Killer Deals? The Impact of Hospital Mergers on Clinical Quality

Elena Ashtari Tafti and Thomas P. Hoe*

October 3, 2022

Abstract

This paper studies the impact of hospital mergers on the quality of clinical care. We use an event study framework to evaluate the population of hospital mergers in the English NHS between 2006 and 2015. We find that mergers have immediate and persistent negative impacts on clinical quality. Our estimates indicate that on average a merger increased the likelihood of death by 0.4 percentage points and the likelihood of readmission by 0.9 percentage points. Under very conservative assumptions, these effects are valued at approximately 4 per cent of annual hospital costs.

*Ashtari Tafti: University College London, email: elena.tafti.17@ucl.ac.uk. Hoe: Cornell University, Department of Policy Analysis and Management; email: thomas.hoe@cornell.edu.

1 Introduction

Industry consolidation has often raised concern among economists. These issues have come to the fore again lately, with recent research showing the extent of consolidation globally [Loecker and Eeckhout, 2018] and other work highlighting the limited benefits [Grullon et al., 2019] or negative impacts [Gutierrez Gallardo and Philippon, 2017] associated with mergers. These concerns have been especially acute in the hospital market where there has been significant consolidation [Cutler and Morton, 2013]. Mergers in this setting have been shown to increase hospital prices which feed through to higher insurance premiums [Dafny and Lee, 2019, Schmitt, 2018], and to slow wage growth in local labor markets [Prager and Schmitt, 2019]. While hospital mergers have also been found to lead to reduced costs [Schmitt, 2017], other work has shown that these benefits are sometimes limited and can be outweighed by other transaction costs [Craig et al., 2019].

This paper provides new evidence on the impact of hospital mergers on clinical quality of care. These outcomes are notoriously difficult to measure but there are clear antitrust concerns. Increasing market power may be exercised through either price increases or a deterioration in product quality, and the latter can literally be a matter of life or death in hospital markets. These concerns have been raised on multiple occasions and antitrust authorities have blocked proposed mergers on this basis.[1]

We use the universe of public hospital medical records in England to examine all public hospital mergers after the introduction of hospital choice in 2006. There were 159 hospital sites involved in mergers over our sample period, comprising 13 transactions. An advantage of our setting is that hospital reimbursement is unaffected by mergers – hospital services are free at the point of care and hospital payments are made and set centrally by the government – which allows us to study the impact of mergers on quality of care in isolation from other changes.

We use an event-study framework and focus on two measures of clinical quality: 30-day unplanned readmissions and 30-day in-hospital mortality. To account for the fact that hospitals may treat different patient populations before and after mergers, we risk adjust our quality measures following the latest methodologies developed for the Center for Medicare and Medicaid Services [Leora, 2012]. These methods use a series of hierarchical logistic re-

[1]A debated case in the UK was for example the merger proposal between The Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust and Poole Hospital Foundation Trust. The merger was prohibited by the Competition Commission in a decision in 2013 on the basis of competition concerns and the absence of demonstrated benefits [Schiraldi, 2019]. Similarly in 2014, the U.S. Court of Appeals for the Sixth Circuit supported the FTC decision to block a hospital merger in Toledo, Ohio, between the area's largest health care system, ProMedica, and one of its rivals, St. Luke's Hospital. The FTC showed that health plans could obtain more competitive prices from ProMedica when St. Luke's existed as a suitable alternative. The loss of that alternative would have increased ProMedica's negotiating clout and left health plans vulnerable to ProMedica's price demands [Ramirez, 2014].

gression models, which control for a variety of observable patient characteristics, to compute standardized risk ratios (SRRs). These ratios report the number of 'excess deaths' (or excess readmissions) at a particular hospital relative to the expected number of deaths nationally for a comparable patient pool.

Our analysis tracks SRRs for the two years prior to and following a hospital merger. We perform this analysis for all acute hospital sites involved in a merger. The event study estimates indicate how clinical quality at these hospitals, as measured by excess deaths and readmissions, evolved relative to national trends.

We find evidence that hospital mergers have immediate and persistent negative impacts on quality of care. Risk-adjusted mortality is flat in the pre-merger period suggesting that mergers are not a case of poorly performing hospitals being acquired. In the post-merger period, mortality increases in the month after a merger and remains above baseline levels for the next two years. There is a similar pattern with readmissions, with some evidence of an increase two months prior to a merger.

As a placebo test, we compute equivalent estimates for hospital sites not involved in mergers. The event study estimates for these hospitals are entirely flat in the pre- and post-merger periods.

The magnitude of the estimated merger effects is substantive. On average, the mergers we study increased the likelihood of a patient dying by 0.4 percentage points, or 27 per cent relative to the baseline mortality rate of 1.4 per cent. Similarly, the likelihood of readmission increased by 0.9 percentage points (11 per cent relative to a baseline of 8.3 per cent).

Scaling these effects up to the patient population suggests that mergers led to approximately 98 additional deaths and 218 additional readmissions per year. Under conservative assumptions on the value of a life-year, the additional deaths are valued at around £11 million, which is approximately 4 per cent of average annual hospital costs. This is the same order of magnitude to previous estimates of cost synergies from mergers in other settings [Schmitt, 2017, Craig et al., 2019] .

These results illustrate that mergers can have serious consequences for the quality of care. These effects could plausibly outweigh any cost savings from mergers. As we develop this work further, we intend to explore the incentives and mechanisms leading to the quality deterioration. In particular, we will test whether the impacts are associated with changes in market power (e.g. HHI variations) or specific decisions taken by hospitals in the post-merger period (e.g. internal department reorganizations). We also plan to address a number of methodological issues, such as the way in which we compute standard errors and the choice of covariates in the risk adjustment methodology.

Our work contributes to the literature on the effects of mergers in the healthcare setting.

The large majority of these studies analyzes mergers between hospitals in the US market and focuses on the effect of consolidation on prices [Lewis and Pflum, 2017], wages [Prager and Schmitt, 2019], and/or on the impact on hospital-insurer negotiations [Dafny et al., 2019]. Fewer studies investigate whether hospital mergers and consolidation have an impact on quality. HO2 [2000] compares the quality of hospital care before and after mergers in California between 1992 and 1995. Quality is measured using mortality for heart attack and stroke patients, 90-day readmission for heart attack patients, and discharge within 48 hours for normal newborn babies. Propper et al. [2012] examines the impact of public hospital mergers in England over the period 1997 to 2006 on a number of outcomes including emergency heart attack mortality. Both of these studies find little to no impact on quality of care. The strongest evidence linking market structure to quality to care is Cooper et al. [2011] and Gaynor et al. [2013]. These studies evaluate the impact of introducing patient choice in hospital markets in England in 2006, finding that mortality rates for heart attack patients was reduced by more in areas where hospitals were exposed to more competition in comparison to areas with less competition.

This paper complements the existing literature by directly analyzing mergers – i.e. changes in market structure – and focusing on hospital-wide measures of clinical quality. The rich administrative data that we have available makes this possible since we observe the entire population of patients over a long time period and have detailed information on patient characteristics to construct state-of-the-art risk adjusted quality measures. While this result is in line with standard predictions from industrial organization, to the best of our knowledge, this is the first paper providing empirical evidence that mergers negatively impact clinical quality. Although more research is needed, our conclusion has potential implications for antitrust policy in healthcare markets.

The remainder of this paper is organized as follows. Section 2 describes the data. Section 3 outlines our empirical specifications. Section 4 presents our results. Section 5 sets out a framework for analyzing how our results may relate to changes in market competition. Section 6 concludes.

2 Data

Our primary source of data is the Hospital Episodes Statistics (HES), a comprehensive administrative database containing all visits to public hospitals in England. We combine HES data with information from NHS Digital about the opening and closing dates of all public hospitals. Together these datasets allow us to identify hospital mergers and observe the treatment and health outcomes of all patients in England.

2.1 Identifying Hospital Mergers

We use NHS Digital data on openings and closures of hospital sites to identify hospital mergers and validate our final list using a variety of other sources of information. We restrict our focus to mergers occurring after 2006, the year marking the introduction of patient choice in the NHS and the prospective payment system. Under the prospective payment system hospitals are reimbursed through fixed prices set and paid centrally by the government [Gaynor et al., 2013].

We identify 25 hospital mergers occurring during the period 2006-2015. We limit our analysis to acute hospitals, the main providers of hospital-based services in England [Gaynor et al., 2013], resulting in a total of 16 mergers. From those, we exclude two mergers that involve hospitals already involved in a merger in the past.

Mergers are somewhat concentrated across time and space. Geographically, mergers occurred in three main areas: London and the south, the north west near Liverpool and Manchester, and the north east near Newcastle, see Figure 1. The bulk of mergers occurs between 2012 and 2014. Figure 2 shows the number of mergers occurring between 2006 and 2015. 3 shows the number of hospitals involved in a merger in the period 2006-2015.

2.2 Hospital Episodes Statistics

The HES data covers the universe of inpatient discharges from NHS hospitals in England, comprising over 9 million admissions per year. The data includes detailed patient clinical information (e.g. diagnoses, operations); patient demographic information; administrative information (e.g. methods of admission and discharge); and geographical information such as where patients are treated and where they live.

We apply three selection rules to the data before conducting the analysis. First, for each year between 2006 and 2015 we select a 50% random sample of patients admitted to hospital. Second, we select only hospitals that belong to an acute trust.[2] Third, we drop from our sample any hospital for which the data required for the analysis is not available.

We divide hospitals into a treatment and a control group. The treatment group is composed by hospitals that have been involved in a merger between 2006 and 2015 , with the remaining hospitals making up the control group. In total, we have 1,199 and 139 hospitals in the control and treatment group respectively. Table 1 shows the characteristics of the treatment and control group at the trust and hospital (i.e. site) level. On average, control-group trusts have a larger number of hospital sites compared to the treatment group. However, once we restrict to acute trusts, the gap disappears. Control trusts also have, on

[2]We define as *acute trust* any NHS trust that in the Estates Returns Information Collection data has had one site recorded as "General and Acute" from 1999 on wards.

average, a larger number of occupied and available beds and a larger number of employees. The average site in the control group has relatively less patients than the average site in the treatment group although this difference is not statistically significant.

3 Empirical Methodology

We use an event-study framework to study the impact of hospital mergers on risk-adjusted measures of clinical quality. In this section, we describe our methodology for computing quality and then set out the event-study specification.

3.1 Measures of Clinical Quality

To measure clinical quality we use standard risk-adjustment methodologies employed by the Center for Medicare and Medicaid Services (CMS). Specifically, we compute two measures: the Hospital Wide Risk Standardized Mortality measure (henceforth HWM) and Hospital Wide Risk Standardized Readmission measure (henceforth HWR) developed for CMS by the Yale New Haven Health System / Center for Outcomes Research and Evaluation (YNHHS/CORE).

The methods that underpin the HWM and HWR are routinely used by the US federal government to evaluate and disseminate information on quality of care at US hospitals. Most notably, the Hospital Readmission Reduction Program one of the largest pay-for-performance policies in health care globally uses similar measures to financially penalise hospitals with excess readmissions[Gupta, 2017]. Similarly, risk-adjusted mortality measures are publicized through hospital report cards that allow patients compare the quality of participating hospitals [Kolstad, 2013].

The HWM measure is a single hospital level summary score that reports the risk-standardized rate of deaths within 30 days of hospital discharge for any condition. Mortality is an unwanted outcome for the majority of patients and when assessed among appropriate individuals, it provides a concrete signal of quality by capturing the result of care processes as well as the impact of both optimal care and adverse events. The measure is computed using a sample of patients for which survival was most likely the primary goal when entering the hospital, and for which improved care quality could have been reasonably expected to impact the chance of survival. The measure is meant to cover all deaths of patients admitted to hospital that died either while in hospital or within 30 days of discharge. From our data, we cannot observe deaths that occur outside the hospital. For this reason, we limit the measure to cover only deaths of patients admitted to acute sites that occur in hospital. Because overall mortality rate for patients admitted more than once is higher than for those with only one admission, the measure randomly selects one admission for each patient in the measurement period. Random selection is meant to reflect that the outcome of an admission can be either survival or death.

The HWR measure is a single hospital level summary score that reports the risk-standardized rate of unplanned readmission within 30 days of hospital discharge for any condition. A readmission is an admission to an acute care hospital within 30 days of discharge from an acute care hospital. Readmissions may be planned or unplanned. A planned readmission is intentional and scheduled as part of the patients plan of care. Unplanned readmissions are acute clinical events experienced by a patient that require urgent hospital admission. Hospital readmissions, of this kind, are disruptive to patients and costly to the healthcare system. Higher than expected unplanned readmission rates suggest lower quality of care and are the focus of quality measurement. Because planned readmissions are not a signal of quality of care, these patient outcomes are excluded from the measure.

Following the CMS methodologies, we compute HWM and HWR in two steps. In the first step we estimate a regression model that risk adjusts the relevant outcome, i.e. unplanned readmission or mortality. In the second step we use the first-stage regression estimates to compute specialty-level Standardized Risk Ratios (SRR) which are then aggregated to produce the HWM or HWR.

3.1.1 Risk-adjustment Model

CMS estimates the following hierarchical logistic regression separately for each specialty cohort c and year t

$$\Pr(y_{icht} = 1 \mid x_i, c, h, t) = F(\alpha_{ct} + \beta_{cht} + \gamma_{ct} x_i + \varepsilon_{icht}) \tag{1}$$

$$\beta_{cht} \sim \mathcal{N}(0, \theta_{ct}^2) \tag{2}$$

$$\varepsilon_{icht} \sim \mathcal{N}(0, \sigma_{ct}^2), \tag{3}$$

where $F(.)$ is the logistic function and y_{icht} is a binary variable indicating the readmission or death of patient i in specialty cohort c at hospital h in year t. The remaining terms are: x_i a vector of (assumed exogenous) patient-level characteristics, α_{ct} the intercept, β_{cht} a hospital-specific fixed effect, and ε_{icht} an error term capturing any over- or under-dispersion.

The model is estimated separately for each specialty cohort. A cohort is a group of discharge condition or procedure categories typically cared for by the same team of specialists. In line with CMS, we estimate the model for five specialty cohorts for the HWR measure and for fifteen specialty cohorts for the HWM measure.[3] The vector x_i is common across

[3]For the HWM measure, we group non-surgical patients into cancer, cardiac, gastrointestinal, infectious

specialty cohorts and includes age, a set of comorbidity indicators, and a set of diagnosis fixed effects.[4]

For each estimation, we use the baseline sample described in section 2.2 and then follow CMS by making a number of nuanced data exclusions that are specific to the HWM or HWR measures.[5]

3.1.2 Constructing Standardized Risk Ratios

Standardized Risk Ratios (SRRs) are a function of the 'predicted' and 'expected' outcomes (i.e. mortality and readmission) for each specialty-hospital combination. The expected outcome is the number of deaths, or readmissions, that would occur if a particular set of patients were treated by an average hospital (i.e. the national average expected performance). The predicted outcome is the equivalent number for a *specific* hospital. We compute these terms at the specialty-hospital-month level as follows

$$\text{predicted}_{chm} = \sum_{i \in c,h,m} F\big(\widehat{\alpha}_{ct} + \widehat{\beta}_{cht} + \widehat{\gamma_{ct}} x_i\big) \tag{4}$$

$$\text{expected}_{chm} = \sum_{i \in c,h,m} F\big(\widehat{\alpha}_{ct} + \widehat{\beta} x_i\big), \tag{5}$$

where m is a month within year t. So while Equation (1) is estimated annually, we use these estimates to construct SSRs which are measured at a monthly frequency.[6]

We then compute the specialty-level SRR as follows

$$\text{SRR}_{chm} = \frac{\text{predicted}_{chm}}{\text{expected}_{chm}}. \tag{6}$$

An SRR of 1 indicates that the number of deaths (or readmissions) in specialty c at hospital h in month m are in line with the number of deaths expected nationally at hospitals treating similar patients during that year. An SRR above (below) 1 indicates that the hospital is

disease, orthopedics, pulmonary, renal, and other conditions categories, while we group surgical patients into cancer, cardiothoracic, general surgery, neurosurgery, orthopedics, and other surgical procedures categories. For the HWR measure, we group non-surgical patients into medical, neurology, cardiovascular, and cardiorespiratory categories, while we group surgical patients in the single category surgery.

[4]The comorbidity indicators are as follows: for the HWR measure, the model controls for 31 risk variables that encompass 74 comorbidity conditions categories.; and for the HWM measure, the model controls for 19 risk variables that encompass 38 comorbidity categories. We use the 12 months prior to the admission to identify the patients comorbid conditions. The diagnosis fixed effects are included only for those categories with more than 1,000 admissions.

[5]The HWM sample excludes the following patients: those that have died in hospital, those that have been transferred between hospitals during the admission; those that have been admitted for psychiatric and metastatic cancer diagnosis, rehabilitation treatments, and those that have been enrolled in a hospice in the 12 months prior. The HWR sample excludes the following patients: those that have died in hospital, that have been transferred between hospitals during the admission; that have been discharges against medical advice; that have been admitted for psychiatric and cancer diagnosis or rehabilitation treatments.

[6]Ideally we would run the risk adjustment regression monthly, however the sample sizes do not allow us to do this with sufficient precision.

under- (over-) performing relative to the national average.

Finally, a hospital-wide SRR is computed as the geometric mean of specialty-specific SRRs

$$\text{SRR}_{hm} = \exp\left\{\frac{\sum_c w_{chm}\log(\text{SRR}_{chm})}{\sum_c w_{chm}}\right\} \tag{7}$$

where the weights, w_{chm}, correspond to the monthly volume of admissions in each specialty cohort.

We run the risk-adjustment estimation and SRR computations for mortality and readmission separately, giving us two measures of SRR_{hm} for each hospital-month in our data. We refer to these aggregated variables as HWM and HWR for simplicity. Table 2 shows summary statistics for the two measures over the period of interest. The average HWR is larger than one indicating a higher-than-expected rate of readmissions. The average HWM is less than one, indicating a lower-than-expected rate of in hospital deaths. Some hospitals appear to be outliers with the value of the measure greatly exceeding the rest of the observations.

3.2 Event Study Framework

We use the following regression specification to estimate the impact of mergers on hospital quality over time

$$y_{hs} = \mu_s + \sum_{k=-24}^{-11}\kappa_k + \sum_{k=-13}^{24}\kappa_k + u_{th} \tag{8}$$

where y_{hs} is one of the two measure of hospital quality, HWM or HWR, in period s for hospital h. μ_s are calendar time fixed effects, κ_k are event time fixed effects, and u_{hs} is an error term.

We estimate Equation (8) using hospitals involved in mergers as described in section 2.2. The parameters of interest are the κ_k, which measure the outcome at event time k relative to the base category which we set at 12 months prior to the merger. The κ_k parameters for periods prior to the merger ($k < 0$) allow us to test for pre-trends or impacts on quality that occur before the merger is formally completed. We are primarily interested in κ_k parameters for periods after the merger ($k > 0$). We anticipate that $\kappa_k = 0$ for $k < 0$ (i.e. no pre-trends) and we test the null hypothesis that $\kappa_k = 0$ for $k > 0$, meaning mergers have no impact on hospital quality. Since our dependent variables HWM and HWR are measured relative to the expected national average, if we find that $\kappa_k > 0$ in the post-merger period this implies that clinical quality at merged hospitals has deteriorated relative to hospitals that did not merge.

As a placebo test, we also estimate Equation (8) for hospitals not involved in mergers and impose artificial mergers at the dates of the actual mergers in our data. In this case, we anticipate that $\kappa_k = 0$ for all k.

We estimate Equation (8) using OLS and cluster standard errors by hospital site. In this specification we treat the hospital quality measures as fixed, which will understate the standard errors because it omits any estimation error from the risk-adjustment exercise. In future work, we plan to bootstrap the standard errors to account for the two-stage nature of the estimation.

4 Results

4.1 Baseline Results

We start our analysis by plotting the event study estimates from equation (8) for our two measures of quality in Figure 5 and 4. The coefficients measure the difference in care quality relatively to the baseline period for the hospitals involved in a merger. We include calendar time fixed effects that control for changes in quality common to all hospitals. Standard errors are clustered at the hospital level. We find a negative and significant effect of mergers on the quality of care, with both measures displaying an increase in the period after the merger (i.e. a reduction in the quality of hospital care).

Our risk-adjusted mortality measure increases in the month following a merger and remains above the baseline level for the following two years. The picture is broadly similar when using risk-adjusted readmissions, with some evidence of an increase in quality two months prior the merger. Reassuringly, the coefficients are close to zero in the time preceding the event indicating that we are not capturing the acquisition of poorly performing hospitals.

The mergers we study increase the likelihood of a patient dying by 0.4 percentage points, or 27 per cent relative to the baseline mortality rate of 1.4 per cent. Similarly, the likelihood of readmission increases by 0.9 percentage points (11 per cent relative to a baseline of 8.3 per cent). This effect corresponds to around 60.000 excess deaths, and 140.000 excess readmissions due to the mergers in the period we study. We estimate the total value of life lost from mergers to exceed 13 millions, 4% of hospital costs.[7]

As a placebo test, we compute equivalent estimates for hospital sites not involved in mergers. The event study estimates for these hospitals are entirely flat in the pre- and post-merger periods, see Figure 8 and 9.

[7] This value is calculated under the assumption that the average patient that died in hospital had two years of life left to leave with value of life per year being 111,860.66 pounds.

4.2 Subgroup Analysis

We estimate the average effect of mergers on hospital quality at specialty cohort level with the intent of uncovering heterogeneous effects. The results are shown in Figure 6 and 7. Here, the coefficients represent the difference between the average quality of merging hospitals before and after the event. We include calendar time fixed effects that control for changes in quality common to all hospitals. Standard errors are clustered at the hospital level. In Figure 6 we break down the analysis into the 15 specialty cohort components of the HWM measure. The effect of mergers on quality appears to vary across different specialties, although in most cases we cant distinguish it from zero with a high level of accuracy. In Figure 6, we repeat the analysis using the 5 specialty cohort components of the HWR measure. Similarly to the HWM measure, the effect of mergers on quality is not homogeneous, with patients undergoing surgical operations being the most negatively affected from the merger.

5 Extension

In this section we sketch out one possible mechanism through which mergers can negatively affect the quality of care: through their impact on market competition. Weaker market competition is believed to reduce hospitals incentives to provide better quality services in markets with fixed prices. As of now we can't conclude on whether this is the ultimate mechanism trough which mergers impact hospital quality.

5.1 Mergers and Market Competition

Gaynor et al. [2013] finds compelling evidence that competition in the NHS reduced acute myocardial infarction mortality and patient length of stay. These findings are consistent with predictions from economic theory. In the absence of price competition, hospitals have to compete on quality to attract patients, hence the higher the number of competitors in a market the higher hospitals incentives to increase quality [Gaynor, 2006].

Mergers reduce the number of competitors in a industry and may therefore weaken competition and increase the merging parties market power leading to a reduction in quality. To produce some descriptive evidence on whether a *competition story* is behind the effects we found we compute a measure of market competition and relate this measure to changes in quality following the mergers.

We choose to measure competition using the Herfindahl Hirschman Index (HHI) which does not require price inputs and is therefore suitable to analyse the environment in which UK hospitals operate. The HHI is the sum of squared market shares of each firm competing in the market, ranging from 0 (perfect competition) to 10000 (monopoly). Following Gaynor et al. [2013], we calculate a hospital-level HHI in two steps. First, we produce General Practice (GP) level HHI. Second, we aggregate HHIs at the hospital level. Equation 9 shows the first stage

$$HHI_{jc} = \sum_{i=1}^{N} S_{ic}^2 \tag{9}$$

i denotes a hospital that competes on the market of GP j for specialty c. S_{ic} is the GP j's share of patients that have been inpatient in hospital i for specialty c expressed as a whole number, not a decimal. We compute S_{ic} using the HES data.

A critical input for this measure is determining the relevant market over which to compute market shares. We define a different relevant market for each GP to mirror the structure of the NHS where patients choose hospitals in conjunction with their doctors [Cooper et al., 2010]. We restrict the geographical extension of each GP market using the 80th percentile of the distance travelled by patients from the GP location to the hospital. This distance approximate patients willingness to travel. More specifically, the GP-relevant market is a circle centered around the GP location with radius equal to the 80th percentile of the distance. All acute hospitals that are located within this circle are potential competitors. In addition, we define a different relevant market for each specialty for two reasons. First, there is little substitutability between specialties. Second, patients needing different treatments may have different willingness to travel.

For each hospital, the hospital-specialty HHI is then computed as a weighted average of GP-specialty HHIs. Equation 10 shows the second stage, that is the HHI at hospital level.

$$HHI_{hc} = \sum_{j=1}^{J} s_{jc} \cdot HHI_{jc} \tag{10}$$

s_{hic} represents the share of patients that hospital h receives from GP j for specialty c. HHI_{jc} represents the GP level HHI for practice j and specialty c. Table 3 shows summary statistics for the site-specialty HHI. On average, site-specialty markets appear to be moderately concentrated in the period of interest.

5.1.1 Inspecting the Mechanism

Antitrust authorities generally consider markets in which the HHI is between 1,500 and 2,500 points to be moderately concentrated and, beyond 2,500 points to be highly concentrated. Mergers occurring in concentrated markets are most likely to give cause for concern.[8]

[8] In particular, mergers occurring in such markets that result in changes in HHI greater than 100 potentially raise competitive concerns; mergers in highly concentrated markets that result in a change in HHI greater than 200 are presumed to be very likely to enhance market power[9].

In order to assess whether the effect found in the previous section can be the result of increased concentration and market power, we compute the pre-merger HHI for each specialty cohort. Figure 10 shows the average specialty HHI for the pre-merger period for the HWM groupings. The HHI of 4 of the 15 HWM specialty categories falls in the range of moderately concentrated; the HHI of 3 specialty categories falls in the highly concentrated range. Mergers occurring in these markets have ex-ante the potential to reduce quality.

Interestingly, some of the specialty cohorts for which we find a negative impact of mergers on hospital quality display a significantly high level of market concentration pre-merger. For example, *Renal* for which we find a statistically significant negative impact of mergers on quality has a pre-merger HHI of more than 5000. Figure 11 shows the average specialty HHI for the pre-merger period for the HWR groupings. *Cardiorespiratory* which we have found to experience a decrease in quality after the mergers shows high level of market concentration pre-merger. In a similar vein, *Medicine* for which we have found no negative impact of mergers on quality shows a low level of HHI pre-merger. On the other hand, *Surgery* shows a very low level of concentration pre-merger and a sizable negative impact of mergers on quality.

To further examine whether the competition mechanism could be a plausible explanation in our context we compute the average impact of mergers at hospital level and relate this to the level of pre-merger market competition faced by the hospital. Figure 12 shows the relationship between the average site-level effect of mergers on the HWM measure and the level of pre-merger market competition. Figure 13 shows the relationship between the average site-level effect of mergers on the HWM measure and the level of pre-merger market competition. There is a mild positive relationship between the level of pre-merger market competition and the impact of mergers on our measures of hospital quality. An increase in the HHI pre-merger is loosely correlated with an increase in the effect of mergers on the HWM and HWR measures (i.e. a reduction in quality following the merger). No direct conclusion can be extracted from these figures. In the future we plan to further develop this area of the analysis.

6 Conclusions

Mergers and acquisitions raise a number of antitrust concerns, chief among them that market consolidation may lead to higher prices or poorer product quality. Both of these effects are incredibly important in health care markets, which have experienced significant merger activity over the past two decades, and where prices and quality can literally be a matter of life or death.

This paper provides novel evidence on the effect of mergers on quality of clinical care. We use an event study framework to evaluate 159 public hospitals involved in mergers in the English NHS during 2006 to 2015.

We find evidence that hospital mergers have immediate, persistent and statistically significant negative impacts on quality of care. On average, the mergers we study increased the likelihood of a patient dying by 0.4 percentage points, or 27 per cent relative to the baseline mortality rate of 1.4 per cent. Similarly, the likelihood of readmission increased by 0.9 percentage points (11 per cent relative to a baseline of 8.3 per cent). Under very conservative assumptions about the valuation placed on life-years, we estimate that the deterioration in health outcomes is valued at approximately 4 per cent of average annual hospital costs. These effects are the same order of magnitude to the estimated effects of mergers on hospital costs.

There are a number of important caveats to this work. First, our work has focused on mergers between acute hospitals. In the future, it would be important to extend the analysis to specialists hospitals. This may uncover positive effects of mergers on hospital quality arising from specialisation economies. Second, the risk adjustment methodology could be further developed. In this work we risk adjust mortality and readmissions using the CMS methodology. This methodology has been developed for US hospitals and in particular Medicare patients. This is a limited share of population which could be very different from NHS patients. In the future we plan to develop our risk adjustment methodology further with the purpose of capturing health shifters relevant to the UK setting. Third, as of now we could improve on the way we estimate our coefficients standard errors. In the future we plan to refine the way we compute standard errors by using bootstrapping techniques. Lastly, we plan to investigate the channels through which mergers impact the quality of hospital care. In particular, we plan to investigate whether the impacts are associated with changes in market power or specific decisions taken by hospitals in the post-merger period (e.g. internal department reorganizations).

Based on the analysis to date, we conclude that hospital mergers may have first order impacts on clinical quality and this should be an important consideration for antitrust authorities. The steps outlined above will help us understand these effects in more detail. Our specific estimates of course apply to the English setting, where hospitals are publicly owned and prices are fixed. While this is an ideal setting to evaluate the clinical quality impacts, understanding how these results generalize to more complex settings is an important direction for future work.

References

Jan De Loecker and Jan Eeckhout. Global market power. NBER Working Paper No. 24768, 2018.

Gustavo Grullon, Yelena Larkin, and Roni Michaely. Are US Industries Becoming More Concentrated? *Review of Finance*, 23(4):697–743, 2019.

German Gutierrez Gallardo and Thomas Philippon. Declining Competition and Investment in the U.S. *NBER Working Paper*, (w23583), 2017.

David M. Cutler and F. Scott Morton. Hospitals, market share, and consolidation. *JAMA*, 310(18):1964–70, 2013.

Katherine Ho Dafny, Leemore S. and Robin S. Lee. The price effects of cross-market mergers: Theory and evidence from the hospital industry. *RAND Journal of Economics*, 50(2), 2019.

Matt Schmitt. Multimarket contact in the hospital industry. *American Economic Journal: Economic Policy*, 10(3), 2018.

Elena Prager and Matthew Schmitt. Employer consolidation and wages: Evidence from hospitals. *Washington Center for Equitable Growth Working Paper*, 2019.

Matt Schmitt. Do hospital mergers reduce costs? *Journal of health economics*, 52:74–94, 2017.

Stuart Craig, Matthew Grennan, and Ashley Swanson. Mergers and marginal costs: New evidence on hospital buyer power. Working paper, 2019.

Whitehouse Russell Schiraldi, Pasquale. Does hospital competition reduce rates of patient harm in the english nhs? *Working Paper*, 2019.

Edith Ramirez. Antitrust enforcement in health care controlling costs, improving quality. *New England Journal of Medicine*, 371(24):2245–2247, 2014.

Chohreh Partovian Zhenqiu Lin Jeph Herrin Jacqueline Grady Mitchell Conover Julia Montague Chloe Dillaway Kathleen Bartczak Lisa Suter Joseph Ross Susannah Bernheim Harlan Krumholz Elizabeth Drye Leora, Horwitz. Hospital-wide all-cause unplanned readmission measure, 2012.

Matthew S. Lewis and Kevin E. Pflum. Hospital systems and bargaining power: evidence from out-of-market acquisitions. *The RAND Journal of Economics*, 48(3):579–610, 2017.

Leemore Dafny, Kate Ho, and Robin S. Lee. The price effects of cross-market mergers: theory and evidence from the hospital industry. *The RAND Journal of Economics*, 50 (2):286–325, 2019.

Hospital mergers and acquisitions: does market consolidation harm patients? *Journal of Health Economics*, 19(5):767 – 791, 2000.

Carol Propper, Mauro Laudicella, and Martin Gaynor. Can governments do it better? merger mania and hospital outcomes in the english nhs. Working papers, Imperial College, London, Imperial College Business School, 2012.

Zack Cooper, Stephen Gibbons, Simon Jones, and Alistair McGuire. Does hospital competition save lives? evidence from the english nhs patient choice reforms. *Economic Journal*, 121(554):228–260, 2011.

Martin Gaynor, Rodrigo Moreno-Serra, and Carol Propper. Death by market power: Reform, competition, and patient outcomes in the national health service. *American Economic Journal: Economic Policy*, 5(4), 2013.

Atul Gupta. Impacts of performance pay for hospitals : The readmissions reduction program. 2017.

Jonathan T. Kolstad. Information and quality when motivation is intrinsic: Evidence from surgeon report cards. *American Economic Review*, 103(7), 2013.

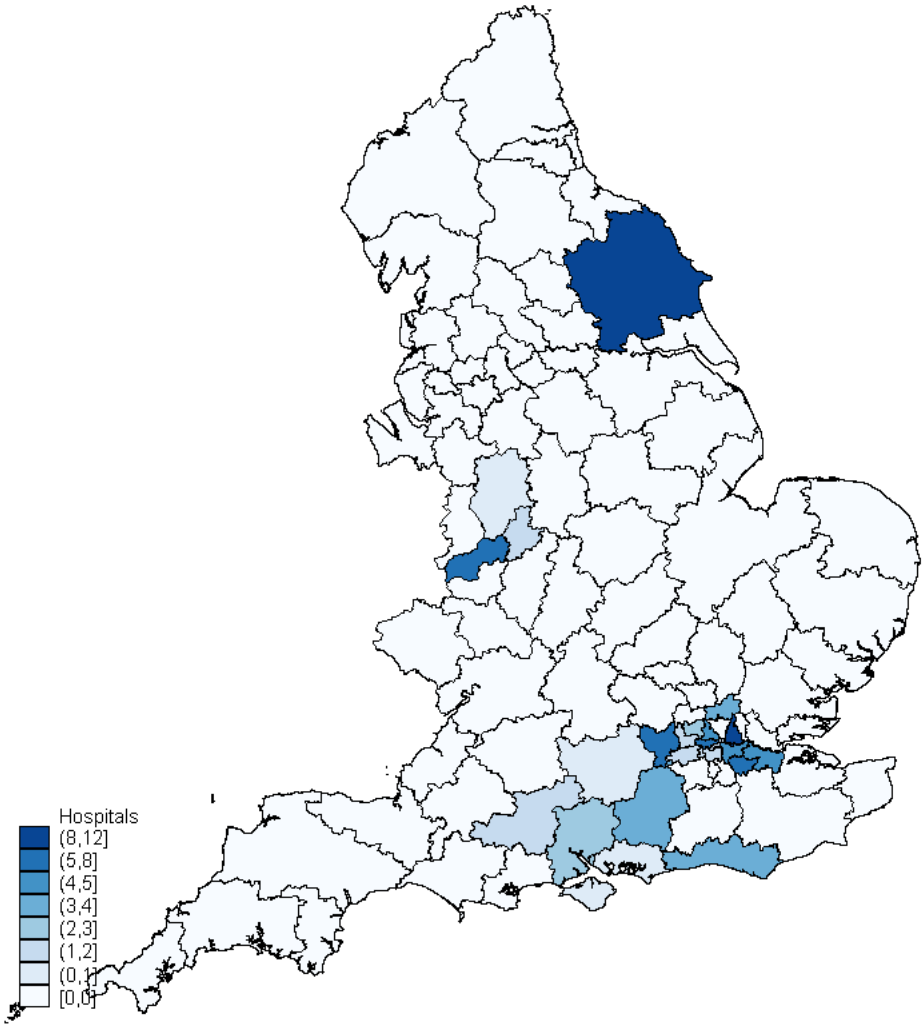
Martin Gaynor. What Do We Know About Competition and Quality in Health Care Markets? NBER Working Papers 12301, National Bureau of Economic Research, Inc, June 2006.

Zack Cooper, Stephen Gibbons, Simon Jones, and Alistair McGuire. Does hospital competition save lives?: evidence from the english nhs patient choice reforms. Technical report, London School of Economics and Political Science, LSE Library, 2010.

Guido W. Imbens and Jeffrey M. Wooldridge. Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*, 47(1):5–86, 2009.

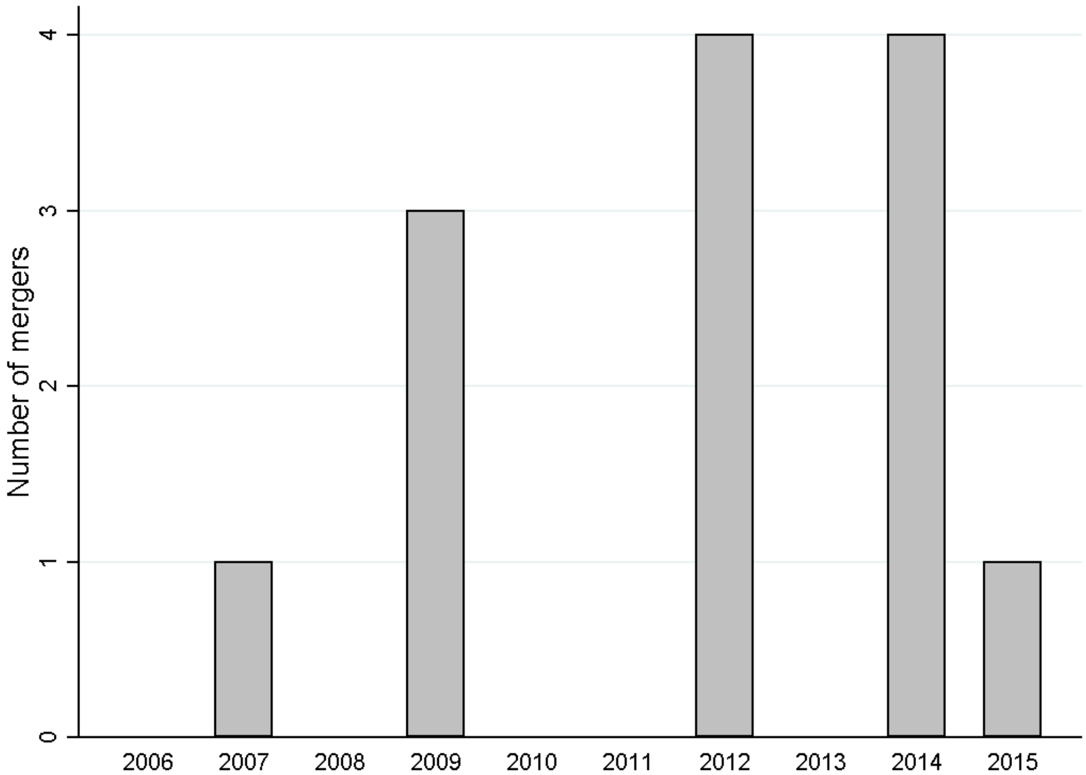
Figures and Tables

Figure 1: Hospital sites involved in mergers, 2006-2015



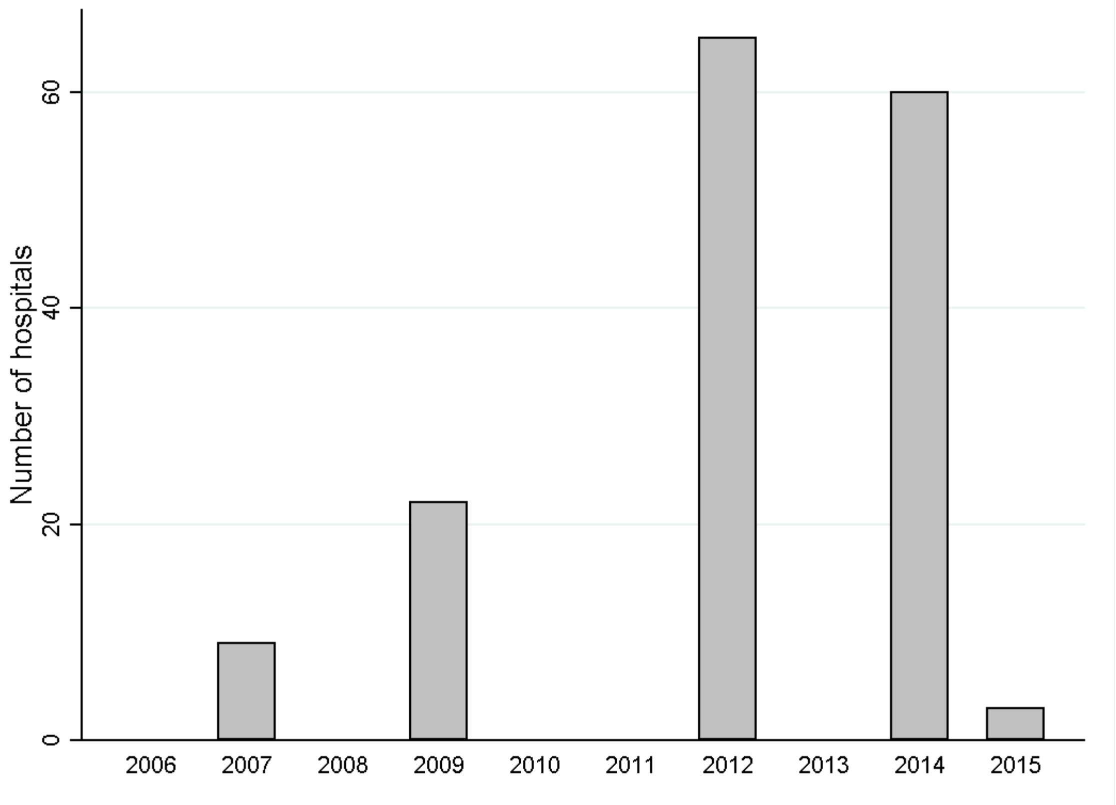
Notes: The figure shows the location of acute hospital sites involved in mergers in England between 2006 and 2015. We display the distribution of hospitals by postal area. Postcode areas used by Royal Mail for the purposes of directing mail within the United Kingdom. The postcode area is the largest geographical unit used and forms the initial characters of the alphanumeric UK postcode.

Figure 2: Number of NHS mergers 2006-2015



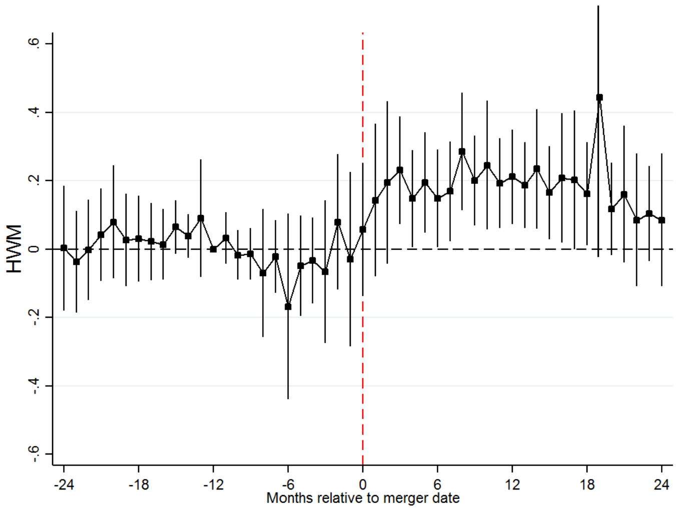
Notes: The Figure shows the number of mergers between Acute NHS Trusts in England between 2006-2015.

Figure 3: Number of NHS sites involved in mergers 2006-2015



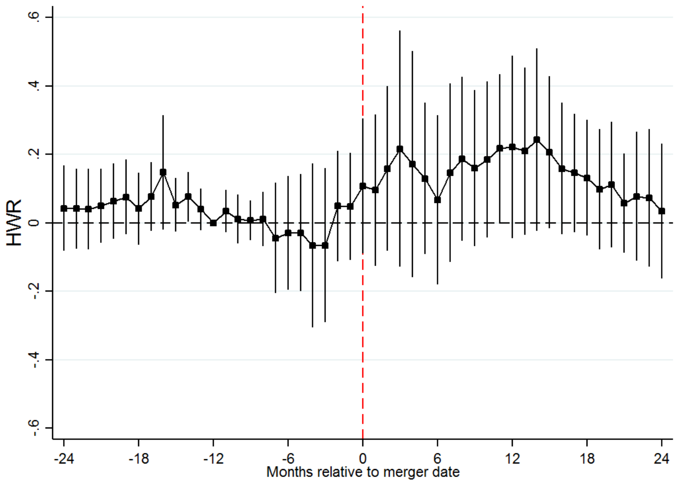
Notes: The Figure shows the number of hospital sites involved in mergers in England between 2006-2015.

Figure 4: Event study estimates of the impact of hospital mergers on in hospital mortality



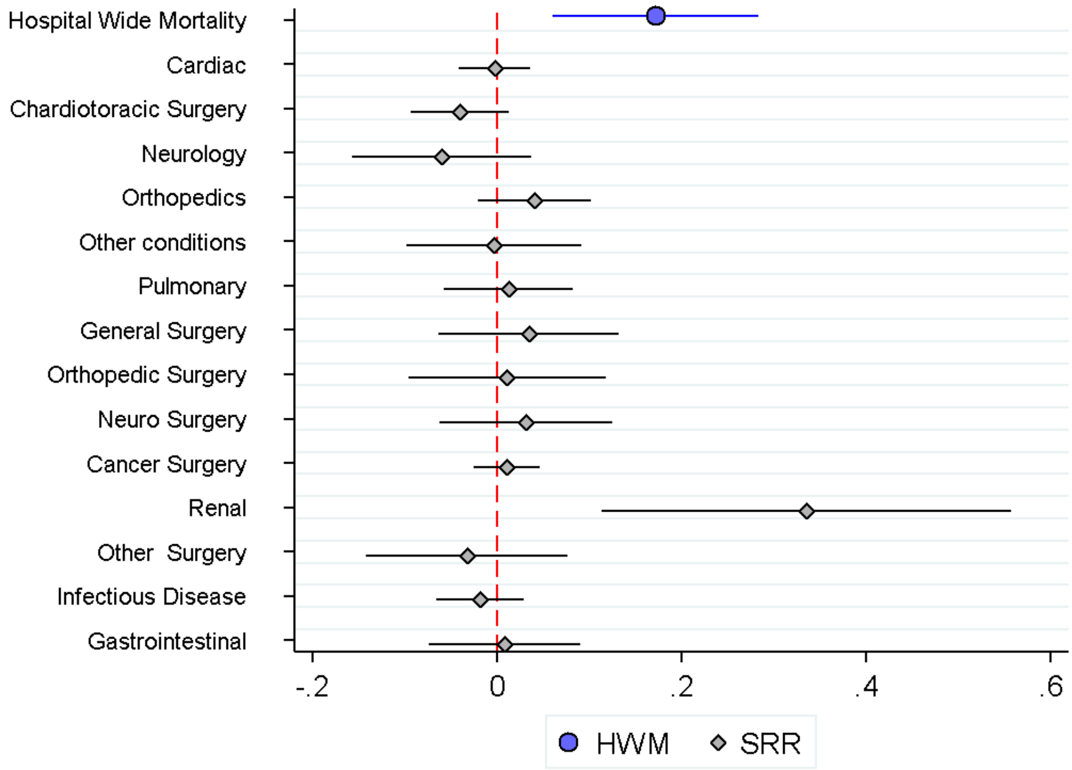
Notes: The Figure plots event study estimates and corresponding 95 percent confidence bands. Dependent variable is the Hospital Wide Risk Standardised Mortality Measure - HWM. The unit of observation is a hospital site. Estimation from OLS regression with standard errors clustered at hospital level. The regression includes calendar time fixed effects. Sample comprises all hospitals involved in a merger that belong to a trust providing acute-care services in England.

Figure 5: Event study estimates of the impact of hospital mergers on unplanned readmissions



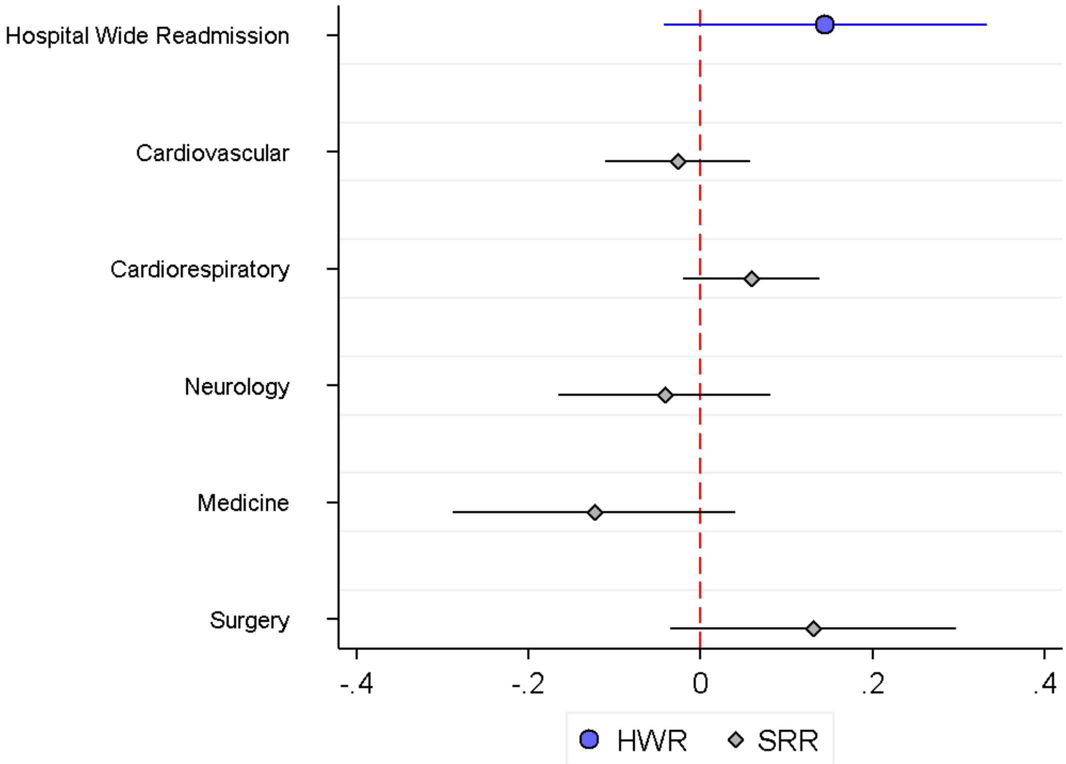
Notes: The Figure plots event study estimates and corresponding 95 percent confidence bands. Dependent variable is the Hospital Wide Risk Standardised Readmission Measure - HWR. The unit of observation is a hospital site. Estimation from OLS regression with standard errors clustered at hospital level. The regression includes calendar time fixed effects. Sample comprises all hospitals involved in a merger that belong to a trust providing acute-care services in England.

Figure 6: Impact of hospital mergers on mortality



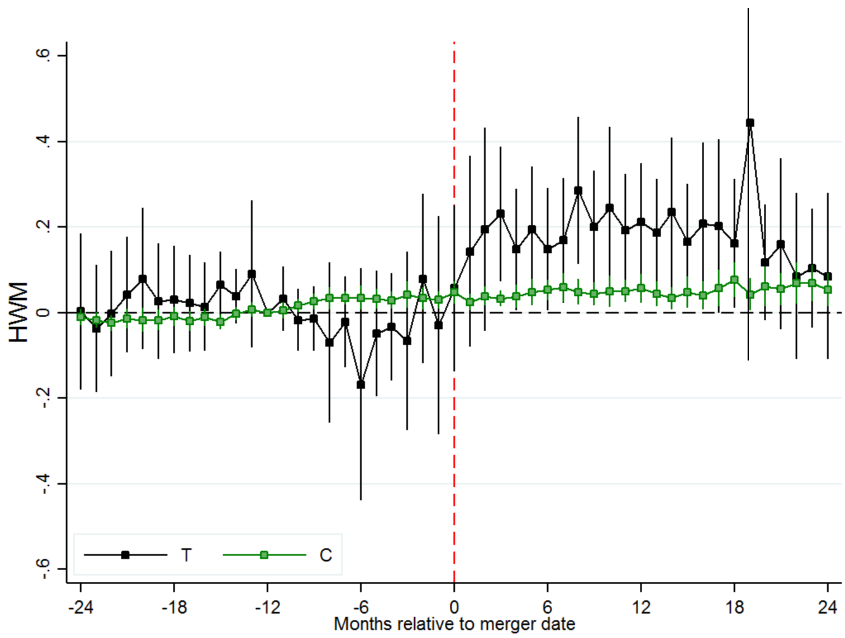
Notes: The Figure plots the estimates and corresponding 95 percent confidence bands of the difference in quality before and after the merger. Quality is measured using the Hospital Risk Standardised Mortality (HWM) measure, and the mortality Standardised Risk Ratio (SRR) for the specialty cohort estimates. The unit of observation is a hospital site. Estimation from OLS regression. The regression includes calendar time fixed effects. Standard errors are clustered at site level. Sample comprises all hospitals involved in a merger that belong to a trust providing acute-care services in England.

Figure 7: Impact of hospital mergers on unplanned readmissions



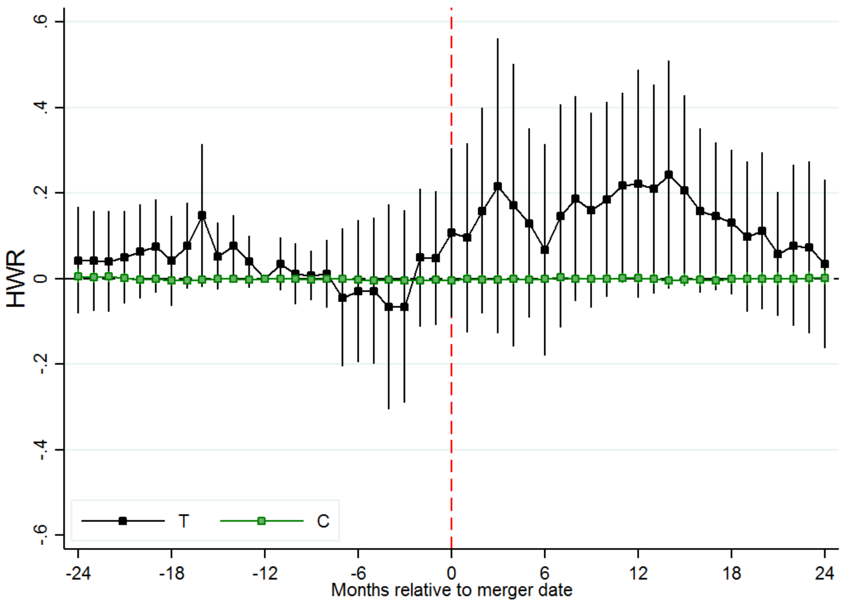
Notes: The Figure plots the estimates and corresponding 95 percent confidence bands of the difference in quality before and after the merger. Quality is measured using the Hospital Risk Standardised Mortality (HWM) measure, and the mortality Standardised Risk Ratio (SRR) for the specialty cohort estimates. The unit of observation is a hospital site. Estimation from OLS regression. The regression includes calendar time fixed effects. Standard errors are clustered at site level. Sample comprises all hospitals involved in a merger that belong to a trust providing acute-care services in England.

Figure 8: Event study estimates of the impact of hospital mergers on in hospital mortality - Placebo test



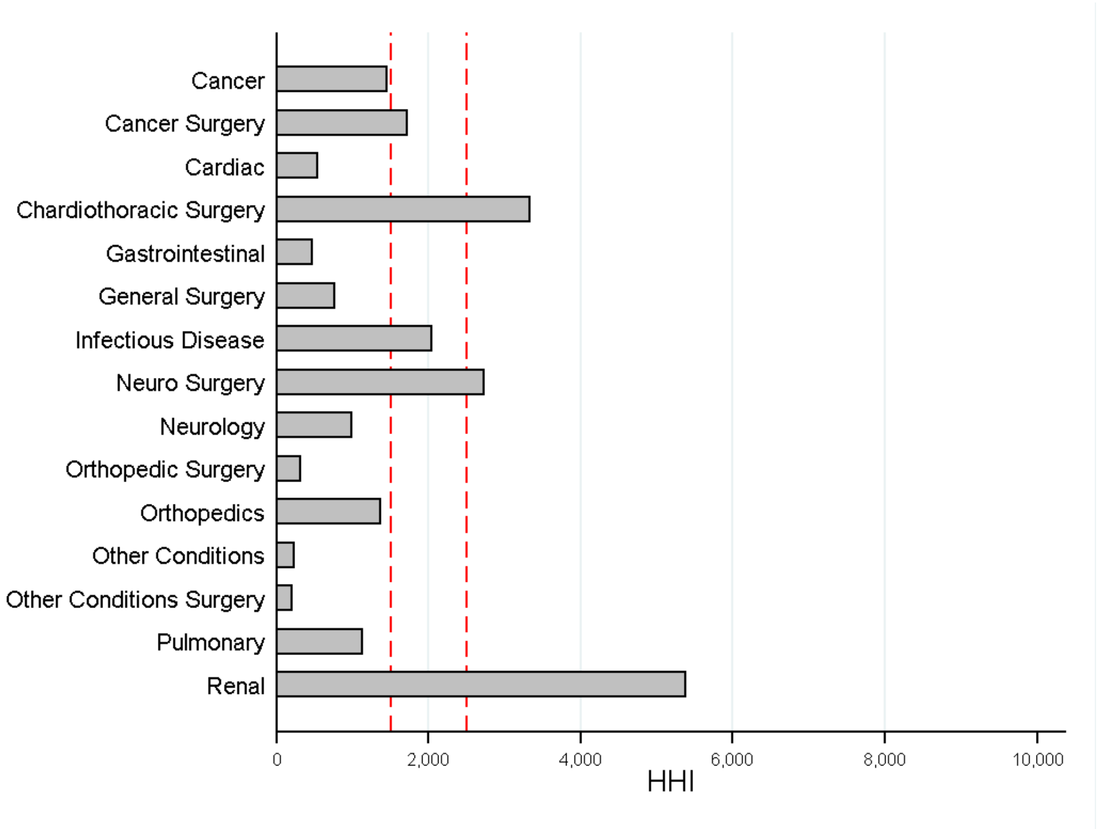
Notes: The Figure plots event study estimates and corresponding 95 percent confidence bands. Dependent variable is the Hospital Wide Risk Standardised Readmission Measure - HWR. The unit of observation is a hospital site. Estimation from OLS regression with standard errors clustered at hospital level. The regression includes calendar time fixed effects. Treatment sample comprises all hospitals involved in a merger that belong to a trust providing acute-care services in England. Control sample comprises all hospitals not involved in a merger that belong to a trust providing acute-care services in England.

Figure 9: Event study estimates of the impact of hospital mergers on unplanned readmissions-Placebo test



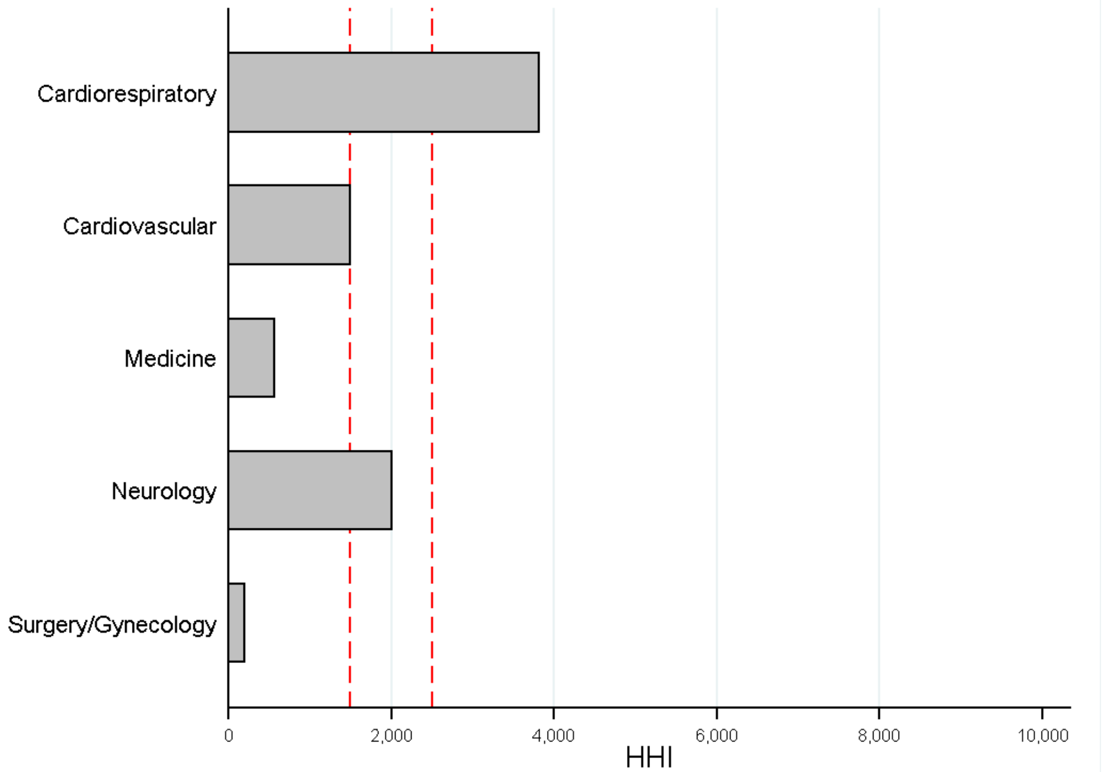
Notes: The Figure plots event study estimates and corresponding 95 percent confidence bands. Dependent variable is the Hospital Wide Risk Standardised Readmission Measure - HWR. The unit of observation is a hospital site. Estimation from OLS regression with standard errors clustered at hospital level. The regression includes calendar time fixed effects. Treatment sample comprises all hospitals involved in a merger that belong to a trust providing acute-care services in England. Control sample comprises all hospitals not involved in a merger that belong to a trust providing acute-care services in England.

Figure 10: Hospital-Specialty HHI for HWM categories



Notes: The Figure plots the average hospital-specialty HHI for the period -1 relative to the date of the merger. Sample comprises hospitals that have been involved in a merger in the period 2006-2015. Groupings of patients from HWM methodology. Red dashed lines denote antitrust authorities thresholds for moderately concentrated (1500¡HHI¡2500) and highly concentrated (HHI¿2000).

Figure 11: Hospital-Specialty HHI for HWR categories

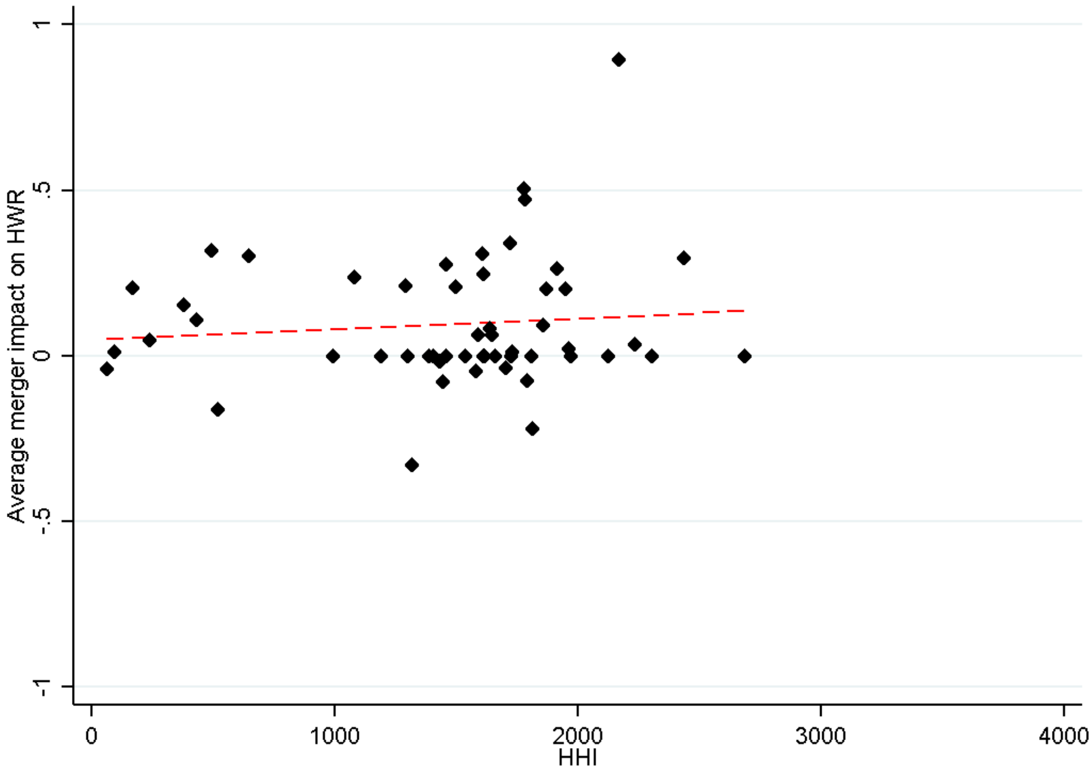


Notes: The Figure plots the average hospital-specialty HHI for the period -1 relative to the date of the merger. Sample comprises hospitals that have been involved in a merger in the period 2006-2015. Groupings of patients from the HWR methodology. Red dashed lines denote antitrust authorities thresholds for moderately concentrated (1500¡HHI¡2500) and highly concentrated (HHI¿2000).

Figure 12: Relationship between effect of mergers and pre-merger HHI

Notes: The Figure displays the relationship between average effect of mergers at hospital level and hospital level HHI in the period pre-merger. Average effect of merger estimated with OLS regression controlling for calendar time fixed effects.

Figure 13: Relationship between the effect of mergers and pre-merger HHI



Notes: The Figure displays the relationship between average effect of mergers at hospital level and hospital level HHI in the period pre-merger. Average effect of merger estimated with OLS regression controlling for calendar time fixed effects.

Table 1: Balancing of characteristics treatment and control group

	Treatment	Control	P-value	N-difference
Panel A: Trust characteristics				
Total number of sites	4.500	8.311	[0.000]	0.298
	(5.051)	(11.76)		
Acute sites	2.088	1.959	[0.210]	0.087
	(0.794)	(1.236)		
Available beds	696.700	937.700	[0.000]	0.472
	(265.500)	(435.700)		
Occupied beds	617.600	746.900	[0.000]	0.272
	(257.900)	(399.400)		
Total staff	4539.700	5105.400	[0.057]	0.159
	(2472.200)	(2552.500)		
Panel B: Hospital characteristics				
Admissions per month	277.400	275.400	[0.954]	0.004
	(328.800)	(366.300)		
Raw mortality rate	0.018	0.028	[0.003]	0.079
	(0.070)	(0.109)		
Raw readmission rate	0.137	0.081	[0.020]	0.194
	(0.250)	(0.146)		

Notes: Column 3 reports p-values from a test of equality of means carried out by OLS regression of each characteristic on a dummy for assignment to treatment. Standard errors are clustered at the site level. Column 4 reports normalized differences are computed following Imbens and Wooldridge [2009]. The sample comprises acute sites in England in the period 2006-2015. The control group includes all acute sites that have not been involved in a merger in the period of interest; the control group comprises all acute sites that have been involved in a merger in the period of interest. The number of sites, acute sites, available beds, occupied beds and total staff is at the year level and retrieved from the ERIC data. The number of patients, readmission rates and mortality rates are computed at the monthly level from the HES data.

Table 2: Summary statistics for quality measures

	Mean	SD	Min	Max
Hospital Wide Readmissions	1.050	0.505	0.242	12.764
Hospital Wide Mortality	0.831	1.004	0.019	34.861

Notes: The Table displays summary statistics for the risk adjusted hospital mortality and readmissions measure. The sample over which they are calculated includes all hospitals involved in a merger that belong to a trust providing acute-care services in England. The level of observation is the hospital in a given month-year.

Table 3: Summary statistics for competition measure

	Mean	SD	Min	Max
Herfindahl-Hirschman Index	1792.958	2278.348	0.000	10000.000

Notes: The Table displays summary statistics for HHI index for site-specialty relevant markets over the period 2006-2013. Sample comprises all hospitals operating in England.