Consolidations for Cost Savings?
Hospital Mergers and Service Repositioning

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Abstract

This paper studies whether merging hospitals eliminate duplicate services to save costs. When confronted with antitrust challenges, hospitals seeking mergers frequently claim substantial cost savings from consolidating their services to achieve economies of scale. Using the California Patient Discharge Data and Hospital Financial Report, we employ a difference-in-differences research design to empirically explore hospitals' post-merger service relocation. We find that targets and acquirers located within 10 miles of each other reduce on average 5.1 of their duplicate services. These adjacent merging hospitals also become more specialized in services, with the volume concentration measurement (Herfindahl-Hirschman Index) across services increasing by 10%. Compared to non-consolidated services, the consolidated services experience a reduction of per unit patient care costs with roughly 20%. These effects are only evident when the merging hospitals are geographically close to one another. Our findings identify a mechanism through which horizontal consolidations generate cost savings.

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1 Introduction

Mergers and acquisitions have been strikingly frequent in the health care industry in recent years, with over 700 acquisition deals announced between 2011 and 2017.[1] The standard antitrust concern is that such consolidations result in price increases due to reduced competition. The merging parties typically argue that their proposed mergers would generate efficiency gains, and that the resulting cost reductions would be passed on to consumers. While many published studies have looked at the price effects of such mergers and found evidence of price increases (Dafny, 2009; Haas-Wilson and Garmon, 2009; Garmon, 2017; Lewis and Pflum, 2017; Cooper et al., 2018), limited systematic evidence has been gathered on cost savings.

A mechanism by which a merger of competing hospitals could generate cost savings is through the elimination of duplicate services. When confronted with antitrust challenges, hospitals seeking mergers frequently claim they can generate substantial efficiency gains through service consolidation.[2] Consolidation of duplicate services can benefit hospitals in several ways. First, eliminating duplicate services generates cost savings on hospitals' capital investment (like medical equipment expenses) and payroll expenditures. Second, consolidating duplicate services to a single facility helps hospitals achieve scale economies. Thirdly, there is the potential for better coordination of care among physicians when hospitals remove services and become specialized. In spite of these potential benefits, hospitals may have difficulty consolidating services due to organizational, regulatory, or financial constraints, so it is an open question whether merging hospitals actually implement these kinds of changes.[3]

In this paper, we examine mergers in California between 2002-2014 and document how the merging hospitals reorganized their services. We investigate whether there exist post-merger consolidations of duplicate services and quantify the magnitude of service repositioning. We mainly study the service consolidation from two aspects. First, we use a difference-in-differences (DID) design to measure the decrease in the hospitals' number of services after mergers. We also analyze the change in the number of duplicate services offered by the merging hospital pairs,

[1] See Kaufman Hall (2019).

[2] For instance, in the case where the Federal Trade Commission (FTC) challenged the horizontal merger between OSF Healthcare System and Rockford Health System, the hospitals stated that the proposed merger could generate "substantial efficiencies." The CEO of OSF asserted that they would achieve the saving by "consolidations of several services (such as trauma, women's and children's, and cardiovascular surgery)" and "combining patient volume [...] to meet or exceeds (the generally-accepted minimum patient volume) thresholds associated with improved outcomes" which both hospitals did not meet independently. Similarly, to defend the proposed merger between the Penn State Hershey Medical Center and PinnacleHealth System, the defendants argued that they "intend(ed) to move low acuity cases from Hershey to Pinnacle and high acuity cases from Pinnacle to Hershey" to achieve service consolidation.

[3] FTC pointed out, there "may exist possible physician resistance and regulatory approval difficulty, [...] numerous cultural, financial, regulatory and other practical issues", which may thwart a hospital's pursuit of service consolidation.

to check if the services removed by hospitals are duplicates for the merging entities. Because the service consolidation is effective only if merging hospitals are geographically close to one another, we allow heterogeneous effect of mergers for geographically close mergers and distant mergers and compare their differences. The change in the total number of services offered by the hospitals is also examined to determine if the service change is in the form of duplicate deletion or removal of services from both members of the merging pair. Using the California Patient Discharge Data, we map the procedures performed by hospitals to services based on the Clinical Classification Software's (CCS) Level 2 categorization of procedure codes. We find that a merging entity removes approximately 4.6 services if the merging hospitals are within 10 miles of one another, but this effect is not evident when the merging hospitals are more distant. For the merging pairs within 10 miles, we find they on average remove 5.1 duplicate services, while the total number of services offered by these pairs does not have a significant change.

We also examine whether service volumes become more concentrated after the hospitals merge. While it may be difficult or undesirable to shut down a service entirely, hospitals may steer the majority of patients to one location in order to achieve scale economies.[4] Analysis of service volumes allows us to identify those services repositioned in the form of volume reshuffle. We find that the volume Herfindahl-Hirschman Index (HHI) across the services of individual hospitals increases by 10-12% for merging hospitals within 10 miles of one another. We then aggregate the service volume of the merging pairs and build the HHI measurement across services for a given merging pair. Our analysis shows that the pair HHI across services remains stable after mergers. These results suggest the service spectrum remains stable for the merging pairs, and that service consolidation happens at the individual facilities within the adjacent merging pairs. These analyses offer information about how services that are not entirely eliminated are effected by the merger. Additionally, we find that service consolidation mostly occurs in the cardiac procedures, obstetrics and other female-related services.

Finally, we find evidence that the service consolidations of merging hospitals leads to cost reductions and no significant change on service quality change patients' travel distance. We use the service-specific direct expense from the California Hospital Financial Report as our measure of cost,[5] and build standardized per-unit cost measurement for services. We compare the per

[4]Traditional work using aggregated hospital financial and output date find mixed evidence about the existence of scale economies in hospital production. For instance, Carey (1997), Preyra and Pink (2006), Kristensen et al. (2012), Gonçalves and Barros (2013) find evidence of scale economics in hospitals, while Dranove (1998) find limited evidence of scale economies. The literature on scope economies in hospital production is also inconclusive. More recent work by Gaynor, Kleiner and Vogt (2015) uses micro data to control output variation and finds substantial scale economies and scope diseconomies in some services.

[5]The direct expense of a service mainly includes the payroll expenditure for the physicians, supplies, and capital costs like leases, rentals and equipment depreciation. The non-service costs, like fiscal and administrative

unit service cost of consolidated and non-consolidated services of merging hospital pairs, and also analyze the heterogeneous effect of service cost changes across merging pairs of different geographic distances. The results show that service consolidation brings a cost reduction of 20%, which is roughly $277 for cardiac catheterization, and $13 for echocardiology services. When it comes to the impacts on patients, we find the readmission rate of consolidated services remain stable, while the travel distance of patients increase by a minor and insignificant amount.

This paper contributes to the ongoing literature evaluating the cost savings of hospitals from mergers. Prior literature has found mixed evidence on whether mergers lead to cost reduction. Some researchers find significant cost reductions post-merger (Harrison, 2011; Schmitt, 2017), while some others do not (Dranove and Lindrooth, 2003; Spang, Arnould and Bazzoli, 2009). This literature typically searches for evidence of cost reductions directly in the hospital financial data. By contrast, in this paper we concentrate on a specific mechanism, service consolidation, whereby hospital mergers are purported to generate cost savings from scale economies. We find that service consolidation brings significant cost savings for the geographically close mergers. This paper also adds new insights to the emerging literature exploring the efficiency improvement mechanism of the merging hospitals. Craig, Grennan and Swanson (2018) identified a specific mechanism that hospitals can decrease costs via leveraging their bargaining power to purchase medical supplies at lower prices. We identify another mechanism of service consolidation which is neglected in the present literature. Based on our results, a critical question for policymakers is how to pass the surplus created by the hospitals to consumers.[6]

Our work also contributes to the literature on post-merger endogenous produce choice of multi-product firms. Theoretical work by Gandhi et al. (2008) and Mazzeo, Seim and Varela (2013) show that a merging firm may choose to reposition its products to differentiate to its merging partners. This repositioning may mitigate the post-merger increase in product prices. Product choice by merging firms is also empirically investigated in music radio (Sweeting, 2010, 2013; Berry, Eizenberg and Waldfogel, 2016), smartphones (Fan and Yang, 2016), the airline industry (Ciliberto, Murry and Tamer, 2016), and the shampoo market (Mao, 2019). We contribute to this string of literature by documenting endogenous product choice in the healthcare industry.

The rest of the paper is organized as follows. Section 2 describes the data we use and provides information about the sample. In section 3, we outline the empirical methodology

spending, are not included.

[6]One potential choice for policymakers could be the price-cap in the Beth Israel Deaconess Medical Center and Lahey Health System's merger.

and present the results with the service repositioning patterns of merging hospitals. Section 4 presents the implications for providers and patients, including the post-repositioning provider cost changes, service quality analysis, and impact on the patients' travel distance. In section 5, we discuss and conclude.

2 Data & Background

We mainly use four data sources to study the service repositioning of post-merger hospitals: (1) Hospital Merger Activity Dataset (Cooper et al., 2018), (2) California Patient Discharge Dataset, (3) California Hospital Financial Report, and (4) American Hospital Association Annual Survey.

Hospital Merger Activity Dataset The Merger Activity Dataset built by Cooper et al. (2018) provides information about the horizontal hospital mergers. The dataset contains a panel of hospitals from the year 2000-2014. It includes the following variables: the system identifier of hospitals, the indicator for whether the hospital is a target/acquirer in every year, and the longitude and latitude of the hospitals. The geographic information and the system identifier together help us to recognize the geographically closest merging counterparts for every target/acquirer. We categorize the mergers based on the target/acquirer's distance to its closest merging counterparts.

California Patient Discharge Data All non-federal California-licensed hospitals are required to report every patient discharge record from their facilities, and we use these discharge data from 2002-2014 to determine which services each hospital offered. Each reported discharge includes detailed patient demographic information, the diagnoses and procedures related to the discharge in the form of ICD-9 code, and charge based on the listed price. We mainly exploit the diagnosis and procedures to build metrics of hospital services and service volumes, which is discussed in full detail in Section 2.1.

California Hospital Financial Disclosure Reports All California-licensed general acute hospitals are required to file detailed annual financial disclosure reports. The report is audited and provides information about various aspects of hospital operations, including capacity, medical staff, utilization, ownership type, balance sheets, income statements, revenue, and expenses. For the medical staff, beds, utilization, and expenses, the reports provide detailed information by service categories. We mainly use the comprehensive cost information from the financial dataset to evaluate the cost change related to service consolidation by comparing the per-unit cost of consolidated and non-consolidated services. The per-unit service cost is defined as the adjusted direct expenses of each service category over the total units performed by the hospitals for that service.

American Hospital Association Annual Survey (AHA) To test whether the repositioning differs across the targets and acquirers, we expand the study to a national sample of hospitals. The sample size in the AHA data is significantly larger than California, thus enables us to study the targets and acquirers separately. We use the American Hospital Association (AHA) Annual Survey to study the services provided by the hospitals. The AHA dataset covers over 80% of all hospitals in the U.S. and contains general information like ownership type, the total number of beds, total discharges. Moreover, it contains the service provision indicators for a list of 120 services. We adopt these service indicators to determine the service offered by the hospitals and test if merging hospitals remove duplicates. However, unlike the discharge data, the AHA dataset does not cover service volume information. It does not allow us to investigate whether service repositioning occurs in any form subtler than complete service removal.

2.1 Service Definition using Patient Discharge Data

The primary dataset we use to build the service spectrum of hospitals is the California Patient Discharge Data. For the baseline analysis, we define the services based on the procedures hospitals performed. In the California Discharge Data, each discharge records includes the detailed ICD-9 procedure codes. There are 3,948 distinct ICD-9 procedure codes, and we use the Clinical Classifications Software (CCS) for ICD-9-CM to categorize procedure codes and map them into more broadly defined services. The CCS is a diagnosis and procedure categorization scheme that is developed as part of the Healthcare Cost and Utilization Project (HCUP). CCS collapses the ICD codes into a smaller number of clinically meaningful categories, and we define the services at Level 2 of the multiple level procedure categories. The Level 2 of procedure categories classifies procedure codes into 207 distinct categories. We map all the procedures hospitals performed to these 207 services and analyze changes in hospitals' provision of these services. Additionally, CCS also classifies the diagnosis codes, which serve as an alternative definition of service. We also use CCS to map diagnosis codes from discharges to services and run robustness checks in Section 3.4.1.

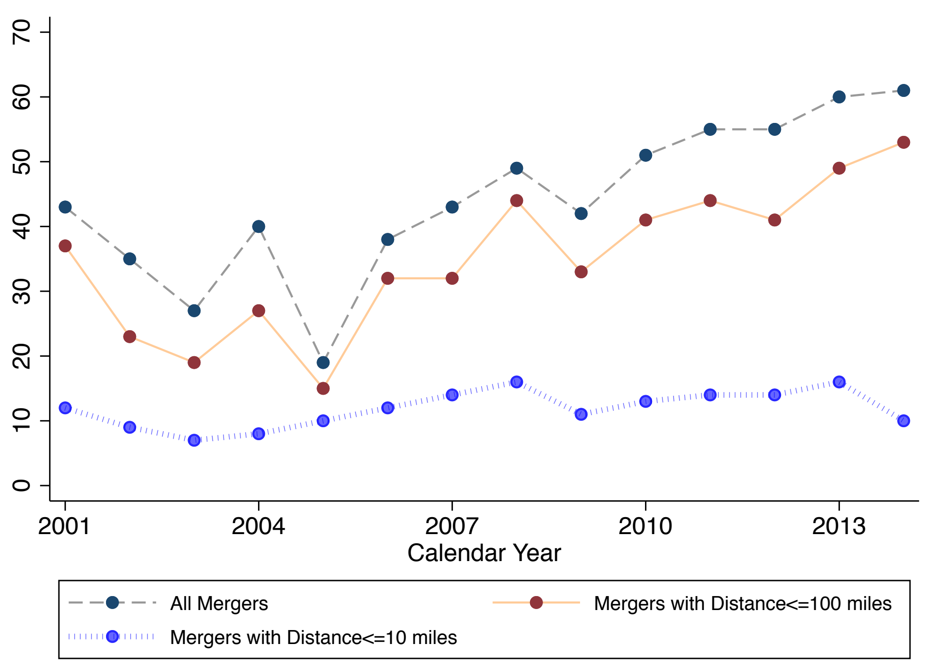


Figure 1: Hospital Merger Transactions, 2001-2014

2.2 Merger Activity & Sample

Merger Activity The Hospital Merger Activity Dataset provides us the information about merger activities, and we categorize these mergers based on distances between merging entities. For two systems of hospitals involving in a merger, System S_1 and System S_2, we temporarily assume these systems have L and K hospitals separately, where $L \geq 1$ and $K \geq 1$. We denote them as $S_1 = \{H_1^1, H_2^1, .., H_L^1\}$ and $S_2 = \{H_1^2, H_2^2, .., H_K^2\}$, where H_i^s stands for a hospital i belonging to System $s \in \{1, 2\}$, with $i \leq L$ for S_1 and $i \leq K$ for S_2. For a hospital H_l^1 belonging to S_1, we call $H_1^2, H_2^2, .., H_K^2$ its merging counterparts because they are from the other system involving in the merger transaction. This merging hospital H_l^1 is said to have a merging counterparts within 10 miles if there exists a hospital H_k^2 from S^2 whose geographic distance with H_1^1 is no larger than 10 miles. This hospital pair (H_l^1, H_k^1) is called a within-10-mile merging pair. We define a merger transaction to be within 10 miles as long as there exists a hospital pair (H_l^1, H_k^2) whose distance is no larger than 10 miles.

Figure 1 summarizes hospital horizontal merger transactions in the U.S. from the year 2001 to 2014. The grey dashed line stands for all transactions, the orange line is the number of mergers whose closest merging entities are no further than 100 miles geographically, and the blue dotted line is for the transactions with merging hospitals no further than 10 miles. The figure shows that horizontal mergers of hospitals frequently involve merging hospitals that are geographically close to one another. A similar situation also exists in California. Figure 2 exhibits the scatter of merging hospitals in California in the sample we built (described in the next paragraph. The yellow points indicate merging hospitals with counterparts within 10 miles, blue is for hospitals with merging counterparts between 10-100 miles, and purple stands for the merging hospitals further away. There exists a nontrivial proportion of geographically close mergers.

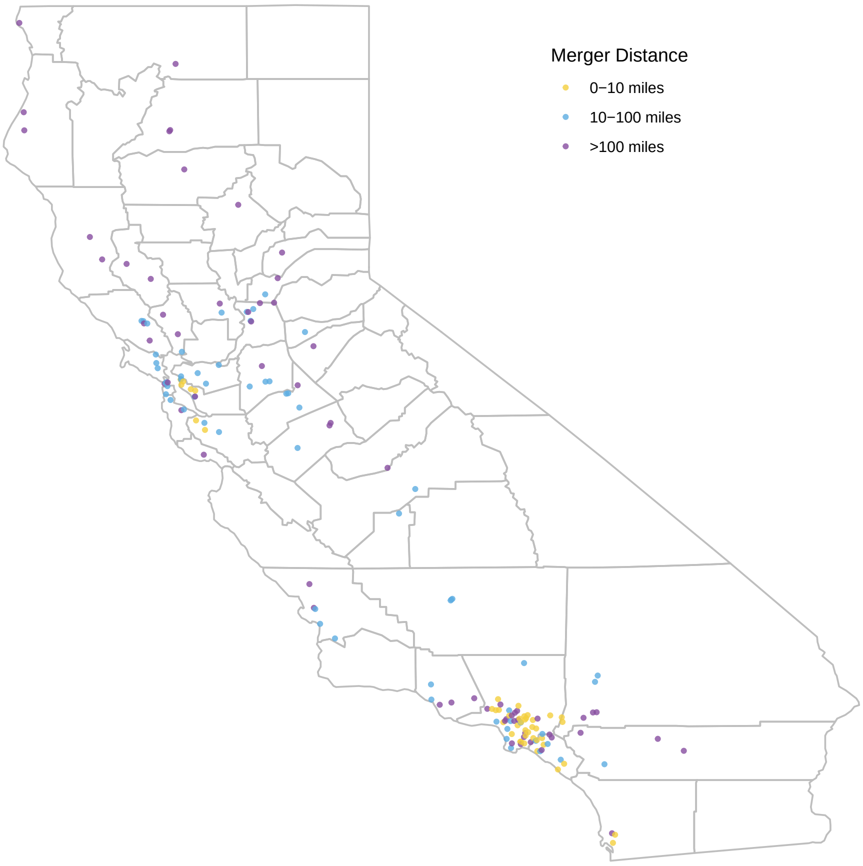


Figure 2: Merging Hospitals in California by Distance

Sample Construction For our primary analysis, we use a similar sample as Gaynor, Kleiner and Vogt (2015) with the California data. We concentrate on the general hospitals with excluding children's hospitals, and hospitals specializing in psychiatric, chemical dependency, or long-term care. After all data trimming, our sample includes 355 California hospitals. Based on the previous service definition, the summary statistics of the California hospitals in the beginning year of the sample period (the year 2002) is presented in Table 1.[7] The first to the

[7]Hospital HHI across services in Table 1 is defined in Section 3.3.1.

third columns show the summary statistics of merging hospitals based on their distance to the closest merging counterparts, and the fourth column presents the statistics of the non-merging hospitals. In the first three columns, the merging hospital characteristics are similar across distance groups. However, the non-merging hospitals are different from the merging entities in some characteristics. The merging hospitals offer more services than the non-merging hospitals and are not as concentrated in service offerings as the non-merging hospitals. Meanwhile, the merging hospitals are operated at lower total patient care costs compared to the non-merging hospitals. Moreover, the merging hospitals treat more complicated patients because they are of a higher case-mix index.[8]

Figure 3 depicts the change in the number of services over time for merging hospitals from different distance group and non-merging hospitals. The solid blue line stands for the merging hospitals within 10 miles, and the long-dashed red line presents the merging hospitals with counterparts in 10-100 miles, while the further merging entities are shown in the dash-dot green line. The orange short-dash line traces the number of services of the non-merging hospitals. For non-merging hospitals, their services are relatively stable over time, but the merging hospitals have a decreasing trend in the services they cover. The graph shows that the mergers within 10 miles decrease at a faster speed in the number of services compared to the further mergers.

Figure 3: Number of Services over Time by Distance Group

[8]The Case-Mix Index (CMI) is the average relative DRG weight of a hospital's inpatient discharges, calculated by summing the Medicare Severity-Diagnosis Related Group (MS-DRG) weight for each discharge and dividing the total by the number of discharges. The CMI reflects the diversity, clinical complexity, and resource needs of all the patients in the hospital. A higher CMI indicates a more complex and resource-intensive case load. Although the MS-DRG weights, provided by the Centers for Medicare & Medicaid Services (CMS), were designed for the Medicare population, they are applied here to all discharges regardless of payer.

Table 1: Summary Statistics of California OSHPD & Financial Data at Year 2002

	Merged <10 miles	Merged 10-100 miles	Merged >100 miles	Non-merged All
Number of services (by proc)	159.0	162.8	164.2	138.1
	(24.63)	(28.95)	(26.71)	(54.40)
Number of services (by diag)	130.0	131.9	132.8	125.7
	(5.866)	(4.588)	(4.892)	(15.92)
Hospital HHI across services (by proc)	1158.2	924.8	927.3	1647.9
	(592.0)	(688.7)	(428.1)	(1856.2)
Hospital HHI across services (by diag)	337.4	361.3	338.3	354.6
	(69.63)	(80.06)	(63.79)	(142.8)
Case-mix index	1.072	1.061	1.111	1.045
	(0.235)	(0.192)	(0.196)	(0.221)
Number of staffed beds	181.5	213.0	204.8	184.8
	(99.83)	(157.9)	(116.3)	(164.4)
Total discharges	8735.0	10875.0	9506.6	9018.6
	(5585.7)	(7038.1)	(5837.0)	(8762.1)
Board certified/eligible physicians	253.2	343.6	248.8	224.6
	(187.1)	(264.0)	(194.1)	(267.3)
Total discharge days (in thousand)	45.59	52.67	43.43	45.56
	(27.71)	(36.98)	(25.83)	(42.57)
Total patient care cost (in million)	95.50	129.4	107.0	123.8
	(70.75)	(102.3)	(66.28)	(161.1)
Number of Hospitals	41	60	64	190

3 Empirical Analysis on Service Repositioning Pattern

3.1 Effects of Service Consolidation

An illustrative example of service consolidation is presented in Figure 4. We use two hospitals in the previously mentioned antitrust case (mentioned in Section 1 Footnote 1), OSF Medical Center and Memorial Rockford hospitals, as an example. These hospitals claimed they would consolidate their cardiovascular surgery and trauma services if the FTC cleared their proposed merger, and we use these two services in our illustration. The left blue box indicates the hospitals' pre-merger service volumes, and the right yellow box stands for post-merger. One possible way in which these two hospitals might consolidate their cardiovascular surgery and trauma services is by eliminating trauma at OSF Anthony Medical Center, eliminating car-

	OSF Anthony Medical Center	Rockford Memorial Hospital
Cardiovascular surgery	200	250
Trauma	300	200

	OSF Anthony Medical Center	Rockford Memorial Hospital
Cardiovascular surgery	0	430
Trauma	450	0

Figure 4: Illustrative Example of Service Consolidation with Service Removal

diovascular surgery at Memorial Rockford, and steering eliminated service's patient volume to the other hospital. In this scenario, both the cardiovascular surgery and trauma services are consolidated and only provided by a single facility.

Consolidation like that described in the example above has two effects, one on the total number of services offered by each hospital, and the other on the number of duplicate services:

- Effect 1 (Individual Facility Concentration): At the facility level, a merging hospital pursuing service consolidation decreases its number of services offered.
- Effect 2 (Within System Differentiation): The service consolidation leads to a decrease in the number of duplicate services across the merging hospitals.

Effect 1 stems from the phenomenon that each hospital participating in the service consolidation shifts some of its services to the other merging hospital. This repositioning leads to a decrease in the number of services the hospital offers. Figure 5 highlights this effect for the example given in Figure 4, showing that after the merger, the number of services offered by each hospital decreases from two to one. In other words, Effect 1 reflects the fact that hospitals pursuing service consolidation become specialized and concentrated because they provide fewer services than before.

Meanwhile, if we choose to summarize the offering list at the service level, the service consolidation shifts the services previously spread between two facilities into a single location. Effect 2 captures this idea. The illustration example is shown in Figure 6, which summarizes the hospitals' service information horizontally by services. In this example, cardiovascular surgery and the trauma service are provided by both hospitals pre-merger but are available at only one facility post-merger. The merging pair therefore become more differentiated in terms of the services each provides.

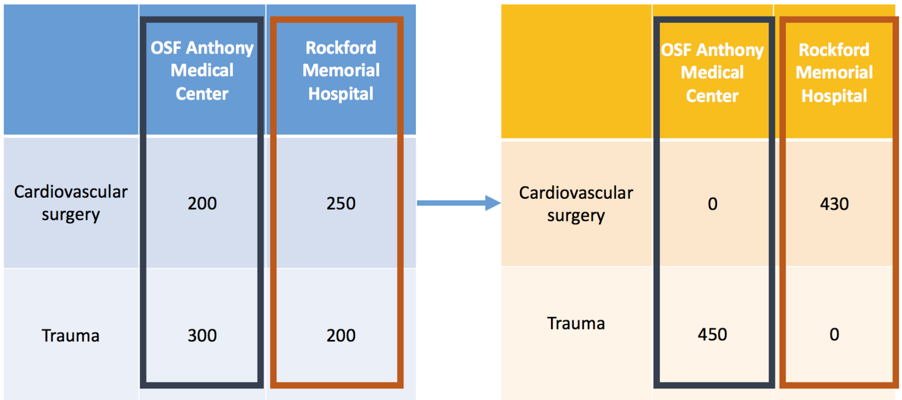


Figure 5: Illustration for Effect 1

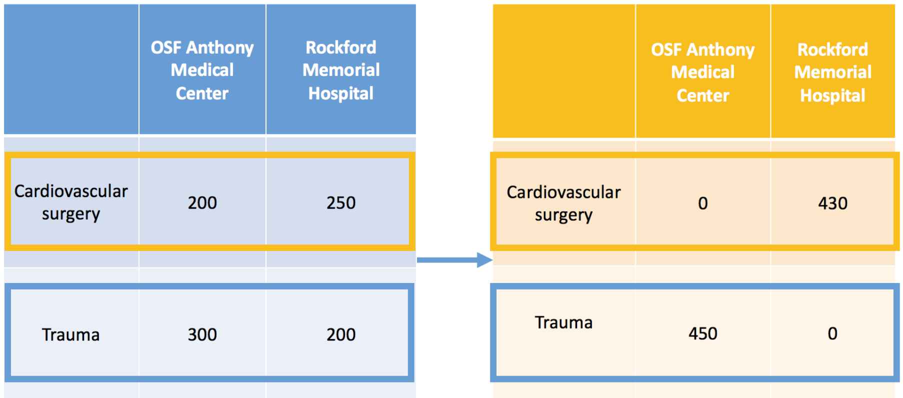


Figure 6: Illustration for Effect 2

These two effects depicts two dimensions of service consolidation. If merging hospitals remove services but mainly remove their unique services, Effect 1 still holds but Effect 2 does not exist. On the other hand, if merging hospitals replace their duplicate services with new services that the other side of merging hospitals do not provide, then we would only observe Effect 2 but not Effect 1. In our assessment of service consolidation, we will examine both of these effects by looking at both changes in the number of services provided by each facility as well as the number of duplicate services available across facilities.

However, because the services we defined are based on aggregated procedure categories, analyses using the number of services neglect the service changes happening at the subcategory level. Moreover, while it may be organizationally difficult to remove or relocate a service entirely, hospitals may try to consolidate services in more subtle ways by redirecting patient flows in a way that concentrates volume at one facility. An example of such reshuffling is illustrated in Figure 7, which alters the previous example to depict service consolidation through patient volume reallocation rather than service removal. Here, OSF Anthony Medical Center keeps some cardiovascular surgery services (e.g. maze surgery), but moves the majority to Rockford

Memorial Hospital. Both of the hospitals still keep cardiovascular surgery, but the volume is highly concentrated in one facility. This type of service consolidation can be described by two effects:

- Effect 1.b. (Individual Facility Concentration of Service Volume): At the facility level, a merging hospital pursuing service consolidation by reallocating patient volume experiences an increase in the concentration of volumes across services.
- Effect 2.b.(Within System Differentiation of Service Volume): For a given service, service relocation concentrates patient volumes in a single facility, increasing the volume HHI across hospitals for that consolidated service.

Effect 1.b. & 2.b. follow the same intuition as the Effect 1 & 2, but change the measurement of consolidation from the number of services to the volume of services performed. There are mainly two benefits to these analyses with the service volume. First, volume catches the change in services present in the absence of complete removal of duplicates. Second, the study with volume evaluates the magnitude of service repositioning from the utilization perspective. If the consolidated services are mainly low-volume services, they will not significantly impact the service volume concentration across services. Therefore, the service volume analysis supplements the number of services results by quantifying the impact on utilization.

	OSF Anthony Medical Center	Rockford Memorial Hospital
Cardiovascular surgery	200	250
Trauma	300	200

	OSF Anthony Medical Center	Rockford Memorial Hospital
Cardiovascular surgery	30	400
Trauma	400	60

Figure 7: Illustrative Example of Consolidation without Service Removal

However, even if we observe the hospitals dropping duplicate services, it may be that the newly merging system is shifting its service spectrum for the whole system and remove some service in every facility. This strategy leads to removal of services from both members of a merging pair, while the service consolidation results in removal in only one hospital but keeping that service in the other. To tell which mechanism drives the change of the hospital services, we analyze the number of services and service concentration of the hospital pairs.

Finally, we also study the heterogeneous effect of mergers across different geographic distance.[9] Service consolidation is feasible only if the merging hospitals are geographically close. If two hospital facilities are distant from each other, it is not realistic to combine the service volume of a given service into a single location as patients are sensitive to travel distance.[10] Thus, we decompose the effects of service consolidation by mergers of different distance groups to seek the effective distance of service consolidation.

In the following section, we detail the specifications used to examine the above effects and present results.

3.2 Number of Services

3.2.1 Effect 1

To start with, we use the following staggering difference-in-differences model to quantify Effect 1:

$$n_{it} = \alpha_i + \gamma_t + \lambda \cdot \mathbb{1}[i \in \mathcal{M}, t \geq \tau_i] + \epsilon_{it}. \tag{1}$$

In Equation 1, n_{it} denotes the number of services provided by hospital i in year t. α_i denotes hospital fixed effects. γ_t is the year fixed effect included to absorb any time trend. $\mathbb{1}[i \in \mathcal{M}, t \geq \tau_i]$ is a binary variable indicating whether hospital i is in the treatment group of merging hospitals $\mathcal{M}$ and year t is in or later than the treatment year τ_i. λ represents the treatment effect and it shows how the number of services changes relative to the control group.

For the baseline analysis, we only include the targets/acquirers whose closest merging counterparts are within 100 miles, and exclude all non-merging hospitals.[11] This avoids potentially biased comparison of merging and non-merging hospitals since there is likely selection into merger activity in this market. Furthermore, because service consolidation is sensitive to the distance between the merging hospitals, we decompose the mergers within 100 miles into two distance groups, a close merging group whose closest merging counterparts are located no further than 10 miles apart, and another group of hospitals involved in mergers of distances between 10-100 miles, as in Equation 2, where λ_g is the post-merger effect of the hospital i belongs to the distance group $\mathcal{G}_g \in \{\mathcal{G}_1, \mathcal{G}_2\}$. $\mathcal{G}_1$ stands for the hospitals with merging counterparts 0-10

[9] A theoretical model to illustate the distance is important to service removal decision is in Appendix Section

[10] For instance, Gowrisankaran, Nevo and Town (2015) find that a five minute increase in travel time to a hospital reduces demand between 17 and 41 percent.

[11] For the baseline regressions, we do not include mergers further than 100 miles, for the worry that the geographically closed mergers may be different from the distant out-of-market mergers. For instance, a merging hospital which has a merging partner within 10 miles may not be comparable to another hospital whose closest merging counterparts are 300 miles away.

miles away, and $\mathcal{G}_2$ is for those with merging counterparts 10-100 miles away.

$$n_{it} = \alpha_i + \gamma_t + \sum_g \lambda_g \cdot \mathbb{1}[t \geq \tau_i] \times \mathbb{1}[i \in \mathcal{G}_g] + \epsilon_{it}. \tag{2}$$

Additionally, to fully understand the evolution of service repositioning after mergers, we also conduct an event study to decompose the effect of mergers on consolidation over time as

$$n_{it} = \alpha_i + \gamma_t + \sum_{k=-5}^{3} \lambda_{k1} \cdot \mathbb{1}[t = \tau_i + k] \times \mathbb{1}[i \in \mathcal{G}_1] + \sum_{k=-5}^{3} \lambda_{k2} \cdot \mathbb{1}[t = \tau_i + k] \times \mathbb{1}[i \in \mathcal{G}_2] + \epsilon_{it}. \tag{3}$$

We group observations that are five or more years prior to the treatment year into $k = -5$, and $k = 3$ indicates three or more years after the merger. λ_{kg} presents the effect on service repositioning of being k years post merger for group $\mathcal{G}_g$.

3.2.2 Effect 2

We analyze the number of duplicate services of hospitals pairs to measure Effect 2. The number of duplicate services are built by pairing every two hospitals in the sample and counting the number of shared services of the hospital pairs. Specifically, we estimate the following equation

$$d_{pt} = \alpha_p + \gamma_t + \sum_g \lambda_g \cdot \mathtt{1}[p \in \mathcal{M}_g, t \geq \tau_p] + \epsilon_{pt}, \tag{4}$$

where p is for hospital-pair identifier, d_{pt} indicates the number of duplicate services for the hospital pair p at time t. $\mathcal{M}_g$ indicates the merging pair falls into different distance group g, where $\mathcal{G}_g \in$ {0-10 miles, 10-100 miles}. τ_p stands for the merger time of hospital pair p, and $\mathtt{1}[p \in \mathcal{T}, t \geq \tau_p]$ indicates the post-merger status of hospital pair p. λ_g is the post-merger change of the duplicate services of hospital pairs belongs to group g. This heterogeneous effect parameter allows us to evaluate how the post-merger duplication change varying with the distance. Besides this specification, we also replace the dependent variable in Equation (4) to the total number of services of the hospital pairs. This specification helps to illuminate the motivation for the service decrease identified in the above specifications. In other words, by study the total number of services of hospital pairs, we can distinguish if the services are dropped for consolidation at one facility and kept at the adjacent facilities, or if the services are entirely removed at both hospitals.

Identification The identification of our specification comes from the variation in the timing of mergers. Similar to any of the Difference-in-Differences model with multiple treatment periods, the later merging hospitals would serve as the control for the first merging hospitals, and the time trend is jointly determined by the merging hospitals together. One advantage of this specification is that it avoids the comparison between merging and non-merging hospitals, which may suffer from selection bias due to endogenous merger choice. Our model still assumes a parallel pre-trend across early merging hospitals and later merging hospitals. The selection of merger time may undermine this assumption. However, due to the complexity of merger activity and involvement of antitrust authorities, hospitals do not necessarily have full control of the merger time, which mitigates the concern about selection on merger time. We provide information about the identification strategy's validity in Appendix 1.2.

3.2.3 Empirical Results

Number of Services of Individual Hospitals Table 2 presents the results with the post-merger effect on the number of services defined from the procedures. The regression sample is the merging hospitals that have merging counterparts within 100 miles. Columns (1) and (2) use the individual hospitals' number of services as the dependent variable. The result in Column (1) shows that for all the merging hospitals which have within-100-mile counterparts, the average number of services has a slight drop of around 1.2 services post merger. This effect is mainly driven by the service change of the close-merging hospitals (merger counterparts within 10 miles), as shown in Column (2). Merging hospitals with counterparts within 10 miles experience a drop of approximately 4.5 services among all the services they offered. In Column (3), we add the interaction term between post merger status and the distance between the merging entities and their closest counterparts. It is shown that, if the distance between the merging hospitals increases, these hospitals are less likely to drop services. The heterogeneous effect results with more narrow distance groups are shown in Table 17 in Appendix.

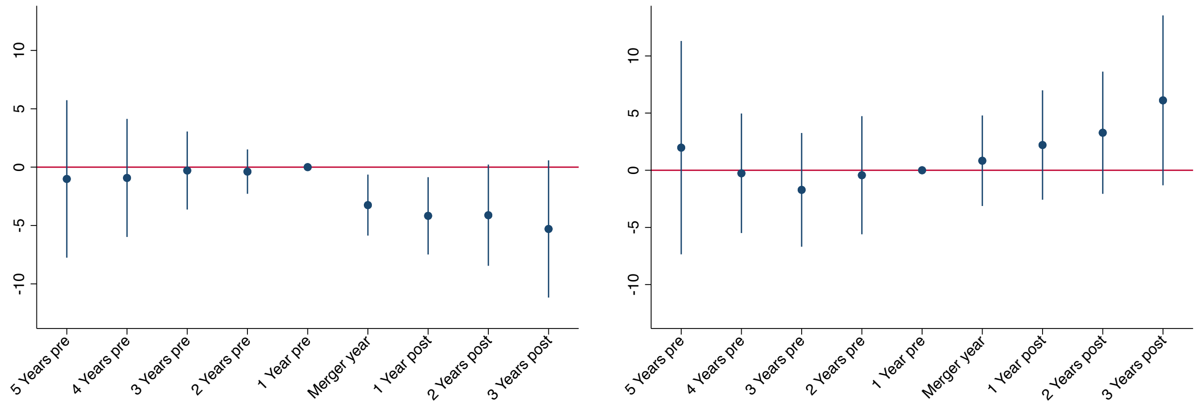
The results of the event study looking at the effect of close and far mergers on the number of services provided per facility are given in the left- and right-hand panels of Figure 8 respectively. The parallel trend assumption holds for the analysis with the total number of services, and there is a lasting post-merger service decrease for merging hospitals in 0-10 miles, while the further merging hospitals do not see such an effect.

Number of Services of Hospital Pairs The analysis with the merging hospital pairs within 100 miles is presented in Table 3. For all the merging hospital pairs within 100 miles, the nearby

Table 2: Post Merger Effect of Individual Hospital of Mergers within 100 miles

	(1) Number of Services	(2) Number of Services	(3) Number of Services
Post merger	-1.248		-4.498*
	(1.942)		(2.411)
Post merger 0-10 miles		-4.531*	
		(2.357)	
Post merger 10-100 miles		2.120	
		(2.365)	
Post merger × Merger distance			0.211***
			(0.068)
N	1208	1208	1208
R^2	0.95	0.95	0.95

Model clusters at individual hospital level.[12] Total number of beds and for-profit status of hospitals are included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$



(a) Merged in 0-10 miles

(b) Merged in 10-100 miles

Figure 8: Event Study of Number of Services

Table 3: Post Merger Effect of Merged Pairs within 100 miles

	(1) Duplicate Services	(2) Total Services
Post merger 0-10 miles	-5.147***	-0.889
	(1.705)	(1.130)
Post merger 10-100 miles	-1.821	-0.209
	(1.443)	(0.846)
N	1475	1475
R^2	0.93	0.92
$DependentMean$	131.43	177.40
$DependentS.D.$	27.16	14.76

Model clusters at hospital pair level. Total number of beds is included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

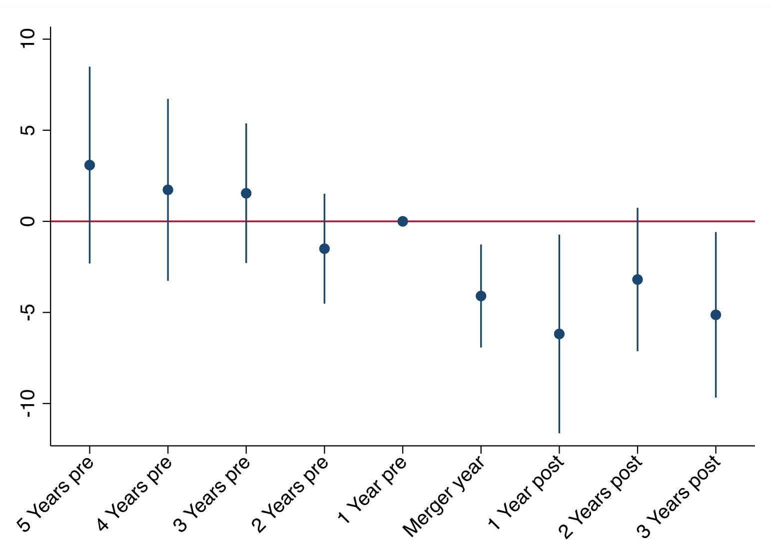


Figure 9: Event Study of Duplicate Services of Merging Pairs within 10 miles

merging hospitals remove averagely 5.1 duplicate services. Furthermore, this decrease in the number of services is mainly due to the service consolidation but not the elimination of the services by the system, because the total number of services by the merging hospital pairs within 10 miles does not have a significant reduction as exhibited in Column (2). The event study of the number of duplicate services of hospital pairs within 10 miles is presented in Figure 9. The effect of number of duplicate services begins in the merger year, and this effect keeps several years after mergers.

3.3 Service Volume

3.3.1 Effect 1.b.

To test Effect 1.b., we adopt a similar specification as Equation (1) by replacing the dependent variable with the hospital's volume HHI across services to measure the concentration of volume across services. The volume HHI across service is defined as

$$HHI_{it} = \sum_{s} (\frac{v_{sit}}{\sum_{s}^{S} v_{sit}})^2 \times 10000 \tag{5}$$

where for each individual hospital i, v_{sit} is the volume of service $s \in \{1, 2, ...S\}$ at time t. HHI_{it} measure the concentration across service. The DID specification we use is

$$HHI_{it} = \alpha_i + \gamma_t + \eta \cdot \mathbb{1}[i \in \mathcal{M}, t \geq \tau_h] + \epsilon_{it}, \tag{6}$$

We still choose 100 miles as our baseline merger sample. Meanwhile, we also care about how the effect varies with the distance of hospitals. Therefore, we decompose the effect by the distance group 0-10 miles and 10-100 miles in Equation (7)

$$HHI_{it} = \alpha_i + \gamma_t + \sum_g \eta_g \cdot \mathbb{1}[i \in \mathcal{G}_g, t \geq \tau_i] + \epsilon_{it} \tag{7}$$

where $\mathcal{G}_g$ indicates the merging hospitals falls into group $\mathcal{G}_g \in \{\mathcal{G}_1, \mathcal{G}_2\}$, and η_g stands for the change on HHI of group $\mathcal{G}_g$ post mergers. Similar as before, we run the event study to separately decompose the time varying effect with the mergers in different distance group.

3.3.2 Effect 2.b.

Specification For each given service, we analyze the pair HHI of every service to examine Effect 2.b. For a given service s, the pair HHI of that given service is defined as

$$HHI_{spt} = (\frac{v_{sit}}{v_{sit} + v_{sjt}})^2 + (\frac{v_{sjt}}{v_{sit} + v_{sjt}})^2, \tag{8}$$

where hospital i and j are the two hospitals composing hospital pair p.

The following Equation (9) is conducted service by service to examine the change of volume distribution across facilities.

$$HHI_{spt} = \alpha_{sp} + \gamma_t + \sum_g \eta_g \cdot \mathbb{1}[p \in \mathcal{M}_g, t \geq \tau_p] + \epsilon_{pt} \tag{9}$$

In this Equation α_{sp} are the pair-service fixed effects and η_g stands for the post-merger change of the HHI of the hospital pair falls into group g in service s. Similar to before, we use only the merging pairs within 100 miles to avoid possible selection bias in the comparison between the merging and non-merging pairs. We conduct this analysis at different service service level, including all services together, by service categorization (Level 1 of CCS), and also service by service.

Additionally, we also study the post-merger change of hospital pair HHI across services. The hospital pair HHI across services is calculated as

$$HHI_{pt} = \sum_s (\frac{v_{spt}}{\sum_s^S v_{spt}})^2 \times 10000, \tag{10}$$

where v_{spt} is the volume of the hospital pair p in service s at time t. The specification used to study its change is

$$HHI_{pt} = \alpha_p + \gamma_t + \sum_g \zeta_g \cdot \mathbb{1}[p \in \mathcal{M}_g, t \geq \tau_p] + \epsilon_{pt}, \tag{11}$$

where ζ_g stands for the change of the hospital pair's HHI across services post-merger if the merging pairs belong to the distance group g. Still, this regression only includes the merging pairs within 100 miles. If we observe a significant treatment effect in this specification, it means at the system level some services are shrunk or even closed, and this could be the reason for the individual facility's concentration change in the testing of Hypothesis 1.b. On the other hand, if no significant increase in the hospital pair's HHI across services is found, then at the system level there is no significant change of service composition, which would confirm that the service repositioning is a shift of services across locations rather than a system-level service shrinkage.

3.3.3 Empirical Results

Service Volume of Individual Hospitals The results with the hospital pairs are presented in Table 4. In Columns (1) and (2), the dependent variable is the Log HHI of individual hospitals across all the services offered. On average, there exists a 6% increase in HHI across services for all merging hospitals with counterparts within 100 miles. When we decompose the heterogeneous effect for mergers with different distance groups, we find that the increase of HHI is mainly due to the change for geographically close mergers (within 10 miles). For merging hospitals with a counterpart in 10 miles, there occurs a 10.7% increase in the HHI across all the services. Meanwhile, the geographically distant merging hospitals do not exhibit a significant change in the HHI. In Column (3) and (4), we change the dependent variable to the Log of HHI of individual hospitals computed using only non-removed services. The difference between the dependent variable in Column (1) & (2) with Column (3) & (4) is that the post-merger removed services are included in building the HHI in Column (1) and (2), while they are excluded in the HHI measurement use in Column (3) and (4). That is to say, while the Column (1) and (2) includes the information of both service removal and patient reshuffle, Column (3) and (4) provides the service volume change only for the services kept even after mergers. For all the merging hospitals within 100 miles, there exists a 5.3% increase of HHI of non-removed services. Moreover, the effect is particularly strong for the nearby merging hospitals (within 10 miles), as they have an 9.2% increase in the non-removed services. Therefore, for the non-removed services, there still exits repositioning in terms of the service volume reshuffle, and hospitals become more concentrated in the procedures they performed.

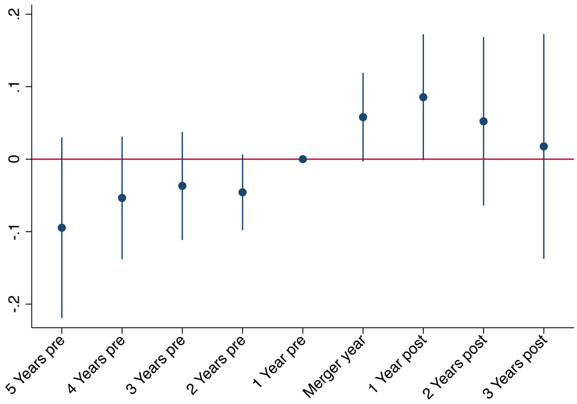
Table 4: Post Merger Effect of Individual Hospital of Mergers within 100 miles

	(1) Log HHI of All Services	(2) Log HHI of All Services	(3) Log HHI of Non-removed Srv	(4) Log HHI of Non-removed Srv
Post merger	0.054		0.046	
	(0.032)		(0.032)	
Post merger 0-10mile		0.102**		0.087*
		(0.050)		(0.049)
Post merger 10-100mile		-0.007		-0.007
		(0.037)		(0.037)
N	1208	1208	1208	1208
R^2	0.89	0.89	0.90	0.90

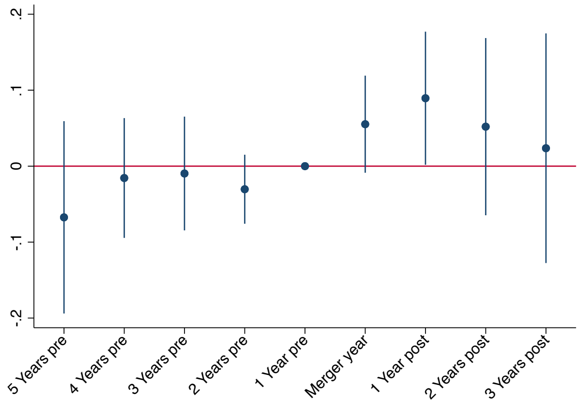
Model clusters at individual hospital level. Total number of beds and for-profit status of hospitals are included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Figure 10 presents the change of the Log HHI of services decomposed by time. Panel (a) uses the specification in Table 4 Column (2) while Panel (b) adopts the specification in Table 4 Column (4). The event study graphs show that the HHI based on all service/ non-removed services both have a post-merger increase around 10%, meaning that the individual hospitals become more concentrated on service provision. We note that, in both graphs, there exists a one-year pre-trend that the increase of HHI starts one year before the merger. One possible reason is that the target hospitals of poor financial conditions may start shrinking the service spectrum they provided one year before the merger. Another potential reason is that mergers take a while to complete. Due to the complexity of merger deals and the other regulation factors, there usually exists a time gap between the merger starting and complete. The merger activity database we used provides the finishing time of the mergers, and any repositioning activity happens after the merger starting time but before the merger finish could result in the pre-trend of service repositioning.

Service Volume of Hospital Pairs Similar to the analysis with the total service number of hospital pairs, we would like to check if the increase of service concentration is because of the reshuffle of patients or is due to the service shrinking at the system level. To test this problem, we analyze the change of the service concentration of the hospital pairs. The result is presented in Table 5, where we do not find a significant change in service concentration. Therefore, there is no evidence indicating the service concentration occurred as the individual hospitals are triggered by the systems shifting their service concentration after mergers.



(a) Log HHI of All Services



(b) Log HHI of Non-removed Services

Figure 10: Event Study of Log HHI of Services for Hospitals with Group 0-10 miles

Table 5: Post Merger Effect of Log HHI of Merged Pairs within 100 miles

	(1) Log HHI of Services
Post merger 0-10 mile	-0.011
	(0.049)
Post merger 10-100 mile	0.026
	(0.033)
N	1475
R^2	0.88
$DependentMean$	-2.63
$DependentS.D.$	0.48

Model clusters at hospital pair level. Total number of beds is included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Service By Service Analysis To identify which services are consolidated, we run analysis service by service using Equation 9. The analyzed results at different samples of services are summarized in Table 6. The second to the fifth column of the table are the estimated coefficients and standard errors using Equation 9 by service categories (CCS Level 1). The last two columns in this table present how many services belong to that specific service category and how many of these services have observed significant increase in concentration when we run the analysis service by service. For instance, for the obstetrical procedures, one service category of CCS Level 1, there is on average 5% increase in pair HHI of all services belongs to that category for merging hospital in 10 miles, and only 0.7% in crease for further mergers. And the last two columns show that there are 10 services fall into this category, and 6 of them have significant increase (at 10% level) in their pair HHI for the 10-mile mergers. Overall, the services experiencing significant consolidation are mainly in obstetrical procedures, operations on female genital organs, and operations on cardiovascular system.[13] The last row of Table 6 is the regression result when all services are included in Equation 9. When all services are pooled together, there is a minor effect of 1.7% increase in services' pair HHI. This effect is not significant because we average the consolidation occurring only in a subset of services to all services and dissipate the effect.

[13]These services are consistent with the claimed services to be consolidated by CEO of OSF Healthcare System when the proposed merger is challenged by FTC.

Table 6: Summary of Service by Service Analysis

Level 1 Service Category	post 0-10 miles	se	post 10-100 miles	se	Num. of Services	Significant Service Num
Obstetrical procedures	0.050**	(0.021)	0.007	(0.013)	10	6
Op. on female genital organs	0.049***	(0.016)	0.022**	(0.010)	13	4
Op. on cardiovascular system	0.039**	(0.016)	-0.004	(0.010)	21	7
Op. on endocrine system	0.034	(0.020)	0.025	(0.019)	3	1
Op. on nervous system	0.032**	(0.015)	0.001	(0.010)	9	3
Op. on hemic & lymphatic system	0.032**	(0.012)	0.016	(0.024)	4	1
Op. on respiratory system	0.025	(0.021)	-0.0034	(0.012)	9	0
Op. on nose; mouth; and pharynx	0.020	(0.020)	0.013	(0.011)	7	1
Misc diag/therapeutic proc	0.011	(0.009)	-0.0068	(0.0070)	42	5
Op. on integumentary system	0.011	(0.012)	0.0010	(0.015)	9	0
Op. on digestive system	0.006	(0.010)	-0.009	(0.009)	31	0
Op. on urinary system	0.001	(0.013)	-0.0003	(0.011)	11	1
Op. on musculoskeletal system	0.0007	(0.017)	-0.021	(0.021)	17	3
Op. on eye	-0.027	(0.024)	-0.0072	(0.020)	9	0
Op. on ear	-0.016	(0.020)	0.019	(0.019)	5	0
Op. on male genital organs	-0.009	(0.014)	0.007	(0.016)	6	0
All Services	0.017	(.011)	-0.002	(0.009)	204	32

[1] We abbreviate "Operations" as "Op.". The last two columns present how many services belong to that specific service category (Num. of Services) and how many of these services have observed significant increase in concentration when we run the analysis service by service (Significant Service Num.).
[2] The estimated coefficients and standard erros in the second to the fifth column are from analyses using only the services belonging to the correpsonding service category in the first column.
[3] Model clusters at hospital pair level. Total number of beds is included in regressions. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Graph 11 shows services which have a significant increase in the pair HHI of mergers 0-10 miles but no such effect in further mergers when we estimate post-merger effects service by service. In the graph, services in different categories are indicated by different colors, and the magnitude of the horizontal axis indicates the magnitude of Log HHI change for the merging pairs within 10 miles. Overall, the services that experienced consolidation are highly concentrated in the cardiovascular system and obstetrical procedures.[14] For instance, for the peripheral vascular bypass, there exists a 10% increase in the pair HHI for the merging pairs within 10 miles, but this effect does not hold for the further mergers. Additionally, some services in the

[14] These service categories are consistent with the service proposed by the CEO of the OSF healthcare system in their antitrust case with FTC.

nervous and musculoskeletal systems also experience significant consolidation. For example, spinal fusion and laminectomy, which are two main surgical procedures to treat lower back pain, have 9.2% and 8.7% increase in the pair HHI for merging pairs within 10 miles. Table 19 in Appendix shows the results of all services.

3.4 Robustness Check

3.4.1 Alternative Definition of Hospital Services Using Diagnoses

Instead of defining the services by the procedure codes, we can define services using the diagnosis information. The diagnoses contain information related to the symptoms and the diseases of patients, while the procedures depict the treatment patients received. To check if there exists evidence of service repositioning regarding the diseases hospitals cover, we use the ICD-9 diagnosis codes from the California Discharge data to build an alternative service measurement. Similar to before, due to the large number of ICD-9 diagnosis codes, we classify them using the Clinical Classification Software and define a service at level two of the multi-level diagnosis categories.

Table 7: Post Merger Effect of Services by Diagnosis of Merged Hospitals within 100 miles

	(1) Number of Srv.	(2) Number of Srv.	(3) Log HHI of Srv.	(4) Log HHI of Srv.
Post merger	-0.911		0.041*	
	(0.861)		(0.023)	
Post merger 0-10 miles		-0.662		0.067***
		(0.477)		(0.019)
Post merger 10-100 miles		-1.280		0.011
		(1.592)		(0.039)
N	1208	1208	1208	1208
R^2	0.78	0.78	0.80	0.80

Services are defined by diagnosis classification. Model clusters at hospital pair level. Total number of beds and for-profit status are included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

We implement the analysis of service numbers and volume HHI at the individual hospitals on the services defined by the diagnoses, and the result is shown in Table 7. When we study the effect on the number of services by diagnoses as in Column (1) and (2), no significant change is observed. Nevertheless, the study with the service volume concentration in Column (3) and (4) illustrates that the individual hospitals become more concentrated on the diagnoses they cover. The results indicate that hospitals may not be able to entirely refuse patients with certain symptoms and diseases, but that they possess some ability to steer patients based on their diseases. Figure 12 is the event study of the Column (4). A one-year pre-trend exists as

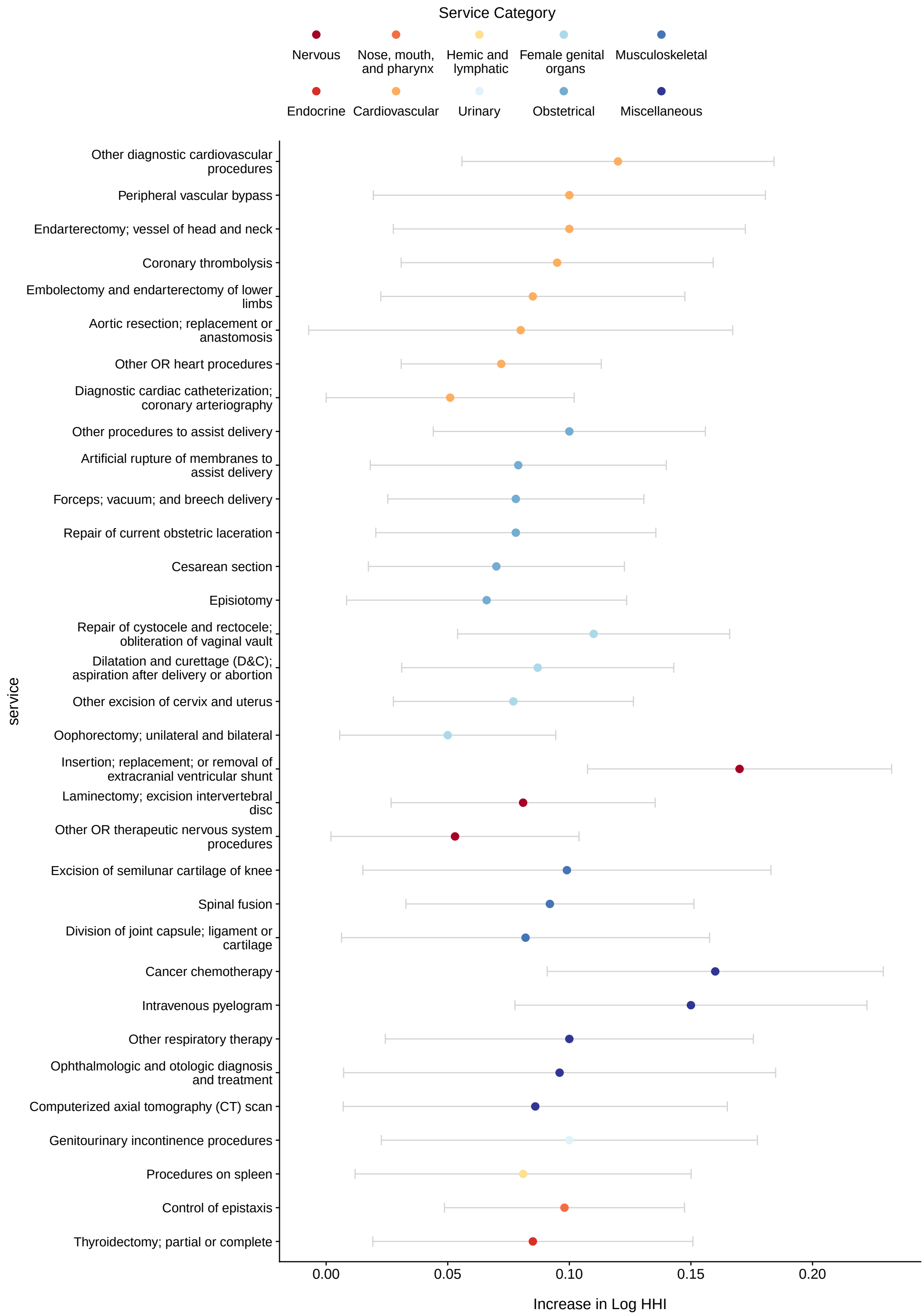


Figure 11: Services Consolidated for the 10-mile Merging Pairs

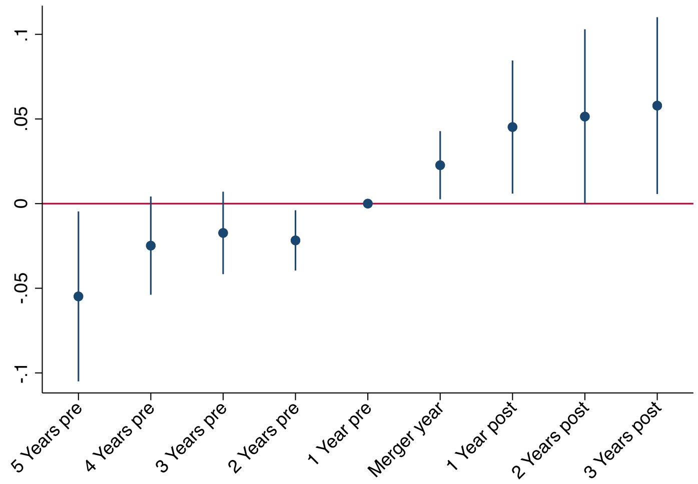


Figure 12: Event Study of Log HHI of Services by Diagnoses of within-10-mile Merging Hospitals

in Figure 10, and could be due to the reason that targets with poor financial conditions starts repositioning early or because of the time gap between the merger starting time and finishing time.

3.4.2 Matched Non-merging Hospitals as Control

To check the robustness of our previous estimators, we use the matching-DID to estimate the change of the within 10-mile merging hospitals compared with the non-merging control hospitals. Specifically, we use propensity score matching to build the control group with a similar service concentration and capacity as the within-10mile merging hospitals. Similar to Heckman et al. (1998) and Smith and Todd (2005), we match on the pre-treatment history of an outcome variable, log HHI of services, and another observable, total beds of the hospitals. We set a caliper of 0.08 to eliminate the treated hospitals without similar controls. The summary statistics of the within-10-mile merging hospitals possessing proper controls and their matched controls in the beginning year (year 2002) are presented in Table 8. Overall, the matched sample is balanced with no significant group mean difference across the treatments and controls.

Meanwhile, we observe that the estimated post-merger effect is robust. Table 9 Column (1) reveals that with the matched control group, the merging hospitals within 10 miles drop approximately 6 services. In the same table, Column (2) & (3) indicates that the HHI of services (defined by procedures increase around 11%-12%, regardless of excluding the dropped services or not. Column (4) and (5) define the services by the diagnosis as in the previous robustness check. The estimated results show that the services defined based on diagnosis do not have significant removal, but there exists a subtler repositioning in terms of patient reshuffle and

Table 8: Summary Statistics of California OSHPD & Financial Data of the Matched Sample, 2002

Number of services (by proc)	160.5	155
	(24.44)	(39.46)
Number of services (by diag)	130.2	130.2
	(5.691)	(13.12)
Hospital HHI of services (by proc)	1151.6	1083.4
	(564.5)	(696.4)
Hospital HHI of services (by diag)	336.7	333.7
	(66.58)	(70.68)
Casemix index	1.099	1.010
	(0.247)	(0.139)
Number of staffed beds	182.8	169.5
	(85.30)	(111.5)
Total discharges	8616.7	9191.5
	(4439.5)	(7044.1)
Board certified/eligible physicians	245.8	224.6
	(154.5)	(227.0)
Total discharge days (in thousand)	46.55	40.93
	(24.44)	(27.94)
Total patient care cost (in million)	94.78	105.1
	(65.82)	(83.69)
Number of Hospitals	34	29

Match is implemented with replacement.

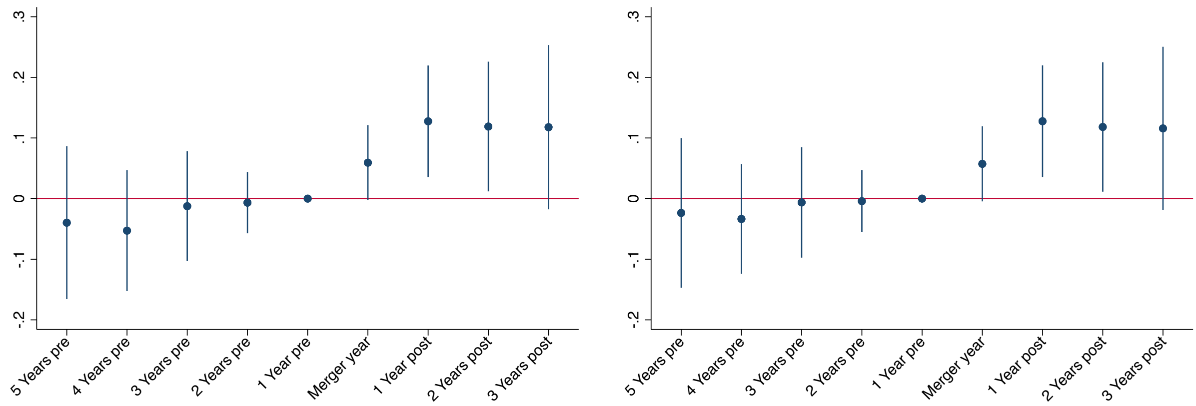
increase the HHI of services defined by the diagnosis around 3.3%.

Table 9: Within-10mile Merged Hospitals Compared with Matched Non-merged Controls

	(1) Number of Services by Proc	(2) Log HHI of All Services by Proc	(3) Log HHI of Non-removed Services by proc	(4) Number of Services by Diag	(5) Log HHI of All Services by Diag
Post merger	-6.085***	0.120**	0.113**	-0.393	0.033*
	(1.937)	(0.055)	(0.054)	(0.255)	(0.019)
N	759	759	759	759	759
R^2	0.95	0.88	0.88	0.93	0.83

Model clusters at hospital level. Total number of beds and for-profit status of hospitals are included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Figure 13 is the event study of the within-10-mile merging hospitals and its matched control group (i.e., the event study for Column (2) and (3) in Table 9). The one-year pre-trend appear in Figure 10 is dismissed in this matching-DID specification, indicating that the matching process manages to select a control group of similar pre-merger outcomes with the treatments. And the parallel trend assumption also holds for other outcome variables, and their event study can be found in the Appendix.



(a) Log HHI of All Services (b) Log HHI of Non-removed Services

Figure 13: Event Study of 10-mile Merging Hospitals and Matched Non-merging Controls

3.4.3 Other Measurements of Hospital Repositioning

California Hospital Financial Reports also report the hospitals' physicians, beds, discharge numbers and discharge days based on service categories, which allows us to examine the service repositioning based on these measurements. Table 10 presents the results.

In Table 10, Column (1)'s dependent variable is the log HHI of physicians across different

Table 10: Other Measurements of Service Concentration of Merged Hospitals within 100 miles

	(1) Log HHI of Physicians	(2) Log HHI of Beds	(3) Log HHI of t days Patient days	(4) Log HHI of Discharges
Post merger of 0-10mile	-0.043***	0.100***	0.077**	0.078**
	(0.014)	(0.036)	(0.034)	(0.034)
Post merger of 10-100 miles	-0.033	0.015	0.011	0.022
	(0.021)	(0.058)	(0.052)	(0.057)
N	1113	1208	1208	1208
R^2	0.78	0.87	0.89	0.83

Models are clustered at individual hospital level. $*p < 0.1$, $**p < 0.05$, $***\, p < 0.01$

service categories and Column (2) uses log of HHI based on beds assigned to different service categories. The dependent variable of Column (3) and (4) are concentration measurement derived from total patient days and discharges of different service categories. We find that, except physicians, all other measurements indicate that services become more concentrated post-merger. This effect does not hold for physicians, perhaps because a large proportion of physicians are not directly hired by hospitals and are able to freely choose at which hospital they treat their patients. The analyses with the heterogeneous effect between targets and acquirers are shown in Appendix.

4 Implications for Service Cost and Quality

4.1 Provider Cost Change

Having established that geographically close hospitals consolidate their services post-merger, we now look for evidence that these consolidations affect hospitals' reported costs. We employ a Difference-in-Differences design to compare the operating cost per procedure for consolidated and non-consolidated services separately.

4.1.1 Specification

Similar to the analysis with hospital pairs to identify service-specific HHI change, we use only the merging hospital pairs and compare the post-merger cost saving between consolidated and non-consolidated services as

$$log(c_{pst}) = \alpha_{ps} + \gamma_t + \lambda \cdot \mathbb{1}[t \geq \tau_p] + \delta \cdot \mathbb{1}[s \in \mathcal{S}, t \geq \tau_p] + \epsilon_{pt} \tag{12}$$

where c_{pst} is the per unit patint care cost for the hospital pair p's service s at time t, $\mathbb{1}[t \geq \tau_p]$ is the indicator for the post-merger status, and $\mathbb{1}[s \in \mathcal{S}, t \geq \tau_p]$ stands for the post-merger status for consolidated services. The parameter λ represents the average cost change of where c_{pst} is the standardized cost per service unit for the hospital pair p's service s at time t, $\mathbb{1}[t \geq \tau_p]$ is the indicator for the post-merger status, and $\mathbb{1}[s \in \mathcal{S}, t \geq \tau_p]$ stands for the post-merger status for consolidated services. The parameter λ is for the average change of services pre and post-merger, while δ indicates the extra cost change for the consolidated services compared with non-consolidated services. This δ term is identified through the comparison between consolidated and non-consolidated services. Under the assumption that the other merger-related factors influence the standardized patient care cost per unit similarly across services, the comparison of the consolidated and non-consolidated cost would be the extra cost change related to the consolidation in the repositioned services.

For the concern that consolidated services and non-consolidated services are not comparable, we take advantage of the fact that service consolidation only occurs when merging entities are close with one another, and compare the cost change of the consolidated services across different merger distance. Specifically, we use

$$log(c_{pst}) = \alpha_{ps} + \gamma_t + \sum_g \eta_g \cdot \mathbb{1}[t \geq \tau_p] \times \mathbb{1}[p \in \mathcal{M}_g] + \epsilon_{pt} \tag{13}$$

where η_g is the post-merger standardized cost change when a hospital pair p belongs to the distance group $\mathcal{M}_g \in \{$0-10 miles, 10-100 miles$\}$. Equation (13) is implemented on the sample consolidated and non-consolidated service separately.

4.1.2 Empirical Results

The primary data we use to analyze the service cost change is the California Financial Report. The financial data report at more aggregate level of service than was used in the above analyses. We reestimate the previous analysis with the hospital pair concentration service by service to identify the consolidated services. We find the cardiac and obstetric services are found to be consolidated, which is similar to before. Table 18 in Appendix is the summary statistics of the per unit cost of the services in the California Financial Report. There exists a large cross-service variation. Therefore, we use the standardization to build the cost measurement comparable across services.

Table 11 presents the results of the cost analysis. Column (1) and (2) include the sample of services of all merging pairs within 100 miles. Column (1) shows that on average there exists an insignificant increase on the standardized cost of services post mergers. However, when comparing the consolidated and non-consolidated services in Column (2), the cost of consolidated services actually decreases by 15%. When we restrict the sample to the merging pairs within 10 miles, we observe that the difference between the consolidation is significantly larger, as the consolidated services on average drop 31% of the per unit service cost. That is to say, the adjacent merging hospitals are the entities achieved most cost savings in consolidated services. However, the event study shows that this setting does not satisfy the parallel trend assumption.

Table 11: Normalized Cost per Service Unit of Merged Hospital Pairs within 100 miles

	(1) 100-mile Merged	(2) 100-mile Merged	(3) 10-mile Merged
Post merger	-0.004	0.016	0.045
	(0.017)	(0.018)	(0.040)
Post merger × Consolidated Service		-0.151***	-0.311***
		(0.033)	(0.073)
N	37692	37692	8046
R^2	0.93	0.93	0.94

Model clusters at hospital level. Year fixed effects and Hospital× Service fixed effects are included. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Table 12 shows the results of different services groups with the consolidated and non-consolidated services separately. For the consolidated services, only the merging pairs with close distance have significant drop in the service cost, as they are the hospitals effectively repositioning the consolidated services. In Column (1), the merging hospital pairs within 10 mile have a drop in cost with 20%, equivalent to approximately $277 for cardiac catheterization and $13 for the echocardiology service. When it comes to the standardized cost change to the non-consolidated services in Column (2), we do not find statistically significant differences across the close merging pairs and further merging pairs. The event study of Column (1) in Table 12 is presented in Figure 14. The figure shows that the consolidated services create long run cost-savings for close merging hospitals.

4.2 Impact on Patients

In the previous section, we find that hospitals' service repositioning leads to cost reductions for providers. In this section, we analyze the service repositioning implications for patients. The hospitals' service repositioning can influence patients from several aspects. First, the providers' cost reductions can be passed on to consumers in the form of lower claim prices.

Table 12: Normalized Cost per Service Unit of Merged Hospital Pairs by Distance

	(1) Consolidated Services	(2) Non-consolidated Services
Post merger 0-10 miles	-0.199***	0.013
	(0.066)	(0.038)
Post merger 10-100 miles	0.008	-0.005
	(0.035)	(0.018)
N	6025	31659
R^2	0.92	0.93

Model clusters at hospital level. Year fixed effects and Hospital× Service fixed effects are controlled. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

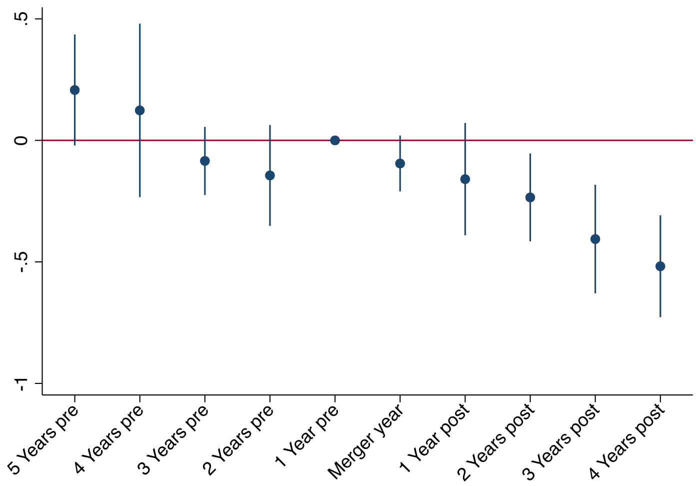


Figure 14: Event Study of Consolidated Service in 0-10 miles Mergers

Second, service relocation can increase patients' travel distance, resulting in patients' travel costs increase. Third, service quality may also change due to service repositioning. For instance, concentrating patient flows in single, specialized locations might lead to better patient outcomes because of physicians' learning-by-doing. Meanwhile, mergers can harm healthcare quality due to a reduction in market competitiveness. Due to data limitations, we do not observe the transaction prices of services. Thus, we mainly analyze the impact on patients by investigating the impact on service quality and patients' travel distance.

4.2.1 Service Quality

To evaluate the change of service quality for the consolidated services, we examine the readmission rate of discharges. We concentrate on patients whose primary diagnosis relating to the consolidated services (circulatory/cardiac, birth delivery, and women genital). For each patient discharge, his/her 30-day all-cause unplanned readmission record is identified following Horwitz et al. (2011). We also control for the Charlson comorbidity conditions D'Hoore, Sicotte and Tilquin (1993) to adjust the risk of patients. Specifically, we analyze the change of readmission at the discharge level using the following equation

$$r_{jit} = \alpha_i + \gamma_t + \sum_g \lambda_g \cdot \mathbb{1}[t \geq \tau_i] \times \mathbb{1}[i \in \mathcal{G}_g] + \beta X_{jt} + \epsilon_{jit} \tag{14}$$

where for patient j's discharge occurred in hospital i at time t, r_{jt} indicating whether any unplanned readmission happens to the patient within 30 days. α_i are hospital fixed effect and γ_t are year fixed effects. $\mathbb{1}[i \in \mathcal{M}, t \geq \tau_i]$ is the indicator function showing whether hospital i is in its post-merger status. When the patient j is admitted by the hospital i in merger distance group G_i, λ_g shows the post-merger change in the readmission for the discharges that occurred in the hospital i. Similar to before, $\mathcal{G}_g \in \{\mathcal{G}_1, \mathcal{G}_2\}$. $\mathcal{G}_1$ stands for the hospitals with merging counterparts 0-10 miles away, and $\mathcal{G}_2$ is for those with merging counterparts 10-100 miles away. X_{jt} stands for the Charlson comorbidity conditions for risk adjustment. We only include patient discharges that occurred in the merging hospitals with the closest partner within 100 miles as before. Discharges with different primary diagnoses are separately analyzed.

The results are presented in Figure 15 and 16. In these figures, each row stands for a primary care diagnosis. The value along the horizontal axis shows the post-merger change of likelihood being readmitted when a patient is discharged in a 0-10 mile merging hospital. Figure 15 exhibits the results with discharges for circulatory diseases and Figure 16 shows the results for birth delivery and women genital discharges. Overall, the readmission rate remains stable after mergers for these repositioned services. We do not find evidence that the service repositioning significantly changes the readmission.

Besides the readmission rate, we also examine the service quality change using other measurements. The analysis with Centers for Medicare and Medicaid Services (CMS) Hospital Compare data's measurement about the timeliness and effectiveness care measures shows some minor improvement in quality after mergers. In summary, our study suggests that service repositioning does not impose a significant impact on service quality.

4.3 Patient Travel Distance

Service relocation can change the travel distance of patients. We establish the travel distance using the home zip information. The travel distance is calculated as the centroid of the zip code to the geolocation of the hospital and travel time is the driving time to cover the distance

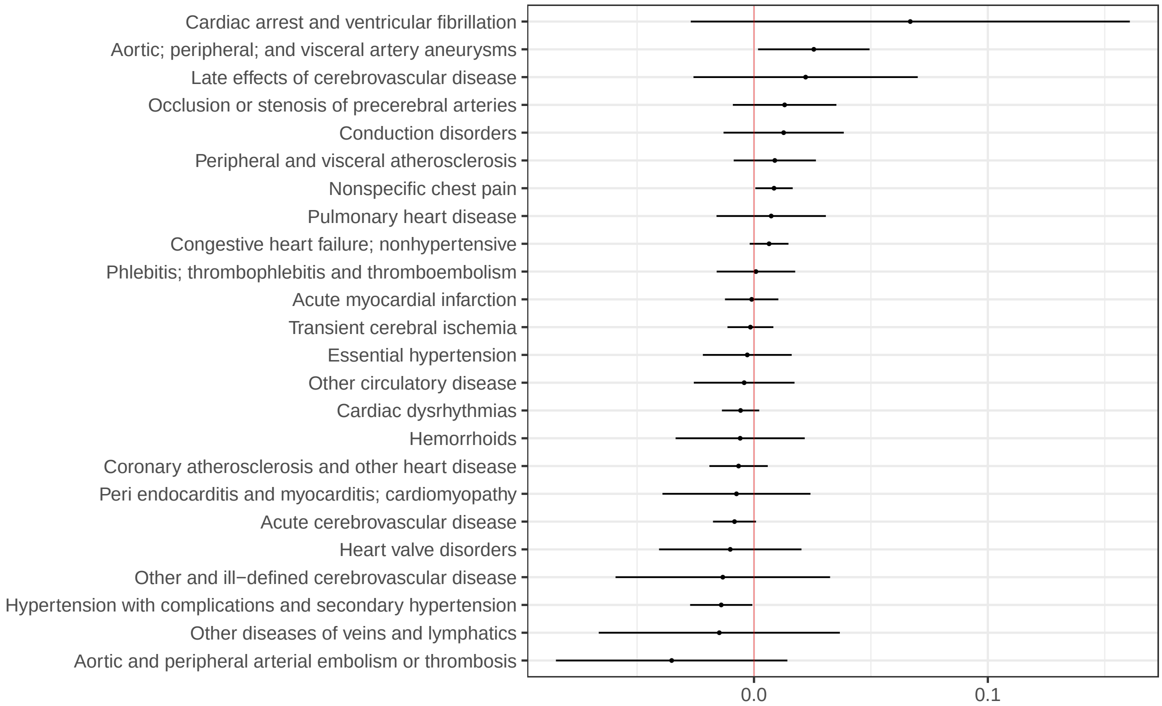


Figure 15: Post-Merger Change of Discharge Readmission in 0-10 mile Merging Hospitals, Discharges for Circulatory Diseases

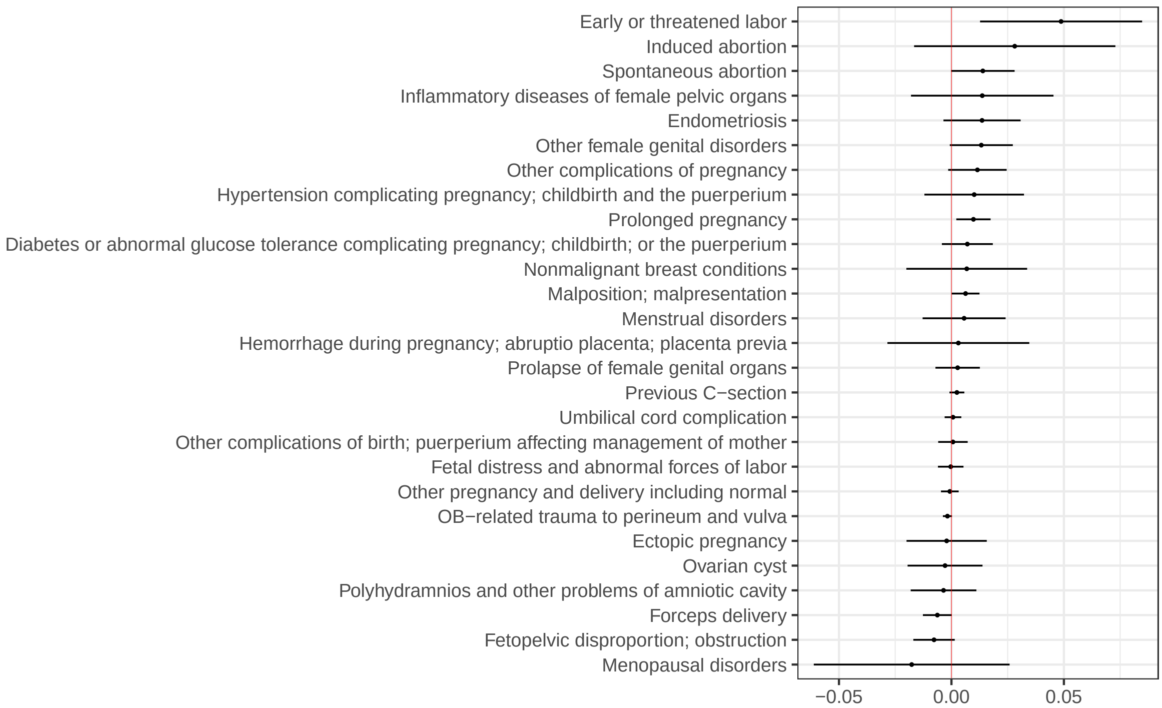


Figure 16: Post-Merger Change of Discharge Readmission in 0-10 mile Merging Hospitals, Patients for Birth Delivery and Female Genital

under normal traffic conditions.[15] And we also concentrate on patients seeking the consolidated services in the 0-10 mile merging hospitals. We implement the analysis using the following equation

$$r_{jit} = \alpha_i + \gamma_t + \sum_g \lambda_g \cdot \mathbb{1}[t \geq \tau_i] \times \mathbb{1}[i \in \mathcal{G}_g] + \epsilon_{jit}. \tag{15}$$

r_{jit} is the travel distance/time of a patient j's discharge at hospital i at time t. α_i are hospital fixed effect and γ_t are year fixed effects. $\mathbb{1}[i \in \mathcal{M}, t \geq \tau_i]$ is the indicator function showing whether hospital i is in its post-merger status and λ_g shows the post-merger average change in travel distance/time,with $\mathcal{G}_g \in \{\mathcal{G}_1, \mathcal{G}_2\}$. $\mathcal{G}_1$ stands for the hospitals with merging counterparts 0-10 miles away, and $\mathcal{G}_2$ is for those with merging counterparts 10-100 miles away.

The result is shown in Table 13. Column (1) takes travel time as the outcome variable and Column (2) in the table uses travel distance as the dependent variable. The analysis shows that both the travel distance and travel time have a very minor and insignificant increase. According to the estimation of Ho and Pakes (2014), the willingness to pay for one-mile travel distance is between 100-1,500 dollars. In our context, this means that the service relocation can leads to the consumer surplus decrease by around 50-750 dollars per discharge for the consolidated services.

Table 13: Post Merger Effect of Travel Distance of Merged Hospitals within 100 mile

	(1) Travel Time (min)	(2) Travel Distance (mile)
Post merger of 0-10 miles	0.433	0.517
	(0.755)	(0.795)
Post merger of 10-100 miles	-0.048	-0.015
	(0.862)	(0.926)
N	4,530,729	4,530,729
R^2	0.004	0.003

5 Discussion & Conclusion

In this paper, we find evidence that hospitals reposition their service via a cost-saving mechanism. By employing a DID study design, we find that the geographically close merging hospitals (within 10 miles) drop around 5 duplicate services, and this effect is statistically significant. This repositioning appears to generate significant cost savings by around 20% for consolidated

[15] See Weber and Péclat (2017) for details.

services. According to our knowledge, this is the first paper that provides systematic evidence supporting hospitals' common claim that mergers can enable efficient re-organizations of services. However, antitrust enforcement is based on a consumer welfare standard, and it is not evident that the cost-reducing service changes described in this paper are beneficial to consumers. First, it is unclear whether cost reductions are passed on to consumers in the form of lower claim prices. Comparison of post-merger price increase between consolidated and non-consolidated services can illuminate on the question of whether service consolidation offsets the price increase aroused by bargaining power change. Second, service reorganization may lead to service quality change. We analyze some measurements of hospital quality and find no significant change. Third, the reallocation of patient flows can change the travel cost of patients. Our results show that the service repositioning indeed leads to increase in travel distance by around 0.5 mile, which can be translated to willingness to pay of 50-750 dollars per discharge for consolidated services.

Altogether, this paper finds evidence that hospitals achieve cost savings through service repositioning. We plan to investigate the pass-through of cost savings to consumers and study how market structures influence this pass-through in our future study. If cost savings generated by service repositioning is not effectively transformed into price reduction, policy interventions may help to achieve this goal. One potential option is to impose the price-cap condition on the merger terms. For instance, in the merger of Beth Israel Deaconess Medical Center and Lahey Health System in Boston, the Attorney General imposed a seven-year price cap condition. Another potential solution to extract the surplus of service repositioning without creating market power is to form operating agreement across close facilities but prohibit them from joint price bargaining. For example, Accountable Care Organizations (ACO) of geographically close hospitals may improve the service repositioning across facilities by aligning their financial incentives, and ACOs are not likely to result in price increase because hospitals are mainly paid under capitation from CMS.

Overall, this paper supports the merging hospitals' claim that their post-merger service consolidation creates cost savings. However, we find this mechanism is valid only when the merging hospitals are geographically close. Our documentation of the endogenous service choice of hospital mergers generates information which is barely studied by previous literature and adds a new angle to merger analysis work in the healthcare industry.

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Appendix

1.1 Illustrative Example

This section shows an illustrative example where hospitals hsave incentives to remove their duplicate services and how the distance between merging hospitals matters. We use a spatial differentiation model similar to Salop (1971)'s circular city. We assume a case with four hospitals $\{A, B, C, D\}$ evenly distributed on a circle, as in Figure 17. Each hospital offers two medical services (s^1, s^2). For simiplicity, we assume these hospitals are identical to consumers except their locations. For service s^i, hospitals have $mc^i = c^i$ for treating each unit of patients and fixed cost of entry f^i. For the consumers, they are distributed uniformly on a circle with circumference 1 and they can only travel on the circle. There are equally amounts of consumers separately seeking service s^1 and s^2 and we assume both type is of mass 1. For consumers seeking service s^i, consumers have unit demands and enjoy utility $V^i - xt - P^i$ if they decide to go to a hospital with x distance away and charge a price P^i. Additionally, we assume there are no other health providers could enter this market.

Before merger, four hospitals are competitors and do not share common ownership. By symmetricity, we have

$$
\begin{aligned}
P_A^1 = P_B^1 = P_C^1 = P_D^1 &= \frac{t}{4} + c^1 \\
Q_A^1 = Q_B^1 = Q_C^1 = Q_D^1 &= \frac{1}{4}
\end{aligned}
$$

Similarly, for s^2, we can solve that

$$
\begin{aligned}
P_A^2 = P_B^2 = P_C^2 = P_D^2 &= \frac{t}{4} + c^2 \\
Q_A^2 = Q_B^2 = Q_C^2 = Q_D^2 &= \frac{1}{4}
\end{aligned}
$$

Now we assume two adjacent hospitals, hospital A & B merged together. The newly merging hospital have two choices: 1) It can continue offer two services in both branches; 2) It could let two branches specialize in only one service. In the former case, the profit of the hospital is equal to:

$$
\pi^{noRel} = [(\frac{t}{4} + c^1 - c^1)\frac{1}{4} + (\frac{t}{4} + c^2 - c^2)\frac{1}{4} - f^1 - f^2] * 2 = \frac{t}{4} - 2(f^1 + f^2)
$$

If it chooses to specialize. Withourt loss of generosity, we suppose hospital A only offers s^1

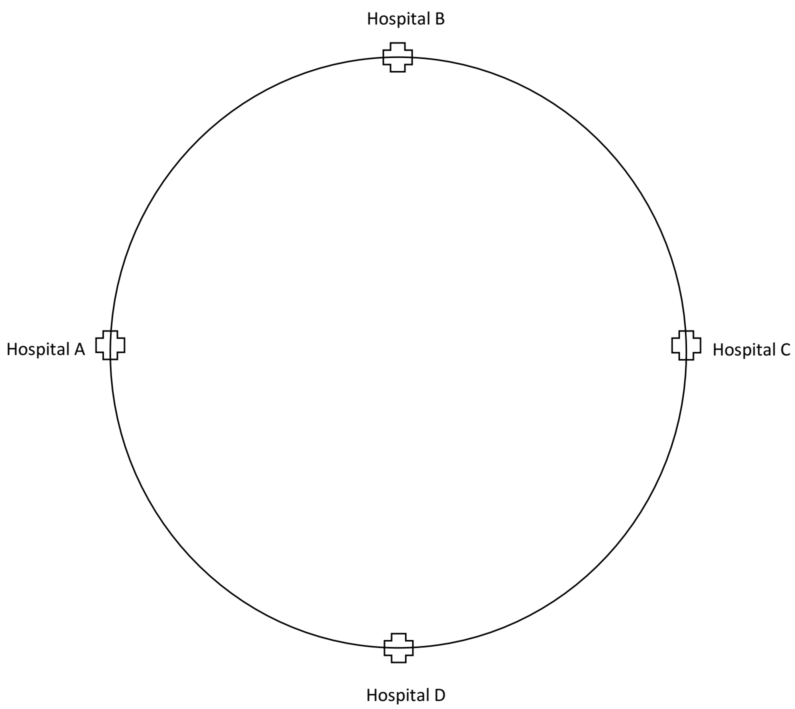

Figure 17: Ilustration of Hospital Distribution

while B only offers s^2. Solving this equilibrium, we have

$$P_A^1 = P_C^1 = \frac{7t}{20} + c^1, \quad P_D^1 = \frac{3t}{10} + c^1$$
$$Q_A^1 = Q_C^1 = \frac{7}{20}, \quad Q_D^1 = \frac{3}{10}$$

and for s^2, we can solve that

$$P_B^2 = P_D^2 = \frac{7t}{20} + c^2, \quad P_C^2 = \frac{3t}{10} + c^2$$
$$Q_B^2 = Q_D^2 = \frac{7}{20}, \quad Q_C^2 = \frac{3}{10}$$

As a result, the profit after relocating services is:

$$\pi^{Rel} = (\frac{7t}{20} + c^1 - c^1)\frac{7}{20} - f^1 + (\frac{7t}{20} + c^2 - c^2)\frac{7}{20} - f^2 = \frac{49t}{200} - (f^1 + f^2)$$

Therefore, when $f^1 + f^2 > \frac{t}{4} - \frac{49t}{200} = \frac{t}{200}$, the merged firm benefits from relocating services between two branches.

However, when it comes to the case that distant hospitals merged, for instance, hospital A & C merged together, they may not cut any service at all because they are competing with B and D. As A & C's close competitora offer both services, the decision of service removal depends on the tradeoff between the cost savings from removing services and the loss of profit due to consumers shifting away. The further the distance of merging hospitals, the larger the loss they have, because the consumers are more likely to choose competiting substitues.

1.2 Internal Validity Check

The main threat to our identification strategy is the selection of merger time. In other words, if there exists a correlation between the merger time and the time-path of the service change of hospitals, our results may bias. In this part, we present evidence to address the internal validity concern.

First, we check the summary statistics of hospitals across different merger time. We categorize the merger time into 3 groups, before (and includes) year 2005, year 2006-2010, and after (and includes) year 2011. Table 14 and Table 15 show the summary statistics of hospitals in the starting year by their merger time group. Table 14 shows the summary statistics of all merging hospitals with counterparts no further than 100 miles, and Table 15 shows the hospitals within merging counterparts within 10 miles. For both samples, we do not observe significant differences across the hospital characteristics.

Second, we conduct the validity test as De Janvry et al. (2015) to examine the correlation between merger time and the pre-merger service changes. We use a regression of pre-merger changes of the nunmber of services on the indicators for the merger years

$$\Delta n_{it} = \gamma_t + \sum_{k \geq t} \delta_k \cdot \mathbb{1}[\text{Merger Year}_i = k] + \epsilon_{it}, \quad \forall\, t \leq \text{Merger Year}_i \tag{16}$$

The dependent variable Δn_{it} is the number of services of hospital i, $n_{it} - n_{it-1}$ and γ_t stands for the year fixed effects. The parameter of interest is δ_k, which shows the relationship between the merger time (year k) and the change of the number of services with year fixed effects controlled. The joint significance of the merger time effects would imply that pre-merger service change is related to the merger time. Table 16 shows the results of this analysis. Column (1) uses the indicators of merger time group as the key indipendent variables and Column (2) adopts the indicators of merger years. In both settings, the year of mergers do not significantly explain the pre-merger change of services.

Table 14: Summary Statistics of 100-mile Merging Hospitals by Merging Time

	2002-2005	2006-2010	2010-2014
Number of procedure classes provided	163.3	163.2	154.1
	(26.54)	(23.25)	(33.06)
Number of diagnosis classes provided	131.3	131.4	130.4
	(5.341)	(5.062)	(5.349)
Hospital HHI of procedures	837.3	1115.4	1266.6
	(425.5)	(654.9)	(923.0)
Hospital HHI of diagnoses	350.1	339.0	371.5
	(71.15)	(55.85)	(106.4)
Casemix index	1.077	1.062	1.049
	(0.187)	(0.171)	(0.297)
Number of staffed beds	204.8	204.5	183.1
	(159.3)	(117.1)	(116.7)
Total discharges	10796.1	9509.2	8995.0
	(7230.7)	(5147.4)	(6855.1)
Total discharge days (in thousand)	50.44	50.55	47.04
	(36.51)	(28.29)	(35.07)
Total patient care cost (in million)	127.1	101.3	111.1
	(106.0)	(68.96)	(88.79)

Table 15: Summary Statistics of 10-mile Merging Hospitals by Merging Time

	2002-2005	2006-2010	2010-2014
Number of procedure classes provided	156.1	160.0	158.8
	(26.45)	(22.51)	(30.07)
Number of diagnosis classes provided	129.1	130.5	129.5
	(6.122)	(5.493)	(6.933)
Hospital HHI of procedures	1117.5	1178.9	1136.8
	(479.6)	(591.9)	(700.5)
Hospital HHI of diagnoses	346.0	335.9	335.5
	(56.24)	(57.97)	(101.7)
Casemix index	1.069	1.050	1.124
	(0.259)	(0.177)	(0.335)
Number of staffed beds	167.7	173.4	208.9
	(76.66)	(85.54)	(140.2)
Total discharges	9189.7	8109.2	9868.2
	(5444.9)	(4085.5)	(8405.7)
Total discharge days (in thousand)	46.90	41.93	53.06
	(26.45)	(20.51)	(41.22)
Total patient care cost (in million)	90.67	83.66	125.5
	(69.86)	(52.88)	(100.1)

Table 16: Relationship between Merger Time & Pre-merger Service Change

	(1)	(2)
	Δ Number of Services	Δ Number of Services
Before 2005	-	
2006-2009	-0.199	
	(0.989)	
After 2010	0.307	
	(1.119)	
Merger year=2003		-
		-
Merger year=2004		-0.590
		(3.274)
Merger year=2005		-2.073
		(2.550)
Merger year=2006		-2.510
		(3.115)
Merger year=2007		-1.525
		(3.086)
Merger year=2008		-0.669
		(3.094)
Merger year=2009		-0.251
		(2.955)
Merger year=2010		-1.230
		(3.049)
Merger year=2011		0.049
		(2.811)
Merger year=2012		-2.809
		(3.116)
Merger year=2013		-0.165
		(2.986)
Merger year=2014		0.163
		(3.174)
N	514	514
R^2	0.02	0.04

1.3 Tables and Graphs

Table 17: Post Merger Effect of Services across Merged Hospitals within 100 mile

	(1) Number of Services	(2) Number of Duplicate Srv	(3) Log HHI of Services	(4) Log HHI Non-removed Srv
Post merger of 0-10 miles	-4.733**	-6.774***	0.103**	0.088*
	(2.024)	(2.012)	(0.049)	(0.050)
Post merger of 10-40 miles	0.453	-5.480**	-0.034	-0.044
	(3.278)	(2.407)	(0.050)	(0.050)
Post merger of 40-70 miles	7.045**	3.393	0.016	0.033
	(3.399)	(6.558)	(0.055)	(0.055)
Post merger of 70-100 miles	6.072	5.887	0.067	0.078
	(5.741)	(4.803)	(0.111)	(0.111)
N	1208	1208	1208	1208
R^2	0.95	0.98	0.89	0.90

[1] Dependent variable in Column (1) is the total number of services of individual hospitals. Dependent variable in Column (2) is the number of duplicate services shared by hospitals and their closest merged counterparts Dependent variable in Column (3) is the log HHI of service volumes, and in (4) is the log HHI of services kept after mergers .

[2] Model clusters at individual hospital level. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 18: Summary Statistics of California Per Unit Cost by Services

Service	Mean	Standard Deviation
Electromyography	70.32	(96.19)
Electroencephalography	152.7	(101.9)
Radiology - Diagnostic	80.71	(47.24)
Radiology - Therapeutic	166.0	(161.6)
Nuclear Medicine	261.5	(191.0)
Magnetic Resonance Imaging	244.8	(158.7)
Ultrasonography	71.60	(33.32)
Computed Tomographic Scanner	80.12	(42.54)
Respiratory Therapy	56.93	(28.42)
Pulmonary Function Services	45.92	(48.76)
Outpatient Chemical Dependency Services	89.38	(82.16)
Coronary Care	1475.6	(480.9)
Neonatal Intensive Care	1328.6	(518.3)
Burn Care	834.1	(157.3)
Definitive Observation	696.0	(269.3)
Medical/Surgical Acute	683.7	(293.9)
Pediatric Acute	1131.1	(613.4)
Psychiatric Acute - Adult	601.3	(235.3)

Continued on next page

Table 18: Summary Statistics of California Per Unit Cost by Services

Psychiatric Acute - Adolescent and Child	392.9	(84.05)
Obstetrics Acute	561.9	(232.9)
Alternate Birthing Center	2118.0	(1156.2)
Partial Hospitalization - Psychiatric	352.9	(1586.6)
Skilled Nursing Care	370.2	(151.1)
Residential Care	33.44	(6.376)
Emergency Services	230.2	(119.7)
Psychiatric Emergency Rooms	793.4	(228.2)
Hospice - Outpatient Services	182.6	(62.84)
Labor and Delivery Services	2274.7	(1083.7)
Surgery and Recovery Services	16.11	(6.574)
Ambulatory Surgery Services	21.62	(35.36)
Anesthesiology	1.669	(1.706)
Clinical Laboratory Services	11.78	(3.594)
Pathological Laboratory Services	35.05	(20.57)
Blood Bank	191.5	(83.19)
Echocardiology	67.14	(61.51)
Cardiac Catheterization Services	1386.1	(1669.0)
Cardiology Services	41.36	(31.18)
Clinics	156.2	(135.2)
Renal Dialysis	199.3	(244.4)
Lithotripsy	1308.8	(623.8)
Gastro-Intestinal Services	325.0	(208.6)
Physical Therapy	31.59	(18.33)
Speech-Language Pathology	54.18	(37.58)
Occupational Therapy	28.39	(15.07)
Psychiatric/Psychological Testing	125.7	(353.6)
Psychiatric Individual/Group Therapy	64.64	(52.65)
Organ Acquisition	52323.0	(27302.6)
Medical/Surgical Intensive Care	1544.9	(574.0)
Observation Care	45.05	(37.60)
Chemical Dependency Services	464.2	(273.8)
Physical Rehabilitation Care	685.6	(231.1)
Hospice - Inpatient Services	549.7	(98.54)
Other Acute Care	504.7	(88.14)
Nursery Acute	354.7	(207.0)

Continued on next page

Table 18: Summary Statistics of California Per Unit Cost by Services

Sub-Acute Care	398.3	(108.6)

Table 19: Service by Service Results with All Services

Service	Post Merger <10	S.E.	Post Merger 10-100	S.E.	N	Adjusted R^2
Insertion; replacement; or removal of extracranial ventricular shunt	0.17***	(0.038)	0.035	(0.033)	965	0.541
Cancer chemotherapy	0.16***	(0.042)	-0.016	(0.025)	1,219	0.649
Intravenous pyelogram	0.15***	(0.044)	0.015	(0.035)	1,114	0.283
Bone marrow transplant	0.15	(0.13)	0.12	(0.12)	31	0.331
Other diagnostic cardiovascular procedures	0.12***	(0.039)	0.012	(0.023)	1,251	0.509
Repair of cystocele and rectocele; obliteration of vaginal vault	0.11***	(0.034)	0.038	(0.028)	1,436	0.627
Laparoscopy	0.11***	(0.031)	0.055*	(0.031)	1,470	0.434
Other procedures to assist delivery	0.100***	(0.034)	0.021	(0.017)	1,379	0.829
Genitourinary incontinence procedures	0.10**	(0.047)	0.039	(0.031)	1,400	0.526
Other respiratory therapy	0.10**	(0.046)	0.0080	(0.039)	1,402	0.209
Peripheral vascular bypass	0.10**	(0.049)	-0.015	(0.023)	1,367	0.589
Endarterectomy; vessel of head and neck	0.10**	(0.044)	0.014	(0.025)	1,341	0.628
Excision of semilunar cartilage of knee	0.099*	(0.051)	-0.00015	(0.037)	1,269	0.249
Control of epistaxis	0.098***	(0.030)	0.027	(0.026)	1,459	0.389
Ophthalmologic and otologic diagnosis and treatment	0.096*	(0.054)	-0.0080	(0.025)	707	0.356
Coronary thrombolysis	0.095**	(0.039)	0.0054	(0.024)	637	0.418
Spinal fusion	0.092**	(0.036)	0.033	(0.027)	1,261	0.565
Other non-OR therapeutic procedures; female organs	0.091**	(0.040)	0.047**	(0.023)	1,443	0.427
Dilatation and curettage (D&C); aspiration after delivery or abortion	0.087**	(0.034)	0.0022	(0.018)	1,465	0.710
Injections and aspirations of muscles; tendons; bursa; joints and soft tissue	0.086	(0.055)	0.025	(0.034)	1,263	0.311
Computerized axial tomography (CT) scan	0.086*	(0.048)	-0.027	(0.041)	1,422	0.290
Thyroidectomy; partial or complete	0.085**	(0.040)	-0.010	(0.033)	1,439	0.559
Embolectomy and endarterectomy of lower limbs	0.085**	(0.038)	0.035	(0.026)	1,351	0.553
Division of joint capsule; ligament or cartilage	0.082*	(0.046)	0.014	(0.042)	1,252	0.317
Laminectomy; excision intervertebral disc	0.081**	(0.033)	0.022	(0.026)	1,346	0.586

Continued on next page

Table 19: Service by Service Results with All Services

Procedures on spleen	0.081*	(0.042)	-0.0043	(0.026)	1,325	0.396
Aortic resection; replacement or anastomosis	0.080	(0.053)	0.017	(0.027)	1,169	0.573
Artificial rupture of membranes to assist delivery	0.079**	(0.037)	0.014	(0.035)	1,338	0.649
Forceps; vacuum; and breech delivery	0.078**	(0.032)	-0.013	(0.016)	1,361	0.816
Repair of current obstetric laceration	0.078**	(0.035)	-0.0077	(0.016)	1,362	0.870
Other excision of cervix and uterus	0.077**	(0.030)	0.024	(0.028)	1,454	0.594
Decompression peripheral nerve	0.076	(0.047)	-0.079*	(0.041)	1,231	0.272
Other OR heart procedures	0.072***	(0.025)	0.022	(0.025)	1,268	0.693
Cesarean section	0.070**	(0.032)	-0.00083	(0.014)	1,376	0.864
Diagnostic ultrasound	0.068	(0.052)	0.012	(0.044)	1,471	0.448
Episiotomy	0.066*	(0.035)	-0.0031	(0.016)	1,357	0.835
Electroencephalogram (EEG)	0.061	(0.049)	-0.031	(0.032)	1,183	0.364
Other operations on fallopian tubes	0.059	(0.040)	0.0076	(0.025)	1,455	0.484
Other OR therapeutic procedures; female organs	0.055	(0.034)	0.051**	(0.023)	1,472	0.532
Diagnostic dilatation and curettage (D&C)	0.055	(0.037)	0.085***	(0.028)	1,461	0.468
Intraoperative cholangiogram	0.054	(0.049)	0.027	(0.027)	1,462	0.518
Other OR therapeutic nervous system procedures	0.053*	(0.031)	0.017	(0.026)	1,404	0.628
Other bowel diagnostic procedures	0.052	(0.044)	-0.047*	(0.028)	1,367	0.319
Ligation of fallopian tubes	0.051	(0.034)	-0.035	(0.023)	1,344	0.806
Diagnostic cardiac catheterization; coronary arteriography	0.051*	(0.031)	-0.0034	(0.021)	1,164	0.856
Other diagnostic procedures of urinary tract	0.050	(0.033)	0.010	(0.028)	1,410	0.415
Oophorectomy; unilateral and bilateral	0.050*	(0.027)	0.027	(0.021)	1,474	0.675
Fetal monitoring	0.050	(0.038)	-0.0019	(0.036)	1,362	0.570
Radioisotope scan	0.050	(0.045)	0.085**	(0.040)	1,224	0.394
Other diagnostic procedures on skin and subcutaneous tissue	0.047	(0.040)	0.029	(0.029)	1,435	0.373
Myelogram	0.046	(0.041)	0.018	(0.033)	832	0.354
Lobectomy or pneumonectomy	0.046	(0.034)	-0.032	(0.028)	1,358	0.540
Debridement of wound; infection or burn	0.045*	(0.026)	0.023	(0.021)	1,475	0.572
Other OR therapeutic procedures of urinary tract	0.044	(0.038)	0.047*	(0.027)	1,467	0.513
Other operations on ovary	0.044	(0.029)	-0.010	(0.021)	1,475	0.647

Continued on next page

Table 19: Service by Service Results with All Services

Diagnostic bronchoscopy and biopsy of bronchus	0.044*	(0.024)	0.035	(0.023)	1,471	0.802
Excision; lysis peritoneal adhesions	0.044*	(0.023)	-0.0015	(0.021)	1,475	0.725
Other diagnostic procedures of respiratory tract and mediastinum	0.043	(0.031)	-0.0049	(0.030)	1,452	0.489
Tracheoscopy and laryngoscopy with biopsy	0.041	(0.036)	0.015	(0.024)	1,424	0.519
Other diagnostic nervous system procedures	0.040	(0.058)	0.047	(0.039)	974	0.393
Gastrectomy; partial and total	0.040	(0.033)	0.065**	(0.032)	1,402	0.391
Other non-OR therapeutic cardiovascular procedures	0.039	(0.029)	-0.019	(0.023)	1,471	0.818
Other non-OR therapeutic procedures on skin and breast	0.038	(0.025)	0.040*	(0.021)	1,475	0.620
Cerebral arteriogram	0.038	(0.062)	-0.035	(0.043)	1,249	0.468
Corneal transplant	0.038	(0.033)	0.099	(0.082)	133	0.038
Other non-OR therapeutic procedures on respiratory system	0.038	(0.034)	0.0021	(0.025)	1,468	0.597
Diagnostic endocrine procedures	0.037	(0.042)	0.028	(0.030)	1,227	0.289
Other OR procedures on vessels other than head and neck	0.037	(0.035)	-0.023	(0.023)	1,475	0.731
Hysterectomy; abdominal and vaginal	0.036	(0.031)	0.0035	(0.022)	1,473	0.719
Excision of skin lesion	0.036	(0.031)	-0.028	(0.033)	1,475	0.486
Swan-Ganz catheterization for monitoring	0.036	(0.049)	-0.021	(0.029)	1,277	0.535
Circumcision	0.035	(0.028)	0.040**	(0.019)	1,318	0.699
Diagnostic procedures; male genital	0.034	(0.067)	0.0081	(0.045)	1,133	0.247
Diagnostic procedures on eye	0.033	(0.055)	-0.058	(0.060)	317	-0.021
Diagnostic procedures on nose; mouth and pharynx	0.033	(0.053)	-0.013	(0.037)	1,363	0.365
Other OR gastrointestinal therapeutic procedures	0.033*	(0.018)	0.0019	(0.019)	1,475	0.722
Skin graft	0.032	(0.030)	-0.088***	(0.030)	1,463	0.555
Amputation of lower extremity	0.031	(0.026)	0.027	(0.021)	1,473	0.647
Bone marrow biopsy	0.031	(0.027)	0.046**	(0.021)	1,463	0.528
Other non-OR or closed therapeutic nervous system procedures	0.030	(0.049)	-0.016	(0.036)	1,433	0.336
Other therapeutic procedures on eyelids; conjunctiva; cornea	0.030	(0.037)	0.018	(0.028)	1,442	0.344

Continued on next page

Table 19: Service by Service Results with All Services

Other therapeutic procedures; hemic and lymphatic system	0.030	(0.034)	-0.0093	(0.020)	1,470	0.613
Other OR therapeutic procedures on respiratory system	0.029	(0.027)	-0.027	(0.023)	1,449	0.576
Other OR therapeutic procedures on bone	0.028	(0.033)	-0.057**	(0.023)	1,452	0.600
Contrast arteriogram of femoral and lower extremity arteries	0.028	(0.044)	0.015	(0.037)	1,377	0.646
Tonsillectomy and/or adenoidectomy	0.028	(0.033)	0.046	(0.038)	1,123	0.432
Other OR upper GI therapeutic procedures	0.028	(0.040)	0.034	(0.035)	1,472	0.514
Proctoscopy and anorectal biopsy	0.028	(0.027)	-0.030	(0.018)	1,473	0.568
Blood transfusion	0.025	(0.028)	0.043	(0.028)	1,475	0.575
Tracheostomy; temporary and permanent	0.025	(0.024)	-0.021	(0.023)	1,453	0.713
Therapeutic procedures on the esophagus	0.025	(0.042)	0.030	(0.031)	1,460	0.326
Other diagnostic procedures on musculoskeletal system	0.024	(0.048)	-0.030	(0.026)	1,456	0.504
Other therapeutic procedures	0.024	(0.033)	0.0040	(0.025)	1,475	0.631
Other OR therapeutic procedures on nose; mouth and pharynx	0.024	(0.033)	-0.032	(0.029)	1,427	0.519
Other non-OR lower GI therapeutic procedures	0.024	(0.030)	0.018	(0.021)	1,472	0.624
Other gastrointestinal diagnostic procedures	0.024	(0.036)	0.017	(0.028)	1,469	0.523
Nephrotomy and nephrostomy	0.022	(0.023)	-0.021	(0.020)	1,409	0.589
Procedures on the breast	0.020	(0.041)	-0.016	(0.022)	1,467	0.495
Biopsy of liver	0.020	(0.035)	-0.020	(0.030)	1,463	0.523
Arterio or venogram (not heart and head)	0.019	(0.050)	0.0024	(0.038)	1,438	0.530
Insertion; revision; replacement; removal of cardiac pacemaker or cardioverter/defibrillator	0.019	(0.027)	0.0037	(0.021)	1,458	0.711
Other diagnostic procedures; female organs	0.018	(0.039)	0.048	(0.031)	1,421	0.409
Contrast aortogram	0.018	(0.055)	-0.012	(0.033)	1,339	0.606
Abdominal paracentesis	0.017	(0.021)	0.012	(0.017)	1,474	0.740
Extracorporeal circulation auxiliary to open heart procedures	0.016	(0.014)	-0.00082	(0.014)	831	0.897
Arthroscopy	0.015	(0.044)	-0.063**	(0.031)	1,358	0.345
Incision of pleura; thoracentesis; chest drainage	0.015	(0.020)	-0.024	(0.017)	1,474	0.798

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Table 19: Service by Service Results with All Services

Other extraocular muscle and orbit therapeutic procedures	0.014	(0.056)	-0.025	(0.043)	911	0.244
Other non-OR upper GI therapeutic procedures	0.014	(0.027)	-0.020	(0.018)	1,473	0.704
Conversion of cardiac rhythm	0.013	(0.027)	-0.0055	(0.026)	1,475	0.611
Percutaneous transluminal coronary angioplasty (PTCA)	0.013	(0.016)	0.0035	(0.012)	956	0.923
Other non-OR therapeutic procedures; male genital	0.012	(0.045)	0.0013	(0.033)	1,437	0.221
Incision and drainage; skin and subcutaneous tissue	0.012	(0.023)	-0.0071	(0.015)	1,474	0.642
Other OR therapeutic procedures on skin and breast	0.012	(0.033)	0.019	(0.030)	1,450	0.397
Psychological and psychiatric evaluation and therapy	0.010	(0.029)	0.012	(0.031)	534	0.338
Alcohol and drug rehabilitation/ detoxification	0.0095	(0.040)	-0.019	(0.029)	1,188	0.288
Other therapeutic endocrine procedures	0.0089	(0.036)	0.020	(0.032)	1,316	0.536
Other non-OR therapeutic procedures on nose; mouth and pharynx	0.0079	(0.046)	-0.028	(0.029)	1,431	0.330
Respiratory intubation and mechanical ventilation	0.0076	(0.022)	0.024	(0.017)	1,475	0.794
Creation; revision and removal of arteriovenous fistula or vessel-to-vessel cannula for dialysis	0.0068	(0.033)	-0.025	(0.030)	1,465	0.630
Coronary artery bypass graft (CABG)	0.0067	(0.010)	0.00069	(0.0092)	726	0.955
Gastrostomy; temporary and permanent	0.0059	(0.022)	-0.0089	(0.018)	1,474	0.774
Removal of ectopic pregnancy	0.0037	(0.029)	-0.024	(0.021)	1,452	0.544
Repair of retinal tear; detachment	0.0024	(0.015)	-0.051	(0.044)	357	0.446
Other OR therapeutic procedures on musculoskeletal system	0.0021	(0.049)	0.049	(0.034)	1,444	0.319
Procedures on the urethra	0.0019	(0.043)	0.045*	(0.023)	1,462	0.504
Colostomy; temporary and permanent	0.00094	(0.022)	-0.036**	(0.018)	1,462	0.572
Other vascular bypass and shunt; not heart	0.00082	(0.053)	-0.0044	(0.035)	844	0.461
Heart valve procedures	0.00024	(0.016)	-0.0080	(0.012)	679	0.950
Cardiac stress tests	-0.00038	(0.043)	0.021	(0.036)	1,252	0.402

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Table 19: Service by Service Results with All Services

Incision and excision of CNS	-0.00053	(0.036)	-0.012	(0.028)	1,086	0.742
Partial excision bone	-0.0017	(0.036)	-0.066***	(0.024)	1,468	0.625
Endoscopic retrograde cannulation of pancreas (ERCP)	-0.0017	(0.035)	0.021	(0.029)	1,456	0.598
Hemodialysis	-0.0018	(0.021)	-0.018	(0.016)	1,471	0.826
Other OR therapeutic procedures on joints	-0.0022	(0.037)	-0.065***	(0.024)	1,456	0.537
Tympanoplasty	-0.0022	(0.053)	-0.075	(0.065)	435	0.147
Treatment of fracture or dislocation	-0.0030	(0.024)	-0.038**	(0.017)	1,465	0.773
Arthroplasty	-0.0033	(0.044)	-0.088**	(0.038)	1,453	0.619
Other hernia repair	-0.0036	(0.023)	-0.023	(0.022)	1,475	0.636
Colorectal resection	-0.0037	(0.019)	-0.054***	(0.016)	1,472	0.777
Inguinal and femoral hernia repair	-0.0056	(0.031)	-0.018	(0.020)	1,469	0.566
Hemorrhoid procedures	-0.0063	(0.037)	-0.045	(0.034)	1,422	0.283
Peritoneal dialysis	-0.0063	(0.033)	-0.027	(0.031)	1,382	0.461
Nasogastric tube	-0.0083	(0.049)	0.044	(0.036)	1,416	0.200
Other therapeutic obstetrical procedures	-0.011	(0.034)	-0.0095	(0.025)	1,341	0.741
Arthrocentesis	-0.011	(0.029)	-0.0041	(0.024)	1,470	0.626
Microscopic examination (bacterial smear; culture; toxicology)	-0.012	(0.044)	-0.0083	(0.036)	768	0.235
Upper gastrointestinal X-ray	-0.012	(0.049)	-0.045	(0.034)	686	0.203
Other OR lower GI therapeutic procedures	-0.012	(0.027)	-0.054**	(0.022)	1,474	0.714
Prophylactic vaccinations and inoculations	-0.013	(0.035)	-0.014	(0.042)	1,411	0.376
Colonoscopy and biopsy	-0.013	(0.026)	-0.013	(0.017)	1,475	0.694
Diagnostic spinal tap	-0.016	(0.023)	0.00081	(0.018)	1,475	0.675
Other OR therapeutic procedures; male genital	-0.017	(0.038)	0.0089	(0.026)	1,457	0.405
Other vascular catheterization; not heart	-0.017	(0.026)	-0.013	(0.022)	1,475	0.793
Exploratory laparotomy	-0.019	(0.041)	-0.035	(0.030)	1,456	0.264
Appendectomy	-0.020	(0.018)	-0.028**	(0.011)	1,474	0.814
Nonoperative urinary system measurements	-0.021	(0.043)	0.044	(0.068)	403	0.361
Therapeutic radiology	-0.021	(0.043)	-0.010	(0.032)	913	0.629
Upper gastrointestinal endoscopy; biopsy	-0.021	(0.024)	-0.019	(0.015)	1,475	0.770
Other therapeutic procedures on muscles and tendons	-0.022	(0.038)	-0.11***	(0.029)	1,472	0.619
Other therapeutic ear procedures	-0.022	(0.038)	0.058*	(0.035)	1,363	0.240

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Table 19: Service by Service Results with All Services

Other non-OR gastrointestinal therapeutic procedures	-0.022	(0.026)	0.0082	(0.023)	1,471	0.766
Small bowel resection	-0.022	(0.022)	-0.045***	(0.017)	1,471	0.623
Myringotomy	-0.024	(0.047)	0.059	(0.058)	683	0.267
Other diagnostic procedures on lung and bronchus	-0.024	(0.051)	-0.046	(0.035)	1,213	0.411
Cystoscopy and other transurethral procedures	-0.027	(0.034)	-0.015	(0.020)	1,473	0.678
Mastoidectomy	-0.028	(0.062)	0.033	(0.069)	493	0.118
Open prostatectomy	-0.029	(0.036)	-0.0099	(0.024)	1,262	0.614
Diagnostic amniocentesis	-0.032	(0.065)	0.032	(0.046)	632	0.316
Ileostomy and other enterostomy	-0.032	(0.028)	-0.064***	(0.022)	1,458	0.505
Enteral and parenteral nutrition	-0.034	(0.053)	0.034	(0.036)	1,469	0.363
Other diagnostic radiology and related techniques	-0.035	(0.044)	0.019	(0.031)	1,471	0.501
Nephrectomy; partial or complete	-0.036	(0.041)	-0.038*	(0.022)	1,286	0.552
Transurethral resection of prostate (TURP)	-0.036	(0.048)	0.059**	(0.029)	1,451	0.510
Other non-OR therapeutic procedures on musculoskeletal system	-0.036	(0.038)	-0.059**	(0.026)	1,428	0.455
Suture of skin and subcutaneous tissue	-0.036	(0.027)	-0.049***	(0.018)	1,473	0.624
Physical therapy	-0.038	(0.042)	0.0026	(0.029)	1,474	0.486
Other diagnostic procedures (interview; evaluation; consultation)	-0.039	(0.034)	-0.072**	(0.032)	1,457	0.473
Cholecystectomy and common duct exploration	-0.039*	(0.022)	-0.043***	(0.015)	1,475	0.771
Electrocardiogram	-0.041	(0.048)	-0.0095	(0.036)	442	-0.029
Nonoperative removal of foreign body	-0.045	(0.029)	-0.047***	(0.018)	1,460	0.355
Lens and cataract procedures	-0.045	(0.044)	-0.12**	(0.046)	691	0.173
Other OR procedures on vessels of head and neck	-0.045	(0.042)	-0.045	(0.031)	1,041	0.439
Dental procedures	-0.047	(0.031)	-0.0081	(0.033)	1,084	0.460
Other non-OR therapeutic procedures of urinary tract	-0.051	(0.041)	0.0044	(0.027)	1,473	0.502
Diagnostic procedures on ear	-0.054	(0.058)	-0.067	(0.046)	299	-0.139
Lower gastrointestinal X-ray	-0.056	(0.046)	-0.043	(0.041)	385	0.206
Abortion (termination of pregnancy)	-0.057	(0.042)	-0.019	(0.040)	712	0.103

Continued on next page

Table 19: Service by Service Results with All Services

Mammography	-0.057	(0.034)	-0.030	(0.024)	417	0.134
Varicose vein stripping; lower limb	-0.059	(0.064)	-0.077	(0.070)	555	0.106
Plastic procedures on nose	-0.060	(0.043)	-0.026	(0.038)	1,306	0.309
Arterial blood gases	-0.062	(0.067)	0.00047	(0.034)	537	0.038
Insertion of catheter or spinal stimulator and injection into spinal canal	-0.065*	(0.035)	-0.023	(0.028)	1,431	0.503
Extracorporeal lithotripsy; urinary	-0.075*	(0.040)	-0.0053	(0.032)	1,262	0.432
Glaucoma procedures	-0.077	(0.057)	-0.086	(0.098)	159	0.237
Indwelling catheter	-0.081	(0.051)	-0.12***	(0.033)	1,435	0.316
Bunionectomy or repair of toe deformities	-0.096	(0.060)	-0.082*	(0.043)	908	0.232
Other intraocular therapeutic procedures	-0.11*	(0.058)	-0.042	(0.056)	834	0.252
Destruction of lesion of retina and choroid	-0.12	(0.087)	0.065	(0.10)	339	0.319
Local excision of large intestine lesion (not endoscopic)	-0.12	(0.074)	-0.13***	(0.040)	857	0.322
Magnetic resonance imaging	-0.14***	(0.047)	-0.21***	(0.044)	1,196	0.326
Electrographic cardiac monitoring	-0.29***	(0.054)	-0.042	(0.027)	408	0.177

Table 20: AHA Service List

Psychiatric education services	Hemodialysis Services
General medical and surgical care (pediatric)	HIV-AIDS services
Obstetrics care	Home health services
Medical/surgical intensive care	Hospital-base outpatient care center/services
Cardiac intensive care	Indigent care clinic
Neonatal intensive care	Linguistic/translation services
Neonatal intermediate care	Meals on wheels
Pediatric intensive care	Mobile Health Services
Burn care	Neurological services
Other special care	Nutrition programs
Other intensive care	Occupational health services
Physical Rehabilitation care	Oncology services
Alcohol/drug abuse or dependency inpatient care	Orthopedic services
Psychiatric care	Outpatient surgery
Skilled nursing care	Patient Controlled Analgesia
Intermediate nursing care	Patient education center
Acute long term care	Patient representative services
Other long-term care	Physical rehabilitation outpatient services
Other care	Primary care department
Adult day care program	Psychiatric child/adolescent services
Airborne infection isolation room	Psychiatric consultation/liaison services
Alcohol/drug abuse or dependency outpatient services	Psychiatric emergency services
Alzheimer Center	Psychiatric geriatric services
Ambulance services	Psychiatric outpatient services
Ambulatory surgery center	Psychiatric partial hospitalization program
Arthritis treatment center	Radiology therapeutic
Assisted living services	Image-guided radiation therapy
Auxiliary	Intensity-Modulated Radiation Therapy (IMRT)
Bariatric/weight control services	Shaped beam Radiation System
Birthing room/LDR room/LDRP room	Stereotactic radiosurgery
Blood Donor Center Hospital	Computed-tomography (CT) scanner
Breast cancer screening/mammograms	Diagnostic radioisotope facility
Adult diagnostic/invasive catheterization	Electron Beam Computed Tomography (EBCT)
Pediatric diagnostic/invasive catheterization	Full-field digital mammography
Adult interventional cardiac catheterization	Magnetic resonance imaging (MRI)

Continued on next page

Table 20: AHA Service List

Pediatric interventional cardiac catheterization	Multislice spiral computed tomography <64 slice
Adult cardiac surgery	Multi-slice spiral computed tomography 64 + slice
Pediatric cardiac surgery	Positron emission tomography (PET)
Cardiac Rehabilitation	Positron emission tomography/CT (PET/CT)
Case Management	Single photon emission computerized tomography (SPECT)
Chaplaincy/pastoral care services	Ultrasound
Chemotherapy	Fertility Clinic
Children wellness program	Genetic testing/counseling
Chiropractic services	Retirement housing
Community outreach	Robotic surgery
Complementary medicine services	Sleep Center
Computer assisted orthopedic surgery	Social work services
Crisis prevention	Sports medicine
Dental services	Support groups
Emergency Department	Swing bed services
Freestanding/Satellite Emergency Department	Teen outreach services
Certified trauma center	Tobacco Treatment Services
Level of trauma center	Bone Marrow transplant services
Enabling Services	Heart transplant
Hospice	Kidney transplant
Pain Management Program	Liver transplant
Palliative Care Program	Lung transplant
Enrollment Assistance Program	Tissue transplant
Extracorporeal shock-wave lithotripter (ESWL)	Other Transplant
Fitness center	Transportation to health services
Freestanding outpatient center	Urgent care center
Geriatric services	Virtual colonoscopy
Health Fair	Volunteer services department
Health information center	Women's health center/services
Health screenings	Wound Management Services

1.4 Supplement Results with the AHA data

1.5 Heterogeneous Effect of Targets and Acquirers

The change we observe above could also be motivated by the financially poor-performed targets' intention to shrink their service spectrum, which is irrelevant with the service consolidation. There is a possibility that targets are financially constrained, and they would remove services even without occurrence of mergers. Under this case, the service removal would occur for the targets, while the acquirers which are of decent financial status might absorb the target hospitals. This mechanism would result in all the services elimination only on the target side, while the service consolidation leads to a simultaneous service exchange on both the targets and acquirers due to the service consolidation. To test whether the services repositioning only occurs on targets or both sides, we turn to the national sample from the AHA Annual Survey to form a large sample to study the effect with the targets and the acquirers separately. We use the same strategy in Section 3.2 to evaluate the change of services at the individual hospitals and hospital pairs. Table 21 presents the summary statistics of the mergers and acquirers at the beginning year of the AHA sample, year 2001. On average, the acquirer hospitals are larger than the targets, offering more services and treats more patients. Meanwhile, for the targets/acquirers having merger counterpart within 10 miles, they are more likely to be in metro areas, and are of larger size compared with the hospitals with further merging partners. The services from the AHA data is listed in Table 20 in Appendix.

Table 21: Summary Statistics of AHA Data in Year 2001

	Targets in 10 miles	All Targets	Acquirers in 10 miles	All Acquirers
Number of services	28.47	23.04	32.60	25.51
	(10.01)	(11.32)	(12.05)	(12.26)
Total staffed beds	252.3	158.9	347.8	207.1
	(138.2)	(136.0)	(267.9)	(203.5)
Total admissions	10755.3	6556.4	15883.1	9241.1
	(6819.8)	(6207.4)	(12955.9)	(9912.0)
Local sys members	3.781	2.625	3.481	3.470
	(4.308)	(3.570)	(3.689)	(3.702)
Metro	0.562	0.427	0.596	0.486
	(0.499)	(0.495)	(0.492)	(0.500)

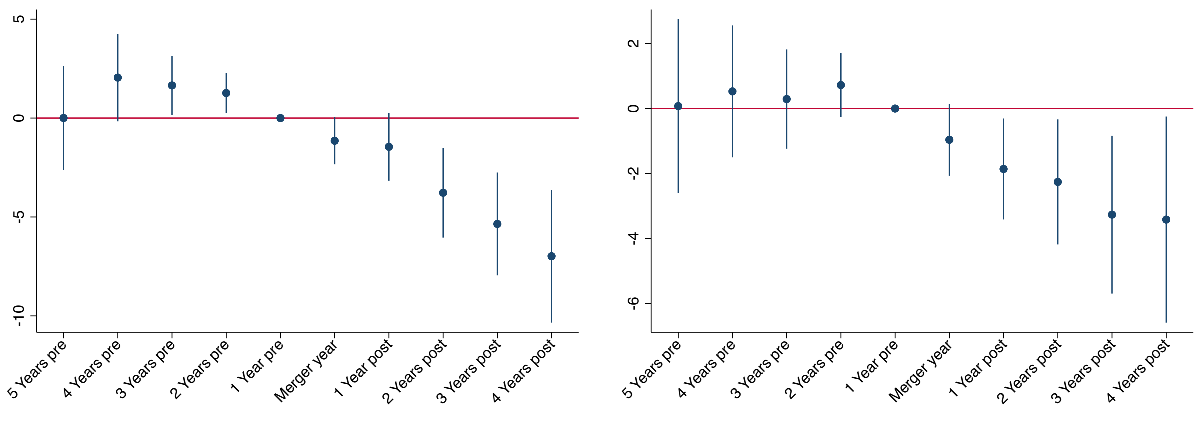
Table 22 implements the two-way fixed effect models only with the target hospitals and acquirer hospitals within 10 miles separately. From Table 22, we can observe that the service

Table 22: Individual Hospital Number of Services for Mergers within 10 miles

	(1) Targets within 10 miles	(2) Acquirers within 10 miles
Post merger	-2.544***	-1.816**
	(0.880)	(0.787)
N	1182	1657
R^2	0.88	0.92

Model clusters at individual hospital level. Total number of beds and for-profit status of hospitals are included in regressions. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

elimination happens simultaneously at the targets and acquirers, and the targets drop more services compared to the acquirers. We decompose the effect by time in the event study in Figure 18, where the left panel is the event study with the targets sample in Table 22 Column (1) and the right panel is the acquirers in Table 22 Column (2). For the target hospitals, we observe that the service removal happens one year before the merger. The early service reposition of the target hospitals can be driven by the possible poor financial performance of targets so that they already shrink the spectrum of services covered. However, the parallel trend assumption holds for the acquirers. Meanwhile, the acquirer hospitals, which may not face financial stress as targets do, still eliminate some services, indicating the service removal we observe are not entirely driven by the worry of financial performance. The pair analysis results is attached in the Appendix. Overall, the service repositioning identified in the California sample also holds in the national sample from the AHA data.



(a) Targets within 10 miles

(b) Acquirers within 10 miles

Figure 18: Event Study of Number of Services for Hospitals within 10-mile Mergers

1.5.1 Robustness Check with the Propensity Score Matching Control

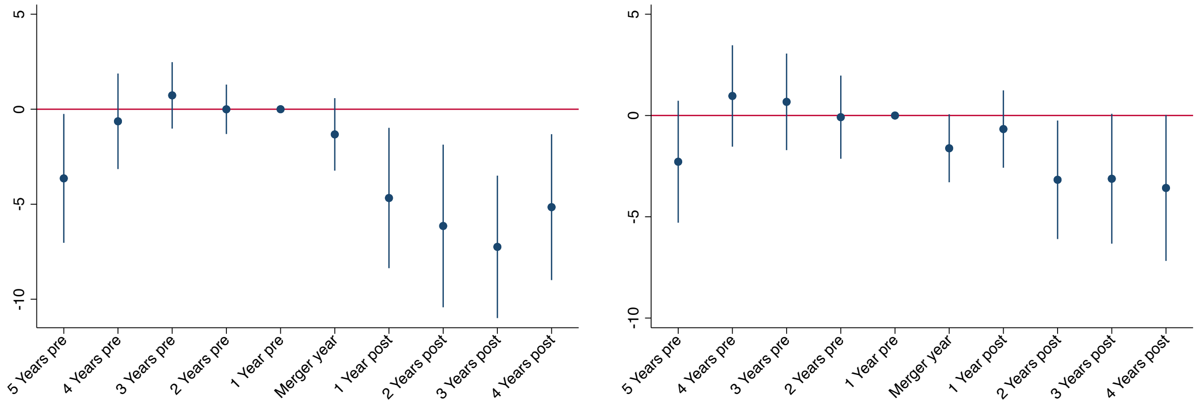
To deal with the pre-trend problem in the event study of the target hospitals in the AHA data, we run a robustness check using the unmerging control group built from the propensity score matching. Similar to Section 3.4.2, we match on the pre-merger outcome variable, the number of services of individual hospitals, and other hospital characteristics and market characteristics. The hospital characteristics include the number of beds, the number of annual admissions, and the number of hospitals affiliated with the hospital's system in the local market. Furthermore, the market characteristics we matched on are the number of hospitals in the local market, the metro status of the market, and the market HHI based on the hospitals' number of beds. Targets and acquirers are separately matched. Similar to before, we use a propensity score matching with a caliper to exclude the treatment hospitals without proper controls. Table 23 presents the summary statistics of the targets/acquirers within 10 miles and their matched controls of the beginning year in the sample. Compared to the targets' matched controls, the controls matched to acquirers are larger hospitals with more services, bed and admissions, and are more liekley to be in the metro areas.

Table 23: Summary Statistics of Macthed Sample from AHA Data

	Targets		Acquirers	
	Within 10miles	Matched Control	Within 10 miles	Matched Controls
Number of services	28.59	25.26	32.32	28.02
	(10.08)	(14.82)	(11.72)	(14.95)
Total staffed beds	258.5	202.8	331.3	237.4
	(140.8)	(169.4)	(250.9)	(194.5)
Total admissions	11107.8	9515	15723.3	10023.0
	(6985.2)	(9024.4)	(13229.1)	(9224.5)
Local sys members	3.568	3.324	3.086	2.808
	(3.857)	(4.002)	(2.314)	(3.973)
Metro	0.630	0.559	0.664	0.587
	(0.486)	(0.500)	(0.474)	(0.495)

Table 24: Number of Services of Merged Hsopitals within 10 miles & Matched Controls

	(1)	(2)
	Targets within 10 miles	Acquirers within 10 miles
Post merger	-3.517***	-1.894*
	(1.340)	(1.059)
N	1789	2738
R^2	0.82	0.81



(a) Targets

(b) Acquirers

Figure 19: Event Study of Targerts/Acquirers within 10 miles & Matched Controls

Table 24 shows the results of the Diff-in-Diff analysis of within 10-mile targets/acquirers and their controls and the event study graph is presented in Figure 19. With the matched non-merging controls, the target hospitals remove approximately 3.5 services while the acquirers averagely decrease 2 services. Graph 19 shows the dynamic of the merger effect with time. For both targets and acquirers, the effect of service repositioning holds in both the short-run and long-run after mergers.

1.5.2 Hospital Pair Analysis

This section presents the analysis with the merging hospitals in the AHA data. Similar to before, we pair every two hospitals within the same market (Defined as Hospital Referral Region) and analysis the change of the total/duplicate services of the merging hospital pairs. The result is presented in Table 25. The sample still includes all the merging hospital pairs within 100 miles, and we estimate the heterogeneous effect of the same sample across different geographic distance group.

Column (1) in Table 25 presents the results with the hospital pairs' total number of services. The hospital pairs keep the similar number of services before and post mergers. However, in Column (2), the merging hospitals pairs within 10 miles have a statistically significant drop of the duplicate services, indicating the occurrence of service repositioning for the merging hospital pairs in the close distance. We also conduct the event study of the merging hospital pairs within 10 miles in Figure 20. The analysis with the duplicate services does not reject the parallel pre-trend assumption, meanwhile, the decrease of duplicate services begins at the merger year and becomes larger as the time grows post merger.

Table 25: Change of Total/Duplicative Services of Hospital Merged Pairs within 100 miles

	(1) Number of total services	(2) Number of duplicate services
Post merger of 0-10mile	-0.561	-2.496***
	(1.311)	(0.788)
Post merger of 10-40mile	-0.022	-0.095
	(0.581)	(0.439)
Post merger of 40-70mile	-1.690**	-0.047
	(0.709)	(0.496)
Post merger of 70-100mile	-0.999	-1.157**
	(1.044)	(0.558)
N	7467	7467
R^2	0.94	0.92

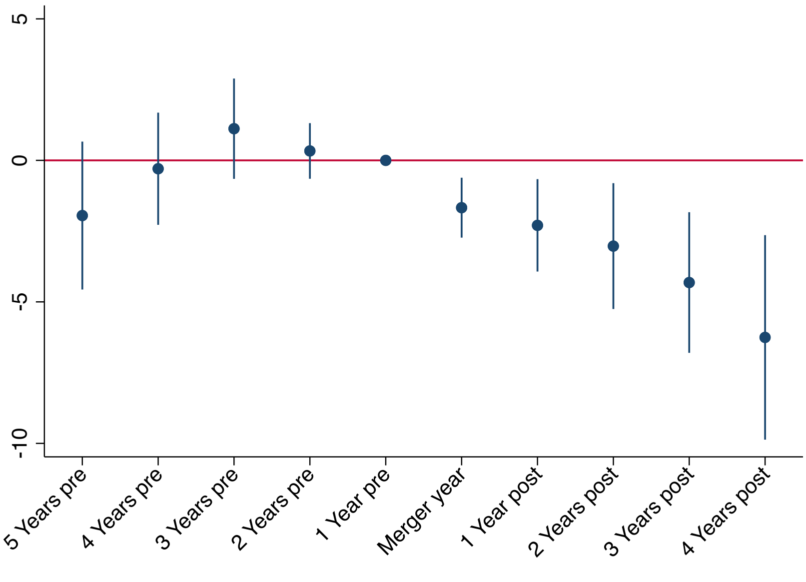


Figure 20: Event Study of Merging Hospital Pairs within 10 miles in AHA Data