, P. (1977) The measurement of migration from census and other sources, *Environment and Planning A*, 9: 257-280.
- Rees, P., Martin, D. and Williamson, P. (eds) (2002) *The Census Data System*, Wiley, Chichester.
- Rees, P. and Boden, P. (2006) *Estimating London's New Migrant Population: Stage 1 – Review of Methodology*, Greater London Authority, London.
- Rosenbaum, M. and Bailey, J. (1991) Movement within England and Wales during the 1980s, as measured by the NHS Central Register, *Population Trends*, 65: 24-34.
- Salt, J. (2005) International Migration and the United Kingdom - Report of the United Kingdom SOPEMI correspondent to the OECD, 2005. http://www.geog.ucl.ac.uk/mru/docs/Sop05fin_20060627.pdf (accessed 15/1/07)
- Scott, A. and Kilbey, T. (1999) Can patient registers give an improved measure of internal migration in England and Wales?, *Population Trends*, 96: 44-55.
- Shields, Ma, P. (1998) The earnings of male immigrants in England: evidence from the quarterly LFS, *Applied Economics*, 30(9): 1157-1168.
- Stillwell, J. (1994) Monitoring intercensal migration in the United Kingdom, *Environment and Planning A*, 26: 1711-1730.
- Stillwell J. and Duke-Williams, O. (2003) A new web-based interface to British census of population origin-destination statistics, *Environment and Planning A*, 35: 113-132.
- Stillwell J. and Duke-Williams, O. (2007) Understanding the 2001 UK census migration and commuting data: the effect of small cell adjustment and problems of comparison with 1991, *Journal of the Royal Statistical Society Series A*, 170(Part 2): 1-21.
- Stillwell, J., Duke-Williams, O. and Rees, P. (1995) Time series migration in Britain: the context for 1991 Census analysis, *Papers in Regional Science: Journal of the Regional Science Association*, 74(4): 341-359.
- Stillwell, J., Duke-Williams, O., Feng, Z. and Boyle, P. (2005) Delivering census interaction data to the user: data provision and software development, *Working Paper 05/01*, School of Geography, University of Leeds, Leeds.
- Stillwell, J. and Hussain, S. (2008) Ethnic group migration within Britain during 2000-01: a district level analysis, *Working Paper, 08/2*, School of Geography, University of Leeds, Leeds.
- Stillwell, J., Rees, P. and Boden, P. (eds) (1992) *Migration Processes and Patterns Volume 2 Population Redistribution in the United Kingdom*, Belhaven Press, London.
- Stillwell, J., Rees P. and Duke-Williams, O. (1996) Migration between NUTS level 2 regions in the United Kingdom, in Rees, P., Stillwell, J., Convey, A. and Kupiszewski, M. (eds) *Population Migration in the European Union*, Wiley, Chichester.
- Stillwell, J., Rees, P., Eyre, H. and Macgill, J. (2002) Improving the treatment of international migration, in ODPM (2002) *Development of a Migration Model*, ODPM, London, pp 223-238.

- Vandeschrick, C. (1992) Le diagramme de Lexis revisité, *Population*, 92(5): 1241-1262.
- Vandeschrick, C. (2001) The Lexis diagram, a misnomer, *Demographic Research*, 4(3): 98-124.
- Williams, M. (2000) Migration and social change in Cornwall 1971-91, in Creeser, R. and Gleave, S. (eds) *Migration in England and Wales Using the Longitudinal Study*, ONS Series LS, No. 9, The Stationery Office, London, pp 30-39.