UCL CENTRE FOR ADVANCED SPATIAL ANALYSIS

UCL

WORKING PAPERS SERIES

Paper 150 - Oct 09

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ISSN 1467-1298

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Choice and the composition of general practice patient registers

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Dated - 14/10/2009

Choice of general practice (GP) in the National Health Service (NHS), the UKs universal healthcare service, is a core element in the current trajectory of NHS policy. This paper uses an accessibility-based approach to investigate the pattern of patient choice that exists for GPs in the London Borough of Southwark. Using a spatial model of GP accessibility it is shown that particular population groups make non-accessibility based decisions when choosing a GP. These patterns are assessed by considering differences in the composition of GP patient registers between the current patient register, and a modelled patient register configured for optimal access to GPs. The patient population is classified in two ways for the purpose of this analysis: by geodemographic group, and by ethnicity. The paper considers choice in healthcare for intra-urban areas, focusing on the role of accessibility and equity.

1. Introduction

There are ongoing efforts within the NHS to increase patient choice, both in terms of treatment options available and the GP[1] used. These efforts are evident in the NHS Constitution which states "**you have the right** to choose your GP practice" (DoH, 2009 p.7 emphasis original) as well as the actions of the Secretary of State for Health, Andy Burnham. In a speech to the Kings Fund, Burnham (2009) sets out the need for "extending further patient choice in primary care" and to "deliver services where it's best for the patient". The intent of this paper is to investigate within the London Borough of Southwark; whether there is currently evidence of GP choice; how any apparent choice varies with different population groups; and whether this situation is 'fair'.

Choice of GP as outlined by the NHS is a question of access, both geographical and socio-economic, making choice an inherently spatial question. Access to primary care services has evolved over the life of the NHS. Early policy set a straightforward geographical criterion such that a GP is "within walking distance for mothers with prams" (Ministry of Health, 1962: source Sumner, 1971). Recent approaches state that GPs are responsible for the health of the local community (DoH, 2006). Whilst

[1] Throughout this paper 'GP' will refer to a surgery, rather than an individual doctor.

definitions of community are hard to find, the Commission on Integration and Cohesion[2] do specify a community as an area “within 15/20 minutes walking distance” (CoIC, 2007 p. 20) which leads to a very similar view on geographical accessibility as in 1962. Therefore, it is not the geographical definition of access to primary care that has changed, but the interpretation of what access means. Health care service provision has increasingly attempted to account for equity, or fairness, in terms of accessibility, driven by the need to mitigate the effects of the inverse care law (Hart, 1971) and the postcode lottery (see Bungay, 2005).

The first section of the paper discusses equity in health care and why it is important. Choice might generally be thought of as an equitable process; however the right to choose may end up creating a set of increasingly segregated patient registers. The next section reviews the application of spatial models in health care analysis, particularly from the standpoint of efficiency of access and also the measurement of equity. This is important as increasing choice in a system will generally have the effect of reducing efficiency of access, but may improve other aspects of the system such as patient welfare. The research rationale is outlined with reference to the previous sections. A methodological section highlights the data used and the limitations posed, before the creation of a model using linear programming is described. An analysis of the results shows a number of interesting patterns of GP registration, such as a tendency for Muslim patients to use GPs with Muslim doctors, which are discussed at the end of the paper. Potential further research is also discussed.

2. Equity, choice and the NHS

2.1 Introduction

This section defines equity and choice, assessing how they fit into the NHS. Equity is a nuanced concept, particularly in health where a different understanding of health equity and healthcare equity can be defined. Having established a working definition of equity in the NHS, its relevance to health inequalities, the inverse care law and the postcode lottery are highlighted. Lastly, the focus switches to how the NHS manages choice of GP, and how new developments in primary care services will change the current picture.

2.2 Universal service, equity and the NHS

The UK operates the National Health Service (NHS) system of universal health care fulfilling a number of criteria for universal service summarised in the NHS constitution (DoH, 2009). The implication of universal service is that the NHS has a duty to provide an equitable service for all

[2] The Commission on Integration and Cohesion (CoIC) was a fixed term body set up by Ruth Kelly in 2006 to investigate how local areas can best deal with the impacts of increasing diversity. Subsequent government work in this area comes from the Department for Communities and Local Government (DCLG).

eligible people, in this case all those legally entitled to free healthcare in the UK. This means achieving a suitable consensus on whether a particular service is deemed to 'fair'. David Harvey describes this as "a just distribution justly arrived at" (1973 p.16). Truelove (1993 p.19) breaks a 'just distribution' into three types:

- 'Horizontal' equity – the notion that people in like circumstances should be treated the same. For example, Targeted policy in government, with the end of reducing regional disparities, can often be understood in terms of improving horizontal equity.
- 'Vertical' equity – the apportionment of services to individuals or groups in unlike circumstances, as a response to their different needs as defined by socio-economic, cultural, ethnic, or other criteria. For example, this provides the rationale for 'means-testing' in social-welfare and other benefit delivery.
- 'Spatial' (or 'territorial') equity – the spatial implications of either 'horizontal' or 'vertical' equity.

Asthana and Gibson (2008) define both health equity and healthcare equity. Health equity is the condition of equal "opportunity to be healthy" (Asthana and Gibson, 2008). Healthcare equity is more targeted than health equity, specifying "equal opportunities of access [to healthcare] for equal needs" (2008 p.4).

The addition of access to the definition of healthcare equity supports the use of spatial analysis in understanding, and planning for, healthcare systems. The World Health Organisation (WHO) report on "The concepts and principles of equity and health" (Whitehead, 1992) states:

> "Differences in health have been noted between different social groups in the population and between different geographical areas in the same country... Large gaps in mortality can also be seen between urban and rural populations and between different regions in the same country" (p.431)

This clearly makes a case for the importance of a geographical approach. The report goes onto align itself with healthcare equity stating:

> "Above all, on humanitarian grounds national health policies designed for an entire population cannot claim to be concerned about the health of all the people if the heavier burden of ill health carried by the most vulnerable sections of society is not addressed. The bias against these social groups in the provision of health care also offends many people's sense of fairness and justice once they learn of its existence." (p.432)

Thus the operational definition of equity in health becomes:

- equal access to available care for equal need
- equal utilization for equal need
- equal quality of care for all

(Whitehead, 1992 p. 436)

2.3 Health inequalities: two geographical examples

Health inequality refers to the presence of "large socio-demographic differences in health experience and expectations" (DoH, 2005 p.10). The Department of Health (DoH) links health inequalities to healthcare equity in its "Choosing Health" (DoH, 2005) white paper by stating that "In order to close the gap, we must ensure that the most marginalised and excluded groups and areas in society see faster improvements in health" (p. 11).

Braveman and Gruskin (2003) note that "not all health inequalities necessarily reflect inequity in health, which implies unfair processes in the distribution of resources and other conditions that affect health" (p. 257). However, there exist some specific examples of health inequalities that not only imply inequity, but are characterised by their geographic component. Firstly, the classic example of the inverse care law (Hart, 1971) and secondly the postcode lottery.

In defining the Inverse care law, Hart (1971) states that "the availability of good medical care tends to vary inversely with the need for the population served" (p. 405). This exhibits itself geographically in the finding that it is the most deprived areas, as well as the poorest individuals, which are most at risk of poor medical care (Stafford and Marmot, 2003). Watt (2002) suggests that this arises from our inexact and misguided practices in measuring and understanding health inequalities. His example of this is the 1999 Scottish Executive Health Department resource allocation review "fair shares for all", which despite the best intentions "largely failed to redistribute resources within primary care" (Watt, 2002 p. 253).

The term postcode lottery refers to "random countrywide variations in the provision and quality of public services" (Bungay, 2005 p. 37). This means that "where you live dictates *where* you are treated, which in turns dictates *how* you are treated, and this in turn affects *whether* you survive" (Bungay, 2005 p. 37). Although examined as an issue academically (Bungay, 2005; Lyon et al, 2004) with the postcode lottery being linked to healthcare inequity, it is the media who have positioned the postcode lottery within popular consciousness. Newspaper headlines have assured the postcode lottery's place in popular culture, examples include: "women denied IVF on NHS 'by postcode lottery'" (Campbell, 2009) in the Guardian, or in the particularly active Daily Telegraph: "postcode lottery in prostate cancer treatment" (Devlin, 2009a) and "heart attack sufferers 'face postcode lottery'" (Devlin, 2009b).

Equity is a pervasive concept in healthcare and is the basis for much of the related analysis, policy and media. Geography is important, not only because a lot of inequities exist as a function of space, but because policy uses geographical techniques to target inequities.

2.4 Developments in equity: Choice in the NHS

Recent moves in the NHS focus on the role that choice has to play in reducing inequities. This is evidenced in successive white papers, "choosing health" (DoH, 2005) and "our health, our care, our say" (DoH, 2006). They prescribe choice in the NHS; for patients though personal care and individual solutions, and for general practices through new budgetary practices and quality management. In establishing a right to choose, concepts of locality, neighbourhood and community come to the fore. Principles of choice are wrapped up in the NHS constitution (DoH, 2009) which sets out the rights and responsibilities of NHS patients and staff. The pledges that the DoH (2009) make to patients and staff served by, and serving in the NHS, explicitly target the importance of 'fairness', which can logically be interpreted as healthcare equity.

The right to choose, however, is not overly apparent in the various portals that advise individuals on how to access a GP. In specifying that you register with "your local GP", Directgov (2009) seems to suggest that there is a geographical limit to which GP you may register with. This is further reinforced by the DoH portal "NHS choices", which although supporting a patient's right to choose, creates a basic proximity ranking of the potential GPs available from an individual's postcode, as per the example of a GP search shown in Figure 1. Search results cannot be manipulated in any other ways, meaning that non-accessibility based criteria which prospective patients might wish to fulfil cannot be met. Options related to choice are not-present at the start (these could include patient list size, number of doctors, services offered etc), although some of this information is available when you 'drill-down' by selecting a specific GP. Unlike hospitals, the quality criteria seem confined to opening and closing times, and not waiting times, successful operations, etc. The NHS has successfully avoided branding GPs as good or bad.

The experience of searching for a GP is in stark contrast to searching for a hospital for secondary or tertiary care. Initially it is possible to search not only by postcode but also by specialty. When search results are presented they are given with an indicator of "Quality of Service" from the NHS Annual Health Check, which measures Hospital performance. Further, the results also include the standardised mortality ratio, and some wiki-style reviews of the hospital. All this information exists for Hospitals without drilling down, and when you do there are further measures to help patients choose a suitable hospital.

The inexplicit definition of 'local' made by the NHS is defined more by how close a patient happens to be to a GP, or a set of GPs, as opposed to being any kind of exacting criteria. The GPs in Figure 1

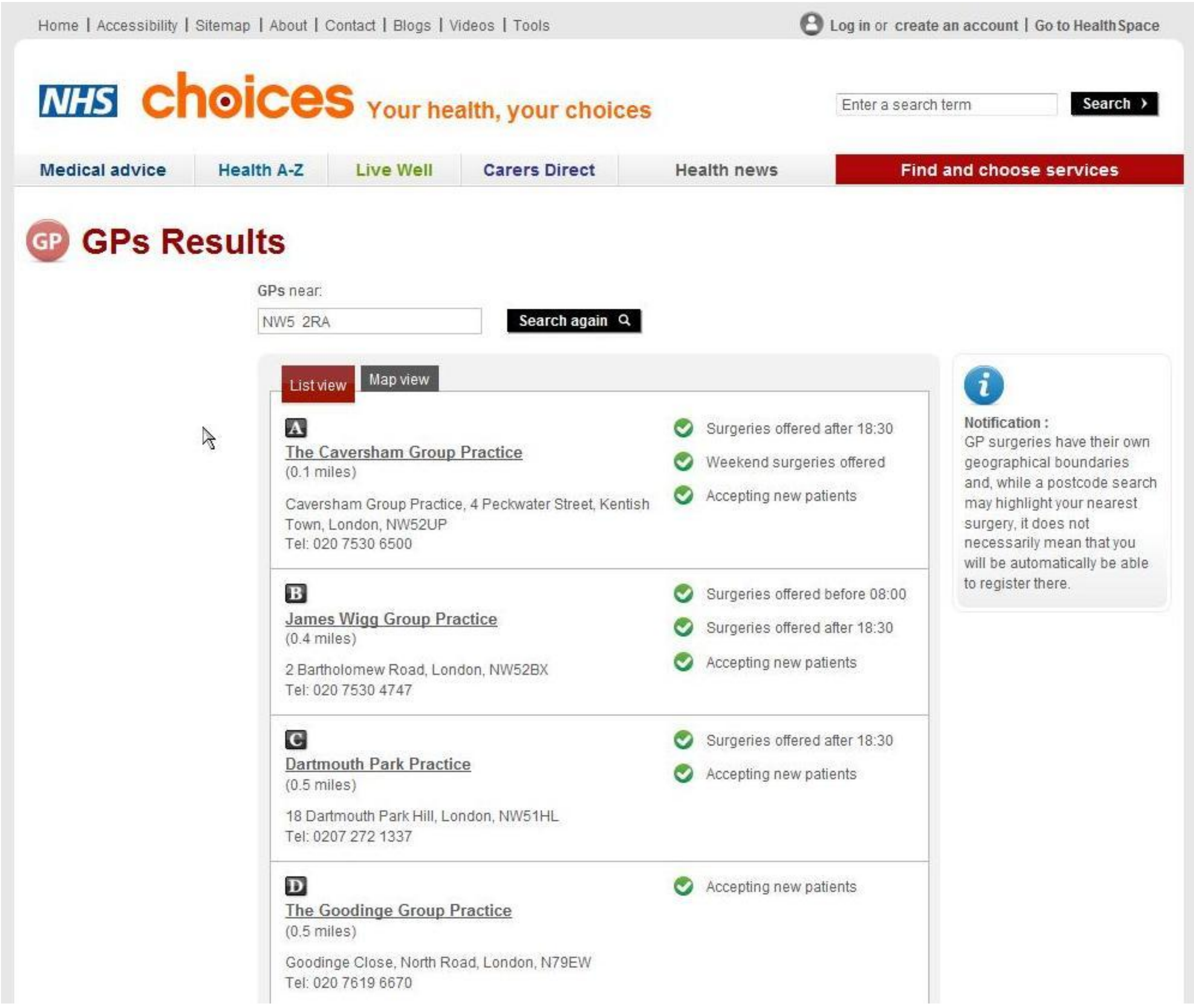

Figure 1: NHS Choices, GP search results for a postcode in North London (http://www.nhs.uk)

are 'local' by the merit that the search areas is inner London, an equivalent search for a rural area might present a set of 'local' GPs which are many miles further away. Essentially the issue of locality seems to break down to firstly, the population density in an area – how many people are looking for primary care- and secondly the density of GPs available – how many GPs are present to provide service.

There are two particularly interesting recent development in primary care: NHS walk-in centres and polyclinics, which are already allowing patients to bypass the GP for some conditions. NHS walk-in centres deal with minor illnesses and injuries without the need for an appointment, or registration

(NHS, 2009a). The role of the polyclinic is seen as the development of large (i.e. 20,000+ patients) clinics which can reduce the gap between what can be provided by general practices and by hospitals, essentially relieving stress from both institutions and providing another primary care pathway for patients (NHS, 2009b). Polyclinics in particular will likely change the ordering of access to health care should they continue as planned. In particular, the flows of patients will be altered, both from patients favouring polyclinics in order to fit healthcare around work commitments, and from hospital referrals for more routine procedures which can be handled by polyclinics. This will likely be realised by a second geography of access to primary care that overlays the traditional GP-based geography, and an evolution in the geography of access to secondary care.

2.5 Consolidation

The principles upon which the NHS was founded made it inevitable that choice was going to be an important part of primary care service provision at some point. Equity is the principle concept that underlies the interaction between patients and services. The NHS has clearly positioned choice as an important facet of that interaction, however their implementation of choice in the primary care setting has so far been limited. It is still abundantly clear that geography has a tangible impact on the health of populations and thus is an important consideration in the assessment of choice. There needs to be a better understanding of how patients actually choose a GP, and only then can the required commitments towards equity and quality be made. This paper focuses on a subset of this question, considering the spatial component of GP choice.

3. Spatial models in the analysis of healthcare systems

3.1 Introduction

Having established that geography is important in healthcare systems, this section investigates the role that spatial analysis has played. Firstly a definition of a model is established, before some examples of spatial models in healthcare are considered. These models are broken into analytical models and efficiency models.

3.2 What are spatial models?

The term 'model' hereby refers to representations of reality, that are, in the classic Chorley and Haggett (1967) sense, "selective abstractions, simplifications of reality" (Longley and Batty, 2003 p.5) Whilst Longley and Batty (2003) define two types of model – iconic and symbolic, the focus here is on the symbolic model, which uses mathematical or statistical relationships to simulate reality. Modelling reality allows for associations to become apparent within otherwise complex systems, however as simplifications of reality, it is important to note that what is left out of a model can be as important as what remains (Longley and Batty, 2003). By extension spatial models are models that are tasked to allow a researcher to conduct some sort of spatial analysis, as such they are models in which space is also encapsulated and simplified.

Crucial to all the models is the concept of distance, the focus is on measurement of geographic distance, be it by using Euclidean, Manhattan or network metrics. Distance can also be substituted for a travel time such as in Lovett et al (2004) who use bus services to measure travel time in East Anglia, or even a cost function which is a function that describes the 'cost' of doing something by combining a number of factors, in this context distance is usually included. Distance is the underlying criterion for defining attractiveness, potential or interaction through spatial models.

3.2 Spatial models in healthcare: analytical

Cromley and Mclafferty (2002) demonstrate the key usages of GIS in analysis of health care systems, particularly in terms of geographic accessibility: the mapping of service locations, health needs, service areas and accessibility potential. These studies are driven by an analytical element, assessing the 'real' situation of health, using spatial models, and geographic understandings, to reveal what might be politically and socially significant.

Martin and Williams (1992) discuss two interesting approaches to health care accessibility. Firstly the gravity model, or spatial interaction model, approach in which they attempt to model GP registration in Bristol. The model works with Euclidean distance and a measure of surgery attractiveness equal to a function of its size. The model does not distinguish between different population groups, such as men and women, or age groups. Nevertheless it is a reasonably good representation of reality, certainly it is much more effective than a simple 'nearest-neighbour' style allocation. Martin and Williams (1992) use this model to investigate the 'market area', also known as catchment, or service, area of each general practice in the model. Market areas, the area around a supply site such as a GP, are models of the region from which a service is likely to draw its customers. Figure 2 shows a market area for a GP in Southwark calculated using surface creation (Kernel Density Estimation (KDE)) and contouring (percent volume contours) techniques described by Gibin et al (2007).

Knox (1978) presents a study of "patterns of intraurban accessibility to primary medical care in four major Scottish cities" (p.415). The intent is to use accessibility as a component in understanding the geography of "social or community well-being" (p.415). The initial analysis involves the consideration of the geodemographic classification of doctor's surgery based on a cluster analysis of the 1971 by the Scottish Development Department. This is referred to by Knox as the 'intraurban ecology'. The basis of the work is a simple gravity model of accessibility calculated on a neighbourhood basis. Knox shows that it is the worst-off areas in the cities studies that are under-served by GPs, and in terms of community health, it is these areas which are subject to greater prevalence of infectious diseases, mental health issues and other illnesses. Knox is able to conclude that the NHS needs a stronger locational policy with respect to primary care if it is to promote equity. Whilst this recommendation was made in 1978, it is still surprisingly relevant as recent financial incentives by the Scottish Government to encourage NHS Dentists into deprived areas shows (NHS Scotland 2009).

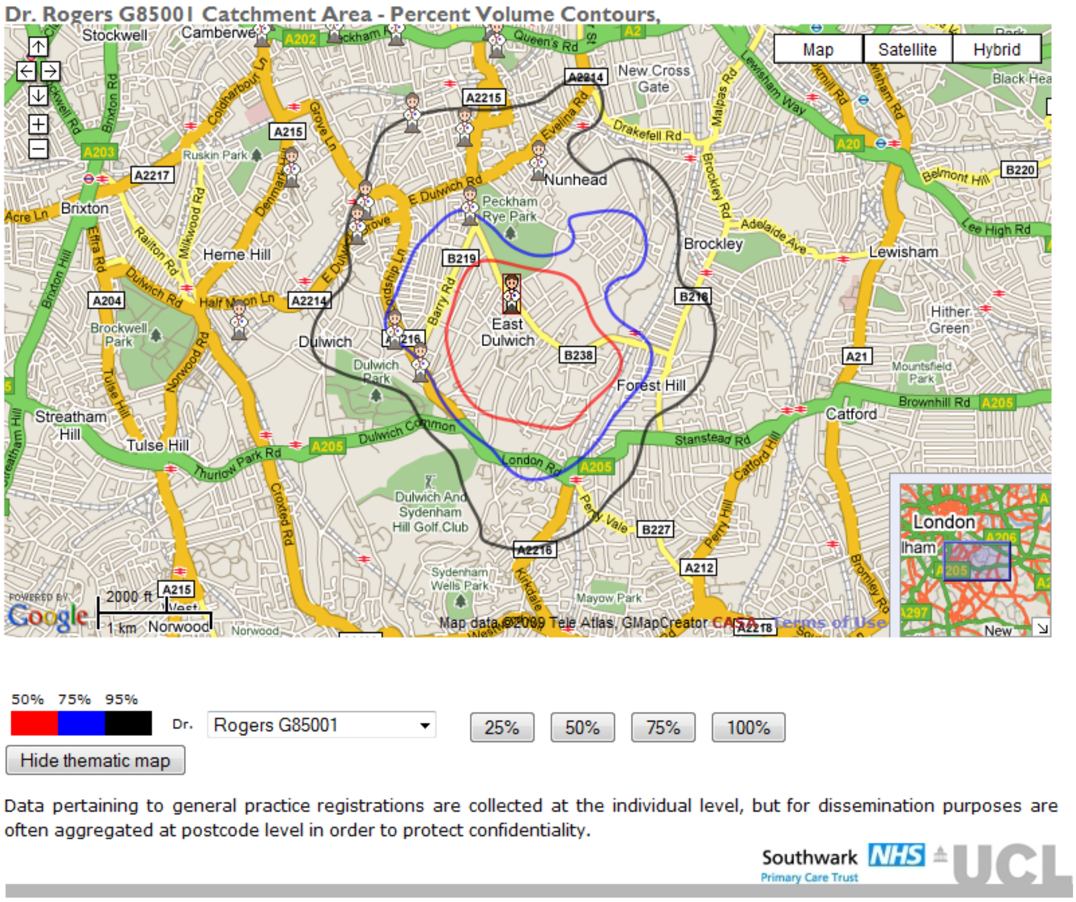

Figure 2: A series of market areas based on patient registration for Dr. Rogers, Southwark, 2006 (Courtesy M. Gibin - http://www.spatial-literacy.org/health/gp_ca/gp_ca.html)

Spatial models can also be used in the assessment of equity in health. Two good examples of models of spatial equity come from Truelove (1993) and Talen and Anselin (1998). Truelove (1993) uses indices of spatial equity to chart the differential levels of equity associated with day-centre centres, finding that there is significant reason to question the spatial arrangement of day care. Talen and Anselin (1998) are more methodologically focused and trial a number of approaches for the assessment of spatial equity in the accessibility of public playgrounds.

3.3 Spatial models in healthcare: efficiency

There also exist a number of more applied models in health and healthcare which focus on efficiency and optimisation, rather than the specific social justice of a health system. Efficiency based models are often described as 'normative', meaning that they are not intended to look at existing patterns and flows in service location, but at ideals and optimums as defined by a decision maker (Cromley and McLafferty, 2002).

The concept of efficiency and equity are often considered to be mutually exclusive to some extent, or at least difficult to reconcile. Symons (1971) asks:

> "One may ask whether a point in space has attributes of equity as well as efficiency, i.e. whether a spatial relationship can be determined which relates the legal requirement for equity with the resource constraints which require efficiency" (p. 54)

The definition of efficiency developed by Symons here is one of optimal location, "a set of locations is said to be efficient if no further spatial adjustments to the set could be made which would make anyone better off without making anyone else worse off" (1971 p.55). This problem is known to be one of a set of "location-allocation" problems.

Cromley and Mclafferty (2002) discuss a number of different approaches to efficiency within the 'location-allocation' paradigm, citing examples that solve the p-median problem in order to suggest a better location of hospitals, or the addition of a new hospital with a number of possible candidate sites. An interesting example of this approach is Messina et al (2006) who use location-allocation models to firstly assess access to hospitals, and then compare this with an optimal set of hospitals. This helps then identify underserved areas. Likewise Densham and Rushton (1996) discuss a type of location-allocation problem in which demand must be allocated to a facility, but some adjustment to the optimum solution must be made in order to ensure the viability of important rural facilities.

3.4 Consolidation

Generally, the specific nature of the analysis will govern model choice, what is clear is that there are a number of models which can target different aspects of healthcare systems. There is a natural divide in modelling between models which aim to assess the contemporary situation, and models which seek to specify an optimum healthcare system. As noted by Thomas (1992), "the planning of health service delivery is something of a compromise" (p.28). Thus "limited funding and geographic variation in population density" (Thomas, 1992 p.28) will often mean that analytical research cannot be fully acted upon, and models of efficiency can be greatly constrained by what a health authority can afford, or where they want to provide service.

The next section is a rationale for this research which seeks to uses a spatial model of efficiency to unpick the geographical question of choice raised earlier. In a sense it is not a true efficiency model as the intent is not simply to optimise, rather it is to optimise for the purpose of comparative analysis. Thus the approach used has elements of both analytical and efficiency based modelling.

4. Rationale for the approach of this research

Provision of primary care service within the National Health Service is two-fold: it both imposes geographical constraints to access and a basic right to choice. The NHS recommends that patients register with their local GP, and that the GP themselves define catchment areas within which they will always take qualifying patients, and outside of which they have the right to refuse any registration request. Thus the NHS has defined a neighbourhood, or community-based approach to service provision. However, this has been simultaneously coupled with a bias towards increased choice for patients both in terms of primary care pathway (GP, walk-in centre, polyclinic) and alternative options when selecting a GP within a range of possible candidates. Therefore, the NHS accepts that patients, within reason (i.e. density of GPs near to a patient's home), have the right to choose a doctor based upon their own particular criteria.

The premise of this research is to investigate the population characteristics that may have influenced choice of doctor's surgery for residents of the London Borough of Southwark (Figure 3). Southwark is an interesting case study area, it is urban, with a large population of around 300,000 people in a relatively small area of roughly thirty square kilometres. Many of Southwark's neighbourhoods are deprived, and as a whole the Borough ranks as the twenty-sixth (out of 354) most deprived local authorities in England[3]. However, there are patches of gentrification evident, particularly in the leafier south of the Borough, and the rapidly developing 'Bankside' area closest to the river Thames. Having said this, the central core of Southwark, the areas with the highest population densities, also have the highest levels of deprivation at LSOA[4] level and are characterised by high proportions of social housing and relatively high income inequality to the rest of Southwark.

Choice of GP is an interesting question in Southwark, not because there is a lack of primary care provision, rather the opposite, because for a great deal of the residents there are several possible options regarding which particular GP to visit. Accessibility questions in healthcare usually arise in a rural setting in which accessibility and choice are each limited. In this context authors investigate the inherent health inequities caused by different levels of accessibility to health care. Location-allocation techniques that minimise the median distance travelled for the rural population to health care facilities are also used, hopefully creating a more equitable, and accessible, set of services. In an

[3] Based on the Index of Multiple Deprivation 2007 (IMD07), the ranking of 26th out of 354 is actually an improvement on the IMD04 ranking of 17th.
[4] Lower-Layer Super Output Area – a census areal unit containing, on average, 1500 people.

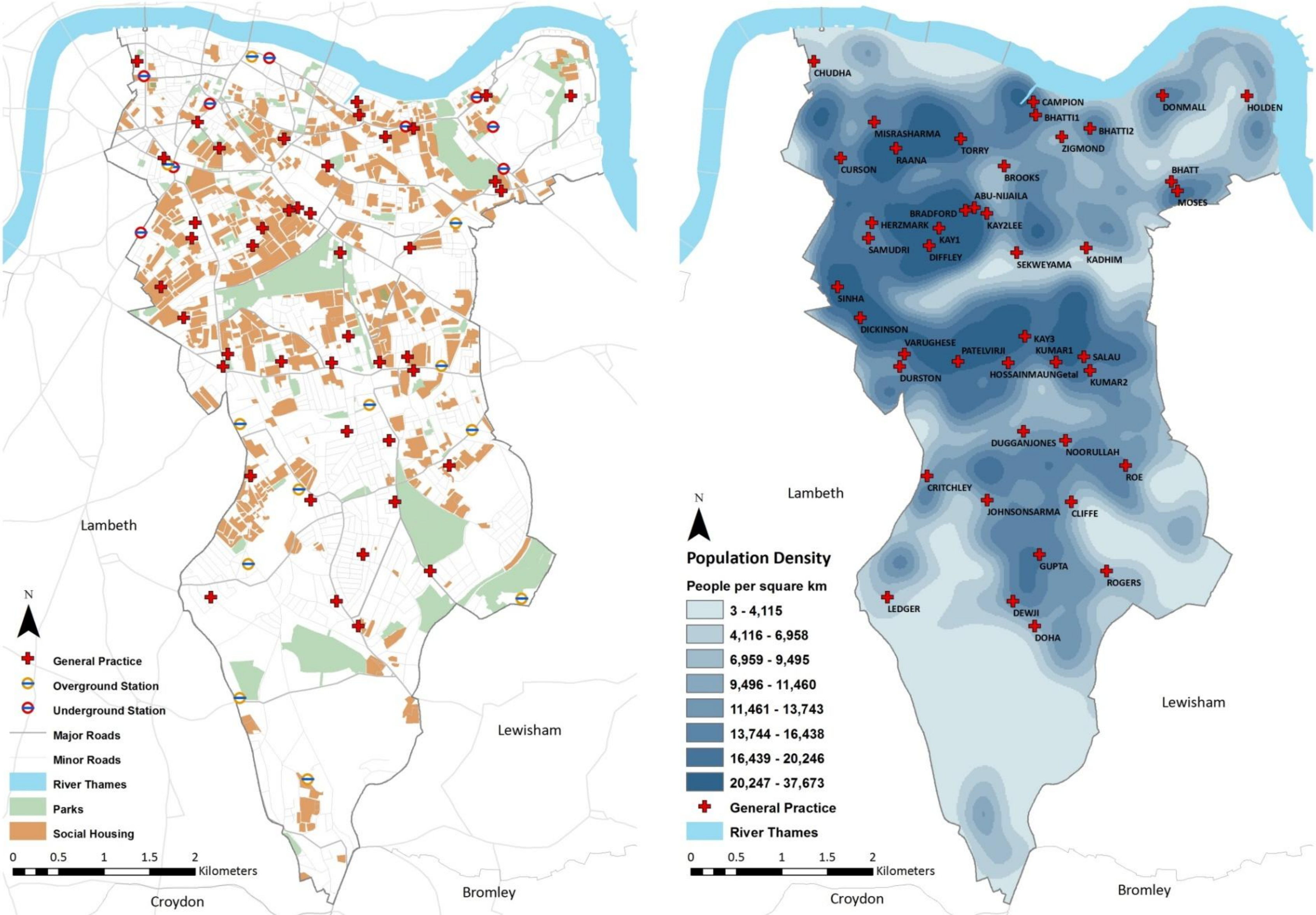

Figure 3: map (left) and population density (from 2009 data) with general practice names (right) for Southwark, London.

urban situation, in which the second or third closest doctor is still at an acceptable distance from a patient's home, it is presumed that a patient may chose an alternative doctor other than the closest one. Reasons for this include: confidence in the GP (Billinghurst, 1993); Practice characteristics, such as size, and the relationship with the GP (Baker and Streatfield, 1995); GP characteristics, such as ethnicity and country of birth, age, sex and marital status (Bornstein et al, 2000); and quality of GP (Rosén et al, 2001).

There are no specific data available that records whether an individual has chosen one GP over another, and administering a suitable survey to uncover this would likely be difficult and time consuming. Further to this, there are no measures of constrained supply or the state of the primary care market in the area, so the number of patients displaced from their desired GP due to it being full cannot be measured. Certainly data exist in the form of a patient register for Southwark that documents to which GP each registered resident of Southwark is enrolled with, however there is no qualification of preference because the right to accept patients is devolved to the individual GP rather than being a responsibility of any NHS central body, in the case of Southwark – Southwark Primary Care Trust (PCT). As a result each particular registration consists of a number of inherent choices based upon characteristics that can be summarised in three spheres:

a) Accessibility, which in terms of choice can include a number of determinants such as: raw distance in metres; travel time, particularly if using different modes of transport; and the monetary cost of travel. Additionally the convenience of the GP may be a factor in terms of incorporating routes to school, work or to local amenities such as shops.
b) GP characteristics (supply side) such as the services provided at the practice, quality of premises, ethnicity of doctor, gender of doctor, the type of neighbourhood within which the GP operates and size of the patient register.
c) Patient characteristics (demand side), i.e. access to information, socio-economic status, community and social network knowledge and so on.

One element involved in the choice of a GP that is directly measurable with the information available to PCTs is geographic accessibility. A geographical information system (GIS) can help compute accessibility for each individual person, or area, with reference to each GP located within a given area of interest. Having calculated the distance from every patient to all GPs available, an optimal solution can then be obtained allocating each patient to their closest GP. Resulting from this exercise a new 'optimised' patient register can be created based solely on geographic accessibility. In this case the expectation would be that the new patient register would differ somewhat from the real-world patient register as a result of the previously mentioned characteristics that also affect patient choice of doctor.

In a sense, by comparing the new patient register, hereafter called the “synthetic register”, with the real-world register, accessibility is controlled for. This allows an insight into the rest of the characteristics likely to be in evidence when choosing a doctor (listed above “b”, GP supply, and “c” patient’s characteristics) by looking at the differences in the spatial variation between the populations of two registers. The patient registers will be classified by ethnicity and by geodemographic group in order to gauge the nature of the variation apparent. The specifics of these classifications are covered in the next section.

The expectation is that different types of GPs, particularly if GPs contain doctors with a professed interest in particular specialist areas of medicine, will attract notably different population groups generating a pattern which cannot simply be accounted for as just an accessibility characteristic. Having uncovered the population characteristics in the real-world patient register (demand side) it is also possible to link the findings back to the characteristics of the GPs themselves (supply side) and suggest what intervening processes might be at play. Moreover, this is the uncharted territory where it is expected that a number of issues will be hinted at, including: patient discrimination on behalf of GPs, on GP selectiveness, as well as a form of spatial segregation both on behalf of patients and GPs, as they both attempt to optimise their benefits in an unequal urban landscape (quality of healthcare for patients and NHS payments vs. cost of treatment for GPs).

5. Data

5.1 Introduction

This research involves several datasets which require some explanation: the Southwark Patient Register; Transport for London (TfL) public transport travel times; onomap name-based ethnicity classification; GP locations for Southwark via Neighbourhood Statistics; and the London Output Area Classification (LOAC).

5.2 The Southwark Patient Register

The NHS uses a centralised registration system (NHSCR) for all patients registered with a doctor in the UK. The information stored is reasonably basic, and is reflective of the information that anyone would give when applying to join a GP: name, address, date of birth, sex, place of birth and NHS number, to which the requisite information about the doctor with whom the patient is registered is added.

Whilst national data are stored centrally, each PCT only has access to specific subsets of the data that pertain to the resident population living within its boundary, and sometimes to those living outside who are registered with a GP within the PCT. The data used in this research are from Southwark Primary Care Trust, and covers the entire registered population within Southwark Borough including both those living in Southwark registered to a Southwark doctor, and those living within Southwark registered to a doctor outside of Southwark. In addition it includes records for those living outside of Southwark but who are registered to a Southwark doctor.

There are some advantages and disadvantages to using this dataset. Positives are that registrations are effectively real-time, providing a continuous population register. Amongst the negative aspects of the patient register, there is a tendency over-registration. Over-registration occurs because GPs are incentivised to have as many patients on their list as possible, particularly if those patients are unlikely to cost the GP too much money, i.e. through infrequent visits. Similarly, patients are dis-incentivised to change GPs, unless they have a specific problem, and may remain registered to an inappropriate GP, failing to update address changes, or migration status, for some time before a GP or PCT takes action to deregister a patient.

The register also suffers from a lack of completeness because it is not a dataset of the whole population of Southwark, but a dataset of the population that is registered to a Southwark GP. As such this misses out individuals that are not registered to a GP. These often include young men, very transient populations, and a small proportion of immigrants (see Boden et al, 1992) that sometimes are only forced to register after having repeatedly attended Hospital Accident and Emergency (see for example Leaman et al, 2006).

The patient register contains around 300,000 records for 2009. The patient register has been geocoded to the postcode level for this research, success rate of over 99.5%. Amongst the failed assignments there was no specific clustering of unassigned patient records to any particular GP. Initially a large number of unassigned records (c. 300) had address related to care homes, these were manually corrected.

5.3 Applying the Onomap name-based ethnicity classification to the Southwark patient register

The Onomap classification has been used to derive a sense of the cultural, ethnic and linguistic origin of the registered individuals (Mateos et al, 2007). This is particularly useful given the uncertainty of the birthplace record in the patient register; not only do the answers here vary in terms of scale from specific hospital to a country or continent of birth, but the free text field can be subject to numerous misspellings for the same place. Birth place can also be inadequate in accurately reporting ethnicity, since it misses totally the second generation, which in the UK 2001 Census comprised half of the ethnic minority population. This is particularly important in Southwark which has high levels of immigration and second and third generation immigrants who would have been born in Britain, but are not, for example, ethnically "British". Such factors can be captured by surnames analysis using the Onomap classification.

The classification works by assigning a taxonomy based on the combination of each individual's forename and surname. The insight being that different forenames and surnames are specific to particular languages, countries, regions, religious affiliations, cultural groups or ethnicities. By understanding how the different combinations of forename and surname impact upon the likely ethnicity of an individual, a reasonable assessment of ethnicity can be made. Whilst using the derived name-based ethnicity to identify the most likely ethnicity of an individual may be uncertain, using it to look at the ethnic proportions of populations, such as those registered to particular GPs, may be less suspect and more useful.

Fine-scale individual based classification of ethnicity using Onomap far surpasses the self reported possibilities contained within the 2001 Census, Onomap has possible 185 categories based on a hierarchical structure of 66 Onomap subgroups and 16 groups, whereas the census records only 16 possible ethnicities. However, Onomap relies on a forename-surname style of naming, which may differ in some cultures, particularly non-western ones. Similarly, a classification that involves paternal surnames will be biased towards the ethnicity of the father, since most surnames are patrilinearly inherited, i.e. passed down the male line only. This may hide ethnicity in cases of children of parents with mixed ethnicities. Finally, it is insensitive to misallocations of ethnicity due to issues of name change, corruptions, transliteration, etc as well as language or name imposition for historic reasons such as colonialism.

5.4 TfL public transport travel times

In order to compute optimal accessibility areas a dataset of public transport accessibility at output area (OA) level is used. In this case Transport for London (TfL) CAPITAL (CAlculator for Public Transport Accessibility in London) data which calculates the estimated time to be on a moving bus, tube or train taking into account average walking speed and waiting time (depending on the frequency of the service) from a given location (see TfL, 2009).

The measure has been constructed by first constructing a grid of points with a 100m spacing between points, and calculating the accessibility of all transport service locations within a specified buffer distance from these grid points. A transport service point can be a train station, a London underground station or a bus stop, and the buffer is based upon the maximum distance people are prepared to walk in order to access each of these services. In the case of bus passengers the maximum walk time is assumed to be 8 minutes, or 640 metres, and for train or underground passengers 12 minutes or 960 metres, average walking speed is assumed to be 4.8 kph. The average waiting time for a bus or train is assumed to be half of the time interval between two transport services (bus or train) travelling the same route. Weighting is used when more than one service operates the same route; a value of one is assigned to the service with the highest frequency and 0.5 to the others.

The travel time between any pair of points can then be calculated, and the result aggregated to the census output area[5] (OA) geography. The clear advantage of using such dataset as opposed to straight line, or even road network distances, is that it gives a realistic insight into the likely constraints of travelling time in Southwark for most of the residents.

This measure is more effective therefore than a Euclidean distance analysis as it takes into account likely modes of transport and the constraints of the public transport network. The complexities of waiting times, multiple routes and multiple modes give an extra-dimension to the OA level data in spite of its areal aggregation. The aggregate nature of the data may be hiding some of the intra-OA variation in travel time, although this should be minor in most cases due to the relatively small size of OAs in Southwark as a result of high population density. Having said this, larger OAs, particularly those in the south of Southwark, as well as those including parks and open spaces are more susceptible to uncertainties of this nature in travel times.

5.5 The London output area classification (LOAC)

The Office for National Statistics (ONS) has created a classification of census output areas according to the key characteristics of the people resident in those areas (Vickers et al, 2005). This classification, known as the Output Area Classification (OAC), collects similar areas into groups, by means of cluster analysis, at a national scale. This is intended as a simplification of the complex array of socio-economic characteristics of areas. The groups can greatly aid the recognition of patterns which can then be explained in more detail. Knox (1978) shows that the use of a geodemographic classification as a basic representation of the neighbourhood types that patients belong to allows for an interesting insight into health care service provision to be made.

The core issue faced in this research with regard to the OAC was the national scale of the classification. Southwark exists in an urban context and a national classification that also accounts for the rural-urban continuum, north-south, and inter-regional difference is somewhat

[5] Output areas (OAs) are the smallest area that the Office for National Statistics (ONS) uses for Census dissemination. An OA typically accounts for 264 people (Vickers et al, 2005).

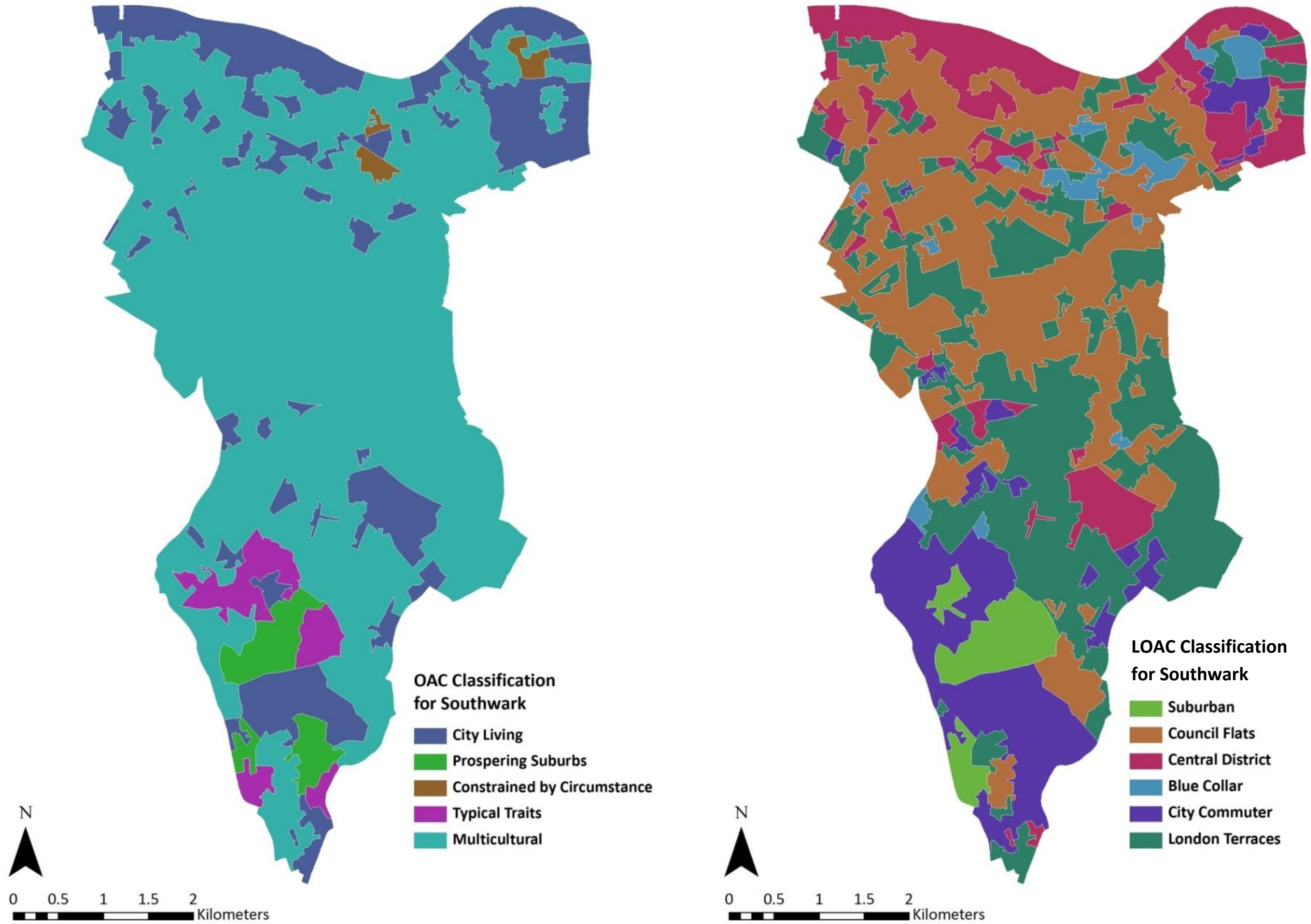

Figure 4: Comparison of OAC (left) and LOAC (right) for Southwark, London (LOAC colours tie in with later analysis).

LOAC Supergroup	Characteristics of Neighbourhood
Suburban	Working age, White ethnic background, two-adult households, large houses, higher education, 2+ cars, routine jobs and part-time employment
Council Flats	Children and young adults, Black ethnic minorities and born abroad, divorcees, single non-pensioner households, lone parents, publicly rented accommodation, apartment blocks, routine jobs, long-term illnesses, unemployed, part-time or economically inactive looking after family
Central Districts	Young adults, born abroad, singles and two-adult households, renting privately, apartment blocks, higher education
Blue Collar	Families, White ethnic background, divorcees, lone parents, two-adult households, renting publicly, terraced housing, routine jobs and part-time employment, economically inactive looking after family
City Commuter	Working age, born abroad, single and two-adult households, apartment blocks, terraced housing, renting privately, large houses, higher education, 2+ cars, part-time employment or economically inactive looking after family
London Terraces	Young adults, Black ethnic background and born abroad, single and two-adult households, renting publicly, apartment blocks, terraced housing, higher education, routine jobs, long term illnesses, part-time employment or economically inactive looking after family

Table 1 : Characteristics of LOAC Supergroups (Source: Petersen et al (forthcoming))

inappropriate. This means that the diversity of Southwark tends to get classified as a single group characterised by diversity, whilst a few remaining areas are classified differently leading to a small numbers problem for these areas. The specifics of this issue are apparent in the mapped representation of the OAC Supergroups, as shown in Figure 4.

To avoid this problem, a London based classification, known as the London Output Area Classification (LOAC), developed by Petersen et al (2007) was used (see Figure 4), the London specific level of the classification meant that there was more variation evident in Southwark, with higher numbers of OAs in each group represented. The implication of this for analysis is a lesser likelihood of encountering small numbers problems, and a greater diversity of neighbourhoods may help in delineating different choices made by individuals belonging to different neighbourhood types. A summary of the core characteristics of the LOAC Supergroups is shown in the Table 1.

5.6 GP Locations for Southwark from Neighbourhood Statistics

The location of GPs is a subset of the national register available from neighbourhood statistics. The georeferenced locations of GPs are from an extract of the NHSCR database from 2006, however all surgeries match the 2009 patient register discussed earlier. There is a record of 48 GPs in Southwark, however some GPs operate out of premises shared with other GPs, so these are aggregated to a single physical location. Likewise, some GPs have multiple practice locations, these are divided to count as multiple GPs. This leaves 44 physical GP locations, named in Figure 3 earlier.

The geographical accuracy of Southwark GPs is likely to be address level, achieved through address matching, and is certainly accurate to postcode level, table 2 shows GP characteristics for each GP based upon ethnicity of the individual doctors, the most common LOAC group of the patients for each GP, and the average age of a patient derived from the patient register. It is notable that Southwark tends towards group practices, rather than single practioner GPs, there are also some trends towards GPs containing doctors with similar ethnicities in some cases.

5.7 Consolidation

This research uses a number of datasets explained above, of course many of them have complex methodologies behind them, such as geodemographic classification, which it is not appropriate to detail here. The next section discusses how these datasets are used to firstly model and then analyse GP choice in Southwark.

GP Name	Ethnicity of Doctors by Surname (onomap)	Mode Neighbourhood (LOAC) of Patients	Mean Patient Age
Abu-Nijaila	1 x Muslim, 1 x English	Council Flats	32
Bhatt	2 x Indian, 1 x English, 1 x French, 1 x Chinese	Council Flats	35
Bhatti	1 x Pakistani, 1 x Sri Lankan	Council Flats	35
Bradford	4 x English, 1 x Welsh	Council Flats	35
Brooks	1 x English, 1 x African, 1 x Pakistani	Council Flats	35
Campion	3 x English, 1 x Spanish	Central District	36
Chudha	1 x Sikh, 2 x French, 1 x English	Council Flats	36
Cliffe	4 x English, 1 x African	London Terraces	36
Critchley	1 x English, 1 x Muslim, 1 x African	Council Flats	33
Curson	4 x English, 2 x Chinese, 1 x Indian	Council Flats	35
Dewji	2 x Pakistani	London Terraces	39
Dickinson	3 x English, 1 x Greek	Council Flats	35
Diffley	3 x English, 1 x Nigerian, 1 x German, 1 x Irish	Council Flats	33
Doha	2 x Pakistani	Council Flats	35
Donmall	4 x English, 1 x Irish, 1 x Indian, 1 x Muslim	Council Flats	35
DugganJones	3 x English, 2 x Muslim	London Terraces	36
Durston	6 x English, 1 x East European, 1 x Pakistani	Council Flats	36
Gupta	4 x Indian, 2 x English, 1 x Chinese, 1 x Polish	London Terraces	32
Herzmark	4 x English, 1 x Vietnamese, 1 x Nigerian, 1 x Indian	Council Flats	34
Holden	2 x English, 2 x Irish	Central Districts	33
HossainMaungetal	2 x Muslim, 1 x Indian, 1 x Pakistani, 1 x Sri Lankan	Council Flats	33
JohnsonSarma	4 x English, 1 x Indian	London Terraces	32
Kadhim	1 x Muslim	Council Flats	32
KayLee	2 x German, 2 x Irish, 2 x French, 2 x English, 2 x Nigerian, 1 x Muslim, 1 x Scottish	Council Flats	35
Kumar	1 x Indian, 1 x French, 1 x English	Council Flats	36
Ledger	2 x English, 1 x Irish, 1 x Israeli, 1 x Pakistani	City Commuter	38
MisraSharma	2 x Indian	Council Flats	35
Moses	1 x English, 1 x Indian	Council Flats	36
Noorullah	1 x Indian, 1 x English, 1 x Muslim	London Terraces	35
PatelVirji	2 x Indian, 1 x English	Council Flats	34
Raana	1 x Hong Kongese, English, Irish, German, Ghanaian, Jewish, Muslim, Indian, Vietnamese	Council Flats	34
Roe	2 x English, 1 x Israeli, 1 x Chinese, 1 x Indian	London Terraces	37
Rogers	6 x English, 1 x Indian, 1 x African	London Terraces	38
Salau	3 x Nigerian, 2 x English, 1 x Indian	Council Flats	33
Samudri	2 English, 2 x Indian	Council Flats	35
Sekweyama	2 x International, 1 x English	Council Flats	32
Sinha	1 x Muslim, 1 x Pakistani	Council Flats	37
Torry	4x English, 3 x Muslim, 1 x Polish, 1 x Indian, 1 x Sikh	Council Flats	34
Varughese	1 x Pakistani, 1 x South Asian	Council Flats	35
Zigmond	1 x English	Council Flats	43

Table 2: Southwark GP doctor ethnicities, mode neighbourhood classification (LOAC) of patient register and average age of patient, from 2009 data

6. Methodology

6.1 Introduction

There are several stages in the methodology of this research; first is the construction of optimal catchment areas from the travel time data from which a synthetic patient register can be created. How these can then be used to delineate GP choice by different patient groups is shown. Some problems are considered, particularly the effect of boundaries. Then a basic measure of entropy is introduced as a way of appraising the fairness of a patient register.

6.2 Preparing the data

Creating an optimal catchment for each doctor means dividing up Southwark geographically so that the area assigned to any particular GP, taking into account the capacity of that GP, is closer to that GP than to any other. In order to work out the optimal catchment for each GP, the travel times from each GP to each Output Area (OA) in Southwark are extracted from the TfL CAPITAL dataset. This data is joined to the OA geography within a GIS and a two-dimensional matrix is formed containing the time required to travel from any Southwark OA to any Southwark GP.

A population is also required for each OA. The ONS records this in disseminated census data, however this data is only appropriate as a snapshot of census respondents on Census day in 2001. In addition, the irregularities present in the patient register with regards to over-reporting the population are mitigated by deriving the population counts and GP capacities from this data source rather than the census. Deriving these two sets of Figures from the patient register data means that we can test two possible solutions for specifying optimal catchment areas. Firstly a model in which the maximum capacity of the GP is constrained, i.e. the GP cannot take more patients in the model than it is seen to take in reality, which can be termed the "GP constrained" model (model 1). Secondly a model in which the maximum capacity of the doctor has to reach a certain level, but then it is allowed to exceed it in order to accommodate potentially unallocated demand stemming from the first model ("OA constrained" model – Model 2).

6.3 Accounting for boundary effects of the data

The geographical scope of this research is Southwark PCT, as such the data are restricted to the PCT boundaries. In spite of this it is perhaps unsurprising that there exist boundary effects. These are characterised by patients that are resident at a Southwark PCT boundary using a doctor in the adjoining PCT (Lambeth or Lewisham for instance). The opposite is also true for patients resident in adjoining PCTs using Southwark PCT services. This can be characterised as primary health care in- and out-migration for Southwark as in Table 3.

Date	In-migration	Out-migration	Net Migration
April 2006	14,839	27,362	-12523
May 2009	16,199	34,658	-18459

Table 3: Values of in- and out- migration for use of Southwark GP services.

It is notable in table 3 that in both cases almost twice as many people use services outside of Southwark PCT than actually come into the system from outside. It is unclear why this would be the case.

The boundary effects evident in Southwark can be mapped, as in Figure 5. It is clear that there is a dominant core which accounts for a 90% uptake by Southwark residents, but also a boundary effect,

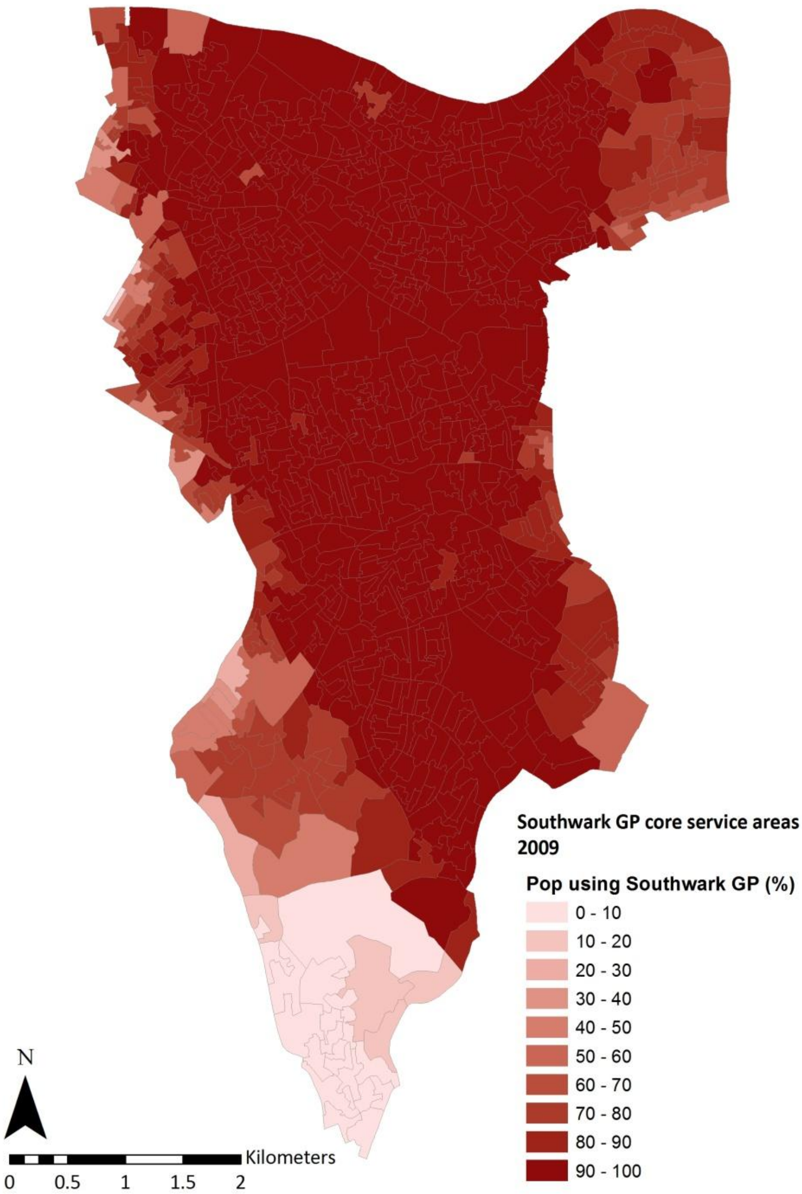

Figure 5: Boundary effects in the uptake of Southwark PCT GP services, 2009.

particularly in the south of the Borough where there is a large drop off in percentage uptake of Southwark PCT GP services. This area in particular coincides with markedly lower rates of accessibility to Southwark PCT services through the public transport network. Higher income and private car ownership in the area may also be a factor in dictating a tendency to travel to the doctors in the Boroughs of Lambeth, Lewisham, Croydon or Bromley. The former docklands in the north-east of the Borough and areas along the western edge of Southwark also show boundary effects.

The remit of a Primary Care Trust, under the current NHS, is that each PCT cover a “separate local area” (NHS, 2009c) and be responsible for “deciding what health services the local population needs and ensuring they are provided and are as accessible as possible” (DoH, 2007). The specific meaning of local is contestable, however given that a PCT is a “free-standing NHS organisation with their own boards, staff and budgets” (DoH, 2007) the general response is to associate this, as Southwark PCT does, with the population living with the bounded area, for example:

“Southwark Health and Social Care is dedicated to improving the health and wellbeing of the people who live in the London Borough of Southwark” – (Southwark PCT, 2009)

The approach in this research, given the constraints of the data, is to take as a base population the entire population living within Southwark that are registered users of NHS GP services. This includes patients that are registered to Southwark GPs as well as non-Southwark GPs. Logically, because a synthetic registered population is being created that accounts for an accessibility-optimised group of patients per GP, it would be inappropriate to exclude those people living within Southwark, but who have chosen to use a non-Southwark GP. These are the characteristics that the research attempts to draw out from the real patient register data. Although the GP system is not a closed system, it has to be treated with less openness than in reality in the context of this modelling approach.

In order to adjust for the impact of including a number of patients not previously registered to a Southwark GP, whilst prohibiting the model to only working within Southwark and with Southwark GPs, the capacity of each GP is increased proportional to the difference between the total Southwark GP list size and the total recorded population. Due to the fact that Southwark has a greater out- than in- migration with respect to uptake of GP services, there is still a deficit in capacity between demand and supply. Thus the two models established earlier apply. This very much reflects the common situation found within locational models of spatial optimisation.

6.4 Constructing Optimal Catchments for GPs

Deriving optimal accessibility catchments for the GPs in Southwark comes down to a classic linear integer programming problem known as 'the transportation problem'. The two models are defined in the next two subsections before the mathematical formulation is shown.

6.4.1 Model 1: 'GP constrained'

The intent of this model is to create a synthetic patient register for the general practices in Southwark that reflects the real patient register in terms of number of registrations by GP. This model is formulated such that in an ideal world in which every member of Southwark used their most optimal GP by taking public transportation, the best service area design for GPs is achieved. Figure 6 shows the mapped result for the 2009 patient registration data.

The implication of this is that because there are more potential patients than overall capacity there are holes in the allocation. The holes are an artefact of lower accessibility with regard to the spatial arrangement of the GPs; they are not necessarily simply related to the accessibility characteristics. Having said this, it is not a surprise that the south of Southwark is excluded from the model, as it shows particularly low accessibility, as well as a low uptake of Southwark GPs by patient registration.

6.4.2 Model 2: "OA constrained"

This model is intended to answer the critique that the holes in the 'GP Constrained' model mean that a specific part of the population of Southwark is being excluded.

Certainly a lower number of people from the boundary areas of Southwark actually use Southwark GPs. However it is always the case that some proportion of the population within these areas does use the GPs and thus contribute to the social make up of the patient register. Given the boundary effects evident in some of the less accessible areas that are included in this model, there may be an overestimation effect. In order to maintain a rough adherence to the actual capacities of the GPs constraint is set so that the GPs have to be at least as big as they are in reality, but are then allowed to expand beyond this to allow for complete allocation of areas in Southwark. Figure 6 demonstrates the model with full allocation for the whole of Southwark.

6.4.3 Definition of transportation problem

Models 1 and 2, discussed above use the same approach given different constraints. The model is defined as such:

Objective function: Minimise $Z = \sum_{i \in I} \sum_{j \in J} d_{ij} \, x_{ij}$

The constraints follow as such:

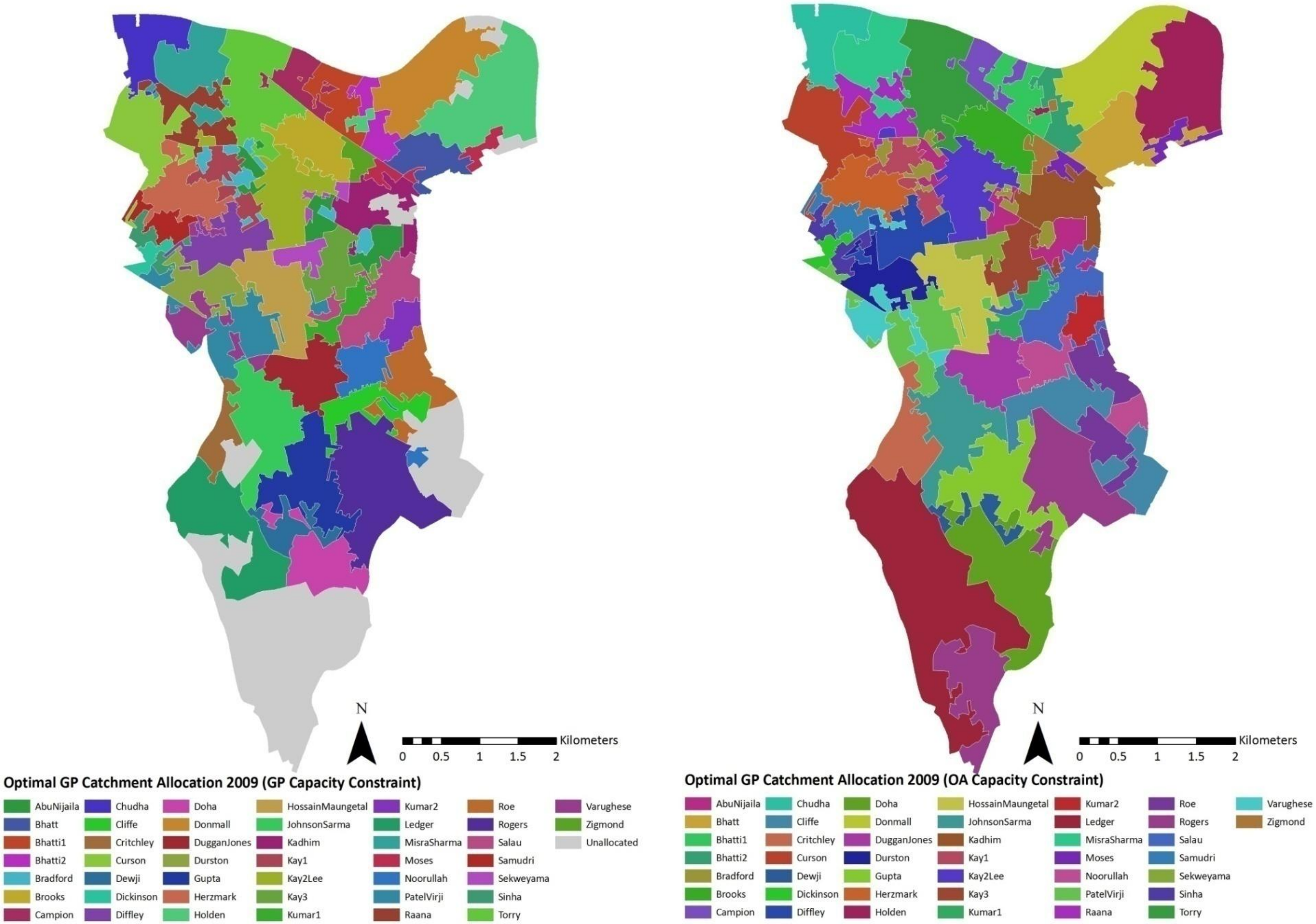

Figure 6: Model 1: 'GP constrained' service areas for Southwark GPs (left) and Model 2: 'OA constrained' service areas for Southwark GPs (right), data for 2009.

Model 1: 'GP constrained' subject to the constraints:

The capacity at a supply site (doctor's surgery) cannot be exceeded $\sum_{i \in I} x_{ij} \leq q_j \; for \; all \; j$

The minimum capacity at a supply site (doctor's surgery) must exceed a threshold amount $\sum_{i \in I} x_{ij} \geq t_j \; for \; all \; j$

The number of people assigned from a particular demand area (OA) to a supply site (doctor's surgery) cannot be negative. $x_{ij} \geq 0 \; for \; all \; (i,j)$

All demand from an individual demand area (OA) is allocated to one supply site (doctor's surgery) $x_{ij} = (0,1) for \; all \; (i,j)$

Model 2: 'OA constrained' subject to the constraints:

All demand at a demand area (OA) must be served $\sum_{j \in J} x_{ij} = r_i \; for \; all \; i$

The minimum capacity at a supply site (doctor's surgery) must exceed a threshold amount $\sum_{i \in I} x_{ij} \geq t_j \; for \; all \; j$

The number of people assigned from a particular demand area (OA) to a supply site (doctor's surgery) cannot be negative. $x_{ij} \geq 0 \; for \; all \; (i,j)$

All demand from an individual demand area (OA) is allocated to one supply site (doctor's surgery) $x_{ij} = (0,1) for \; all \; (i,j)$

Where:

Z is the objective function

I is the set of demand areas (OAs) and subscript i denotes a particular demand area (OA)

J is the set of supply sites (doctor's surgeries) and subscript j denotes a particular supply site (doctor's surgery)

d_{ij} is the travel time separating demand area (OA) i from supply site (doctor's surgery) j

x_{ij} is the number of people from demand area (OA) i allocated to receive service at supply site j, all demand at a demand area (OA) i must be allocated to a particular supply site (doctor's surgery) j

q_j is the total capacity of supply site (doctor's surgery) j

t_j is the minimum number of people to be served by supply site (doctor's surgery) j

r_i is the total number of people to be served in demand area (OA) i

6.5 Creating a synthetic patient register for comparison

In order to create a synthetic patient register, the registered patient list is taken and spatially joined with the required information; this includes geodemographic group as well as the optimal GPs surgery for each of the two models. This dataset of c.300,000 individuals with associated attributes can then be exported and investigated in a statistical package. Analytically it is useful to use the geodemographic classification initially as it is the most generalised data in the dataset as it is areal and a summary of a number of census variables. This allows an insight into patterns at the neighbourhood level, before individual level data on ethnicity is considered.

6.6 A basic measure of equity

The analysis uses a measure of entropy as a basic indicator of equity. The entropy score calculated is based upon Theils H, a measure of evenness across multiple groups (Iceland, 2004). This is an indication of the extent to which groups of people are evenly distributed across different organisational units such as census districts, and in this case GPs.

The entropy score itself measures the extent to which multiple groups are present, in this case different groups within the LOAC classification, or the Onomap ethnicity classification. The entropy score for each GP should give an idea of how diverse the registered population is. The score for the real patient list can be compared to the synthetic patient list in order to see whether the diversity is spatially equitable.

The entropy score is given by the following (Batty, 1974):

$$E = -\sum_{i} p_i \log p_i$$

Where p_i is a particular group's proportion within the context of that organisational unit, be it an individual GP or Southwark as a whole.

6.7 Consolidation

The next section presents an analysis of the data derived using the methods specified in this section.

7. Analysis

7.1 Introduction

There are two main sections to this analysis, presented first an analysis of changes in GP list composition and GP entropy by neighbourhood classification, and secondly an analysis of changes in GP list composition and entropy by Onomap ethnicity classification. The subsequent discussion in the next section will attempt to link these observations to choice and equity.

7.2 Neighbourhood differences between actual GP registration and synthetic GP registration

7.2.1 Introduction

This section describes the coarsest scale of analysis undertaken in this research, using the London output area classification (LOAC) to investigate variation in GP patient register composition by neighbourhood type.

The geography of LOAC means there will be a scale effect in the data. The synthetic patient register is constructed using LOAC which uses OAs as the base unit. Each OA in Southwark contains an average of 380 people in Southwark, calculated for the 2009 patient register. This means that the implied unit of comparison is not changes in individual registration by neighbourhood, but changes in neighbourhood registration by neighbourhood size. Nevertheless, part of the utility of general practices is that they are spatially dependent, as they are intended to provide a 'local' service. As a result, a limited subset of neighbourhoods is expected in the modelled data when compared to the real data. This is because 'noise' in the real data is expected to characterise patient choice of GP.

This in mind, the key is to find large anomalies in the real composition of a GP's patient register when compared to the synthetic register; small changes may be artefacts of the scale effect.

7.2.2 Analysis of GP patient register neighbourhood composition data

The comparison of GP registrations to modelled registrations are reported in Figure 8. Each group of three bars relate to a single GP; the first bar is the composition of real patient registration; the second bar is the synthetic register created from Model 1, optimising geographic accessibility but constrained by GP capacity; the third bar is the synthetic register created from Model 2, optimising geographic accessibility, whilst also assuring that all of Southwark is served.

The most immediately striking pattern in Figure 8 is how different GP Ledger is when compared to others. Much of Southwark consists of the LOAC groups: Council flats and London Terraces, as shown by Figure 7. This is reflected in the patient register composition of most Southwark GPs, GP Ledger, however, is mostly comprised of the minority 'city commuter' group and also is the only doctor to have a sizable proportion of the tiny suburban group.

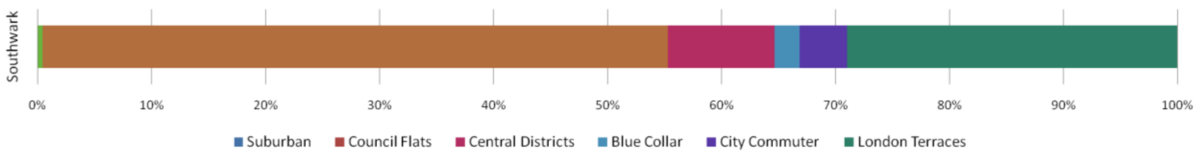

Figure 7: Composition of Southwark population by LOAC supergroup, 2009

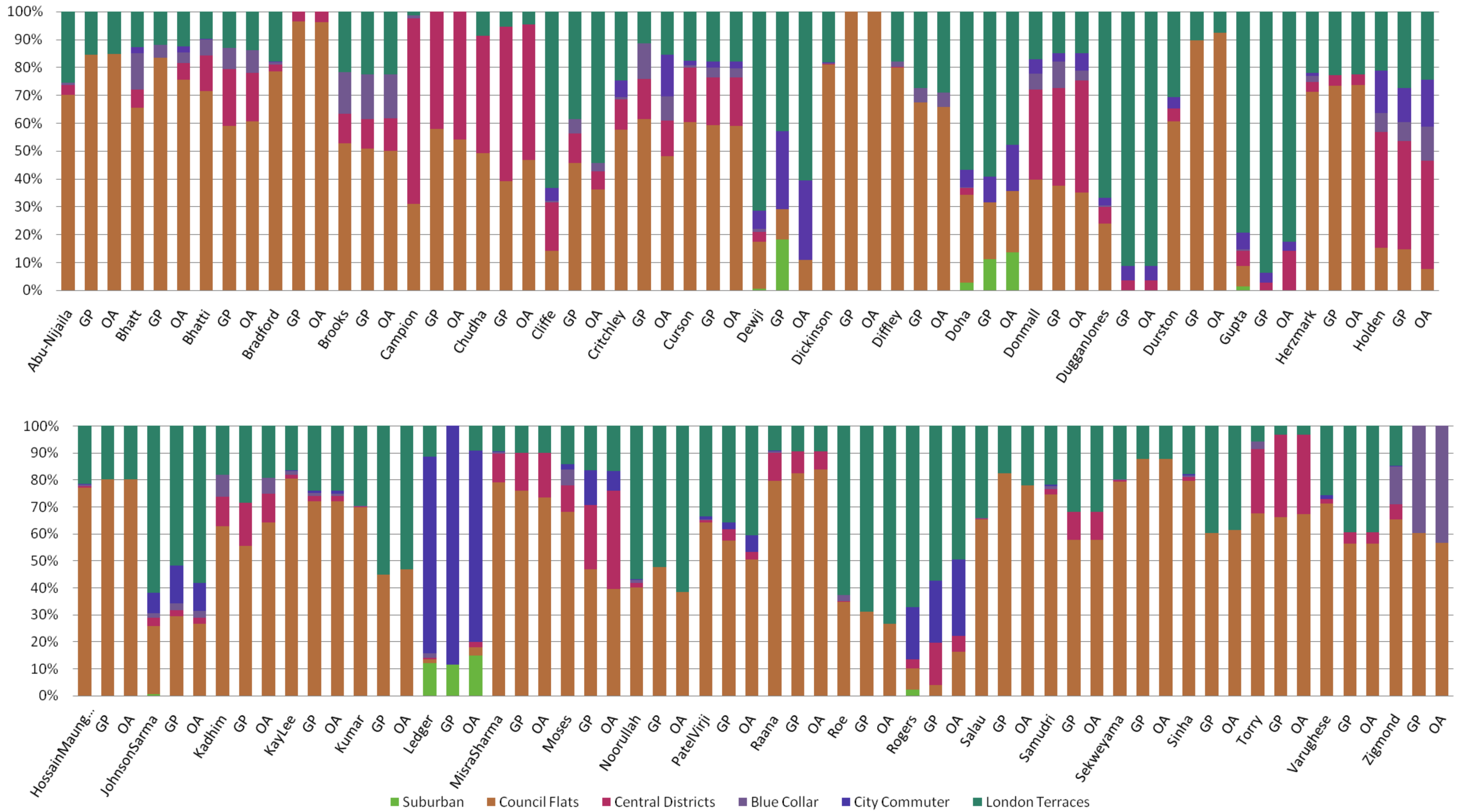

Figure 8: GP patient register composition by LOAC, ordered by real GP register, the synthetic GP register for Model 1 (GP constrained) , and Model 2 (OA constrained), then by GP alphabetically, 2009

Several other GPs show interesting differences between the real patient register and the synthetic register. Staying with the tiny suburban group, it seems that GP Rogers attracts a small proportion of people from this neighbourhood, without this being reflected in the modelled registers. Conversely GP Doha and GP Dewji who, according to the synthetic registers should attract a comparatively sizeable proportion of suburbanites, actually in reality do not.

Other differences are also evident. From the synthetic register it is expected that GP Campion serve a large proportion of the Central Districts neighbourhoods due to the presence of such areas in the GP's local area, but the real situation goes beyond this expectation. As such the Council Flats group which should be in the majority for this GP is not.

In a similar situation to GP Ledger, GP Holden serves a very broad range of different types of neighbourhood, which like GP Ledger is backed up by the model. The model indicates that they have located within a very socio-demographically interesting area and may face diverse challenges within their GPs.

Several GPs with White British senior doctors are seen to deal with a lower proportion of patients from the council flats group than would be expected from the synthetic patient registrations. These include GP Bradford, GP Cliffe, GP Dickinson, GP Campion and GP Durston. A number of GPs with non-white doctors serve more people from the council flats group than is expected by the synthetic registers, such as GP Bhatti, GP Moses, GP Dewji and GP Sinha as well as other GPs with White British lead doctors such as GP Roe and GP Diffley.

7.2.3 Analysis of entropy scores for GP patient register neighbourhood composition

An entropy score was created for each GPs real patient register as per the method in section 6.6. The scores were only created for the real patient register in this case due to the issue of scale effects in the modelled patient registers previously mentioned, and thus the presence of each in GP register of a number of LOAC groups with zero values. Therefore the values for each GP are compared to the Southwark average.

There are six LOAC groups accounted for in Southwark, giving a maximum possible entropy score of the natural logarithm of six, or 1.792. A higher entropy score simply indicates a higher level of diversity, Figure 9 shows the entropy scores calculated for the real patient registers for Southwark GPs in 2009, note the score for the whole of Southwark in red.

Figure 9 suggests that Southwark doctors are prone to specialise in the treatment of specific groups, all but three GPs fall below the average value of entropy for Southwark. In particular GPs such as GP Dickinson, GP Diffley, GP Sekweyama and the association of practices belonging to GPs Hossain,

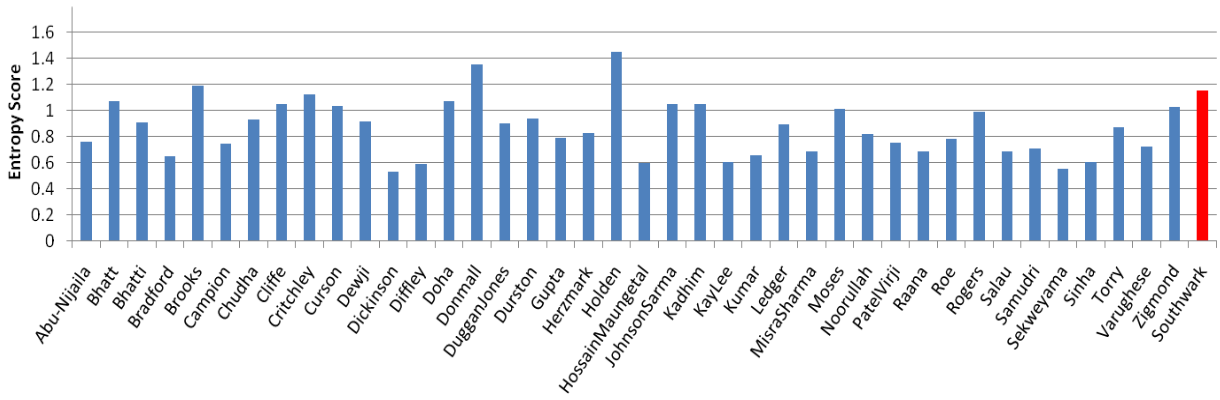

Figure 9: Entropy scores for GP patient registers by LOAC, 2009

Maung, Ullah and Arumugaraasah score particularly low. Figure 8 confirms this, showing patient register populations that are very directed at particular neighbourhood groups. By way of contrast, GPs Holden, Donmall and Brooks all receive an entropy score greater than Southwark's indicating that they have a higher diversity of patients than the Borough average, and indeed better proportional representation of minorities than exists for Southwark itself.

7.2.4 Consolidation

Despite being a reasonably coarse and general indicator of the characteristics of a population within defined neighbourhoods, there are distinguishable patterns in patient registration by LOAC supergroup. The reasons behind this are suggested in the discussion section later. The next part is an analysis of ethnicity in the same vein as the neighbourhood analysis presented above.

7.3 Analysis of GP patient register Onomap ethnicity composition data

7.3.1 Introduction

The motivation for this analysis is to help to uncover whether there is a cultural, ethnic, or linguistic component in the way individuals choose a GP. Using individual patient level data, this analysis compares the likely ethnic composition of each GP patient register, coded by the Onomap classification, with the synthetic patient register created by reassigning individuals to a GP based upon the two models described earlier.

Given some of the trends in patient register composition in terms of the LOAC analysis, it is likely that echoes of this will be apparent in an assessment of ethnicity. However the individual level of analysis allows for a much finer appreciation of the differences evident. Despite this, there may still be a spatially determined link between likely locations of particular ethnic populations due to processes of residential segregation.

7.3.2 Analysis of GP patient register neighbourhood composition data

Figure 10 shows the composition of Southwark GP patient registers across 14 different ethnic,

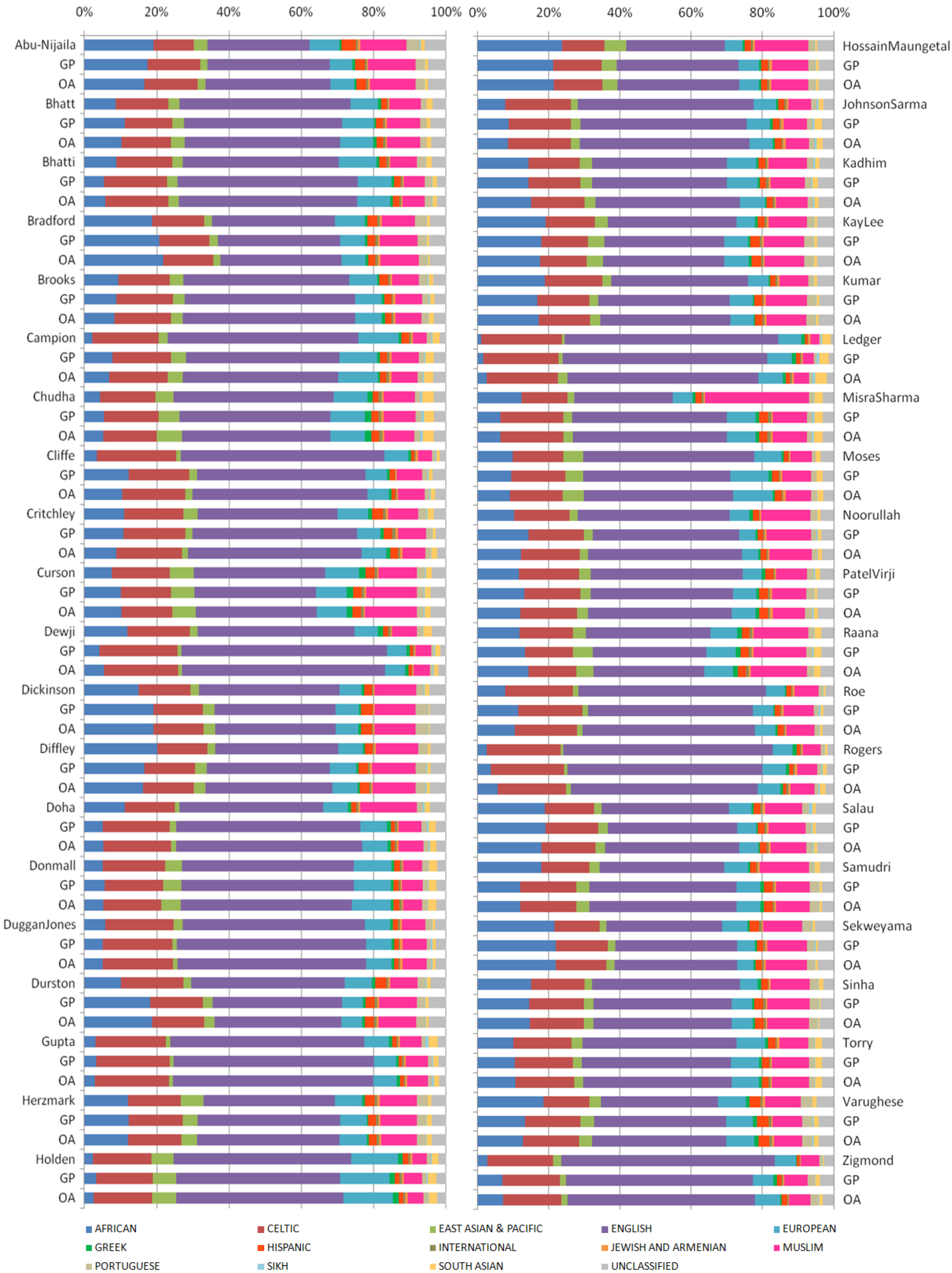

Figure 10: GP patient register composition by Onomap ethnicity, ordered by real practice register, Model 1 (GP constrained register) and Model 2 (OA constrained register), then by GP alphabetically, 2009

linguistic or cultural classes. In the original Onomap classification the ‘Nordic’ group and the ‘Japanese’ group have been classified with ‘European’ and ‘International’ respectively as there were very low numbers of people belonging to these groups living in Southwark. This could not be done for the Hispanic and Portuguese groups, however, as it was possible that they would contain Latin American individuals.

The Onomap classification for the whole of Southwark for 2009 can be seen in Figure 11. It is notable that even though the Borough of Southwark is regarded as a ‘multicultural’ area, and is classified as such by the ONS Output Area Classification (OAC), the non-white population is still in the minority.

Figure 11: Southwark population ethnic composition, based on patient register for 2009.

In terms of the composition of GP patient registers, there are some interesting anomalies that occur in the real register that are not present in the synthetic registers. These revolve around particular population groups being under or over represented than they ought to be relative to the accessibility of a GP.

Taking the initial analysis using LOAC, it was shown that GP Ledger, and GP Holden were fundamentally different in patient composition by neighbourhood type than other GP. This is manifest in the ethnicity composition of these two GPs both of which have very low proportions of African patients in favour of high proportions of English, Celtic and European people. In this case however the comparison of the real register to the expected composition of the patient register does not show any major differences; it is simply that these two doctors are situated in areas that are distinctly different in terms of ethnic makeup to the rest of Southwark.

There are several GPs which have unexpectedly high populations of particular groups. The two most notable are GP Doha and the combined practice of GP Misra and GP Sharma which have over twice the expected proportion of Muslim registered patients than the modelled patient registers suggest they should. Similarly GP Samudri and the group of 4 GPs Hossain, Maung, Ullah and Arumugaraasah have a greater than expected number of Muslim patients. This is coupled, as with GPs Doha, Misra and Sharma, a lower than expected proportion of Celtic or English patients. GPs Misra, Sharma, Samudri and Doha, and GPs. Hossain et al, also account for a larger proportion of African patients than expected. Similarly several GPs serve greater proportions of the English group than would be expected, for instance GPs Campion, Durston, Rogers, Zigmond, Roe and Moses and Cliffe, this seems to be at the expense of proportionally fewer spaces for African patients.

Differences in the minority groups are unclear because they represent smaller proportions of each GP as a whole. Thus they are very susceptible to small number problems where the presence or absence of one or two people can lead to an apparently large comparative difference being observed.

In terms of the synthetic patient registers, most of the minority groups have some representation for each GP. There are some differences in uptake, but nothing as striking as for the majority groups shown previously. East Asian and Pacific peoples make up the largest of the minority groups shown in Figure 11, accounting for around 3.3% in 2009 and equating to around 10,000 people. There are greater than expected levels of uptake in some GPs such as GPs Herzmark, Hossain et al, Critchley, Duggan, Jones and Abu-Nijaila and subsequently lower levels in other GPs such as GPs Durston or Diffley, however these changes are not of the same magnitude as examples amongst Muslim or English patients.

7.3.3 Analysis of entropy scores for GP patient register Onomap ethnicity composition

As shown in the previous section of analysis using LOAC, entropy scores will be used to consider the relative diversity of GPs, however this analysis will also show whether the GPs themselves differ from the level of diversity that is expected from them based upon the synthetic patient register. This will allow an assessment of the fairness of the patient register composition, based on a geographical accessibility criterion.

In this particular case there are 14 possible classifications leading to a maximum possible entropy score of 2.64, with Southwark as a Borough scoring around 1.9 in 2009.

From Figure 12 it is clear that there are five or six GPs which have service areas that are substantially less diverse than the norm for Southwark. These include GPs Dewji, Gupta, Ledger, Rogers and Zigmond. GPs Dewji and Gupta, however, have diversity scores based upon the real patient register that are greater than expected based upon the synthetic registers.

Conversely GPs Rogers, Zigmond and Ledger have entropy scores which are below the expected levels of entropy from the synthetic registers. In fact these GPs are joined by several others that have similarly lower than expected entropy scores compared to synthetic registers such as GPs Campion, Cliffe, Moses and Roe but who are expected to have more diverse registers comparative to

Southwark. These GPs seem to be characterised by unexpectedly high proportions of a particular ethnic group, characteristically the ‘English’ group.

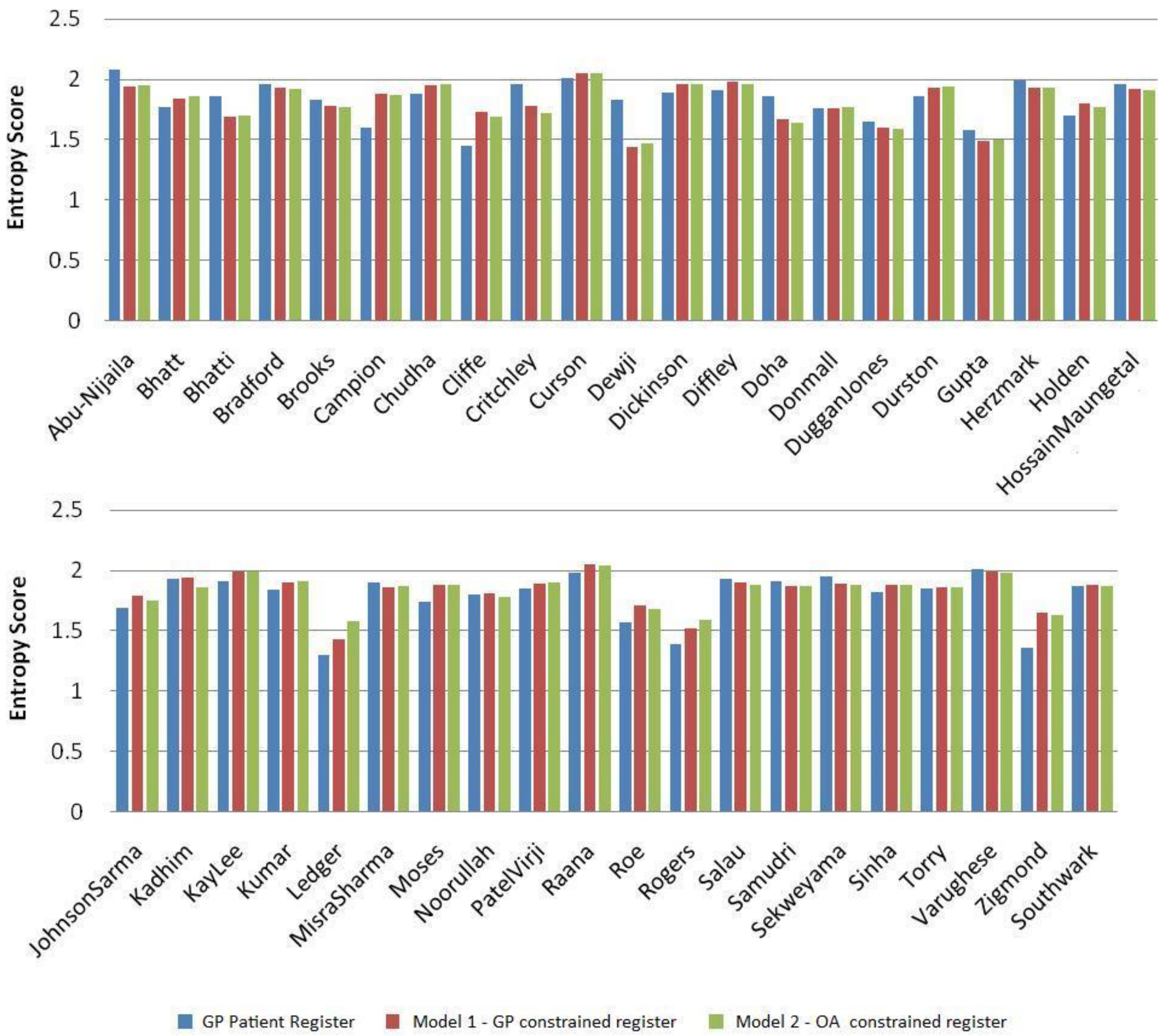

Figure 12: GP patient register Onomap ethnic diversity using entropy scores, by real practice register, model 1 (GP constrained register) and Model 2 (OA constrained register), then by GP alphabetically, 2009.

A number of GPs actually record diversities above and beyond what is expected, including GPs Abu-Nijaila, Dewji, Critchley, Herzmark and Bhatti. This agrees with the analysis of the composition of patients in the previous part, these GPS have notably high proportions of minority populations at the expense of majority populations creating a more even patient list composition by ethnicity.

7.3.4 Consolidation

The analysis of ethnicity seems to corroborate with the LOAC analysis in suggesting that there do exist differences in the composition of GP patient registers between the real register and the modelled, accessibility based register. This is a good indication that patients are making some non-accessibility based choices when it comes to choosing a GP, and that these choices may be based on the socio-economic characteristics of the patient (demand side) and the characteristics of the GPs themselves (demand side). The final section discusses these findings.

8. Discussion and Conclusion

8.1 Introduction

The first part of the discussion links the analysis back to some of the ideas of choice and equity previously discussed. Subsequently the limitations of the research are considered. Finally a conclusion is presented that includes ideas for further work.

8.2 Patient choice of GP: Evidence from patient register composition.

8.2.1 Neighbourhoods and Health using LOAC

Neighbourhoods are important in the study of health, particularly in the urban context (Macintyre and Ellaway, 2003). The council flats neighbourhood is an interesting example of the effects that neighbourhoods can have on patient register compositions. There are no GPs with ethnically English lead doctors who have a greater than expected patient register composition of the council flats group. This includes GPs Dickinson and Diffley who the model anticipates will draw a patient register almost exclusively from this neighbourhood. This may be because there is simply a greater chance of the council flats group having greater numbers of non-white population, who would rather see a doctor of their culture or ethnicity. Similarly the presence of an ethnically English doctor may draw other English or Celtic patients in from different, less local, neighbourhoods.

There is a range of literature on neighbourhoods and health, and undoubtedly ethnicity is a very important component of a sense of neighbourhood. However the geodemographic approach is widely considered to provide richer insights into neighbourhood processes than solely ethnicity, which is considered independently in this research. Certainly Kawachi and Berkman (2003) link rising residential segregation to neighbourhood processes, but also to class segregation. This may be an important factor in which GP individuals choose to visit – use of a GP within a neighbourhood which is at least as socio-economically desirable as your own may lead to a belief that health outcomes, and quality of service will be better. It may also suggest a need to mix with a class of people with issues similar to your own. As such residential segregation patterns that are increasingly linked to a widening gap between rich and poor may be being mirrored in access to, and choice of, public services.

GP Ledger's stark compositional contrast seems to be due to his location, one of few GPs in the geodemographically different southern part of Southwark. It is not the only GP available in this area, but certainly the only one with an ethnically English lead doctor. This is similarly true of GP Rogers who attracts individuals from the suburban group who, if travelling from home, would certainly have to pass GPs Doha and Dewji in order to access GP Rogers. It is possible this is a reaction to the neighbourhood type which most accounts for the patient register composition. GP Rogers contains a relatively large proportion of the city commuter group compared to other GPs. The city commuter group is socio-economically more similar to the suburban group than the London terraces' and council flats, which GPs Dewji and Doha are characterised by.

A similar story can be seen to unfold for GP Campion's surgery, which attracts an increased number of individuals from the central districts neighbourhood type. It could be argued that GP Campion is no more advantageously positioned than GP Bhatti, however GP Campion gets the majority of patients from the central districts' group and GP Bhatti far fewer than expected. GP Campion's surgery is based within the central districts classification with GP Bhatti in the council flats classification and this difference may explain differential uptake by individuals who feel they belong more to one particular neighbourhood type than another and use a GP situated accordingly. Having said this, there seems to be a preference in this group for an ethnically English lead doctor, over a non-English one.

Cliffe is an interesting GP in this respect, located within an area classified as central districts there are certainly more patients registered from this neighbourhood class than would be expected. There are also far more city commuters and London terraces neighbourhoods represented and significantly fewer 'council flats' than the two models would suggest. This is in spite of accessible areas classified as council flats to the north and east of GP Cliffe. The location of the surgery within a particular neighbourhood context may simultaneously be attracting a particular patient type, whilst distancing others. Equally, there may be greater barriers to access for the council flats groups than other groups.

The question raised by any evidence of segregation, as observed here amongst GPs in terms of neighbourhood types, is whether or not the de facto specialisation of certain doctors for certain groups is fair. This cannot necessarily be answered without specific recourse to a quantification of the relative performance of GPs. This in mind however, there is a specific difference between some types of specialisation, such as women wanting to see a female doctor, which might be deemed allowable or even acceptable, and others such as neighbourhood or ethnic specialisations.

8.2.2 Ethnicity and Health using Onomap

The analysis of ethnicity in GP choice using Onomap (Mateos, 2007) presents some interesting patterns. In a number of cases the patterns shown in the analysis seems to support a situation in which people that belong to particular cultural, ethnic or linguistic groups are more inclined to use a GP which employs doctors that belong to the same, or a similar Onomap group.

This is certainly true of GPs such as GP Campion, which employs a wholly European staff of doctors, whilst having an ethnicity profile that very much seems to favour individuals of English and Celtic background. This also goes some way to explaining why GPs such as GPs Critchley or Torry, who appear at first to have lead practioners from a white ethnic background, do not seem to show strong neighbourhood or ethnicity preferences: the doctors employed at these surgeries represent a number of different cultural or ethnic groups, and often speak languages that are useful in the context of the communities found in Southwark.

At the other end of the spectrum, GPs such as Misra, Sharma and Dewji have staff that are exclusively one ethnicity or cultural group. It is perhaps unsurprising that these GPs seem to be favoured by individuals of the same culture or ethnicity as the doctors. This might be for reasons including the importance of sharing a common language with the doctor, particularly if a patients English is not perfect, or the patient feels uncomfortable using English in a health situation. Likewise Europeans may be concentrating at certain surgeries due to the presence of a Polish-speaking receptionist – just as the GP is the gatekeeper to the NHS, the receptionist is the gatekeeper to the GP.

The question is whether these trends towards increased segregation on the basis of doctor-patient similarity is fair. The entropy scores, whilst by no means a well developed indicator of everything that might be considered important in defining equity, nonetheless give an interesting window into whether the GPs lists represent a fair level of diversity, based on their particular locational constraints. As such the pattern that seems to be present suggests that GPs with a composition of doctors that is very English or European, are less diverse than would be expected, and indeed are less diverse than GPs that employ a mix of cultural and ethnically different doctors.

This observation inevitably favours larger GPs, symptomatic of the new model of NHS primary care. In fact the GPs that exhibit patterns of increased segregation tend to be smaller GPs with either a single doctor or no more than a couple of doctors. The suggestion is therefore that some segregation may be caused by engagement with the more traditional model of a personal, family, doctor. This design is often argued to provide a better continuity of care for patients as well as a better appreciation of the specific health outcomes of certain communities, as well as being more reassuring for the patients themselves. However, larger GPs have specific advantages towards provision of a wide range of treatments and services. As well as greater chance of getting a useful appointment, and potentially better representing patients from the whole local community rather than a particular subset.

8.3 Some limitations of this research

Much of what has been presented in the analysis, and that has been considered throughout, is founded on modelling through an area-based analysis. This area-based representation underpins the calculation of synthetic GP patient registers, as well as the geodemographic classification of neighbourhoods as in LOAC.

Longley et al (forthcoming) discuss the nature of centrality in area-based analysis, where the generalised attribute for an area is represented by the centre of the area, the “two-dimensional equivalent of the mean” (Longley et al, forthcoming). This is particularly useful when minimising total travel time for a number of facilities, as in the ‘transportation problem’ discussed earlier. Centrality constitutes a discrete approach to optimisation, points are allocated, and with them the ‘building block’ of the area for which the point stands. As such the model is one that carves up the territory and allocates based on a conceptually homogeneous neighbourhood. The limitation this poses has already been considered in terms of scale effects for LOAC earlier (section 7.2.1).

Additionally, it inherently restricts the precision of the solution, as the size of the building blocks, the OAs, vary with population density. Thus there may be a bias in the less populous areas, which are inherently larger, towards a less reliable solution for the synthetic patient registration models. Having said this, all the models computed were very similar, even accounting for varying population size and constraint characteristics, suggesting stability in the process. Furthermore, the nature of modelling suggests that the intent is to manage the complexity of the real world, and create a form that represents chosen aspects of reality. The core element of this research embraces the fact that only one aspect of real world complexity is controlled, allowing the other influences of choice to come to the fore.

Often geographical approaches that using spatial analysis are intentioned toward results that are generalisable for the population(s) that they analyse. This is not the case in this research, to start with the population being considered is the whole population of Southwark, rather than a sample from which inference could be made. The population only accounts for Southwark, which is not especially representative of anywhere other than Southwark, perhaps a case could be made for similarity to Lambeth or Lewisham, but certainly not nationally. What is evident is that the analysis undertaken points towards specificities, that is: results that are characteristic of the particular situation being investigated, with the particular nuances of the population accounting for the patterns seen. Certainly there are notable trends, but they are not evident in all cases. Of course nothing stops these trends being something that is actively sought out in other contexts to investigate whether a similar pattern is present elsewhere, it cannot however simply expect that similar patterns in other areas will be seen.

It is very likely that there exists a level of spatial determinism in the results, spatial determinism being the idea that the characteristics of a phenomenon are determined by its location, or the characteristics of that location. Under this assumption, the specifics of a neighbourhood influence the observed pattern, and can explain why it does not occur elsewhere, the patterns that are apparent in the analysis in this research are contingent on a lot of factors, the influence of place- a spatially deterministic process- may be one of them.

Regardless of whether the pattern shown in the analysis can be said to be generalisable or not, there is another aspect of their interpretation that needs to be considered, that of causality. Causality refers to the interpretation of the way in which an association observed was caused. The intent in this research is to investigate variations in registration to GPs due to choice, that different characteristics may cause groups to choose GPs other than those closest to them. This hypothesis assumes that everyone has a level playing field and a fully supported right to choose, this may not be the case. Some population groups may choose a particular doctor through lack of choice. If for instance their closest GP refuses their admission to the patient register, necessitating their registration at a different GP, this would constitute a lack of choice.

This is the articulation of the question over equity versus choice, is a decision to use a particular doctor founded on freedom to choose, or an inherent limiting of justice? Naturally there is no way of analysing the causality of the situation in this research, and patient choice is assumed, as it is a socially just mechanism in primary care provision. The alternative is that doctors are cherry-picking the patients they want, a situation for which there is no proof and is unlikely to be happening in the vast majority of cases. In spite of this there are several reports in media suggesting that cherry-picking may be an issue (see for example Manchester Evening News, 2002; Pulse, 2009).

Finally it is interesting to note that the GP level scale of analysis creates a reasonably coarse interaction between individuals and GPs, in that a GP will usually contain more than one doctor. As such it is possible to observe community and neighbourhood based choice effects as shown, but much more difficult to show how individual characteristics such as age and sex have an effect. This is because there is a mixing effect which masks differences in uptake for individual doctors by taking an average for the GP surgery as a whole. As such investigations into the effect of sex on choice did not show any notable patterns because the effect was masked, likewise age. Although age did show some concentrations of young and old patients at particular GPs, this may be due to the specialism of some doctors towards geriatric or paediatric medicine.

8.4 Conclusions and further work

Limitation to the research in mind, it is clear that there are some dominant and tangible patterns in the data analysed that point towards particular population groups engaging in behaviour that constitutes choice. Additionally it is interesting to note that these behaviours may not necessarily be geared towards maximising health outcomes, but are potentially the result of seeking a comfortable health care scenario in line with the patient's ethnic or socio-economic status.

On a more general level, this research provides significant evidence of the value and the increasing need for social research into health care services and the characteristics of populations. Shifts in the health system concerned with reinterpreting the role of the NHS with regard to accessibility, equity and the increasing basis for community health, the role of neighbourhoods and places within the health system, have made such enquiry particularly relevant. Undoubtedly this is a vast area of study, and this research does very little beyond highlighting some interesting patterns in the patient characteristics of health services at a very local level. In particular highlighting some differences in patient choice of GP through the filters of neighbourhoods and ethnicity.

There is no reason to believe that such patterns are not evident elsewhere, at a variety of scales, and with similar implications in terms of the social and political effect as this example of Southwark PCT. Certainly the possibility of links between the kind of demand effects shown, trends in uptake by specific population groups, and the supply side effects, characteristics of the GPs and of the service provision, need to be more explicitly investigated.

Social scientists are often quick to highlight the differences in the role of equity, fairness, within a public service and the role of efficiency. The supposition made is that choice in the context investigated is an extension of the fairness argument. However, choice as exhibited by people from particular ethnicities may be a choice based upon efficiency. Efficiency to the extent that they are able to better articulate their health issues, and receive culturally sensitive, or specific, treatment from a doctor of their ethnicity or cultural background. This is notably still a choice, however it may be a different kind of choice to those being made by people living in a particular type of neighbourhood and wanting to see a consistency in their environment.

There are also broader issues to be considered, the nature of segregation being one of them, whether an apparent specialisation is beneficial to the communities served or if it actually creates an issue in terms of healthcare equity. This is only achievable by introducing measures that relate to health outcomes and primary care performance, interestingly the NHS have so far managed to avoid an overt ranking of GP quality. The next best thing is the Quality and Outcomes Framework (QoF)data which assesses some elements of GP performance nationally, however the data is lacking in demographic patient information making it subject to socio-economic bias if used as a performance measure. Connected to this, there is also the question of GP workloads, in that performance to a greater or lesser extent may be influenced by the characteristics of a GP's patients. GPs with registrations from particular socio-economic (or geodemographic, to tie in with the analysis of neighbourhoods) group will intrinsically have different workloads. Some groups, such as families with young children, will consume primary care resources faster than other groups. Specialisation in this case may provide higher performance for a high consumption group and be more efficient in terms of resource allocation, whilst also being equitable in terms of the performance gains for other groups.

The greater impetus for this research is to extend the scale of investigation, incorporating London and perhaps the UK and attempting to model some of the characteristics observed at the local scale in a more generalised approach from available data. This would allow an assessment of regional differences in equity, a greater appreciation of neighbourhood effects, and possibly urban-rural characteristics as well as ethnicity characteristics. The Southwark data set on its own has a lot of potential, and further investigation of this through an investigation of flows and spatial interaction, as well as analysis of health needs and neighbourhood, place or community characteristics (however so defined) could bring together a wider appreciation of the contemporary health system at the scales discussed. Additionally, research is needed to construct a model of health outcomes, and delineate different groups of healthcare users, in order to better understand the effects of population on choice, GP performance and GP workloads.

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10. Acknowledgement

All maps are subject to the following acknowledgement:

Crown Copyright Ordnance Survey. An EDINA/JISC supplied service.

This research was undertaken at University College London (UCL) with funding as part of an ESRC-CASE award in collaboration with Southwark Primary Care Trust.