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Critical Review of the Quality and Competition Measures and Indentification Strategies Used in Health Care Stuides

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Glossary

AAAR: Abdominal Aortic Aneurysm Repair

AMI: Acute Myocardial Infarction

BCC: Bilateral Cardiac Catheterization

CABG: Coronary Artery Bypass Grafting

CHF: Congestive Heart Failure

CQC: Care and Quality Commission

GIH and CBH: Gastrointestinal Haemorrhage

ISTC: Independent Sector Treatment Centres

HIP: Condition = Hip fracture, surgical procedure = Hip replacement

MRSA: Methicillin-Resistant Staphylococcus Aureus

PCI: Percutaneous Coronary Intervention

PCTA: Percutaneous Transluminal Coronary Angioplasty

S-C-P: Structural-Conduct-Performance framework

S-P-O: Structure-Process-Outcome framework

Executive Summary

The OHE Commission on Competition in the NHS commissioned a critical review of the quality and competition measures and identification strategies used in peer reviewed health care literature. The objective W to assess how robust is the evidence emerging from the empirical literature to guide policy on competition in the NHS.

The literature analysed can be characterized by the following features**:**

1. The literature mainly focuses on hospital competition rather than competition for other types of health care.

2. Most studies are US based, though a small core of studies employ English NHS data.

3. Most studies use hospital market concentration measures to proxy for market competition. The most widely used is the Herfindahl-Hirschman Index (HHI). Recent English analyses have employed HHI indices based on hospitals' shares of non-emergency patient activity. They follow a Structure-Conduct-Performance (S-C-P) approach and measure how changes in concentration indices might be causally associated with changes in hospital services' quality. In this framework, hospitals are modelled as a "black box", and studies do not generally investigate the process by which hospitals' actions may affect quality.

4. Outcome measures are extensively used to measure hospital quality and mortality rates are the most popular and widely used. Studies conducted under conditions of competition on price and quality simultaneously have generally evolved to include a variety of outcome measures. The reason seems to be the perception that the effects of competition can show heterogeneous impacts on quality across different hospital markets. In contrast, studies conducted under fixed-price quality-based competition regimes, although with some exceptions, often include one quality measure. The reason for this approach is not obvious from the literature but seems driven by theory, which predicts that competition with regulator-fixed prices increases quality. Therefore, researchers have focused their efforts on measuring overall hospital quality, because competition is expected to increase quality across all hospital services.

5. The most commonly used outcome measure in competition studies is the 30 day in-hospital AMI (Acute Myocardial Infarction) mortality rate. This is especially true for English NHS related literature. The reasons are that: AMI deaths are relatively common; death as an outcome is easy to measure and hard to obscure; the scope for patient selection by hospital service providers in AMI emergency cases is less than for non-emergency cases; AMI mortality is argued to be a general marker of hospital quality overall; and AMI mortality data is routinely collected by regulators. In addition, using AMI death rates permits *de facto* comparability across studies.

6. Researchers have used a wide variety of econometric techniques to identify the effects of competition and link these causally to changes in hospital service quality. These techniques have generally been developed to deal with the confounding of competition and quality effects. English time series and panel studies have the additional advantage that they can exploit a policy change, observing differences in trends before and after the policy takes effect, while US based studies have been more restricted in using this strategy.

The critical analysis reveals the following:

1. Measuring quality is difficult because quality is multi-dimensional and complex. There is debate about the suitability of AMI mortality, which is commonly used in empirical studies, as an appropriate proxy for overall hospital quality. Evidence presented in the English literature is largely based on statistical correlations between AMI and other outcome measures. This evidence is difficult to evaluate because the literature is silent in explaining underlying factors causing these statistical relationships. In future it should become possible to better study the impact of competition on quality as more and different quality measures are becoming available, including patient reported outcome measures (PROMs). Future research could usefully examine a wider range of hospital markets for the impact of competition on quality in them.

2. There is a lack of understanding of the spillover mechanisms by which competition restricted to non-emergency services may impact on general markers of hospital quality, including indicators of the quality of hospital emergency services such as AMI mortality. There is a need to research further into: (1) the relationship between competition and changes that may be happening at overall hospital level (e.g. managerial quality); (2) outcomes in areas where changes in hospital behaviour have been shown to have happened; and (3) by modelling underlying demand and supply rather than relying on S-C-P "black box" approaches.

3. The role of market entry and exit is relatively neglected in the empirical literature. However, much of the potential benefits of competition are driven by these dynamic aspects. Further research is warranted in this area.

1   Introduction

The OHE Commission on Competition in the NHS commissioned OHE to undertake a critical review of the evidence on the impact of competition on health care quality. The complete terms of reference for the study reported here are in Annex 1. Essentially the objective was to provide an analysis of how robust are the empirical findings arising in the literature, to understand their usefulness to guide policy on competition in the NHS.

I undertook a literature review to identify the most relevant peer reviewed empirical studies. Section 2 provides details of the methodology used, and the full list of relevant literature identified is presented in Annex 2.

The intention was to analyse the effects of competition on the full array of services provided by the NHS, but the literature search revealed that the main bulk of the most robust evidence is centred on hospital competition, especially the studies that made use of English data. Hence, the report focuses on reviewing the evidence on the effects of competition on the quality of hospital care provision, while acknowledging the existence of a small amount of literature related to GP competition in the NHS.

Section 3 presents an overview of the multiple definitions of health care quality, with the aim of clarifying what is meant by health care quality, and what are the most important dimensions that characterize it. The most robust definition was found in Donabedian (2003), who provides a useful framework to understand how quality has been measured in hospital competition studies.

Section 4 presents the main issues identified in the literature concerning appropriate measurement of hospital quality with the aim of capturing hospital competition effects, with a special emphasis on hospital mortality rates. Annex 3 lists the different quality measures used in the literature.

Section 5 presents how competition has been measured and how its effects have been identified in the hospital competition literature, with a special emphasis on how market concentration measures have been made operational to proxy for hospital competition. Annex 4 presents a detailed summary of the competition measures employed in the selected literature.

Section 6 presents English NHS evidence on the impact of hospital competition on the different health care quality dimensions identified by Donabedian. Section 7 highlights the main controversies surrounding the evidence and assesses the arguments behind these controversies.

Section 8 concludes and provides recommendations on possible ways forward in terms of further research to appropriately understand the overall impact of NHS hospital competition.

2   Literature review method and outcomes

The objective of the literature review was to identify the relevant, up-to-date, peer reviewed literature, to understand how quality and competition have been measured in health care studies, and how robust are the resulting empirical findings. To this end, I specified the following initial search criteria[1]:

- Focus on published literature from 2000 onwards as, in general, empirical methods employed during this period address in a more rigorous manner than previously some crucial econometric concerns that compromise the identification of the "competition effect" on quality.

- Even though there was a high "a priori" probability that many of the empirical findings would be US related, I focused on UK-relevant literature.

- The search did not focus solely on literature drawing on competition on quality with regulator-fixed prices. I also searched for studies that assessed the effects of competition on price and quality simultaneously, as their inclusion provides a much richer view of how quality and competition have been measured in the literature.

- I acknowledge the existence of a substantial literature focusing on physician and nursing home competition in the US. But given time constraints and the high volume of hospital competition studies to be analysed in this review I exclusively focused the search on hospital competition studies. This is justified by the fact that the most reliable evidence assessing the effects of competition in health care provision in the UK is almost entirely derived from hospital competition studies, and hence the US physician and nursing home competition literature is less relevant to the work of the OHE Commission.

I started by defining a total of 44 search terms to be used with the Econlit and PubMed search engines. Examples of relevant search criteria used are the following: "*competition AND quality AND health care*", "*competition AND quality AND hospital*", "*competition AND quality AND nursing home*", "*competition AND quality AND General Practice*", "*competition AND quality AND Medicare*", "*competition AND quality AND NHS*", "*competition AND quality AND hospital quality differentiation*", "*competition AND quality AND health care market structure*", "*competition AND quality AND patient choice*", "*competition AND quality AND mortality*", "*competition AND quality AND surgery*", "*competition AND quality AND transplant*", "*competition AND quality AND patient safety*", "*competition AND quality AND AMI*" *(Acute Myocardial Infarction)*, "*competition AND quality AND coronary*", "*competition AND quality AND heart attack*," and "*competition AND quality AND kidney*".

In general the number of hits per search criterion was very high and consequently I considered only the first 200 hits whenever a search criterion resulted in an intractable number of hits. After applying all of the 44 search criteria I was left with a total of 754 Econlit hits and 1,323 PubMed hits.

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[1] I greatly benefited from initial discussions with Carol Propper who provided guidance on the literature review.

The filtering methodology to identify relevant literature was then as follows:

- Phase 1: Initial screening by reading titles and abstracts

- Phase 2: Literature selection by reading introductions, conclusions and other relevant passages from phase 1 selected literature

- Phase 3: Identify relevant literature referred to in selected phase 2 literature

- Phase 4: Search for literature that cited the most important articles or authors from selected phase 2 and 3 literature

The results of the literature search were:

- 57 references in total - see Annex 2 for the list
- 38 hospital competition studies
- 10 hospital quality measurement studies
- 9 other studies

The 38 references for hospital competition include 28 studies that measure the effect of hospital competition on quality. These are included in the literature list in Annexes 2 and 3. I have also included 5 additional studies, which even though they do not analyse the effect of hospital competition on quality nevertheless provide an interesting approach to measuring hospital competition. These are included in the literature list presented in Annex 4. Finally, I found 4 literature reviews of studies related to hospital competition and 1 relevant opinion article.

Literature that falls within the "hospital quality measurement" category refers to studies that do not analyse the effects of hospital competition, but do address the issues involved in measuring hospital quality.

"Others" refers to: reports or studies that empirically analyse the quality of health care in general, rather than hospital care specifically; a GP competition study based on English data; reports that are not peered reviewed; and relevant opinion articles.

3 Dimensions of health care quality

Before going into the details of how health care quality has been measured in hospital competition studies, it will useful to clarify what we mean by health care quality. Donabedian (2003) gives a precise definition:

"It is possible to conceive of quality as the product of two factors. One is the science and technology of health care, and the second is the application of that science and technology in actual practice…that product can be characterized by several attributes that include efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity. These, taken singly or in a variety of combinations, constitute a definition of quality and, when measured in one way or another will signify its magnitude". (Donabedian 2003, p. 4).

Table 1 shows the components or attributes of quality and their definitions as described by Donabedian.

Table 1 Components of quality and definitions

1. Efficacy

The ability of the science and technology of health care to bring about improvements in health when used under the most favourable circumstances

2. Effectiveness

The degree to which attainable improvements in health are, in fact, attained

3. Efficiency

The ability to lower the cost of care without diminishing attainable improvements in health

4. Optimality

The balancing of improvements in health against the costs of such improvements

5. Acceptability

Conformity to the wishes, desires and expectations of patients and their families

6. Legitimacy

Conformity to social preferences as expressed in ethical principles, values, norms, mores, laws and regulations

7. Equity

Conformity to a principle that determines what is just and fair in the distribution of health care and its benefits among the members of the population

Source: Donabedian, A. (2003) *An introduction to quality assurance in health care*. New York: Oxford University Press.

Two concepts are worth further disaggregation in the context of the present report: efficiency and acceptability. Donabedian identifies three potential sources for efficiencies in providing health care:

- <u>Clinical efficiency</u> occurs when health care practitioners prescribe and implement care that does not include harmful, useless or less effective remedies or methods.

- Managerial efficiency occurs when goods and services that are used to provide care are produced more efficiently, and it includes changes in procedures that reduce the frequency of errors that may cause injury to health and hence further costs.

- Distributional efficiency distributes care among different class of patients in such a way that it is proportionate to the expected improvements in health.

Donabedian characterises acceptability as combining the following attributes:

- Accessibility: relates to the ease with which each person can obtain care

- The patient-practitioner relationship: should ensure that patients are not only pleased with, but also reassured by, the care they receive

- The amenities of care: relate to the desirable aspects of the circumstances under which care is given

- Patients' preferences regarding effects, risks and costs of care: practitioners should explain the expected costs, risks, and effects of alternative methods of care and respond to patients' consequent preferences

There are numerous other definitions of health care quality. For instance, the Care Quality Commission2 (CQC) in England defines quality as meaning that health care:

- Is safe

- Has the right outcomes, including clinical outcomes (for example, do people get the right treatment and are they well cared for?)

- Is a good experience for the people who use it, their carers and their families

- Helps to prevent illness and promotes healthy, independent living

- Is available to those who need it when they need it

- Provides good value for money

The 2006 WHO report on quality of care[3] highlights that the following dimensions of quality can be targeted to make improvements in a health care system:

- Effectiveness: care that adheres to an evidence base and results in improved health outcomes for individuals and communities, based on need

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[2] See: http://www.cqc.org.uk/about/whoweare/ourvisionandvalues.cfm

[3] World Health Organization.(2006) *Quality of care: A process for making strategic choices in health systems*. Geneva: World Health Organization.

- <u>Efficiency</u>: delivering health care in a manner which optimizes resource use and avoids waste

- <u>Access</u>: care that is timely, geographically reasonable in terms of proximity and provided in a setting where skills and resources are appropriate for medical need

- <u>Patient centred</u>: takes into account the preferences and aspirations of individual users and the cultures of their communities

- <u>Equity</u>: care that does not vary in quality because of personal characteristics such as gender, race, ethnicity, geographical location, or socioeconomic status

- <u>Safety</u>: care that minimizes risks and harm to service users.

At the heart of these definitions and characterisations lies the complexity and multidimensionality of health care quality. It is useful to bear this in mind that, *a priori*, competition may impact all quality dimensions in positive ways, or all in negative ways, or may affect quality in ways that imply trade-offs because positive impacts on some dimensions may only be achieved by allowing negative impacts on other dimensions of health care quality. For instance, promoting hospital competition might be thought to improve the overall effectiveness and efficiency of hospital service provision, but this might come at the expense of reducing access to quality services for some patients who might have to travel longer distances than before if competition drives their current provider out of business. Therefore, analysis of the overall impact of a competition on health care quality should take into account the effects on all of the numerous dimensions of quality, so as to balance the expected impacts and trade-offs arising.

4   Quality measurement in hospital competition studies

Donabedian developed the so called structure-process-outcome (S-P-O) framework for measuring quality, which is suitable to evaluate clinical practice (Donabedian, 2003). This framework proposes three general types of quality measures for which there is an established causal link: structural, process and outcome measures. Romano and Mutter (2004) use Donabedian's classification to describe the quality measures that have been used in hospital competition studies:

- Structural measures: measure factors that enable or facilitate health professionals to provide high quality care. These include: material resources such as facilities and equipment; human resources, such as number, variety, and qualifications of professional and support personnel; organisational characteristics, such as the organisation of the medical and nursing staff, the presence of teaching and research functions, kinds of supervision and performance review, methods of paying for care, and so on. Sari (2002) mentions an additional class: input quality measures such as hospital staffing and equipment. However, these can be seen as falling within the structural measure category.

- Process measures: describe the content of health care provided in the following general health service areas: screening, diagnosis, pharmacotherapy, surgery, rehabilitation, patient education, and prevention.

- Outcome measures: describe changes that are attributable to health care, and they generally include changes in: mortality, morbidity, functional status and pain, patients' health related knowledge, behaviours, and patient satisfaction.

Donabedian argues that "good structure increases the likelihood of good process, and good process increases the likelihood of good outcome" (Donabedian, 1988). This causal relationship is not a wholly certain one, but rather is defined in terms of probability. These probabilities may be large or small, and they may be well established by scientific evidence or merely widely presumed. The higher the probabilities and the more firmly established they are by scientific evidence, the more credible are the judgments about quality that can be made.

Annex 3, provides a detailed overview of quality measures reported in hospital competition studies selected from the literature review, in terms of this framework. All 28 studies listed in Annex 3 use outcome measures. The most widely used outcome measures are mortality rates for specific patient illness conditions or surgical procedures or arising from clinical complications and/or patient safety event episodes[4]. The acute myocardial infarction (AMI) mortality rate is by far the most commonly used hospital quality measure, used in 19 studies. However, only 2 of these 19 studies use AMI mortality rate as their sole quality measure. Out of the 28, a total of 11 studies consider mortality rates for other medical conditions, surgical procedures, complication rates and/or patient safety events that are not related to an AMI condition.

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[4] Patient safety event episodes refer to preventable or potentially preventable complications occurring during patients' hospital stays, for particular diagnoses, surgical procedures or combinations of both. See Sari, N. (2002) Do competition and managed care improve quality? *Health Economics.*11(7), 571-584 for an example with a full list of these quality measures.

4.1 General issues around hospital quality measurement in competition studies

In this section we present the issues involved in measuring hospital quality to capture the effects of competition. Because hospital mortality rates, and in particular in-hospital mortality rates, are so widely used in the literature, we devote Section 4.2 to describing the issues involving their use. Section 4.3 then reviews the properties that make AMI mortality rates in particular so appealing for researchers. Annex 3 provides a detailed list of the quality measures used in the literature.

It is worth noting at this point that over time data for a wider range of quality measures beyond mortality rates are becoming available. Indeed, in the NHS in England a start has been made on collecting patient-reported outcome measures (PROMs) for some common non-emergency surgical procedures. Consequently, future research into the measurement of quality, and into the impact of competition on that, can be expected to become less reliant than hitherto on measures of mortality.

4.1.1   The quality measure has to reflect the quality of care provided

Volpp, et al. (2003) and Propper, Burgess and Gossage (2008) reflect on the fact that quality measures selected for empirical analyses have to capture the quality of care provided. For instance, AMI mortality rates are used in the literature because there is evidence of a direct link between mortality and the quality of care provided for patients suffering AMI[5]. Romano and Mutter (2004) point out that an important advantage of outcome measures over process or structural measures, is that outcome measures of quality not only reflect what was done, but also how well it was done. This highlights a crucial superiority of outcome measures over process and structural measures of quality. Despite this, the use of outcome measures is not without problems.

Firstly, outcome measures have an important random component, as outcomes depend on the characteristics of the patients being treated and the link between processes and outcomes maybe obscured by a lack of scientific evidence (Donabedian, 2003).

Secondly, in order for outcome measures to be useful in assessing the effects of competition on quality, it is important to ensure that the final outcome of the quality measure is under the provider's control to a meaningful extent. This can be a serious issue for outcome measures, as it is sometimes difficult for a researcher to form a view about maximum achievable effects on outcomes and their expected timing (Romano and Mutter, 2004).

Regarding process measures of quality, Romano and Mutter (2004) argue that they may reflect how providers evaluate and treat patients, because they shed light on "opportunities for intervention" that are directly actionable by providers. Further, some process interventions have been tested in medical trials, so they provide scientific evidence on the link between actions and improved patient outcomes when these procedures are applied correctly. As noted in McGuire and Papanicolas (2011), process measures can also be related to compliance with best practice. For example, prescribing beta blockers to patients after an AMI is an indication of good medical practice.

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[5] Papanicolas, I. and McGuire, A. (2011) *Using a vector autoregression framework to measure the quality of English NHS hospitals.* Working paper no. 22/2011. London: LSE Health provides a list of supporting evidence.

However, the use of process measures has limitations. As Papanicolas and McGuire (2011) emphasize, the link between process interventions and improved patient outcomes can be tenuous at best for many process measures. However, these authors mention the following outcome measures where there is an established link between process treatment and quality: stroke mortality rate; surgical mortality rates for Coronary Artery Bypass Graft (CABG) surgery, Abdominal Aortic Aneurysm Repair (AAAP), Pancreatic Resection, Paediatric Heart Surgery, Craniotomy and Hip Replacement (HIP).

Romano and Mutter (2004) note that there is no reliable evidence on the impact of structural measures on patient outcomes, as structural measures explain little of the observed variability in process and outcome measures. Some providers are able to offer effective care despite structural problems, whereas others offer relatively ineffective care despite structural advantages. Moreover, changing structural features is generally not easily actionable by providers. As a result, the relationship between structural features and the quality of care provided is unclear (Romano and Mutter, 2004).

4.1.2 A plausible causal link between the process of competition and its impact on the quality measure

Researchers must expect a causal link between the process of competition and its impact on outcomes because hospitals also take actions that may improve outcomes but are not due to competition. For example, in the context of hospital mortality rates, Gaynor, Moreno and Propper (2010) argue that hospitals are unlikely to be deliberately choosing particular mortality rates, but hospitals facing less competitive pressure may choose to exert less effort or supply less quality in ways that indirectly affect mortality. In the particular case of AMI mortality in the English NHS, Cooper, et al. (2011) argue that although hospitals are not competing for AMI patients, because competition is only over elective care patients, they expect competition to result in "*across-the-board improvements in hospital performance, which in turn will lower AMI death rates*". However, for all studies listed in Annex 3 that use outcome measures, the effects of competition are modelled as a "black box". This means that the literature analysed does not make explicit how hospital actions may affect outcomes.

Romano and Mutter (2004) argue that process measures can be important in the assessment of the causal link between competition and its impact on outcomes. This is based on the observation that process measures indicate those actions that a provider can take to improve patient outcomes, in response to competitive pressures. In particular, these authors view a greater role for process measures where there is a tested link between process implementation and patient clinical outcomes. The aim is to offer a more comprehensive approach to quality assessment, and understand the ways by which competitive forces may affect outcomes. However this comes at a risk. As Papanicolas and McGuire (2011) note, using process measures in this fashion risks pre-judging hospitals' responses, which may not be identical in all clinical settings.

4.1.3 Taking into account multiple dimensions of hospital quality: two approaches

Quality is a complex multidimensional concept, which implies that quality of care can be measured in a variety of ways. This multidimensionality has fed into hospital competition studies in two ways.

Firstly, quality has been measured for patients suffering from a particular condition or receiving a particular surgical procedure. In this scenario, the most widely used outcome measure is the 30 day in-hospital mortality rate after receiving a surgical procedure or other hospital treatment for a particular condition. In addition, the literature has incorporated other outcomes such as: readmission and complication rates; and mortality rates from complications, or readmission for specific conditions or surgical procedures. This approach has mainly been applied to patients treated for an AMI, e.g.: Ho and Hamilton (2000), Kessler and McClellan (2000), Volpp, et al. (2003), Shen (2003), Tay (2003), Gaynor, Moreno-Serra and Propper (2010) and Cooper, et al. (2011).

Process measures are not frequently used and only Ho and Hamilton (2000), Volpp, et al. (2003), Tay (2003) and Kessler and Geppert (2005) include process measures as part of their overall quality assessment.

Secondly, as Bamezai, Mukamel and Zwanziger (2002), and Romano and Mutter (2004) argue, providers performing well in one dimension may not perform well in other dimensions, so it is easy to arrive at wrong conclusions if the analysis focuses on a single measure, or even on multiple measures of a single dimension of quality, e.g. focusing just on AMI mortality and readmission rates. To deal with this issue, hospital quality has also been measured across different patients receiving hospital treatment for different conditions, e.g. receiving different surgical procedures, or across different patient safety events. The aim is to provide a more comprehensive assessment of the overall effects of competition on hospitals' quality of service provision. In terms of the selected literature, 14 of the 28 studies in Annex 3 assess the effects of competition on quality measures for more than one condition, surgical procedure, complication and/or patient safety event. In addition to AMI, the most widely used conditions or surgical procedures are:

- Stroke
- Pneumonia
- Hip fracture
- Gastrointestinal haemorrhage
- Coronary artery bypass grafting (CABG)

Relevant examples of the multi-condition approach are: Sari (2002), who focuses on a set of in-hospital complications measures; Smith, et al. (2007), who draws on a set of paediatric safety indicators applying to hospitalized children; Begun, Friedman and Jiang (2006), who use a composite score index of 10 hospital mortality indicators; Propper, Burgess and Gossage (2008), who use a waiting time measure and AMI mortality rate; Gaynor, Moreno-Serra and Propper (2010), who use an all-cause mortality rate in conjunction with an AMI mortality rate; and Beckert, Christensen and Collyer (2011), who use the HIP mortality rate and methicillin-resistant staphylococcus aureus (MRSA) infection rate.

Further details on the studies mentioned in this section can be found in Annex 3.

4.1.4   Risk adjustment

In general, using raw outcome measures to represent quality is problematic. Without any further adjustment, differences in hospital outcomes as measured would not only reflect differences in the quality of care provided, but also differences in patients' severity of illness and comorbidities, i.e. differences in hospitals' case mixes. This effect may be pervasive due to the selection bias problem.

This problem arises when hospitals are able to choose their patients to a meaningful extent, e.g. encouraging the most sick to go elsewhere, or when sicker patients are able to choose the best hospitals to receive their treatment. For this reason, authors such as Cooper, et al. (2001), favour the use of AMI mortality rates because AMI is an emergency procedure so hospitals have little opportunity to "cherry pick" their patients.

In essence, the purpose of risk adjusting outcome measures is to ensure that they just reflect differences in the quality of care provided. Failure to account for patient severity of illness can result in omitted variable bias, which can result in incorrect inferences about the effects of hospital competition on quality (Romano and Mutter, 2004). The literature has dealt in different ways with the patient severity of illness problem. We follow Romano's and Mutter's (2004) classification of the techniques used to deal with this problem:

- Dependent variable strategy: adjustment is directly to the dependent variable, that is, the variable representing the quality measure. These adjustments generally aim to account for patient demographics (usually control for age and gender) and health status (usually control for principal diagnosis, comorbidities, source and type of admission, and a risk score based on hospitalizations in the previous months).

- Independent variable strategy: adjustment by using additional explanatory variables in the empirical analysis. These generally use data on demographics and/or socioeconomic characteristics of patients among the explanatory variables.

4.1.5 Noise

McClellan and Staiger (1999) report that virtually all quality measures are subject to an important degree of noisiness, which results in the so-called "variability of rates" problem. The sources for this problem can be:

- The quality measure is calculated using small numbers of patients, e.g. the number of patients with AMI that a hospital treats in a given period

- The time period over which the quality measure is calculated, e.g. a long-term mortality rate, may capture the influence of a number of factors beyond the quality of hospital care that might affect the final outcome

The literature has generally favoured the use of AMI mortality rate because hospitals generally deal with a significant number of AMI emergencies, which makes mortality frequently observed. For example, Cooper, et al. (2011) note that in 2008 in the English NHS hospitals, 30 day mortality rate for emergency AMI was 11.7% as compared to 0.2% mortality of patients for elective hip replacements.

4.1.6 Measurement error

As noted by McClellan and Staiger (1999), the process to collect data can be costly and can induce measurement error. For example, hospital personnel may not record adequately patient admissions for a specific condition, and/or criteria as to how to classify and record cases may differ between hospitals. Another example is that the relevant period for measuring outcomes such as survival after

a heart attack may be weeks or longer, and it generally requires matching an individual hospitalization records to death records, which is a process that is inherently vulnerable to error.

Other sources of measurement arise from the possibility of hospitals gaming or manipulating outcome measures. Cooper, et al. (2011) argue that AMI mortality, and mortality rates in general, are less susceptible to these practices than are waiting times and other outcome measures.

4.2 Mortality rates

Mortality rates following hospital care and in-hospital mortality rates in particular are widely used in the literature to measure hospital quality. In this section, we present the general issues concerning the use of mortality rates as hospital quality measures. When a researcher uses mortality rates as a measure of quality they have to take a view on the following issues.

Time period

The time period chosen over which to calculate a mortality rate is generally left to the researchers' discretion, or is determined by which data are available. Shorter time periods are good for capturing the effect of care just received, but they exclude the consequences of care in the long run. Using mortality rates for longer time periods captures the longer term effects of care, but at the expense of measuring these effects with greater error as other factors other than the episode of care may influence the observed outcome.

In-hospital vs case fatality rates

The literature has generally used two types of mortality rates: 30-day in-hospital mortality rate, and the 30-day case-fatality rate, usually referred to in the literature as the post-admission mortality rate. The main difference is that the number appearing in the numerator of the 30-day in-hospital mortality rate is the number of deaths that occurred in the hospital within 30 days of admission among patients with the same primary diagnosis, but the numerator in the 30-day case-fatality rate also includes what happened to patients who were discharged from the hospital, within 30 days of the admission date[6]. Note that a 30 day in-hospital mortality rate will be affected by hospitals' discharge and transfer practices, and hence comparisons between hospitals are compromised[7]. Annex 3 provides a detailed overview of the different mortality measures used in the selected literature.

Risk adjustment

Researchers have devised different strategies to risk-adjust mortality rates[8] but, as noted by Sari (2002), this is not easy. Papanicolas and McGuire (2011) explain that there are concerns about how good these different techniques are at controlling for differences in case mix across hospitals.

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[6] I have followed the Mattke, et al. (2006) OECD mortality rate definitions.

[7] See Ho, V. and Hamilton, B.H. (2000) Hospital mergers and acquisitions: Does market consolidation harm patients? *Journal of Health Economics*. 19(5), 767-791 for an example of how researchers have dealt with this problem.

[8] An evaluation of techniques employed to risk adjust is outside the scope of this critical review.

Moreover, even when outcome measures, such as mortality rates, are risk adjusted, these still run the risk of not accounting for factors that cannot be identified or measured accurately[9].

Relevance

Sari (2002) provides a critique of using mortality measures in hospital competition studies. He notes that they are not meaningful quality indicators in many clinical contexts, especially for outpatient treatments and for hospitalization involving younger patients. Further, mortality rate may not be a reliable measure of quality for all groups of patients for whom mortality is only observed infrequently.

Multiple vs single condition approach

There are two conflicting approaches in the literature regarding the use of mortality rates as hospital quality measures.

Firstly, some studies use multiple hospital mortality rates for specific conditions, surgical procedures, complications or patient safety events for their hospital quality assessment. The main reason for adopting this multiple approach was explained in section 4.1.3 above, and can be traced to authors such Bamezai, Mukamel and Zwanziger (2002) and Romano and Mutter (2004). They argue that providers performing well in one dimension may not perform well in other dimensions. Bamezai, Mukamel and Zwanziger (2002) reference Rosenthal (1997) to support this claim. Using US hospital data, Rosenthal showed that hospital risk adjusted mortality rates for individual diagnoses are weakly associated with each other in statistical terms. He finds that the statistical correlations between mortality rates for different diagnoses and treatments (AMI, pneumonia, stroke, obstructive lung disease, CABG and hip fracture) range between 0.30 and 0.34. Given these findings, the author concludes that it may not be valid to generalize conclusions about hospital performance from a single diagnosis.

This observation also has implications for the use of all-cause hospital mortality rates. As explained in Bamezai, Mukamel and Zwanziger (2002), these may be biased towards zero and show less variation when compared with cause-specific mortality rate measures, precisely because hospitals performing well in a particular clinical area may not perform well in others. In the light of these limitations, Bamezai, Mukamel and Zwanziger (2002) included in their analysis multiple cause-specific mortality rates[10]. There are several papers that consider a similar approach to measuring hospital quality. It is noteworthy that studies find statistical evidence that competition is associated with different effects across mortality rates for different conditions (including patients treated for AMI), surgical procedures, and patient safety events.

Under a regime where hospitals compete on price as well as on quality, Rogowski, Jain and Escarce (2007) find that mortality is lower for three to five of the six conditions they consider in less concentrated markets. Importantly, they find no statistical significant impact of market concentration on hospitals' AMI mortality rates. Gaynor and Town (2011) note that these results are expected, as theory predicts that anything can happen under this competition regime scenario.

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[9] See Wright, J. and Shojania, K.G. (2009) Measuring quality of hospital care. *British Medical Journal*. 338 (569), 783-784 for a more detailed explanation of this matter.
[10] Annex 3 gives more details on the mortality measures used by these authors.

Mutter, Romano and Wong (2011) find statistically significant impacts on a few mortality rates that they use, but there are both positive and negative effects. Gaynor and Town (2011) argue that these results indicate that mergers between hospitals can have positive or negative effects depending on the measure of quality used and the specifics of the merger.

Regarding studies conducted in a regime where prices are fixed by a regulator so that competition is solely on the basis of quality, Gowrisankaran and Town (2003) find that competition is associated with increases in AMI and pneumonia mortality rates. The authors argue that a possible explanation for these results is that the administered price may have been below the marginal cost of provision of the services. However, Gaynor and Town (2011) note that this is unlikely for AMI. Further, these results contrast with those of Kessler and McClellan[11] (2000) who find that competition under regulator-fixed prices reduces AMI mortality. Because of these opposing results, Gaynor and Town (2011) suggest caution in drawing strong conclusions about the impact of competition on hospital mortality when prices are fixed by a regulator.

Using English data, Gaynor, Moreno-Serra and Propper (2010) find that competition is associated with decreases in AMI and all-cause hospital mortality rates. These are the only two studies that I have found that use additional hospital mortality measures in conjunction with an AMI mortality rate in this competition environment.

Other studies concentrate on a single hospital mortality rate. In the majority of such cases, the AMI mortality rate is the one chosen. The main justification offered for this decision is that it is argued that AMI mortality rates are well placed to capture hospitals' overall quality.

For example, Cooper, et al. (2010) choose a 30-day risk adjusted AMI mortality rate. They argue that it is highly correlated with other aspects of hospital quality and process of quality. The authors, in the NBER Working Paper version of their analysis, mention Allison, et al. (2000), Chen, et al. (1999), Dubois, et al. (1987) and Meehan, et al. (1996) as supporting evidence of this relationship. Using US data, Allison, et al. (2000) suggest that unadjusted AMI mortality is lower in teaching hospitals because they offer better care. Teaching hospitals were found to be providing more aspirin, β- blockers, and angiotensin-converting enzyme (ACE) inhibitors to Medicare patients. Chen, et al. (1999) find that admission to a hospital ranked high on the list of "America's Best Hospitals" was associated with lower 30 day AMI mortality rate. A substantial portion of survival rate advantage may be associated with these hospitals' higher rates of use of aspirin and beta-blocker therapy. Dubois, et al. (1987) use a subjective review of patient medical records by expert clinicians. First, they find no significant differences in "preventable deaths" between hospitals with higher and lower than expected mortality rates for patients admitted with AMI. Second, they find significant differences in "preventable" deaths between hospitals with higher and lower than expected mortality rates for patients admitted for pneumonia and cerebrovascular accident. Third, when the three conditions are combined, they estimated a higher rate of "preventable deaths" for hospitals with higher than expected mortality rates. These results suggest that pneumonia and cerebrovascular accident mortality rates were better placed to capture hospitals with poorer quality than the AMI mortality rate. Indeed these references are absent from the revised version of the analysis subsequently published in the *Economic Journal* (Cooper, et al. (2011)).

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[11] Note that Kessler and McClellan use a single condition approach to measure hospital quality.

Gaynor, Moreno-Serra and Propper (2010) argue that infrastructure used to treat AMI is common to that needed for other hospital services, particularly accident and emergency (A&E) services, making AMI a good general marker of quality. Many of the actions to reduce death following A&E admission for AMI need to be taken soon after the heart attack, and so the performance of the hospital in terms of AMI reflects the performance of its A&E department. Their supporting reference, Gaynor (2006), argues that "the most likely story", as quoted from the author, is that heart attack patients are the "canary in the mine shaft", i.e. a sensitive area in which greater hospital competition pressures manifest themselves. A similar argument can also be found in Cooper, et al. (2010).

Cooper, et al. (2011) argue that according to Dr. Foster Health data, risk-adjusted AMI mortality in English NHS hospitals presented a correlation of $r=0.33$ with overall hospital mortality for the financial year beginning in 2009. Further, using their own data, they find that their raw AMI mortality presented a correlation of $r=0.33$ with hip and knee replacement waiting times, and a correlation of $r=0.11$ and $r=0.22$ with the length of stay for hip and knee replacement, respectively.

We discuss what can be concluded from the various views on AMI mortality in more detail in section 7.

4.3 Measuring other dimensions of hospital quality

Bloom, et al. (2010) develop a survey tool to construct an index of hospital management quality. Their survey comprises 18 questions, which can be grouped in the following categories[12]:

1. Operations, e.g. testing how well the patient pathway is configured at the infrastructure level, or the rationale for introducing pathway management.

2. Monitoring, e.g. testing whether performance is tracked using meaningful metrics and with appropriate regularity

3. Targets, e.g. testing whether targets cover a sufficiently broad set of metrics

4. Incentives management, e.g. testing whether good performance is rewarded proportionally

The survey was implemented in 61% of all English acute hospitals that had orthopaedic and cardiology departments. About 80% of respondents were managers as opposed to clinicians, and responses were split evenly between specialities, with 52% cardiology and 48% orthopaedics. The authors find that their measure of management quality is strongly correlated with financial and clinical outcomes, such as patients' survival rate from heart attacks. They show that adding three more rival hospitals to a market, increases their index of management quality by more than one standard deviation, which is associated with a 6% reduction in heart attack mortality rates in acute English hospitals.

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[12] The interested reader is referred to Appendix A of Bloom, et al. (2010) where the full set of questions in the survey tool can be found.

5 Competition measurement and identification strategies in hospital competition studies

In general, the way in which hospital competition has been measured and its effects identified in the literature, has evolved over time by exploiting: an increasing availability of data, the occurrence of natural experiments and the development of new econometric techniques.

The economic framework that has been most extensively used in the literature is the Structure-Conduct-Performance (S-C-P) framework, but there is an increasing use of more sophisticated approaches, such as structural models that explicitly use economic theoretical models to derive the empirical relationships to be estimated.

In the following pages I we present the different ways in which competition has been measured in the literature, and explain problems that different measures have in identifying competition effects, and how the literature has worked around them. Annex 4, presents a table with the relevant literature identified and illustrates how competition has been measured in these studies.

5.1 Event studies

Event studies exploit the occurrence of a "natural experiment" to identify the effects of competition. In hospital competition studies, policy changes aimed at increasing or changing the nature of competition and mergers are the most common 'events'. For instance, Bamezai, Mukamel and Zwanziger (2002), Volpp, et al. (2003) and Volpp, et al. (2005) exploit the impact on quality of market deregulation policy changes aimed at introducing price competition among US hospitals. Ho and Hamilton (2000), Cuellar and Gertler (2005), Balan and Romano (2011) and Mutter, Romano and Wong (2011) study the impact on quality of mergers and acquisitions among hospitals in the US.

The identification of the competition effect in event studies crucially depends on the selection of an adequate hospital control group. The control hospitals are assumed to identify what would have happened to hospital outcomes in the absence of the event. Researchers can then make statistical inferences about the differences in quality outcomes between hospitals under the effects of the event and those of the control group to identify the impact of competition.

5.2 Structure-Conduct-Performance (S-C-P) studies

The S-C-P framework posits a causal relationship between market structure, firm conduct and the performance of the market. The S-C-P relationship establishes that the number of hospitals in the market determines how competitively hospitals behave, which in turn affects performance.

The standard empirical S-C-P relationship appearing in hospital competition studies assessing the effects of competition on quality is the following: The standard empirical S-C-P relationship appearing in hospital competition studies assessing the effects of competition on quality is the following:

$$z_j = \beta_0 + \beta_1 HHI_j + u_j \qquad\qquad (1)$$

Where z_j is the value of a particular quality measure for hospital j, HHI_j is the Herfindahl-Hirschman Index of market concentration assigned to hospital j, β_1 is the statistical parameter capturing the competition effect on quality measure z_j, and u_j captures the effect of other variables that are not observable to the researcher. In addition, some studies use patient-level data, in which case the

empirical model specified in equation (1) is modified slightly in the following way:

$$z_{ij} = \beta_0 + \beta_1 HHI_j + u_{ij} \qquad\qquad (2)$$

Where z_{ij} is the value of quality measure for patient i that was treated at hospital j. The interpretation of the rest of the elements of the equations remains the same as before.

Some authors have replaced the HHI concentration measure by other measures of competition, such as the number of nearby hospital competitors[13]. There seems to be two main reasons for this. First, data may not be available from which to compute patient market shares. Second, the HHI may not be attractive to use because competition and quality effects are confounded, so that higher quality hospitals will appear to operate in more concentrated markets (higher HHI). An important drawback to using the number of competitors is that it assumes that each hospital in the market exerts the same competitive pressure, and so it does not measure competition as accurately as a HHI.

There are also model specification issues with the S-C-P studies conducted in an environment with regulator-fixed prices and competition is on quality alone. As Gaynor and Town (2011) note, there is no *a priori* theoretical argument justifying the omission of the regulated price in their empirical model specifications. However, in practice the regulated price has been omitted in all of the S-C-P studies considered, except for Gaynor, Moreno-Serra and Propper (2010), and so omitted variable bias may be a concern.

It is important to note that S-C-P studies abstract from the role of market entry and exit. This implies that firm location is exogenous in these models. However, firms may decide not to enter into markets where there is a strong competitor, or firms may decide to exit as a response to increased competitive pressures or cost shocks. This creates endogeneity concerns because there is a potential that higher quality firms may appear to be operating in more concentrated markets, or in markets with fewer hospitals.

I now assess in turn how HHI has been operationalized in the literature, what are the main identification problems, and how the literature has dealt with them.

5.2.1 Empirical implementation of the Herfindahl-Hirschman Index (HHI) of market concentration in hospital S-C-P studies

To make HHI operational the researcher needs to define the group of treatments and patients over which market shares are going to be calculated, and the geographic extent of the market from which a hospital potentially draws its patients. In other words, it is necessary to take a view on the product and geographical market definition.

Product market definition captures which group of patients, receiving which treatments, belong to the market and hence will be the subjects of the analysis. In the literature, patients belong to the same market if they suffer from the same medical condition, they have received the same surgical procedure or they have suffered the same hospital patient safety event

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[13] See Propper, C., Burgess, S. and Gossage, D. (2008) Competition and quality: Evidence from the NHS internal market 1991-9. *The Economic Journal*. 118(525), 138-170.

Geographic market definition captures the spatial dimension of hospital competition and specifies the geographical boundaries of where competition among hospitals is economically meaningful. This has been done in several ways in the literature[14], as explained in the following paragraphs.

Spatial markets defined on a geopolitical boundary basis

Under this approach, the geographic market definition is based on pre-existing geopolitical boundaries of areas to which each hospital is assigned. In general, this makes a poor definition of an economic market, because such definitions have the potential to under- or overestimate the extent of competition that a particular hospital faces. For instance, it underestimates competition when a nearby hospital is arbitrarily excluded from the market just because it lies on the other side of an administrative boundary. On the contrary, it overestimates the potential for competition when far away hospitals, that are unlikely to be competing for patients, are included within the same market because they lie within the same administrative area.

Spatial markets defined on a fixed radius linear distance basis

Under this approach, each hospital is assigned a spatial, circular market that is hospital centred, and boundaries are defined by a fixed radius linear distance from each hospital. Hospitals falling within the circular area are regarded to be competitors, and hospital patient shares are then computed over the total number of patients resident in the circular market area. The problem arising from this spatial market definition is that patients may well be willing to travel longer distances in areas where hospital density is low, so that spatial markets are greater in comparison to areas where hospital density is higher. As with geopolitical boundaries, competition may well be either under- or overestimated when markets are defined on a fixed radius distance basis.

Spatial markets defined on a variable per hospital basis

There are various approaches to implement a spatial market definition that is variable on a per hospital basis:

1. Variable radius: this approach defines a circular market which is hospital centred, and captures, say, 75% or 90% of actual patient flows for the relevant group of patients treated at a particular hospital. The radius of the market measured in this way will vary from hospital to hospital.

2. Patient flows: this approach defines a spatial market using actual patient flow information. It is generally defined by the collection of geographical areas (generally zip code or postcode areas), that send a non-trivial amount of the relevant group of patients to a particular hospital, and that collectively account for 40-95% of these patients. Note that under this definition, the spatial market need not be circular.

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[14] See Wong, H.S., Zhan, C. and Mutter, R.L. (2005) Do different measures of hospital competition matter in empirical investigations of hospital behaviour? *Review of Industrial Organization*. 26(1), 27-60 and Cooper, Z., et al. (2010) *Does hospital competition save lives? Evidence from the English NHS patient choice reforms.* Working Paper No. 16/2010. London: LSE Health for more detailed expositions.

3. <u>Travel time</u>: this approach defines a spatial market that encompasses a 30 minutes, say, travel time, generally by car, from a particular hospital. Note that under this definition, the spatial market need not be circular.

Kessler and McClellan (2000) provide an insightful criticism of spatial market definitions that are based on actual patient flows (points 1 and 2 above), when studying the impact of competition on hospital quality. They make the following important points:

1. <u>Endogeneity of spatial markets defined using actual patient flows</u>: this is a problem when patients are willing to travel longer distances to be treated at higher quality hospitals. It follows that hospitals with higher quality will attract patients from longer distances, and therefore their spatial markets are likely to encompass a greater number of hospital competitors. Measures of competition like HHI that are based on actual patient flows thus confound the "competition" and the "quality" effect, which compromises the OLS[15] statistical inferences that can be made when estimating models (1) and (2) above.

2. <u>Measurement error</u>: as noted above, definitions using patient flows arbitrarily include or exclude patients. This implies that competition is measured with error.

3. <u>HHI is already the result of a competitive process</u>: this is relevant when factors affecting hospitals' entry and exit decisions into a market, and hence affecting the value of the HHI, are not taken into account in equations (1) or (2).

4. <u>The matching problem</u>: when using patient level data, assigning hospital HHIs to individual patients based on which hospital a patient actually attends is problematic, as sicker patients will tend to choose higher quality hospitals, and so "quality" effects are confounded again in the HHI competition measure.

Kessler and McClellan (2000) also provide an approach to deal with the identification issues explained above. In particular, they propose an approach that has been widely used in S-C-P studies from 2000 onwards. Before constructing HHIs the authors estimate a probabilistic hospital choice model based solely on exogenous factors (e.g. age and gender). Then, based on the hospital *predicted* patient choice probabilities, they can compute *predicted* HHIs and argue that "quality" effects are no longer confounded within the competition measure, thereby solving the identification problem. In general, two choices of HHI have been used depending upon whether the researcher is using hospital or patient level data for the analysis:

1. <u>Hospital level data</u>: each hospital is assigned a predicted HHI that captures how much competition, on average, there is for the patients that are predicted to attend the hospital[16].

2. <u>Patient level data</u>: this approached is used when data on patient's residential zip code or postcode is available. Each patient is assigned a predicted neighbourhood HHI that captures how much competition, on average, there is for patients that live in a particular

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[15] Ordinary Least Squares regression.
[16] See Gowrisankaran, G. and Town, R.J. (2003) Competition, payers, and hospital quality. *Health Services Research*. 38(6), 1403-1421 for further details.

zip code or postcode area[17]. Note, that in this case, assigning to patients predicted HHIs based on the hospital that they actually attended gives rise to the "matching problem" discussed above.

As noted in the literature, the different approaches to define spatial markets have their costs and benefits. Using spatial market definitions that are not based on actual patient flows has the advantage that "quality" and "competition" are not confounded. However, when these definitions are used to construct hospital HHIs, they can under- or overestimate the extent of competition in important ways. On the other hand, using actual patient flows to define spatial markets makes it difficult to identify the competition effect because this is confounded with the quality effect.

Some researchers have used the Kessler and McClellan (2000) methodology to deal with this identification problem, but their solution rests on assumptions that seem to be challenged by the scientific community, specifically those relating to the exogeneity of the explanatory variables that appear in their probabilistic hospital choice model[18].

Some authors, such as Cooper, et al. (2011), Propper, Burgess and Gossage (2008) or Propper, Burgess and Green (2004) have resorted to other spatial market definitions, such as those based on travel distances. It is argued that defining hospital spatial markets in this way is useful because quality and competition effects are not confounded, and urban density is taken into account. However, as Cooper, et al. (2010) note, defining markets under this approach results in spatial markets being defined similarly to when a fixed radius linear distance approach is used, so the advantages of using travel distances may only be hypothetical.

There are also numerous studies that exploit local variation in hospital market structure (e.g. HHIs) and the occurrence of an event to estimate the impact of competition on quality. For instance, Gaynor, Moreno-Serra and Propper (2010) exploit a pro-competitive market reform in the UK in 2006, which introduced quality competition with regulated prices, and increased patient choice across hospitals. Hospitals in less competitive markets are the control group, as the effect of competition brought by the policy change is assumed to be less intense in a significant way for these hospitals. Therefore, hospitals in more competitive markets are the 'treatment' group. The measure of competition used is the predicted neighbourhood HHI based on patient shares for all elective care.

Cooper, et al. (2011) exploit the same 2006 pro-competitive market reform in the UK and use a similar approach to Gaynor, Moreno-Serra and Propper (2010). However, they use an HHI measure based on actual patient flows that is GP centred[19]. This means that the spatial hospital market depends on GPs' actual referral decisions, and is defined by a variable radius that represents the 95th percentile of distance from patient's GP to the hospital the patient was treated in for an elective procedure. Because they attempt to measure competition in elective services, they construct individual HHIs for five different high volume procedures: hip replacement, knee replacement,

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[17] See Kessler, D.P. and McClellan, M.B. (2000) Is hospital competition socially wasteful? *The Quarterly Journal of Economics*. 115(2), 577-615, for further details.

[18] See Cooper, Z., et al. (2010) *Does hospital competition save lives? Evidence from the English NHS patient choice reforms.* Working Paper No. 16/2010. London: LSE Health.

[19] The authors use a range of competition measures besides the GP centred HHI, but this is the most innovative measure. The other measures they employ have already been commented on elsewhere in this report. The interested reader is referred Cooper, et al. (2011).

arthroscopy, hernia repair and cataract repair. The final HHI is a weighted average of the HHIs computed for these different elective service markets.

Using a similar study design, Propper, Burgess and Gossage (2008) identify the impact of competition by exploiting a pro-competitive policy reform that introduced price competition in the UK at the beginning of the 1990s. Control and treatment groups are defined in the same way as in Gaynor, Moreno-Serra and Propper (2010). But competition is measured by the number of hospitals in the local market.

Additional identification problems arise in this kind of study because spatial HHIs vary within time periods because of hospital merger, entry and/or exit decisions.

Other authors have used an instrumental variable approach. Because their GP centred HHI is computed over actual patient flows, Cooper, et al. (2011) instrument for market structure and use a 2 stage least square estimation strategy. Their instrument is the standard deviation of distances from GPs to their nearest hospital. The authors chose this instrument based on the fact that NHS hospitals' relative positions to a GP are not determined by quality, but rather by historical artefact. Using English data, Bloom, et al. (2010) use political competition to instrument for hospital market structure[20]. During the time period they consider, almost all major English hospitals are publicly owned. The authors exploit the fact that closing hospitals in areas where the governing political party nationally has only a small majority is rare due to fear of electoral punishment. Therefore, the authors expect that hospitals in these areas are more likely to have a greater number of competitors since closures are less likely, and new hospitals are more likely to be opened.

5.3 Studies that estimate a structural model of competition

Structural models explicitly use economic theoretical models to derive the empirical relationships to be estimated. By making assumptions about the form of demand, costs, objectives and strategic conduct, researchers can use the data to estimate, among other things, demand elasticities or simulate the effects of mergers and other important strategic decisions made by hospitals.

Structural demand estimation models are generally silent on the supply-side of the equation, so competition cannot be examined explicitly. Tay (2003) uses a structural demand model to estimate patient demand for hospital services for patients suffering from AMI or coronary heart failure (CHF) complications in the US. Competition is measured by the quality elasticity of demand, and she simulates the effects of an increase in hospital quality and of the exit of a high quality hospital from the market. Howard (2006) also analyses patients' responsiveness to changes in quality, by calculating a quality elasticity of demand for patients in the US who suffer from kidney failure. Beckert, Christensen and Collyer (2011) simulate the effects of merger by looking at how the quality elasticity of demand faced by merging firms changes pre- and post-merger, in the market for hip replacements in England. Gaynor, Propper and Seiler (2011) evaluate whether the 2006 choice policy reform in England, resulted in an increased elasticity of demand being faced by hospitals with respect to their quality of care.

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[20] Market structure refers to the number of hospitals in a market, as well as their relative market size. For example, HHI is a measure of market structure.

In these studies, the identification of the competition effect relies on the econometric robustness of the estimated quality elasticity of demand. In particular, Tay (2003), Howard (2006) and Beckert, Christensen and Collyer (2011) do not deal with the potential endogeneity of the quality measures used in their demand models, as higher quality hospitals also attract more severely ill patients, which in turn affects (negatively) the outcome of the unadjusted quality measures for these hospitals. However, Gaynor, Propper and Seiler (2011) provide and use a method to deal with this potential source of endogeneity.

As noted in Gaynor and Town (2011), Tay (2003) uses an approach that suffers from a common model specification issue: she is estimating demand in an environment where prices are fixed and competition is on quality, and the regulated price is omitted from the empirical model.

Entry and exit are the dynamic forces that are thought to drive competitive improvements in terms of productivity, innovation and quality. A growing number of structural econometric studies are incorporating structural dynamic models to assess the role of entry and exit in hospital competitive markets. Gaynor and Town (2011) provide a comprehensive literature review on these econometric models, which hitherto exclusively use US data.

6 Summary of the effects of competition on hospital quality in England

As noted in section 4, health care quality can be characterized by multiple dimensions or attributes. I now turn to assess the evidence of the effects of competition of hospital quality rising from England data, in terms of: effectiveness, efficiency, optimality, acceptability and equity. The aim is to illustrate how complete is the available evidence of the impact of competition on quality. I focus on studies that are conducted in an environment of regulator-fixed prices and competition on quality.

Effectiveness

The majority of the empirical literature analyses the effects of competition on the effectiveness of care. Cooper, et al. (2010), Gaynor, Moreno-Serra and Propper (2010), Bloom, et al. (2010) and Cooper, et al. (2011) all find that local markets with greater competition on quality and regulator-fixed prices are associated with better quality outcomes, as measured by decreases in AMI mortality or all-cause mortality rates. This evidence suggests that hospitals in more competitive markets provide more effective health care.

Efficiency

Bloom, et al. (2010) measure the effect of competition on what Donabedian calls "managerial efficiency". They find that hospitals in more competitive markets are associated with increased management quality. Gaynor, Moreno-Serra and Propper (2010) also measure the effects of competition on "managerial efficiency". The authors find no evidence that increasing competition on quality resulted in lower hospital operating expenditure or expenditure per admission or in higher labour productivity. However, they do find increases in "clinical efficiency", as hospitals in more competitive markets are associated with significant falls in patient's length of stay.

The competition literature related to England is generally silent with respect to "distributional efficiency". The only indirect reference appears in Gaynor, Moreno-Serra and Propper (2010), where they find that the balance between elective and non-elective hospital admissions did not change as a result of England's 2006 pro-competitive policy reform in the NHS. Only one US study seems to explicitly address this point. Using data for Medicare patients[21], Kessler and Geppert (2005) find that "low valuation" patients in competitive markets receive less intensive treatment than in uncompetitive markets, but have similar health outcomes. In contrast, "high valuation" patients in competitive markets receive more intensive treatment than in uncompetitive markets, and have significantly better health outcomes[22].

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[21] Competition for Medicare patients is on quality with regulated prices, which is relevant to the English NHS.
[22] High valuation patients are assumed to have a higher willingness to pay, because they have a "high risk" of death as result of second episode of an AMI after a year of being hospitalized for this condition. On the contrary, low valuation patients have a lower willingness to pay because they have a "lower risk" of death as a result of being hospitalized for a first episode of an AMI.

Optimality

Gaynor, Moreno-Serra and Propper (2010) find that the 2006 pro-competitive policy reform in the NHS in England saved lives without increasing hospital costs. They conclude that the reform was welfare enhancing. However, as noted in Gaynor and Town (2011), their measure of hospital expenditures does not accurately capture economics costs, i.e. hospital expenditures do not fully account for hospitals' opportunity costs. Therefore, welfare inferences are not necessarily clear.

Acceptability

In general, studies in the spirit of Gaynor, Moreno-Serra and Propper (2010), Cooper, et al. (2010) and Bloom, et al. (2010) are indirectly measuring the accessibility of care. Their principal findings are that hospitals in more competitive localities have better quality of care. Given the "localism" of hospital competition, these studies seem to suggest that patients coming from less competitive markets will have more difficulties in accessing higher quality care, than patients coming from more competitive markets.

Studies that estimate a structural demand model give relevant information about how competition may affect accessibility of care. Beckert, Christensen and Collyer (2011) find that hospital mergers in less competitive markets reduce access to higher quality of care for elective services, because the quality elasticity of demand decreases following merger. This is because patients cannot switch hospitals in response to a decrease in quality by the newly merged hospital. Gaynor, Propper and Seiler (2011) find that higher risk patients are more likely to choose a hospital with better quality, and that lower income patients are more sensitive to waiting times.

Gaynor, Moreno-Serra and Propper (2010) find that the total number of hospital admissions did not increase in more competitive areas as a result of England's 2006 pro-competitive policy reform.

Equity

In the empirical studies of the impact of competition on quality I have not found any significant references to distributional issues arising.

7 Controversies

In this section I present in more depth the controversies arising in the empirical competition literature, concentrating on those in the English NHS. The controversies arising in this literature are also common to the wider US related literature identified in the review.

7.1 Is the AMI mortality rate a good proxy for hospital quality in general?

Generally, researchers using a "single condition" approach to measure quality argue that AMI mortality is well placed to capture overall hospital quality. Others disagree, e.g. Pollock, et al. (2011), and maintain that a 30 day hospital AMI mortality rate is at best a measure of clinical care in cardiology.

As discussed in Section 4.2, Cooper, et al., in the NBER Working Paper version of their study (2010), referenced evidence that fails to support their claim that AMI mortality is good a general marker of quality. In the revised *Economic Journal* version of their study, Cooper, et al. (2011) present a set of statistical correlations between AMI mortality and overall hospital mortality, length of stay and waiting times for the elective procedures they consider. The correlation between AMI mortality rate and overall hospital mortality rate is r=0.33. Thus there is a clear and positive but not overwhelming correlation. Pollock, et al. (2011) argue that these correlations are not clinically significant and do not make AMI a valid proxy of safety or quality in elective care.

Gaynor, Moreno-Serra and Propper (2010) are also proponents of the suitability of AMI to proxy overall hospital quality. This is because the infrastructure used to treat AMI is common to other hospital services and AMI death outcomes are sensitive to the quality of care provided at an A&E department. The authors present statistical correlations that are significant at a 1% level between the two AMI mortality rates they employ and the overall hospital mortality rate, and are around 0.2. The correlations between non-mortality outcomes and mortality indicators range from 0.3-0.4. As with the correlations presented in Cooper, et al. (2011) it is difficult to evaluate the clinical significance and robustness of these correlations.

The empirical literature I have reviewed provides statistical evidence that the effects of competition differ across conditions, surgical procedures and patient safety events. However these results only apply in studies conducted under competition on price and quality regime, and they are US related. The results from this set of studies where there is price competition support the view that AMI mortality rate is of limited usefulness as a general marker of hospital quality.

When competition is on quality with fixed prices the picture is less clear cut. There seems to be an agreement in the literature that competition with fixed prices increases quality. Further, researchers seem to assume, based on theory predictions, that the direction of change of quality will be the same across all hospital markets in response to changes in competition. This implies that focusing on a single general quality measure is not as problematic as when competition is on price and quality.

However, Gaynor and Town's (2011, p. 49) model of fixed price competition shows that certain conditions need to be met in order for theory to predict that more competition increases quality. In essence: hospitals have to maximize profit/surplus; demand has to be responsive enough to quality changes to give incentives to hospitals to attempt to win business away from their rivals and compensate for the costs of increasing quality; and the fixed administered price has to be above the

marginal cost of service provision. If these conditions are not met, theory predicts that even in markets with greater competition, hospitals may choose to decrease quality.

Therefore, there are theoretical reasons to expect that the effects of competition with fixed prices may differ across different hospital markets.

7.2 The causal link between competition and hospital outcomes

As Pollock, et al., (2011) note, statistical association is not the same as causation. In general, econometric regressions will not distinguish between statistical correlation and causality, and so proper methodologies must be used to identify causal effects. From an econometric point of view, the identification of competition effects in S-C-P studies such as Copper, et al. (2011) and Gaynor, Moreno and Propper (2010), will crucially depend on:

- The quality of the instruments used in Cooper, et al. (2011)

- The extent to which the Kessler and McClellan (2000) approach to constructing HHIs, used in Gaynor, Moreno-Serra and Propper (2010), is sufficient to deal with the confounding of quality and competition effects

- The extent to which the natural experiment that both studies exploit, a pro-competitive policy change, provides an exogenous variation to the variables used in their regressions

From a theoretical perspective, the causal interpretation of S-C-P study findings is more cpntroversial. This is because the empirical model used is not directly derived from a theoretical model, but it is rather based on a suggested causal relationship rising from a Cournot model of competition with homogenous goods[23]. Hence, the causal effect between HHI and its impact on quality is not theoretically established in a strict sense.

Further, the empirical strategy used in S-C-P studies relies on a "black box" approach. For the Cooper, et al. (2011) and Gaynor, Moreno-Serra and Propper (2010) studies, this means that researchers do not make explicit the causal mechanism by which the effects of competition in hospital elective services may spillover and impact AMI mortality outcomes.

The English related literature, in particular Cooper, el al. (2011), has attempted to bypass these short comings by relying on the results of Bloom, et al. (2010). Bloom and colleagues find that competition increases hospital management quality, which in turn is significantly correlated with decreases in AMI mortality. However, the extent to which this study provides evidence on the causal link between competition in elective services and its impact on AMI mortality is unclear as 52% of the responses used to construct their index of management quality were from individuals pertaining to the cardiology department and it is not clear by what mechanism competition for elective surgery would have impacted on the management of cardiology services.

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[23] The Cournot model is a basic static theoretical model of oligopolistic competition with homogeneous goods. Firms are assumed to compete on quantities by stealing market share from their rivals. Results from this simple model motivate the use of concentration measures such as HHI in S-C-P studies.

8 Conclusions and recommendations

The critical analysis emerging from the literature review shows that there are reasons to be cautious about the empirical studies available to policy makers. More research on the effects of competition on quality with prices fixed by a regulator as in the English NHS hospital section shows that further research to compile a more robust body of evidence is desirable to guide policy. The evidence there is suggests that competition under fixed prices increases quality, but the evidence is not particularly robust.

The use of AMI mortality as a general marker of hospital quality is not clearly established in the evidence presented in this literature review. Core evidence is based on a series of statistical correlations between AMI mortality and other outcome measures. Even though these statistics may indicate an underlying relationship, it is difficult to assess their clinical meaning without further complementary research into the factors that might explain them.

Simple static theoretical models show that fixed price competition is not a sufficient condition to ensure that increases in competition will result in quality increases. This result only emerges under certain demand, cost and competitive conditions. In this scenario, using general markers of hospital quality may not be the most correct approach to measure the effects of hospital competition. Using AMI mortality in this fashion may fail to detect the effects of competition in other markets.

Ways forward include the possibility of incorporating in the analysis alternative outcome measures related to different hospital markets. Optimal selection criteria would focus on outcome measures where quality of care is known to have a large impact on patient outcomes. Papanicolas and McGuire (2011) suggest candidates, such as: stroke mortality rate; and surgical mortality rates for coronary artery bypass graft (CABG) surgery, abdominal aortic aneurysm repair (AAAP), pancreatic resection, paediatric heart surgery, craniotomy and hip replacement (HIP). Future availability of NHS Patient Reported Outcome Measures (PROMs) can also be considered as a candidate.

Evidence on the causal mechanism by which the effects of competition in hospital elective services may spill over and affect outcomes such as AMI mortality is minimal. This is important to interpreting the causal significance of the findings emerging in Cooper, et al. (2011) and Gaynor, Moreno-Serra and Propper (2010). Further researcher into this area could involve looking at:

    a. The relationship between competition and changes that may be happening at overall hospital level (e.g. managerial quality)

    b. Outcomes in areas where changes in hospital behaviour have been shown to have happened

    c. Modelling underlying demand and supply rather than relying on S-C-P "black box" approaches

The impact of entry and exit has not been widely explored in the English NHS literature. However, economic theory posits that much of the benefits of competition in terms of increases in productivity, innovation and quality improvements may be driven by these dynamic aspects of competition. Moreover, hospitals could enter into strategies to deter potential efficient entry, or

competition may be not be efficient if there is the perception that hospitals will not be allowed to fail. This is a potential area of interesting future research.

Finally, the extent to which the evidence emerging from this literature can be extrapolated to assess what would happen in other NHS markets is limited. This is because the NHS is characterized by a diversity of services that differ in their economic nature and market environment. Further, not all of NHS services fall within the fixed price payment system so caution has to be exercised on the appropriateness of evidence from fixed price and variable price competition studies respectively.

Annex 1: Terms of reference

The use of empirical studies assessing the effects of competition in health care markets to inform evidence based policy decision making is not free of controversy.

A common element of these studies is their focus on the effects of market competition on the final quality of hospital service provision. However, there are many dimensions to quality. Hospitals provide a wide range of services, and patients rarely have all the knowledge or information to judge hospital services with respect to all possible quality dimensions. As a result, the task of measuring the overall quality of hospital service provision is not only inherently difficult, but there are also serious challenges to identifying appropriate measures of quality capable of capturing the overall effect of quality based competition. In this direction, many of the quality measures used in the literature have to rely on assumptions about how competition will impact on them which can be to some extent questionable.

Choosing and/or constructing an appropriate measure of competition is problematic. This will generally be contingent upon a number of factors that determine the competition effect identification strategy such as data requirements and the econometric strategies and methods that can be employed. As a result, there are various ways in which competition effects have been empirically identified in the literature. They all come with their advantages and disadvantages that determine the overall significance and robustness of their empirical results.

The OHE Commission on Competition in the NHS has asked OHE to undertake a critical review on the measures of quality and competition that have been employed in the health care literature. Given that much of this literature is around hospital competition, the aims of the critical review will be to:

- Understand the degree to which quality measures employed in the literature reflect overall hospital quality.
- Understand the degree to which quality measures employed capture the effect of hospital quality based competition.
- Understand the advantages and disadvantages of the strategies used to identify competition effects in the health care competition literature.
- Understand the extent to which the evidence and conclusions from this literature can be extrapolated to other NHS markets.

There will be two main literature review work streams:

- Review on the empirical literature on how to measure the effects of quality based competition, with a particular focus in health care markets.
- Review on the health economic literature on how to measure quality in health care provision.

The final deliverable will include a critical assessment of the quality and competition measures and on the econometric techniques employed in the health care competition literature, and try to build upon the lessons emerging from the health economic literature on how to measure quality where possible.

Annex 2: Literature review results

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Annex 3: How quality has been measured in the literature

	Year	Author	Objective	Condition	Surgical procedures	Complications	Quality measure		
							Outcome	Process	Structural
1	2000	Ho and Hamilton	Estimate the effects of hospital consolidation and quality of healthcare	AMI stroke newborn			30 day M-hospital mortality rate for AMI 90 days readmission rate for AMI 30 days M-hospital mortality rate for stroke	Newborn discharge within 48 hours	
2	2000	Kessler and McClellan	Study the consequences of hospital competition for patients with heart attack	AMI			1 year hospital mortality rate for AMI 1 year hospital readmission for AMI 1 year hospital readmission for CHF		
3	2001	Mukamel, Zwanziger and Tomaszewkii	Estimate the effects of hospital and HMO competition and quality of care	AMI CHF pneumonia stroke	CABG HIP		30 day post-admission mortality rate for all conditions and surgical procedures		
4	2002	Bamezai, Zwanziger and Mukamel	Estimate the effect of price and quality competition on hospital "hotel services"	AMI CHF pneumonia Stroke			30 day post-admission mortality rates for all conditions 30 day post-admission all cause mortality rate		

	Year	Author	Objective	Condition	Surgical procedures	Complications	Quality measure		
							Outcome	Process	Structural
5	2002	Sari	Estimate the impact of managed care and hospital competition on quality of care		1-hysterectomy, cholecystectomy, etc. 2-CABG, cesarean section delivery, etc.	1-obstetrical complications, wound infection, complications among surgical patients 3-low birth weight, pediatric asthma, perforated appendix, etc.	1-in-hospital mortality rate following, and elective procedures 2-potential inappropriate utilization of procedures: *outcome/population at risk 3-potential avoidable admissions: *outcome/population at risk		
6	2003	Gowerisankara and Town	Estimate effect of competition on Medicare and HMO patients	AMI pneumonia			30 days in-hospitals mortality rate for AMI 10 day in-hospital mortality rate for pneumonia		
7	2003	Volpp, et al.	Estimate the impact of a policy change in price competition on quality	AMI			30 day in-hospital mortality rate for AMI	30 day procedure rate for all surgical procedures	
8	2003	Shen	Estimate the effect of financial pressure on hospital quality	AMI			7 day post-admission mortality rate for AMI 30 day post-admission mortality rate for AMI 90 day post-admission mortality rate for AMI 1 year post-admission mortality rate for AMI 2 year post-admission mortality rate for AMI 30 day readmission rate for AMI 90 day readmission rate for AMI		

	Year	Author	Objective	Condition	Surgical procedures	Complications	Quality measure		
							Outcome	Process	Structural
9	2003	Tay	Estimate patient demand responses to distance and quality of hospitals	AMI	catheterization revascularization		1 year mortality rate for AMI 1 year hospitality complication rate for AMI and CHF	Binary variable (=1 if surgical procedures offered)	*nurses per bed *hospital size
10	2004	Propper, Burgess and green	Assess whether competition leads to better outcomes for patients	AMI			30 day in-hospital mortality rate for AMI		
11	2005	Cuellar and Gertier	Examine the effects of hospital consolidation	Not mentioned	Not mentioned	Not mentioned	*rate of in-patient mortality following conditions are procedures *rate of overuse procedures *rate of adverse safety events		
12	2005	Volpp, et al.	Assess whether competition leads to better outcomes for patients	AMI CHF pulm emb pneumonia stroke HIP			30 day in-hospital mortality rate for all conditions		
13	2005	Kessler and Geppert	Estimate the effects of hospital competition on quality differentiation for elderly Medicare patients with heart attack	New occurrence of AMI			1 year mortality rate for AMI 1 year readmission rate for AMI or for CHF		*total expenditure on acute and non-acute treatment for AMI patients *total acute and non-acute days in hospital for AMI patients
14	2006	Begun, Friedman and Jiang	Explore organizational market indicator characteristics associated with hospital performance of quality and cost	AMI CHF GBH HIP pneumonia stroke	AAR CABG craniotomy HIP		Composite score *weighted average of all 10 mortality rates, with weights equal to the proportion of patients for each individual condition or procedure		
15	2006	Howard	Gauge patients' responsiveness to quality when choosing hospital for kidney transplantation	Kidney failure			1 year graft survival rate		

	Year	Author	Objective	Condition	Surgical procedures	Complications	Quality measure		
							Outcome	Process	Structural
16	2007	Rogkowski, Jain and Escarce	Estimate the effect of hospital competition and HMO penetration on quality of care	AMI HIP stroke GIH CHF diabetes			30 day post-mission mortality rate for all conditions		
17	2007	Smith, et al	Estimate the effect of hospital competition on preventable adverse medical events				Probability of experiencing an adverse event for both type of complication		
18	2008	Propper, Burgess and Gossage	Estimate the effect of competition in an environment with limited quality signals in which hospitals compete on price	AMI			30 day in-hospital mortality rate for AMI *waiting times		*Number of effective admissions
19	2008	Mutter, Wong and Goldfarb	Estimate the effects of hospital competition across 38 distinct measures of inpatient quality	AMI CHF stroke GIH HIP pneumonia	CABG craniotomy pancreatic resection PCTA BCC	Complications of anesthesia decubitus ulcer failure to rescue foreign body left during procedure transfusion reaction post-operative sepsis	in-hospital mortality rates for all conditions in-hospital mortality rates for all surgical procedures incident rates for complications		
20	2010	Cooper, et al.	Estimate the effect of competition on quality with fixed reimbursement prices	AMI			30 day mortality rate for AMI		
21	2010	Cutler, Huckman and Kolstad	Assess whether entry in market for cardiac surgery led to surgeries using higher quality surgeons		CABG		In-hospital mortality rate of surgeons' patients Number of CABGs per surgeon		

	Year	Author	Objective	Condition	Surgical procedures	Complications	Quality measure		
							Outcome	Process	Structural
22	2010	Gaynor, Moreno-Serra and Propper	Estimate the effect of hospital competition on outcomes by exploiting procompetitive policy reform	AMI			28 in-hospital mortality rate for AMI 30 post-admission monthly rate 28 day in-hospital all causes mortality rate 30 day all cause post-mission mortality rate length of stay (days)		*operating expend *total admissions *operating expense/ad-mission ($) if elective nonelective
23	2010	Sivey	Examine how much waiting times affect choice of hospital		Cataract operations		1 year average waiting times		
24	2011	Balan and Romano	Retrospective analysis of the clinical effects of a merger	AMI CHF pneumonia stroke	CABG PCI	decubitus ulcer postoperative hip fracture	In-hospital mortality rate for all conditions in-hospital mortality rate for all surgical procedures incidence rates for all complications		
25	2011	Cooper, et al.	Estimate the effect of competition on quality with fixed reimbursement prices	AMI	Angioplasty		30 day in-hospital mortality rate Binary variable (=1 if underwent angioplasty)		Indicators status: Teaching Foundation trust Others Site activity for heart attacks
26	2011	Beckert, Christiansen and Collyer	Examine the choice of the acute service providers in the case of hip replacements	HIP		MRSA	In-hospital mortality for hip replacements MRSA infection rates Waiting times		

	Year	Author	Objective	Condition	Surgical procedures	Complications	Quality measure		
							Outcome	Process	Structural
27	2011	Gaynor, Propper and Seiler	Evaluate whether increased choice resulted in increased quality elasticity of demand		CABG		30 day post-CABG mortality rate Waiting times		
28	2011	Mutter, Romano and Wong	Examine the impact of hospital consolidations on 25 measures of quality	AMI CHF stroke GIH HIP pneumonia	AAR CABG craniotomy PCTA	Postoperative hemorrhage postoperative respiratory failure post-operative sepsis iatrogenic pneumothorax	In-hospital mortality rates for all conditions in-hospital mortality rates for all surgical procedures incidence rates for all complications		

Annex 4: How competition has been measured in hospital competition studies

	Year	Author	Objective	Institution	Type	Patients	Place/year	Competition Measure					
								HHI					
								Local Market	Type	Number of Competitors	Elasticity	Strategic Decision	Event
1	2000	Ho and Hamilton	Estimate the effects of hospital consolidation and quality of healthcare	Price and quality competition	Event study (merger)	All patients	California (1992-1995)						Impact of M&A
2	2000	Kessler McClellan	Study the consequences of hospital competition for patients with heart attack	Regulated price and quality competition	SCP	Medicare patients	US (1985, 1988, 1991, 1994)	Predicted patient floats	Predicted neighbor-hood HH I				
3	2001	Mukamel, Zwanziger and Thomazewski	Estimate the effects of hospital and HMO competition and quality of care	Regulated price and quality competition	SCP	Medicare patients	US 1990	Actual patient flow	Zip code hospital market HH I				
4	2002	Barmezai, Mukamel and Zwanziger	Estimate the effect of price and quality competition on hospital "hotel services"	Price and quality competition	Event study (policy change)	Medicare patients	California (1992-1998)						Policy change towards price compe-tition
5	2002	Sari	Estimate the impact of managed care in hospital competition and quality of care	Price and quality competition	SCP	All patients	16 US states (1992-1997)	Not mentioned (sourced from the American Hospital Asso-ciation data)	Indicator: 1=above median HH I				
6	2003	Gaynor and Vogt	Estimate of structural demand model to stimulate the effects of a merger	Price and quality competition	Demand esti-mation						Changes in price elasticity		
7	2003	Gowrisan-karan and Town	Estimate effective competition on Medicare HMO patients	Both institutions	SCP	All patients	California (1989-1993)	Predicted patient floats	Predicted hospital HH I				
8	2003	Volpp, et al.	Estimate the impact of a policy change in price competition and quality	Policy and quality competition	Event study (policy change)	All patients	New Jersey New York (1990 and 1996)						Price de-regulatio n

| | Year | Author | Objective | Institution | Type | Patients | Place/year | Competition Measure | | | | | |
| | | | | | | | | HHI | | | | | |
								Local Market	Type	Number of Competitors	Elasticity	Strategic Decision	Event
9	2003	Shen	Estimate the effect of financial pressure on hospital quality	Regulated price and quality competition	SCP	Medicare	All US (1985-1994)	Fixed radius	Hospital HH I				
10	2003	Tay	Estimate patient demand responses to distance and quality of hospitals	Regulated price and quality competition	Demand esti-mation	Non-HMO Medicare patients	US all states (1994)				Quality elasticity of demand		Stimu-lations: effect of an increase in hospital quality
11	2004	Propper Burgess and Green	Assess whether competition leads to better outcomes for patients	Price and quality competition	SCP	NHS patients	England (1995-1998)			30 min. drive from trust			
12	2005	Cuellar and Gertier	Examine the effects of hospital consolidation	Prices and quality competition	Event study (merger)	Insured patients	Four states, US (1995-2000)						Impact of M&A
13	2005	Dafny	Assess the possibility of strategic investment as an entrance deterrence strategy	Regulated price and quality competition	Structural model	Medicare patients	US (1998-1989)					Invest-ments to deter entry	
14	2005	Smith, et al.	Assess whether competition leads to better outcomes for patients	Price and quality competition	Event study (policy change)	All patients	New Jersey New York (1990 and 1996)						Price deregula-tion
15	2005	Kessler and Geppert	Estimate the effects of hospital competition on quality differentiation for elderly Medicare patients with heart attack	Regulated price and quality competition	SCP	Medicare patients	US (1985-1996)	Predicted patient floats	Predicted zip code hospital market HH I				
16	2006	Begun, Friedman and Jiang	Explore organizational market characteristics associated with superior hospital performance in quality and cost	Price and quality competition	SCP	All patients	10 US states (1997-2001)	Zip codes that account for 90% of hospital's actual patient volumes	Hospital HH I				

| | | | | | | | | Competition Measure | | | | | |
| | | | | | | | HHI | | | | | | |
	Year	Author	Objective	Institution	Type	Patients	Place/year	Local Market	Type	Number of Competitors	Elasticity	Strategic Decision	Event
17	2006	Howard	Gauge patients' responsiveness to quality when choosing hospital for kidney transplantation	Price and quality competition	Demand esti-mation	All patients	US (2000-2002)				Quality elasticity of demand		Simula-tions: effects of de-crease in hospital quality
18	2007	Rogkowski, Jain and Escarce	Estimate the effect of hospital competition HMO penetration on quality of care	Price and quality competition	SCP	All patients	California (1994-1999)	Predicted radius (70-90% of admits)	Predicted hospital HH I				
19	2007	Cheung, et al.	Estimate the effect of hospital competition on preventable adverse medical events	Regulated price and quality competition	SCP	Children in Medicaid	Florida, New York and Wisconsin (1999-2001)	Actual patient floats	Zip code hospital market HH I				
20	2008	Propper, Burgess and Gossage	Estimate the effect of competition in an environment with limited quality signals		Event study (policy change)	NHS patients	England (1991-1999)			30 min. drive from trust			Intro-duction of price compe-tition
21	2008	Mutter, Wong and Goldfarb	Estimate the effects of hospital competition on 38 distinct measures of inpatient quality	Price and quality competition	SCP	All patients	22 US states (1997)	Various HH I measures					
22	2009	Dafny	Obtain an unbiased estimate of the effect of consummated mergers	Price and quality competition									
23	2010	Cooper, et al.	Estimate the effect of competition on quality with fixed reimbursement prices	Regulated price and quality competition	Event study (policy change)	NHS patients	England (2002-2008)	Variable radius using actual patient flows	GP-centered				
24	2010	Cutler, Huckman and Kolstad	Assess whether entry in market for cardiac surgery led to surgeries using higher quality surgeons									Impact of dual entry *business stealing effects *entrants	Removal of entry restric-tions for CABG surgery

	Year	Author	Objective	Institution	Type	Patients	Place/year	Competition Measure					
								HHI		Number of Competitors	Elasticity	Strategic Decision	Event
								Local Market	Type				
25	2010	Gaynor. Moreno-Serra and Propper	Estimate the effect of hospital competition on outcomes by exploiting up pro-competitive policy reform	Regulated price and quality competition	Event study (policy change)	NHS patients	England (2003 and 2007)	Actual and predicted patient flows	Actual and predicted neighbor-hood HHIs				Policy change from compe-tition focused on price of quality
26	2010	Bloom, et al.	Assess the causal impact of competition on management quality	Regulated price and quality competition	SCP	Public hospitals	England (2006)						
27	2010	Sivey	Examine how much waiting times affect choice of hospital	Regulated price and quality competition	Demand esti-mation	NHS patients	England (2001-2004)				Waiting time elasticity of demand		
28	2011	Cooper, et al.	Estimate the effect of competition on quality with fixed reimbursement prices	Regulated price and quality competition	Event study (policy change)	NHS patients	England (2002-2008)	Variable radius using actual patient flows	GP-centered				
29	2001	Balan and Romano	Retrospective analysis of the clinical effects of a merger	Price and quality competition	Retrospe ctive event study (merger)	All patients	Illinois, US (1998/2003)						Impact of a hospital acqui-sition
30	2011	Beckert, Christiansen and Collyer	Examine the choice of acute service providers in the case of hip replacements	Regulated price and quality competition	Demand esti-mation	NHS patients	England (2008/2009)				Changes in quality elasticity of demand		Merger simu-lation
31	2000	Gaynor, Kleiner and Vogt	Employee a structural model of market competition to implement a SSNIP test								Price elasticity of demand		Antitrust market definition simu-lated by SSNIP test

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	Year	Author	Objective	Institution	Type	Patients	Place/year	Local Market	Type	Number of Competitors	Elasticity	Strategic Decision	Event
32	2011	Gaynor, Propper and Seiler	Evaluate whether increased choice resulted in increased elasticity of demand	Regulated price and quality competition	Demand esti-mation	NHS patients	England (2003-2007)				Quality elasticity of demand (mortality and waiting time)		Patient choice policy reform
33	2011	Mutter, Romano and Wong	Examine the impact of hospital consolidations on 25 measures of quality	Price and quality competition	Event study (mergers)	All patients	16 US states (1999/2000)						Impact of hospital M&A