

# The Impact of Competition on Management Quality: Evidence from Public Hospitals

NICHOLAS BLOOM

*Stanford University, NBER, Centre for Economic Performance and CEPR*

CAROL PROPPER

*Imperial College, CMPO University of Bristol and CEPR*

STEPHAN SEILER

*Stanford University, Centre for Economic Performance*

and

JOHN VAN REENEN

*London School of Economics, Centre for Economic Performance, NBER and CEPR*

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We analyse the causal impact of competition on managerial quality and hospital performance. To address the endogeneity of market structure we analyse the English public hospital sector where entry and exit are controlled by the central government. Because closing hospitals in areas where the governing party is expecting a tight election race (“marginals”) is rare due to the fear of electoral defeat, we can use political marginality as an instrumental variable for the number of hospitals in a geographical area. We find that higher competition results in higher management quality, measured using a new survey tool, and improved hospital performance. Adding a rival hospital increases management quality by 0.4 standard deviations and increases survival rates from emergency heart attacks by 9.7%. We confirm the robustness of our IV strategy to “hidden policies” that could be used in marginal districts to improve hospital management and to changes in capacity that may follow from hospital closure.

*Key words:* Management, Hospitals, Competition, Productivity

*JEL Codes:* J45, F12, I18, J31

In almost every nation, health-care costs have been rapidly rising as a proportion of Gross Domestic Product (GDP) and as a result there is great policy emphasis on improving efficiency. One possible lever to increase efficiency is through competition that may put pressure on hospitals to improve management and, therefore, productivity. As Adam Smith remarked, “monopoly ... is a great enemy to good management” (*Wealth of Nations*, Chapter XI Part 1, p. 148). Given the large differences in hospital performance across a wide range of indicators, it is plausible that there is a lot of scope for improving management practices.<sup>1</sup> In this article, we address these

1. There is substantial variation in hospital performance even for areas with a similar patient intake *e.g.* Kessler and McClellan (2000), Cutler *et al.* (2009), Skinner and Staiger (2009), and Propper and Van Reenen (2010).

issues by analysing the causal impact of competition on management quality using the U.K. public health-care sector as a test case.

Examining the relationship between management and competition has been hampered by at least two major factors. First, one must deal with the endogeneity of market structure, and secondly researchers must be able to credibly measure management practices. We tackle both of these tricky problems. Using a novel identification strategy and new survey data on management practices we find a significant and positive impact of greater local hospital competition on management quality. Adding a rival hospital increases our index of management quality by 0.4 standard deviations and increases heart attack survival rates by 9.7%.

We use an identification strategy that leverages the institutional context of the U.K. health-care sector. Closing a hospital in any health-care system tends to be deeply unpopular. In the case of the U.K. National Health Service (NHS), the governing party is deemed to be responsible for the NHS, and voters therefore tend to punish this party at the next election if their local hospital closes down.<sup>2</sup> We show below that this idea receives econometric support, but there is also much anecdotal evidence that successive governments have responded to these political incentives. For example, the *Times* newspaper (15 September 2006) reported that “A secret meeting has been held by ministers and Labour Party [the then governing party] officials to work out ways of closing hospitals without jeopardizing key marginal seats.”

Hospital openings and closures in the NHS are centrally determined by the Department of Health. If hospitals are less likely to be closed in areas that are politically marginal districts (“constituencies”), there will be a relatively larger number of hospitals in these marginal areas than in places where a party has a large majority. Therefore, in equilibrium, politically marginal areas will be characterized by a higher than expected number of hospitals. Clear evidence for this political influence on market structure is suggested in Figure 1, which plots the number of hospitals per person in English political constituencies against the winning margin of the governing party (the Labour Party in our sample period). Where Labour won by a small margin or lagged behind by a small margin (under 5 percentage points) there were over 20% more hospitals than when it or the opposition Conservative and Liberal Democratic parties enjoyed a large majority. To exploit this variation we use the share of “marginal” constituencies in a hospital’s market as an instrumental variable for the numbers of competitors a hospital faces.

As another piece of descriptive evidence supporting our main results, Figure 2 shows that English counties with an above median number of marginal constituencies have not only more hospitals, but also have better managed hospitals and a lower death rate from acute myocardial infarction (AMI, commonly known as “heart-attacks”). The differences are statistically significant and quantitatively important: the difference in terms of number of hospitals and management scores between high and low marginality areas (defined as above or below the median) is equal to about one standard deviation of the respective variable. For the case of AMI the effect magnitude is roughly half a standard deviation.

Furthermore, because hospital markets do not overlap completely we can implement a tough test of our identification strategy by conditioning on marginality around a hospital’s *own* market. This controls for “hidden policies” that might improve management quality and identifies the competition effect purely from political marginality around the *rival* hospitals’ markets (we also

This variation is perhaps unsurprising as there is also huge variability in productivity in many other areas of the private and public sector (*e.g.* Foster *et al.*, 2008; Syverson, 2011).

2. A vivid example of this was in the U.K. 2001 General Election when a government minister was overthrown by a politically independent physician, Dr Richard Taylor, who campaigned on the single issue of “saving” the local Kidderminster Hospital (where he was a physician) which the government planned to scale down (see <http://www.bbc.com/news/uk-england-hereford-worcester-23527574>, accessed 7 January 2015).

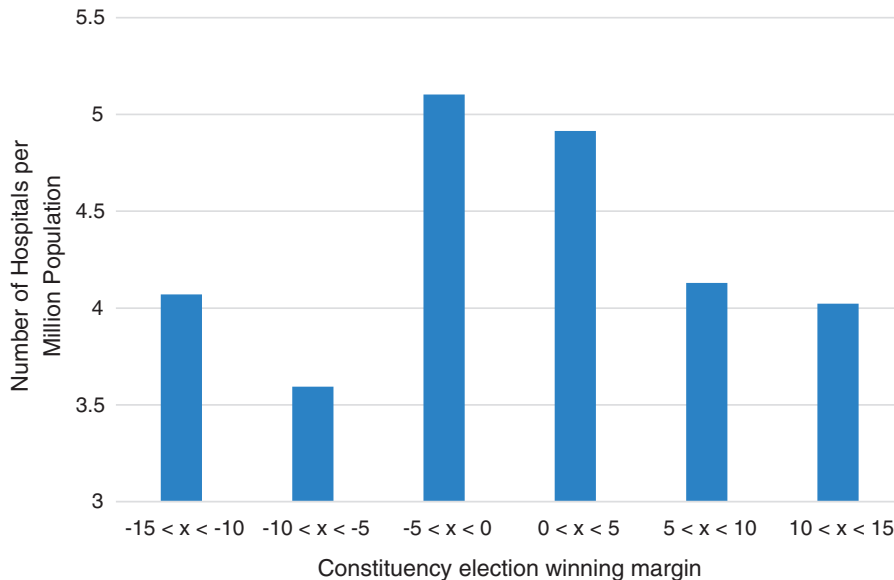


FIGURE 1

Governing party's (Labour) winning margin and the number of hospitals in a political constituency

*Notes:* This figure plots the mean number of hospitals per 1 million people within a 15 km radius of the centroid of a political constituency against the “winning margin” in 1997 of the governing party (Labour). When Labour is not the winning party, the margin is the negative of the difference between the winning party (usually Conservative) and Labour. The margin is denoted “x”. There are 529 political constituencies in England.

show directly that the transparency of the health funding formula means that there was no redirection of government money to marginal constituencies). We also subject our analysis to extensive robustness tests over the precise definitions of political marginality and hospital markets, and to concerns that a reduction in the number of competitors may have a direct effect on management through changes in capacity in the area.

The second problem in examining the impact of competition on management is measuring managerial quality. In recent work, we have developed a survey tool for quantifying management practices (Bloom and Van Reenen, 2007; Bloom *et al.*, 2012). The measures, covering incentives, monitoring and target-setting are strongly correlated with firm performance in the private manufacturing sector. We apply the same basic methodology to measuring management in the health-care sector. We implement our methods in interviews across 100 English acute (short-term general) public hospitals, known as hospital trusts, interviewing a mixture of clinicians and managers in two specialties: cardiology and orthopaedics. We cover 61% of all NHS providers of acute care in England, a sample that appears random based on observable characteristics.

We find that competition does appear to improve a core set of management practices that are likely to improve hospital productivity. However, a concern is that “better management” in these indicators may not actually improve welfare in a public service environment.<sup>3</sup> For example, smarter managers may simply be able to better game the system, meet formal targets, and improve the hospital's finances without improving clinical outcomes. It is reassuring that in our context patient and worker outcomes as measured by AMI survival rates and staff turnover rates also

3. For example, Rasul and Rogger (2013) find that the monitoring elements of the Bloom and Van Reenen (2007) management scores are associated with worse outcomes in the Nigerian civil service.

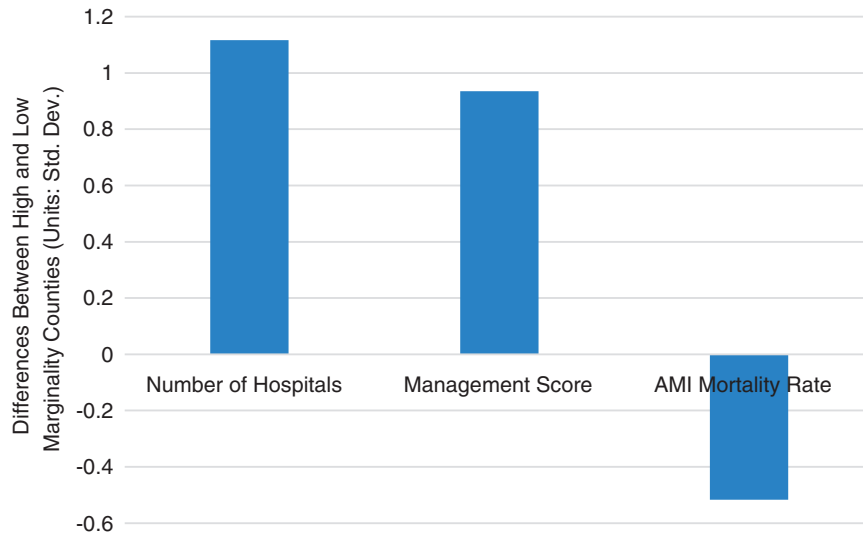


FIGURE 2

Difference between high and low marginality areas: number of competitors, management and AMI mortality

*Notes:* This figure plots the differences between high and low marginality counties (split at the median of marginality after controlling for the baseline regression covariates). All three measures control for the baseline regression covariates from column (4) in Table 4 (they are residuals from a regression on these covariates) to strip out the effects of demographics, teaching hospitals, London, etc. The difference between low and high marginality is statistically significant at 1% for the Number of Hospitals and Management; at the 10% level for AMI mortality.

improve, suggesting that the benefits of competition are widely shared. So although there could be deterioration on some unobservable hospital quality, we do not find this on any observable measure.

Our article contributes to the literature on competition in health care. Competition is being introduced in many countries, such as the Netherlands, Belgium, the U.K., Germany, Norway, and Australia as a means of improving the productivity of the health-care sector. The concern for quality in health-care means that many countries seeking to introduce competitive forces adopt a regulated approach where prices (reimbursement rates) are fixed across hospitals (essentially the same as the U.S. Medicare system). In such a system, where there is competition to attract patients, this has to be in non-price dimensions such as quality. Yet, despite the appeal to policy makers, there is no consensus on the effects of such pro-competitive interventions. Furthermore, the majority of studies examines the relationship between market structure and outcomes, but do not examine what might be driving this relationship.<sup>4</sup> And while markets have long been used for the delivery of health care in the U.S., massive consolidation among hospitals has led to concerns about the functioning of these markets.<sup>5</sup> The central issue is whether and how competition improves quality where providers, as in the U.S., are heavily dominated by public and private non-profits. Our finding of a positive role for competitive forces in such a set-up is thus very relevant to this global debate.

4. Positive assessments include Kessler and McClellan (2000) for the U.S. and Gaynor *et al.* (2012b) and Cooper *et al.* (2011) for England. Overall, the evidence on competition in health care is mixed—see Dranove and Satherthwaite (2000), Gaynor and Haas-Wilson (1999), and Gaynor (2004).

5. For example, Federal Trade Commission and U.S. Department of Justice (2004) and Vogt and Town (2006).

More generally, our results tie in with the large literature in industrial organization examining whether competition has a positive effect on productivity.<sup>6</sup> We leverage the institutional features of English hospitals to provide a credible identification strategy for these effects. Our work also relates to the literature on the effect of the political environment on economic outcomes. In a majoritarian system, such as the British one, politicians pay greater attention to areas where there is more uncertainty about the electoral outcome, attempting to capture undecided voters in such “swing states”. We produce support for the approach of List and Sturm (2006) who show that politicians do target policies at a geographical level to attract undecided voters.<sup>7</sup>

The structure of the article is as follows. The next section presents a simple model of the effect of competition on managerial effort. Section 2 discusses the data, Section 3 describes the relationship between hospital performance and management quality, Section 4 examines the relationship between political pressure and marginality, and Section 5 analyses the effect of competition on hospital management and hospital performance and examines robustness to key definitions. Section 6 examines further possible threats to identification and Section 7 concludes.

## 1. A SIMPLE MODEL OF MANAGERIAL EFFORT AND COMPETITION

The vast majority of hospital care in the U.K. is provided in public hospitals. The private sector is very small and accounted for only around 1% of elective care over our sample period.<sup>8</sup> Public hospitals compete for patients who are fully covered for the costs of their health care and make choices about which hospital to use in conjunction with their family doctors (“General Practitioners”). NHS hospitals, as in many health-care systems, are non-profit making. Tax financed purchasers responsible for their local populations buy health care from NHS hospitals. In 2006 the bulk of the income of NHS hospitals was from a prospective per case (patient) national payment system, modelled on the diagnostic-related group system used in the U.S.. Hospitals have to break even annually and Chief Executive Officers (CEOs) are penalized heavily for poor financial performance. In this system, to obtain revenues hospitals must attract patients.

In the U.K., when a General Practitioner (the local “gatekeeper physician” for patients) refers a patient to a hospital for treatment she has the flexibility to refer the patient to any hospital. Having more local hospitals gives greater choice for General Practitioners and so increases the elasticity of demand and provides greater competition for hospitals. Since funding follows patients in the NHS, hospitals are keen to win patient referrals as this has private benefits for senior managers (*e.g.* better pay and conditions), and reduces the probability that they will be fired. There is an active market for hospital CEOs in the U.K. with a high level of turnover (*e.g.* Kings Fund, 2011). Reforms in the early 1990s (“the Internal Market”) and in the 2000s strengthened these incentives by tightening hospital budgets and increasing the information available to choosers of care.

We explore a simple model that reflects key features of this type of hospital market. Consider the problem of the CEO running a hospital where price is nationally regulated and there are a fixed number of hospitals. She obtains utility ( $U$ ) from the net revenues of the hospital (which will

6. There is a large theoretical and empirical literature on productivity and competition, for example, see Nickell (1996), Syverson (2004), Schmitz (2005), Fabrizio, Rose and Wolfram (2007), and the survey by Holmes and Schmitz (2010).

7. See also, for example, Persson and Tabellini (1999), Milesi-Ferretti *et al.* (2002), Nagler and Leighley (1992), and Stromberg (2008). Clark and Milcent (2008) show the importance of political competition in France for health-care employment.

8. Private hospitals operate in niche markets, particularly the provision of elective services for which there are long waiting lists in the NHS. Most of their activity in 2006 was paid for by private health insurance.

determine her pay and perks) less the costs of her effort,  $e$ .<sup>9</sup> By increasing effort the CEO can improve hospital quality ( $z$ ) and so increase demand, so  $z(e)$  with  $z'(e) > 0$ . Total costs are the sum of variable costs,  $c(q, e)$  and fixed costs  $F$ . For simplicity we assume that revenues and costs enter in an additive way. Note that the CEO's utility is not equal to the hospital's profit function due to the presence of effort costs. Therefore, our formulation does not require that hospitals are profit maximizing. The quantity demanded of hospital services is  $q(z(e), S)$  which is a function of the quality of the hospital and exogenous factors  $S$  that include market size, demographic structure, average distance to hospital, etc. We abbreviate this to  $q(e)$ . There are no access prices to the NHS so price does not enter the demand function and there is a fixed national tariff,  $p$ , paid to the hospital for different procedures.

As is standard, we assume that the elasticity of demand with respect to quality ( $\eta_z^q$ ) is increasing with the degree of competition (e.g. the number of hospitals in the local area,  $N$ ). A marginal change in hospital quality will have a larger effect on demand in a more competitive marketplace because the patient is more likely to switch to another hospital. Since quality is an increasing function of managerial effort, this implies that the elasticity of demand with respect to effort ( $\eta_e^q$ ) is also increasing in competition, i.e.  $\frac{\partial \eta_e^q}{\partial N} > 0$ . This will be important for the results. Given this set-up the CEO chooses effort,  $e$ , to maximize:

$$U = pq(e) - c(q(e), e) - F \quad (1)$$

The first-order condition can be written:

$$p \frac{\partial q}{\partial e} - \left( \frac{\partial c}{\partial q} \frac{\partial q}{\partial e} \right) - \frac{\partial c}{\partial e} = 0 \quad (2)$$

This can be re-arranged as:

$$\frac{e}{q} = \left( \frac{p - c_q}{c_e} \right) \eta_e^q(N) \quad (3)$$

where  $c_q = \frac{\partial c}{\partial q} > 0$ , is the marginal cost of output and  $c_e = \frac{\partial c}{\partial e} > 0$ , is the marginal cost of effort. The managerial effort intensity of a firm ( $e/q$ ) is increasing in the elasticity of output with respect to effort so long as price-cost margins are positive. Since effort intensity is higher when competition is greater (from  $\frac{\partial \eta_e^q}{\partial N} > 0$ ), this establishes our key result that managerial effort will be increasing in the degree of product market competition. The intuition is quite standard—with higher competition the stakes are greater from changes in relative quality: a small change in managerial effort is likely to lead to a greater change of demand when there are many hospitals relative to when there is monopoly. This increases managerial incentives to improve quality/effort as competition grows stronger. From equation (3) we also have the implication that managerial effort is increasing in the price-cost margin and decreasing in the marginal cost of effort.

Price regulation is important for this result (see Gaynor, 2007). Usually the price-cost margins ( $p - c_q$ ) would decline when the number of firms increases which would depress managerial incentives to supply effort. In most models, this would make the effects of increasing competition ambiguous: the “stakes” are higher but mark-ups are lower (a “Schumpeterian” effect).<sup>10</sup>

9. It is trivial to extend the model so that the utility function includes other objectives such as hospital size or patient health directly. What matters is that the net revenues of the hospital have some weight in the objective function of key hospital decision makers.

10. For example, Raith (2003), Schmidt (1997) or Vives (2008).

In this paper, we do not focus on the demand channel but instead examine a reduced form of the relationship between competition and managerial practices. Estimating a structural model of demand is outside the scope of this article, but evidence for the operation of the demand channel is provided by a number of recent papers. Gaynor *et al.* (2012b) estimate a structural model of patient choice for English hospitals for treatment for cardiac treatment and find that referrals are sensitive to the hospital's quality of service. Sivey (2011) and Beckert *et al.* (2012) both find that patients value quality in choosing a hospital for their treatment. Gaynor *et al.* (2012b) look at patient travel patterns in response to the introduction of greater patient choice in England. They find that, post-reform, patients tended to choose hospitals further away from home if they were of higher quality. These results indicate that demand is responsive to quality and suggest that the mechanism we identify is operating through greater demand sensitivity in less concentrated markets translating into sharper managerial incentives to improve. A second possible mechanism is yardstick competition: with more local hospitals CEO performance is easier to evaluate because yardstick competition is stronger. The U.K. government actively undertakes yardstick competition, publishing summary measures of performance on all hospitals and punishing managers of poorly performing hospitals by dismissal (Propper *et al.*, 2010).

## 2. DATA

Our data are drawn from several sources.<sup>11</sup> The first is the management survey conducted by the Centre for Economic Performance at the London School of Economics, which includes 18 questions from which the overall management score is computed, plus additional information about the process of the interview and features of the hospitals. This is complemented by external data from the U.K. Department of Health and other administrative datasets providing information on measures of clinical quality and productivity, as well as hospital characteristics such as patient intake and resources. Finally, we use data on election outcomes at the constituency level from the British Election Study. Descriptive statistics are in Table 1 with further details in Supplementary Appendix B.

### 2.1. Management survey data

The core of our dataset is made up of 18 questions that can be grouped in the following subcategories: operations and monitoring (6 questions), targets (5 questions) and incentives management (7 questions). For each one of the questions the interviewer reports a score between 1 and 5, a higher score indicating a better performance in the particular category. A detailed description of the individual questions and the scoring method is provided in Supplementary Appendix A.<sup>12</sup>

To try to obtain unbiased responses we use a *double-blind* survey methodology. The first part of this was that the interview was conducted by telephone without telling the respondents in advance that they were being scored. This enabled scoring to be based on the interviewer's evaluation of the hospital's actual practices, rather than their aspirations, the respondent's perceptions or the interviewer's impressions. To run this "blind" scoring we used open questions (*i.e.* "can you tell me how you promote your employees"), rather than closed questions (*i.e.* "do you promote your employees on tenure [yes/no]?"). Furthermore, these questions target actual practices and examples, with the discussion continuing until the interviewer can make an accurate assessment

11. A full replication file for all tables and graphs is available at <http://www.stanford.edu/~nbloom/BPSV.zip>

12. The questions in Supplementary Appendix A correspond in the following way to these categories. Operations and Monitoring: questions 1–6, Targets: questions 8–12, Incentives management: questions 7 and 13–18.

TABLE 1  
Means and standard deviations of variables

Variable	Mean	Median	Standard Dev.	Obs
Average management score (not z-scored)	2.46	2.44	0.59	161
Competition measures				
Number of competing hospitals (in 30 km radius)	7.11	3	9.83	161
HHI based on patient flows (0–1 scale)	0.49	0.46	0.19	161
Performance measures				
Mortality rate from emergency AMI after 28 days (quarterly av. %)	15.55	14.54	4.46	140
Mortality rate from emergency surgery after 30 days (quarterly av. %)	2.18	2.01	0.79	157
Staff likelihood of leaving within 12 months (1 = v. unlikely, 5 = v. likely)	2.70	2.69	0.13	160
Average HCC rating (1–4 scale)	2.25	2	0.68	161
Average length of stay in hospital	1.99	1.92	0.65	161
Finished consultant episodes per patient spell	1.14	1.13	0.07	161
Political variables				
Proportion of marginal constituencies (in 45 km radius, %)	8.41	5.88	9.78	161
Number of marginals (in 45 km radius)	2.646	2	2.430	161
Number of constituencies (in 45 km radius)	37.795	25	32.38	161
Proportion of marginal constituencies (in 15 km radius, %)	10.10	0	23.51	161
Labour share of votes (average of constituencies in 45 km radius, %)	42.08	43.01	13.43	161
Covariates				
Density: total population (millions) in 30 km radius	2.12	1.24	2.26	161
Foundation Trust hospital (%)	34.16	0	47.57	161
Teaching hospital (%)	11.80	0	32.36	161
Specialist hospital (%)	1.86	0	13.56	161
Managers with a clinical degree (%)	50.38	50.0	31.7	120
Building age (years)	25.98	27.06	8.37	152
Mortality rate in catchment area: deaths per 100,000 in 30 km radius	930	969	137	161
Size variables				
Number of total admissions (quarterly)	18,137	15,810	9,525	161
Number of emergency AMI admissions (quarterly)	90.18	82	52.26	161
Number of emergency surgery admissions (quarterly)	1,498	1,335	800	161
Number of sites	2.65	2	2.01	161

*Notes:* See Supplementary Appendix B for more details, especially Table B1 for data sources and more description. Due to space constraints we have not shown the means for the demographics of the local area which are included in the regressions. The AMI mortality rate is reported for hospitals with a minimum of 150 yearly cases. Mortality from emergency surgery is reported only for non-specialist hospitals. See main text for more details.

of the hospital's typical practices based on these examples. For each practice, the first question is broad with detailed follow-up questions to fine-tune the scoring. For example, question (1) *Layout of patient flow* the initial question is "Can you briefly describe the patient journey or flow for a typical episode?" is followed up by questions like "How closely located are wards, theatres and diagnostics centres?"

The second part of the double-blind scoring methodology was that the interviewers were not told anything about the hospital's performance in advance of the interview.<sup>13</sup> This was collected post-interview from a wide range of other sources. The interviewers were specially trained graduate students from top European and U.S. business schools. Since each interviewer ran 46 interviews on average we can also remove interviewer-fixed effects in the regression analysis.

13. Strictly speaking they knew the name of the hospital and might have made inference about quality from this. As the interviewers had not lived in the U.K. for an extended period of time, it is unlikely that this was a major issue.



Obtaining interviews with managers was facilitated by a supporting letter from the Department of Health, and the name of the London School of Economics, which is well known in the U.K. as an independent research university. We interviewed respondents for an average of just under an hour. We approached up to four individuals in every hospital—a manager and physician in the cardiology service and a manager and physician in the orthopaedic service (note that some managers may have a clinical background and we control for this). There were 164 acute hospital trusts with orthopaedics or cardiology departments in England when the survey was conducted in 2006 and 61% of hospitals (100) responded. We obtained 161 interviews, 79% of which were with managers (it was harder to obtain interviews with physicians) and about half in each specialty. The response probability was uncorrelated with observables such as performance outcomes and other hospital characteristics (see Supplementary Appendix B). For example, in the 16 bivariate regressions of sample response we ran only one was significant at the 10% level (expenditure per patient). Finally, we also collected a set of variables that describe the process of the interview, which can be used as “noise controls” in the econometric analysis. These included the interviewer-fixed effects, the occupation of the interviewee (clinician or manager) and her tenure in the post.

## 2.2. *Hospital competition*

Since travel is generally costly for patients, health-care competition always has a strong geographical element. Our main competition measure is simply the number of other public hospitals within a certain geographical area. An NHS hospital consists of a set of facilities located on one site or within a small area run by a single CEO responsible for strategic decision making with regard to quality of clinical care, staffing, investment, and financial performance.<sup>14</sup> The number and location of hospitals in the NHS are planned by the Department of Health. When it believes that there is excess capacity in a local area or a need to improve quality through co-location of facilities the Department consolidates separate hospitals under a single CEO (*i.e.* replacing at least one CEO) and rationalizing the number and distribution of facilities, though it does not necessarily reduce overall capacity in the short run.

In our baseline regression we define a hospital’s catchment area as 15 km, a commonly used definition in England (Propper *et al.*, 2007). Given a 15 km catchment area, any hospital that is <30 km away will have a catchment area that overlaps to some extent with the catchment area of the hospital in question. We therefore use the number of competing public hospitals within a 30 km radius, *i.e.* twice the catchment area, as our main measure of competition. We use the number of public hospitals, as private hospitals offer a very limited range of services (*e.g.* they do not have Emergency Rooms). Figure 3 illustrates graphically the relationship between the catchment area radius and the area over which the competition measure is defined.

We subject this simple definition of a hospital’s market to a battery of robustness checks in Section 5.4 below. We also use an alternative measure of competition, the Herfindahl Index (HHI), which takes into account the patient flows across hospitals and is commonly used in the hospital competition literature. This measure has two attractive features: first, we take asymmetries of market shares into account; and secondly, we can construct measures that do not rely on assuming a fixed radius for market definition. The disadvantage of an HHI, however, is that market shares are endogenous as more patients will be attracted to hospitals of higher quality. We address this problem following Kessler and McClellan (2000) by using *predicted* market shares based on

14. There are no hospital chains in the NHS.

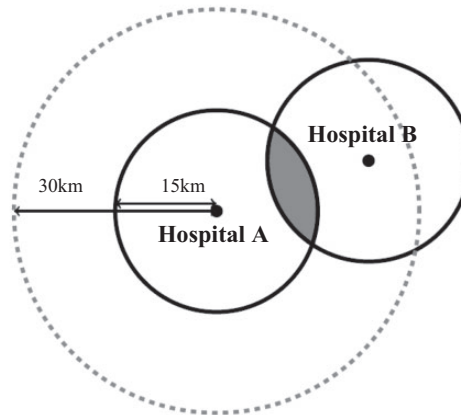


FIGURE 3

Graphical representation of the competition measure

*Notes:* The figure shows the 15 km catchment area for Hospital A. Any hospital within a 30 km radius of hospital A will have a catchment area that overlaps (at least to some extent) with Hospital A's catchment area. The overlap is illustrated in the graph for Hospital B. Our competition measure based on a 15 km catchment area, therefore, includes all hospitals within a 30 km radius. This is represented by the dashed grey circle in the figure.

exogenous characteristics of the hospitals and patients (such as distance and demographics) but this does not deal with the deeper problem that the number of hospitals may itself be endogenous.<sup>15</sup>

### 2.3. *Political marginality*

We use data on outcomes of the national elections at the constituency level from the British Election Study. We observe the vote shares for all parties and use these to compute the winning margin. We define a constituency to be marginal if the winning margin is <5%, but show what happens when we vary this threshold. There are three main parties in the U.K. (Labour, Conservative, and Liberal Democrat). We define marginal constituencies with respect to the governing party because the government decides about hospital closures. For this reason we measure political pressure for Labour, the governing party during the relevant time period, by looking at constituencies the Labour party marginally won or lost. Our key instrumental variable is the lagged (1997) share of Labour marginal constituencies, defined as constituencies where Labour won or lagged behind by less than 5 percentage points.<sup>16</sup> We use this definition of marginality, together with the 15 km definition of each hospital's catchment area, to construct a measure of marginality of the *rivals* of each hospital and use this as our key instrumental variable. We discuss the construction in detail in Section 4.1.

15. Supplementary Appendix B details this approach which implements a multinomial logit choice model using 6.5 million records for 2005–2006.

16. We use lagged marginality for reasons we detail in Section 4. Results are similar if we use a definition of marginality from later elections as Labour's polling ratings were relatively constant for the decade from 1994 after Tony Blair took over as leader, through the 1997 and 2001 elections (majorities of 167 and 179 seats, respectively), until the mid-2000s after the electorally unpopular 2003 invasion of Iraq.

#### 2.4. *Hospital performance data*

Productivity is difficult to measure in hospitals, so regulators and researchers typically use a wide range of measures.<sup>17</sup> We use measures of clinical quality, productivity, staff satisfaction, and performance as rated by the government regulator of hospitals. The clinical outcomes we use are the in-hospital mortality rates following emergency admissions for (i) AMI and (ii) surgery.<sup>18</sup> As measures of productivity we use average length of stay (reductions in length of stay are productivity increasing) and finished consultant episodes per patient spell (a measure of the volume of treatments received by the patient during a hospital stay). We measure worker job satisfaction by the average intention of staff intending to leave in the next year. Finally, we use the English Government's regulator [the Health Care Commission (HCC) in 2006] rating of health care at the hospital level, which is a composite performance measure across a wide number of indicators including access, quality of clinical care, and financial performance (this is measured on a scale from 1 to 4).

#### 2.5. *Controls*

We show robustness to the inclusion of different sets of controls. In all regressions, we include patient case-mix by using the age/gender profile of total admissions at the hospital level (6 groups in the "minimal control" specification and 11 groups in our baseline for each gender).<sup>19</sup> To control for demand we measure the health status of the local population by its age–gender distribution (nine groups) and population density. We condition on characteristics of the hospital: these are hospital size, "Foundation Trust" status (such hospitals have greater autonomy) and management survey "noise" controls (interviewer dummies, interviewee occupation, and tenure). We also present regressions with more general controls that include teaching-hospital status, a larger set of patient case-mix controls and the political variables as they may be correlated with health status and the demand for health care. These variables are the share of Labour votes and the identity of the winning party in the 1997 election.<sup>20</sup>

#### 2.6. *Preliminary data analysis*

The management questions are all highly correlated so in most of our analysis we aggregate the questions together either by taking the simple average (as in the figures) or by *z*-scoring each individual question and then taking the *z*-score of the average across all questions.<sup>21</sup> Figure 4

17. See, for example, <http://2008ratings.cqc.org.uk/findcareservices/informationabouthealthcareservices.cfm>

18. We choose these for four reasons. First, regulators in both the U.S. and the U.K. use selected death rates as part of a broader set of measures of hospital quality. Secondly, using emergency admissions helps to reduce selection bias because elective cases may be non-randomly sorted among hospitals. Thirdly, death rates are well recorded and cannot be easily "gamed" by administrators trying to hit government-set targets. Fourthly, heart attacks and overall emergency surgery are the two most common reasons for admissions that lead to deaths. Examples of the use of AMI death rates to proxy hospital quality include Kessler and McClellan (2000), Gaynor (2004), and, for the U.K., Propper *et al.* (2008) and Gaynor *et al.* (2012b). [http://www.performance.doh.gov.uk/performance/2002/tech\\_index\\_trusts.html](http://www.performance.doh.gov.uk/performance/2002/tech_index_trusts.html)

19. We split admissions into 11 age categories for each gender (0–15, 16–45, 46–50, 51–55, 56–60, 61–65, 66–70, 71–75, 76–80, 81–85, >85 years), giving 21 controls (22 minus 1 omitted category). These are specific to the condition in the case of AMI and general surgery. For the minimal control specification we use more aggregate categories for each gender (0–55, 56–65, 66–75, >75 years). For all other performance indicators we use the same variables at the hospital level. Propper and Van Reenen (2010) show that in the English context the age–gender profile of patients does a good job of controlling for case-mix.

20. The share of Labour votes is defined over the same geographic area as our marginality instrument (see later discussion for more details). The identity of the winning party refers to the constituency the hospital actually lies in.

21. *z*-scores are normalized to have a mean of zero and a standard deviation of one.

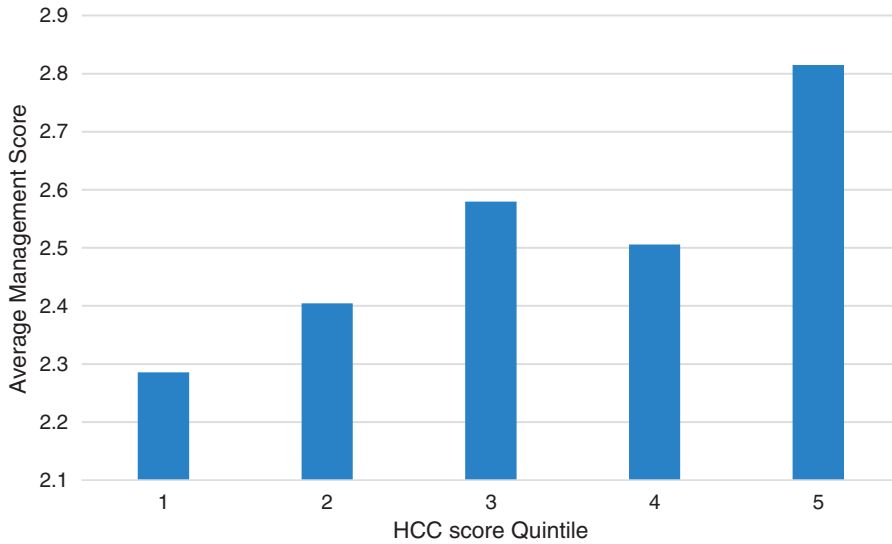


FIGURE 4

Management score by quintiles of average HCC rating

*Notes:* The HCC is an NHS regulator who gives every hospital in England an aggregate performance score across seven domains (see Supplementary Appendix B). We divide the HCC average score into quintiles from lowest score (first) to highest score (fifth) along the *x*-axis. We show the average management score (over all 18 questions) in each of the quintiles on the *y*-axis. The better performing hospitals have higher management scores.

divides the HCC hospital performance score into quintiles and shows the average management score in each bin. There is a clear upward sloping relationship with hospitals that have higher management scores also enjoying higher HCC rankings. Figure 5 plots the entire distribution of management scores for our respondents. There is a large variance with some well-managed hospitals, and other very poorly managed hospitals.

### 3. HOSPITAL PERFORMANCE AND MANAGEMENT PRACTICES

Before examining the impact of competition we validate the data by investigating if the management score and its sub-components are correlated with external performance measures. This is *not* supposed to imply any kind of causality. Instead, it merely serves as a data validation check to see whether a higher management score is correlated with a better performance. We estimate regressions of the form:

$$y_j^P = \alpha_1 M_{jg} + \alpha'_2 x_{jg} + u_{jg} \quad (4)$$

where  $y_j^P$  is performance outcome  $P$  (*e.g.* AMI mortality) in hospital  $j$ ,  $M_{jg}$  is the average management score of respondent  $g$  in hospital  $j$ ,  $x_{jg}$  is a vector of controls and  $u_{jg}$  the error term. Since errors are correlated across respondents within hospitals we cluster our standard errors at the hospital level.

Panel A of Table 2 shows results for regressions of each of the performance measures on the standardized management score. We see that higher management scores are associated with better hospital outcomes across all the measures, and this relationship is significant at the  $\geq 5\%$  level in four out of six cases. This suggests our measure of management has informational content.

TABLE 2  
*Hospital performance and management practices*

Dependent variable:	(1) Mortality rate from emergency AMI	(2) Mortality rate from all emergency surgery	(3) Intention of staff to leave in next 12 months	(4) HCC overall rating	(5) Average length of stay in hospital	(6) Finished consultant episodes per patient spell
Mean	15.55	2.18	2.70	2.25	1.99	1.14
Standard deviation	4.46	0.79	0.13	0.68	0.65	0.07
Panel A: overall management score	-0.968** (0.481)	-0.099** (0.044)	-0.031** (0.013)	0.108*** (0.041)	-0.060 (0.050)	0.005 (0.006)
Panel B: monitoring	-0.693* (0.398)	-0.073* (0.039)	-0.015 (0.011)	0.030 (0.037)	-0.019 (0.041)	0.006 (0.005)
Panel C: targets	-0.847** (0.409)	-0.075* (0.040)	-0.033** (0.014)	0.090** (0.045)	-0.072 (0.053)	0.003 (0.006)
Panel D: incentives	-0.753 (0.486)	-0.085** (0.040)	-0.031** (0.014)	0.155*** (0.040)	-0.063 (0.048)	0.002 (0.005)
Observations	140	157	160	161	161	161

*Notes:* \*\*\* Indicates significance at the 1% level; \*\* significance at 5%; \* significance at 10%. Every cell constitutes a separate regression. The dependent variables in columns (1), (2), (3), and (5) are generally considered to be “bad” whereas columns (4) and (6) are “good”—see text for more details. In all panels, individuals questions are z-scored, averaged across the relevant questions, and then z-scored again so each index has mean zero and a standard deviation of unity. In Panel A, the management score is across all 18 questions. In Panel B, the score is averaged over the monitoring and operations questions (questions 1–6 in Supplementary Appendix A); in Panel C, for targets we use questions 8–12 and in Panel D for incentives we use questions 7 and 13–18. These are OLS regressions with standard errors that are clustered at the hospital level (there are 100 clusters). All columns include controls for whether the hospital was a Foundation Trust, a teaching hospital dummy, number of total admissions, the fraction of households owning a car, a London dummy, the share of managers with clinical degree and a joint decision making dummy. Controls for case-mix are also included, but vary across columns (see Supplementary Appendix Table B1). Column (1) uses 22 AMI-specific patient controls (11 age groups by both genders) and column (2) does the same for general surgery. The other columns use controls across all admissions. All columns also include “noise controls” comprising interviewer dummies, tenure of the interviewee, and whether the respondent was a clinician (as opposed to a manager). In column (1), we drop hospitals with less than 150 AMI cases per year; in column (2), specialist hospitals that do not perform standard surgery are dropped. There is minor variation in the number of observations for the other columns due to the fact that not all performances measures were available for all hospitals. Column (4) uses the average of HCC’s rating on resource use and quality of service as dependent variable (a score ranging between 1 and 4).

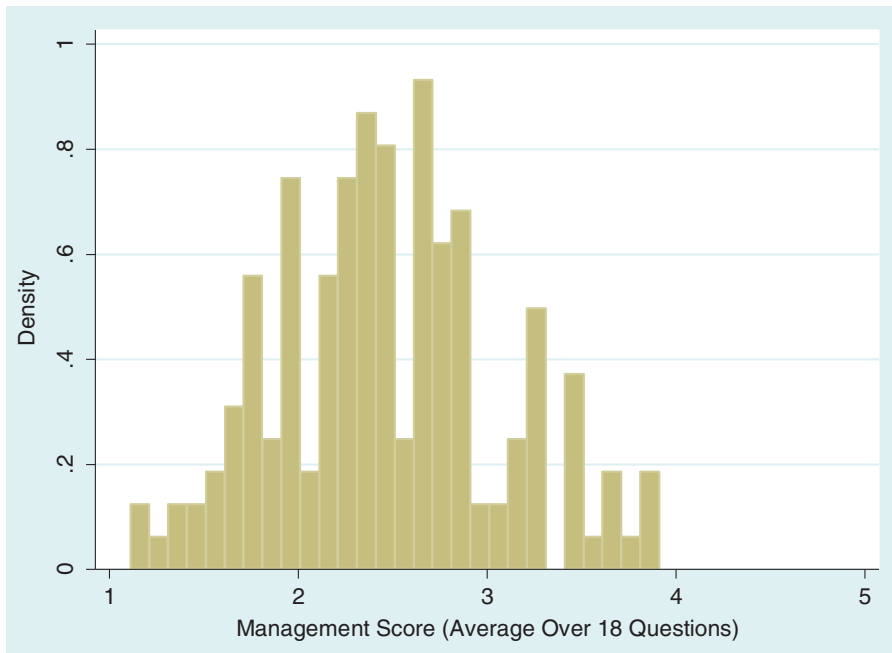


FIGURE 5  
Management scores in hospitals

Notes: The distribution of the management score (average across all 18 questions). 1 = worst score, 5 = best score.

Looking in more detail, in the first column of Table 2 we present the AMI mortality rate regressed on the management score controlling for a wide number of confounding influences.<sup>22</sup> High management scores are associated with significantly lower mortality rates from AMI—a one standard deviation increase in the management score is associated with a reduction of 0.97 percentage points in the rate of AMI mortality (or a fall in 6.2% over the mean AMI mortality of 15.6%). Column (2) examines death rates from all emergency surgery (excluding AMI) and again shows a significant correlation with management quality. In column (3), we show that better-managed hospitals have significantly fewer staff intending to leave, which suggests that the management practices we examine are not associated with greater worker dissatisfaction. In column (4), we show that higher management scores are positively and significantly correlated with higher composite scores from the health-care regulator (HCC). The last two columns show that better-managed hospitals have lower average lengths of stay and higher numbers of consultant episodes per patient spell (although the coefficient on management is not significant). These are both measures of productivity. Other measures of quality such as Methicillin-Resistant *Staphylococcus Aureus* (MRSA) infection rates, waiting times, and financial performance were also better in hospitals with high management scores (see Bloom *et al.*, 2010).

In the other panels of Table 2, we examine the association between these measures of performance and the three key sub-components of the management score: monitoring and operations (Panel B), targets (Panel C), and incentives (Panel D). While the results are generally

22. We drop observations where the number of cases admitted for AMI is low because this leads to large swings in observed mortality rates. Following Propper and Van Reenen (2010) we drop hospitals with under 150 cases of AMI per year, but the results are not sensitive to the exact threshold used.

weaker (the result of averaging over fewer questions leading to more measurement error and attenuation bias), several of the sub-components are significantly associated with the performance measures and are consistent with basic intuition about what type of management should correlate with certain outcomes.<sup>23</sup> For instance, staff intending to leave is not significantly associated with monitoring (which may be disliked by workers), but is significantly associated with target setting and incentives (people management). Death rates are significantly lower when monitoring and target management (but not incentives) is better, which may reflect the fact that better layouts of operating theatres and use of check lists reduces medical error rates (Provonost *et al.*, 2006). The association of the HCC regulator score with targets (but not incentives) may reflect the fact that the regulator score particularly rewards meeting government targets.

#### 4. POLITICAL PRESSURE AND MARKET STRUCTURE

##### 4.1. *Definition of the instrumental variable*

To quantify the degree of political pressure we exploit the institutional features of the British electoral system. There is a first-past-the-post system similar to the election of the U.S. president through the Electoral College. For the purpose of the National Elections, votes are counted in each of over 650 U.K. political constituencies (533 in England, the focus of our study). Constituencies are very similar in terms of population size as each constituency elects one Member of Parliament only. Whichever party obtains the majority of votes within a particular constituency wins the constituency and the party's representative will become a Member of Parliament. The party that wins the majority of constituencies will form the government. One implication of this type of electoral system is a strong incentive for the ruling party to cater to constituencies in which they predict a tight race with another party in the next election. They will therefore avoid implementing policies that are very unpopular with voters in those constituencies, such as hospital closures. In the context of the U.K. such constituencies are referred to as "marginal", in reference to a small winning margin ("swing" states in the U.S.).

Politicians do seem to get punished for closing hospitals. If we run regressions across 527 constituencies with the change in Labour vote share between elections as the dependent variable, the number of hospital closures in a 15 km radius has a negative and highly significant effect on Labour's share of votes (Supplementary Appendix Table C1).<sup>24</sup>

As constituencies are fairly small geographical units to define marginality for a hospital we use the share of marginal constituencies in all the constituencies that lie within a certain radius of the hospital to construct our instrument.<sup>25</sup> For any given hospital, any other rival hospital within a 30 km radius will have an overlap in its catchment area (defined as a 15 km radius). Following a similar logic, political pressure within the catchment area of every possible competitor (who might be up to 30 km away) will matter for determining the absolute number of competitors

23. Bloom and Van Reenen (2007) also found this in their work on manufacturing. In productivity equations, the coefficient on the overall management score was much larger than the coefficient on each sub-component.

24. For example, in a regression where the dependent variable is the change in the Labour vote share between 2005 and 1997, the coefficient (standard error) on hospital closures 2005 to 1997 was  $-0.837$  (0.118). This covers two election cycles as there were General Elections in 1997, 2001, and 2005. Performing regressions in the two sub-periods produces similar results. Voters also have long-lived memories. For the 2005–2001 vote change, the coefficient (standard error) on 2005–2001 closures was  $-0.792$  (0.116) and the coefficient on closures 2001–1997 was  $-0.503$  (0.113).

25. We draw a radius around each hospital location and find all constituencies whose centroid lies within this radius. The percentage of those constituencies that are marginals is defined as our instrument. We do not weigh by population density as constituencies are of similar size by design. As a test of this, we constructed a measure of marginality weighted by population density. It has a 0.999 correlation with our measure and when used to re-estimate our IV results in Section 5 gave essentially exactly the same results.

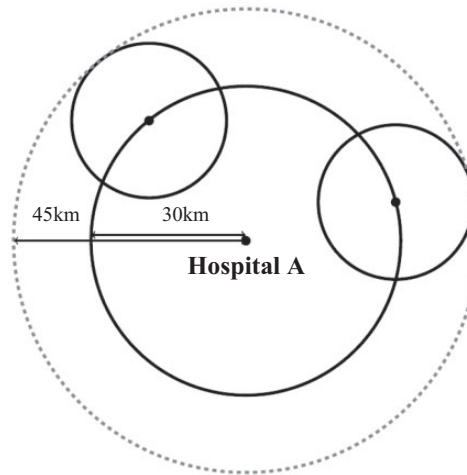


FIGURE 6

Graphical representation of the marginality measure

*Notes:* The figure illustrates the definition of our main marginality measure. Any hospital within a 30 km radius of Hospital A is considered to be a competitor (see Figure 3). We care about the political environment in the catchment area of any possible competitor. Therefore, we draw a 15 km radius (our definition of the catchment area) around each possible location for a competitor (as illustrated by the two smaller solid circles). The intersection of all these areas is given by the area within the grey dashed circle. In other words, we compute our marginality measure for Hospital A based on all constituencies within a 45 km radius of the hospital.

nearby. Therefore, a constituency that lies up to 45 km away from the hospital matters as it lies within the catchment area (15 km) of a potential competitor hospital that lies up to 30 km away. Our baseline measure of political contestability is, therefore, defined to be the share of marginal constituencies within a 45 km radius of the hospital. Figure 6 illustrates graphically the relationship between the catchment area (15 km radius), the area used for the competition measure (30 km radius) and our marginality measure (45 km radius).<sup>26</sup>

We also need to define the dating of the instrument relative to our measure of competition. One challenge is the fact that marginality influences the closures and openings of hospitals *i.e.* the *change* in the number of hospitals. However, we only have access to cross-sectional measures of management quality so the appropriate measure of market structure is the current number *stock* of hospitals. The stock of course is a function of the past changes in hospital numbers. Fortunately, we are able to exploit the fact that between 1997 and 2005 there was a large wave of hospital closures, which substantially reduced the number of hospitals in the U.K. (Figure 7). Much of this was driven by merger and acquisition activity, with the combined hospital trusts closing services in one hospital site and consolidating them on another (thus increasing travel costs for some local residents). The political environment was stable over this period. Although the 1997 election was the high watermark for Labour, the party achieved very similar election outcomes in 2001. Out of a total of 328 constituencies which Labour won in 2001, they won only two constituencies they did not previously hold and lost seven that they had won in 1997. We therefore think of the distribution of marginal constituencies in 1997 as affecting the geographical variation in political pressure during the period leading up to 2005. This leads us to use marginality in 1997 as an

26. In our sample, there are 38 constituencies on average in this radius (Table 1).



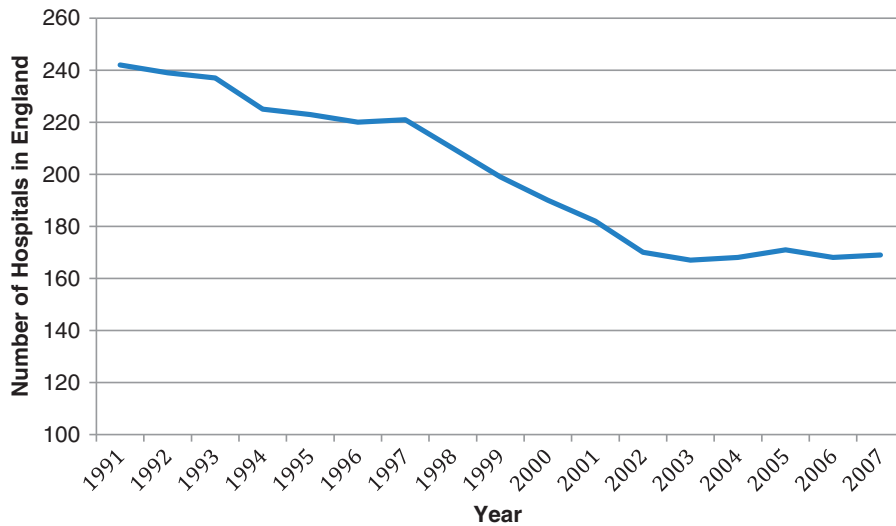


FIGURE 7

The evolution of the total number of hospitals in England between 1991 and 2007

*Notes:* This figure plots the total number of hospitals for each year between 1991 and 2007. The dataset used for our main analysis begins in 1997 so we use a different data source for this graph. For the years in which both datasets overlap, they are extremely close together.

instrument for the number of hospitals in 2005 (in Section 6.2 we show that the results are robust to using 2001 instead). In this way, our IV-strategy leverages the combination of a stable political environment with a large change in hospital numbers from 1997 to 2005. In principle, we could use marginality from earlier elections as well because previous governments should have had similar incentives. However, there was a relatively small amount of change in the number of hospitals prior to 1997, and therefore there was less scope for the government to influence the geographical distribution of hospital density.

#### 4.2. Analysis of the first stage: the effect of political marginality on hospital numbers

In Table 3, we report regressions of the number of hospitals in 2005 on the degree of political marginality in 1997. We use the sample of all hospitals which existed in 1997 and define a radius of 30 km around every hospital and count the number of hospitals still operating within this radius in 2005.<sup>27</sup> To address potential geographic overlap we cluster at the county level (there are 42 of these in England). We also present results using spatially corrected standard errors as in Conley (1999) in Supplementary Appendix Table C3 which produce slightly smaller standard errors. The regressions are of the form:

$$COMP_j = \gamma_1 MARGINALITY_j + \gamma_2' Z_j + v_j \quad (5)$$

where  $COMP$  is our measure of competition for hospital  $j$ ,  $MARGINALITY_j$  denotes our instrumental variable based on political contestability,  $z_j$  is a vector of controls referring to hospital  $j$ , and  $v_j$  is an error term.

27. The number will include the hospital around which the radius is drawn. If the hospital is closed this is still used as an observation and the number of hospitals within its 30 km market is reduced by one.

TABLE 3  
*The effect of political pressure ("marginality") on the number of hospitals*

Sample	(1) All hospitals in 1997	(2) All hospitals in 1997	(3) All hospitals in 1997	(4) All hospitals in 1997	(5) All hospitals in 1997	(6) Interviewed hospitals
Dependent variable	# Hospitals 2005	Change in # hospitals 1997–2005	Change in # hospitals 1997–2005	Closure dummy	Closure dummy	# Hospitals 2005
Political marginality in 1997	4.127*** (1.279)			−0.894** (0.359)	−1.308*** (0.376)	4.955*** (1.382)
Change in marginality 1992–1997		4.708** (2.026)	2.919** (1.256)			
# Hospitals per capita in 30 km radius (in 1997)					0.309*** (0.092)	
Teaching hospital dummy					−0.083 (0.097)	
Specialist hospital dummy					−0.344* (0.181)	
Population controls	Yes	No	Yes	No	Yes	Yes
Further controls (see Table 4)	No	No	No	No	No	Yes
Observations	212	212	212	212	212	161

*Notes:* \*\*\* Indicates significance at the 1% level; \*\* significance at 5%, \* significance at 10%. The number of hospitals is measured within in a 30 km radius around the hospital (based on a "catchment area" of 15 km for the individual hospital, see text for more details). A political constituency is defined as marginal if Labour won/was lagging behind by <5% in the 1997 General Election (proportion of marginal constituencies is based on a 45 km radius). Standard errors are clustered at the county level (there are 48 clusters in all columns except column (6) where there are 42). "Population controls" include total population and age profile (nine categories) in the catchment area as well as a London dummy. In column (3), population controls refer to the change in population between 1997 and 2005. "Further controls" are whether the hospital was a Foundation Trust, number of total admissions, and basic case-mix controls (six age/gender bins of patient admissions), the tenure of the respondent, whether the respondent was a clinician and interviewer dummies, the share of managers with a clinical degree, the fraction of households owning a car, and a London dummy.

Column (1) of Table 3 shows that marginality in 1997 has a significant positive impact on the number of hospitals that exist in 2005. Consistent with Figure 1, a one standard deviation increase in political marginality (0.098) leads to almost half an additional hospital ( $0.405 = 0.098 \times 4.127$ ). Incentives regarding which constituency to target may be more complex than a response to levels, so to test whether the trend in losing votes rather than the level matters, we regress changes in the number of hospitals between 1997 and 2005 on the change in marginality between 1992 and 1997 in column (2).<sup>28</sup> These fixed-effects/long difference estimates have a similar coefficient on marginality without population controls in column (2), and are only slightly lower with population controls in column (3). We also examined the change between 1992 and 2001 and found very similar results (not surprisingly, as the results of the 2001 election were very similar to those of 1997).<sup>29</sup> In column (4), we look directly at closures that constitute the mechanism through which marginality affects the change in the number of hospitals. We regress whether a hospital was closed or consolidated with another hospital on our marginality measure and find that marginality significantly lowers the likelihood of being part of a closure/consolidation. Column (5) shows

28. We also estimated this differenced regression on the sub-sample of 100 hospitals where we have survey data. The coefficient on marginality was insignificantly different from column (2): 3.367 with a standard error of 2.393. Note that the sample size drops from 212 hospitals to 100 which is why the standard error rises.

29. Using the 1992–2001 difference in marginality we obtain a coefficient (standard error) of 5.009 (2.766). We do not use the political change 1997–2001 as this, as discussed in the text above, is very small.

that even after adding further controls the effect of marginality on hospital closures continues to be robustly negative.

The first stage of our main IV specification has to be run on a smaller sample than the results in Table 3, because management score is only available for the sub-sample of hospitals who responded to our 2006 management survey. We therefore have a smaller sample relative to the full set of 1997 hospital locations. Column (6) of Table 3 reports a regression on this sub-sample, which shows a very similar coefficient (4.96 compared to 4.13). A fixed-effect estimator for the second stage of the IV regressions is infeasible as we observe management quality at only one point in time but the similarity of the coefficients in columns (1) and (2) is reassuring, as it suggests little bias (at least in the first stage) from omitting fixed effects.

We note that a concern is that the sample of hospitals we observe in 2006 is non-randomly selected. Since political marginality affects both hospital competition and the problem of appearing in the sample we may have classic sample selection bias. The most likely concern is that worse performing hospitals are closed down first and marginal areas are, therefore, characterized not only by a higher number of hospitals but also a different distribution of managerial quality (and other quality dimensions). Unfortunately, it is hard to think of an exclusion restriction to identify the selection equation. We can however test directly whether observed past hospital quality affected survival and find this not to be the case.<sup>30</sup> Furthermore, the bias from selective closures, if it exists, is most likely to lead to an underestimate of our effect. We outline the reasoning behind the bias direction in more detail in Supplementary Appendix C.10.

## 5. MANAGEMENT PRACTICES AND HOSPITAL COMPETITION

### 5.1. Empirical model of management and competition

Our main regression of interest is:

$$M_{jg} = \beta_1 COMP_j + \beta_2' z_{jg} + \varepsilon_{jg} \quad (6)$$

where  $M_{jg}$  is the average management score of respondent  $g$  in hospital  $j$  (we have a mean of 1.65 respondents per hospital),  $z_{jg}$  is a vector of controls (most of which are  $j$ -specific not  $fg$ -specific) and  $\varepsilon_{jg}$  is the error term.

### 5.2. Basic results

To investigate whether competition improves management practices, column (1) of Table 4 presents an Ordinary Least Squares (OLS) regression (with minimal controls) of management on the number of rivals that could serve a hospital's geographical catchment area. The basic controls are population density and demographics in the hospital's catchment area, a limited set of hospital-specific measures of patient case-mix, hospital type, hospital size and sample "noise" controls (such as dummy variables for each interviewer). There is a positive and significant coefficient on the competition measure. Adding one rival hospital is associated with an increase in management quality of 0.161 of a standard deviation. The key set of controls is the patient

30. We re-ran the "survival equation" of column (4) in Table 4 but included measures of observable hospital quality in 1997 such as AMI death rates and average length of stay. The coefficients on these quality measures were always insignificant. Since unobserved hospital quality is the variable most likely to cause a correlation between the error terms in the selection equation and management quality equation, selection may be limited here and thus the magnitude of any bias is likely to be small.

TABLE 4  
*The effect of competition on management practices*

Type of regression	(1) OLS	(2) IV: first stage	(3) IV: second stage	(4) OLS	(5) IV: first stage	(6) IV: second stage
Dependent variable	Management	Number of competing hospitals	Management	Management	Number of competing hospitals	Management
Number of competing public hospitals	0.161*** (0.042)		0.325* (0.178)	0.181*** (0.049)		0.366** (0.168)
Proportion of marginal constituencies		4.955*** (1.382)			7.228*** (2.115)	
F-statistic of excluded instrument in corresponding first stage		12.85			11.68	
General controls	No	No	No	Yes	Yes	Yes
Observations	161	161	161	161	161	161

*Notes:* \*\*\* Indicates significance at the 1% level; \*\* significance at 5%, \* significance at 10%. The dependent variables in columns (1), (3), (4), and (6) is the average management score in the hospital (z-scored). The dependent variables in columns (2) and (5) is competition measured as the number of hospitals in a 30 km radius around the hospital (based on a “catchment area” of 15 km for the individual hospital, see text for more details). A political constituency is defined as marginal if Labour won/was lagging behind by <5% in the 1997 General Election (proportion of marginal constituencies is based on a 45km radius). Standard errors are clustered at the county level (there are 42 clusters). All columns include controls for the total population and age profile (nine categories) in the catchment area, whether the hospital was a Foundation Trust, number of total admissions, and basic case-mix controls (six age/gender bins of patient admissions), the tenure of the respondent, whether the respondent was a clinician and interviewer dummies, the share of managers with a clinical degree, the fraction of households owning a car and a London dummy. “General controls” include all the baseline controls as well as Labour’s share of votes, the number of political constituencies in the catchment area, a set of dummies for the winning party in the hospital’s own constituency, teaching hospital status, and a dummy for whether there was joint decision making at the hospital level as well as detailed “case-mix” controls (22 age/gender bins of patient admissions). Labour share of votes is defined as the absolute share obtained by the Governing party in the 1997 U.K. General Election averaged over all constituencies in the catchment area.

case-mix and population density, as areas with greater demographic needs (*e.g.* more old people) tend to have more hospitals.<sup>31</sup>

To test whether the positive correlation between management quality and various measures of competition is causal we use our political marginality IV approach. Column (2) of Table 4 reports the first stage showing that marginality strongly predicts hospital numbers. Column (3) presents the IV second-stage results and shows a positive effect of the number of competing hospitals on management quality that is significant at the 10% level. In columns (4)–(6), we include a richer set of covariates including dummies for teaching hospital status, the share of Labour votes and the identity of the winning party.<sup>32</sup> (The full set of coefficients is presented in column (4) of

31. Without the case-mix controls (six age/gender groups in this specification) the coefficient on competition drops to 0.138 (standard error 0.052), which is consistent with a downward bias resulting from failing to control for demographic demands. Dropping admissions caused the coefficient on competition to change from 0.161 to 0.133 (standard error 0.046). The model above delivered the result that competition should increase managerial effort and quality conditional on size which is why we include size as a basic control, but size could be endogenous. It is therefore reassuring that we can drop the size variable with no change to the results.

32. The set of control variables used in this specification is identical to the ones used in Table 2, except for the additional controls for area demographics, population density, and political controls. Including the total mortality rate in the hospital’s catchment area was also insignificant with a coefficient (standard error) of 0.001 (0.004) in column (6) with a coefficient (standard error) of competition of 0.389 (0.202). This implies our case-mix controls do a good job at controlling for co-morbidity.

Supplementary Appendix Table C2.) The coefficients on our key variables are little changed by these additional covariates.<sup>33</sup>

The most likely reason why the IV estimates are larger than OLS is simply omitted variable bias. Although entry and exit is governed by the political process rather than by individual firms, the government locates more hospitals in areas where demand is expected to be higher. Conditional on population density, “sicker” areas will have more hospitals, in particular those with older and poorer populations. These neighbourhoods are likely to be less attractive to good quality managers thus generating a spuriously negative relationship between  $COMP_j$  and management quality and biasing the coefficient  $\beta_1$  downwards.<sup>34</sup> We do condition on population density and proxies for disadvantage, but if we do not control for them completely they will generate a downwards OLS bias. This bias would also operate in the same direction when looking at IV estimates of other health outcomes, such as AMI death rates, and we will show exactly this bias at play in the IV regressions of other hospital outcomes below.

There are several other reasons for the OLS bias which are probably of second order. First, classical measurement error will attenuate the OLS coefficient towards zero. While the number of hospitals in an area is not measured with much error, the count of the number of competitors may be too crude a measure of competition. Secondly, reverse causality may matter because closure is easier to justify if patients have a good substitute due to the presence of a neighbouring well-managed hospital. Because of this, a higher management score would generate a lower number of competing hospitals, just as in the standard model in industrial organization where a very efficient firm will tend to drive weaker firms from the market (*e.g.* Demsetz, 1973). However, we did not find a strong relationship between measures of performance and the probability of closure (Section 4.2 above). Finally, our IV estimate is LATE, a local average treatment effect, and it may be that the sub-population of hospitals induced to stay open by the political instrument may be in areas where competition has a particularly strong effect on management quality.<sup>35</sup> We did not find much evidence of heterogeneity of competition based on observables,<sup>36</sup> but there may still be unobservable heterogeneity.

To explore the dimensions along which hospitals improve most when facing competitive pressure we report IV regressions of the three sub-components of the management score on competition (Supplementary Appendix Table C9). This shows that all of the dimensions of the management score improve, with the largest point estimate being around incentives, an area of the management grid that public sector organizations may struggle most to improve. The gap between the public and private sector average management scores tends to be greater for incentives than for other sub-components, possibly because basing pay, promotion, and removal of underperformers strongly on effort and ability is difficult when unions are powerful.

33. We also examined adding higher order controls for Labour’s vote share or dropping Labour’s vote share completely. This made practically no difference. For example, dropping the Labour vote share completely yields a coefficient of 0.389 (0.175) on the competition measure.

34. OLS could in principle also be biased upwards. For example, maybe more hospitals enter areas where the local population are “health freaks” (with high demands for health) and these areas are also attractive to high quality managers. But this problem is sharper in market-driven system, not one where hospital entry and exit is strictly controlled by the government who focus more on objective health needs.

35. If the hospitals kept open for political reasons were under-performers, they would pose a lower competitive threat to others in the area. In Supplementary Appendix Table C13 we show that performance was not predictive of closure. However, we do find that smaller hospitals were more likely to be closed down. If smaller hospital are less of a competitive threat this would make it *harder* to identify a positive effect of competition on management quality.

36. We split our sample at the median along several dimensions (using market characteristics) and estimate the model for each half of the sample separately. We tried doing this using population density, Labour vote-share, the general area mortality rate and unemployment as the dimensions that determined the sample split. We find little evidence of systematic difference in the coefficients on marginality.

TABLE 5  
*The effect of competition on various hospital performance measures (IV estimates)*

Type of regression	(1) IV second stage	(2) IV second stage	(3) IV second stage	(4) IV second stage	(5) IV second stage	(6) IV second stage
Dependent variable	Mortality rate from emergency AMI	Mortality rate from all emergency surgery	Intention of staff to leave in next 12 months	HCC overall rating	Average length of stay in hospital	Finished consultant episodes per patient spell
Number of competing public hospitals	-1.502** (0.654)	-0.244 (0.183)	-0.058* (0.032)	0.096 (0.070)	-0.233*** (0.084)	0.062*** (0.014)
F-statistics of excluded instrument in corresponding first stage	16.91	6.29	11.68	11.68	11.68	11.68
General controls	Yes	Yes	Yes	Yes	Yes	Yes
Specific controls	Yes	Yes	No	No	No	No
Observations	140	157	160	161	161	161

*Notes:* \*\*\* Indicates significance at the 1% level; \*\* significance at 5%, \* significance at 10%. Competition is measured as the number of hospitals in a 30 km radius around the hospital (based on a “catchment area” of 15 km for the individual hospital, see text for more details). A political constituency is defined as marginal if Labour won/was lagging behind by <5% in the 1997 General Election (proportion of marginal constituencies is based on a 45 km radius). Standard errors are clustered at the county level (there are 42 clusters). All columns include controls for the total population and age profile (nine categories) in the catchment area, whether the hospital was a Foundation Trust, number of total admissions, the tenure of the respondent, whether the respondent was a clinician and interviewer dummies, the share of managers with a clinical degree, the fraction of households owning a car, a London dummy, Labour’s share of votes, the number of political constituencies in the catchment area, a set of dummies for the winning party in the hospital’s own constituency, teaching hospital status, and a dummy for whether there was joint decision making at the hospital level as well as detailed “case-mix” controls (22 age/gender bins of patient admissions). Labour share of votes is defined as the absolute share obtained by the Governing party in the 1997 U.K. General Election averaged over all constituencies in the catchment area. “AMI specific controls” are those in Table 2 column (1), similarly “Emergency Surgery specific controls are those in Table 2 column (2). None of the other outcome regression includes outcome-specific controls. Column (4) uses the average of HCC’s rating on resource use and quality of service as dependent variable (a score ranging between 1 and 4).

### 5.3. Competition and hospital quality and productivity

While our primary focus is on the impact of competition on management quality, we also consider whether competitive pressures lead to improved outcomes across the range of performance measures that hospitals might be expected to be judged by. Research on U.S. data which examines the effect of increasing hospital competition by using report cards found that hospitals respond by changing treatment patterns to avoid mortality, which benefitted some patients but harmed others (Dranove *et al.*, 2003). To examine whether such trade-offs may be operating where competition operates through patient choice and regulated prices, we repeat our IV results for the set of hospital outcomes described in Table 2.

In Table 5, we present the second-stage results, together with the *F*-statistics from the corresponding first stages. The results show that competition improves hospital performance on all six measures and that this relationship is statistically significant at the  $\geq 10\%$  level for four of these performance measures. First, competition improves clinical quality as measured by lower AMI mortality. Column (1) shows adding one extra hospital in the neighbourhood reduces death rates by 1.5 percentage points (or 9.7%). Secondly, productivity rises. Column (5) shows that adding an extra hospital reduces length of stay by 0.233 days (or 11.7%) and column (6) shows that activity increases by 0.062 consultant episodes (5.4%) per patient stay. Staff satisfaction also rises: column (3) indicates that adding another hospital decreases staff wanting to leave by 0.058

points (0.45 of a standard deviation).<sup>37</sup> We do not find a significant effect for either the HCC score or deaths from general surgery, but neither coefficient indicates that competition leads to poorer performance. Thus, our IV results provide support for earlier research which shows that competition reforms after 2000 in England improved hospital outcomes, but did not explore how this mechanism may operate. We also find, in line with our theoretical model, that hospitals do not appear to be trading off outcomes in response to competition.

#### 5.4. *Validity of the political marginality instrument*

A threat to our IV strategy is that political marginality may be correlated with some unobserved factors that could lead directly to better management. This might be due to omitted variables, or it might be because politicians find other routes via “hidden policies” to improve management practices directly other than via market structure. There is U.K. evidence that marginality affects various policies and political behaviour in other dimensions (*e.g.* Besley and Preston, 2007; Larcinese, 2007). To examine this we carry out five tests.

First, we present a tough test of hidden policies. Although one might worry that the political environment in the hospital’s *own catchment area* influences its management score, the political environment in the hospital’s *competitors’ catchment areas* instead should not have any direct impact on the quality of management. Our baseline definition of a 15 km hospital catchment area leads us to use the fraction of Labour marginals within a 45 km radius as our instrument.<sup>38</sup> We are therefore able to control for the political contestability in the hospital’s own catchment area, while simultaneously using the political contestability in the area that affect its competitors as an instrument. Specifically, we use the fraction of Labour marginals both within a 15 km radius (own catchment area) and a 45 km radius (competitors’ catchment areas) in the first stage, but only exclude the latter from the second stage. By controlling for political marginality in the hospital’s own catchment area we effectively rule out the problem that our instrument is invalid because it is correlated with an unobservable factor within the hospital’s catchment area (such as omitted demographic variables) correlated with management quality.

This test also addresses the concern that closure or merger may directly affect the hospital’s organizational structure and so affect outcomes independently of any competition effect. For example, mergers may result in the sorting of patients and doctors across hospitals. Movement of more patients with more severe illnesses away from hospitals at risk of merging could bias our estimates as would a loss of higher quality staff. While we do have measures of patient case-mix, these are relatively crude and we do not have measures of the quality of staff. By controlling for the focal hospital’s own probability of closure, we are able to control for these—and other unobserved factors that may affect the organizational structure—and so cleanly identify the effect of competition.

Figure 8 illustrates the approach graphically. Essentially, we only use marginality in constituencies that are far enough away not to influence the hospital itself, but near enough to still have an impact on its competitors.

Table 6 reports the baseline IV estimate in column (1) which is the same as Table 4 column (6). Column (2) of Table 6 presents the alternative first stage where we include both political marginality around rivals (the standard IV) and also the political marginality around the hospital (the new variable). As expected, marginality around the location of potential rivals continues to

37. Staff satisfaction is recorded on a 1–5 scale, but answers are bunched in the middle of the scale with a mean of 2.7 and a standard deviation of 0.13. The low percentage change is therefore not very meaningful for this variable.

38. The logic of how the 45 km radius for marginality follows from the 15 km radius of the catchment area was presented in Section 4.2 and Figures 3 and 6.

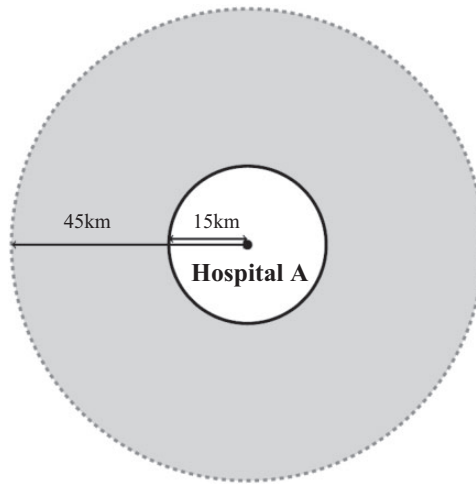


FIGURE 8

Controlling for hidden policies by conditioning on marginality around own hospital

*Notes:* The figure illustrates the idea behind the sensitivity check conducted in columns (2) and (3) of Table 6. In the first-stage regression, we include the political marginality measure defined over a 45 km radius (the standard instrument) and the one defined over a 15 km radius in the first stage. The latter controls for factors that may affect management in the hospital due to “hidden policies”. In the second stage, only the 45 km measure is excluded, *i.e.* it serves as an instrument for the number of rival hospitals. We therefore effectively only use marginality within the grey-shaded area of the graph to instrument for the number of competitors.

be strongly positive for hospital numbers, whereas political marginality around the hospital itself has no significant effect. Column (3) presents the second stage. Competition still has a positive and significant impact on management quality (the coefficient falls slightly from 0.366 to 0.336). The coefficient on marginality around the hospital itself is positive but insignificant in this second stage.

Secondly, we test directly for the most obvious channel through which politicians might influence hospital performance—better funding. In principle this should not be an issue in the U.K. context as the allocation of health funding is a separate process from decisions on hospital closures. The purchasers of health care cover a defined geographical area. They buy health care from hospitals at fixed national prices for their local population. They neither own nor are vertically integrated with hospitals. They are allocated resources on the basis of a formula that measures need for health care (essentially, the demographics and the deprivation of their area). This formula is designed by a technical group and is changed periodically, but these changes are in response to technical concerns such as quality and availability of data and have not coincided with the electoral cycle (see Bevan, 2008). This system is intended to ensure resources are not used to prop up poorly performing local hospitals nor are subject to local political influence. So there should be no automatic association between funding and marginality. Nevertheless, it is possible that lobbying by politicians could distort the formal system and target resources at marginal constituencies.

To examine this we investigate the relationship between marginality and resources. We first examine whether there is an empirical relationship between marginality and the resources allocation to Health Authorities (HAs) which were the main purchasers of care between 1997 and 2002. Among other things they entered into contracts with hospitals to assure the



TABLE 6  
*Instrument validity and robustness tests*

Type of regression Dependent variable	(1) IV Manag- ment 15 km 5%	(2) First stage Number of rival hospitals 15 km 5%	(3) IV Manag- ment 15 km 5%	(4) OLS Funds allocated to HA 15 km 5%	(5) IV Manag- ment 15 km 5%	(6) IV Manag- ment 15 km 5%	(7) IV Manag- ment 15 km 5%	(8) IV Manag- ment 15 km 5%	(9) IV Manag- ment 13 km 5%	(10) IV Manag- ment 17 km 5%	(11) IV Manag- ment 15 km 3%	(12) IV Manag- ment 15 km 7%
Catchment radius												
Marginality threshold												
Number of competing public hospitals	0.366** (0.168)		0.336** (0.144)		0.369** (0.163)	0.338** (0.181)	0.366** (0.178)	0.361** (0.160)	0.484** (0.225)	0.395* (0.219)	0.227* (0.126)	0.485* (0.279)
Proportion of marginal constituencies within 45 km		9.001*** (2.722)		7.800 (8.022)								
Proportion of marginal constituencies within 15 km		-1.092 (0.916)	0.135 (0.371)									
Funds allocated to HA (1997, unit: £10,000)				-0.010 (0.008)								
Average age of hospital buildings						0.009 (0.010)						
Physicians per capita in local area							-0.014 (0.499)					
Growth in total admissions 2001–2005 (10,000s)								-0.124 (0.175)				
Observations	161	161	161	100	161	152	161	161	161	161	161	161

Notes: \*\*\* Indicates significance at the 1% level; \*\* significance at 5%, \* significance at 10%. Competition is measured as the number of hospitals in a 30 km radius around the hospital (based on a “catchment area” of 15 km for the individual hospital, see text for more details). A political constituency is defined as marginal if Labour won/was lagging behind by <5% in the 1997 General Election (proportion of marginal constituencies is based on a 45 km radius). Standard errors are clustered at the county level (there are 42 clusters). All columns include controls for the total population and age profile (nine categories) in the catchment area, whether the hospital was a Foundation Trust, number of total admissions, the tenure of the respondent, whether the respondent was a clinician and interviewer dummies, the share of managers with a clinical degree, the fraction of households owning a car, a London dummy, Labour’s share of votes, the number of political constituencies in the catchment area, a set of dummies for the winning party in the hospital’s own constituency, teaching hospital status, and a dummy for whether there was joint decision making at the hospital level as well as detailed “case-mix” controls (22 age/gender bins of patient admissions). Labour share of votes is defined as the absolute share obtained by the Governing party in the 1997 U.K. General Election averaged over all constituencies in the catchment area. “AMI specific controls” are those in Table 2 column (1). Column (4) is a regression at the HA level with no additional control variables.

provision of secondary care. If the government did indeed try to influence hospital funding they would have had to do it through the indirect route of allocating more money to HAs in more marginal areas. We construct the fraction of marginal constituencies located in the geographical area covered by each HA (there were 100 HAs) in 1997 and test whether marginality is associated with levels and changes in the allocation of funds after the 1997 election. There is no significant relationship between any measure of levels or changes in health fund allocation and marginality.<sup>39</sup> Further, when funding is added to the management regressions, the coefficient on competition is essentially unchanged. For example, column (4) of Table 6 shows that the level of funding allocated to HAs is not significantly higher in more marginal area. Further, column (5) shows that the coefficient on health-care funding is insignificant in the management equation and the competition measure remains positive and significant. We also looked at capital and technology investment and usage which could be higher if the marginal areas were being given special treatment (as capital is allocated by a different process to revenue funding). Again, there was no evidence that this was the case. The only exception to this was the age of the hospital buildings which was mildly *higher* in marginal areas. Column (6) shows that including building age makes no difference to the competition results.<sup>40</sup>

Thirdly, we look directly at whether there is a relationship between marginality and the potential demand for health care in the area. Apart from demographics and population density which we control for in the regressions, we find no significant correlations (Supplementary Appendix Table C8).

Fourthly, political variables should not affect the location of private hospitals. A relationship between the location of private hospitals and marginality could indicate that marginality is picking up unobserved local health status. There is, however, no relationship between marginality on the number of private hospitals. Using the number of private (instead of public) hospitals as the dependent variable in a specification identical to that of column (5) in Table 4 leads to a coefficient (standard error) on marginality of 2.541 (4.589). As these hospitals vary substantially in size, we also examine the number of private hospital beds and again found no significant relationship.<sup>41</sup>

As a final test of whether there are hidden policies at local level we examined the relationship between marginality and high school outcomes. In contrast to hospital location, schooling location is not controlled by national politicians, but they do care about schooling outcomes. Thus, they would try to affect location of high schools and outcomes if they could. We found that neither high school entry/exit nor schooling outcomes were affected by national political marginality (details in Supplementary Appendix Table C12).

39. We test whether total funding in 1999/2000 is affected by marginality in 1997 and also use an extensive set of the components of total funding. Full results are in Supplementary Appendix Tables C6 and C7. We also repeated the analysis for funding between the 2001 and 2005 elections (results available on request) and again found no significant correlation with marginality.

40. Full results on measures of capital and investment are presented in Supplementary Appendix Tables C4 and C5.

41. As a further test of identification we examine the relationship between competition and management of private hospitals. There should be no impact of competition on the management of private hospitals as they operate in a niche market. From our survey we have data on management practices in 21 private hospitals. A regression of the management scores in these hospitals on public hospital competition has a small and insignificant coefficient (standard error) of 0.0237 (0.0215). From this we conclude that there is no effect of competition on private management as well as no correlation between marginality and the number of private hospitals.

## 6. FURTHER EXTENSIONS AND ROBUSTNESS TESTS

6.1. *Capacity rather than competition?*

A fall in the number of hospitals could arise from either the closure of a hospital or the merging of two (or more) hospitals. Most of the fall in hospital numbers in Figure 7 actually came from mergers and acquisitions. This is likely to reduce the degree of competition. Typically after a merger, the combined hospital will consolidate hospital services on one site or another which means that some patients will have to travel further for their services, hence creating political opposition to such merger activities. Note, however, that the fall in competition after such a merger does not necessarily lead to a fall in the overall supply of hospital services in the area. Even when a hospital is completely closed the capacity is often relocated onto a different hospital rather than removed entirely.<sup>42</sup>

We were concerned, however, that our competition measure (number of hospitals) means lower overall capacity and so higher demand at any given hospital. This could itself result in less effort devoted to quality improvements by management (although it may do the opposite and galvanize improved management practices) and worse hospital outcomes.

We cannot test this by using resources at the hospital level, as anything that increases the demand for the hospital will reduce the resources per patient, so measures like the number of physicians per patient at the hospital level is, therefore, endogenous to management quality. Ideally, we would have an additional instrument for capacity per person in the local area. As there is no such obvious instrument, we investigate this empirically by adding controls to our baseline IV regression for the number of physicians per capita in the local area, which reflects potential rather than realized demand. Column (7) of Table 6 shows that our results are robust to inclusion of this additional control.<sup>43</sup>

A related concern is that areas that experience more hospital closures may suffer from disruption because incumbent hospitals face unexpected patient inflows. Hospitals with a high number of marginal constituencies nearby might, therefore, be able to improve their management quality as they operate in a more stable environment. We examine this by including the hospital's *growth* in admissions from 2001 through 2005 into the regression in column (8) of Table 6. We find no evidence for an impact of the change in admissions on the quality of management. The coefficient on competition remains significant with a very similar magnitude to that in column (1).<sup>44</sup> If growth in admissions is correlated with changes in severity of patient illness, this test also controls for any changes in severity that may occur in hospitals in areas which experience more closures.

Another concern with the instrument might be that the lower risk of a hospital being closed down in a marginal constituency may *decrease* managerial effort because the CEO is less afraid of losing his job (*e.g.* the "bankruptcy risk" model of Schmidt, 1997). This mechanism is unlikely to be material in the NHS because hospital closure is relatively rare compared to a high level of managerial turnover. In the context of our set-up, the bankruptcy risk model still implies that marginality would cause a greater number of hospitals, but this would be associated with a

42. Gaynor *et al.* (2012a) show that the reduction in hospital capacity and staff post-closure is relatively slow. Merged hospitals have 10% less growth in staff and admissions 4 years post-consolidation compared to their pre-merged entities.

43. Nor does including higher order terms in physicians per capita in the local area matter. For example, when including a cubic in this variable in column (1) of Table 6 the coefficient (standard error) on competition was 0.341(0.171).

44. We repeated the same exercise using the variance in yearly admissions over the same time period as an alternative measure of shocks. The variable was insignificant and the competition coefficient remained positive and significant. As there were almost no closures after 2001 (Figure 7) we would, therefore, not expect to still see the disruptive effects of closures that happened at least 4 years prior to our survey.

*decrease* in management quality. In fact, we find the opposite: managerial quality increases with the number of hospitals. Furthermore, looking at the reduced form, management quality is higher in areas where there is greater political competition, implying that the bankruptcy risk model is unlikely to be empirically important in our data.<sup>45</sup>

## 6.2. *Alternative specifications of competition, thresholds for catchment areas, and marginality*

Our baseline estimates use a very simple measure of competition, the number of competing hospitals within a fixed radius of 30 km. We undertake a number of tests to check that our results are robust to other more empirically complex but theoretically better grounded measures. We first present robustness checks with alternatives based on the HHI. Higher competition is positively and significantly related to management quality for both OLS and IV.<sup>46</sup> This is true whether we use basic or general controls and whether we use the actual HHI or the HHI that is predicted from a demand model based on exogenous characteristics such as distance following Kessler and McClellan (2000).

Secondly, we allow for a differential impact of competing hospitals as a function of distance. In our baseline model, each hospital within the 30 km catchment area gets equal weight. Instead, here we weight each competing hospital proportionally to the overlap in catchment areas. At the extremes, a hospital at zero km distance gets a weight of 1, a hospital at 30 km a weight of 0; in between the amount of catchment area overlap (relative to full overlap) gives the associated weight. As there may be similar concerns over our count measure of marginality, we similarly construct the marginality measure by computing a weighted average of marginality within all constituencies within a 45 km radius. The weight is determined by the weight associated with the closest competitor that is influenced by this constituency.<sup>47</sup> The first and second stage estimates using these measures are presented in Supplementary Appendix Table C10. In these tests, we also alter the definition of the radius over which the catchment areas are defined as the overlap-based weighting scheme attaches a smaller weight to hospitals at the edge of the catchment area (relative to our simple count procedure). The first and second stage results are all robust to these more complex alternative ways of measuring competition.

We can also examine the effect of changes in the size of the catchment area using our baseline count measures of competition and marginality. Figure 9 shows the results from varying the baseline 15 km catchment area in 1 km bands from 10 km to 25 km. The coefficient on the marginality variable in the first stage is robustly positive and significant with a maximum at around 24 km. In terms of the second stage, we show that changing the catchment area in Table 6, columns (9) and (10), makes little difference. Figure 10 shows how the first stage changes when we vary the precise value of the threshold that defines marginality from 1 percentage point to 10 percentage points (instead of our baseline 5 percentage points). Unsurprisingly, the point estimate is strongest when we choose a value of 1%, but we still obtain a (weakly) significant effect even at 7%. Looking at the second stage in Table 6, using a 3% or 7% threshold for marginality in columns (11) and (12) makes little difference to the main results. Our results are also robust to using marginality in 2001 rather than 1997. Changing the timing yields a coefficient (standard error) of 0.584 (0.246) which is slightly stronger than our baseline specification.

45. There is a coefficient (standard error) on political marginality of 2.644 (1.013) in the reduced form regression with management as the dependent variable—see Supplementary Appendix Table C2 column (2).

46. Supplementary Appendix Table B3 presents these results in full.

47. We also used a simple triangular kernel that assigns competitors at 0 distance a weight of 1 and those at 30 km and interpolates the weighting linearly between them. For marginality the weighted kernel is defined over a 45 km radius. Results are very similar to the overlap-based kernel weighting (results available on request).

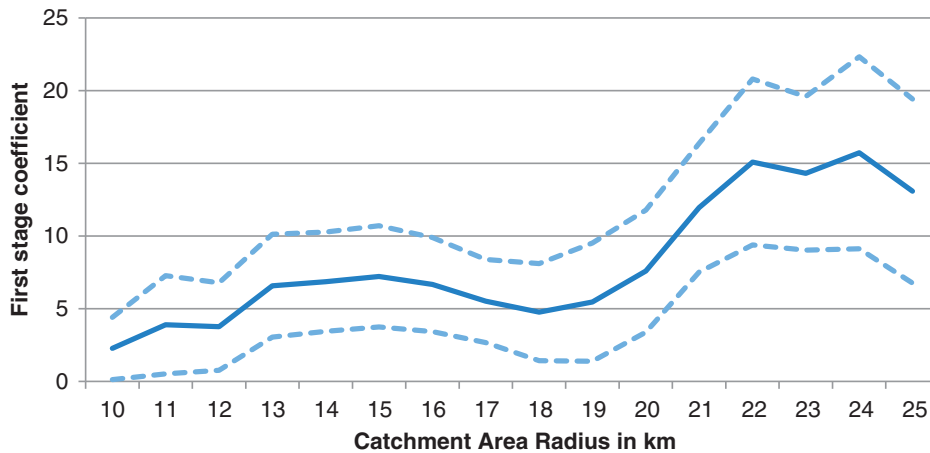


FIGURE 9

Robustness of results to changing the definition of the size of hospital catchment area

*Notes:* These are the results from 16 separate first-stage regressions of the number of hospitals on the marginality instrument (identical in specification to those of column (5) in Table 4). The solid line is the OLS coefficient and the dashed lines show the 90% confidence bands. We vary (on the x-axis), the size of the catchment area around the hospital in an interval from 10 km to 25 km (our baseline results use a 15 km catchment area). Note that this implies that the area over which we define competition varies from 20 km to 50 km. The effective political catchment area (relevant for number of rival hospitals) varies from 30 km to 75 km. The y-axis plots the coefficient on marginality (and confidence intervals) in each of separate regression.

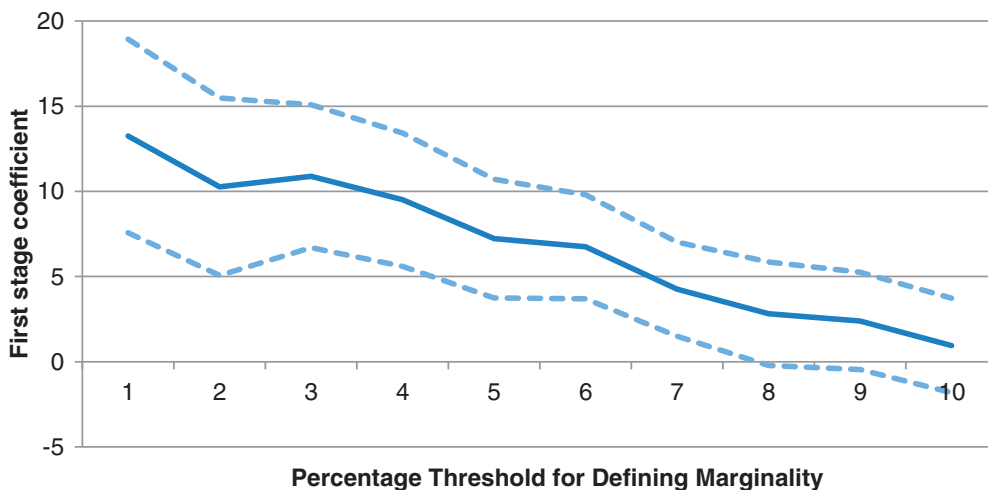


FIGURE 10

Robustness of results to changes in the threshold for marginality

*Notes:* These are the results from 10 separate first-stage regressions of the number of hospitals on the marginality instrument (identical in specification to those of column (5) in Table 4). The solid line is the OLS coefficient and the dashed lines show the 90% confidence bands. We vary (on the x-axis), the percentage margin by which Labour won/was lagging behind from 1 percentage point to 10 percentage points (our baseline results use a 5 percentage point definition of marginality). The y-axis plots the coefficient on marginality (and confidence intervals) in each separate regression.

Finally, our baseline marginality measure makes no distinction between marginally won and marginally lost constituencies in 1997: marginality is defined as between  $-5\%$  and  $+5\%$ . We might expect the marginally lost ones to matter less as these would have been further out of reach in a close election (the 1997 election was a landslide win for Labour). We find exactly this result in two robustness tests.<sup>48</sup> First, we split the marginals into those marginally won and those marginally lost and find that marginally won constituencies have more explanatory power in the first-stage regression. Secondly, we allow the marginality percentage threshold to vary asymmetrically, separately examining first excluding some of the losing marginals and second some of the winning marginals. Excluding the losing marginal results in our instrument having a bigger effect on competition, though the tighter window also restricts the variation in the data as fewer constituencies are used to define the threshold window and this results in larger standard errors. The estimates of the first stage are also robust to excluding some of the winning marginals. From this, we conclude that our results are robust to exact definitions of our key competition and marginality measures.

### 6.3. *Direct evidence for our theoretical mechanism*

The model we discussed in Section 1 assumed that patients become more sensitive to quality in areas where there is more hospital competition. To investigate this we used estimates of patient demand with respect to quality from Gaynor *et al.* (2012b). These authors estimate a model of hospital choice using English hospital discharge data for coronary artery bypass graft (CABG).<sup>49</sup> We regressed their estimates of the demand elasticity on the number of competitors within a 30 km radius (to maintain consistency with our main analysis). When doing so we find a significant effect of the number of hospitals on the elasticity of demand with a coefficient (standard error) of 0.0177 (0.0026). To put this number into context, note that the average elasticity is equal to 0.115 so adding an additional competitor, therefore, corresponds to roughly a 15% increase in the elasticity of demand. This suggests that there is a direct relationship between the number of competitors and demand elasticities consistent with our theoretical model.

### 6.4. *Local labour markets*

Rather than proxying product market competition, larger numbers of hospitals may reflect a more attractive labour market for medical staff. It is not *a priori* clear why this should be the case as we control for population density in our main specification. Nevertheless, as a test of this hypothesis, we include as a control the proportion of teaching hospitals among the number of competing hospitals within a 30 km radius. A high share of teaching hospitals serves as a proxy for a local labour market with better employment opportunities for high-quality medical staff. When this proxy is added to the specification the coefficient (standard error) on the competition measure is 0.351 (0.167) and the coefficient on number of teaching hospitals in the local area is actually negative (clinical skills may be better, but managerial skills are not). This would also suggest it is not learning through local knowledge spillover which is driving the effect of the number of rival hospitals on performance.

48. Full results are in Supplementary Appendix Table C11.

49. This is the same dataset used here to construct the HHI competition measures for all elective admissions (of which CABG is one).

## 7. CONCLUSIONS

In this article, we have examined whether competition can increase management quality. We use a new methodology for quantifying the quality of management practices in the hospital sector, and implement this survey in two-thirds of acute hospitals in England. We find that management quality is robustly associated with improved mortality rates and other indicators of hospital performance. We then exploit the U.K.'s centralized public hospital system to construct an instrumental variable for hospital competition. We use the share of marginal political constituencies around each hospital as an instrument for the number of nearby competing hospitals. This works well because in the U.K. politicians rarely allow hospitals in politically marginal constituencies to close, leading to higher levels of hospital competition in areas with more marginal constituencies. We find in both OLS and Two Staged Least Squares (2SLS) (using our political instrument) that more hospital competition leads to improved hospital management and to higher hospital performance in terms of quality, productivity, and staff satisfaction. Our results suggest competition is useful for improving management practices and outcomes in health care.

We examined a variety of issues that would invalidate our IV strategy. First, we test and control for hidden political policies that would affect the performance of hospitals directly. Secondly, we carry out extensive tests of robustness to alternative definitions of marginality and the size of the hospital market. Thirdly, we check that our results are not driven by any capacity changes that may follow closures that might directly impact on the quality of management. Our strategy passes all these tests.

In general, our article provides positive evidence for competition in health-care markets and so provides support for policies that aim to increase health-care productivity by promoting competition (including those of the governments of the U.S. and the Netherlands, Germany, the U.K., Sweden, and Norway). The setting we examine—non-profit hospitals reimbursed using *ex ante* regulated prices—is common in many health-care systems. Non-profits are important providers in many health-care markets and governments (and other third party payers) seek to limit the growth in health-care costs, frequently by setting regulated prices. While private insurers in the U.S. bargain with hospitals based on both price and quality, publicly funded care (both Medicare and Medicaid) is reimbursed using a regulated price system that was used as the basis for the English regulated price system. Regulated prices are also used in around a dozen European countries, including Germany and France (Busse *et al.*, 2011). The incentives facing CEOs of hospitals in many health-care systems are similar to those we examine there: to earn revenues subject to convex effort costs. This all suggests that the results we find are likely to be generalizable to contexts outside the U.K. setting, although empirical testing of this is clearly required in any specific institutional context.

Finally, although we have shown evidence of a positive effect of competition on quality of care, this does not answer the normative question of whether welfare would unambiguously increase. Our results do not necessarily imply that new hospitals should be created or that over-capacity should be maintained, as there are resource costs to building new hospitals and there are likely to be gains from large hospitals as a result of economies of scale. What the estimates presented here suggest is that benefits from competition should enter any social cost–benefit analysis. Policies that focus on increasing the demand elasticity for hospitals, for example, through information, incentives and other reforms (such as the patient choice reforms in England in the 2000s, see Gaynor *et al.*, 2012b) and which do not require the building of extra hospitals are, therefore, likely to have large effects on quality at very low cost.

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### Supplementary Data

Supplementary data are available at *Review of Economic Studies* online.

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