Churning population?

New ways of understanding Camden's population change

Introduction

'Population churn' is often used to describe the movement of population. While some define 'churn' as moves across administrative boundaries and calculate it as the sum of in- and out-migration moves divided by the total population (Camden Council 2017), others emphasise the importance of short-distance moves within each area (Bailey and Livingston 2005). The overall churn of an area is thus described as a combination of people 'who have either moved *in* or *out* or *within* the area' (Hollis 2010:20).

Churning population influences the scale and composition of the local population and is often used as an indicator of local population dynamics (Dennett and Stillwell 2008). Studying population churn enables greater insight into the size, structure, composition of a population and the scale of population change, which has significant implications for understanding the openness and closeness of an area, as well as the permeability of its boundaries. This is vital when it comes to service planning and allocation, capitation and budget estimates, as well as democratic participation. For instance, churn will affect the number of children joining a new school, the number of patients changing general practitioners, the number of households setting up new council tax accounts, and the number of persons who are entitled to vote in elections. As an indicator of residential change, churn also affects the ability of local communities to face challenges, enhance interactions and engagement, and promote neighbourliness and social cohesion.

Population churn has a significant impact on London. The 2011 census showed that in some parts of London, almost half of the population churned in a single year before the census date. This is significantly higher than the average churn rate across the UK during the same period when 12.01 per cent of the population have changed address. More importantly, the significant impact of churn is not being felt uniformly by all London boroughs. Early evidence from London Councils suggests that, compared to Outer London boroughs, Inner London boroughs experienced higher levels of churn in the early 2010s[1]. This is especially the case in Camden, which has the 6th largest population churn in the UK. In- and out- flows[2] accounted for 28% of Camden's total population in the year to mid-2019 (Camden Council 2021).

[1] Source: https://www.londoncouncils.gov.uk/node/28515.

[2] This includes university student moves to and from Camden.

Existing research has documented a variety of demographic, economic, and social factors that contribute to population churn in London, such as age and life-stage transitions, family type, employment status, educational qualifications, housing tenure and ethnicity. Scholars argue that higher rates of churn are more likely to be found among people who are young adults or young children, single or lone parents, unemployed, with higher educational qualifications, private tenants, and from ethnic minority groups (Bailey and Livingston 2005; Long 1992; Musterd et al. 2016). These driving factors affect London boroughs disproportionately, creating unique spatial patterns of population churn across London. For instance, according to ONS Population Estimates, the inflow of children and young people (0-15) is more likely to happen in outer London boroughs, especially Havering, Barking & Dagenham, and Bromley. A disproportionate increase in Local Housing Allowance (LHA) claims was also found in outer boroughs, but most notably in Ealing, Brent, Barnet, Enfield, and Haringey.

Recent research also explores driving factors behind population churn and its various effects. Travers and his colleagues (2007) particularly distinguish *escalator churn*, where residents whose circumstances improve move out, and *gentrifier churn*, where better-off households move into the area. Four types of churn areas were further identified by research carried out into the National Strategy for Neighbourhood Renewal (Robson, Lymperopoulou, and Rae 2009), including

- *'Escalator' areas*, where residents whose circumstances improve move out of the area and the neighbourhood becomes part of a continuous onward-and-upward progression through the housing and labour markets.
- *'Gentrifier' areas*, where better-off households move into the area. Although most in-movers come from less deprived areas and most out-movers go to similarly or more deprived areas, this may or may not entail the kind of conscious process of markedly richer households displacing markedly poorer households envisaged by much of the literature that discusses gentrification (Lees 2000).
- *'Transit' areas*, where households move in and out, to and from less deprived areas. Typically, this implies young or newly established households coming from less deprived areas (such as their parental home) and starting on the housing ladder with limited initial resources.
- *'Isolation' areas*, where households move in and out, to and from similarly or more deprived areas.

Although scholars and policymakers have recognised the importance of population churn and its far-reaching impacts, empirical evidence on London's churning population remains limited. Despite the many sources of statistics about migration to and from London (e.g.

Mid-year population estimates, Annual Population Survey, NHS patient register and National Insurance Number registrations), there remain problems and inconsistencies in pinning down the numbers of migrants/movements and characteristics of migration due to definitional, timing, coverage, measurement, and quality differences between data sources[3]. Moreover, the Census and other publicly available statistical sources suffer from low temporal or spatial granularities. We have limited knowledge of churning populations beyond the decennial Census and limited insight into the granularities of churn, since most publicly available population data are hardly available at fine geographic scales and fail to reflect the substantial amount of short-distance moves.

To address these gaps, we introduce a new measure of population churn – the Residential Mobility Index (RMI), which derives from a 'Linked Consumer Registers' dataset drawing on consumer registers, electoral registers, and land registry data. The aim of this is to reflect the annual (dis)continuity of residence, allowing us to monitor changes in patterns of internal migration over the past decades and provide 'highly granular inventories' (Lansley, Li, and Longley 2019:1587) of local populations and their movement. This would provide new insights into the rapidly churning population in and across London, especially in and across Camden.

The remainder of the report is structured as follows: in section two, we present existing empirical evidence on London's churning population, drawing on publicly available population statistics, primarily Census migration data. This provides a contextual framework to understand the general trends and broader patterns of population churn throughout Camden. Acknowledging the limitation of Census migration data, we introduce the RMI and the 'Linked Consumer Registers' in section three. By anchoring the RMI to conventional migration data, we find strong correspondence between RMI 2011 and 2011 Census, demonstrating that the RMI has the potential to supplement conventional population statistics by capturing changing patterns of residential mobility in London at a high spatial and temporal granularity. This is followed by RMI-based analysis in section four. We visualise the changing spatial and temporal patterns of RMI at the London, Camden and LSOA levels, showing how the RMI acts as a new way of understanding population change in London. The last section summarises the main findings and discusses some policy implications.

Notes on data and methodology

Population churn is 'the outcome of mobility of all types' (Scanlon, Travers, and Whitehead 2010:11). Depending on the origin and destination of the movement, at least three types of

[3] A detailed discussion see https://migrationobservatory.ox.ac.uk/resources/briefings/who-counts-as-a-migrant-definitions-and-their-consequences/.

mobility can be observed in London: to and from overseas (i.e. international migration); to and from the rest of the UK (i.e. domestic or internal migration) and within the capital itself (i.e. within London movement). Domestic migration can be further divided into those moving between London and other UK regions (i.e. inter-regional flow) and those moving between London boroughs (i.e. intra-London flow or inter-borough flow). The relationship between each type of mobility and main sources of data are presented in Figure 1.

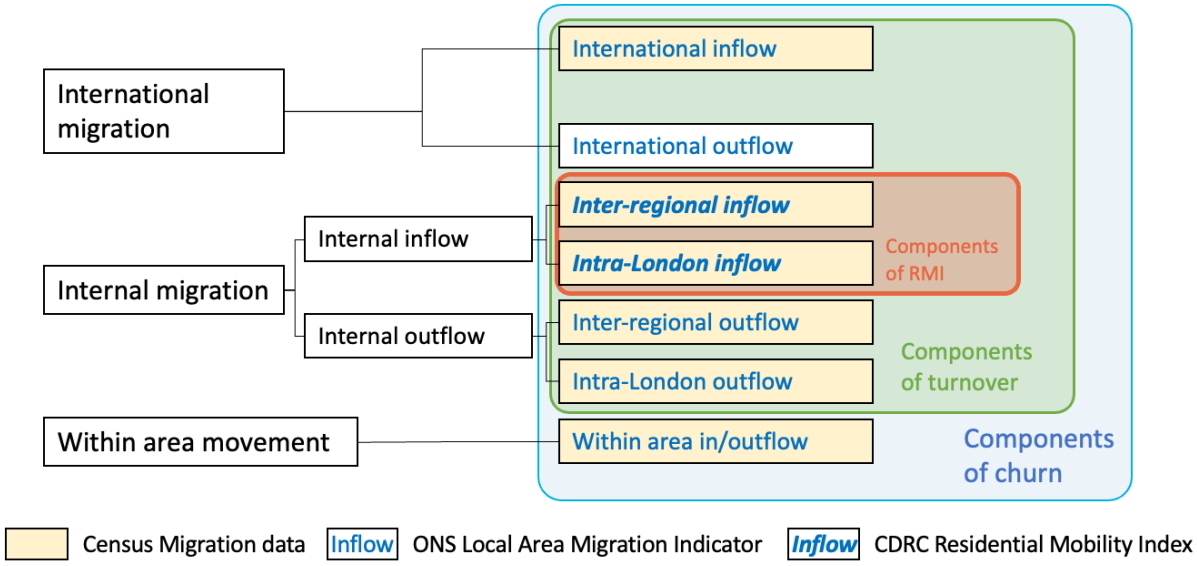


Figure 1 Types of mobility and components of churn

In this report, we define key measures of population movement as:

- *Population turnover,* which is the sum of long-term international inflow, long-term international outflow[4], internal[5] inflow and internal outflow, relative to population size (the green box in Figure 1). This is the way Camden Council used to calculate churn: 'the sum of in- and out-migration divided by the total population. Churn is 28 per cent in the year to mid-2019 but includes university student moves to and from Camden' (Camden Council 2021)[6].
- *Population churn*, which is the sum of population turnover and movement within the area, relative to population size. Notably, (the blue box in Figure 1). This is different from the way Camden Council used to define and calculate churn.

[4] Census migration data do not provide information on international outflow.

[5] According to the ONS, internal migration refers to 'residential moves between local authorities and regions in England and Wales, as well as moves to or from the rest of the UK (Northern Ireland and Scotland)'. See https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/migrationwithintheuk/methodologies/internalmigrationestimatesqmi

[6] https://opendata.camden.gov.uk/download/9m7e-5qyt/application/pdf

- *Residential mobility*, which is the sum of inter-regional and intra-London inflows, relative to relative to population size (the amber box in Figure 1). We will discuss this measure in detail in section three.

Churning population: Evidence from the Censuses

In this section, we present existing empirical evidence on London's churning population, focusing on migration into, away from and within London over the past three decades (1981-2011). Drawing on publicly available population statistics, primarily Census migration data, we calculate churn rates and discuss the main characteristics of churning population in London and Camden.

Longitudinal trends

Figure 2 presents the churn rate for each London borough at four time points, 1981, 1991, 2001 and 2011, respectively. The boroughs were ranked from the most mobile one with the highest churn rate in 2011 (i.e. Westminster and City of London[7]) to the most stable one with the lowest churn rate (i.e. Bexley).

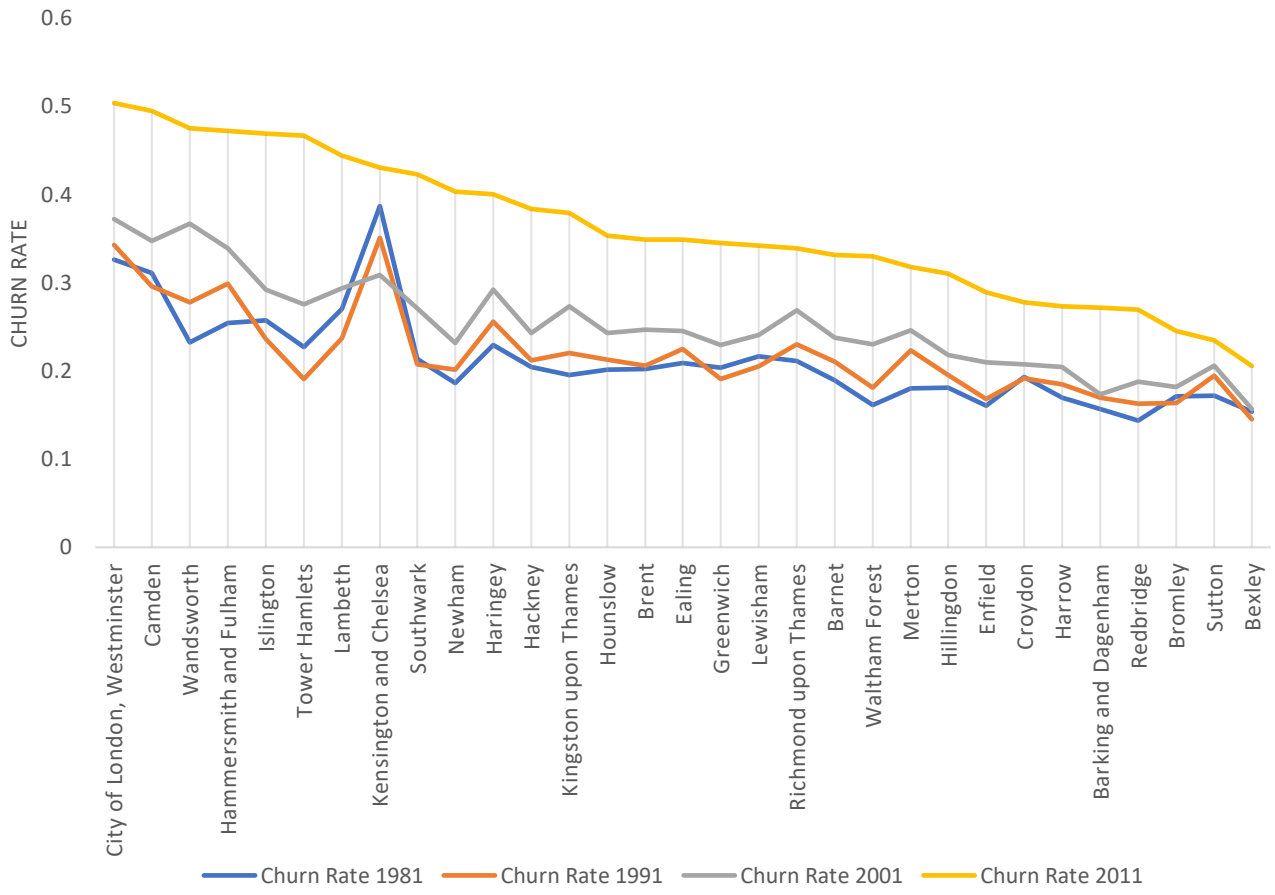


Figure 2 Churn rates by borough

Source: 1981, 1991, 2001 and 2011 Census.

[7] In residential terms the City of London is markedly different from other 32 boroughs. For the purpose of this analysis, data for the City of London is combined and presented together with Westminster.

Compared across the four Censuses, we observed a slight increase in churn rate in 2000/2001, when the average churn rate increased from 21.61 per cent to 24.95 per cent. In 2010/2011, greater patterns of flux and transience were experienced across London boroughs than a decade earlier. This led to a massive increase in average churn rates, which rose from less than 25 per cent to more than 35 per cent, meaning that more than one-third of the London population was on the move.

The increase in churn rate was also consolidated based on the rate of change, as presented in Figure 3. All grey bars lie on the right-hand side of the y-axis, suggesting that all London boroughs have experienced positive changes in churn rate during 2001-2011. Most amber bars lie on the right-hand side of the y-axis, indicating that most boroughs have become more residentially mobile during the 1990s. The only exception was Kensington and Chelsea, which reported negative changes in churn rates. When it came to the 1980s, negative changes in churn rates have been reported by more than one-third of boroughs, including Tower Hamlets, Kensington and Chelsea, Lambeth, Islington, Camden, Greenwich, Lewisham, Bexley, Bromley, Southwark, Croydon and Havering.

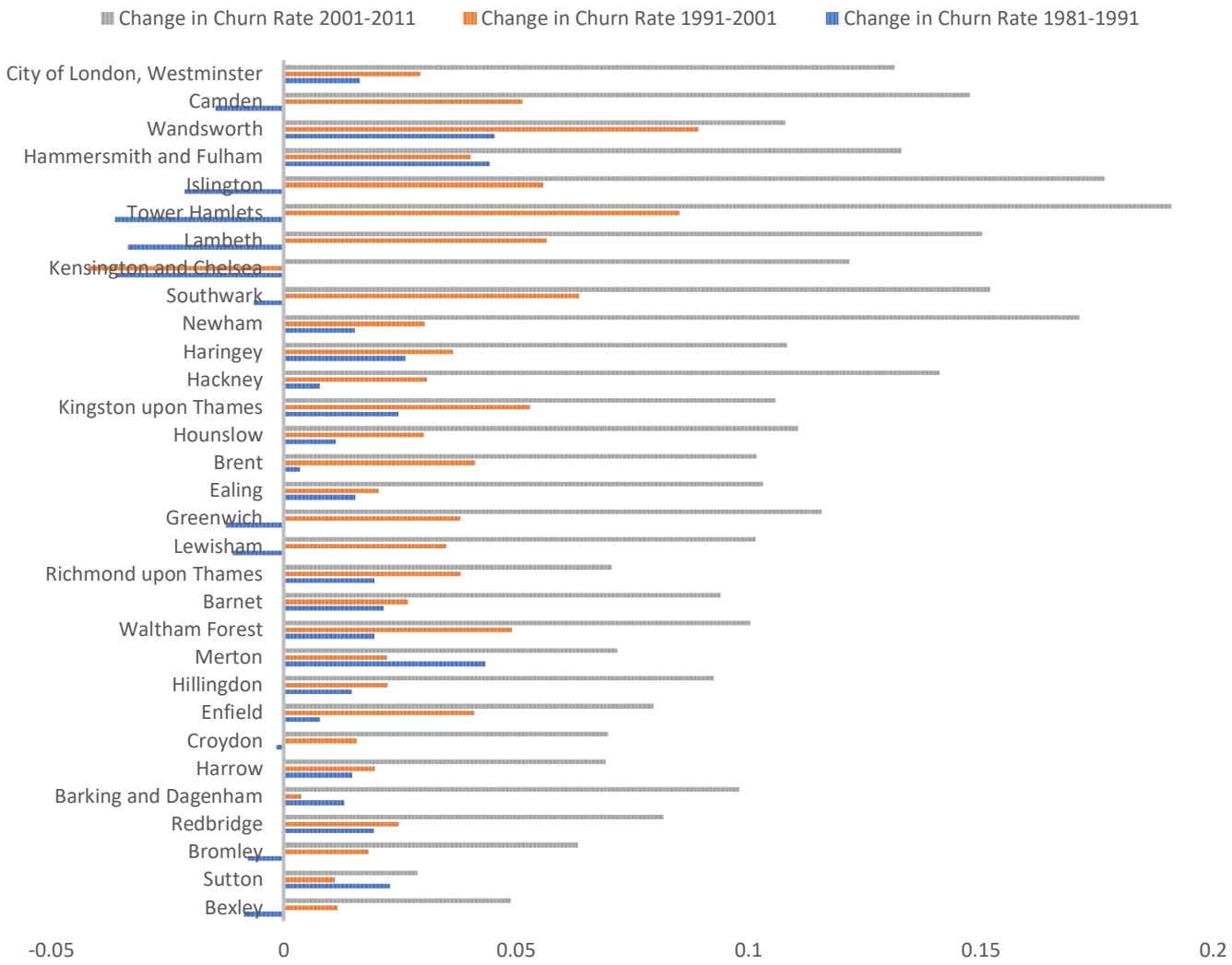


Figure 3 Change in churn rates by borough

Source: 1981, 1991, 2001 and 2011 Census.

We map out the distribution of population churn across space to explore the geographies of London's churning population. As shown in Figure 4, central London has remained to see a relatively large proportion of people moving in and out over the past three decades, such as Kensington and Chelsea, Westminster and Camden. Other Inner London boroughs caught up in the 2000s, such as Wandsworth, Hammersmith and Fulham, and Tower Hamlets. Outer London boroughs, especially those in East London, have remained relatively residentially stable over the past three decades.

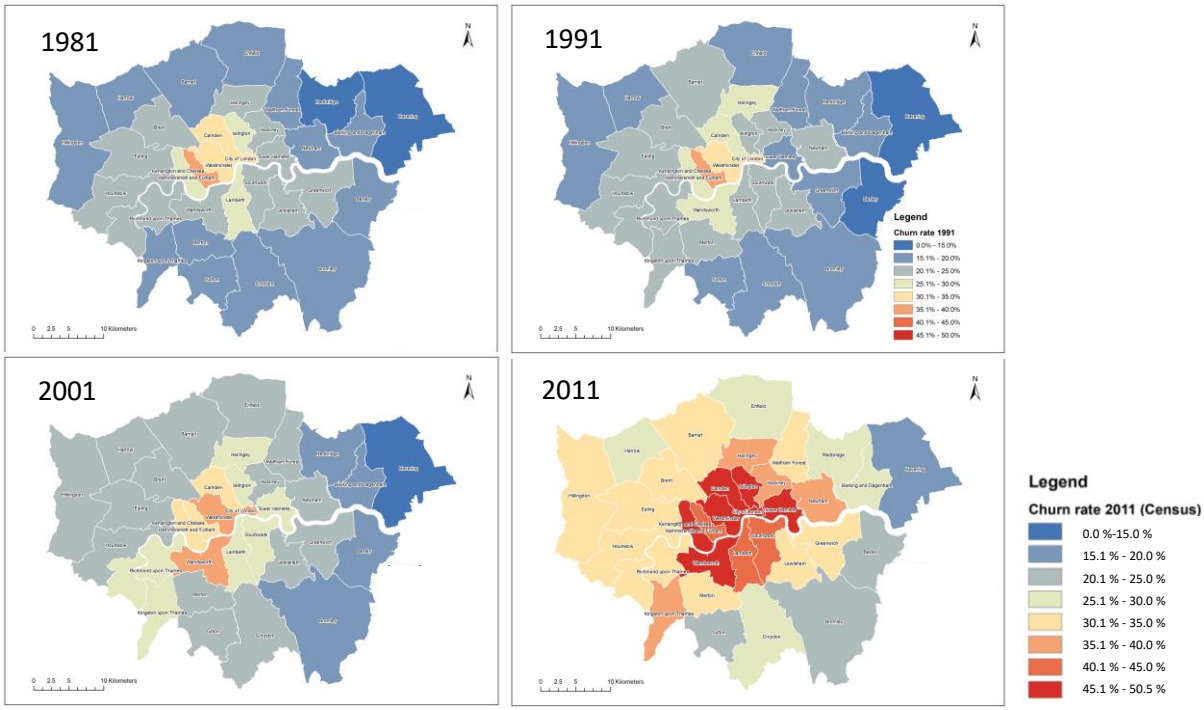


Figure 4 Distribution of churn rates by borough

Source: 1981, 1991, 2001 and 2011 Census.

Another interesting observation is that Westminster replaced Kensington and Chelsea and has become the borough with the highest churn rate in 2011. As much as 50.37 per cent of its usual population changed their addresses in 2010/11 – an incredibly high figure.

We also map out how changes in churn rates are distributed across London boroughs. The increase in population churn – as discussed earlier, was more apparent for inner London boroughs, such as Tower Hamlets, Islington, Wandsworth, Camden and Westminster. In addition, Figure 5 clearly shows that the rate of change has increased significantly during the 2000s. Compared to the first two inter-censual periods, the third inter-censual period witnessed a general increase in the rate of change (figure on the right with larger areas coloured in amber and red). Tower Hamlets replaced Wandsworth and became the borough with the largest net increase in churn rate; its change rate has more than doubled and reached 19.10 per cent during the 2000s.

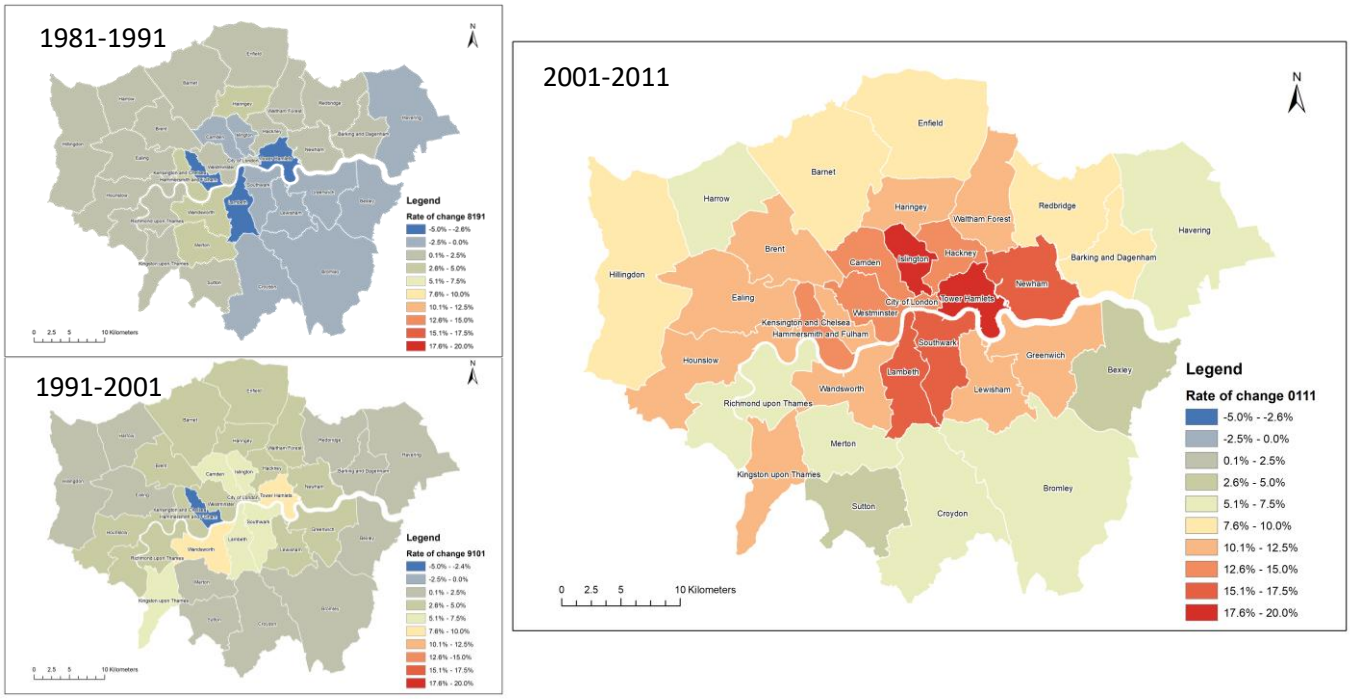


Figure 5 Distribution of change in churn rates by borough

Source: 1981, 1991, 2001 and 2011 Census.

Camden has experienced rapid population changes since the 1990s. The share of churning population rose from 29.61 per cent in 1991 to 34.75 percent in 2001, and finally to 49.51 per cent in 2011. This makes Camden the second most mobile borough in London in 2011 – second only to Westminster and City of London.

The only publicly available migration data on sub-borough levels are from the 2011 Census. On the Output Area (OA) level, 2011 Census migration data show that relatively high levels of population turnover were mostly seen in South Camden, such as areas in King's Cross, Bloomsbury, and Regent's Park (Figure 6), and their turnover rates could reach as high as 200%. A sizeable proportion of movement is the annual transfer of students to/from Camden, both international and within the UK. Contrastingly, residents living in northeast Camden, especially those from Highgate and Hampstead Town, reported relatively high levels of residential stability.

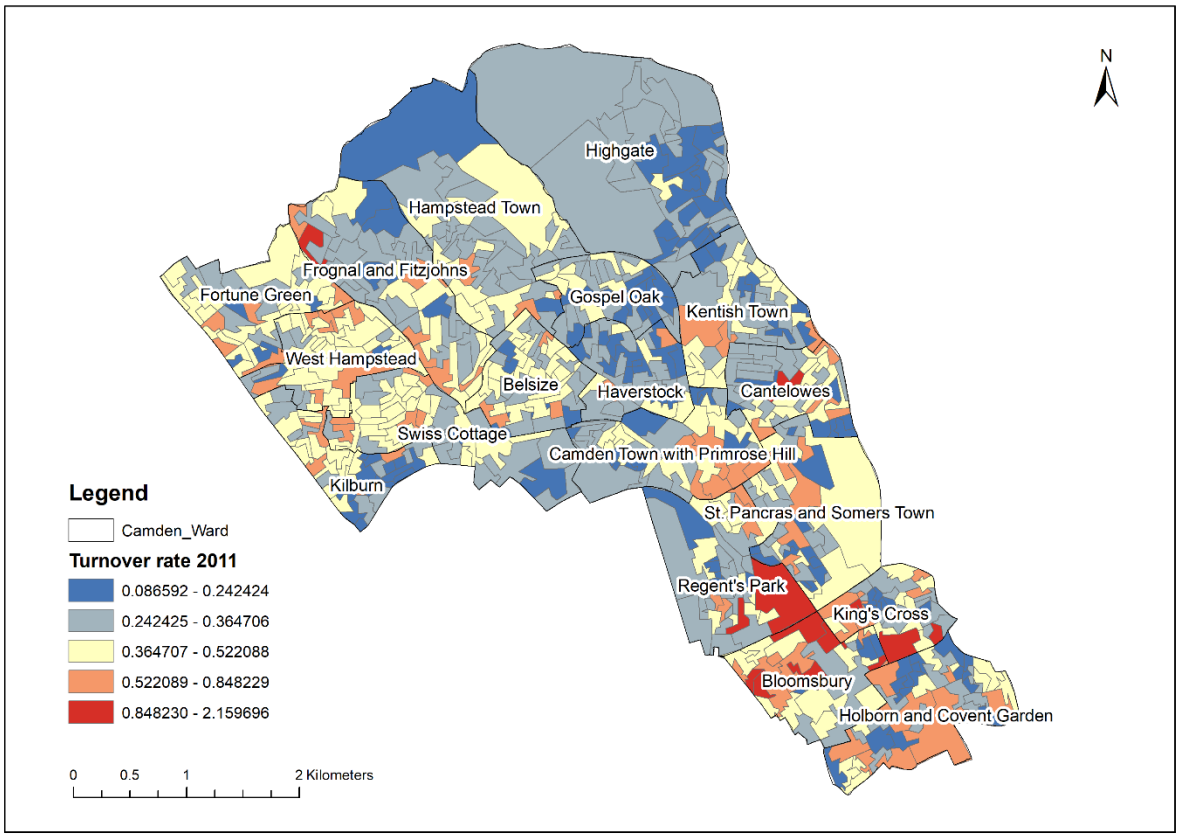


Figure 6 Camden population turnover (OA, 2011)

Source: 2011 Census.

Characteristics of churning population

Churning population brings magnificent demographic, social and economic changes to London. In this section, we examine some of the main characteristics of churning populations and the changes they bring to local areas.

The first characteristic is the origins and destinations of population flows. We do not consider international immigrants in the O-D figures since the UK Census does not collect information on international outflows. Figure 7 presents inter-regional flows between London and the other UK regions. Since more than two-thirds of moves in the UK were of less than 10 kilometres (Hollis, 2010), it is not surprising to see that people tend to move to neighbouring areas just outside their region and many inter-regional movements away from London had destinations in the adjacent regions, such as South East, and East. According to the 2011 Census, the greater South East attracted more than 90,000 people from London, followed by the East (55,000) and South West (20,000). The three regions were also the most popular places or origins within the UK for those moving in to the capital (South East 63,000, East 35,500, and South West 20,000).

Figure 7 Inter-regional flows between London and other UK regions

Source: 2011 Census.

Similar to inter-regional flows, the largest intra-London movements are found between adjacent boroughs (Figure 8). This is especially the case for Inner London boroughs in South London, such as between Wandsworth and Lambeth and between Lambeth and Southwark. Another interesting observation is that inner London boroughs gained more population than they lost from intra-London flows. This is indicated by the thickness of arrows pointing to these boroughs, compared to those pointing against these boroughs.

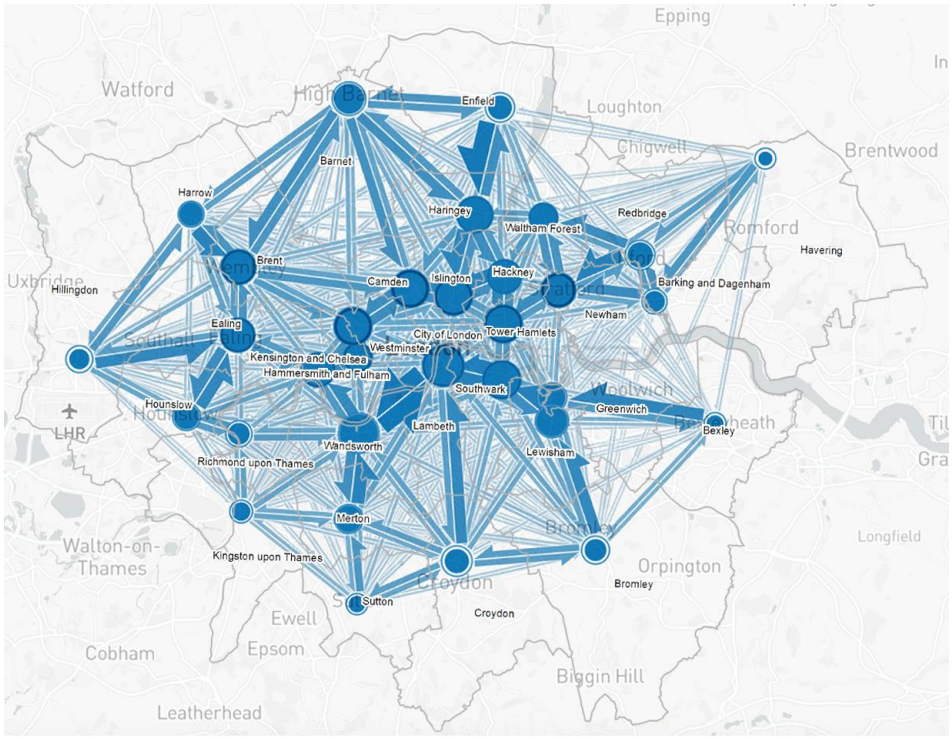


Figure 8 Intra-regional flows between London boroughs

Source: 2001 Census.

The scales of migration should also be taken into consideration since different types of flows manifest differently across different boroughs. According to their origins and destinations, migration flows can be split between those from outside (international), from other UK authorities (inter-regional), between London boroughs (intra-London or inter-borough) and those moving with each borough (intra-borough). Of all types of flows (Figure 9), 2011 Census suggests that inter-borough flow account for the largest proportion for all London boroughs. Inner London boroughs are more likely to see larger shares of long-distance moves (i.e. international and inter-regional), as well as inter-borough migration. Outer London boroughs generally report higher rates of intra-borough flows but remain relatively stable with regards to long-distance moves – the only exception is Kingston upon Thames which has the largest share of inter-regional flows among all London boroughs.

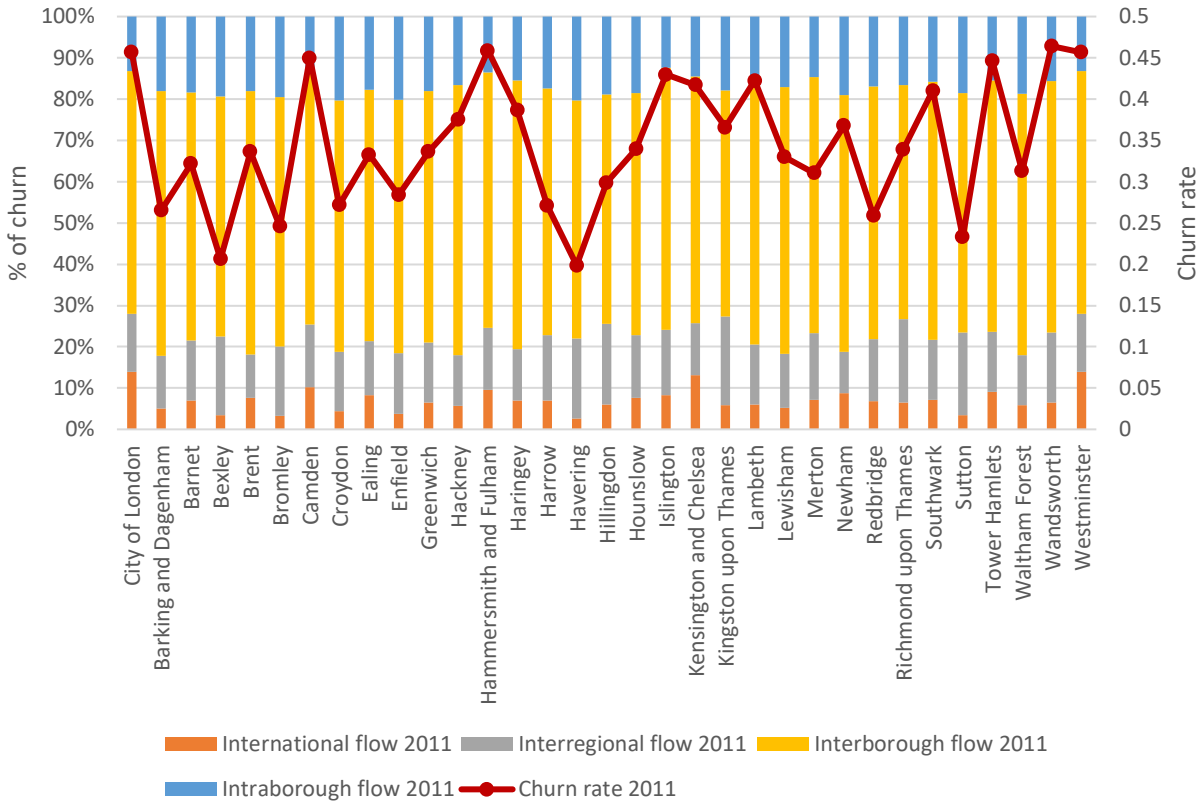


Figure 9 Rates of population churn and types of flows of London boroughs (2011)

Source: 2011 Census.

The dominant flows for Camden are to/from other London boroughs, accounting for more than three-fifths of its churning population (60.89%). The Census migration data also indicate that within-London flows account for 39% of the total inflows to Camden and nearly half of the outflows from Camden to other London boroughs. Among all residents moving from Camden to other parts of the capital in 2011, more than half (54%) moved to neighbouring boroughs, and more than 40% moved to outer London boroughs. Islington (28%) was the most popular destination for Camden out-movers, followed by the City of London, Westminster (22%) and Barnet (19%) (Table 1 and Figure 10).

Figure 10 Inter-regional flows between London and the other UK regions (2011)

Source: 2011 Census.

Table 1 Within-London moves from and to Camden (2011)

	Within London	From/to neighbouring boroughs	From/to outer London boroughs
In-movers (count)	14457	7436	5217
%	-	39.52%	36.09%
Out-movers (count)	18816	7663	10215
%	-	54.29%	40.73%

Source: 2011 Census.

Another characteristic worth attention to is ethnicity. Figure 11 compares the ethnic compositions of Londoners, according to the 2001 and 2011 Censuses. The figure shows the number of white Londoners fell in the intercensal period, with its proportion dropping from 71.15 per cent in 2001 to 59.79 per cent in 2011. As a result, the proportion of ethnic minority residents in London rose from 28.85 per cent to 40.21 per cent.

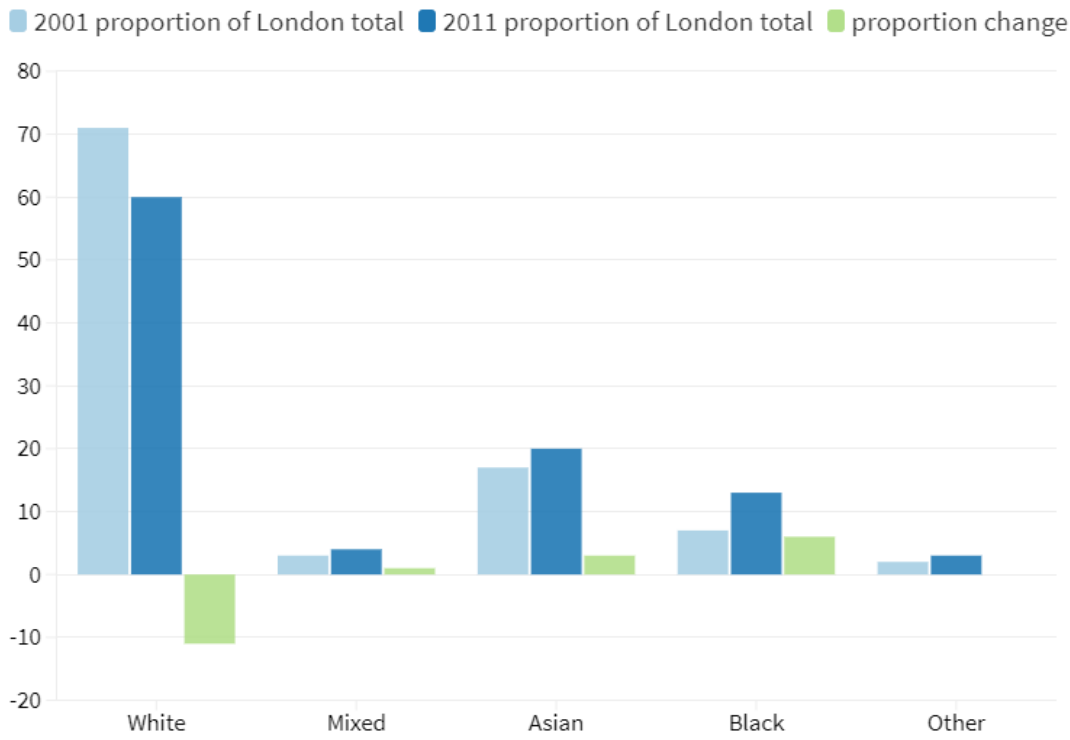


Figure 11 Broad ethnic group proportions in London, 2001 and 2011

Source: 2001 and 2011 Census.

To be more specific, the change in the White population was composed of a dramatical decrease of White British (14.90 per cent), and a huge increase in the 'Other White' group, which contains many of the eastern European migrants who have settled in London over the last decade (increased by 402,800 people, a 49.40 per cent rise). Even so, the White British remained the largest single group in 2011. All ethnic minority groups, except the Chinese (decreased by 0.34 per cent, not shown in the figure), saw increases in their proportions (Figure 12).

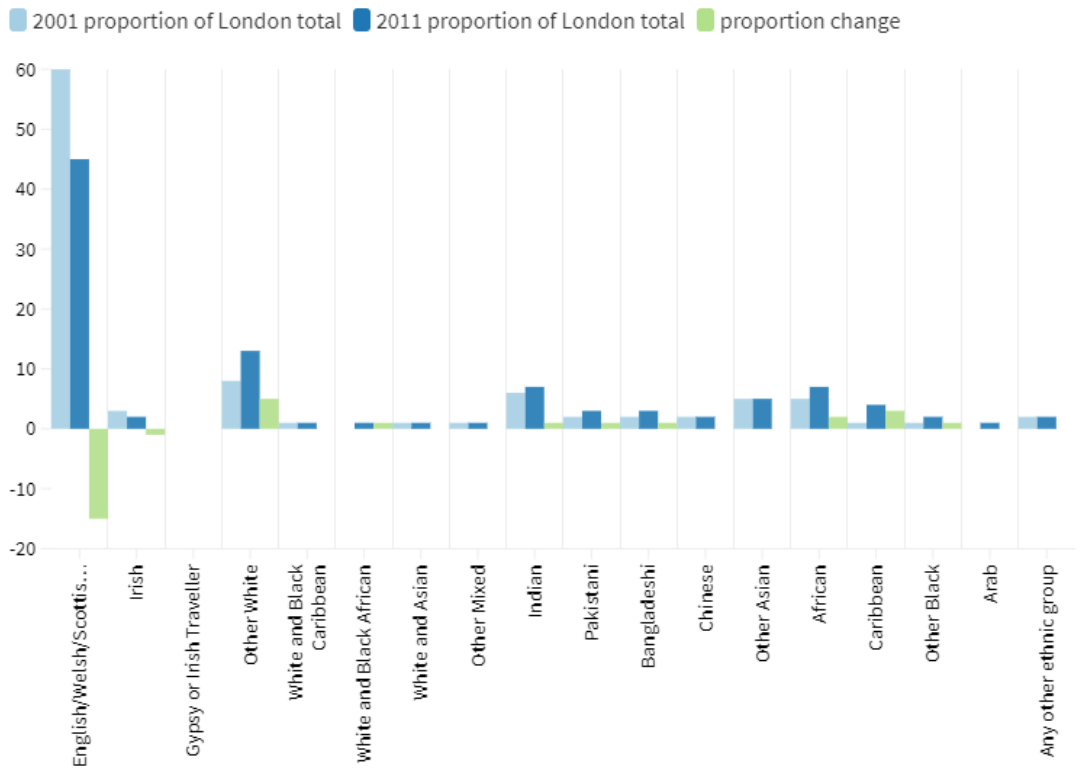


Figure 12 Ethnic group proportions in London, 2001 and 2011

Source: 2001 and 2011 Census.

Figure 13 visualises the distribution of the non-White population in London according to the 2001 and 2011 Census, respectively. The figures reveal several 'hotspots' in London where there are relatively higher concentrations of non-White residents: Newham, Redbridge, Brent and parts of Harrow, Ealing, Hounslow and Croydon.

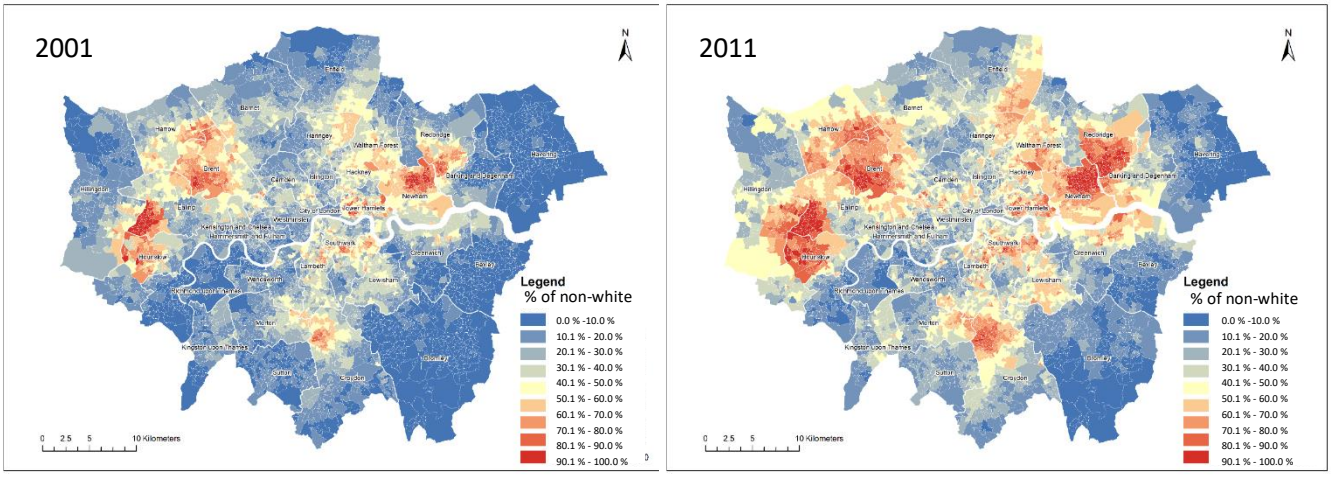


Figure 13 Distribution of other ethnic minority populations in London

Source: 2001 and 2011 Census.

We compare the two figures and present how the distribution of the non-White population has changed during the intercensal period (Figure 14). Higher changes are more likely to be found in outer London boroughs, such as Barking and Dagenham, Redbridge, Hillingdon and Enfield. Some of these boroughs did not see large numbers of international migrants in 2001 but have attracted considerable numbers of immigrants in the 2000s.

When comparing Figure 14 with Figure 5, it is interesting to see that areas with the greatest increase in churn (such as Tower Hamlets, Islington, Lambeth and Southwark) are not the areas with the greatest increase in ethnic minorities (such as Barking and Dagenham, Redbridge and Hillingdon).

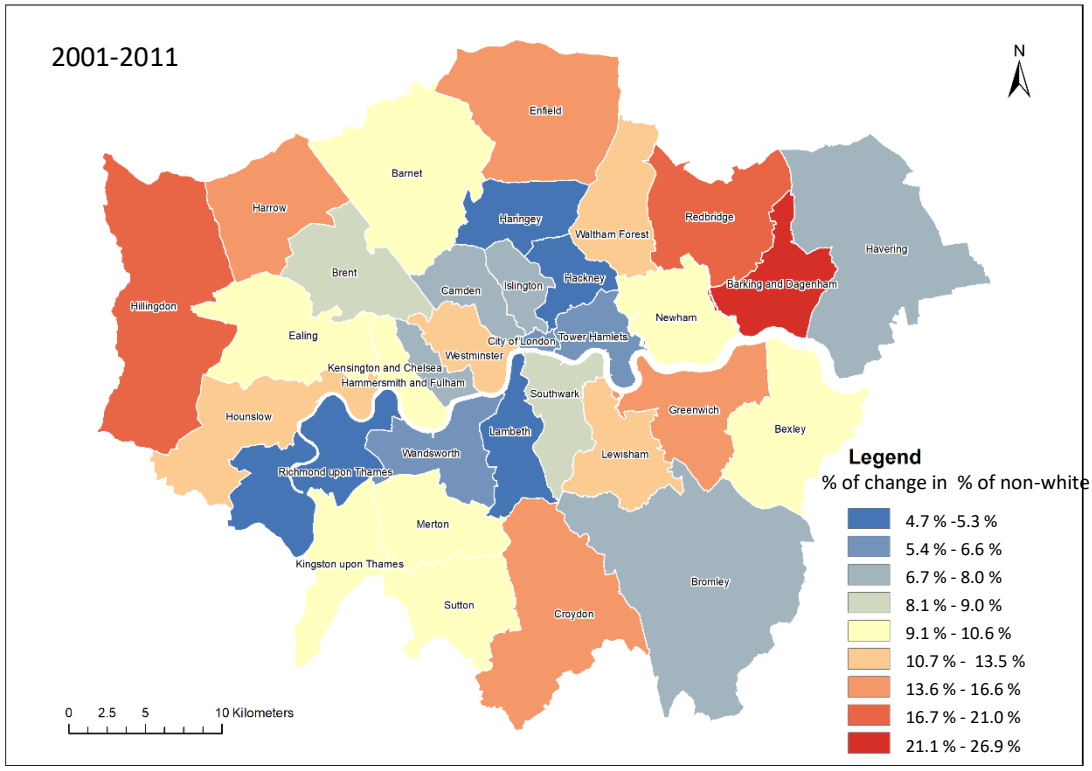


Figure 14 Change in the share of non-white population in London

Source: 2001 and 2011 Census.

Another characteristic of London's churning population is their country of birth. In the decade between the 2001 and 2011 Censuses, the UK-born population decreased by 53,500 people and as a result, the proportion of non-UK born residents in London rose from 27.14 per cent to 36.72 per cent.

Figure 15 shows where foreign-born populations were distributed in London in 2001 and 2011, respectively. In 2001, non-UK born residents were mostly concentrated in central London, particularly in Westminster, Kensington and Chelsea, and parts of Brent. In 2011, there was an increase in foreign-born citizens and an expansion of their places of residence.

They were no longer confined to inner-city areas and spread out to some outer London boroughs, such as Harrow and Hounslow in the North West, and Redbridge and Barking Dagenham in the North East.

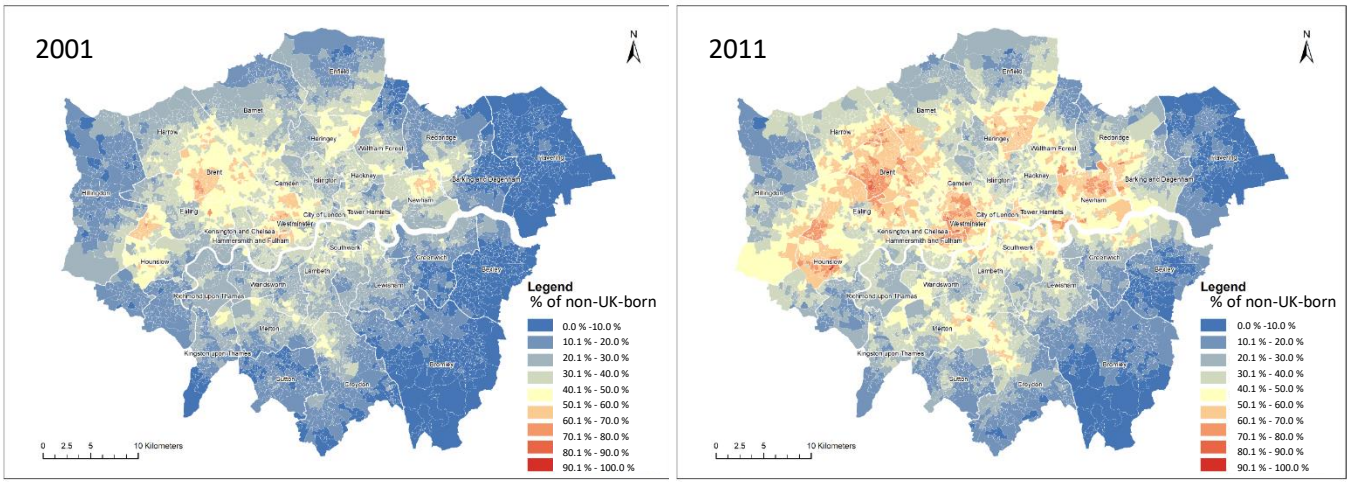


Figure 15 Distribution of the non-UK-born population in London

Source: 2001 and 2011 Census.

It is therefore not surprising to see those higher changes in the distribution of non-UK born residents were found in outer London boroughs, such as Barking and Dagenham, Newham, and Hounslow (Figure 16, top figure). Further analysis (Figure 16, bottom figure) shows that migrants from the EU countries did not account for most changes in these boroughs. This observation indicates that EU migrants did not account for most changes in the non-UK born population, at least in the popular destinations of international migrants. Instead, EU migrants accounted for most changes in Haringey and Hackney, and a large proportion of changes in Barnet, Brent, Ealing, Lambeth and Islington.

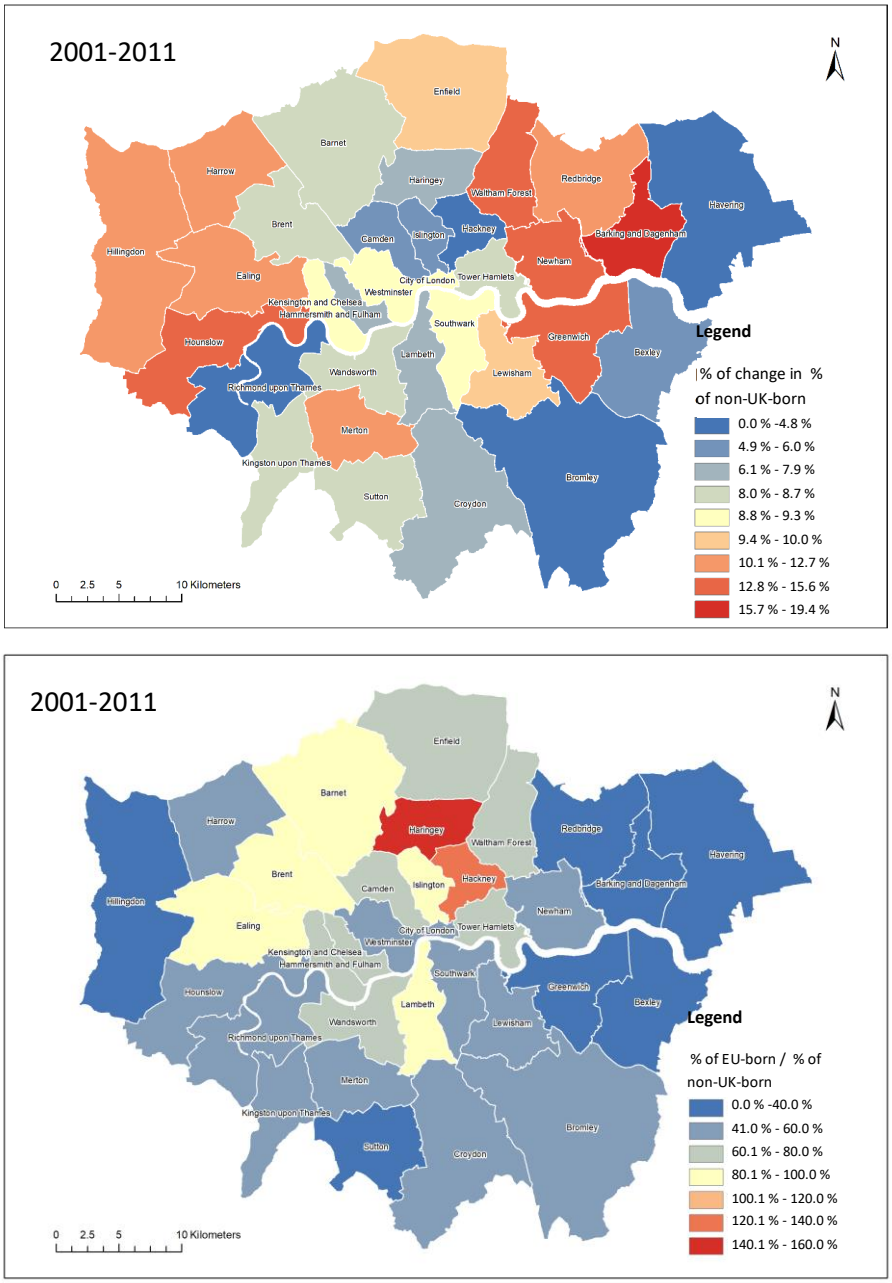


Figure 16 Change in the share of the non-UK-born population (top) and EU-born population (bottom) in London

Source: 2001 and 2011 Census.

Within Camden, the spatial distribution of non-White and non-UK born residents are similar. Figure 17 suggests that non-White and non-UK born migrants were concentrated mostly in the northwest part of the borough, such as Kilburn and Swiss Cottage

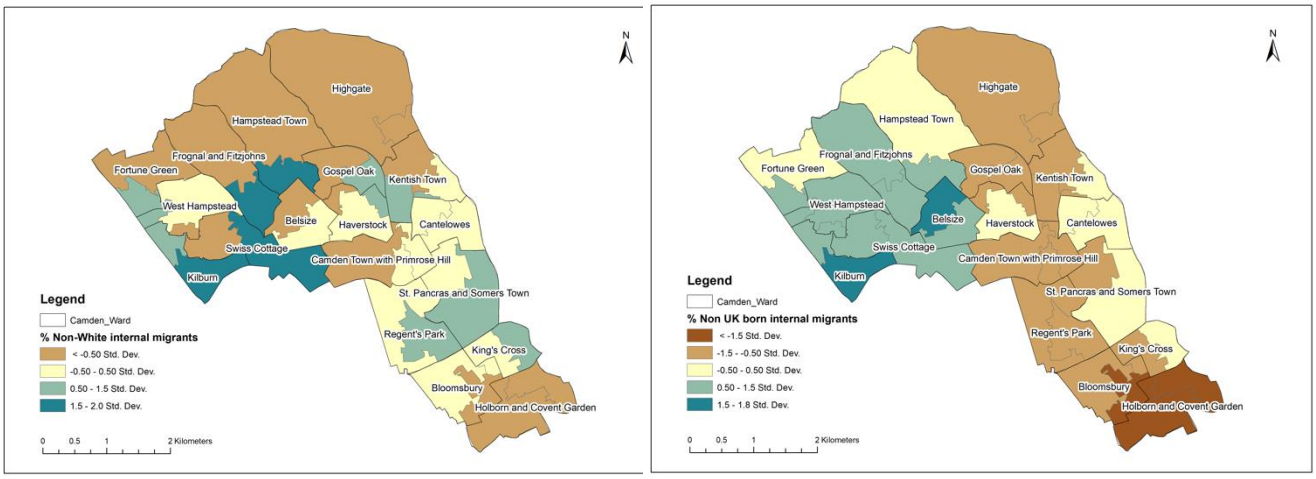


Figure 17 Proportion of non-white (left) and non-UK born (right) migrants to Camden wards (2011)

Source: 2011 Census.

Another effect of population movement is that migration flows have the effect of keeping London's population relatively young (Figure 18). This is because the highest inflows for both international and internal migration are found among those around 20 to 30 years old. For all other ages, net international migration has added to London's population while net internal migration has cut down London's population.

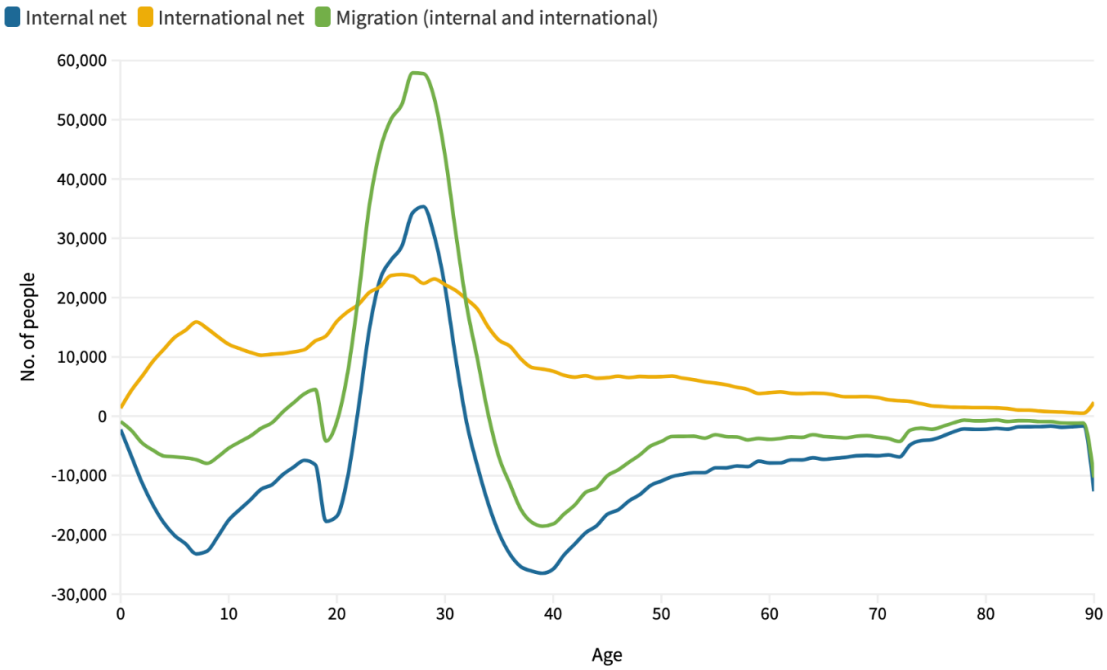


Figure 18 Churning population in London by age groups

Source: 2019 ONS population estimates.

Young migrants tend to concentrate in some parts of London. A detailed look at London boroughs (Figure 19) shows that, of all international migrants, higher proportions of juveniles and students are likely to gather in Outer London boroughs, such as Hillingdon, Kingston upon Thames and Newham.

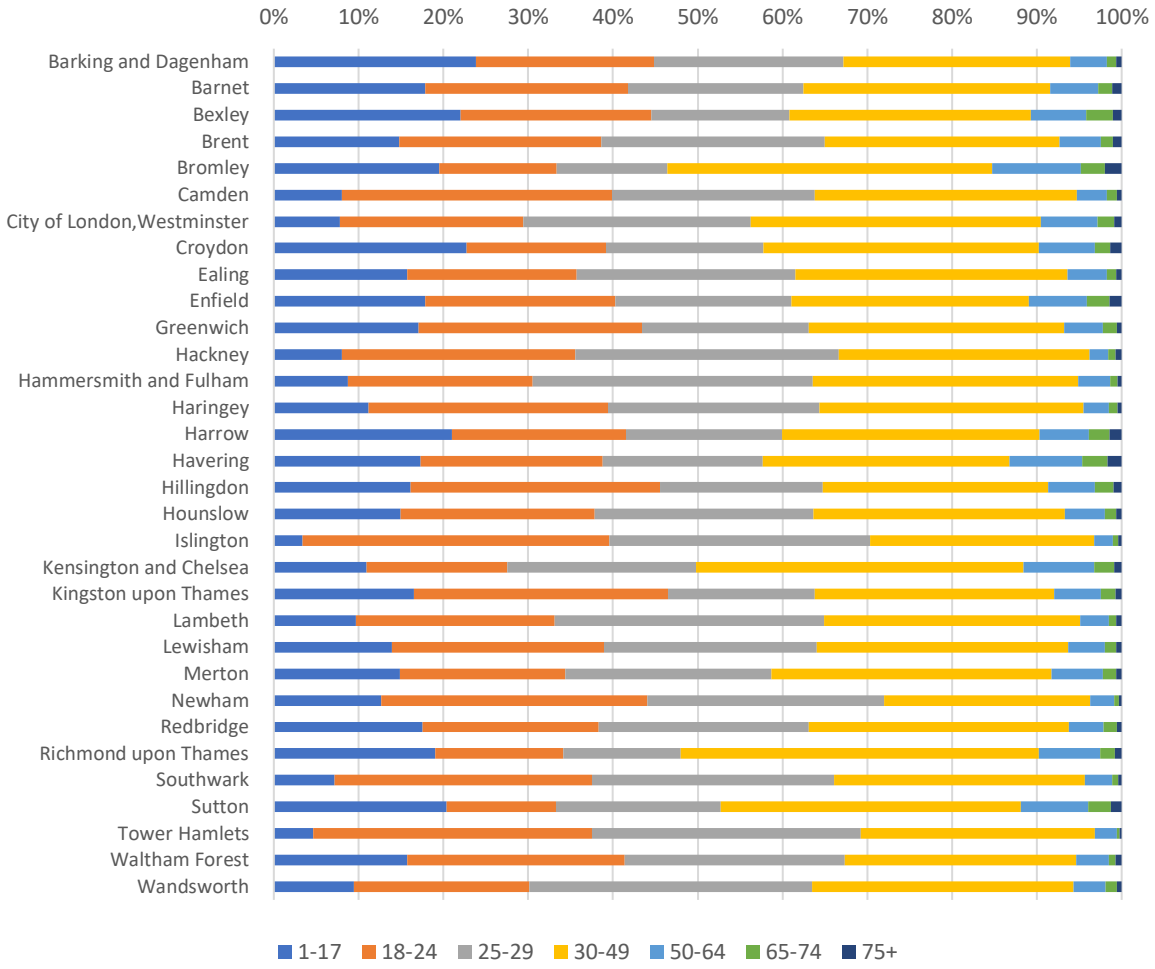


Figure 19 International inflow to London boroughs by age group

Source: 2011 Census.

Within Camden, the spatial concentration of young migrants is more obvious (Figure 20). Wards in South Camden, such as Bloomsbury, King's Cross and Regent's Park, had a high proportion of young migrants, especially those aged 18-24. This is in tandem with their high levels of population turnover composed mostly of student flows. Wards in North Camden, such as West Hampstead, Swiss Cottage, Belsize, and Kilburn, had a high proportion of working-aged migrants (e.g. aged 25-64).

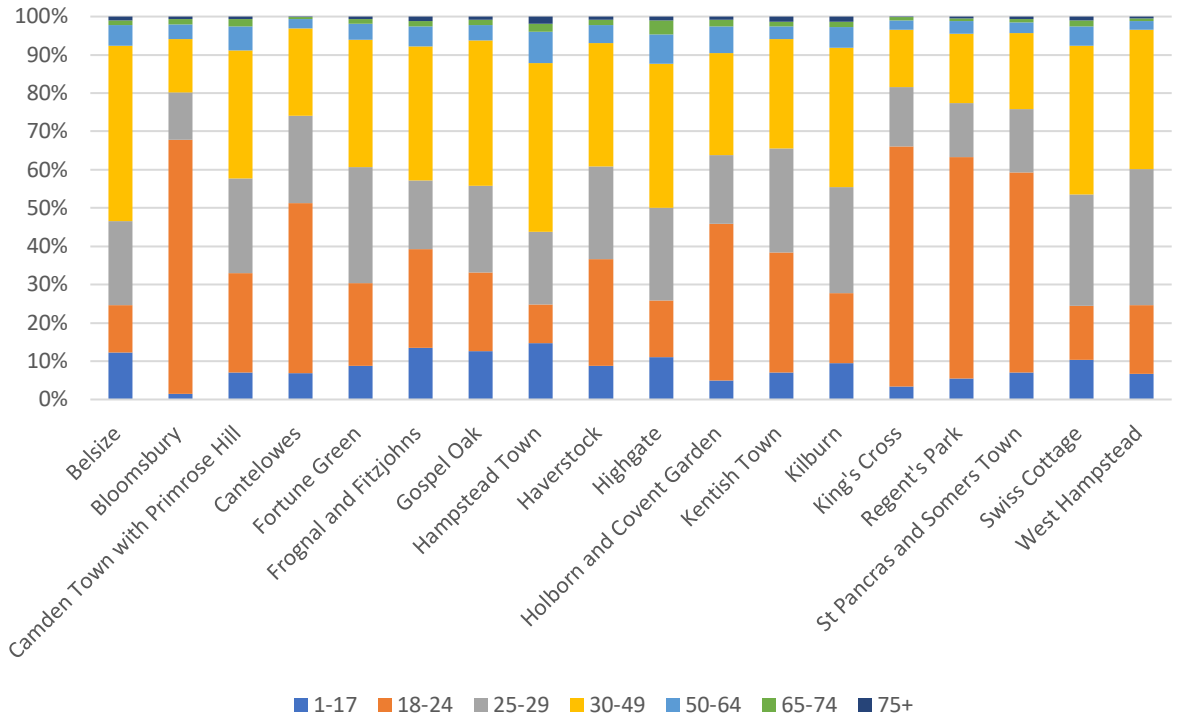


Figure 20 All migration inflow to Camden wards by age group (2011)

Source: 2011 Census.

We also looked at the length of time in the UK for international migrants and this data are only available at the London scale. Figure 21 presents the areas in London that had relatively higher levels of 'newcomers' (who we define as those who spent less than 2 years in the UK) in 2011. The figure shows that while newcomers were scattered across the city, some outer London boroughs host few or almost none of them (such as Havering, Bexley, Bromley and Sutton). These boroughs are also areas with relatively lower levels of population churn.

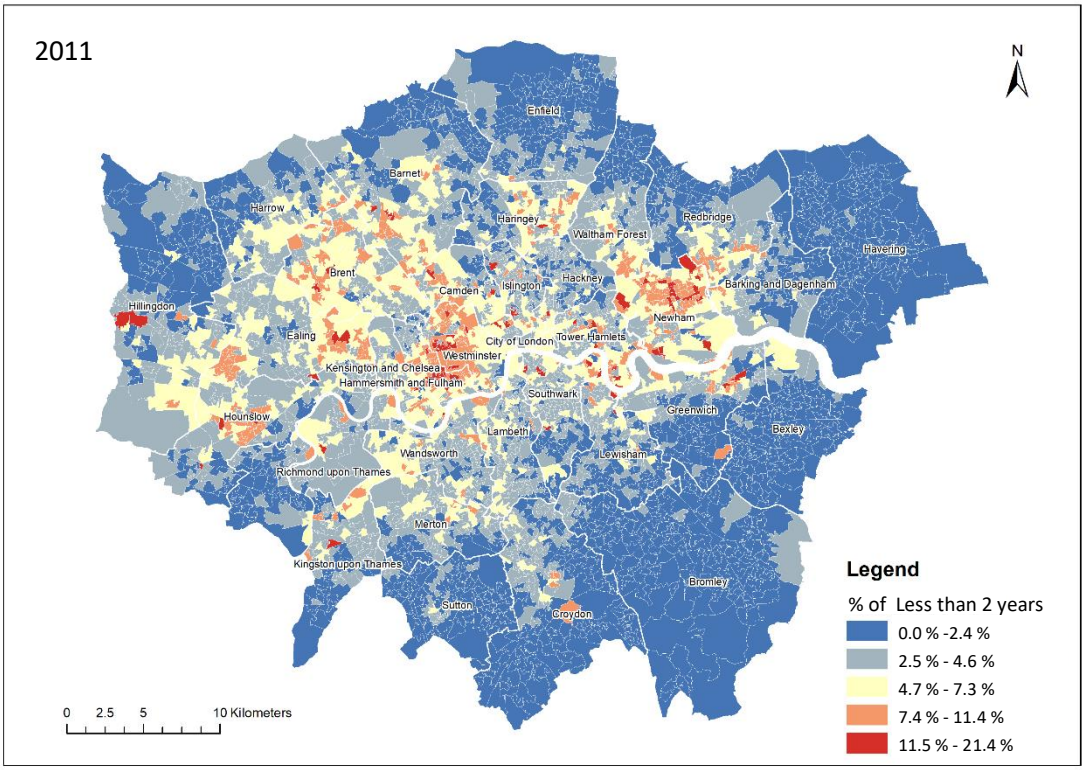


Figure 21 Distribution of new-comers (less than 2 years in the UK) in London

Source: 2011 Census.

The analysis above demonstrates that Census migration data provide snapshots of residential moves. They help analyse long term trends of and differences in population churn and turnover between areas at a point in time and are very accurate at the local level. Our analysis reveals many interesting patterns of churn and population movement in London. Among these patterns, there are two most striking ones. First, we discovered accelerated rates of change and churn across London. The 2011 Census reports significantly higher rates of churn compared to the 1981-2001 Censuses, both for London as a whole and for the London borough of Camden. Second, the Census-based analysis shows emerging new geographies of London. An increase in population churn has been observed in all London boroughs, but disproportionately higher levels of increase in churn have been experienced by most inner London boroughs. The rates of increase are greatest in newer areas of migration (e.g. Tower Hamlets, Islington, Lambeth and Southwark in inner London, Figure 5), rather than traditional destinations for international migrants (e.g. Barking and Dagenham, Redbridge and Hillingdon, Figure 14).

However, Census migration data are insufficient to understand the process of population change since they are only collected once every ten years (i.e. low temporal granularity). They are thus not able to reflect continuity or discontinuity of residence and do not give up-

to-date information on population change. They cannot be relied upon to provide information on rapidly changing areas and/or population groups. This is especially the case when migration patterns had the greatest proportional changes since the 2011 Census. The 2011 Census does not consider groups that have arrived more recently, such as Romanians and Bulgarians, let alone the effects of Brexit and the pandemic.

Other publicly available population statistics, such as population estimates and administrative data, are also insufficient due to their low spatial granularities. They either have less detailed local-level estimates or poor-quality estimates that come with substantial margins of error. One consequence of this is that a large proportion of short-distance moves are under-documented (esp. those not moving across local authority boundaries), even though these moves are the most common drivers/components of population churn[8].

Residential Mobility Index: New insights on residential Churn

The Census and most publicly available statistical sources suffer from low temporal or spatial granularities and are insufficient to understand the process of population change and migration on the ground (Lomax and Stillwell 2017). To address these gaps, new forms of data showing digital footprints of business or service delivery are repurposed to provide new insights into the rapidly changing population (Lansley et al. 2019). Here, we employ a new measure of population mobility: the Residential Mobility Index (RMI), which derives from a 'Linked Consumer Registers' dataset and captures population activities at a high spatial and temporal granularity (van Dijk and Longley 2021).

RMI and Linked Consumer Registers

Released by the Consumer Data Research Centre (CDRC), the RMI provides a household estimate of residential mobility in London, covering the period from 1997 to 2020[9]. It describes the population at large with 'big data' arising through transactions between consumers and service/good providers and administrative data from public UK electoral registers. To be more specific, datasets underlying the RMI include (CDRC, 2021)[10]:

[8] According to Dataloft Rental Market Analytics, 27 per cent of renters in the UK move less than 1 mile, and 14 per cent move within 1-2 miles. See the following link for details: https://www.dataloft.co.uk/dataloft-rental-market-analytics.

[9] Source: https://data.cdrc.ac.uk/dataset/cdrc-residential-mobility-index. The data for this research have been provided by the Consumer Data Research Centre, an ESRC Data Investment, under project ID CDRC [Project Number], ES/L011840/1; ES/L011891/1.

[10] For details on the process of how these data sources are linked, please see Lansley, Li and Longley (2019) and van Dijk, Lansley and Longley (2021).

- Public versions of electoral registers, covering the UK's adult population or nationals of an EU or Commonwealth country consent to inclusion on the Electoral Roll (both parliamentary and local government elections).
- Consumer registers[11], covering populations assenting to inclusion on the contact lists of services or goods. These include many of those who 'opt out' of the public version of electoral registers and are not eligible to vote.
- Land registry house sale data, to identify residential moves in the owner-occupied sector (for validation).

Drawing on the assemblages of the consumer and the electoral registers, the CDRC introduced the RMI as an indicator to estimate population turnover across space. The RMI is calculated based on estimating the first and last year of which a household[12] moved into and out of a property at a particular address. If not all household members joined an address in the same year, then the CDRC considers the earliest move-in date/year (Lansley et al. 2019). The estimates are further aggregated to the neighbourhood level (e.g., the LSOA level), where a yearly estimate of the proportion of households that are different to those in 2020 is calculated. This means that if 100 households were recorded in a given area in 2020, of which 90 were also there in 2016, and 85 in 2015, that area would get an RMI value of 0.10 for the year 2016, and 0.15 for the year 2015. A larger RMI denotes a higher level of residential mobility or neighbourhood turnover, or a lower level of residential stability.

RMI and Census migration data: understanding the differences

Since consumer datasets underlying the RMI are neither of known provenance nor with full population coverage, it is necessary to anchor the data to conventional data sources. Here we validate RMI with the 2011 Census, which is the only reliable source of information on local migration in the UK. Notably, the RMI is a ratio drawing on the quantitative relationship between the number of households in the base year (2020) and the number of households that remained in that area in any preceding target year. It reflects cumulative 'household difference' between the two years: the RMI of a target year takes into account all in-migration flows that happened from the target year to 2020. To make the RMI more comparable to Census migration data that measure changes in place of residence for one year, we calculated the annual RMI by subtracting the RMI of one year from the RMI of the

[11] The consumer data were originally supplied by CACI and DataTalk from 2002. Following the introduction of new GDPR regulations in 2018, they were no longer included in the RMI dataset.

[12] A 'household' is defined as a unit consisting of all residential who were estimated to be present in the same address in 2020. As such, the RMI is limited to capture residential mobility in houses in multiple occupation.

subsequent year. The new ratio generated reflects annual neighbourhood turnover in comparison to 2020.

Figure 1 (p.4) shows the comparison between components of Census-based churn rate and annual RMI. The figure suggests that the annual RMI is a limited version of the 'in-migration' component of 'churn'. The limitation could be understood in the following way: if a household moved into an area in 2018 and moved out in 2019, it would be counted as an 'in-migrating household' in the calculation of churn rate of 2018. However, this would not be included in the estimate of the annual RMI of 2018 because such a household moved out in 2019 and was longer in the study area in the baseline year of 2020.

The following figures compare annual RMI with multiple mobility rates derived from Census migration data, including churn rate, turnover rate and internal inflow rate. In general, statistical analysis demonstrates that a strong and positive correlation exists between annual RMI and internal inflow rate for the year 2011, with a correlation coefficient of 0.62 ($p<0.001$). The strong correlation suggests that, for most London boroughs, their relative levels of annual RMIs correspond to their relative levels of internal inflow.

Further analysis, as shown in Figure 22, indicates that, for most London boroughs, the absolute values of annual RMI are significantly lower than corresponding mobility rates calculated with 2011 Census data. This is not surprising given the limitations discussed above. The ratio between annual RMI and internal inflow rate is somewhere between 22.44 per cent to 50.4 per cent, with an average ratio of 35.73 per cent.

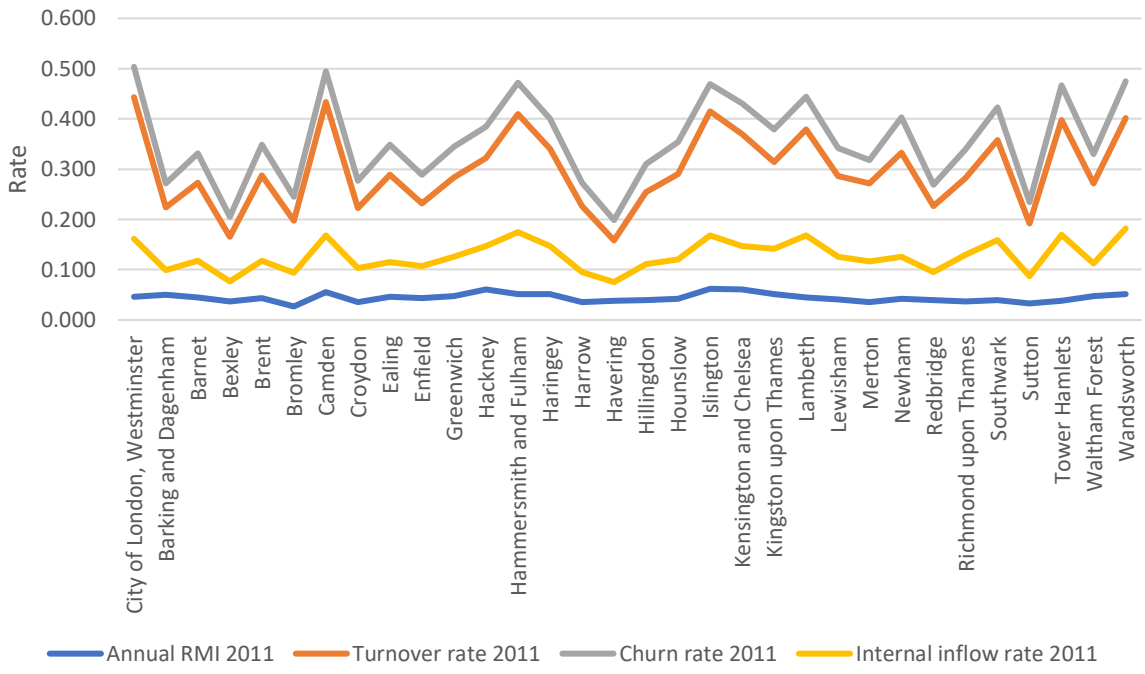


Figure 22 Comparison across annual RMI and multiple mobility rates, London boroughs, 2011 (values)

Source: CDRC Residential mobility Index (2020) and 2011 Census.

To account for the differences in measurement, we transformed the numerical values of mobility rates into rank orders, with the most residentially mobile borough ranking the highest. Figure 23 compares across multiple rankings. For most London boroughs, we found the relative levels of annual RMIs correspond to their relative levels of internal inflow. For a few boroughs, however, we observed significant differences (>10) between their annual RMI ranking and Census internal inflow rate ranking. Two boroughs – including Barking and Dagenham and Waltham Forrest, reported that their annual RMI rankings in 2011 were 'significant higher' than the corresponding Census internal inflow rate rankings. Four boroughs reported 'significantly lower' RMI rankings, including Lambeth, Richmond upon Thames, Tower Hamlets, and Southwark.

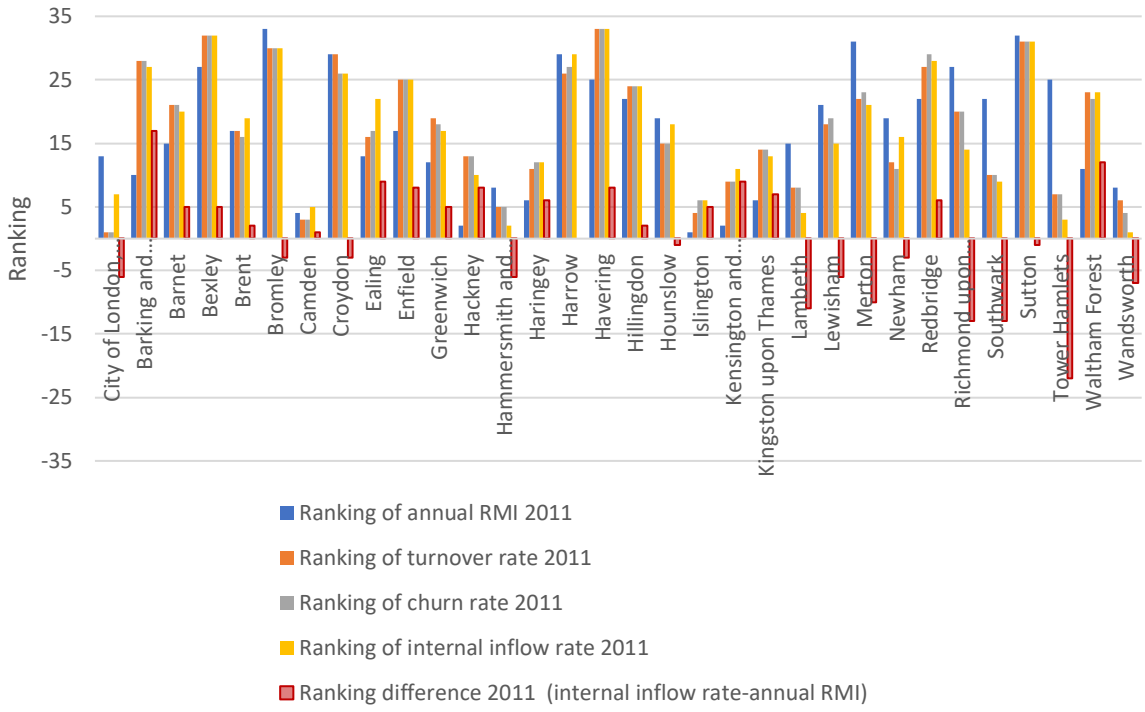


Figure 23 Comparison across rankings of annual RMI and multiple mobility rates, London boroughs, 2011

Source: CDRC Residential mobility Index (2020) and 2011 Census.

Further analysis in Figure 24 shows how differences in rankings are distributed across London boroughs. Compared to rankings of the 2011 Census migration rates, lower annual RMI rankings (i.e. negative differences, coloured in blue) were mostly reported by boroughs in Central and South London, such as Tower Hamlets, Newham, Lambeth, Southwark,

Wandsworth and Richmond upon Thames. These boroughs witnessed relatively high levels of internal flow, according to the 2011 Census (see the previous discussion on p. 8). Higher annual RMI rankings (i.e. positive differences, coloured in red or amber) were mostly reported by Outer London boroughs in East and North London, such as Barking and Dagenham, Waltham Forrest and Havering. These boroughs were marked as 'low churn' with Census migration data (see the previous discussion on p. 8). These patterns indicate that RMI estimates are closer to Census estimates – both in terms of absolute values and rank orders, in areas where relatively lower levels of mobility are reported. RMI estimates tend to be less accurate where there is a relatively high level of churn.

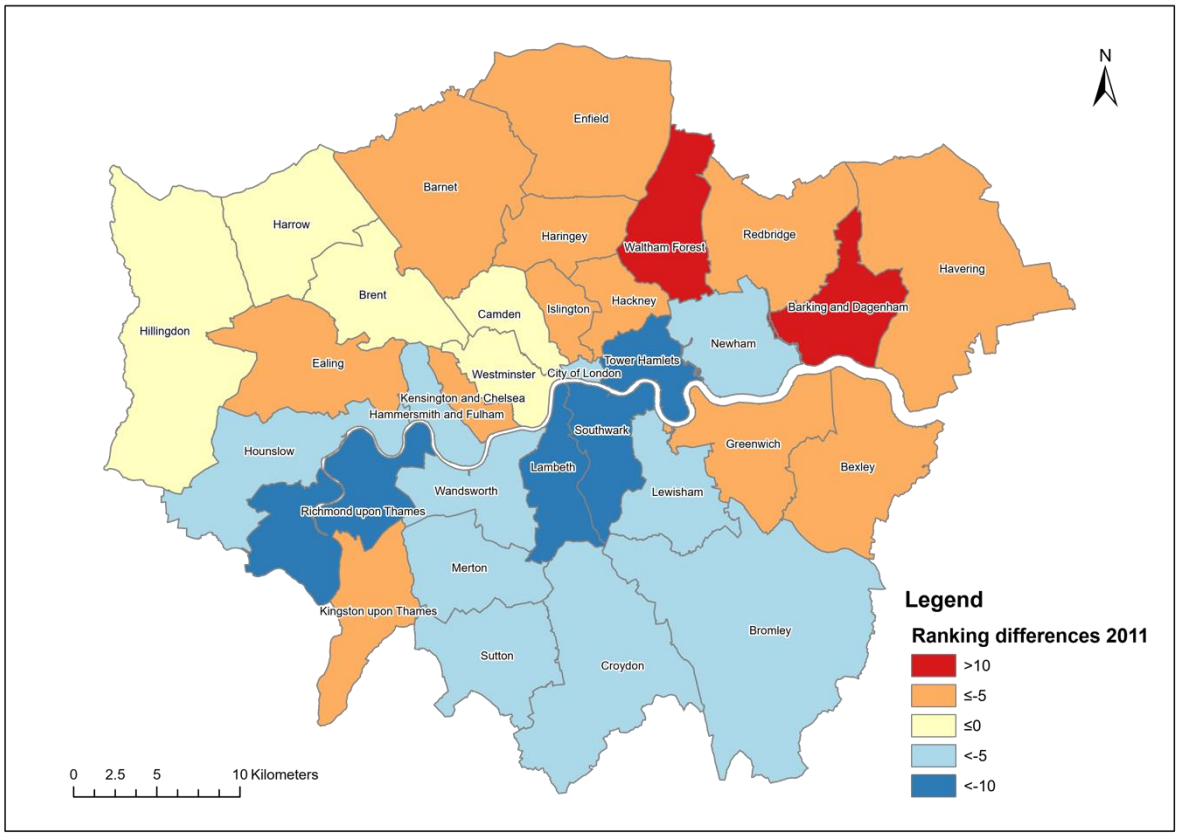


Figure 24 The distribution of ranking differences across London boroughs, 2011

Notes: Ranking difference= ranking of internal inflow rate – ranking of annual RMI. Source: CDRC Residential mobility Index (2020) and 2011 Census.

The differences between annual RMI and churn rates derived from Census migration data can be attributed to two main sources. Firstly, some of the major differences originate from the conceptual end, relating to how RMI is defined and estimated. As discussed earlier, the RMI measures change in the number of households and reflects neighbourhood turnover occurring between the two years. This focus makes the RMI distinctive from the Census that collects information on individual migratory behaviours. When estimating RMI, the CDCR uses a 'household' as the unit of analysis and aggregates migration/turnover patterns onto

the LSOA or district level. This is different from the Census that uses 'individual' as the unit of analysis. More importantly, the RMI estimate does not consider migratory behaviours not altering quantitative relations between the number of households in 2020 and preceding years, such as out-migration and within-area movement. This contributes to a significant proportion of the mismatch between the two data sources. Notably, the mismatch is cumulative: the longer the period between the target year and 2020, the larger the differences are likely to be between annual RMI estimates and Census estimates. This partly explains why we did not find a statistically significant relationship between annual RMI 2001 and 2001 Census migration rate ($r=0.04$, $p>0.05$).

The second source of difference relates to biases associated with the two registers underlying the RMI. Since neither electoral nor consumer data are collected for research purposes, both registers lack strict quality controls and scientific sampling frameworks. There are some widely acknowledged limitations of the two registers[13]. Apart from those who opt out of public versions of electoral registers, the electoral register is known to sufficiently under-represent the younger age groups, the non-white British population, recent movers, and those in rented accommodation (Electoral Commission, 2019). Past research has also suggested that the earlier consumer registers (2003-12) tended to under-represent the adult population relative to mid-year population estimates, and the recent consumer registers (from 2013-17) tended to overrepresent the number of adults living in the UK (CDRC 2021). These limitations make it difficult or even impossible to reconcile the differences between the RMI and Census data.

To summarise, the comparison demonstrates the strong correspondence between RMI 2011 and migration data from the 2011 Census, indicating that the RMI has the potential to fill in some of the gaps left by currently publicly available data and supplement conventional population statistics. The combination of multiple data sources at the address level enables the RMI to capture changing patterns of residential mobility in London at a high spatial and temporal granularity (van Dijk and Longley 2021). On the one hand, the RMI provides a longitudinal profile of households/adult residents of domestic properties. As a set of time-series data, the RMI is able to reflect the (dis)continuity of residence at a high temporal granularity, allowing us to monitor changes in patterns of internal migration over the past decades (e.g. between the 2011 and the 2021 Census), a period in which London experienced rapid population growth, as well as rapid recessions. The analysis will provide us with additional insights into temporal changes in internal migration propensities that fail

[13] For detailed discussions on population counts and distribution of data sources underlying RMI and official population statistics, including the UK Census (2011) and the ONS mid-year population estimates (2012-2019), please see van Dijk and Longley (2021).

to be captured by the Censuses that take place only every ten years (Lansley et al. 2019; Lomax and Stillwell 2017).

On the other hand, the RMI is a valuable source of data covering inter-censual periods when detailed pictures of the population were hardly available from conventional statistics at small geographies (e.g. sub-borough levels). Drawing on the linkage of public electoral and consumer registers grounded at the level of address/household, the RMI provide 'highly granular inventories' (Lansley et al. 2019:1587) of local populations and their movement. This is especially the case for the last decade when conventional population projections suffered from non-neglectable errors in assumptions of migration, which became an issue of increasing concern for neighbourhoods in London during Covid-19 (O'Connor and Portes 2021; ONS 2021).

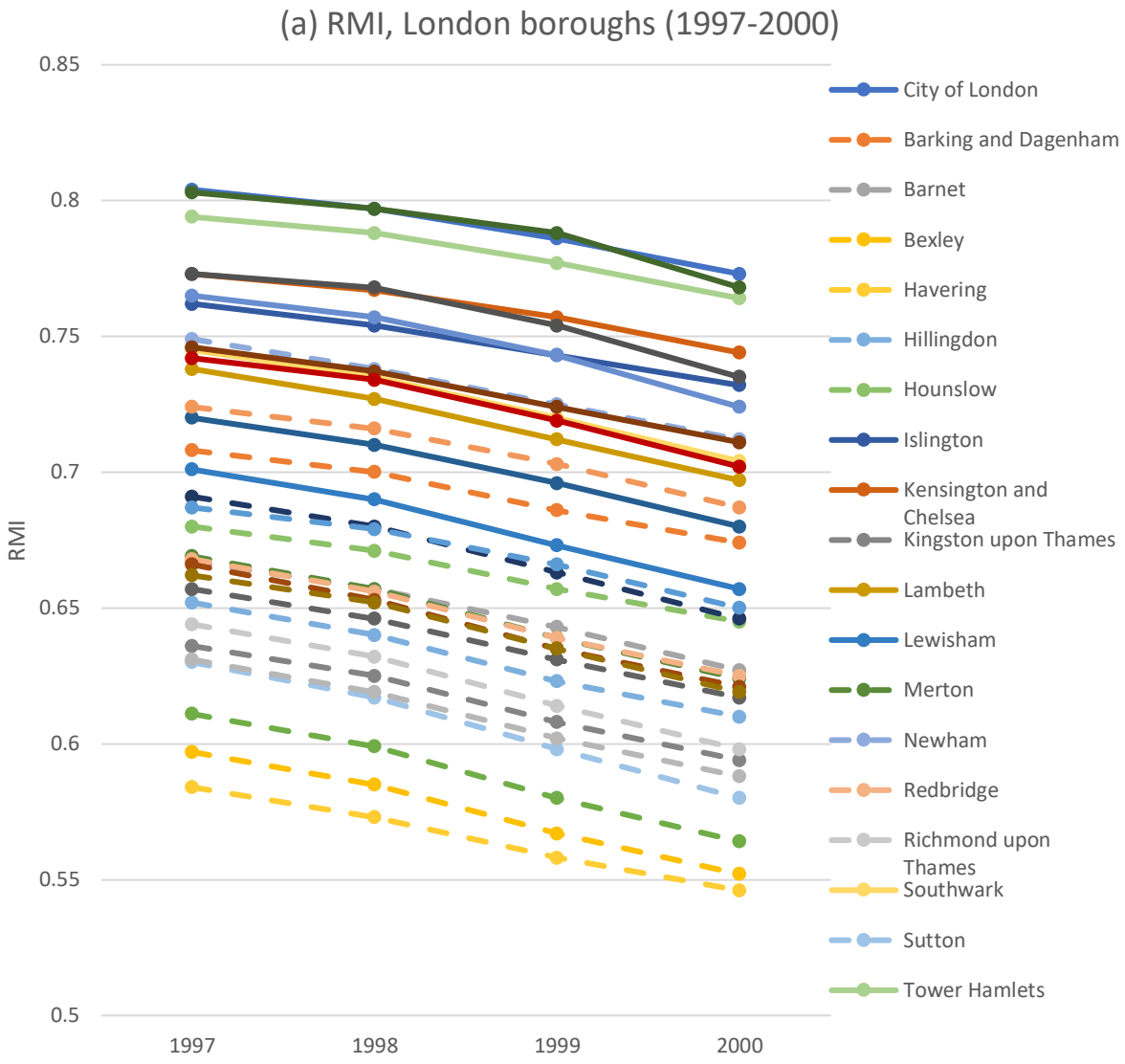
However, one shall remain cautious when interpreting RMI results due to three limitations of RMI. Apart from systematic biases associated with the Linked Consumer Registers, RMI 2001 appears to be a poor surrogate of the 2001 Census migration rates. In addition, differences in the mobility ranking are significant for some boroughs, calling for further investigations into the quality of RMI and consumer data files.

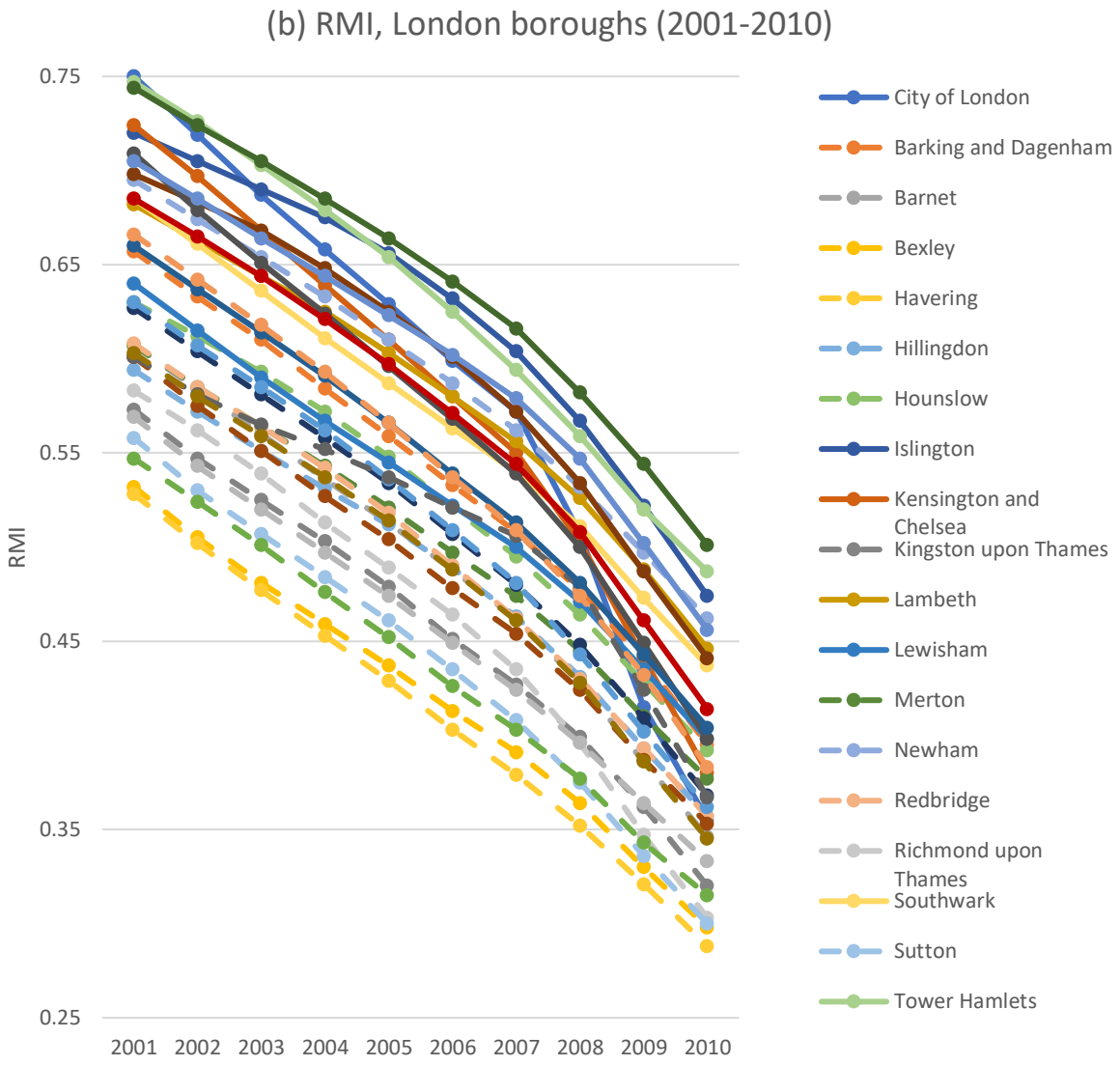
Churning population: New insights from the Residential Mobility Index

In this section, we present RMI-based analysis, demonstrating how RMI provides new insight for understanding London's churning population. The RMI, as a set of time-series data, allows us to monitor changes in patterns of internal migration over the past two decades.

Longitudinal trends

The general trends of RMI across London boroughs from 2011 to 2019 is presented in Figure 25, providing us with additional insights into temporal change in internal migration propensities that fail to be captured by the decennial Censuses. Inner London boroughs are presented in solid lines and outer London boroughs in dash lines.


(a) RMI, London boroughs (1997-2000)
RMI
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
1997
1998
1999
2000
City of London
Barking and Dagenham
Barnet
Bexley
Havering
Hillingdon
Hounslow
Islington
Kensington and Chelsea
Kingston upon Thames
Lambeth
Lewisham
Merton
Newham
Redbridge
Richmond upon Thames
Southwark
Sutton
Tower Hamlets


(b) RMI, London boroughs (2001-2010)
RMI
0.75
0.65
0.55
0.45
0.35
0.25
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
City of London
Barking and Dagenham
Barnet
Bexley
Havering
Hillingdon
Hounslow
Islington
Kensington and Chelsea
Kingston upon Thames
Lambeth
Lewisham
Merton
Newham
Redbridge
Richmond upon Thames
Southwark
Sutton
Tower Hamlets

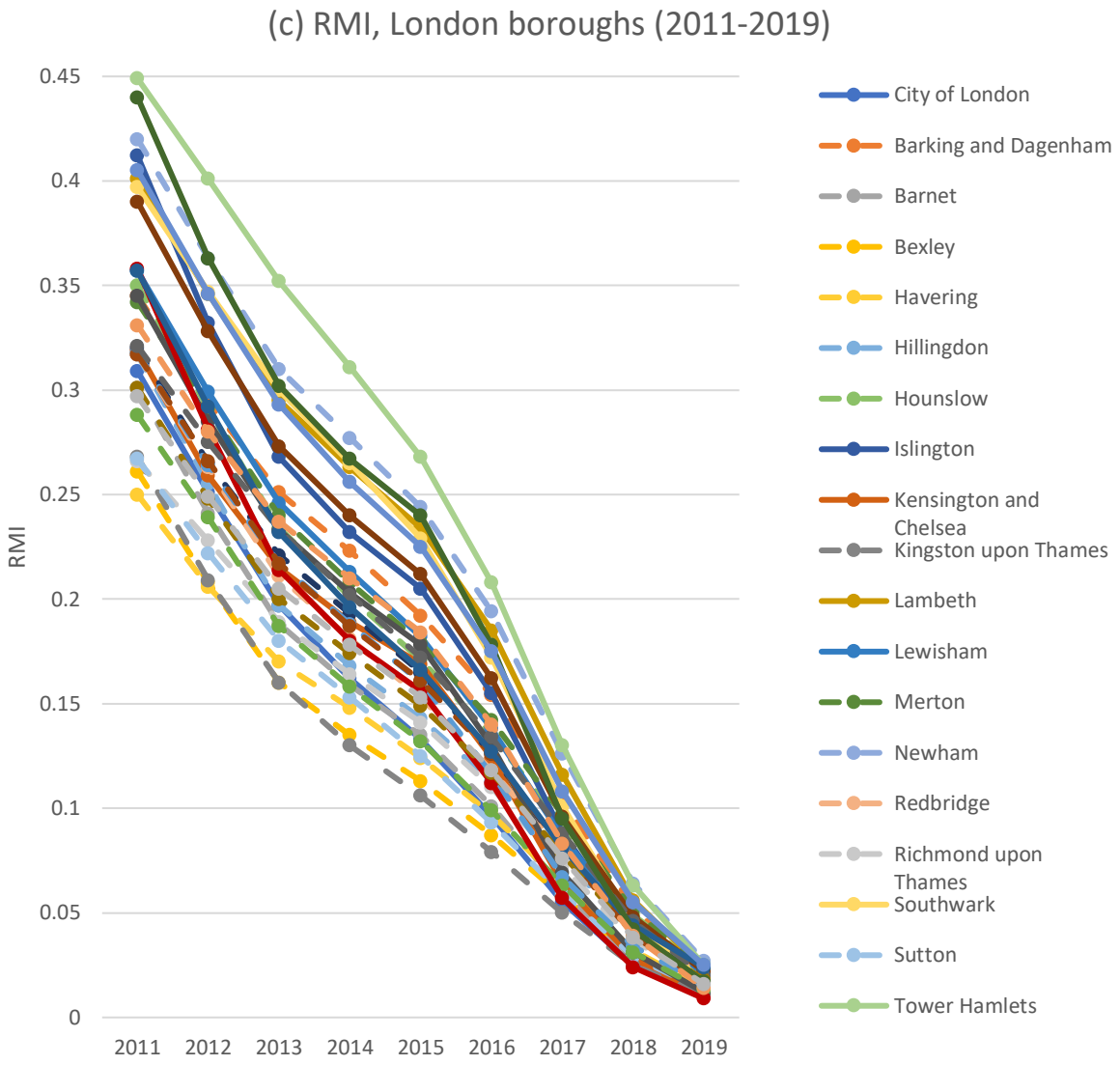


Figure 25 Residential Mobility Index of London boroughs, 1997-2019 (values)

Notes: an interactive version of RMI (1997-2019) can be found at https://app.flourish.studio/visualisation/7012934. Source: CDRC Residential mobility Index (2020).

To improve interpretability, we transformed the numerical values of RMI into rank orders, with the most residentially mobile borough ranking the highest. The RMI rankings of London boroughs are presented in Figure 26, with the RMI ranking of Camden highlighted in red.

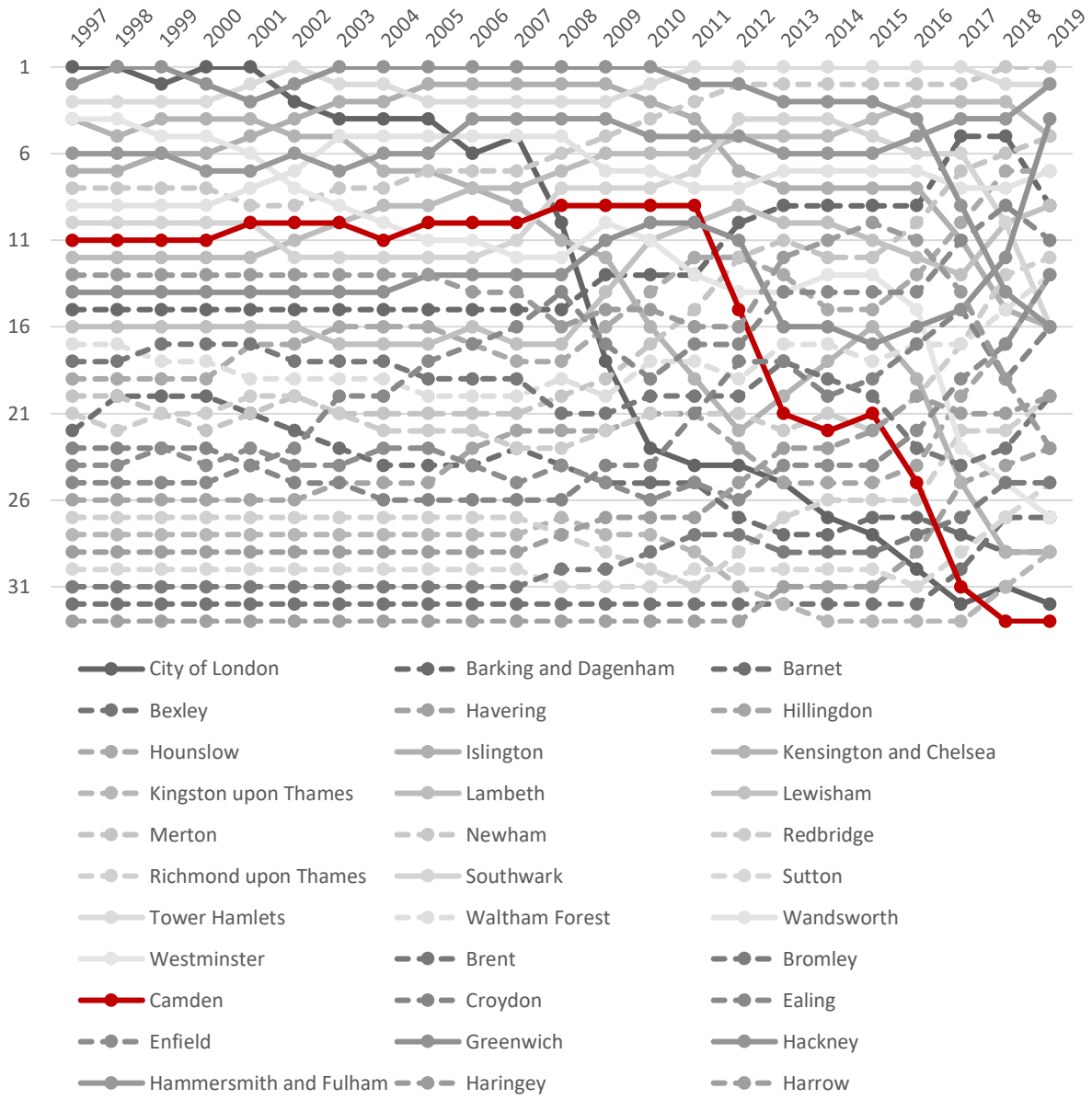


Figure 26 Rankings of Residential Mobility Index of London boroughs, 1997-2019

Note: an interactive version can be found at https://app.flourish.studio/visualisation/7012934. Source: CDRC Residential mobility Index (2020).

According to Figure 25 (a) and (b), most inner London boroughs generally reported higher levels of RMI than outer London boroughs in the late 1990s and 2000s. This indicates, compared to their counterparts, more households in the central part of the capital were on the move and they no longer remained in the same borough in 2020.

2008-2010 appeared to be a turning point for most London boroughs. Figure 25 (b) and Figure 26 reveal the sharp difference between central London boroughs and other Inner London boroughs. Central London boroughs, such as Kensington and Chelsea and the City of London, witnessed a sharp decline in residential mobility and became more residentially

stable after the global financial crisis. On the contrary, other Inner London boroughs, especially boroughs in South London, have seen a rise in the number of mobile households since the 2010s, such as Greenwich and Lewisham.

2015-2018 appeared to be another key moment for most London boroughs. As the RMI reflects in-migration, the figure suggests that most London boroughs became less attractive to immigrants after the EU referendum. This is demonstrated by the downward trends in residential mobility experienced by, for instance, Camden, Kensington and Chelsea and Haringey (Figure 26).

Regarding Camden, our RMI findings have shown that its relative level of residential mobility has been steadily declining since 2011. Although there has been a slight revival in mobility rates during 2013-15, Camden seemed to be hit hard by the EU referendum; its mobility rate has decline dramatically since 2016. As a consequence, it became the most residentially stable borough (i.e. least residentially mobile) by the end of 2018.

RMI at the Lower Super Output Area (LSOA) level

Borough is still a scale that is too coarse to understand mobility patterns on the ground. Figure 27 below shows the distribution of households that moved houses across LSOA boundaries between each target year and the end of 2020. Relative RMI values are presented for London LSOAs at five time points: 2011, 2013, 2015, 2017 and 2019. Green colour means an LSOA has a relatively high level of residential mobility (e.g. fewer households have stayed until the end of 2020), compared to the average level of residential mobility in London. Brown colour indicates an LSOA has a relatively low level of residential mobility or more stable households.

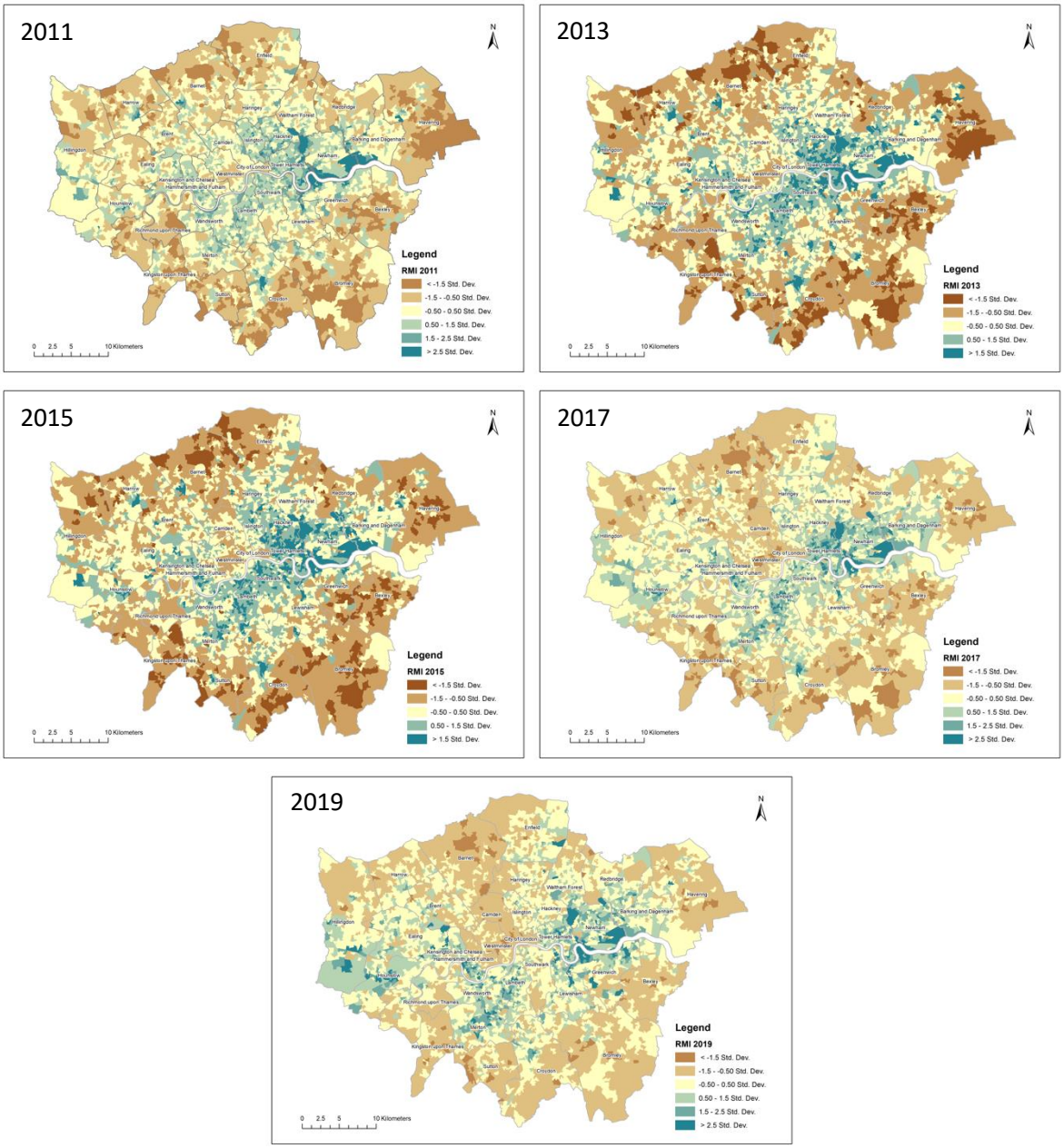


Figure 27 Residential Mobility Index, London LSOAs (by standard deviation)

Source: CDRC Residential mobility Index (2020).

In general, residentially mobile neighbourhoods were mostly found in Inner London, such as those in Westminster and southern parts of Hackney, Islington, and Tower Hamlets. Such patterns also 'spilt over' to some adjacent Outer London boroughs, such as neighbourhoods in south-western and north-western Newham. Residentially stable neighbourhoods were distributed widely in the outer suburbs, such as Havering, Bexley, Bromley and Sutton.

When we compare the five figures, what can be clearly seen from Figure 27 is that magnificent changes in residential churn took place across central London boroughs between 2015-17. In the meantime, some new 'hotspots' of residential churn emerged in

outer London in the late 2010s, such as neighbourhoods in north-eastern Merton and central Hounslow.

When focusing on Camden, we are able to explore residential mobility in and across the area at high spatial and temporal granularity with LSOA-level RMIs. In Figure 28, we compare the RMI value of LSOAs in Camden and the average RMI value in London and present the results by standard deviation at five time points: 2011, 2013, 2015, 2017 and 2019.

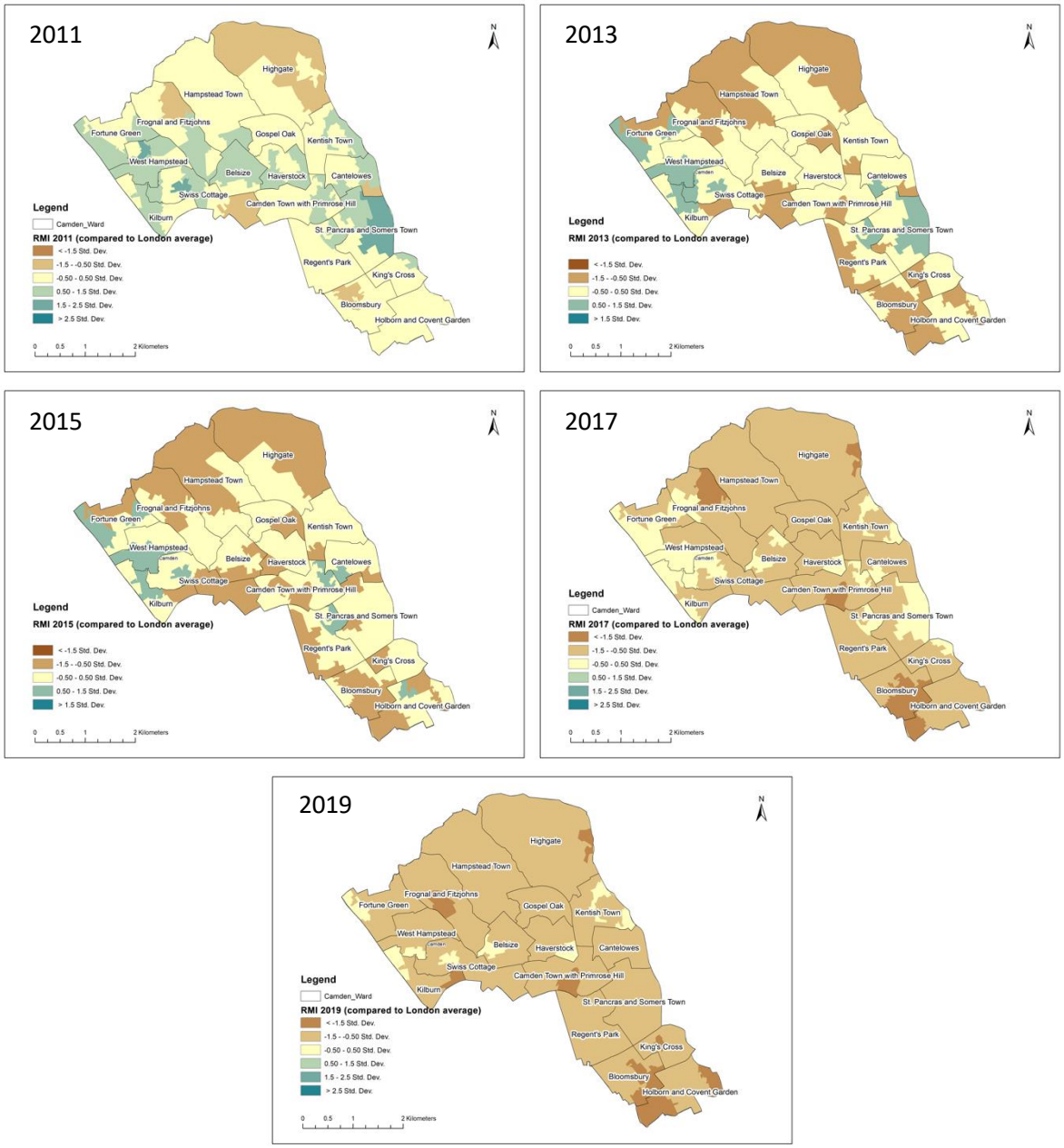


Figure 28 Residential Mobility Index, Camden LSOAs (by standard deviation, compared to London average)

The top left figure suggests that only a small number of LSOAs in Camden reported relatively low levels of residential mobility, compared to London's average level in 2011. These LSOAs were most concentrated in North Camden, such as north-east Highgate and north-east Frognal and Fitzjohns. Other LSOAs reported similar or higher levels of RMI, indicating that most parts of Camden were relatively residentially mobile in 2011 – an observation that is consistent with 2011 Census.

The steady decrease in residential mobility started in 2013. The top right figure shows that relatively stable areas (i.e. in brownish colours) expanded from North Camden to central and South Camden, including south Swiss Cottage, west Regent park, west King's Cross and most parts of Bloomsbury. Such an expansion has been accelerating during 2015-2019. As presented by the middle right figure, most LSOAs in Camden were coloured in light or dark brown in 2017, indicating that their levels of residential mobility were lower than the London average. These residentially stable areas were further expanded in 2019, leaving hardly any Camden LSOAs reporting higher-than-average levels of residential mobility. This observation echoes our analysis on the borough level, showing how Camden has changed from one of the most mobile boroughs to the least mobile borough in less than 10 years.

Conclusion and discussion

An understanding of the scale of population churn can enable greater insight into the size of a population, service provision, capitation, and budget estimates as well as democratic participation and community engagement. To measure population churn, existing studies often use data from the decennial Census, population estimates or administrative sources, which are often out-of-date or imprecise at local levels. In this report, we used CDRC data to develop a new Residential Mobility Index (RMI). By linking consumer registers, electoral registers, and land registry data, the RMI provides a 'highly disaggregate' and 'frequently updateable' (Lansley et al. 2019:1587) inventory of local populations and their movements, which allows us to monitor changes in internal migration at a high spatial and temporal granularity.

The RMI-based analysis sheds light on new trends and geographies of population churn in London, which supplement conventional population statistics. The Censuses point to greater patterns of flux experienced across London boroughs during the 2000s, the RMI further extends this argument and suggests that demographic changes were being felt differently by different boroughs at different moments. While Inner London boroughs consistently experienced disproportionately higher levels of population churn, their relative positions have undergone significant changes in the past two decades. 2008-2010 appeared to be one key moment of change, when most Inner London boroughs experienced a sharp decline in their residential mobility rankings after the financial crisis, except Greenwich, Lambeth and

Southwark. 2015-2018 was another key moment of change when more than half of London boroughs became less attractive to immigrants after the EU referendum. This especially the case for Camden, the RMI value of which has been declining drastically ever since. This is demonstrated by our time-series analysis presenting the (dis)continuity of residence in most parts of the borough, especially South Camden, which happened in tandem with the EU referendum.

The RMI-based analysis also highlights the importance of scale. Drawing on the aggregation of address-level consumer data, the RMI is able to capture short distance moves within local authority boundaries, which are usually under-documented in publicly available population statistics (except the Census). The RMI provides a reliable estimation of the spatial consequences of residential mobility at fine geographic scales (e.g. the LSOA level and above). This enables us to explore the granularities of churn at different scales.

A paragraph on policy implication (MK to complete?)

Different churn patterns, different challenges for different boroughs?

The research that is described here is a starting point, rather than an endpoint. It presents multiple ways through which the novel source of data – the RMI – could be used to glean new geodemographic insight into London's churning population. Future work aims to establish a holistic understanding of London's population churn and its socio-demographic consequences, involving origin-destination analysis, population flow mapping, and neighbourhood ethnic composition estimate.

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