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Citation: Cookson, R., Laudicella, M. & Li Donni, P. (2013). Does hospital competition harm equity? Evidence from the English National Health Service. *Journal of Health Economics*, 32(2), pp. 410-422. doi: 10.1016/j.jhealeco.2012.11.009

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Does hospital competition harm equity? Evidence from the English National Health Service

Draft date: 05/11/12

Richard Cookson (a), Mauro Laudicella (b,c), Paolo Li Donni(c)

(a) Centre for Health Economics, University of York, UK

(b) School of Health Science, City University London, UK

(c) Business School and Centre for Health Policy, Imperial College London, UK

(d) Department of Economics, Business and Statistics, University of Palermo, Italy

ABSTRACT

Increasing evidence shows that hospital competition under fixed prices can improve quality and reduce cost. Concerns remain, however, that competition may undermine socio-economic equity in the utilisation of care. We test this hypothesis in the context of the pro-competition reforms of the English National Health Service progressively introduced from 2004 to 2006. We use a panel of 32,482 English small areas followed from 2003 to 2008 and a difference in differences approach. The effect of competition on equity is identified by the interaction between market structure, small area income deprivation and year. We find a negative association between market competition and elective admissions in deprived areas. The effect of pro-competition reform was to reduce this negative association slightly, suggesting that competition did not undermine equity.

JEL classification: I1, L3

Keywords: competition, hospital, inequality

Acknowledgements:

This working paper arises from research project SDO/164/2007 funded by the UK Department of Health NIHR SDO research programme and managed by the Department of Health PRP Health Reform Evaluation Programme. The project was entitled “Effects of health reform on health care inequalities”. The views and opinions expressed in this paper are those of the authors and do not necessarily reflect those of the SDO programme, NIHR, NHS or the Department of Health. Hospital episode statistics data, QOF data and GP practice attribution data were provided by the NHS Health and Social Care Information Centre, on license from the Department of Health. Mid-year population estimates were provided by the Office for National Statistics. Preliminary results were presented at the American Society for Health Economics (ASHE) meeting in July 2010 and at the Health Economists Study Group meeting in York in January 2011. For useful comments and discussions, we would like to thank Sara Allin, Mark Dusheiko, Hugh Gravelle, George Leckie, Nick Mays, James Nelson-Smith, Carol Propper, Eileen Robertson and Andrew Street. We would also like to thank Mark Dusheiko from the University of York Centre for Health Economics for facilitating access to the HES, QOF and GP practice attribution data used in this project, the Northern and Yorkshire Public Health Observatory for facilitating access to population data, and Peter Halls for calculating travel distances used in preliminary versions of our competition indices. The maps in this paper are reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty’s Stationery Office © Crown Copyright.

1 Introduction

There is a substantial body of economic theory and evidence about the effects of competition on the cost and quality of hospital care (Gaynor, 2006). It is known, for instance, that competition can improve quality (Kessler and McClellan, 2000) though not if buyers have poor information about quality (Propper et al., 2008). Less is known, however, about the effects of competition on socio-economic inequality in hospital care (Cookson et al., 2010). We aim to provide some evidence in the context of the pro-competition reforms of the universal and comprehensive English National Health Service (NHS) between 2003 and 2008.

The reforms were introduced by a Labour administration led by Prime Minister Tony Blair and his Chancellor Gordon Brown, who subsequently became Prime Minister from 2007-10. These “Blair/Brown” reforms fostered competition in two main ways. First, on the supply side, independent sector (IS) hospitals were encouraged gradually to enter the market for NHS funded patients: we estimate that IS activity made up 0.03% of NHS non-emergency inpatient activity in 2003/4 rising to 2.17% by 2008/9. Second, on the demand side, patients were offered a choice of hospital from December 2005 and case based hospital payment was gradually phased in from 2003/4 to 2008/9 so that money would follow the patient’s choice (Department of Health, 2003). Prime Minister Blair predicted his reforms would enhance equity for poorer patients, by increasing hospital capacity and patient choice (Blair, 2003). By contrast, critics predicted that choice and independent sector provision would undermine socio-economic equity (Appleby et al., 2003; Barr et al., 2008; Oliver and Evans, 2005; Tudor-Hart, 2006). Evidence on the equity effects of competition is timely, as at the time of writing the English NHS is embarking upon another controversial programme of pro-competition reform under the coalition administration of Conservative Prime Minister David

Cameron and Liberal Democrat Deputy Prime Minister Nick Clegg (Department of Health, 2010, Whitehead et al. 2010).

In providing evidence of this kind, one key challenge lies in disentangling the effects of hospital competition on socio-economic equity from the effects of other contemporaneous changes in the health system and the wider social and economic environment. For example, the rapid growth in NHS spending and capacity during the 2000s may have tended to improve socio-economic equity in hospital care, if activity was able to grow faster in deprived areas with greater unmet need. Changes in the wider socio-economic environment may also have played a role, for example improved access to web-based information and the ageing of the consumerist “baby boomer” generation. Our research design aims to disentangle the specific effects of competition from these broader influences on socio-economic equity in hospital care.

We identify the effect of competition on utilisation of hospital services by exploiting geographical variation in the “dose” of competition generated by the introduction of the pro-competition reforms, as measured by change in market concentration. Indices of local market concentration are constructed by computing hospital level indices based on both observed and predicted patient flows, and then attributing these to small areas using distance-weighted averages. As one would expect, the pro-competition Blair/Brown reforms were accompanied by a general fall in hospital market concentration throughout the period as competition set in. However, local market concentration changes by different amounts in different parts of the country and over different points in time. Towards the beginning of the reform period, change in local market concentration is very small and reflects variation in local demand and supply factors. As the pro-competition reforms are gradually phased in, however, fairly large

and widespread falls in local market concentration are observed which are likely to reflect increases in competitive pressure. We can therefore identify the effect of competition by comparing geographical differences in the magnitude of change in market concentration before and during the introduction of pro-competition reforms using a difference in differences (DID) approach.

The second key challenge lies in measuring change in socio-economic equity in hospital care, and doing so in a way that can be linked to change in local hospital market concentration. Conventional individual level survey data approaches are unable to include adequately large samples of individuals using hospital care each year in all local hospital markets in England. We therefore use administrative data on all individuals aged 18 and over who used hospital care in the English NHS from 2003 to 2008, comprising a total of 37.7 million elective inpatient hospital admissions. Unfortunately, this data cannot be linked to individual level data on socio-economic status in England. Therefore, we aggregate to the level of 32,482 English small areas with average population of 1,500 and use available indices of small area socioeconomic deprivation.

The concept of equity we examine is small area socio-economic equality in health care utilisation for equal need. We estimate fixed effect linear panel data models of small area hospital utilisation as a function of population need, deprivation and market structure. The competition effects on equity are identified by examining how the interaction between market structure and deprivation changes over time. Changes in equity over time can be more robustly identified than levels of equity at a given point in time. Levels of equity are hard to quantify in cross sectional analysis because one has to assume that observed utilisation inequalities relative to need are not biased by unobserved heterogeneity in population need.

By contrast, our identification of equity effects rests on the more reasonable assumption that unobserved heterogeneity in population need between more and less deprived areas remains stable from one year to the next. Cookson et al (in press) measure inequality in utilisation of hospital care at the small area level in England between 2001 and 2008 and provide a discussion on the differences between level and trend inequality analysis.

To facilitate the discussion throughout the paper, we interpret a relative increase in hospital utilisation in deprived areas as a beneficial improvement in socio-economic equity, and a relative decrease as a harmful deterioration in socio-economic equity.

2 Background

2.1 The Blair/Brown pro-competition reforms of the English NHS

The Blair/Brown reforms involved both supply side and demand side mechanisms for introducing hospital competition. On the supply side, independent sector (IS) providers were encouraged to enter the market for publicly funded NHS patients, initially through the “Independent Sector Treatment Centre” programme of nationally agreed contracts with generous terms (Mason et al., 2010). This reform was introduced in 2003/4, but IS providers only started to provide more than 1% of NHS activity from 2006/7 - we estimate that IS activity made up 0.03% of NHS non-emergency inpatient activity in 2003/4, rising to 0.08% in 2004/5, 0.31% in 2005/6, 1.12% in 2006/7, 1.42% in 2007/8 and 2.17% in 2008/9.¹ Prior to this reform, IS provision of NHS funded services was mostly sub-contracted on an *ad hoc* basis by publicly funded NHS hospitals at times of capacity shortage, for example to perform “waiting list initiatives” to clear patient backlogs, rather than routinely offered on a competitive basis.

¹ Source: Hospital Episodes Statistics.

On the demand side, patient choice of hospital at the point of GP referral was phased in nationally from December 2005. The policy was that from December 2005 all patients should be offered a choice of four or five hospitals including one independent sector provider, leading up to “free choice” of any public or independent hospital in the NHS national directory from April 2008 (Dixon et al., 2010). This was coupled with a national system of fixed price case based hospital payment based on a local variant of DRGs (“Healthcare Resource Groups”), which was gradually phased in nationally from 2003/4 for a small basket of elective inpatient services and progressively expanded to include all elective services in 2005/6. The financial impact of this policy on hospital revenue was also gradual with a four year transition path which came to an end in 2008/9. Prior to these reforms, NHS patients largely had to accept whatever referral their GP made for them and hospitals were largely paid on the basis of block contracts negotiated with local public agencies (“Primary Care Trusts”) responsible for purchasing health care on behalf of the local population.

All of these reforms were introduced alongside substantial growth in NHS expenditure. From 1999 to 2010, real annual NHS spending growth averaged 6.56% compared with 3.48% from 1950/01 to 1999 (Appleby et al., 2009). Between 2003 and 2008, real net expenditure on the NHS in England grew by 30.1% from 72.7 to 92.5 billion in GBP sterling at 2008 prices, with real annual spending growth of 9.4% in 2003, 4.7% in 2004, 7.8% in 2005, 3.2% in 2006, 7.8% in 2007 and 3.6% in 2008 (House of Commons Health Committee, 2010). The reforms were also introduced alongside a strong target-based performance management regime for hospitals involving publication of data on performance against target and associated rewards and sanctions for hospital managers. In particular, hospital managers were strongly incentivised to meet an aggressive sequence of maximum waiting time targets for elective inpatient treatment: 18 months from outpatient consultation to inpatient treatment

by March 2001, falling by three months a year to 12 months by March 2003, 9 months by March 2004, then 6 months by December 2005 and ultimately to 18 weeks from GP referral to inpatient treatment by December 2008 (Department of Health, 2000, 2004). There is evidence that these reforms increased hospital competition and that this competition improved hospital quality (Cooper et al., 2010; Gaynor et al., 2010). However, there is no evidence about the effects of hospital competition during the Blair/Brown reform period on socio-economic equity.

2.2 Economic theory on the relationship between competition and equity

This paper tests the hypothesis that fixed price competition in the context of universal health insurance tends to undermine socioeconomic equity in health care. This is an empirically driven hypothesis motivated by policy debates between critics and proponents of pro-competition reform in health care, rather than a theoretically driven hypothesis motivated by economic theory. Nevertheless, it is worth considering whether economic theory can elucidate this hypothesis.

Economic theory offers competing predictions about the relationship between competition and socioeconomic status. For example, increased competition could in theory improve equity by increasing activity volumes, if the marginal patient brought into the market is a low-income one. In what follows, however, we describe three possible theoretical explanations for why competition in the context of the English NHS might undermine equity in health care.

Reduced rent for pursuing equity objectives

Hospital objective functions might be partially benevolent, incorporating concern for equity in health care. As a result, hospitals may seek to make implicit transfers to relatively sick or poor or otherwise disadvantaged individuals. In theory, hospital competition might therefore undermine equity by reducing the rents available to hospitals for making implicit transfers of this kind. In a US context, the implicit transfers might take the form of price discrimination against well-insured individuals and in favour of under-insured individuals. In an English NHS context of universal insurance coverage and fixed prices, by contrast, the implicit transfers might take the form of treating unprofitable high-cost patients – i.e. refraining from engaging in profit-maximising “creaming” and “dumping” behaviour (Ellis 1998). If poor patients are more expensive to treat *within the HRG service provided* – for example, because they are harder to discharge – and hence relatively unprofitable to treat under a fixed price system, then competition may reduce the rent available to managers to make implicit transfers to such patients by treating them. This could lead to creaming and dumping behaviour which could take the form of tighter hospital admission thresholds for such patients for elective care, resulting in reduced treatment volumes and not merely diversion of patients from one hospital to another. However, evidence that poor patients cost substantially more is mixed (Epstein et al., 1990; Cookson et al., 2011).

Crowding out of pro-social motivation

Critics of pro-competition reform often warn that competition might erode the pro-social motivation of hospital managers and clinicians, with harmful consequences for equity (Tudor Hart 2006). According to the behavioural economic theory of “motivation crowding out” (Frey and Oberholzer-Gee, 1997), the introduction of incentive mechanisms with “extrinsic” rewards and punishments – such as competition – may cause pro-social motivation to be crowded out by self-interested motivation. To put it in Le Grand’s colourful terminology,

competition may encourage hospital managers and clinicians to behave more like self-interested “knaves” than pro-social “knights” (Le Grand, 2003). As before, however, this explanation only makes sense in the context of universal health insurance and fixed prices if poor patients cost more and are less profitable to treat.

Choice and waiting times

Waiting times and waiting lists are used as a rationing mechanism to regulate access to hospital care in England, and before the introduction of the reform a large number of patients were waiting longer than 12 months for treatment. Thus, the early political debate on competition focused on the potential role of patient choice in reducing waiting times. Opponents of the reform argued that patient choice of provider would advantage skilled patients from higher socioeconomic groups, since they face lower costs in accessing information and have greater willingness to travel away from their local hospital provider in order to get their treatment quicker. This in turn would result in a larger volume of services being allocated to such patients every year as compared with socioeconomically disadvantaged patients who face higher costs in exercising choice and hence are more likely to stay on the waiting list of their local hospital provider. In contrast, advocates of reform claim that this sort of two tier system was already in place before the introduction of competition, with socioeconomically advantaged individuals travelling longer distances (Propper et al 2007) in order to obtain their treatment in hospitals with shorter waiting times (Laudicella et al. 2012, Cooper et al 2009). The introduction of choice and competition would then benefit socioeconomically disadvantaged patients by making it easier for them to choose hospitals with shorter waiting times (Dixon and Le Grand, 2006).

3 Data

Table 1 presents global descriptive statistics for the main small area level variables, pooled from 2003 to 2008, and table 2 presents year-by-year means. The unit of analysis is the Lower Super Output Area (LSOA). There are 32,482 LSOAs in England with a mean population of about 1,500 individuals and a minimum of 1,000.

Table 1 about here

Table 2 about here

3.1 Hospital utilisation

Our hospital utilisation variable is based on data from the national Hospital Episode Statistics (HES) inpatient database, which covers all hospital patients admitted to hospital in the English NHS. All elective (non-emergency) inpatient admissions were extracted for individuals aged 18 and over in financial years 2003/4 through 2008/9. We focus on acute hospital elective admissions excluding admissions to Primary Care Trusts (PCTs) and mental health care trusts. Anonymous records were extracted by financial year and summed to the patient's small area of residence. Observations were excluded if there were missing data fields for small area or age, which occurred in a very small proportion of cases (fewer than 0.1%), or if there were duplicate records or other forms of multiple counting of episodes for the same admission. Records were linked in the form of Continuous Inpatient Spells that include transfers between consultant and hospital within same admission spell (Castelli et al., 2008). We included all relevant providers of NHS hospital care, including Independent Sector Treatment Centres (ISTCs) under national contracts and Independent Sector providers

under local contracts. As discussed later, ISTC activity reporting is incomplete, especially from 2003/4 to 2006/7.

Year by year utilisation rates per 100,000 population for all elective adult inpatient hospital utilisation are reported in Table 2, based on mid-year population estimates from the Office for National Statistics (ONS).

3.2 Indices of hospital market structure

We measure market structure using a Herfindahl-Hirschman Index (HHI) of hospital market concentration. The index is defined as the sum of the squared market shares of all hospitals in the market, and normally ranges from 0 (max market dispersion) to 10,000 (max market concentration).

In our analysis, a “hospital” is defined as either an NHS Trust (a group of local public hospital sites funded and managed under the same organisational umbrella) or an independent sector provider site. Our data on market shares include patient flows to both NHS Trusts and IS sites; though in sensitivity analysis we also construct indices based on NHS Trusts only.

We calculate two versions of the HHI using two different approaches. The first is based on observed patient flows from their GP practice² to the hospital, and is calculated separately for each year from 2003 to 2008 as described in Appendix 1. The “observed HHI” assumes the GP practice is the relevant market unit since in the English hospital market patients access elective care through a referral from their GP. Also, a number of surveys conducted by the Department of Health show that the patient’s GP is the most important source of information

² This is the medical practice where the patient is registered for accessing primary care.

when patients choose the hospital for their treatment³. However, GPs received specific guidelines to offer at least four alternative hospitals to their patients and they have no incentives for establishing exclusive relations with one particular hospital. Also, patients can “choose and book” completely autonomously using an internet booking facility that provides information on hospital services, distance and waiting times. In sensitivity analysis, we therefore also calculate an alternative version of this index using the patient small area of residence (i.e. the LSOA) as the initial market unit in place of the GP practices. We find a 90% correlation between these two versions of the observed concentration index. This is not surprising given that patients typically choose a GP practice close to their home in order to minimize travel costs.

The second version of the HHI is based on predicted probabilities of patients being admitted to any hospital. Estimated probabilities are based on the interaction between exogenous patient and hospital characteristics that are likely to influence the patient’s choice of hospital. Therefore, the “predicted HHI” is purged of potential bias from unobservable patient and hospital characteristics, such as hospital quality or patient health status. This index is based on the works of Kessler and McClellan (2000) and Gowrisankaran and Town (2003) and is described in Appendix 2. We construct the predicted HHI using observations in 2003 and 2008 only, since its calculation requires a considerable amount of data and computer resources.

Finally, we compute a time varying index of independent sector penetration, in order to test the hypothesis that apparent effects of competition are an artefact of increases in local hospital capacity rather than a real increase in competition. This index simply counts the

³ Reports on the National Patient Choice Survey, July, December, January 2008.

number of independent sector providers within a 60km fixed radius distance from the LSOA demographic centroid. We also conduct sensitivity analysis using a 15km, 30km and 45km radius and including IS providers with at least 1,000 NHS patient admissions only, though we are not able to produce an indicator of IS penetration based on the number of beds due to lack of data on IS providers. We find that the largest impact on elective admissions is obtained using a 60Km radius and including all IS providers with at least 100 NHS patient admissions.

3.3 Area deprivation

Small area socio-economic status is measured using the income deprivation domain of the English Indices of Deprivation 2007 (Noble et al., 2008). This index indicates the proportion of individuals resident in the LSOA in the year 2004 who were living in low income households. Low income households are defined as those either receiving means-tested low income out-of-work benefits (including income support, income-based job seeker's allowance, pension credit guarantee, and subsistence or accommodation support from the national asylum support service) or receiving means-tested low income in-work benefits (including working families tax credit and child tax credit) and whose equivalised income is below 60% of the median before housing costs. The index was produced by the Social Disadvantage Research Centre at the University of Oxford for the Department of Communities and Local Government.

We use this index because it is easy to interpret on a cardinal scale suitable for regression analysis and does not include any health related variables that might introduce circularity into the modelling. For most of the analysis, we treat this index as a cardinal variable. This allows us to take account of the full socio-economic distribution and avoids the potential selection biases associated with focusing on ratios or gaps between arbitrarily defined extreme groups. In one illustrative graph, however, we use this index to categorise small areas as “deprived”

or “non-deprived” in terms of the absolute proportion of individuals living in low income households: (1) 0-20% (“low deprivation”) and (2) 20% or more (“high deprivation”). This generates two unequally sized groups comprising 72.2% and 27.8% of small areas respectively. We also conduct a sensitivity analysis using the Economic Deprivation Index (Noble et al., 2009). This index measures income deprivation among individuals aged under 60 and is time-varying for the first three years of our period from 2003 to 2005 but frozen thereafter for the next three years.

3.4 Need and GP supply variables

We control for a range of time varying small area need variables including population size, age-sex structure, and disease prevalence. We use ONS mid-year population estimates in 5 year age-sex bands (from 15-19 to 85 plus). Our disease prevalence variables are (from 2003-8) cancer, chronic kidney disease, coronary heart disease, diabetes, epilepsy, hypertension, hypothyroidism, stroke, transient ischaemic attack and (from 2006-8) atrial fibrillation, chronic obstructive pulmonary disease, obesity and heart failure. Estimates of disease prevalence at the GP practice level are obtained from data collected in the process of administering the pay for performance scheme for GPs in the NHS introduced in 2004/5, known as the “Quality and Outcomes Framework” (QOF). The data cover nearly all GP practices in England, and are extracted from disease registers submitted to the national Quality Management and Analysis System (QMAS). The data show the proportion of individuals registered to the GP practice who are recorded as having the disease in question. We attribute this to the small area level using the Attribution Dataset of patient registration addresses within GP practices. The attribution process assumes that prevalence for a particular small area is a weighted sum of the prevalence in each GP practice serving that small area, with weights proportional to the number of small area residents registered with

each GP practice. Both the QOF data and practice to small area attribution data were obtained from the NHS Information Centre. Eight of the twelve variables we use are available from 2004/5, though four of them (atrial fibrillation, chronic kidney disease, heart failure and obesity) are only available from 2006/7 following a revision to the QOF scheme. Most of the disease prevalence variables are based on the full population of patients registered with the GP practice. However, diabetes prevalence is based on patients aged 17 and over; epilepsy and chronic kidney disease is based on patients aged 18 and over; and obesity prevalence is based on patients aged 16 and over.

We also control for time varying GP supply, by computing GPs per 10,000 population. This variable is based on GP practice level administrative data on whole time equivalent GPs per registered patient, from the General Medical Services database. This GP practice level variable is then attributed to LSOA level using the same procedure described above, as a weighted average based on the share of GP practice registered patients resident in the LSOA.

4 Methods

We model small area utilisation as a function of local market structure, a time trend, and population demographic and need variables. We use small area level fixed effects to allow for unobserved heterogeneity between small areas in local supply and demand factors that did not change between 2003 and 2008. The effect of each explanatory variable is therefore identified using within-area variation over time rather than between-area variation in global mean levels of the variables across all periods. We use a fixed effects specification in order to control for unobserved heterogeneity between small areas in time invariant characteristics likely to be correlated with local market structure, such as historical supply and demand factors that generate between-area variations in global mean utilisation, market structure and need.

Our small area level regression equation can be written:

$$\begin{aligned}
y_{it} = & \delta \text{dispersion}_{it} + \omega \text{deprivation}_i * \text{dispersion}_{it} + \\
& + (\tau + \gamma \text{dispersion}_{it} + \varphi \text{deprivation}_i + \theta \text{deprivation}_i * \text{dispersion}_{it}) * I(t) + \\
& + \boldsymbol{\beta}' \mathbf{x}_{it} + \mu_i + \varepsilon_{it} \quad (1)
\end{aligned}$$

Where:

y_{it} is the utilisation count in small area i in year t .

dispersion_{it} is an index of market dispersion obtained by multiplying the HHI by -1/100.

deprivation_i is the time invariant index of small area income deprivation.

$I(t)$ is an indicator function of the post reform period that takes value equals 1 in the financial year 2008 and zero in 2003⁴.

$\mathbf{x}_{it}$ is a vector of time varying control variables, including need variables (small area population size and demographic characteristics and prevalence of diseases) and supply variables (number of independent sector hospitals within 60km and whole time equivalent GP numbers).

μ_i is the small area fixed effect.

In all regression models, we use an index of market dispersion obtained simply by multiplying the HHI concentration index by a constant term (-1/100) so that the index measures increasing market dispersion rather than concentration and ranges from -100 (minimum market dispersion, i.e. monopoly) to 0 (maximum market dispersion). This facilitates the interpretation of the model coefficients δ , ω , γ , and θ in terms of marginal

⁴ Our preferred model specification includes 2003 and 2008 years only. We also estimate alternative model specifications including all observations from 2003 to 2008 using 2003 as baseline.

effects of increasing market dispersion and increasing competition rather than increasing concentration and decreasing competition. Also, we treat income deprivation as a continuous variable on a scale of 0 to 100.

We estimate the effect of competition on equity using two model specifications based on equation (1). The first model uses an index of dispersion based on the observed HHI and estimates the year by year impact of competition as the reform is gradually phased in from 2003 to 2008. The second model uses an index of market dispersion based on the predicted HHI and is estimated using observations before (2003) and during the reform implementation (2008) only. The predicted HHI allows for a more accurate identification of the competition effect, although this index requires intensive calculations and thus we limit the analysis to two years only. Details of the construction of observed and predicted HHI are given in Appendix 1 and 2 respectively.

The effect of competition on socio-economic equity is identified using a three-way interaction term between the indicator of local market dispersion, the indicator of small area deprivation, and a year dummy variable capturing the introduction of the competition reform. The estimated coefficient θ (“theta”) on this crucial three-way interaction term can be interpreted as the effect of competition on utilisation by increasing level of deprivation. Or, equivalently, it can be interpreted as the effect of deprivation on utilisation by increasing levels of competition.

The baseline effect of deprivation on utilisation is not identified by our fixed effect model since our indicator of deprivation is not time varying. However, we can identify change over time in the effect of deprivation, based on within-area change over time in utilisation. The

coefficient φ (“phi”) on the $deprivation_i * I(t)$ term can be interpreted as the difference in the effect of income deprivation on utilisation between 2008 and 2003 (the baseline year) for small areas in highly dispersed markets (the baseline market structure). A negative coefficient would indicate a relative decrease in utilisation among deprived areas in dispersed markets since 2003 – which can be interpreted as a harmful decline in socio-economic equity – and *vice versa*.

The coefficient ω on the $deprivation_i * dispersion_{it}$ term identifies the effect of local market dispersion by increasing level of income deprivation in 2003 (the baseline year). This coefficient captures the effect of market dispersion on socio-economic equity before the introduction of the competition reform. Such an effect cannot be attributed to competition, however, since in 2003 patients were not allowed to choose the hospital for their treatment and hospitals have no incentives to compete to attract their patients. Instead, it can be attributed to other local supply and demand factors that influence the degree of market dispersion in 2003 – such as hospital re-configurations and changes in GP referral patterns for reasons unconnected with competition, such as waiting time targets.

After 2005, however, change in dispersion starts to be more closely related to competitive pressure, as competition is introduced and starts to influence local market dispersion⁵. The effect of competition on socio-economic equity can therefore be identified by the coefficient θ on the $deprivation_i * dispersion_{it} * I(t)$ term. This coefficient identifies the change in how dispersion modifies the effect of deprivation on utilisation before and after the introduction of the competition reform, namely the effect of competition on equity. A positive coefficient indicates that post-reform competition increases utilisation by more

⁵ Our time unit of analysis is the UK financial year. Each financial year spans from April to March, hence the competition reform is already in operation in the last 3 months of the financial year 2005.

where the level of deprivation is greater. This can be interpreted as competition having a positive effect on equity – rather than leading to “over-treatment” in deprived areas – since other studies have shown that deprived areas use less health care service than needed (Dixon et al., 2007). In contrast, a negative coefficient indicates that competition reduces utilisation in more deprived areas and thus has a negative effect on equity. In sensitivity analysis, we calculate the interaction effect in each of the 2003-2008 years. So the estimated coefficients show the full pattern of changes over time in the relationship between market dispersion and deprivation.

Other coefficients of interest include the baseline dispersion coefficient, δ , which indicates the marginal effect of market dispersion on utilisation in 2003 for small areas with no income deprivation (i.e. at the baseline), and the dispersion-year coefficient, γ , which indicates the change in this marginal effect over time for the same small areas.

Our identification of the effect of competition is obtained through the within small area variation in the level of market dispersion that is generated by the introduction of the reform. Before the reform, English health markets are hierarchically controlled systems where patients cannot choose providers and the latter are not in competition to attract patients. Variations in market dispersion are very small, and are associated with variations in demand and supply factors rather than variations in hospital competition. Pro-competition reform then changes the market structure, inducing an exogenous change to the level of market dispersion that affects some areas more than others. Therefore, the reform provides a natural experiment allowing us to identify the effect of competition.

Identification of the effect of competition on elective admissions can be achieved straightforwardly, in the absence of time variant unobservable confounders correlated with market dispersion, under the standard “parallel trends” assumption of the DID estimator. However, the effect of competition on elective admission is not the focus of this paper. The identification of the effect of competition on equity, i.e. the parameter θ , is obtained assuming absence of unobservable time variant confounders correlated both with market structure and deprivation. This assumption is slightly different than the standard identification hypothesis of DID estimators. Time variant policy confounders are allowed to be correlated with market dispersion or deprivation as long as they are not correlated with both. For instance, imagine the implementation of the competition reform were accompanied by extra health care resources in areas with highly dispersed markets. This would lead to bias in the estimated effect of competition on utilisation (i.e. coefficients δ and γ). However, the effect of competition on equity (i.e. coefficient θ) can still be identified provided that the extra funding is randomly allocated between deprived and non-deprived areas. Identification of the effect of competition on equity is achieved by subtracting the effect of market dispersion from the effect of deprivation pre and post the introduction of the reform. Therefore, the coefficient θ is still identified even when the coefficients δ and γ are not, provided that the bias affects deprived and non-deprived areas equally.⁶ Therefore, the identification assumption of the three-way interaction term is similar to the DDD estimator.

One of the confounders potentially capable of influencing the relationship between deprivation, competition and utilisation could be the entry of independent sector providers into NHS market during this period. Independent sector providers were authorised and

⁶ Equivalently, if a flow of extra funding is injected in income deprived areas over time, then the identification of the effect of deprivation on utilisation will be biased (i.e. coefficient φ), but the effect of competition on equity can be still identified.

incentivised to enter hospital markets with lack of supply, which were often characterised by low market dispersion and located in income deprived areas. We control for this potential confounding effect by including in the regression analysis a time varying indicator of independent sector penetration in the local hospital markets. The indicator counts the number of independent sector providers within 60Km fix radius distance from the small area.

The functional form of the model in Equation 1 allows for the separate identification of all the parameters of interest. In sensitivity analysis, we relax this assumption by fixing market dispersion at pre-reform level in 2003 and interacting pre-reform market dispersion with deprivation and time⁷:

$$y_{it} = (\tau + \gamma \text{dispersion}_i + \varphi \text{deprivation}_i + \theta \text{deprivation}_i * \text{dispersion}_i) * I(t) + \beta' \mathbf{x}_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

Equation 2 assumes that pre-reform market characteristics are exogenous and allows for the identification of the main parameter of interest θ , i.e. the effect of competition on equity. However, equation 2 cannot identify the association between market dispersion and utilisation (δ) and market dispersion and equity (ω) at the baseline year 2003.

5 Results

5.1 Change in hospital market structure between 2003 and 2008

Table 1 shows descriptive statistics of the variables used in the analysis pooled from 2003 to 2008. The HHI scale ranges from 0 (infinite market dispersion) to 10,000 (monopoly) and shows global mean of 5,747 points in the pooled 2003-2008 years. Before the introduction of

⁷ We thank an anonymous referee for this comment.

the competition reform markets are highly concentrated and variations in the HHI are very small as shown in Table 2. The mean of the HHI index remains virtually unchanged from 2003 to 2004 at 5,900 and 5,883 points respectively. After the introduction of competition, however, market concentration starts a progressively to fall to 5,715 points in 2006 and 5,490 in 2008. The HHI is calculated using observed patients flows from GP practice to hospitals as described in Appendix 1. Figure 1 shows two maps of hospital market concentration in England: the left hand map shows baseline level of concentration in 2003 and the right hand map shows change between 2003 and 2008. The left hand map shows that, as one might expect, baseline market concentration tends to be low in and around densely populated cities served by many different hospitals, such as London, Bristol, Birmingham, Liverpool, Manchester and Newcastle. However, the right hand map shows that change in market concentration – which we use to identify competition – exhibits quite a different geographical pattern with relatively large increases in market dispersion in many sub-urban and rural areas. This is reassuring, as it shows that our identification strategy does not confuse the degree of competition with the baseline level of market concentration or the degree of urbanisation.

Figure 1 about here (Heat map of hospital market concentration in the English NHS comparing baseline level in 2003 with difference 2003-8)

5.2 Equity effects on all elective inpatient hospital utilisation

Figure 2 shows crude annual utilisation trends in all elective inpatient admissions broken down by two dispersion groups (“low dispersion” and “high dispersion”) and two deprivation groups (“low deprivation” and “high deprivation”).

Figure 2 about here (utilisation by dispersion and deprivation)

In 2003, “low dispersion” areas have substantially higher hospital utilisation than “high dispersion” areas. Furthermore, within both dispersion groups, “high deprivation” areas have higher utilisation than “low deprivation” areas in 2003. Utilisation then grows over time in all four groups, though more rapidly in “high dispersion” than “low dispersion” areas. Within the “low dispersion” group, utilisation grows faster in the “low deprivation” areas. By contrast, within the “high dispersion” group, utilisation grows slightly faster in the “high deprivation” areas. Growth of utilisation in deprived areas was thus faster within the “high dispersion” group of areas than the “low dispersion” group. By 2008, the “dispersed, deprived” group had caught up with the “non-dispersed, deprived group”, whereas the “dispersed, non-deprived” group still lagged behind the “non-dispersed, non-deprived” group. Insofar as the “high dispersion” group is likely to face a larger increase in competitive pressure during the period, this is suggestive evidence that competition may have helped to facilitate growth in elective hospital admissions in deprived areas and thus to improve socio-economic equity.

We now turn to the regression results, to examine competition effects on equity using more rigorous statistical methods that control for confounding factors and are less sensitive to the arbitrary definition of dispersion groups and deprivation groups.

Figure 3 about here (effect of dispersion on elective inpatient hospital admission)

Our regression results are perhaps easiest to understand in graphical form, since the interaction terms can be hard to interpret. Figure 3 shows how the marginal effect of local market dispersion on utilisation varies by deprivation and over time. The graph is obtained by plotting the coefficients estimated using model 1 (table 3). It shows the change in total

elective admissions associated with a one unit change in market dispersion by deprivation and year. In 2003 a one unit increase in the dispersion index (i.e. a drop in the HHI of 100 points) leaves utilisation unchanged in non-deprived areas (i.e. areas with IMD index = 0), decreases utilisation by 1 admission in areas with 10-20% of resident relying on income benefits (i.e. the average deprivation areas), and by 4 admissions in areas with over 50% of residents relying on income benefits (i.e. the most deprived 5% of areas). After the introduction of the competition reform this negative association reduces in areas with average deprivation and particularly in the most deprived areas, while it remains substantially unchanged in non deprived areas. Therefore, competition has slightly increased utilisation in deprived areas. We now turn to the full regression results, for completeness.

Table 3 about here (regression results for inpatient utilisation)

Table 3 shows the results of three linear fixed effect models of all elective inpatient admissions. Model 1 uses the observed competition index (described in Appendix 1) and model 2 uses the predicted competition index (described in Appendix 2).

The deprivation*year interactions show a pattern of significant and increasingly positive coefficients, rising to 1.339 by 2008 in model 1. This suggests that, in the reference category areas with high market dispersion, the effect on admissions of a one unit increase in the percentage of individuals living in households on low income benefits was 1.339 higher in 2008 than 2003. This implies a small relative increase in the volume of utilisation received by people living in deprived areas, and hence implies a slight overall improvement in inequality during the period in line with a previous study using this dataset (Cookson et al. in

press). However, this is a relatively small effect in the context of a global mean small area admission count of 193. Moreover, this effect is substantially smaller (0.740) in model 2 using the predicted competition index.

The dispersion*deprivation coefficient of -0.0656 in model 1 is also significant though very small. There are two logically equivalent ways of interpreting this coefficient. First, in terms of the effect of deprivation on utilisation, and how this is modified by dispersion. Second, in terms of the effect of dispersion on utilisation, and how this is modified by deprivation. In the former interpretation, this coefficient suggests that in 2003 (the baseline) a one percentage point increase in local hospital market dispersion modifies the effect of deprivation on utilisation by -0.0656 of one admission. Equivalently, in the latter interpretation, this coefficient suggests that at baseline in 2003 a one percentage point increase in deprivation modifies the effect of local hospital dispersion by -0.0656 of one admission. However, this effect is much smaller (-0.0150) and no longer significant in model 2.

The effect of competition on equity is captured by the crucial dispersion*deprivation*year terms. These show a pattern of significant and increasingly positive coefficients (model 1) after the introduction of the reform. Specifically, Model 1 and Figure 2 show zero marginal effects of competition on equity in 2003 and 2004, suggesting that variations in market dispersion are not associated with variation in elective admissions and deprivation before the competition reform. This result supports our identification hypothesis as described in the method section. The dispersion*deprivation*year terms can be interpreted in two different though logically equivalent ways. First, it suggests that competition slightly attenuated the negative modification effect of dispersion on the effect of deprivation on utilisation. Second, it suggests that competition slightly attenuated the negative modification effect of deprivation

on the effect of dispersion on utilisation. Either way, the coefficient suggests that competition slightly increased utilisation in deprived areas and therefore slightly improved socio-economic equity. These coefficients are very small, however. By 2008, the modification effect is attenuated by only 0.0155 of one admission. Model 2 provides a very similar estimate of the same coefficient (0.0141) suggesting that the effect of competition on equity is robust to the use of either the observed or the predicted competition index.

Table 4 reports the results of our sensitivity analyses using a time varying index of income deprivation (i.e. the income domain of EDI index) and the predicted competition index. We obtain precisely the same pattern of results produced by model 2.

Table 4 about here (regression results for time varying deprivation)

Table 5 shows results of our sensitivity analysis using a competition index fixed at pre-reform level of market dispersion as described in Equation 2. This alternative model specification relaxes the functional form assumption of Model 1 and produces very similar results.

Table 5 about here (regression results for time invariant dispersion)

6 Discussion

6.1 Main findings

We find no evidence that increased competition in the English NHS from 2003 to 2008 had any harmful effect on socio-economic equity in hospital care. If anything, we find that competition may have very slightly improved socio-economic equity, by helping to facilitate the slightly more rapid growth of elective inpatient admissions over time in deprived areas.

So our findings do not support the hypothesis that competition undermines socio-economic equity in health care as argued by the opponents of pro-competition reform.

However, the increase in hospital competition between 2003 and 2008 was not large. One indication of this is that hospital market concentration fell by just under 500 points in the HHI between 2003 and 2008, from 5,900 to 5,490. So it remains possible that larger doses of competition could have important effects on socio-economic equity.

We can offer two possible speculations as to why competition appears to have very slightly increased elective inpatient admissions in deprived areas. One is that patient choice was particularly beneficial to deprived patients living in “high choice” areas with dispersed hospital markets, in helping them choose hospitals with lower waiting times. In turn, this may have increased utilisation in those deprived areas by reducing local waiting list backlogs and allowing local clinicians to lower referral and treatment thresholds. Another possible speculation is that competitive pressure may have generated market incentives for hospitals to seek out profitable new business among patients with previously unmet needs, who may disproportionately reside in deprived areas. However, the effect is so small as to be negligible from a national policy perspective, and so we cannot conclude that competition improved socio-economic equity to any meaningful extent.

Figure 2 illustrates the importance of using a fixed effect specification. Elective inpatient admission rates in 2003 are substantially higher in areas with more concentrated hospital markets. Since competition was only gradually introduced after 2003, this between-area association cannot be attributed to competition in 2003 but must instead be the result of unobserved historical factors. One possible speculation is that the association may be due to

population growth in some metropolitan areas during the 1980s and 1990s outstripping growth in hospital capacity in those areas. Those areas may therefore tend to have both low utilisation rates per head of population and relatively dispersed hospital markets compared with rural areas with low population density and few local hospitals. Our fixed effect specification purges the effect of this historical between-area association from our estimates.

The predicted HHI provides substantially smaller estimates of the effect of competition on elective admissions than the observed HHI. The former is calculated excluding potentially endogenous factors, such as hospital quality and waiting times. Hospitals that increase capacity are likely to expand their market share by lowering waiting times and hence becoming more appealing to patients. This might explain the difference in the estimated effect of competition when using the observed HHI as compared with the estimated HHI. However, both indices provide similar predictions of the effect of competition by deprivation and year. This suggests that the bias might equally affect deprived and non-deprived areas, and hence may cancel out in the DID setting.

Finally, we find that allowing for IS penetration generally reduces the effect of market dispersion as expected, but does not affect the key coefficient on the three way interaction terms between market dispersion*deprivation*time under all model specifications.

6.2 Methodological strengths and limitations

One strength of our study is the use of panel data methods to identify effects of competition. We exploit both change in local market dispersion within small areas and change in policy regime to identify effects of competition. This is more powerful than relying on cross sectional variation in market dispersion between small areas, which may be correlated with unobservable historical and geographical determinants of hospital utilisation that have

nothing to do with competition. Also, our study uses a measure of competition based on predicted HHI as well as observed HHI. This allows for potentially endogenous factors influencing the patient choice of hospitals such as hospital quality and patient health status.

A third strength is that our study covers all adult patients in the English NHS. This is an important advantage of administrative data over survey data. Our study is representative of all sections of the community including the most socio-economically deprived individuals who are sometimes hard to include in sample surveys. Moreover, we have a sufficient number of observations to detect statistically significant changes in equity trends associated with changes in competition.

This study also has several limitations. First, we only observe socio-economic status at the level of small areas – with mean population 1,500 – and not at the level of individuals. This means that we can only draw conclusions about people living in low income areas, since not all individuals living in low income areas have low socio-economic status. Nevertheless, living in a low income area is a reasonable proxy for low socio-economic status, since housing in England is highly segregated by socio-economic status and LSOA boundaries were designed by ONS to delineate relatively homogenous small areas in terms of socio-economic status and other social factors. Second, we focus on hospital admissions and do not directly examine equity in primary care. However, all of our hospital utilisation indicators potentially capture inequities arising at the primary care stage in the patient pathway. Third, like all administrative datasets, HES contains coding and measurement errors. One possible source of bias is missing data for Independent Sector (IS) providers. If IS patients are less likely to be drawn from deprived communities, the missing data could in theory obscure disproportionate rises in IS activity in affluent areas. However, mean area deprivation is not

much lower among IS patients than among patients treated by NHS Trusts: only 1.56 percentage points lower in a recent study of 2007/8 data covering 78% of procedures coded in IS activity (Mason et al. 2010). Furthermore, IS activity makes up a relatively small proportion of NHS activity in the early years of the ISTC programme when coding was particularly poor – less than 1% until 2006/7 – and activity coding has improved since then (NHS Information Centre 2009). Missing data on IS activity is thus unlikely to be sufficiently large proportion of total activity to bias our results. A final limitation is that we only examine inequality in the volume of hospital care, as opposed to the quality and outcomes of hospital care. We therefore cannot test hypotheses about effects of competition on quality of care or theoretical stories about deprived patients being less able than affluent patients to avoid low quality hospitals due to poor information and reluctance to travel long distances.

6.3 Comparison with other studies

Our main finding that hospital competition had no substantial effect on socio-economic equity during the Blair/Brown reforms is consistent with previous findings about the effects of hospital competition during the Thatcher/Major “internal market” reforms of the NHS in the 1990s. Using different methodologies, two small area study of NHS hospital episode statistics from 1991 to 2001 found that the NHS “internal market” reforms had no impact on socio-economic inequalities in hip replacement (Laudicella et al. 2008) and hip replacement and revascularisation (Cookson et al., 2010). Like the Blair/Brown reforms, however, the “internal market” reforms of the 1990s involved a relatively small dose of hospital competition.

Our findings are also consistent with studies of overall trends in small area socio-economic equity during the 2000s, which have generally shown no change during the period –

including small area socio-economic equity in waiting times for hip replacement, knee replacement and cataract surgery from 1999 to 2007 (Cooper et al., 2009), rates of preferred surgery for colorectal, breast and lung cancer between 1999 and 2006 (Raine et al., 2010) and rates of all elective inpatient admissions, all outpatient visits, hip replacement, cataract surgery, gastroscopy and coronary revascularisation (Cookson et al., in press).

Taken together with the results of other studies, our results suggest that socio-economic patterns of health care utilisation are deeply ingrained, and that small doses of “quasi market” competition have little or no effect on socio-economic equity in health care in the context of universal and comprehensive health systems.

Table 1: Descriptive statistics for key small area variables, pooled from 2003 to 2008

Variable	N	Mean	Std. Dev.	Min	Max
<i>Outcome variable</i>					
All elective inpatient admissions	194,700	194	87	1	1,225
<i>Other variables of interest</i>					
Observed HHI (*)	194,700	5,747	1,149	3,184	9,095
Predicted HHI (**)	64,900	5,561	2,331	4,054	9,625
Independent sector hospitals within 60km	194,700	3.923	4.970	0	29
Public hospitals within 60km	194,700	21.974	15.334	1	51
Deprivation (IMD 2007 income domain)	194,700	15.626	12.182	0.130	83.017
<i>Supply variable</i>					
GPs per 10,000 population	194,688	5.153	2.181	0.004	22.820
<i>Need variables</i>					
Atrial fibrillation	194,688	1.313	0.432	0.002	3.862
Cancer	194,688	0.837	0.376	0.000	3.158
Chronic kidney disease	194,688	2.632	1.224	0.004	11.722
Chronic obstructive pulmonary disease	194,688	1.429	0.581	0.000	4.720
Coronary heart disease	194,688	3.559	1.031	0.002	11.371
Diabetes	194,688	3.618	0.764	0.002	9.961
Epilepsy	194,688	0.599	0.140	0.000	2.303
Heart failure	194,688	0.774	0.259	0.001	3.972
Hypertension	194,688	12.182	2.511	0.006	26.771
Hypothyroidism	194,688	2.484	0.708	0.001	6.427
Obesity	194,688	7.563	1.965	0.011	22.327
Stroke and transient ischaemic attack	194,688	1.580	0.502	0.001	10.106
Total population aged 20 or over	194,700	1178	210	307	7,849

Notes to table 1:

1. Observations on the 32,480 Lower Layer Super Output Areas (LSOAs) in England are pooled across all seven years from 2003 to 2008.
2. Population size variables by 5 year age-sex bands not reported for reasons of space.

(*)Herfindahl-Hirschman Index of market concentration; range from 0 (max dispersion) to 10,000 (max concentration). Calculation described in Appendix 1.

(**)Predicted HHI is calculated for 2003 and 2008 only. Calculation described in Appendix 2.

Table 2: Descriptive statistics by year (small area mean values)

	2003	2004	2005	2006	2007	2008
Total population aged 20 or over	1,155	1,161	1,173	1,183	1,193	1,203
All elective inpatient admissions per 100,000	15,129	15,137	16,055	16,851	16,960	19,039
Observed HHI (*)	5,903	5,885	5,814	5,715	5,676	5,487
Predicted HHI (*) (**)	4,096	n/a	n/a	n/a	n/a	4,013
Independent sector hospitals within 60km	0.077	0.298	3.081	3.217	5.888	10.978
Public hospitals within 60km	22.194	22.194	22.194	21.929	21.665	21.665

Notes to table 2:

(*) Herfindahl-Hirschman Index of market concentration; range from 0 (max dispersion) to 10,000 (max concentration). Calculation described in Appendix 1.

(**) Predicted HHI is calculated for 2003 and 2008 only. Calculation described in Appendix 2.

Table 3: Competition effects on equity in utilisation of elective hospital services across small areas.

Variables	Model 1		Model 2	
	(Observed competition index)		(Predicted competition index)	
	Coefficients	se	Coefficients	se
Dispersion * Deprivation * 2008	0.0155**	(0.00362)	0.0141**	(0.00205)
Dispersion * Deprivation * 2007	0.0116**	(0.00319)	n/a	n/a
Dispersion * Deprivation * 2006	0.0135**	(0.00299)	n/a	n/a
Dispersion * Deprivation * 2005	0.00956**	(0.00247)	n/a	n/a
Dispersion * Deprivation * 2004	0.00229	(0.00183)	n/a	n/a
Dispersion * 2008	0.144*	(0.0733)	-0.0659	(0.0444)
Dispersion * 2007	0.149*	(0.0630)	n/a	n/a
Dispersion * 2006	0.202**	(0.0594)	n/a	n/a
Dispersion * 2005	-0.0661	(0.0503)	n/a	n/a
Dispersion * 2004	-0.00485	(0.0377)	n/a	n/a
Deprivation * 2008	1.339**	(0.216)	0.740**	(0.0964)
Deprivation * 2007	1.019**	(0.193)	n/a	n/a
Deprivation * 2006	0.980**	(0.183)	n/a	n/a
Deprivation * 2005	0.722**	(0.151)	n/a	n/a
Deprivation * 2004	0.225*	(0.110)	n/a	n/a
Dispersion * Deprivation	-0.0656**	(0.00842)	-0.0150	(0.00871)
Dispersion	-0.461**	(0.135)	-0.146	(0.145)
Independent sector hospitals within 60km	0.466**	(0.0792)	0.434**	(0.120)
year2008	27.25**	(4.818)	10.33**	(3.565)
year2007	9.380*	(4.035)	n/a	n/a
year2006	19.09**	(3.727)	n/a	n/a
year2005	-1.300	(3.129)	n/a	n/a
year2004	-1.867	(2.272)	n/a	n/a

Notes to table 3:

1. Results from linear panel data models with fixed effects
2. Dependent variables: all elective hospital admissions
3. Unit of analysis: small areas (LSOAs)
4. Both models include controls for: GPs per 10,000 population, population size, age-sex fractions and prevalence of diseases described in Table 1(coefficients not shown).
5. Baseline: zero deprivation and zero competition areas in 2003.
6. Dispersion is measured by using the HHI indices of market concentration described in Appendix 1 and 2. Both indices are re-scaled from -100 (min market dispersion) to 0 (max market dispersion) to facilitate the interpretation of the regression results.
7. Deprivation is measured by using the income domain of the Indices of Multiple Deprivation 2007. Scale from 0 to 100, with 100 representing 100% of individuals from households on low income benefits. Deprivation is fixed over time, so its effect cannot be separately identified from the fixed effects in both models.
8. Robust standard errors clustered by small areas in parentheses.
9. ** p<0.01, * p<0.05

Table 4 Competition effects on equity in utilisation of elective hospital services across small areas. A sensitivity analysis using time-varying income deprivation index

Variables	Model 3 (Predicted competition index & time varying deprivation index)	
	all elective	se
Dispersion * Deprivation * 2008	0.0174**	(0.00238)
Dispersion * 2008	-0.0473	(0.0412)
Deprivation * 2008	0.887**	(0.108)
Dispersion * Deprivation	-0.0122	(0.00783)
Dispersion	-0.225	(0.117)
Deprivation	-0.406	(0.438)
Independent sector hospitals within 60km	0.426**	(0.120)
year2008	12.44**	(3.473)

Notes to table 4:

1. Results from linear panel data models with fixed effects
2. Dependent variables: all elective hospital admissions
3. Unit of analysis: small areas (LSOA)
4. Model includes controls for: GPs per 10,000 population, population size, age-sex fractions and prevalence of diseases described in Table 1(coefficients not shown).
5. Baseline: zero deprivation and zero competition areas in 2003.
6. Dispersion is measured by using the HHI indices of market concentration described in Appendix 1. the index is re-scaled from -100 (min market dispersion) to 0 (max market dispersion) to facilitate the interpretation of the regression results.
7. Deprivation is measured using the income domain of the Economic Deprivation Index 2008. Scale from 0 to 100, with 100 representing 100% of individuals aged under 60 from households on low income benefits. Time-varying values are only available from 2003 to 2005; we use fixed 2005 values as measure of deprivation in 2008.
8. Robust standard errors clustered by small areas in parentheses.
9. ** p<0.01, * p<0.05

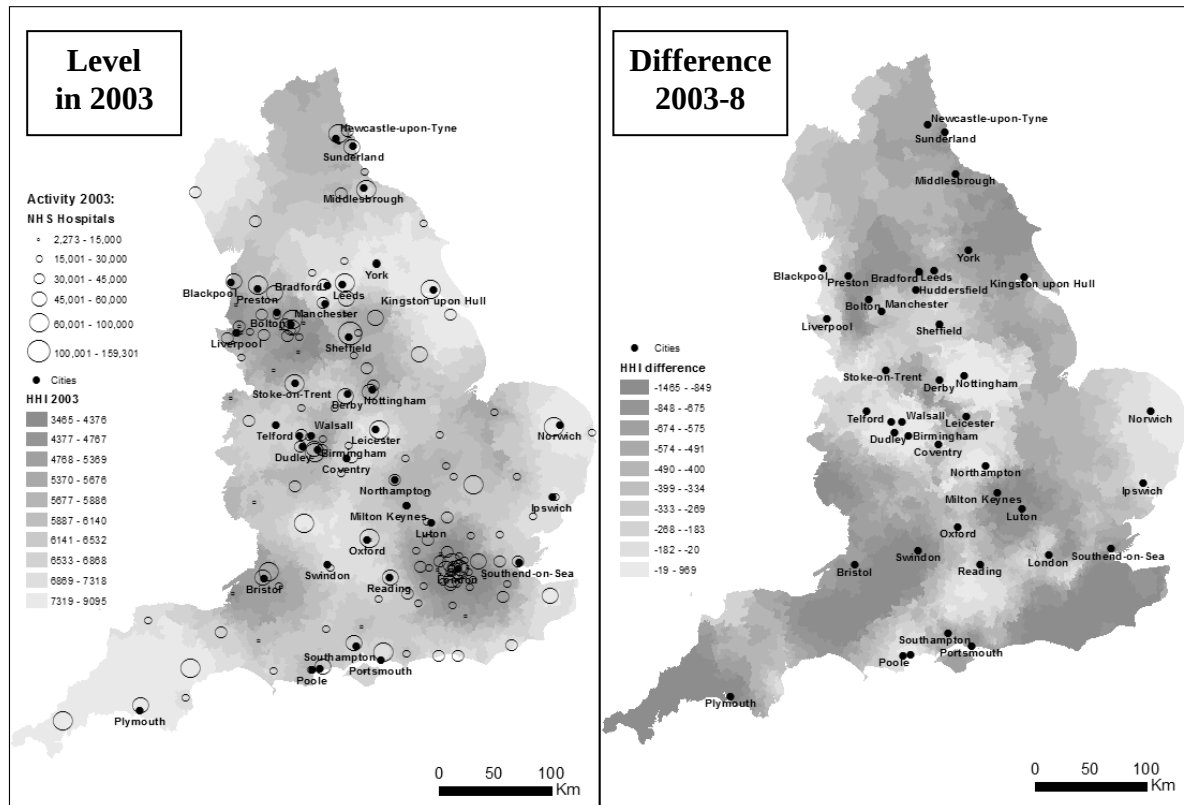
Table 5 Competition effects on equity in utilisation of elective hospital services across small areas. A sensitivity analysis using competition index fixed at pre-reform level of market dispersion in 2003.

Variables	Model 4	
	(Competition index fixed at 2003 values)	
	Coefficients	se
Dispersion * Deprivation * 2008	0.0206**	(0.00358)
Dispersion * Deprivation * 2007	0.0175**	(0.00319)
Dispersion * Deprivation * 2006	0.0152**	(0.00300)
Dispersion * Deprivation * 2005	0.00952**	(0.00247)
Dispersion * Deprivation * 2004	0.000740	(0.00183)
Dispersion * 2008	0.175*	(0.0731)
Dispersion * 2007	0.160*	(0.0635)
Dispersion * 2006	0.190**	(0.0600)
Dispersion * 2005	-0.0656	(0.0506)
Dispersion * 2004	-0.0273	(0.0378)
Deprivation * 2008	1.462**	(0.223)
Deprivation * 2007	1.261**	(0.197)
Deprivation * 2006	1.020**	(0.184)
Deprivation * 2005	0.650**	(0.150)
Deprivation * 2004	0.0897	(0.110)
Dispersion * Deprivation	n/a	n/a
Dispersion	n/a	n/a
Independent sector hospitals within 60km	0.365**	(0.0794)
year2008	28.77**	(4.937)
year2007	9.904*	(4.081)
year2006	18.29**	(3.769)
year2005	-0.937	(3.148)
year2004	-2.810	(2.275)

Notes to table 5:

1. Results from linear panel data models with fixed effects
2. Dependent variables: all elective hospital admissions
3. Unit of analysis: small areas (LSOA)
4. Model includes controls for: GPs per 10,000 population, population size, age-sex fractions and prevalence of diseases described in Table 1(coefficients not shown).
5. Baseline year 2003.
6. Dispersion is measured by using the HHI index of market concentration fixed at 2003 values. The index is re-scaled from -100 (min market dispersion) to 0 (max market dispersion) to facilitate the interpretation of the regression results.
7. Deprivation is measured by using the income domain of the Indices of Multiple Deprivation 2007. Scale from 0 to 100, with 100 representing 100% of individuals from households on low income benefits. Deprivation is fixed over time, so its effect cannot be separately identified from the fixed effects in both models.
8. Robust standard errors clustered by small areas in parentheses.
9. ** p<0.01, * p<0.05

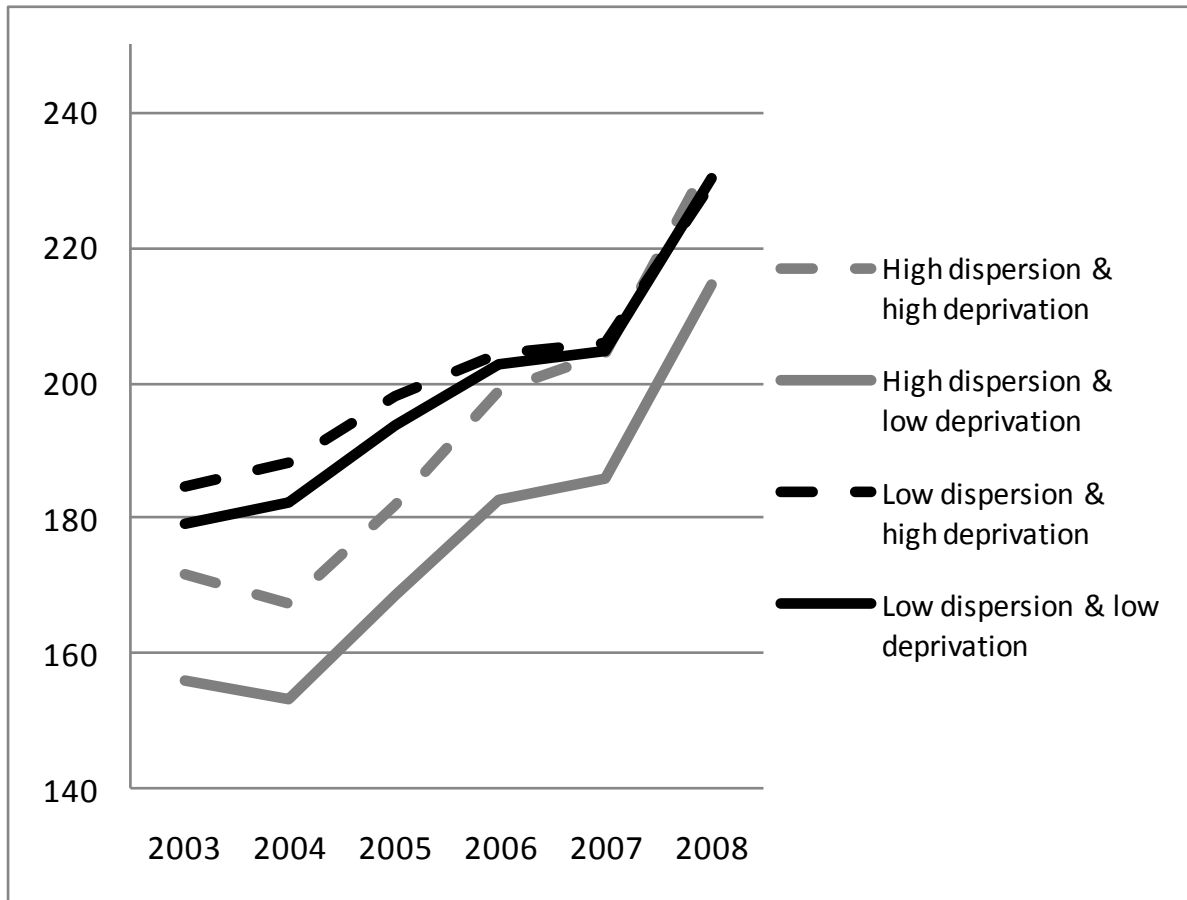
Figure 1: Heat map of hospital market concentration in the English NHS comparing baseline level in 2003 with difference 2003-8



Notes to Figure 1

1. Market concentration is measured using actual HHI on a scale of 0 to 10,000. The calculation of HHI is described in Appendix 2.
2. The different shades of grey represent deciles of the relevant variable (i.e. HHI 2003 and HHI 2008 minus HHI 2003 respectively)
3. Darker shades thus correspond to less concentrated markets at baseline in 2003, and larger reductions in market concentration 2003-8

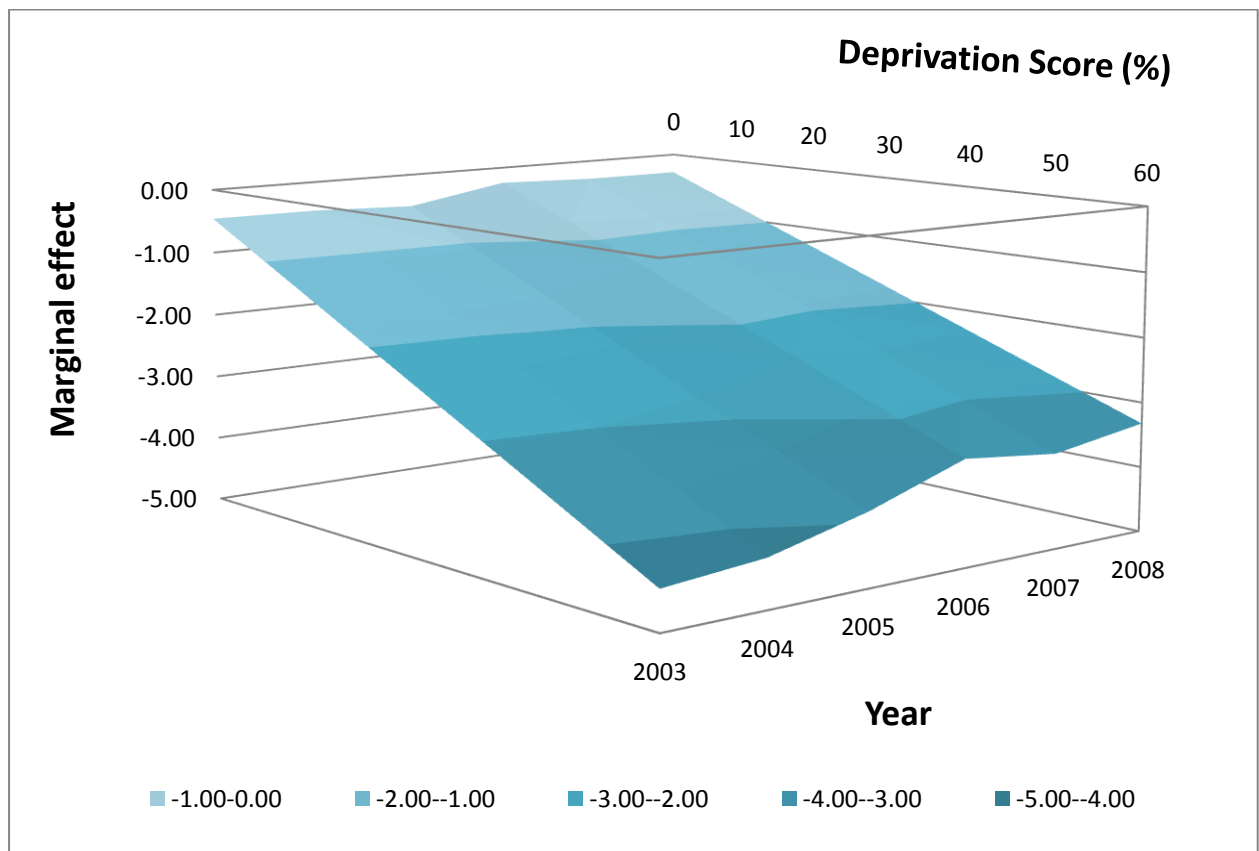
**Figure 2: Elective inpatient hospital utilisation by deprivation and dispersion
(observed rates per 100,000 population)**



Notes to Figure 2:

1. "High dispersion" refers to areas with HHI in 2003 < 5,000 (34.3% of areas) and "low dispersion" to other areas (65.7% of areas).
2. "High deprivation" refers to areas with IMD 2007 income deprivation score > 20% (27.8% of areas) and "low deprivation" refers to all other areas (72.5% of areas).

Figure 3: Marginal effect of hospital market dispersion on all elective inpatient admissions



Note to Figure 3

The figures plots the estimated marginal effects reported in table 3 using model 1.

Appendix 1

The observed competition index is calculated following a three step procedure. We first calculate HHI concentration indices at the GP practice level, based on observed shares of patients referred by the GP practice to any hospital. This index measures the degree of concentration of GP practice referrals for elective admissions for each GP practice in England.

In the second step, we calculate HHI indices at the hospital level as a weighted average of the HHI scores of all GP practices referring patients to that hospital. The weights are calculated using the number of hospital admissions coming from each GP practice.

Finally, we attribute the hospital level HHI indices to each LSOA as weighted average of public hospitals located within a 60 km fixed radius distance from the LSOA demographic centroid. The weights are inversely proportional to the hospital distance from the LSOA to reflect patient willingness to travel: hospitals closer to the LSOA population are given greater weight. All hospital within 5 km distance from the LSAO are given same weight. Propper et al. (2007) find that 90% of patients for elective admissions travel no further than 60km.

Almost all LSOAs in England have at least one hospital within 60 km. The few (about 30) LSOAs with no hospitals within 60 km are on the border with Scotland, and most probably seek care in Scottish hospitals, so we exclude them from our study. All hospitals that are very close to the LSOA centroid are given same weight, since LSOA residents do not all live in the population centroid but are dispersed within this area. In sensitivity analysis, we use alternative fix radius indices (30Km and 45Km) and find the completion indices are highly correlated and produce very similar results.

In order to test whether hospital competition is influenced by GP practice styles, we construct an alternative version of the HHI concentration index described above. This index uses patient small area of residence as the relevant market unit and is also based on a three step procedure. In the first step, we calculate the HHI at the level of patient area of residence based on observed shares of patient residents admitted to any hospitals. The second and the third steps are the same as in the previous version of the index. We find 90% correlation between the two versions of the index and very similar results in the empirical analysis.

Appendix 2

The identification of the effect of competition on equity in utilisation is potentially exposed to endogeneity bias when using an index of competition based on observed patient flows to hospitals. For example, a hospital investing in extra capacity might attract larger patient flows by lowering its waiting time, thus influencing both market structure and absolute utilisation volume. Moreover, the relationship between patient volumes and patient shares might vary by the socioeconomic characteristics of patients. Patients from lower socioeconomic backgrounds might not be willing to travel long distances and choose a different provider from their local hospital (Propper et al., 2006). Finally, patient flows might be affected by unobservable characteristics of patient health status, which are potentially correlated with their socioeconomic background.

To overcome potential problems of endogeneity, we follow the approach described in Kessler and McClelland (2000) and Gowrisankaran and Town (2003) and measure competition using patient travel distances that are exogenous to unobserved characteristics of patients and hospitals. The predicted competition index at the small area level is obtained following a three steps procedure.

In the first step, we specify a model of hospital choice at the patient level as a function of exogenous determinants of the patient admission using the following specification of the patient indirect utility function (Kessler and McClelland, 2000):

$$U_{ij} = \sum_{h=1}^3 \{ DD_{ij}^{h+} \times [\theta_1^h Z_j^h + \theta_2^h (1 - Z_j^h)] + DD_{ij}^{h-} \times [\theta_3^h Z_j^h + \theta_4^h (1 - Z_j^h)] \} + \sum_{h=1}^3 \{ X_i Z_j^h \lambda^h \} + \epsilon_{ij} \quad (2)$$

The utility of patient i from choosing the hospital j depends on: the relative distance of hospitals of a similar h type to hospital j - captured by the vector DD_{ij}^{h+} in the first term of equation 2; the relative distance of hospitals of different type - captured by the vector DD_{ij}^{h-} in the second term of equation 2; and the interaction between individual i characteristics, X_i , and hospital j characteristics - the latter are captured by a binary indicator Z_j^h in the last term of equation 2, $Z_j^h = 1$ if hospital j is of the type h and zero otherwise.

We allow for three different types of hospitals in our model – large public hospitals, teaching hospitals, independent sector hospitals. Also, we allow for individual characteristics such as patient severity (i.e. patient admitted with just one diagnosis, 2-3 co-diagnoses and more than three), patient age (i.e. patients aged from 18-50 and more than 50), patient socioeconomic status (i.e. patients from the most income deprived 20% of small areas). We restrict the choice set to all hospitals within 100km fix radius conditional of having at least one hospital of each type in the choice set.

The model described in equation 2 is used to predict the probability of each patient admission:

$$\Pi_{ij} = \Pr(Y_{ij} = 1) = \frac{\exp(U_{ij})}{\sum_{j=1}^J \exp(U_{ij})} \quad (3)$$

Where J_i are the hospitals in the choice set of individual i . Equation 3 is solved by maximising the following log-likelihood function:

$$\log L = \sum_{i=1}^n \sum_{j=1}^{J_i} \log(\Pi_{ij}) \quad (4)$$

We estimate equation 4 using a conditional logit separately for 2003 and 2008.

In the second step, we can calculate the hospital level HHI following Gowrisankaran and Town (2003):

$$HHI_j = \frac{1}{n_j} \sum_{i=1}^{J_i} \hat{\Pi}_{ij} \times HHI_i \quad (5)$$

With:

$$n_j = \sum_{i=1}^n \hat{\Pi}_{ij} \quad \text{and} \quad HHI_i = \sum_{j=1}^{J_i} (\hat{\Pi}_{ij})^2$$

Following Kessler and Mclellan (2000) and Gowrisankaran and Town (2003), we exclude patient level and hospital level characteristics from the main effects entering equation 2 and obtain an index of competition based on exogenous determinants of patient flows rather than potentially endogenous factors.

In the third step, we attribute the hospital level competition index obtained from equation 5 to small areas using a weighted average of public hospital HHI. We weight the hospitals' HHI by the inverse of their distance to the demographic centroid of the LSOA:

$$HHI_l = \frac{1}{w_l} \sum_{j=1}^J w_{jl} \times HHI_j \quad (6)$$

We restrict the number of hospitals to be directly included in the LSOA market to those falling within a radius of 60km from the small area demographic centroid and attribute an equal distance to hospitals located within a radius of 5Km. Fixing the LSOA market radius at 60Km prevents to artificially inflate the competition of those LSOAs having few hospitals in their closest neighbourhood. The contribution of distant hospitals is indirectly included in the LSOA market through their competition interactions with local hospitals as described in equation 5. In sensitivity analysis, we use alternative fix radius indices (30Km and 45Km) and find the completion indices are highly correlated and produce very similar results.

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