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Abstract

Urban policy makers and service providers need to understand the magnitude and dynamics of population migration to and from towns and cities since both the internal and international components are increasingly important in driving urban demographic development. In this chapter, an information system is outlined with a simple interface that allows migration data alongside data for natural change for selected districts or city regions to be tabulated and visualised so that time series trends and spatial patterns can be identified and compared. The data suggest that, during the 2000s, the major cities in the UK collectively experienced significant population growth, a large increase in net international migration and a decline in the relatively longstanding process of counterurbanisation.

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Chapter 23
Monitoring and Visualising Sub-national Migration Trends in the United Kingdom

John Stillwell, Nik Lomax and Nikola Sander

Abstract Urban policy makers and service providers need to understand the magnitude and dynamics of population migration to and from towns and cities since both the internal and international components are increasingly important in driving urban demographic development. In this chapter, an information system is outlined with a simple interface that allows migration data alongside data for natural change for selected districts or city regions to be tabulated and visualised so that time series trends and spatial patterns can be identified and compared. The data suggest that, during the 2000s, the major cities in the UK collectively experienced significant population growth, a large increase in net international migration and a decline in the relatively longstanding process of counterurbanisation.

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1 Introduction

In both the developed and less developed worlds, cities are growing rapidly and smart methods are increasingly required to manage complexity, increase efficiency, reduce expenditure and improve quality of life. Whilst emerging technologies (ultra-low power sensors, wireless networks and web and mobile-based applications) have begun to reshape urban environments and smart cities are fast becoming a reality (Batty 2012; Department for Business Innovation and Skills 2013; Centre for Cities 2014), basic understanding of the demographic evolution of towns and cities is imperative if local authorities are to provide housing, infrastructure and services that accord with demand. This involves understanding the complexity

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of flows into and out of metropolitan areas as well as the spatial demographic dynamics taking place within cities and their hinterlands.

Mid-year population estimates for local authority districts in the United Kingdom (UK) are generated by the national statistical agencies. Together with population projections, they are used directly by local authorities for planning and policy making but they also underpin the annual allocation of financial resources from central government to local authorities following the Lyons enquiry (Lyons 2007). Demographic change (in both urban and rural areas of the UK), as in other parts of the world, is driven by the changes in the components of growth: the balance between births and deaths and between in-migration and out-migration. It is important to monitor patterns and trends in each of these components to establish, quantify and understand the processes that have occurred in the relatively recent past (e.g. urbanisation, suburbanisation) and that are currently taking place (e.g. counterurbanisation, reurbanisation) as well as to provide a basis for projecting what might happen in the future.

In this chapter we report on the construction of a system for monitoring population change, natural change, internal migration and international migration over time from the beginning of the twenty-first century for a hierarchical system of spatial units that includes local authority districts, city regions and NUTS1 regions in each of the countries that constitute the UK. Details of the time series data sets estimated for a consistent set of spatial units are outlined in the next section. An information system has been built to support the quick and easy retrieval of estimated data based on user specification of a spatial unit and time period. The system interface is based on the concept of a demographic dashboard for illustrating the time series trends in different demographic components for a selected city by the user, but in this case the data are assembled manually and the user observes time-series rather than real-time indicators. Thereafter, there are two sections which provide analyses of time-series trends and spatial patterns which are, at the moment, not automated as part of the information system. First, key trends occurring in flows between metropolitan and non-metropolitan areas across the UK are presented together with relationships between internal and international migration. Second, London's migration characteristics are examined using conventional mapping methods before directional flows between city regions are visualised using circular plots. Some conclusions are included in the final section with proposals for further improvements and extensions to the system.

2 Demographic Data and Spatial Units

The decennial census of population is a key data source for planning in the UK; not only does it provide the benchmark for mid-year estimates but it also provides a matrix of migration flows taking place in the year prior to the census between Local Authority Districts (LADs). Between censuses, sub-national population estimates for LADs are produced by the Office for National Statistics (ONS), by the

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National Records of Scotland (NRS) and by the Northern Ireland Statistics and Research Agency (NISRA) for England and Wales, Scotland and Northern Ireland respectively. These estimates are derived by taking the population measured in the most recent census, ageing this on and then adjusting for births, deaths, international migration and internal migration (see ONS 2014a, for a full explanation of the methods used for producing mid-2013 estimates for England and Wales). Although population estimates from Scotland and Northern Ireland are also collated by ONS to produce UK totals, one of the shortcomings of this approach involving three separate national statistical agencies is that a complete matrix of flows between all LADs in the UK for each mid-year to mid-year period between censuses is not assembled. Each agency estimates flows between LADs within its own jurisdiction using data from administrative databases and surveys, but the cross-border migration flows between local authorities in the three constituent countries are never properly estimated from aggregate totals between the countries that are available. Figure 1 is a schematic diagram of the matrix of migration flows between districts across the UK.

Working in collaboration with the ONS, Lomax (2014) has developed a methodology to estimate complete matrices of internal migration flows between LADs across the UK for a time series commencing in mid-year 2001–02 using data from censuses and administrative and survey sources. Details of the methodology are explained in Lomax et al. (2013) and an initial analysis of the estimated flows is reported in Lomax et al. (2014) for the system of 406 LADs shown in Fig. 1. This system of spatial units, which includes adjustments for boundary changes due to the restructuring of local government in England and Wales in 2009, can be aggregated into more macro regions to facilitate summary and comparative analysis. Two levels of aggregation of LADs include (i) the 12 regions which are equivalent to European Union NUTS1 regions, and (ii) 13 city regions, which in most cases have four component areas: core, rest, near and coast and country and were first used by Stillwell et al. (2000, 2001) for comparison of migration in the UK and Australia (Fig. 2).

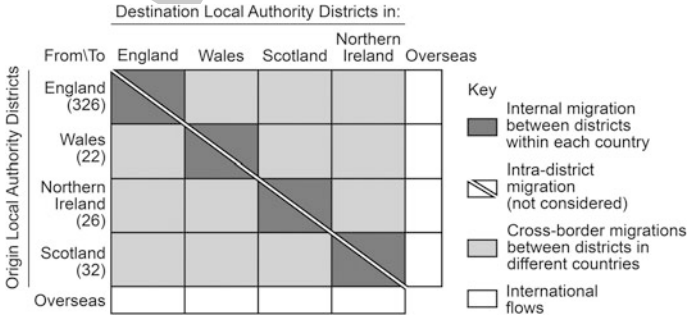

Fig. 1 Schematic diagram of the matrix of estimated migration flows between LADs in the UK

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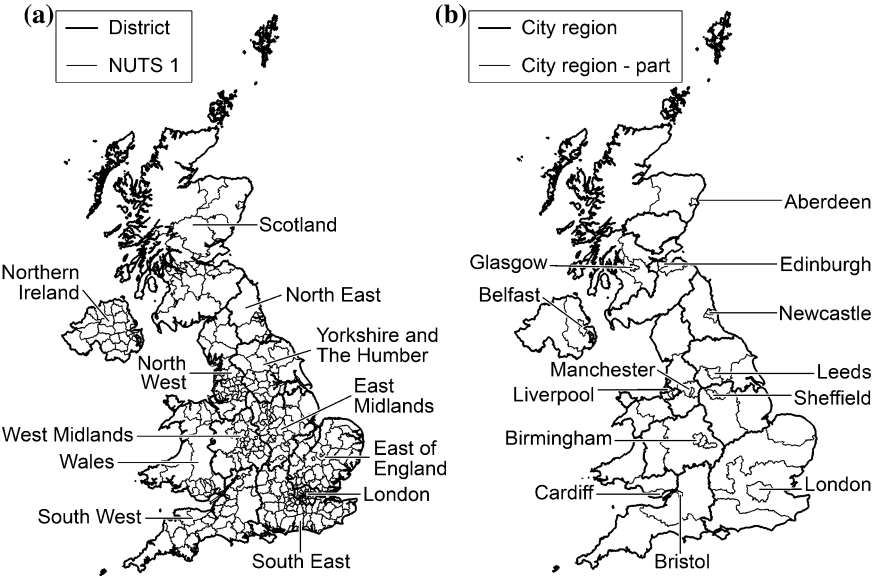

Fig. 2 Boundaries of the spatial units used for monitoring. **a** Local authority districts and NUTS 1 regions. **b** City regions and their component areas

In addition to the estimated inter-censal mid-year to mid-year time-series matrices of internal migration flows, vectors of mid-year populations, annual births and deaths and international immigrants and emigrants have been assembled from official sources and adjusted where necessary, enabling a full accounting of the population change from one mid-year period to the next from 2000–01 to 2010–11 for sets of spatial units with consistent boundaries throughout the period. Considerable time and effort has been invested in building this unique set of data for the UK for monitoring and analysis of changing spatial patterns and processes. The following sections explain the user interface and identify, for the first time, some of the trends and relationships that characterize migration in the UK in the 2000s. Although estimates have been produced for populations by five-year age group and sex, we have confined our analysis to aggregate statistics in this chapter.

3 Structure and Exemplification of the Monitoring Tool

One example of the development of creating, modelling and communicating aspects of the smart city is the ‘city dashboard’, a service that collects various types of near-live publically available data from different external websites and makes them available through a web interface that enhances public awareness. One example of this is that created for London and other cities in the UK (Roumpani et al. 2013).

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The concept of a dashboard underpins the interface of the information system that we have constructed which in our case is based on 'historical' data estimated externally and assembled manually in Microsoft Excel with each of the time-series data sets for every component being assembled in the same workbook. The interface is a spreadsheet with VLOOKUP functions to retrieve values for each of the variables for the spatial unit (LAD) selected by the user from a dropdown list.

In the example of the interface presented in Fig. 3, Leeds LAD has been chosen, an area which is the core component of the wider Leeds city region and which is the regional capital of the Yorkshire and Humber region. We observe from the time-series estimates—presented in tabular and graphic form—that the population increase in Leeds Core over the period has not been linear; there is a steep increase in population between 2003–04 and 2004–05 with more steady growth in previous and subsequent years. Growth over the decade has been less than the national average and that taking place in the city region as a whole. The graph of vital statistics indicates how growth in the natural change component has occurred as births have risen and deaths have declined. Net internal migration, on the other hand, remains relatively marginal over the period with gross inflows, though increasing, being cancelled out by gross outflows. The migration efficiency index measures net migration as a percentage of migration turnover (in-migration plus out-migration) (Stillwell et al. 2000, 2001; Lomax et al. 2014) and gives a clearer picture of how the net migration fluctuates around zero whilst the connectivity index suggests that Leeds is connected by both outflows and inflows involving more than 3 migrants with around 94 % of the other 405 LADs in the UK.

It is apparent from the international migration graph that the time-series trends have been much less stable over time, with a significant increase in immigration taking place between 2002–03 and 2004–05 without a corresponding change in emigration. The demographic trajectory of the Leeds population has therefore been impacted by the net immigration rising from 5422 to 8028 to 12,961 over the three years concerned with serious implications for the provision of services such as housing and schools.

Demographic growth in Leeds of 5 % over the 2000s has generated pressures for additional accommodation, some of which has been provided through the construction of private housing in outlying suburbs but much of which has taken place through private sector investment in the development of blocks of flats in areas adjacent to the city centre (particularly along the waterfront) once used for industrial or commercial purposes (Unsworth and Stillwell 2004). The latter phenomenon, involving mostly relatively young single or dual income households without children, and known as city living (Unsworth 2005), occurred in many other cities in the UK as a result of urban regeneration processes and is partly responsible for the high rates of growth that are apparent elsewhere. Rates of population change expressed as an index that takes the value of 100 at the start of the period are shown in Fig. 4a for each of the 13 city region cores. Manchester has experienced the largest growth between 2001 and 2011 at almost three times the national average, with all the city region cores apart from Newcastle, Glasgow and Belfast having experienced relatively more growth than Leeds by the end of the period. In the case

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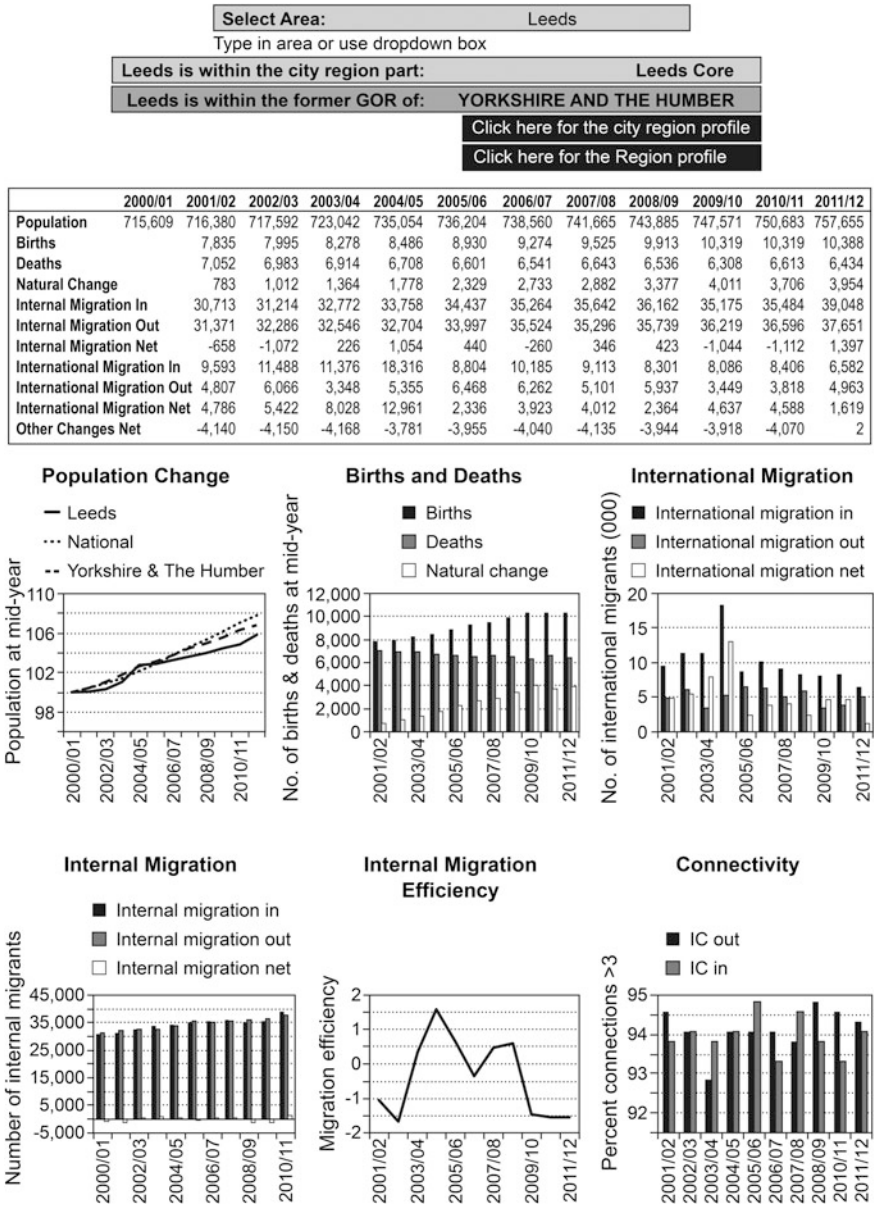

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Population	715,609	716,380	717,592	723,042	735,054	736,204	738,560	741,665	743,885	747,571	750,683	757,655
Births		7,835	7,995	8,278	8,486	8,930	9,274	9,525	9,913	10,319	10,319	10,388
Deaths		7,052	6,983	6,914	6,708	6,601	6,541	6,643	6,536	6,308	6,613	6,434
Natural Change		783	1,012	1,364	1,778	2,329	2,733	2,882	3,377	4,011	3,706	3,954
Internal Migration In		30,713	31,214	32,772	33,758	34,437	35,264	35,642	36,162	35,175	35,484	39,048
Internal Migration Out		31,371	32,286	32,546	32,704	33,997	35,524	35,296	35,739	36,219	36,596	37,651
Internal Migration Net		-658	-1,072	226	1,054	440	-260	346	423	-1,044	-1,112	1,397
International Migration In		9,593	11,488	11,376	18,316	8,804	10,185	9,113	8,301	8,086	8,406	6,582
International Migration Out		4,807	6,066	3,348	5,355	6,468	6,262	5,101	5,937	3,449	3,818	4,963
International Migration Net		4,786	5,422	8,028	12,961	2,336	3,923	4,012	2,364	4,637	4,588	1,619
Other Changes Net		-4,140	-4,150	-4,168	-3,781	-3,955	-4,040	-4,135	-3,944	-3,918	-4,070	2

Fig. 3 Example layout of interface with indicators for Leeds Core

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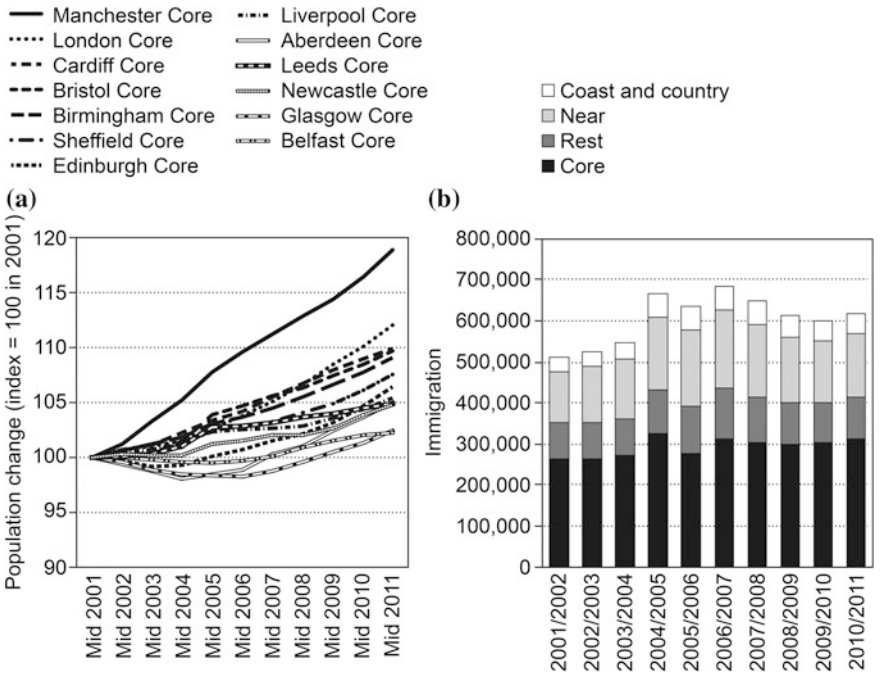

Fig. 4 Population and immigration time series, 2001–2011. **a** Population change. **b** Immigration change

of the large cities in Scotland and Northern Ireland (Edinburgh, Glasgow, Aberdeen and Belfast), the trajectories shown in Fig. 4a indicate population losses in the first half of the decade with overall growth rates that remain below the national level for the decade of 7 %.

One of the key features of demographic development in the UK during the 2000s has been the extent of net immigration from the rest of the world, an issue that has led to much political debate and public discussion, not least in terms of its implications for the labour market and for the provision of services. Figure 4b captures the time series trend in the total number of immigrants into the UK during the decade, rising from around half a million in 2001–02 to 666,000 in 2004–05 and remaining at over 600,000 per year for the rest of the decade. Around one half of this migration has been into the city region cores, with London attracting one third of a total immigration (over 6 million)to the UK throughout the period, whilst contributing only 28 % of the total flow of migrants (3.7 million) leaving the country.

The system allows for the easy generation of league tables for selected variables over user-defined periods of time. Table 1 exemplifies this by showing the top and bottom ten positions in the population change league table for different city region parts over the decade. As indicated previously, Manchester is the UK's 'boom city'

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Table 1 Top and bottom positions in the population change league table, 2001–2011

Rank	LAD	2001 Population	Population change	% Change
1	Manchester Core	502,902	79,987	18.9
2	London Core	8,204,407	882,004	12.0
3	Aberdeen Near	347,120	33,180	10.6
4	Sheffield Coast and Country	714,768	67,128	10.4
5	Aberdeen Coast and Country	305,080	28,530	10.3
6	Cardiff Core	472,121	42,756	10.0
7	Bristol Core	428,074	38,025	9.7
8	Belfast Near	726,714	62,050	9.3
9	Birmingham Core	1,074,823	89,641	9.1
10	Belfast Coast and Country	654,245	53,721	8.9
38	Liverpool Coast and Country	191,436	6786	3.7
39	Liverpool Near	496,981	17,068	3.6
40	Newcastle Near	1,492,300	39,026	2.7
41	Glasgow Core	593,060	14,350	2.5
42	Manchester Coast and Country	499,817	12,022	2.5
43	Glasgow Rest	1,112,740	25,390	2.3
44	Belfast Core	433,359	9709	2.3
45	Newcastle Rest	825,049	4474	0.5
46	Glasgow Coast and Country	543,910	170	0.0
47	Liverpool Rest	915,114	−10,383	−1.2

of the 2000s (Crook and Linton 2012) with London appearing in second place. Aberdeen, in Scotland, has benefited from North Sea oil-related development and this is likely to explain the relatively high population growth in its affiliated near and coast and country areas. Cardiff, Bristol and Birmingham Cores are also in the top ten, the latter being the UK's second largest city and the only other city with more than a million inhabitants. Whilst Belfast Near appears in the top third of the table with growth of nearly 9 %, Northern Ireland's capital city itself (Belfast Core) experienced a slower rate of growth of 2.3 %. The area immediately adjacent to Newcastle Core (Newcastle Rest) grew only marginally (0.5 %), whilst the equivalent area of Liverpool Rest was the only area at this spatial scale to lose population during the period. These areas contain some of the old industrial LADs in the north of the country including Barrow-in-Furness, Knowsley, Sefton, South Tyneside and Sunderland, all of which experienced population declines of 3 % or more.

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4 Trends in and Relationships Between Demographic Components

Whilst the monitoring framework allows the trajectory of each LAD or city region to be profiled against that of its corresponding region or against national figures, and to show its position in league table *vis a vis* its competitors, it also proves useful to identify trends in the components of change at a more macro level, in order to identify what processes are happening throughout the country as a whole for places of similar type or at different spatial scales. This is illustrated in Fig. 5, which shows two sets of time-series trends. The graph on the left-hand side plots the migration flows between LADs classified as either metropolitan (core and rest areas) or non-metropolitan (near and coast and country areas), indexed to a value of 100 in 2001–02. The graph reveals a decline in flows from metropolitan to non-metropolitan areas suggesting a decline in counterurbanisation (Champion 1989), a process that has characterised internal migration in the UK for several decades. The graph also reveals a decline in movements between rural areas but an increase in movements into metropolitan areas from rural areas and other metropolitan areas. These statistics support the hypothesis of reurbanisation or 'back to the city' movement in the UK that has been occurring over this decade, generating the type of 'city living' environment apparent in Leeds.

The graph in Fig. 5b depicts only migration from the core areas of city regions, again indexed to 2001–02. In this case, we observe that whilst core to core movements have been increasing, regardless of whether London Core is included or excluded in the analysis, it is longer-distance movement from the cores to the coast and country (C & C) areas of the city regions that has declined significantly. Flows out of cores to neighbouring rest or near regions have only shown marginal decline.

The boundary of the core of the London city region coincides exactly with that of the Greater London region which is composed of the City of London and 32

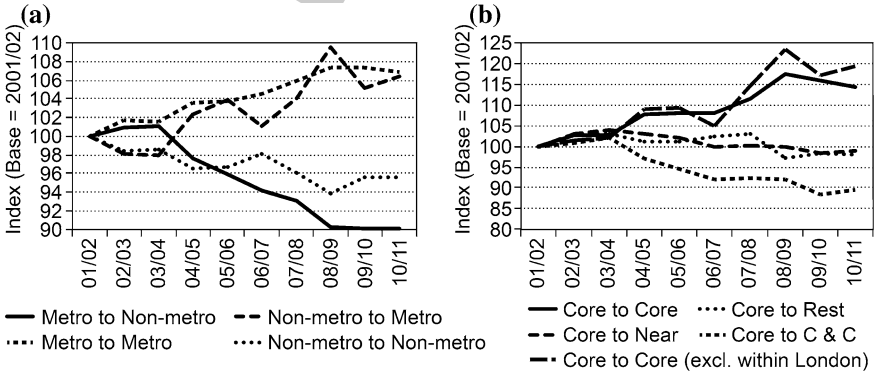

Fig. 5 Time series indices of aggregate flows **a** flows between metropolitan and non-metropolitan areas in UK and **b** away from city region core areas in UK, 2001–2011

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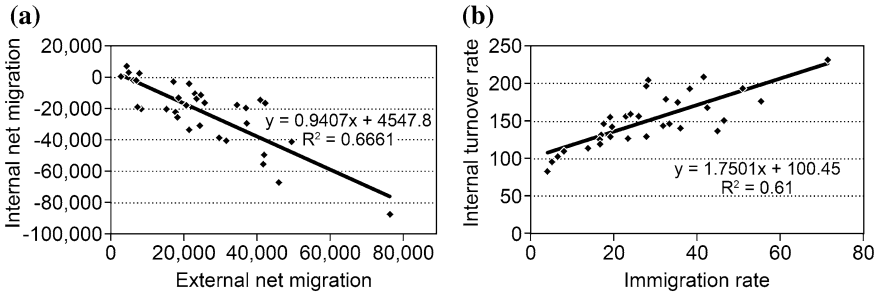

Fig. 6 Linear regression relationships between selected variables, 2001–2011. **a** Internal and external net migration. **b** Internal turnover and immigration rates

London boroughs. It is this (NUTS1) region which is the engine that drives the whole migration system of the country, attracting in-migrants from overseas and from the rest of the UK, but also generating out-migrants elsewhere in large volumes. In net terms, all boroughs bar the City of London, Harrow and Brent lost net migrants over the decade from mid-2001 to mid-2011 to elsewhere in the UK but these losses were more than offset by net migration gains to each borough from the outside the UK. Figure 6a captures this linear relationship whilst Fig. 6b illustrates that whilst London boroughs with relatively low turnover rates, measured as the sum of in-migration and out-migration each year over the decade and divided by a mid-decade population, had lower rates of immigration from overseas, boroughs with high internal turnover had high rates of immigration. In other words, rates of immigration were higher to boroughs where internal migration activity, measured by turnover, was more buoyant.

These estimates of net migration for the decade as a whole provide a useful summary of the extent of internal net losses and external net gains in migration but they conceal fluctuations that may have occurred during the time period from year to year as well as processes of internal migration within London Core. In the next section, we retain our focus in the first instance on London and examine patterns of net and gross migration using conventional mapping techniques but then demonstrate a new method of mapping directional flows using data for city regions.

5 Visualising Internal Migration Flow Patterns

London Core grew by 12 % during the 2000s from an initial population of 7.3 million to 8.3 million by mid-2011. Our estimates suggest that gains from international net migration offset losses from net internal migration in each year of the decade apart from 2002–03 and 2003–04. Overall, London gained around 929,000 from overseas and lost around 724,000 over the ten-year period and Fig. 7 presents the year-on-year breakdown of net migration balances between internal

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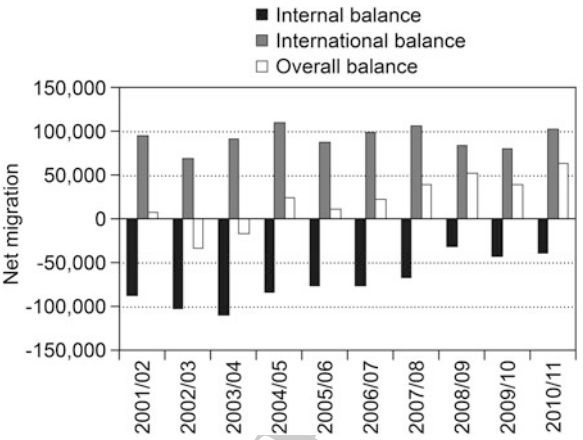

Fig. 7 Net migration balances of London Core, 2001–02 to 2010–11

and international flows, indicating how internal losses reduced during the latter half of the period, resulting in increased overall net gains.

The overall net migration balances for individual London boroughs can be decomposed into three component parts which are shown in Fig. 8 for the first and last years of the time series. Internal net migration is divided into two types with maps a and b illustrating the net result of flows between boroughs within London whilst maps c and d show the pattern of net migration flows between each borough and the rest of the UK. These maps reveal important patterns of net migration that are concealed by the aggregate balances.

Within London, a process of deconcentration is taking place resulting in net losses in inner London and net gains in outer London as migrants reveal their preference for more suburban residential environments in the outer boroughs or fewer opportunities to find suitable accommodation in the inner areas where house prices have risen disproportionately during the decade. However, inner London boroughs are gaining migrants in net terms from the rest of the UK whilst outer London boroughs are losing migrants in significant quantities to the rest of the UK. These patterns align with the concept of London as an 'escalator' region (Fielding 1992). Inner London is an important destination for employment and educational opportunities and therefore, like other cities, attracts large numbers of migrants in higher education or early career life stages, whereas migrants departing London from the outer boroughs tend to be older and motivated to leave for housing and other reasons. Comparison between the two years indicates how more inner London boroughs were experiencing net in-migration from the rest of the UK by the end of the period. The pattern of international balances shown in map e shows net gains across the board in 2001–02 which are particularly high in the north (Haringey, Barnet, Enfield, Waltham Forest and Redbridge) but also in the west (Ealing) and in

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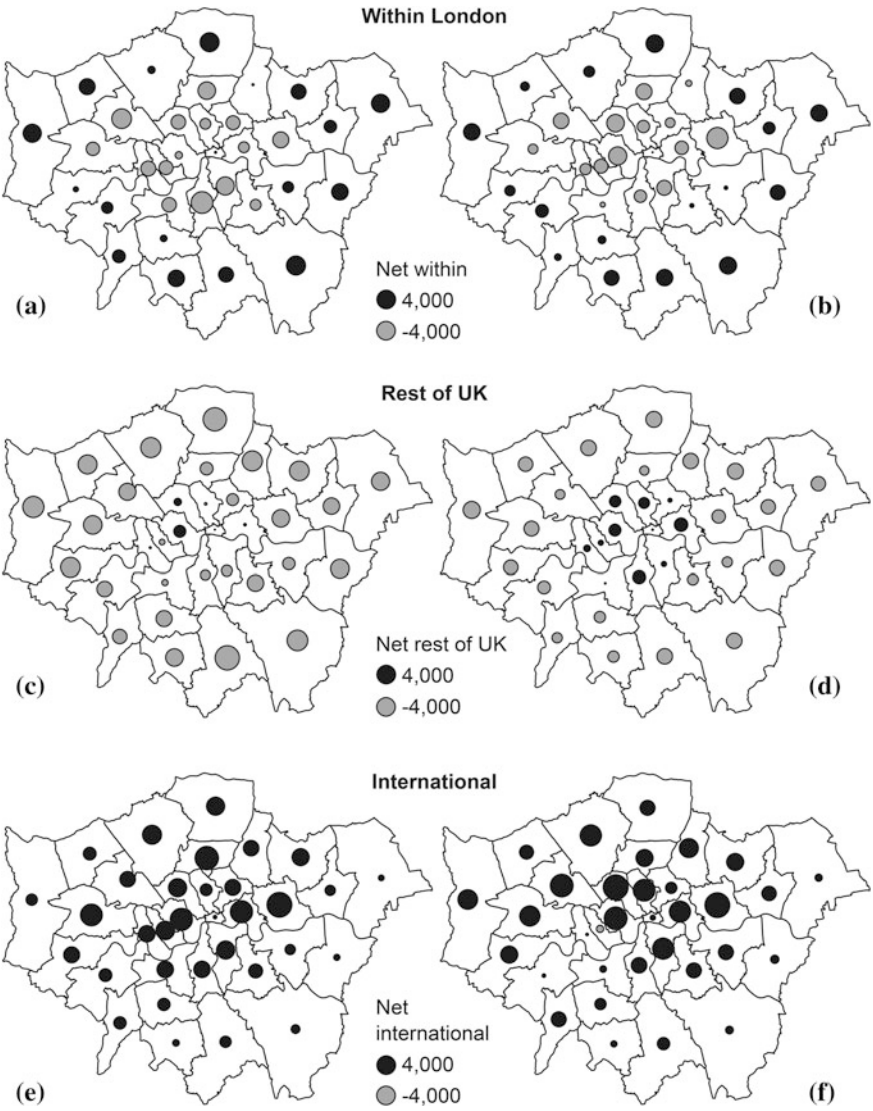

Fig. 8 Net migration balances for boroughs of London Core, **a**, **c**, **e** 2001–02 and **b**, **d**, **f** 2010–11

the east (Newham and Tower Hamlets). A similar pattern is evident for 2010–11 (map f) with the exception of Kensington and Chelsea, whose balance has turned positive.

Whilst the analyses and visualisations shown in the previous sections allow the capture of trends for individual areas or groups of areas in summary form, the net internal migration balances conceal the directional movements that are taking place between origin and destination areas. Conventional migration flow

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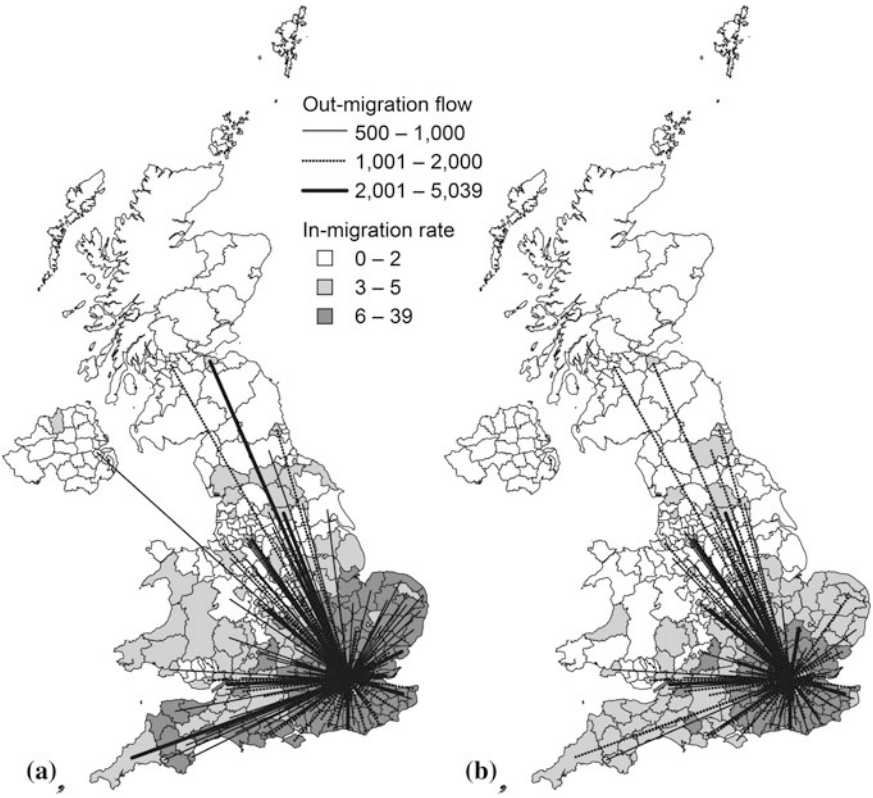

Fig. 9 Flow maps of out-migration from London in **a** 2001–02 and **b** 2010–11

mapping—involving the drawing of lines on a base map—dates back to the early visualisations by Minard (flow map of Napoleon's disastrous Russian campaign in 1812) and Ravenstein (1885) and has been slowly improving since the early experiments with automated cartography (e.g. Tobler 1987). Figure 9 contains two flow maps that illustrate changes in the pattern of flows between London Core and other districts in the UK between the beginning and the end of the period.

Both the maps in Fig. 9 shows gross out-migration flows of over 500 individuals originating from London Core and moving to other LADs in the UK, overlaid on top of choropleth maps showing the rates of in-migration from London into each of the destination LADs. The rates are computed as the number of in-migrants per 1000 resident population in each LAD. At the beginning of the period, outflow destinations are predominant in the south and east of England. By 2010–11, the pattern has changed, with far fewer migrants moving from London to the Midlands and the North of England as well as moving shorter distances to the East, South West and rest of the South East. The number of LADs that receive over 500 migrants from London fell from 155 in 2001–02 to 134 in 2010–11. This decline

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is driven primarily by a fall in the number of LADs that received between 500 and 1000 migrants (the black lines in Fig. 9), which fell from 69 in 2001–02 to 51 in 2010–11. While London has maintained a substantial influence as a distributor of migrants around the UK, this influence in terms of out-migration rates appears to have declined over the 2000s, and as the maps illustrate, the highest in-migration rates are more spatially confined to LADs close to London in the South East by the end of the time series.

Although flow mapping can be undertaken using proprietary GIS packages and various specialist software packages are now available,[1] the complexity of the patterns being visualised often means that the resulting flow maps are chaotic and indecipherable, particularly if the aim is to consider flows between all origins and destinations simultaneously. In this instance, we use the approach developed by Sander et al. (2014) to visualise migration flow patterns between city regions and their component parts using circular plots. Abel and Sander (2014) have introduced circular migration plots as a way of visualising their estimates of flows of migrants between countries of the world and we have used this approach to produce interactive plots for our time series of migration within the UK as illustrated in Figs. 10 and 11. The basic idea behind the plot in Fig. 10 is to show the relative size of the flows that have been estimated between city regions which are represented by the segments of the circle. Neighbouring city regions are located close to one another in the circle and the size of each migration flow is represented by the width of the links between the regions, with colour coding to identify origins and destinations. The direction of the flow is shown both by the origin colour and by the gap between link and circle segment at the destination.

Figure 10 shows the larger gross flows between each of the 13 city regions and reveals that inter-regional flows are not entirely dominated by London although London does have major links with all the other city regions in England. There are also relatively strong migration flows between those city regions that are adjacent to one another—between Sheffield and Birmingham, Manchester and Leeds, Sheffield and Leeds and Liverpool and Manchester. The numbers around the perimeter of the plot are gross flows in 10,000s and only gross flows over 7380 are shown on the plot so as not to obscure the image with a lot of smaller links. Consequently, the city regions in Scotland and Northern Ireland appear relatively isolated apart from the link in both directions between Glasgow and Edinburgh.

The second circular plot (Fig. 11) illustrates the flows of net migration in excess of 280 individuals between each of the component parts of the city regions, where the numbers around the perimeter are net flows measured in 1000s. In this instance, the plot is dominated by the net flows from London Core to London Rest although this pattern is replicated for other provincial city regions.

[1] http://www.csiss.org/clearinghouse/FlowMapper/.
http://flowmap.geo.uu.nl/index.php.

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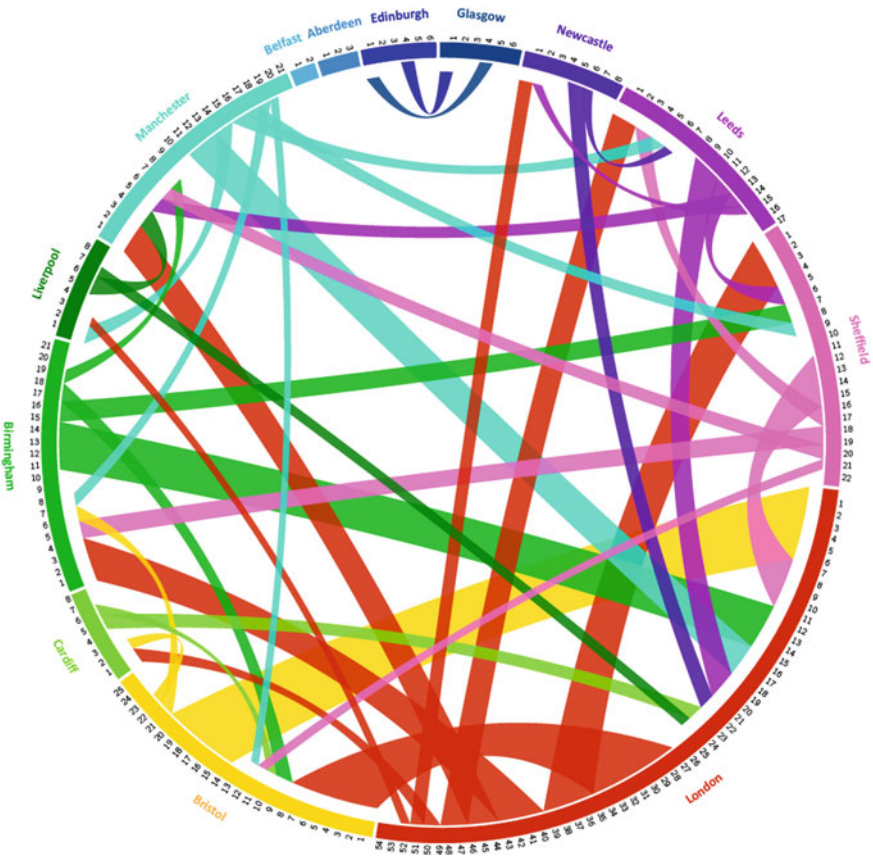

Fig. 10 Circular plot showing gross migration flows between city regions of over 7380 migrants in 2010–11

If we compare the plots between the beginning and end of the decade,[2] although changes have taken place, there is remarkable stability of directional origin-destination migration patterns over time. The proportion of intra-versus inter-city region migration is fairly stable across the time series, hovering around 63 % of total. Collectively, it is the city region core to core moves that have increased at a faster rate than any other kind of move, while moves from core to coast and country have declined and moves to the core from all other types of area have increased.

[2]The interactive circular plots for city regions for the time series will be available at www.uk.migration.info.

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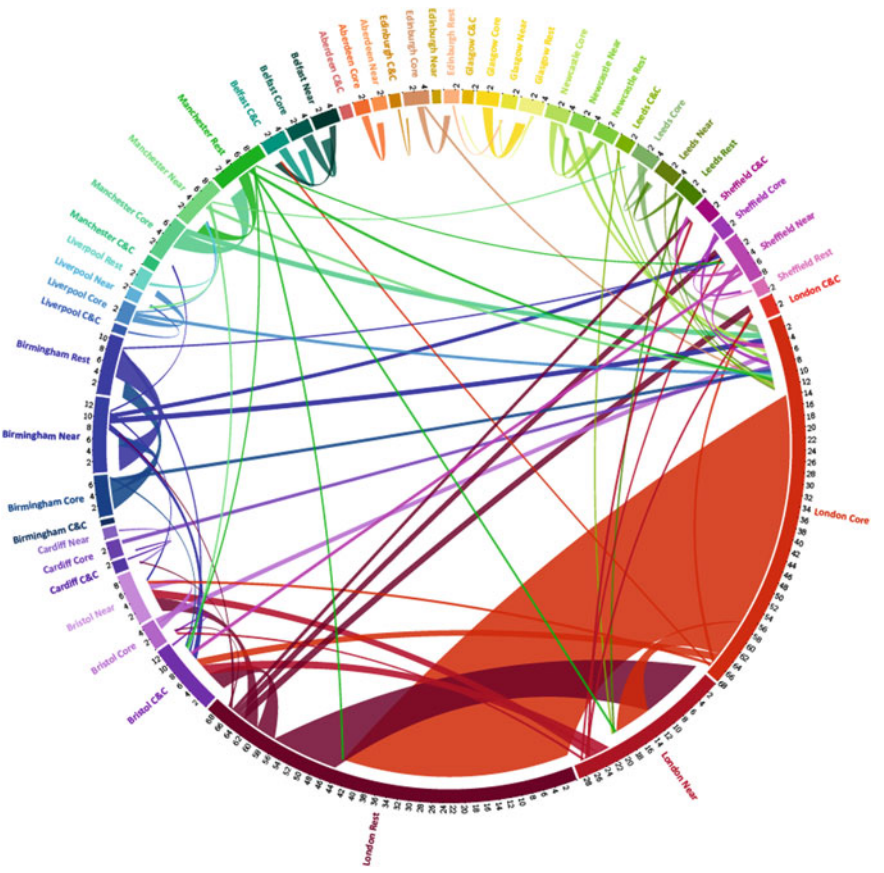

Fig. 11 Circular plot showing net migration flows between city region component areas of over 280 migrants in 2010–11

6 Conclusions

Whilst urban planners must understand the complexities of demographic change within cities, we contend that it is also important that policy makers and service providers have an equally good understanding of the relationship between cities and their migration 'hinterlands', be they within the same country or overseas. This is equally true of other interaction phenomena such as commuting, tourism or trade flows, but migration is a particularly important component of demographic change because of the relative permanence associated with changing place of usual residence and the implications for housing and the labour market as well as the provision of welfare, education and health services. We also believe that grouping like areas together is a beneficial approach for illustrating sub-national patterns and helping to understand the underlying processes.

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During the 2000s, the UK as a whole has experienced population growth more rapid (7 %) than for a number of decades and much of this growth has come about in the cities. Collectively, the city region cores have grown by 10 %, due in many cases to the increased levels of immigration rather than internal migration, although the overall magnitude of the latter is far greater. Net international immigration has reached unprecedented levels and captured the attention of politicians and journalists as well as urban planners concerned with the implications for service and infrastructure provision. Concern has also been expressed over the shortcomings associated with the collection and measurement of international migration data, prompting the National Statistician in 2006 to set up an Inter-Departmental Task Force on Migration Statistics (National Statistics 2006), leading to recommendations for an ONS programme on 'Improving Migration and Population Statistics (IMPS)'. In 2008, a Parliamentary Committee reviewed complaints from local authorities about the inadequacy of official population statistics and its report (House of Commons Treasury Committee 2008) resulted in a cross-government programme to deliver the Task Force recommendations by 2012. In other words, the primary consideration given by central government to improving the measurement of migration is indicative of the importance that is attached to this dimension of urban and regional development.

The information system that we have constructed provides access to a valuable new collection of both internal and international migration estimates and natural change components over time which allows users to explore and compare trends and patterns for selected districts or their wider city regions or NUTS1 regions. At the moment, we make use of the lookup functions of Excel to perform the queries that generate the dashboard of indicators for selected areas but the creation of graphics, maps and circular plots presented as part of the subsequent analyses of the data are not automated or linked to the spreadsheet. Although this platform satisfies the basic demands for handling the data, it would be beneficial to move to a database system with a web interface for access and analysis, akin to the Web-based Interface to Census Interaction Data (WICID)[3] used by the UK Data Service-Census Support to provide users with access to migration and commuting flow data from the last five successive censuses (Stillwell and Duke-Williams 2003; Dennett et al. 2010). This transition would seem imperative because estimates have also been made of inter-district migration flows for each year for five-year age groups for males and females and a spreadsheet is less suitable for handling a much larger number of cell counts. It would also facilitate linkage with the software for creating circular plots and necessitate the adoption of web mapping tools. We envisage using a bundle of open source software (postgres, R and QGIS) with some scripts to automate the SQL queries and support a series of options that take the multi-scale origin-destination flow matrices, plus the boundary files and populations at risk, and create the charts and maps required for analysis from pick lists.

[3] http://census.ukdataservice.ac.uk/get-data/flow-data.aspx.

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Aside from these technical or computational developments, the next steps in terms of data acquisition and estimation include: (i) adjustment of the time-series estimates for each of the inter-censal years so that they are consistent with the flows due to be released from the 2011 Census; (ii) updating the time-series estimates for the years following the 2011 Census so that more contemporary dynamics can be monitored and analysed; (iii) extending the time series beyond the immediate past by estimating future trends in different components or incorporating future projections generated by the national statistical agencies; and (iv) the addition of some key socio-economic time-series indicators such as employment, house prices, GDP and deprivation so that relationships between demographic and socio-economic development can be investigated.

Finally, there is the challenge of estimating the inter-censal time series of annual migration flows taking place within districts. In London this has been partly achieved since data are available on flows between boroughs but, both in London and elsewhere, planners and policy makers would find it extremely useful to know something about annual flows taking place between smaller spatial units on an annual basis. Although the current census provides flows of migrants between small sub-district areas such as wards and super output areas, annual estimates would rely on using data collected from administrative sources which, as yet, are not available on a national level across the UK. It is to be hoped that current and future work by the national statistical agencies on the use of administrative data as an alternative to the traditional census (ONS 2014b), will be fruitful in this respect, particularly if the traditional population census is replaced in due course by an alternative approach in which small area migration statistics are no longer collected.

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