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Does hospital competition increase health care inequalities? Evidence from the English National Health Service 1991-2001

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Abstract

Aim: To estimate the effects of "internal market" hospital competition on small area socio-economic inequality in the use of hospital services in the English NHS 1991-2001.

Data: Hospital records are aggregated to a common geography of frozen 1991 English electoral wards and followed from 1991 to 2001. Two indicators of inequality are examined: elective total hip replacement and revascularisation. Indices of hospital concentration are constructed to indicate potential for competition, based on the number of NHS Hospital Trusts within a fixed distance of the ward centroid plus inverse Herfindahl indices based on bed capacity and activity. Control variables include population size, age, sex, ethnicity, standardized mortality and illness ratios, emergency admissions, beds per head, primary care doctors per head, waiting time, and penetration of hospital budget holding among primary care doctors.

Methods: To identify inequality effects, we examine geographical variation and change over time in hospital concentration, alongside the natural experiment provided by the internal market. Random and fixed effect negative binomial regression models of ward utilisation are estimated, with interaction terms between hospital concentration, socio-economic status and a 1993-6 internal market dummy.

Results: Internal market competition is significantly associated with a small increase in hip replacement inequality of between 3 and 5%. By contrast, internal market competition is significantly associated with a small reduction in revascularization inequality of between 3 and 4% along with an overall revascularization rate increase of between 10 and 14%. The revascularization results are less robust to sensitivity analysis using alternative specifications.

Conclusions: Internal market competition appears to have different inequality effects on different kinds of care. In the case of hip replacement, competition may have incentivised "cream-skimming" of lower cost, shorter-staying patients from affluent areas. In the case of revascularisation, by contrast, competition may have given local payers additional leverage over hospitals to pursue national targets for improved access to this high profile life saving treatment.

Key terms:

Access to Health Care, Economic Competition, Socioeconomic Factors

"The availability of good medical care tends to vary inversely with the need for it in the population served. This inverse care law operates more completely where medical care is most exposed to market forces, and less so where such exposure is reduced".

Tudor-Hart (1971)

1. Introduction

Pro-competition market reform of publicly funded services is a perennial policy prescription, of increasing importance in health system reform debates across the world (Cutler 2002; Federal Trade Commission and Department of Justice 2004; Cookson and Dawson 2006). Under the banner of "choice", for example, a major programme of pro-competition reform is currently under way in the English National Health Service (Propper et al. 2006).

The main objective of pro-competition reform is to improve efficiency – i.e. to reduce unit costs, increase activity and improve quality. A common concern, however, is that hospital competition may have the unintended consequence of undermining equity in health care. Tudor-Hart's "inverse care law" is a classic expression of the view that market forces tend to exacerbate health care inequalities (Tudor-Hart 1971). The equity issues are obvious in relation to "real" market forces (i.e. hospital competition for privately funded patients), which distribute health care according to ability to pay as well as need. However, equity issues can also arise in relation to "quasi" market forces (i.e. hospital competition for publicly funded patients), in a context where health care is free at the point of delivery and so ability to pay is taken out of the equation. One concern is that competitive pressures on hospitals to reduce costs may incentivise "cream-skimming" – i.e. conscious or unconscious prioritization of lower-cost, short-staying patients. This may differentially impact less advantaged patients – for instance, socio-economically deprived patients with multiple chronic co-morbidities – who tend to cost more to treat (Tudor-Hart 2006, Taylor et al. 2003, Epstein, Stern and Weissman 1990). Another concern is that disadvantaged patients may be even less able to "work the system" in a competitive environment than in a non-competitive environment – for example, by travelling long distances to obtain care (Propper *et al.* 2007). Since equity is a primary goal of all publicly funded services, these concerns have to be addressed by those seeking to implement reform.

There is considerable evidence of systematic inequalities in the use of hospital and other specialist health services, favouring advantaged groups, even in high income countries with universal coverage (Goddard and Smith 2001, Dixon et al. 2003, Van Doorslaer, Koolman and Jones 2004). There is less evidence about the causes of this pervasive inequality. Supply factors may include lower availability of primary care doctors in deprived areas; demand factors may include low expectations and practical, cultural and educational barriers to seeking specialist care. Another issue is that disadvantaged individuals are more likely to have severe multiple co-morbidity, which may lower capacity to benefit from treatment. To our knowledge, no previous study has examined the effects of pro-competition reform on health care inequalities (Le Grand, Mays and Mulligan 1998; Cookson and Dawson 2006, Burgess et al. 2005, Mannion 2005).

This study draws on the natural experiment provided by the "internal market" reforms of the English National Health Service (NHS) from 1991-7, which were designed to introduce "payer-driven" competition into the NHS. Two strategies are used to identify inequality effects. One strategy is to examine variation in hospital concentration between and within small areas over time. Insofar as hospital concentration indicates the possibility of competition (i.e. whether there is more than one hospital in the local market) and/or the potential degree of competition (i.e. the number of hospitals within the local market), this helps to identify any general effect of market structure on inequality, irrespective of pro-competition "internal market" reform. There is substantial time variation in hospital concentration over this period due to new entry, mergers and reconfigurations, with a wave of mergers in the late 1990s. This variation allows the use of “fixed effect” panel data methods in an attempt to control for unobservable confounding factors – such as any special characteristics of inner city areas other than the fact that they are served by many hospitals – on the assumption that those factors do not change over time.

The second identification strategy is to exploit variation in the national policy environment over time: the pro-competition "internal market" reforms were at their height during 1993-1996. This helps to identify any specific effect of pro-competition reform, using a "difference-in-differences" approach. The idea is to estimate the inequality difference between competitive and non-competitive areas and examine the difference in this difference between the reform period 1993-6 and all other time periods. This helps to identify any effect of “internal market” competition, on the assumption that any changes over time in unobserved determinants of inequality run parallel between competitive and non-competitive areas.

The study tracks small area variations in use of NHS hospital care from 1991 to 2001 using a common geography of 8,500 frozen 1991 electoral wards covering the whole of England. Census data on the size, age, sex and socio-economic characteristics of ward populations are linearly interpolated between Census 1991 and 2001, and combined with other sources of administrative data. The primary indicator of socio-economic status is the Townsend deprivation index; secondary indicators used in sensitivity analysis are the Department of Environment deprivation index and the proportion of residents unemployed or receiving incapacity benefit. These are the best indicators available for measuring both cross-sectional variation and change in the socio-economic status of English small areas from 1991 to 2001. Control variables include population size, age, sex, ethnicity, standardized mortality and illness rates, emergency admissions, hospital beds per head, primary care physicians per head, population per hectare, waiting time, and penetration of hospital budget holding by primary care doctors.

Elective total hip replacements and revascularisations are used as primary indicators of small area socio-economic inequality. These are both high volume routine procedures, readily observable using HES data, and both exhibit clear socio-economic inequality in use after controlling for need in small area studies (Chaturvedi and Ben-Shlomo 1995, Dixon et al. 2004; Cookson, Dusheiko and Hardman 2007, Ben-Shlomo and Chaturvedi 1995, Payne and Saul 1997, Alter et al. 1999, Hippisley-Cox and Pringle 2000) and in some but not all individual level clinical survey studies (Milner et al. 2004, Morris et al. 2005; but see also Propper et al. 2005 and Britton et al. 2004). As a result, both have been cited in the health policy literature as important and striking examples of health care inequality (Le Grand 2006). The study focuses on inequality in publicly funded care – i.e. NHS care. It does not include data on private sector activity, which was negligibly small for revascularisation but which made up about one quarter of all hip replacements performed in England in the 1990s (Williams et al. 2000).

Indices of “potential” hospital competition are constructed based on the number of Hospital Trusts within fixed radius distances (15, 20, 30 and 40km) (Propper, Burgess and Green 2004; Siciliani and Martin 2007). Inverse Herfindahl indices based on market share by bed capacity and activity are also explored in sensitivity analysis. Panel data negative binomial models of ward utilisation are estimated, with population averaged random effect and conditional fixed effect specifications. The general effect of market structure is assessed using an interaction term between potential competition and socio-economic status; the specific effect of "internal market" competition is assessed using an interaction term between potential competition, socio-economic status and a dummy variable indicating the period of internal market competition 1993-6.

The basic finding is that internal market competition has small but significant effects on inequality, with different effects for the two different kinds of procedure. In the case of hip replacement, internal market competition is associated with a small increase in inequality. In the case of revascularization, by contrast, internal market competition is associated with a small reduction in inequality together with a substantial increase in overall utilization.

2. Competitive incentives in the NHS "internal market"

The NHS "internal market" reforms in England created two types of local public payer - District Health Authorities (DHAs) and General Practice Fundholders (GPFHs) - responsible for purchasing hospital services from local hospital providers (Hospital Trusts). DHAs were responsible for purchasing all services within a geographically defined administrative boundary; GPFHs were primary care practices responsible for purchasing a subset of elective services for their list of patients. The competitive incentives generated by these reforms were weak and the political limits to competition strong (Le Grand, Mays and Mulligan 1998). There were political barriers to entry and exit: central government discouraged local Health Authorities from “destabilising” local Hospital Trusts, who in turn were bailed out of any serious financial difficulties (Enthoven 1999). Nevertheless, there is evidence that the reforms did generate some competition between hospitals. This includes qualitative evidence from market participants and commentators (Renade 1994, Propper 1996) as well as quantitative evidence that hospitals in competitive areas cut overall prices and, by 1994, costs (Propper and Soderlund 1998). In the case of emergency cardiac care, there is also some suggestion of "quality skimping" by hospitals in competitive areas as evidenced by a small increase in 30 day mortality following emergency admission for acute myocardial infarction (Propper, Burgess and Green 2004).

The reforms also generated theoretical incentives for "cream-skimming" of low-risk patients by hospitals in more competitive areas. One hypothesis is that this may have exacerbated health care inequalities, insofar as disadvantaged patients with multiple co-morbidities tend to consume more hospital resources, including more complications and longer lengths of stay (Taylor et al. 2003, Epstein, Stern and Weissman 1990). This concern about provider cream-skimming by hospitals should be distinguished from concern about payer cream-skimming by General Practice Fundholders, who controlled their own patient lists. Incentives for the latter were attenuated by a "stop-loss" insurance scheme - no GPFH would be responsible for individual patient costs above £5,000 in one year. The received wisdom is that little cream-skimming of either kind took place (Le Grand, Mulligan and Mays 1998). However, in the case of hospital cream-skimming this is based on an absence of evidence rather than evidence of absence.

In theory, Hospital Trusts faced strong incentives for cream-skimming. Health Authorities and Hospital Trusts typically negotiated "block contracts" whose central feature was a lump sum payment for providing a minimum volume of activity. This provides an obvious incentive to limit activity above the minimum volume, by restricting admissions and encouraging GPs to restrict their referrals, and to prioritise less resource-intensive patients. These incentives need not reflect a “profit” motive to increase the surplus between revenue and expenditure. Instead, they might reflect non-monetary managerial concerns to conserve hospital resources (including bed space and staff time) in order to avoid overloading hard-pressed staff and/or to comply with targets set by central government – in particular, waiting list targets – under the conditions of excess demand and capacity constraints that were prevalent in the 1990s.

To mitigate the obvious incentives to limit activity under simple block contracts, more "sophisticated" block contracts were often negotiated, specifying additional case payments for additional activity with limited adjustment for case-mix. As is well known, however, simple case payments provide a powerful theoretical incentive to "cream-skim" low-risk patients, insofar as (i) the marginal cost of a high-risk patient may exceed the marginal revenue from the negotiated case payment and (ii) prioritising low-risk patients may allow more activity to be performed (and more revenue generated and non-monetary managerial concerns satisfied) within hospital capacity constraints (Ellis 1998). Hospital Trusts located in more competitive areas had incentives to compete for contracts by offering a lower lump sum fee, higher minimum volume and/or lower price for additional activity - all of which would strengthen the theoretical incentive to engage in cream-skimming. The same applies to competition for contracts from General Practice Fundholders, which were typically exclusively on a case payment basis. Hospital Trusts in more competitive areas thus had incentives to offer lower case payments to win business, thus generating stronger heoretical incentives to cream-skim low-cost patients whose marginal cost lies below the case payment.

It is not known how far (if at all) Hospital Trusts responded to these theoretical incentives for cream-skimming - no evidence is available, either for or against. Both GPs and hospital consultants had the opportunity to engaging in cream-skimming activity by adapting their referral or admission decisions in response to the incentive pressures facing their own organization and their local health economy – quite possibly in an unconscious manner, without any conscious discrimination taking place. However, GPs and hospital doctors have clinical freedom over their referral and admission decisions, and so were to some extent insulated from organizational incentives facing hospital managers. So doctors' own internal professional norms of medical ethics may have outweighed any external pressures. Furthermore, NHS Hospital Trust management information systems were not designed to provide information on patient risk and cost. So an explicit, systematic policy of cream-skimming by Hospital Trusts would have been impractical as well as unethical. Nevertheless, these powerful theoretical incentives may have generated informal and unconscious cream-skimming behaviours in more competitive areas, as hospital consultants and GPs adjusted their practice styles in response to the wider financial and managerial pressures facing their local health economy.

2. Methods

2.1 Data

Hospital utilisation

Hospital utilisation data were obtained from Hospital Episode Statistics (HES) for financial years 1991/2 through 2001/2. HES provides data on all NHS hospital inpatient episodes in England, including day cases, but excludes private hospital admissions. Data on all finished first consultant episodes were obtained for all adults over 44 by age, sex and frozen 1991 ward code for (1) elective primary total prosthetic replacement of hip joint (OPCS4 codes W37, W38, W39) excluding revisions (W37.3, W38.3, W39.3), (2) coronary artery bypass grafts (CABG) (OPCS4 K40-K46) and (3) percutaneous transluminal coronary angioplasty (PCTA) (OPCS4 K49-K50). Revascularisation is the combination of (2) and (3) i.e. CABG and PCTA. To improve comparability, aggregation and record linkage were performed using the frozen 1991 ward codes provided by HES. This common geography minimises the risk that apparent inequality effects might be an artefact of electoral ward boundary changes.

Population

Data on the characteristics of ward resident populations in 1991 and 2001 were obtained from the respective National Censuses (Office of Population Censuses and Surveys 1991, Office of National Statistics 2001). Census 2001 data was allocated to frozen 1991 wards at the level of 2001 Census Output Areas, which each contain around 125 households. This was done using geographical software (MapInfo), by matching each Output Area to the ward which contained the "population centroid" of that Output Area (i.e. the point of maximal population density). Census data was then linearly interpolated between 1991 and 2001 endpoints to estimate population characteristics for the years 1992-2000. To facilitate standardisation for age and sex, data on population size was split into five-year age bands from 45 up to 90 plus for both males and females, setting aside younger individuals in whom utilization of these procedures is low.

Socio-economic status

The Census-based Townsend deprivation Z-score was used as the primary indicator of socio-economic status (Townsend 1987, Carstairs 2000). It has four components: (i) unemployment – unemployed residents over 16 as a percentage of all economically active residents over 16), (ii) overcrowding – households with one person per room and over as a percentage of all households, (iii) non-car ownership – households with no car as a percentage of all households, and (iv) non home ownership – households not owning their own home as a percentage of all households. Each component is normalised to zero by subtracting the mean and dividing by the standard deviation, following a log-transformation for unemployment and overcrowding, and these four component Z-scores are then summed. The resulting Townsend score ranges from about –8 to about +13, with higher values indicating greater deprivation. Townsend scores were computed separately for each year, based on linearly interpolated raw data between Census 1991 and Census 2001 endpoints, and normalized for ease of interpretation by dividing by their standard deviation.

A secondary socio-economic indicator was the Department of Environment index of deprivation index, which is computed analogously to the Townsend index using a different set of Census variables: unemployment, overcrowding, lone pensioners, lone parents and lacking amenities. A third Census-based indicator was the proportion of residents aged 16 to 74 who were unemployed or in receipt of incapacity benefit. This may provide a better comparison over time than the proportion unemployed, given the secular shift away from unemployment benefit and towards incapacity benefit during the 1990s.

Hospital competition

A number of indices of hospital competition are used in extensive sensitivity analyses. Indices of hospital concentration (i.e. market structure) are first computed at the level of the organisation - the Hospital Trust - based on fixed radius geographical market boundaries. Ward level indices are then computed as distance weighted averages of the Trust level indices for all Trusts within the same fixed distance radius of the ward. The aim is to measure the potential degree of competitive pressure facing the Trusts most likely to be frequented by patients living in the ward.

The primary index of potential hospital competition is based on the number of General and Acute Hospital Trusts with more than 200 beds within 20km of the ward centroid, denoted cn20 (Propper, Burgess and Green 2004). This is our preferred index because it focuses on a relatively exogenous aspect of market structure - the location of Hospital Trusts - rather than endogenous aspects such as activity shares that can fluctuate in the short-term as an effect rather than a cause of competitive pressure. The 20km radius is our preferred distance radius, drawing on previous work on effects of hospital competition on waiting times by Siciliani and Martin (2007). However, secondary competition indices are also computed using 15, 30 and 40km radius geographical boundaries. The index is computed from data on locations and bed capacity of Hospital Trusts for each year from 1994/5 onwards from “Bed Availability and Occupancy”, an annual report published by the Department of Health. Data for earlier years was not available, since Hospital Trust organisational status was phased in from 1991/2 onwards. This index is converted into a binary index, cn20poss, which indicates whether competition is possible or not. This index is set equal to 1 if cn20 > 1 and is set to zero otherwise. (In the case of the 40km radius index, a binary index is instead constructed based on the bottom quartile, since few Trusts have no competitor within 40km).

Other analogously defined indices of competition examined in sensitivity analyses include:
cn20bed: = capacity-based inverse Herfindahl index: one divided by the sum of square market shares by bed capacity.
cn20act: = activity-based inverse Herfindahl index: one divided by the sum of square market shares by all elective activity recorded in HES.

The inverse Herfindahl index is also known as the “number of effective competitors” and is comparable with the actual number of competitors (Siciliani and Martin 2007).

To allow for possible non-linear effects of competition, models are also computed using competition squared terms. A non-linear effect might occur, for example, if a move from 1 to 2 Trusts represents a larger increase in competition than a move from 35 to 36 Trusts.

These competition indices aim to indicate the overall degree of competitive pressure facing local Hospital Trusts as a whole. They are not speciality-specific indicators of competition between Clinical Departments located within Hospital Trusts – i.e. between the Orthopaedic Departments that provide hip replacements and between Cardiology Departments that provide revascularizations. The relevant geographical markets for analysis of competition between Cardiology Departments would be wider than those analysed in this paper, since cardiology services tend to be concentrated in large specialized regional centres. However, the relevant unit for analysis of internal market competition is the organization i.e. the Hospital Trust. Competitive pressures facing Hospital Trusts may have differential impacts on different Departments within a Trust, due to internal factors such as the degree of financial devolution within the Trust. However, the Hospital Trust has ultimate legal authority over financial management and deployment of internal resources – including bed space, theatre space and human resources – and so competitive pressures facing a Hospital Trust are likely to be felt at least to some extent by all its Departments.

Need
In addition to population size, age and sex, it was possible to construct two further time-varying need variables by combining Census 1991 and Census 2001 Output Area data: ethnicity (proportion of residents aged 50 plus who are non-white) and standardised illness ratio (proportion of residents of households aged 60 and over with limiting long standing illness, standardised for age and sex). Ward level standardised mortality ratios for all cause mortality and ischaemic heart disease were also computed, based on mortality data from the Office of National Statistics. An additional time-varying need variable was obtained from HES data: the rate of emergency procedures per 100,000 population.

Supply and other variables
Hospital supply was indicated by hospital beds per 1,000 population within 20km of the ward centroid, for each year. A time-varying index of primary care supply was not available, but GPs per 10,000 registered patients within the ward was available for 1995. Data on waiting time in months (from the decision to treat, usually taken at an outpatient appointment, to the inpatient admission) were obtained from HES and trimmed to remove outlier waits of more than three years. In cases of missing waiting time values due to no activity in a given year, a 5-year moving average was taken.

Finally, a time-varying index of GP fundholding penetration was computed, to capture any effect of fundholding on admissions. This was computed as the proportion of the ward population registered with a standard fundholding practice (i.e. a practice that purchased hospital services). Sources of data for this index included Prescription Pricing Authority data from 1998/9 on all practices in England (with practice code, fundholding type and start/end date), Attribution Data Set data on practice registrations for 1999 and 2000, and a lookup table between practice and senior partner codes from the Codes Service Database 2001.

2.2 Methods of analysis
Ward-level utilisation equations were estimated separately for hip replacement and revascularisation. Panel data negative binomial maximum-likelihood regression models were used (Cameron and Trivedi 1998). The negative binomial model is a generalisation of the standard Poisson model of small area counts (Breslow and Day 1987). It assumes that the utilisation count dependent variable follows a Poisson-like process, although characterised by over-dispersion (i.e. with variance greater than the mean).

The basic model can be written:

$$\ln(\mu_{it}) = \ln(p_{it}) + \delta_{1i} + \delta_{2t} + \beta X_{it} + \gamma Z_{it} + \varepsilon_{it}$$

$$\beta X_{it} = \beta_1 . d_{it} + \beta_2 c_{it} + \beta_3 d_{it} Y_t + \beta_4 d_{it} c_{it} + \beta_5 d_{it} c_{it} Y_{it}$$

where:

μ_{it} is expected utilisation for ward *i* in year *t*

p_{it} is the population aged over 44 in ward *i* at time *t*

δ_{1i} and δ_{2t} are ward effects and year effects, respectively

d_{it} is an index of deprivation

c_{it} is an index of hospital competition

Y_t is a dummy variable set to 1 from 1993-1993 (height of the internal market), otherwise 0

Z_{it} is a vector of control variables (e.g. age-sex proportions, need, supply, waiting time, etc.)

Year effects (i.e. year dummy variables) were included to account for the growth trend in utilisation over time. Both population averaged random effects and conditional fixed effects specifications are used. Ward level fixed effects allow for unobserved factors that are stable over time. The additional time-varying control variables, Z_{it}, were included in an attempt to allow for observable determinants of utilisation that change over time. Since wards vary in population size, time-invariant importance weights were applied based on mean population size.

The effects of competition on socio-economic inequality were assessed by examining the coefficients on key interaction terms – i.e. β_4 and β_5. The former – a two-way interaction between potential competition and socio-economic status – can be interpreted as a general effect of market structure. The latter – a three-way interaction between potential competition, socio-economic status and the period 1993-6 – can be interpreted as a specific effect of "internal market" competition.

Regression coefficients are presented as incident rate ratios. A coefficient of 1 therefore represents zero effect; a coefficient of 1.10 means that a one point increase in the regressor yields a 10% increase in hospital utilisation; and a coefficient of 0.90 means that a one point increase in the regressor yields a 10% decrease in utilisation.

To facilitate computation of interaction terms and computation of marginal effects, all regressors were centred by subtracting their global mean. To facilitate interpretation of regression coefficients, deprivation indices were normalised by dividing by their standard deviation, and percentages were re-scaled from 0 to 100. All calculations were performed using Stata 9.0.

4. Results

4.1 Descriptive statistics

Table 1 about here

Table 2 about here

The dataset contained 8,500 wards - i.e. virtually all wards in the 1991 census. However, there are 186 missing wards (2.2%) from 1991 to 1995 due to linkage problems with the pre-1996 "frozen 1991 ward" code in HES. The total adult population over 44 of all the wards represented in the dataset was 17,481,546 in 1991 rising to 19,379,839 by 2001. Descriptive statistics for key variables are in tables 1 and 2.

4.2 Hip replacement results

Table 3 about here

Table 3 shows results of the hip replacement analysis for four models: random effects and fixed effects, using cn20poss, with the "kitchen sink" specification (i.e. all control variables) and a "preferred" specification. The "preferred" specification removes three problematic need variables - standardized illness ratio, standardized mortality ratio and emergency admissions – the first two of which have the "wrong" sign. These variables may partly confound with aspects of socio-economic status and hospital supply and, arguably, are unlikely to predict need for hip replacement any more accurately than population size, age and sex. The "preferred" specification also removes waiting time, since waiting time is one of the mechanisms through which hospitals can influence admissions. Controlling for waiting time thus excludes any indirect effect of competition on admissions that is mediated by waiting time.

In all four models – random effects and fixed effects using "kitchen sink" and "preferred" specifications – the key coefficients on the three-way interaction term between socio-economic status, potential competition and the 1993-6 dummy are significant and below one. This suggests that internal market competition resulted in a significant increase of between 3 to 5% in hip replacement inequality, favouring affluent wards. This basic finding is robust to extensive sensitivity analysis using different competition indices and control variables; it also carries across to model specifications using ordinary least squares. Figure 1 illustrates this effect for the random effects "preferred" specification.

Figure 1 about here

The coefficients on the "competition possible" main term differ between random and fixed effect specifications, showing a significant negative effect on utilisation with random effects and no effect with fixed effects. The fixed effect results suggest that market structure *per se* has no causal effect on overall hip replacement utilization, even though unobserved characteristics of competitive areas are associated with lower utilization in random effects models.

The random effects models show a significant social gradient in use of hip replacement, favouring affluent wards. However, most fixed effect specifications are unable to identify a significant gradient. As discussed below, the random effect result is to be preferred given the substantial cross-sectional variation but limited change over time in socio-economic status. The random effects coefficient of 0.928 suggests that, across the period 1991-2001, a one unit increase in a ward's normalised Townsend deprivation score (i.e. a one standard deviation increase in the original Townsend deprivation score) results in a reduction of 7.2% in the likelihood of receiving a hip replacement.

4.3 Revascularisation analysis

Table 4 about here

Results from kitchen sink and preferred specifications are presented in table 4. The preferred specification is the same as for hip replacement, except including emergency admissions as an additional need variable. Population size, age and sex alone are inadequate predictors of need for revascularization and, despite partial confounding with socio-economic status and supply, the emergency admission rate is plausibly related to population morbidity including heart disease.

The presented models all have a coefficient greater than unity on the key interaction term between potential competition, socio-economic status and the 1993-6 dummy. This suggests that internal market competition reduced inequality in revascularization. However, the coefficients are not all significant at 5%. This pattern is repeated in sensitivity analysis using alternative competition indices and control variable sets: the coefficient is consistently greater than unity, but not always significant at 5% or even at 10%. This inequality effect is illustrated in figure 2.

Figure 2 about here

A second key finding is that the coefficient on the interaction term between "competition possible" and the 1993-6 dummy is significant and greater than unity, lying between 1.108 to 1.144 in the presented models. This suggests that internal market competition increased the overall utilization rate by between 10 and 15%. This result is robust to sensitivity analysis.

Finally, the coefficient on the "competition possible" main term varies between fixed and random effects models, showing an increase in revascularization with random effects and a decrease with fixed effects. The fixed effects result is more likely to identify a causal effect, as opposed to unobservable characteristics of competitive areas. One way to think about this fixed effects result is in terms of mergers, which were the dominant force driving change in concentration in the late 1990s outside the internal market period. A decrease in potential competition due to a Hospital Trust merger tends to increase the revascularization rate.

The coefficient on socio-economic status is generally significant and below unity, suggesting that there was a general social gradient in revascularization across the period. In the preferred specification, using a random effects model to exploit the substantial cross-sectional variation in deprivation, the coefficient is 0.938. This suggests that a one standard deviation increase in a ward's Townsend deprivation score reduces the likelihood that a person living in that ward will receive a needed revascularization procedure by 6.2%. However, this coefficient varies considerably between different control variable specifications.

5. Discussion

In "preferred" specifications, there is clear socio-economic inequality in use of elective total hip replacement and revascularisation during the period 1991-2001. In the case of revascularization, however, the inequality coefficient is relatively unstable between different model specifications. This may be due to relatively poor control for need: need for revascularization varies more between wards than need for hip replacement, and is harder to measure using routine data. Furthermore, fixed effect specifications are generally unable to identify a gradient in hip replacement. This is probably due to the quite limited degree of change over time in deprivation status: only 186 wards move in to and out of the bottom quartile of Townsend deprivation from 1991 to 2001 and deprivation scores in between these years are based on linear interpolations.

In the case of hip replacement, “internal market” competition increases the inequality gradient by between 3 and 5%. By contrast, in the case of revascularization “internal market” competition reduces the inequality gradient by between 3 and 4% and increases overall utilization by between 10 and 15%. The hip replacement findings are consistent with the “cream-skimming” hypothesis that competitive pressures during the “internal market” led hospitals to under-treat more costly and longer-staying patients in deprived areas. The revascularisation results are clearly inconsistent with a “cream-skimming” hypothesis. A possible explanation lies in the politically high profile nature of revascularization targets during the period of the “internal market”. During this period, increasing revascularization rates was a high profile political target, since waiting times for revascularization were high (averaging 24 months in 1991 and falling to 12 months by 1997) and there was a non-negligible risk that patients would die while waiting for treatment. During the internal market, payers in competitive areas could threaten to move contracts elsewhere and so may have had more leverage over Hospital Trusts to achieve those revascularization targets compared with payers in non-competitive areas. Another issue, relating to ethics rather than politics, is that doctors may face particularly strong ethical barriers against cream-skimming in the case of life saving procedures such as revascularization.

From a policy perspective, the first main conclusion from this study is that “internal market” competition did have small but significant effects on health care inequalities. Given that the “internal market” reforms were limited and the competitive incentives were weak, this sounds a warning note for policy-makers designing more ambitious pro-competition reforms with potentially more powerful incentives. The second main conclusion is that inequality effects were strikingly different for the different types of care examined: an inequality-increasing effect for hip replacement and an inequality-reducing effect for revascularization – the latter being subject to national targets with a particularly high political profile during the period in question. This difference suggests that the inequality effects of competition may depend crucially on interactions between market forces and other more politically-driven incentive mechanisms.

Table 1: Descriptive statistics for key variables

Variable	Description	Mean	Std. Dev.	Min	Max
hiprate	hip replacements per 100,000	183.81	138.63	0.00	2,770.65
revasrate	revascularisations per 100,000	108.26	101.72	0.00	3,661.59
towntot	Townsend deprivation index (normalized)	0.00	-1.00	-3.01	4.02
doetot	DoE deprivation index (normalized)	0.00	-1.00	-3.88	3.27
cn20	Hospital Trusts within 20km	5.03	7.26	0.00	36.00
cn20act	Activity-based inverse Herfindahl	4.41	6.14	0.00	30.04
cn20bed	Bed-based inverse Herfindahl	4.83	6.55	0.00	33.12
c1poss	1 if c1 > 1 Trust; otherwise 0	0.66	0.47	0	1
emergrate	emergency admissions per 100,000	10,152	3,745	0	107,223
sir60	standardised illness ratio (age 60+)	98	18	46	181
bedper1000	hospital beds per 1,000 population	2.88	1.49	0.00	26.82
fundh	fundholding penetration	20.28	29.55	0.00	100.00
wt_hip5	hip replacement waiting time (mths)	7.20	4.63	0.03	36.50
wt_revas5	revascularisation waiting time (mths)	15.02	15.30	0.03	36.50
pwhite	proportion white (age 50+) (%)	97.46	6.28	14.41	100.00
pophectare	population per hectare	20.80	26.19	0.02	218.85
gpper10000	GPs per 10,000 for 1995	5.43	0.85	2.05	13.01
pop45	population age 45+	2,187	1,464	115	14,204
m5054	male 50-54 (%)	8.1	1.4	2.4	17.2
m5559	male 54-59 (%)	7.1	1.0	2.4	12.3
m6064	male 60-64 (%)	6.3	0.8	2.8	13.9
m5969	male 65-69 (%)	5.7	0.8	1.8	14.0
m7074	male 70-74 (%)	4.6	0.8	1.3	9.4
m7579	male 75-79 (%)	3.5	0.7	0.7	7.9
m8084	male 80-84 (%)	2.0	0.6	0.0	5.8
m8589	male 85-89 (%	0.9	0.4	0.0	4.0
m90	male 90 + (%)	0.3	0.2	0.0	2.2
f4549	female 45-49 (%)	8.2	1.5	2.2	18.2
f5054	female 50-54 (%	8.1	1.3	2.5	15.2
f5559	female 55-59 (%)	7.1	0.9	2.8	14.3
f6064	female 60-64 (%)	6.6	0.8	2.9	14.8
f6569	female 65-69 (%)	6.3	1.0	2.0	13.5
f7074	female 70-74 (%)	5.6	1.1	1.4	12.7
f7579	female 75-79 (%)	4.9	1.2	0.8	12.0
f8084	female 80-84 (%)	3.6	1.1	0.0	12.7
f8589	female 85-89 (%)	2.1	0.9	0.0	11.4
f90	female 90+ (%)	1.1	0.6	0.0	9.6

Notes:

(1) N = 92,745 observations for each variable

(2) Observations clustered within 8,519 wards over 11 years

(3) 931 missing observations due to linkage failure for 186 wards in years 1991-1995

Table 2: Means of key variables by year

Year	pop45	hiprate	revasrate	pcta share of revas (%)	cn20 poss	fundh (%)	bedper1000	hip wait (mths)	revas wait (mths)
1991	2,099	164	64	29%	5.23	5.7	2.93	7.4	23.5
1992	2,117	174	76	30%	5.23	10.2	2.93	6.8	20.2
1993	2,135	180	88	31%	5.23	19.9	2.93	6.7	17.2
1994	2,153	188	98	33%	5.23	27.8	2.93	6.5	15.3
1995	2,171	193	106	35%	5.39	31.7	2.95	6.3	14.4
1996	2,184	174	107	37%	5.33	41.1	2.91	6.4	13.5
1997	2,202	167	108	38%	5.23	43.9	2.86	7.0	12.7
1998	2,220	191	126	39%	5.02	42.7	2.84	7.6	12.1
1999	2,239	191	127	41%	4.72	0.0	2.82	7.7	11.2
2000	2,257	197	138	45%	4.50	0.0	2.83	8.2	12.0
2001	2,275	203	151	48%	4.19	0.0	2.70	8.4	13.3
Total	2,187	184	108	38%	5.03	20.3	2.88	7.2	15.0

Table 3: Hip replacement regression results: Negative binomial random effect and fixed effect models

	(1)	(2)	(3)	(4)
Dependent variable: hip replacement count by ward and year	Random Effect "kitchen sink"	Fixed Effect "kitchen sink"	Random Effect "preferred"	Fixed Effect "preferred"
Normalised Townsend deprivation score	0.92922***	0.98672	0.92808***	1.01811
	(0)	(0.49)	(0)	(0.31)
competition possible (0 or 1)	0.90643***	1.01153	0.92197***	0.99939
	(0)	(0.51)	(0)	(0.97)
competition * 9396	0.99500	0.99229	0.99226	0.98062*
	(0.67)	(0.48)	(0.51)	(0.085)
Townsend * competition	0.99615	1.00747	0.99772	1.01504
	(0.69)	(0.70)	(0.83)	(0.45)
Townsend * competition * 9396	0.97275*	0.96399***	0.96250***	0.94525***
	(0.053)	(0.0045)	(0.0084)	(0.000021)
fundholding penetration (0-100)	0.99982	0.99996	0.99993	1.00003
	(0.10)	(0.70)	(0.51)	(0.78)
NHS beds per 1,000 population	0.99674	1.01154***	0.99844	1.02040***
	(0.15)	(0.0023)	(0.53)	(0.00000011)
proportion white ethnicity (0-100)	1.00857***	1.00581***	1.00829***	1.01021***
	(0)	(0.0100)	(0)	(0.0000016)
population per hectare	0.99914***	0.99465***	0.99947***	0.99438***
	(0.0000020)	(3.95e-09)	(0.0043)	(0)
emergency admissions per 1,000 pop	1.00562***	1.00614***		
	(0)	(0)		
Standardised Illness Ratio (base=100)	0.99506***	0.99867*		
	(0)	(0.050)		
All cause SMR (base = 100)	0.99911***	0.99917***		
	(0)	(9.82e-10)		
waiting time (months)	0.98979***	0.99222***		
	(0)	(0)		
GPs per 10,000 population	1.06261***		1.08110***	
	(0)		(0)	
Constant	0.00171***	0.00884***	0.00174***	0.00670***
	(0)	(0)	(0)	(0)
Observations	92,558	92,569	92,569	92,569
Number of wards	8,499	8,500	8,500	8,500
Notes:				
(1) p values in parentheses				
(2) *** p<0.01, ** p<0.05, * p<0.1				
(3) Coefficients on population age-sex fractions and year dummies suppressed due to space constraints				
(4) competition possible = 1 if there is at least one NHS Hospital Trust > 200 beds within 20km of the ward centroid with at least one within 20km of itself as a potential competitor; otherwise 0				
(5) Missing values include one ward with missing values for all 11 years for GPs per 10,000 population; plus 931 missing observations due to HES linkage failure for 186 wards in years 1991-1995				

Table 4: Revascularisation regression results
Negative binomial random effect and fixed effect models

	(1)	(2)	(3)	(4)
Dependent variable: revascularisation count by ward and year	Random Effect "kitchen sink"	Fixed Effect "kitchen sink"	Random Effect "preferred"	Fixed Effect "preferred"
Normalised Townsend deprivation score	1.00173	0.90402***	0.93822***	0.88750***
	(0.84)	(0.0000079)	(0)	(2.77e-09)
competition possible (0 or 1)	1.01592	0.91270***	1.07281***	0.91959***
	(0.14)	(0.000024)	(2.53e-09)	(0.00012)
competition * 9396	1.10844***	1.12749***	1.13101***	1.14396***
	(0)	(0)	(0)	(0)
Townsend * competition	0.99424	1.01090	0.97203**	1.00490
	(0.64)	(0.64)	(0.032)	(0.83)
Townsend * competition * 9396	1.02879*	1.02715	1.04148**	1.03185*
	(0.099)	(0.10)	(0.022)	(0.058)
fundholding penetration (0-100)	1.00026*	1.00037***	1.00025*	1.00033**
	(0.074)	(0.0049)	(0.092)	(0.011)
NHS beds per 1,000 population	1.00439	0.96988***	0.99912	0.96845***
	(0.12)	(7.24e-09)	(0.78)	(1.98e-09)
proportion white ethnicity (0-100)	0.99271***	0.99241***	0.99043***	0.99308***
	(0)	(0.00051)	(0)	(0.0013)
population per hectare	0.99898***	0.99761***	0.99997	0.99944
	(0.000014)	(0.0073)	(0.91)	(0.53)
emergency admissions per 1,000 pop	1.00480***	1.00492***	1.00499***	1.00517***
	(0)	(0)	(0)	(0)
Standardised Illness Ratio (base=100)	0.99674***	0.99929		
	(0)	(0.36)		
Ishaemic heart disease SMR (base = 100)	0.99974***	0.99984*		
	(0.0031)	(0.057)		
waiting time (months)	0.98468***	0.98822***		
	(0)	(0)		
GPs per 10,000 population	0.99307		0.97801***	
	(0.23)		(0.00037)	
Constant	0.00097***	0.00470***	0.00105***	0.00448***
	(0)	(0)	(0)	(0)
Observations	92,558	92,481	92,569	92,481
Number of wards	8,499	8,492	8,500	8,492
Notes:				
(1) p values in parentheses				
(2) *** p<0.01, ** p<0.05, * p<0.1				
(3) Coefficients on population age-sex fractions and year dummies suppressed due to space constraints				
(4) competition possible = 1 if there is at least one NHS Hospital Trust > 200 beds within 20km of the ward centroid with at least one within 20km of itself as a potential competitor; otherwise 0				
(5) Missing values include one ward with missing values for all 11 years for GPs per 10,000 population; plus 931 missing observations due to HES linkage failure for 186 wards in years 1991-1995; plus 8 wards with all revas counts zero excluded in fixed effect model				

Figure 1: Hip replacement inequality effect of internal market: comparing 1993-6 vs. other years for potentially competitive areas

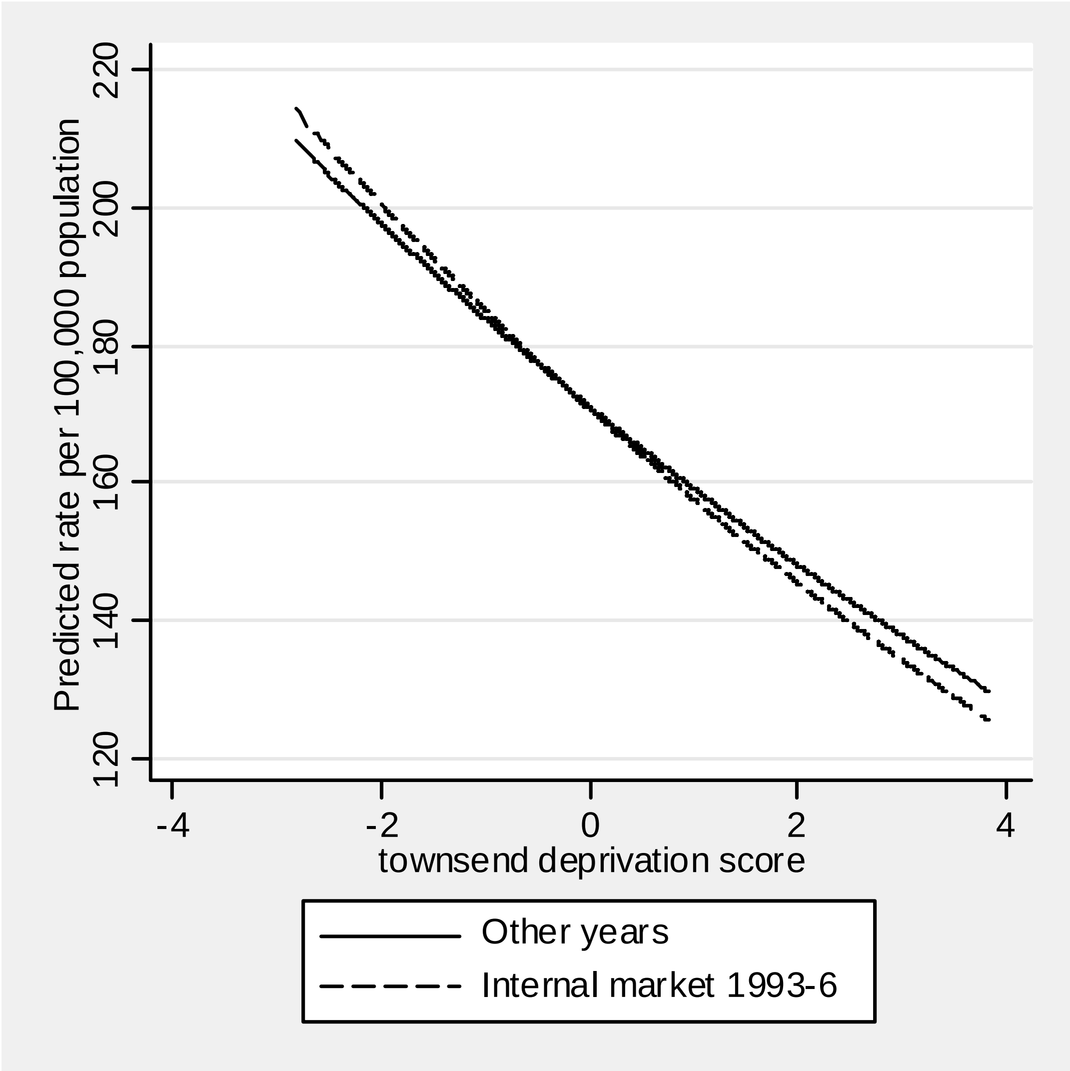
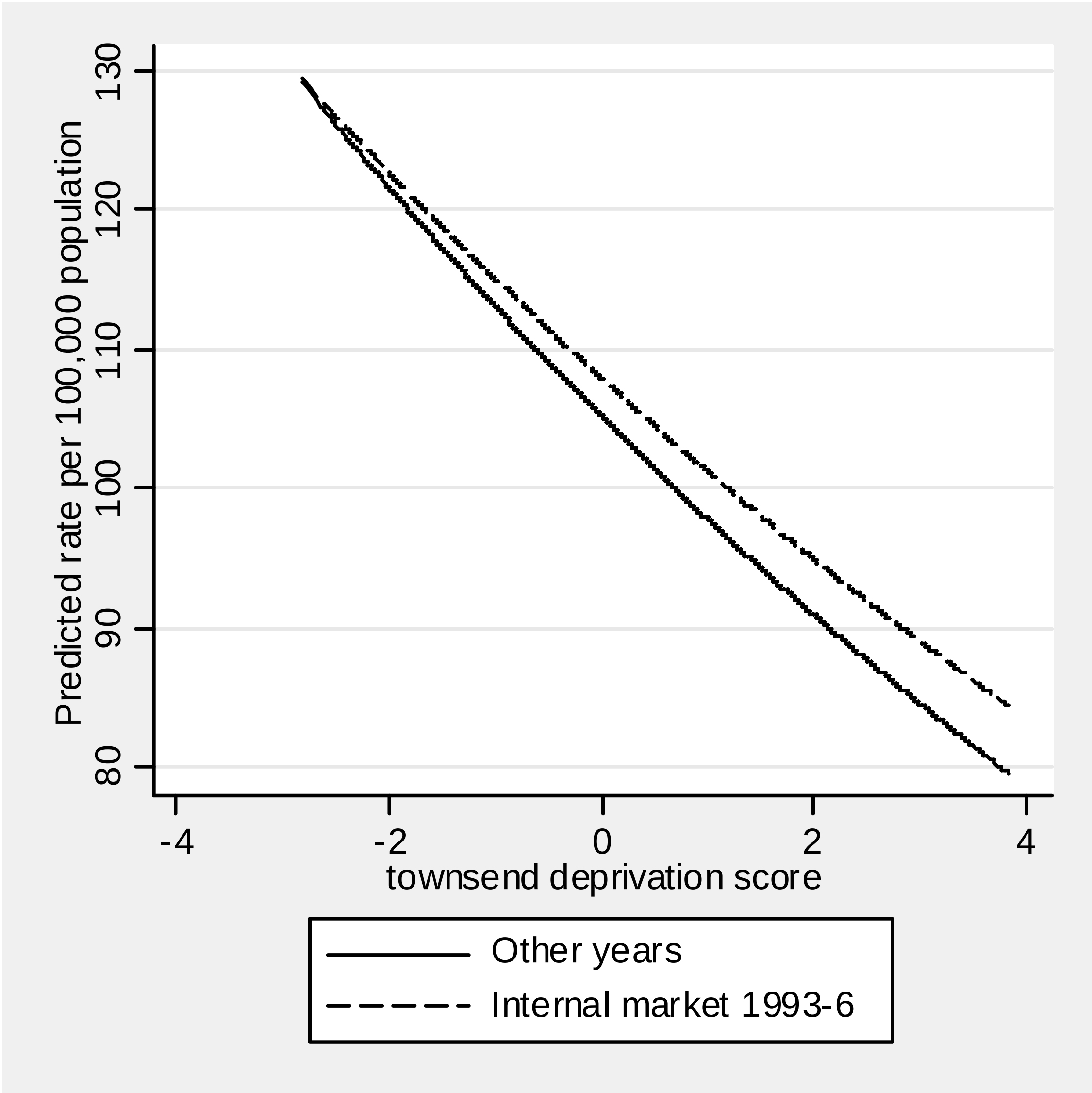


Figure 2: Revascularisation inequality effect of internal market: comparing 1993-6 vs. other years for potentially competitive areas



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