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EXPECTING HARM? THE IMPACT OF RURAL HOSPITAL ACQUISITIONS ON MATERNAL HEALTH CARE

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Expecting Harm? The Impact of Rural Hospital Acquisitions on Maternal Health Care
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ABSTRACT

While numerous papers document the effects of mergers on cost and quality, the effects of hospital mergers on access to care are less certain. Merging hospitals may limit access by closing one of the affected hospitals or eliminating individual service lines. However, hospital systems may have more resources to improve care delivery. We study the impact of hospital mergers on obstetric care in rural markets, where there may be heightened concern about the availability of local care options. Using a differences-in-differences approach, we find that when rural hospitals are acquired, there are substantial increases in the probability of obstetric unit closures, with resulting large reductions in the number of births at the hospital. We find mixed effects on health outcomes: there are small increases in maternal morbidity, but no changes in newborn outcomes on average. However, there are improvements of newborns with Medicaid coverage. Additionally, we find decreases in maternal transfers and increases in procedures consistent with women delivering in more resourced hospitals.

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1 Introduction

The hospital industry is one of the most important sectors in the U.S. economy, both because of its size (accounting for ∼$1.3 trillion in spending and 5.3% of GDP in 2022 Hartman et al., 2024), and its impact on the health and well-being of the population. The industry has undergone tremendous transformation over the past few decades, with nearly 1,600 mergers between 1998 and 2021 (Gaynor, 2021) and over 500 closures over a similar time period. As suggested by William Kissick's seminal work "Medicine's Dilemmas," wholesale changes to the health care system, as embodied by the consolidation trend, can simultaneously affect costs, quality, and access to care (Kissick, 1994).

While numerous studies find that consolidation generally leads to higher prices, a smaller set of studies find ambiguous (at best) effects on quality, and few if any studies examine access to care (see e.g., Gaynor et al., 2015; Handel and Ho, 2021). Moreover, most of the quality studies focus on specific urban markets and examine a limited set of measures, primarily mortality. The limited research on rural hospital mergers tends to look at financial outcomes, rather than access or quality.[1] Separate bodies of work have examined the causes and impacts of rural hospital closures (Hung et al., 2016; Kozhimannil et al., 2018; Jiang et al., 2022; Carroll, 2023), rural hospital acquisitions (Henke et al., 2021; O'Hanlon et al., 2019), and the closures of obstetric units in general (Avdic et al., 2024; Fischer et al., 2024; Battaglia, 2025). That research is important, but does not (attempt to) address the issue of the impacts of rural hospital mergers. This paper begins to fill these voids.

We examine how acquisitions of rural hospitals affect access and quality of obstetric care. Over the period 2006 to 2019, we identify 467 mergers involving rural hospitals. Of these mergers, 317 involve rural hospitals as the target. These trends have raised concerns about access to care for residents of rural areas. In his 2021 Executive Order on Promoting Competition in the American Economy, President Biden noted how "hospital consolidation has left many areas, particularly rural communities, with inadequate or more expensive healthcare options."

There is especially heightened concern about obstetric care (e.g., American Hospital Association, 2022; U.S. Government Accountability Office, 2022; Kozhimannil et al., 2025). Of the 317 acquired rural hospitals, 40 closed their obstetric departments. Many of these were the sole local source of obstetric care. After obstetric units close, pregnant women may face markedly higher travel costs. They may also receive less prenatal care, less timely obstetric

[1] For a notable exception, see Jiang et al. (2021).

care, more fragmented care, or less postnatal care, any of which could result in worse outcomes for mothers or children (Center for Health Care Quality and Payment Reform, 2023). This concern about closures manifests itself in the proposed KOLA Act (Keep Obstetrics Local Act)[2], which would raise Medicaid rates for obstetrics care provided at rural hospitals. The Act's sponsor, Senator Maggie Hassan (D-NH) stated that "All families deserve access to safe, quality maternity care, regardless of where they call home."([3])

Closing obstetric units may offer some offsetting benefits. Closed units tend to be small and treat relatively few patients. A number of studies document that complication rates and birth outcomes are poorer at low-volume hospitals (Kyser et al., 2012; Matsuo et al., 2022).

To assess the impact of rural hospital acquisitions on access and quality, we assemble a panel of hospital mergers combining information from the American Hospital Association's (AHA) Annual Survey of Hospitals[4] and the merger database from Irvin Levin Associates.[5] The AHA hospital-level data include service offerings, births, and staffing. We measure birth outcomes using county-level data from the National Vital Statistics System (NVSS) [6]We estimate the impact of rural hospital acquisition using a difference-in-difference design, leveraging variation in the timing of hospital mergers. We find that 5 years after acquisition, rural hospitals are 30 percent less likely to offer obstetric services. This corresponds with large declines in the numbers of births at the acquired hospitals and is accompanied by decreases in the quantity of obstetric care resources in the county in which the acquired hospital is located.

Despite the potential loss of local obstetric services following acquisition, the number of births to women residing in the affected counties does not change. C-section and induction rates remain constant, as do measures of newborn well-being. However, we find important heterogeneity by insurance coverage: newborns with Medicaid coverage see improvements across a number of health measures. We identify acquired hospitals that do not close an obstetric unit as the key driver of this result, suggesting that acquired hospitals change the quality of care provided in a way that benefits newborn health.

Although we do not find direct effects on newborn health on average, we find some

[2] https://www.finance.senate.gov/chairmans-news/wyden-and-hassan-lead-introduction-of-legislation-to-stop-labor-and-delivery-unit-closures-in-rural-and-underserved-communities

[3] https://www.hassan.senate.gov/news/press-releases/senators-hassan-and-wyden-introduce-legislation-to-help-keep-open-labor-and-delivery-units-in-rural-and-underserved-communities

[4] https://www.ahadata.com/aha-annual-survey-database

[5] https://www.levinassociates.com/health-care-services-acquisition-report/

[6] National Center for Health Statistics, "Birth Files 2006-2019," as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program.

evidence that hospital acquisitions negatively affect maternal health. We find elevated rates of smoking among pregnant women (which may indirectly affect infant health in ways we do not observe) and small increases in maternal morbidity. We speculate that these adverse outcomes may be attributable to a measurable decline in local obstetricians, who may be key sources of information about prenatal health.

Finally, while there is no evidence of changes in c-section or induction rates, we find evidence that hospital acquisitions affect other procedure choices during labor. We find higher rates of anesthesia, labor augmentation, external cephalic version procedures, and forceps deliveries, which are suggestive of more sophisticated care delivery. There are small declines in the probability that mothers are transferred between hospitals during labor.

Taken together, our results suggest that the closure of obstetric units is a mixed bag for maternal and newborn health. Acquisitions result in decreased local access for patients, but any adverse effects of decreased access may be counterbalanced by patients going to higher quality facilities elsewhere or by improved quality of the local hospital post-merger.

The rest of the paper is organized as follows. Section 2 provides further detail on the data that we use and presents some descriptive statistics. Section 3 describes our event study approach to estimating the effects of hospital acquisition on obstetric care. We then present our estimates of the impacts of rural hospital acquisitions on several outcomes in Section 4, taking account of possible heterogeneity and assessing the robustness of the results. Finally, we conclude in Section 5.

2 Data Sources and Descriptive Statistics

2.1 Hospital Data

We use data from several sources to measure how hospital acquisitions affect access to maternity care and birth outcomes. First, we use the Annual Survey of Hospitals from the American Hospital Association (AHA) from 2006-2019 to construct a panel of hospital mergers and for information on hospital service lines, patient flows, and staffing.

To identify mergers, we first detect all system changes in the AHA data and flag these as potential mergers. These include both the addition of new hospitals to existing systems and the creation of new systems. We then link these mergers with Irving Levin (IL) Associates' Healthcare M&A Report to verify the dates of system changes and to assist in identifying targets and acquirers. If the merger consists of existing systems, we identify the largest system as the acquiring system as measured in the AHA data. To identify acquirers and

targets for mergers where all hospitals are independent hospitals or new hospitals, we rely on the classification in the IL data.

For mergers with conflicting dates between the AHA data and IL data, we use the AHA system change date as the date of the merger. We hand check roughly 300 mergers that cannot be matched between the AHA and IL data.

We focus on rural general hospitals as identified by the AHA.[7] During this period, we observe 467 mergers and acquisitions that involve at least one rural hospital. There are 317 acquisitions of rural hospitals in our constructed panel. We additionally have 68 rural hospitals that are involved in some merger activity where we cannot classify the hospitals as either the target or acquirer; our results are robust to including these hospitals in the treatment group of target hospitals.

We focus on mergers that were either (1) the first time a hospital was acquired in our sample period or (2) the first time that a county had a hospital located in it that was acquired in our sample period. In the case of rural hospitals, this is not very restrictive; of the 280 rural hospitals that were acquired during this time window, 241 of the hospitals were acquired only once. Of the 205 rural counties that experience a hospital being acquired, 168 experience only one acquisition.

Table 1 presents summary statistics for all mergers from 2006-2019 that involve at least one rural hospital. We present descriptive statistics for all mergers (column 1), then classify mergers as involving hospitals within the same hospital referral regions (HRRs) (column 2), mergers that involve hospitals in different HRRs, but within the same state (column 3), and across state lines (column 4).[8] We also classify mergers by the ownership structure of the involved parties, distinguishing among mergers involving entirely nonprofit parties, entirely for-profit parties, having a for-profit acquirer with a nonprofit target, and having a nonprofit acquirer with a for-profit target. Most mergers involve hospitals within the same HRR, and most of these involve exclusively nonprofit hospitals. Within-HRR mergers tend to be slightly larger on average, as measured by the total number of hospital beds (or annual deliveries) involved across the involved hospitals.

Table 2 presents summary statistics at the hospital level for characteristics at the start

[7]The AHA identifies rural hospitals as all hospitals that are located outside of Metropolitan Statistical Areas or Micropolitan Statistical Areas as defined by the Office of Management and Budget. We classify counties as rural counties if either they contain a rural hospital or are outside of Metropolitan Statistical Areas or Micropolitan Statistical Areas.

[8]A hospital referral region (HRR) is a geographic area where most of the patients in that area are referred for major cardiovascular surgical procedures and for neurosurgery. See https://data.dartmouthatlas.org/downloads/methods/geogappdx.pdf.

Table 1: Merger Summary Statistics

	All Mergers	Within HRR	Across HRR	Across State
Number of Mergers	467	301	84	41
All Nonprofits	277	199	58	20
All For-Profits	42	35	3	4
For-Profit Acquires Nonprofit	75	57	8	10
Nonprofit Acquires For-Profit	62	54	5	3
Total Beds	4087.242	4917.571	3175.869	3513.171
Total Births	19813.53	23875.46	15743.56	16356.85

Notes: This table reports summary statistics for all mergers from 2006-2019 involving at least one rural hospital.
Data source: AHA Annual Survey of Hospitals

of our sample period (2006). Columns 1 through 5 correspond to all urban hospitals, all rural hospitals, rural hospitals that are not involved in any merger activity from 2006-2019, rural hospitals that are acquired at least once during the sample period, and all hospitals that acquire a rural hospital.

As compared with rural hospitals that have no merger activity (column 3), acquired rural hospitals (column 4) are relatively less likely to be government hospitals. They are also less profitable, more likely to have obstetric care, and have more total admissions. They are also less likely to be closed. Acquiring hospitals (column 5) are substantially larger than the rural hospitals that they acquire.

During the period that we study, both hospital acquisitions and obstetric unit closures were common. In 2006, there were 1,182 rural hospitals, and 50 percent offered obstetric care; in 2019, there were 1,047 rural hospitals, and 36.7 percent offered obstetric care. Among all hospitals with obstetric units, the unconditional probability that they close their obstetric unit is 3.1 percent. Among recently acquired hospitals (in the last 5 years), this closure rate roughly doubles to 6.3 percent.

Figure 1 shows the number of annual acquisitions, obstetric unit closures, and hospital closures for rural hospitals between 2006 and 2019. There are between 11 and 55 obstetric unit closures a year and between 10 and 31 acquisitions of rural hospitals. This implies that there are many obstetric unit closures occurring independent of hospital consolidation activity; these obstetric closures have different characteristics than those at hospitals that have been recently acquired.

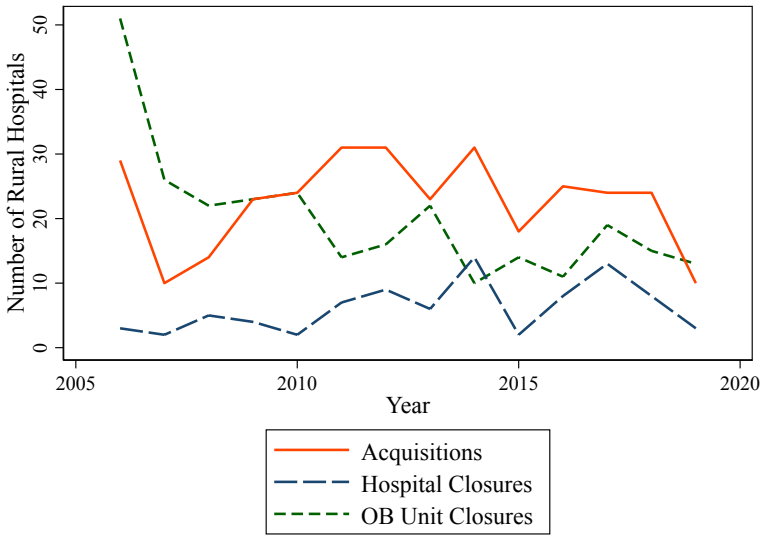
Figure 2 is a binned scatter plot that shows how the probability of obstetric unit closure

Table 2: Hospital Summary Statistics

	Urban	Rural	Rural, No Merger Activity	Rural, Acquired	Acquirer of Rural Hospital
In System	0.592	0.370	0.052	0.437	0.827
Government	0.177	0.443	0.582	0.324	0.160
For-Profit	0.183	0.079	0.044	0.116	0.236
Nonprofit	0.641	0.478	0.374	0.560	0.604
Margin	0.020	0.027	0.037	-0.002	0.047
Has Obstetric Care	0.775	0.499	0.465	0.539	0.733
Total Admissions	9724.027	1159.774	934.509	1496.373	6940.714
Medicaid Discharges	1786.807	196.541	148.351	268.718	1154.783
Total Births	1153.218	95.269	75.893	124.113	777.518
Closure	0.121	0.075	0.093	0.063	0.065
N	3382	1182	572	284	1558

Notes: This table reports 2006 characteristics for hospitals in the AHA data. Column 1 reports averages for all urban hospitals. Column 2 reports averages for all rural hospitals. Column 3 reports averages for all rural hospitals that are involved in no merger activity from 2006-2019. Column 4 reports averages for all rural hospitals acquired at least once from 2006-2019. Column 5 reports averages for all hospitals that acquire a rural hospital. This includes both urban and rural acquiring hospitals.
Data source: AHA Annual Survey of Hospitals

Figure 1: Acquisitions, Obstetric Closures, and Hospital Closures at Rural Hospitals



Notes: This figure shows the annual number of rural hospitals that are acquired, closed their obstetric units, or closed entirely from 2006-2019.
Data source: AHA Annual Survey of Hospitals

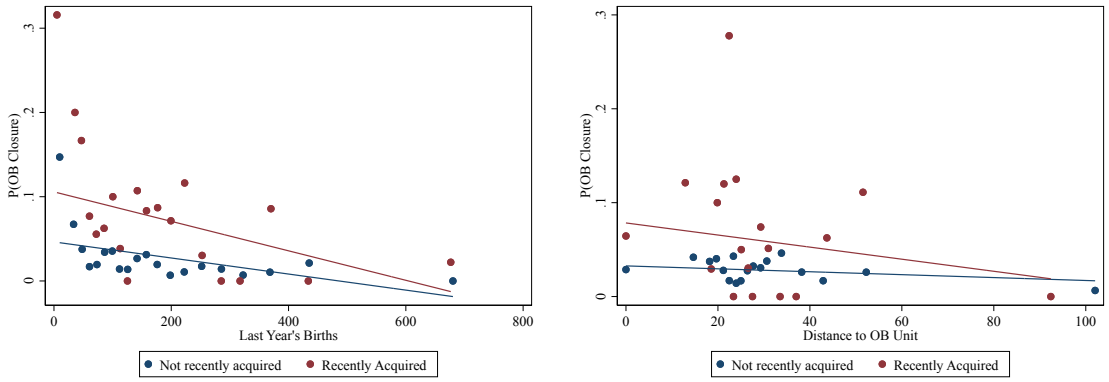
is associated with the number of births in the prior year (subfigure (a)) and the distance to the next nearest hospital with obstetric services (subfigure (b)), separately by whether the hospital has been recently acquired or not. Each bin represents 5% of hospital-year observations. We restrict our sample to hospitals that had an open obstetric unit in the previous year.

Subfigure (a) shows that for both hospitals that have been recently acquired and those that were not, there is a negative relationship between birth volumes and closures. This relationship is stronger for those hospitals that have been recently acquired. Note that throughout the distribution of birth volumes, hospitals that have been recently acquired are consistently more likely to close their obstetric units. Subfigure (b) shows that acquired hospitals are more likely to lose their obstetric units when there is an open obstetric unit nearby. We do not find evidence of a similar relationship among hospitals that were not recently acquired.

In Figure 3, we look for other differences and similarities among three types of hospitals that closed obstetric units: (1) those that were not acquired and remained open, (2) those that were acquired in the five years before the obstetric unit closure, and (3) those that closed

Figure 2: Probability of Closure by Acquisition Type

(a) Number of Births (b) Distance to Next Nearest Obstetric Unit



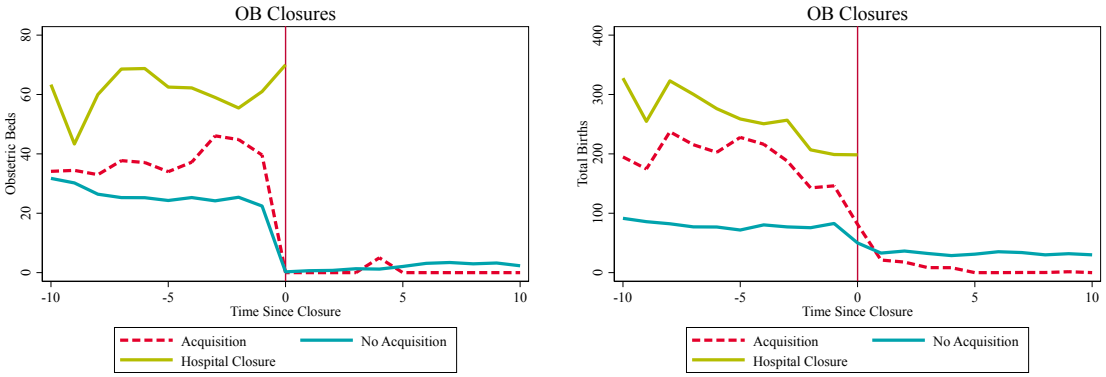
Notes: This figure presented binned scatter plots that show how the probability of obstetric unit closure varies with the number of births and acquisition status (subfigure (a)) and with the distance to the nearest obstetric unit and acquisition status (subfigure (b)). Each point represents 5% of hospital-year observations. Only hospitals with an obstetric unit open in the previous year are included.
Data source: AHA Annual Survey of Hospitals

altogether. We examine four important hospital characteristics: the number of obstetric beds, total births at the hospital, Medicaid discharges, and operating margin. Subfigure (a) shows that closed hospitals had more beds than those that remained open. A similar pattern emerges for the number of births (subfigure (b)) and the number of Medicaid discharges (subfigure (c)). The pattern is different for hospital margins (subfigure (d)). Here, there is little evidence of differences in hospital margins between hospitals that were acquired and those that were not and remained open, but there is substantial evidence that hospitals that shut down were in financial distress immediately prior to the closure.

Figure 3: Comparison of Obstetric Closures

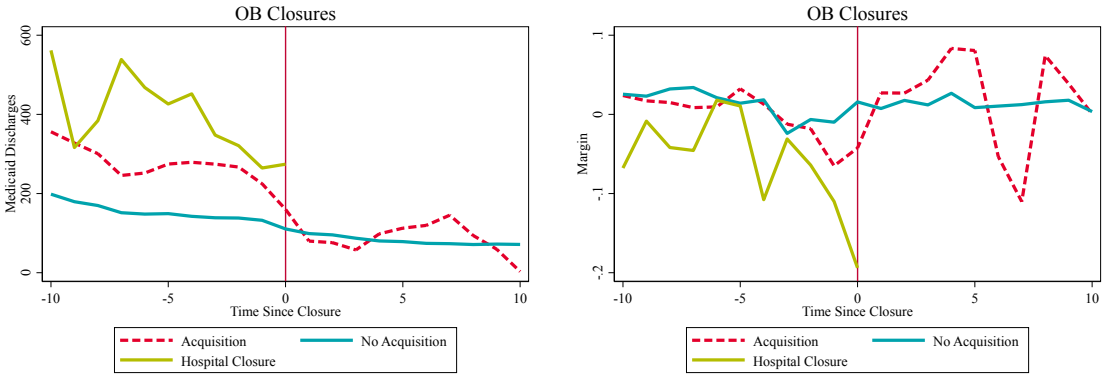
(a) Number of Obstetric Beds

(b) Total Births



(c) Medicaid Discharges

(d) Hospital Margin



Notes: This figure shows the time series of characteristics of hospitals over time leading up to the closure of their obstetric unit. Subfigure (a) looks at the number of obstetric beds. Subfigure (b) looks at the number of births. Subfigure (c) looks at the average number of Medicaid discharged. Subfigure (d) examines hospital margins.
Data source: AHA Annual Survey of Hospitals

2.2 Health Outcomes Data

To measure patient outcomes, we use birth records from the National Vital Statistics System (NVSS). NVSS data are drawn from birth certificates and allow us to construct measures of birth outcomes at the county-level, but do not identify the birth hospitals.

We supplement county-level measures of birth outcomes with county-level population characteristics from the 5-Year American Community Survey (ACS)[9] and county level health care resources from the Area Health Resource Files (AHRF) from 2010-2019. One limitation of the AHRF is that providers may not accurately report their practice locations. Not only do physicians fail to regularly update their addresses, AHRF (and any alternatives that track provider locations) assigns one location to a provider, even if that provider practices in multiple locations. This may be especially problematic for pinning down the location of providers in rural markets, where physicians must see patients in several locations to support a full-time practice.

Table 3: County Level Summary Statistics

	Urban	Rural	Rural, w/ hospital	Rural, hosp acquired	Rural, no hosp acquired (has hospital)	Rural, no hosp acquired (all)
Medicaid	0.387	0.402	0.402	0.423	0.394	0.397
Mother Transferred	0.008	0.013	0.013	0.012	0.013	0.013
Same Location	0.496	0.196	0.249	0.274	0.240	0.176
Induction	0.265	0.279	0.279	0.284	0.278	0.278
Augmentation	0.208	0.208	0.210	0.210	0.209	0.208
Anesthesia	0.619	0.564	0.560	0.560	0.561	0.566
C-Section	0.325	0.327	0.328	0.330	0.328	0.327
Births	2117.349	199.329	231.343	377.730	178.533	153.688
LBW	0.080	0.080	0.079	0.084	0.078	0.079
Preterm	0.116	0.119	0.120	0.124	0.118	0.118
N	1735	1399	1075	285	790	1114

Notes: This table shows summary statistics at the county-level for 2012.
Data source: NVSS

Table 3 shows summary statistics at the county level for characteristics in the NVSS for

[9]We assign each 5 year survey to the final year that is included in that survey. Relatively few rural counties are included in the 1 Year ACS.

2012. Columns 1-5 refer to the same hospital groupings as in Table 2. Column 6 refers to all rural counties without a hospital acquisition, including counties that do not have a hospital.

The most striking differences that emerge are between urban and rural counties. Urban counties have substantially more births, low transfer rates, and more women delivering in their county of residence. Birth characteristics look more similar across urban and rural counties, with the exception of anesthesia which is more common for women who live in urban counties. Among rural counties, counties that have a hospital acquired have slightly more births on average and have a slightly higher percent of mothers who have Medicaid at the time of birth.

We further explore how counties with acquired hospitals compare to counties with acquiring hospitals in Table 4. Acquired rural hospitals look similar to acquiring rural hospitals, but have far fewer births than acquiring urban hospitals. Counties with acquiring urban hospitals also have higher anesthesia rates, lower transfer rates, and a smaller proportion of Medicaid patients.

Table 4: Comparison Between Counties with Target and Acquiring Hospitals

	Acquired Rural Hospitals	Acquiring Rural Hospitals	Acquiring Urban Hospitals
Anesthesia	0.541	0.526	0.594
Augmentation	0.197	0.211	0.209
Births	257.637	243.354	4277.642
C-Section	0.329	0.322	0.321
Induction	0.308	0.299	0.274
LBW	0.083	0.077	0.083
Medicaid	0.397	0.335	0.334
Mother Transferred	0.012	0.011	0.006
Preterm	0.126	0.120	0.122
Same Location	0.244	0.302	0.649

Notes: This table shows summary statistics at the county-level for the year prior to acquisition.
Data source: NVSS

3 Empirical Strategy

To examine the effects of hospital acquisition on hospital outcomes, we use a differences-in-differences research design, leveraging variation in the timing of hospital acquisition. We

estimate the following econometric specification:

$$Y_{it} = \alpha_i + \tau_t + \beta \cdot PostMerger_{it} + \epsilon_{it}$$

where Y_{it} is an outcome for hospital i in year t, α_i are hospital fixed effects, τ_t are year fixed effects, and $PostMerger_{it}$ is an indicator for whether hospital i has already been acquired in year t. Our coefficient of interest is β, which measures the effect of hospital acquisition on our outcome variable. We cluster our standard errors at the hospital level. We refer to this as the difference-in-differences estimator.

We also estimate separate effects for each time period leading up to and following the acquisition as follows:

$$Y_{it} = \alpha_i + \tau_t + \sum_{t-6 \leq \tau \leq t+6} \beta_\tau \cdot Merger_i \cdot I[t = \tau] + \epsilon_{it}$$

where $Merger_i \cdot I[t = \tau]$ denotes the interactions of whether the hospital is acquired with each time period leading up to and after the date of the merger. This specification allows us to assess whether acquired and non-acquired hospitals were trending similarly prior to the acquisition. We refer to this as the event study estimator.

We additionally estimate similar models at the county level with county-level outcomes as the dependent variable. The key distinction between the two is how we define treatment. At the hospital level, our treatment is whether the hospital was acquired. At the county level, our treatment is whether there was an acquired hospital is located in that county. We estimate this model separately for all counties and for all counties that have a hospital at some point during our sample period.

As mentioned previously, we only consider acquisitions that are the first time a hospital was acquired during our sample period. This condition is not very restrictive. In Appendix Figure B2, we show that most rural hospitals are acquired only once during our sample period. Moreover, because many rural counties contain only a single hospital, these counties only experience a single acquisition during our sample period.

A key concern regarding identification of causal effects in a differences-in-differences econometric framework is a violation of the parallel trends assumption - i.e., in the absence of the merger, whether acquired hospitals would have trends similar to those of non-acquired hospitals. To address this, we first test whether there is evidence of differential trends in the pre-period using an event study approach. We additionally test for selection on observable

characteristics into acquisition in two ways. In Appendix Figure B1, we present balancing regressions that show the differences in hospital and county characteristics between acquired and non-acquired hospitals once we account for time and state fixed effects. We find no differences between acquired and never-acquired rural hospitals in terms of financial characteristics but do find higher patient utilization and more service offerings at acquired hospitals. We find that counties where a hospital was acquired have larger populations and more OBGYNs per capita on average, but otherwise look similar on socio-demographic characteristics.

We also estimate our event study specification at the county level using characteristics we think are unlikely to have been directly affected by the hospital merger to test whether the communities in which acquired hospitals are located were trending differently than non-acquired hospitals. As we detail in Section 4, we find little evidence of large changes in demographic characteristics.

Our preferred specifications are estimated using the Callaway and Sant'Anna (2021) event study estimator to address concerns about dynamic treatment effects, given the staggered nature of our treatment.

4 Results

In this section, we present estimates from our event study model examining service lines, births, resource availability, and patient outcomes.

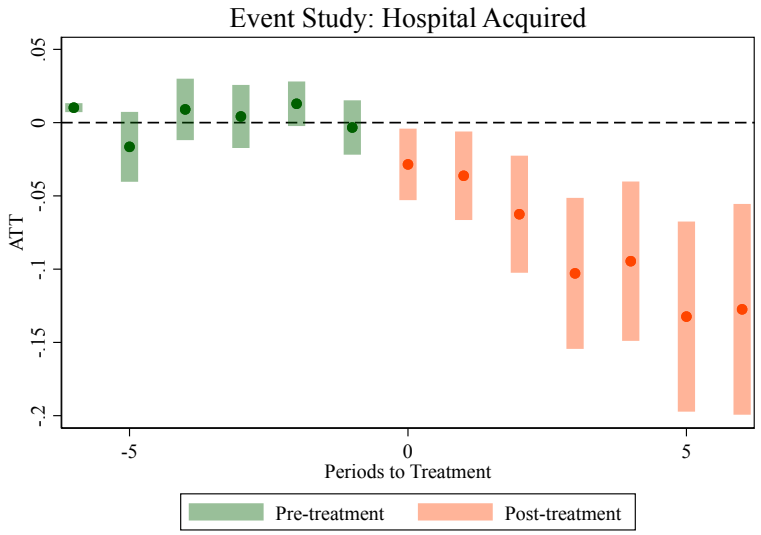
4.1 Obstetric Care Units

We begin by estimating the effect of hospital acquisition on obstetric units. Figure 4 shows that acquisition reduces the probability that the hospital has an obstetric unit, with the effect building over time.[10] We find no evidence that acquired hospitals were trending differently to non-acquired hospitals in the pre-period.

Column 1 of Table 5 shows our aggregated estimated average treatment effect for the treated (ATT) from the difference-in-differences estimation. The ATT estimate is -0.09, which is roughly a 20 percent decrease in the probability of having an obstetric unit.

[10]Note that we estimate this unconditionally. That is, we do not restrict our sample to hospitals that have an obstetric unit in the pre-period. We do this for two reasons. First, we want to allow for the possibility that acquisitions could lead to either the opening or closures of an obstetric unit. Second, because acquisitions occur at different time periods through out the sample, there is not a clean comparison group to hospitals that have an obstetric unit before acquisition.

Figure 4: Effect of Acquisition on Probability of Hospital Obstetric Unit



Notes: This figure reports estimates of the effect of hospital acquisition on operating an obstetric unit. These are calculated using the Callaway and Sant'Anna (2021) event study estimator.
Data source: AHA Annual Survey of Hospitals

Table 5: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Obstetric Units

	(1) Baseline	(2) Include Not Yet Treated	(3) Drop Never Treated	(4) Financial Controls
ATT	-0.0893***	-0.0889***	-0.0995***	-0.0890***
	(0.0233)	(0.0233)	(0.0276)	(0.0237)
N	15492	15493	3406	15273
Outcome Mean	.44	.44	.44	.43

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents our estimated aggregated average treatment effects for the effect of hospital acquisition on obstetric units. Column 1 reports our baseline estimate that does not include the not-yet-treated in the control group. In column 2, the control group includes both never-treated hospitals and not-yet-treated hospitals. Column 3 estimates this model using only hospitals that are acquired at some point in the sample period. Column 4 matches on pre-period financial controls. Standard errors are clustered at the hospital level.
Data source: AHA Annual Survey of Hospitals

We also assess robustness to several possible alternative specification choices. In particular, we vary our control group and include pre-period financial controls. The baseline control

group in column 1 is never-treated units (i.e., hospitals never involved in a merger during our time period). In column 2, the control group also includes not-yet-treated units (hospitals that have not yet been acquired, but will be during our time period). Column 3 drops all never-acquired hospitals from the analysis. This specification only leverages variation in the timing of mergers, which substantially reduces our sample size. Column 4 conditions on pre-period financial controls using the doubly-robust method suggested in Callaway and Sant'Anna (2021) using inverse probability weighting to model selection into treatment.

In Appendix Table A1, we estimate the robustness to our particular choice of treatment group. Recall that we estimate the effects of the first acquisition in our sample window. Some rural hospitals will have been acquired previously and be parts of hospital systems in 2006. In column 1, we restrict our sample to only hospitals that are independent in 2006. In column 2, we drop hospitals from our control group who are involved in any merger activity during our sample period. In column 3, we include equal-sized mergers in our treatment group. Our main results are robust to these alternative sample choices.

We then explore what characteristics of the merger contribute to this decline in obstetric care service. We examine two sources of potential heterogeneity: the geographic proximity of the acquiring system and the relative ownership structure of the target and acquiring hospital. Table 6 classifies acquisitions by whether the acquiring hospital[11] is located in the same HRR as the target hospital, the acquiring hospital is located in the same state but not in the same HRR, or all hospitals in the acquiring system are located across state lines. Note that the majority of mergers involving rural hospitals are within-HRR mergers; roughly 20 percent involve hospitals in different HRRs but in the same state, and less than 10 percent involve a merger across state lines (see Table 1). The estimated coefficients are not statistically distinguishable from one another, though the largest and only statistically significant effect is for mergers involving hospitals within the same HRR.

Table 7 classifies mergers based on the ownership structure of the acquired and acquiring parties. In column 1, both parties are nonprofits ("All Non"). In column 2 both parties are for-profits ("All For"). In column 3, the acquirer is a nonprofit and the target is a for-profit ("Non Acquires For"). In column 4, the acquirer is a for-profit and the target is a nonprofit ("For Acquires Non.") The estimated effects of "All Non" and "All For" are virtually identical, though only "All Non" is statistically significant. The effect of "For Acquires Non" is significant though less than half as large. The effect of "Non Acquires For" is near zero.

[11] Or some hospital in the acquiring system.

Table 6: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Obstetric Units: Merger Geographic Classifications

	(1) Within HRR	(2) Across HRR	(3) Across State
ATT	-0.0888***	-0.0597	-0.0689
	(0.0308)	(0.0398)	(0.0632)
N	13930	12974	12490
Outcome Mean	.44	.43	.43

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents our estimates of the aggregated treatment effect of hospital acquisition on obstetric units for different types of mergers. Within HRR denotes mergers where the target and at least one hospital in the acquiring system are located in the same HRR. Across HRR denotes mergers where the target and no acquiring hospitals are located in the same HRR, but at least one hospital in the acquiring system is located in the same state. Across state denotes mergers where the target hospital is located in a different state from all hospitals that make up the acquiring system.
Data source: AHA Annual Survey of Hospitals

Table 7: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Obstetric Units: Ownership Types

	(1) All Non	(2) All For	(3) Non Acquires For	(4) For Acquires Non
ATT	-0.0545*	-0.0498	0.0108	0.0222***
	(0.0302)	(0.0550)	(0.0286)	(0.00515)
Observations	14311	12692	12978	12911

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents our estimates of the aggregated treatment effect of hospital acquisition on obstetric units for different types of mergers. Column 1 examines the effects of mergers where both the target and acquiring system are non-profits. Column 2 examines the effects of mergers where both the target and acquiring systems are for-profits. Column 3 examines the effects of mergers where the target is a for profit hospital and the acquiring system is non-profit. Column 4 examines the effects of mergers where the target is a non-profit hospital and the acquiring system is for-profit.
Data source: AHA Annual Survey of Hospitals

4.2 County Level Healthcare Resources

While we have established that acquisitions lead to obstetric closures, the size of the reduction in health care resources in the county is unclear, as other health care providers may adjust in response to the closure. In particular, we are interested in the net effect on hospital beds,

as nearby hospitals could expand capacity in response to the closure. We are also interested in the effects on physicians and midwives who may change their practice location in response to the closure.

Figure 5 displays estimates of the effect of a rural hospital acquisition on the number of obstetric beds in the county (subfigure (a)), the number of hospitals with an obstetric unit (subfigure (b)), the distance from the county to the nearest hospital with an obstetric unit (subfigure (c)), the number of OBGYNs per capita (subfigure (d)), and the number of midwives per capita (subfigure (e)). We additionally report aggregated ATT estimates at the county level in Appendix Table A2.

Consistent with our hospital-level results, we find substantial reductions in county-level health care resources. There is a roughly 35 percent decline in the number of obstetric beds and a 28 percent decline in the number of hospitals with obstetric units. This implies that nearby hospitals are not expanding capacity in response to changes that the newly acquired hospital makes. The reduction in obstetric units results in a 7 percent increase in the distance to the nearest obstetric unit.

This decline in hospital resources may spill over to other obstetric resources in the county. We find a reduction in the per capita number of OBGYNs practicing in the county, as measured by the Area Health Resources Files. As discussed in the data section, this measure may be problematic because it relies on self-reported physician location and does not account for physicians practicing in multiple locations. We find no change in midwives per capita, with the same caveat. This null result is unsurprising, given the low baseline levels of midwives; on average, there are .08 midwives per 10,000 people in the rural counties in our sample, or an average of .26 per county.

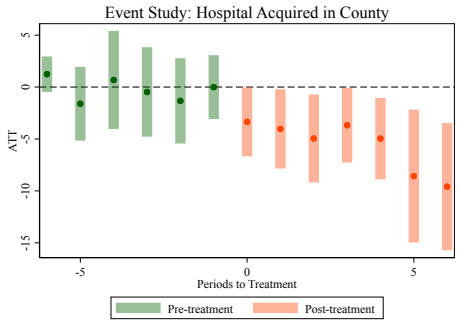
4.3 Patient Admissions

Figure 6 presents the event study estimates of the impact of hospital acquisitions on the number of births at acquired hospitals. There is a 28% reduction in the number of births. This large reduction in births is unsurprising, given our previous results documenting the closures of obstetric units following acquisitions.

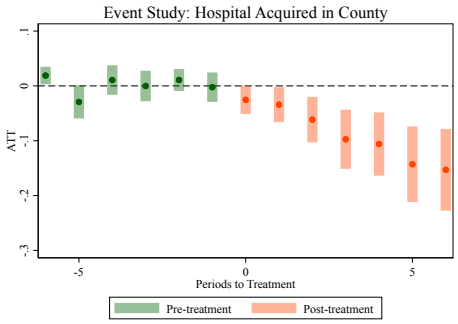
In Appendix Figure B4, we show suggestive evidence that this reduction in births is predominately occurring at hospitals that shut their obstetric unit. We plot the number of births at the hospital each year before and after the merger. Hospitals that do and do not close their obstetric unit show similar pre-merger trends, but there is a sharp decline in the number of births at hospitals with obstetric unit closures with no break in the trend at

Figure 5: Event Study Estimates of the Impact of Hospital Acquisition on County Level Healthcare Resources

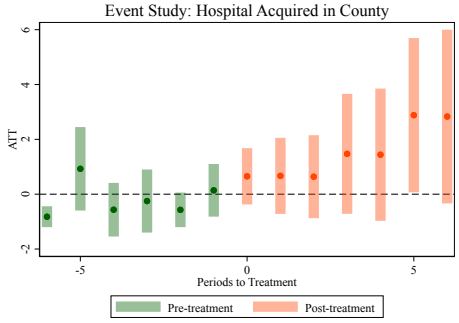
(a) Number of Obstetric Beds



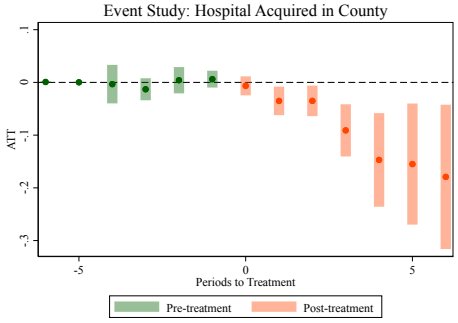
(b) Number of Hospitals with Obstetric Units



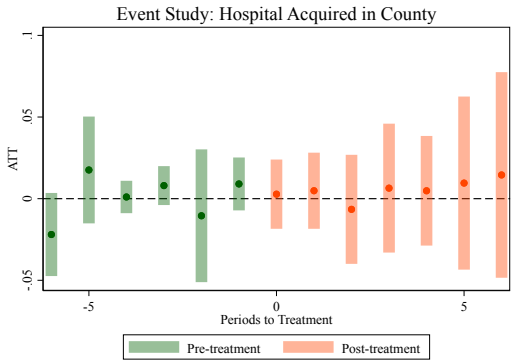
(c) Distance to Nearest Obstetric Unit



(d) OBGYNs Per Capita

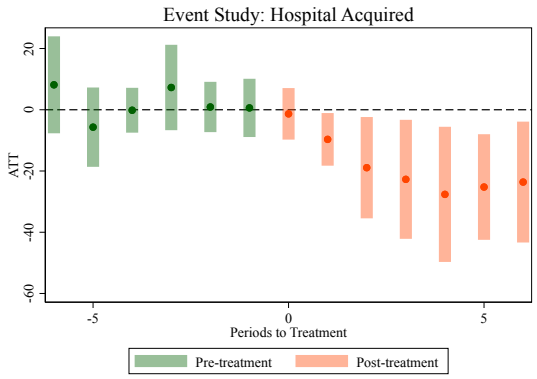


(e) Midwives Per Capita



Notes: This figure shows the event study estimates of the impact on hospital acquisition on county-level obstetric resources. Subfigure (a) examines the total number of obstetric beds. Subfigure (b) examines the number of hospitals with obstetric services. Subfigure (c) examines the distance to the nearest obstetric unit. Subfigure (d) examines the number of OBGYNs per capita (per 10,000). Subfigure (e) examines the number of midwives per capita (per 10,000).
Data source: AHA Annual Survey of Hospitals, Area Health Resource Files

Figure 6: Event Study Estimates of the Impact of Hospital Acquisition on Births



Notes: This figure shows the event study estimates of the impact on hospital acquisition on hospital-level births.
Data source: AHA Annual Survey of Hospitals

hospitals that did not close their obstetric unit.

Table 8: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Birth Locations

	(1) County of Residence	(2) Distance Traveled
ATT	-0.0374***	0.653**
	(0.00853)	(0.321)
N	19356	19356
Outcome Mean	.19	34.56
Outcome Std Dev	.27	16.93

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports estimates of the aggregate ATT from an event study regression estimating the effects of a hospital acquisition in a county. These are estimated using the Callaway and Sant'Anna (2021) estimator. Column 1 examines the probability that mothers deliver in their county of residence. Column 2 examines the distance women travel to deliver, as measured by the distance between their county of residence and the county in which they deliver.
Data source: NVSS

We use data from birth certificates at the county-level to test whether hospital mergers change birth locations. We are first interested in whether hospital acquisitions change the probability that women deliver in their county of residence. As a baseline, 50 percent of women who live in a rural county with a hospital obstetric unit deliver within their county

of residence, suggesting a preference for local deliveries. Across all rural counties, 19 percent of women deliver in their county of residence.

Table 8 reports estimates of the effect of a hospital acquisition in the mother's county of residence on where she delivers. We estimate a 3.7 percentage point reduction (20 percent reduction relative to the outcome mean across all counties) in the probability that mothers deliver in the county in which they reside, shown in column 1. The bulk of this reduction comes from the closure of obstetric units; Appendix Figure B5 shows the time series of the probability that mothers deliver in the county in which they reside for counties where a rural hospital was acquired, split by whether the hospital closed its unit. There is no break in the trend for counties that did not see an obstetric closure post merger.

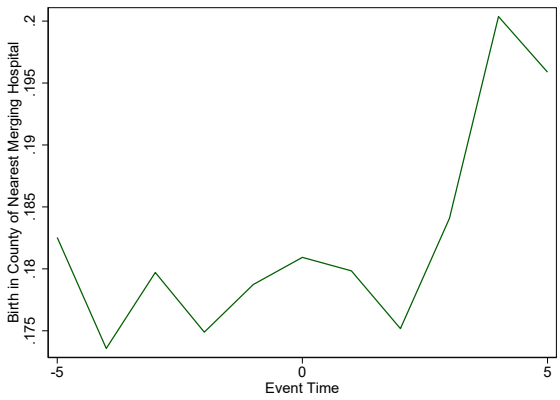
This reduction in in-county births results in a small increase in distance traveled of .6 miles, as measured by the distance between the county of residence and the county in which the baby is born.[12].

Estimating birth displacements is difficult in this context because of the size disparity between acquired and acquiring hospitals. In the 5 years before acquisition, on average, target hospitals with obstetric care see 248 births per year. Target hospitals that later shut down their obstetric unit see only 165 births a year. In contrast, acquiring hospitals with rural targets see 1,129 births per year on average. If all births at the target hospital were displaced to a single acquiring hospital, this would represent a 15 percent increase in births at the acquirer. In practice, there will not be 100 percent displacement, making the percent increase harder to detect. To complicate matters, we are unable to identify births at specific hospitals in the NVSS data.

Given these caveats, we calculate the difference change in births in the county of the nearest acquiring hospital with an obstetric unit for each treated hospital. We find that on average, births in the county of the nearest acquiring hospital with an obstetric unit rise by about four percentage points (slightly over 20 percent of the baseline). The time series is shown in Figure 7.

[12]Note that we winsorize the distance traveled to minimize the influence of outliers where women deliver across the country from their primary residence

Figure 7: Births in county of nearest acquirer with obstetric unit



Notes: This figure shows the average probability that women who live in a county with an acquired hospital give birth in the county of the nearest hospital in the acquiring system with an obstetric unit.
Data source: AHA Annual Survey of Hospitals, NVSS

4.4 Patient Outcomes and Treatments

In this section, we evaluate the effects of mergers on maternal health outcomes, infant health outcomes, and maternal and infant mortality. We also examine whether mergers affect medical interventions during labor and delivery.

4.4.1 Maternal Health

We first examine outcomes and treatments related to maternal health, both before and during birth. We examine smoking rates, rates of gestational diabetes, hypertension, and eclampsia. We additionally estimate the effects on the timing of the initiation of prenatal care, the number of prenatal visits, whether there was any severe maternal morbidity, and whether the mother was transferred during labor. The measures of severe maternal morbidity reported in the birth certificate data are whether there was a maternal transfusion, perineal laceration, ruptured uterus, unplanned hysterectomy, or admit to intensive care. Finally, we measure the impact on participation during pregnancy in Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). This is an assistance program available to pregnant and post-partum women based on income eligibility. WIC is administered through non-profits that determine eligibility (Bitler and Seifoddini (2019)); changing hospitals may enable women to more (or less) easily access these services. Our event study estimates

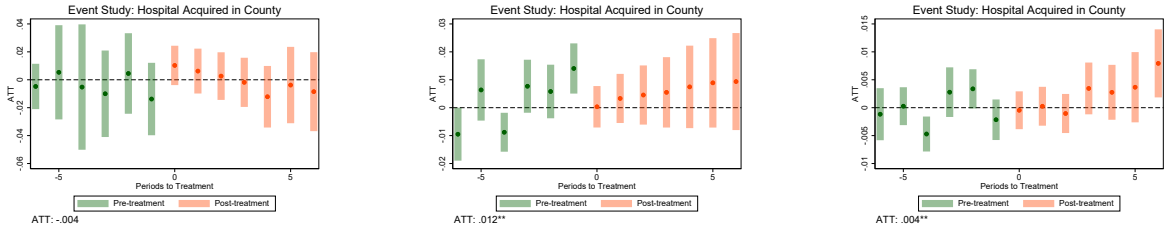
are shown in Figure 8. The corresponding difference-in-difference estimates are shown in Appendix Table A3.

We find increases in smoking during pregnancy and gestational diabetes following the hospital acquisition. We additionally find small increases in severe maternal morbidity as well as decreases in the probability that mothers are transferred during labor. We find no evidence of changes in other measures of maternal health or in the frequency and timing of initiation of prenatal care. We additionally find an increase in participation in WIC. Given that we find no changes in the percent of women on Medicaid and no changes in county-level median income, it is plausible that this reflects changes in uptake rather than eligibility. This could reflect changes in the social services available at the hospitals at which women deliver, which may be affected by the merger.

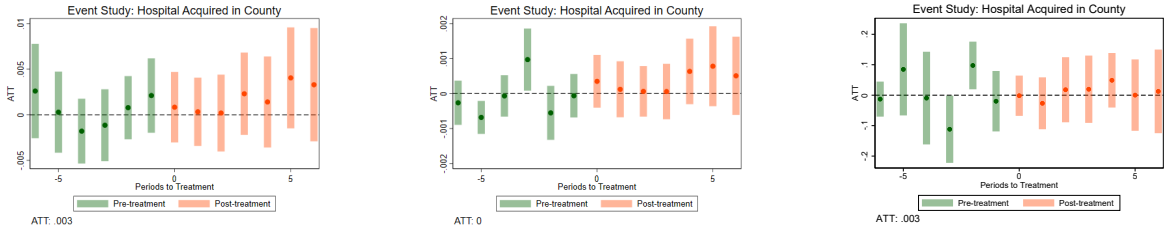
Thus there does seem to be some evidence of impacts of an acquisition on aspects of maternal health during pregnancy.

Figure 8: Event Study Estimates of the Impact of Hospital Acquisition on Maternal Health

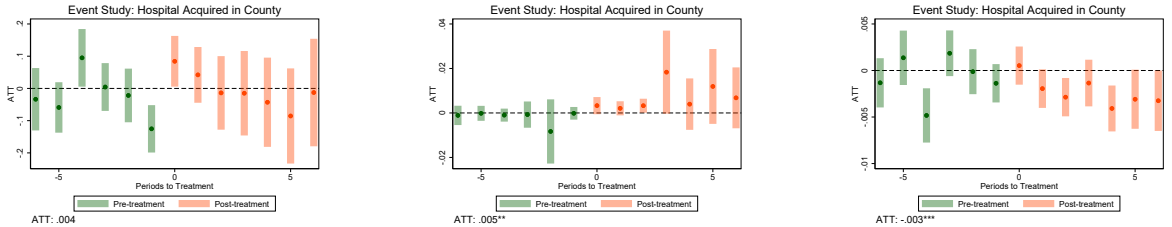
(a) Smoking Before Pregnancy (b) Smoking During Pregnancy (c) Gestational Diabetes



(d) Gestational Hypertension (e) Eclampsia (f) Month Prenatal Care Began



(g) Number of Prenatal Visits (h) Maternal Morbidity (i) Maternal Transfer



Notes: This figure reports estimates of the effect of a hospital being acquired on maternal health outcomes at the county-level. Subfigure (a) examines the smoking rate pre-pregnancy. Subfigure (b) examines the smoking rate during pregnancy. Subfigure (c) examines the rate of gestational diabetes. Subfigure (d) examines the rate of gestational hypertension. Subfigure (e) examines the rate of eclampsia. Subfigure (f) examines the month of pregnancy during which prenatal care was initiated. Subfigure (g) examines the total number of prenatal visits. Subfigure (h) examines maternal morbidity, which includes maternal transfusion, perineal laceration, ruptured uterus, unplanned hysterectomy, or admit to intensive care. Subfigure (i) looks at whether the mother was transferred to a different hospital during labor and delivery.
Data source: NVSS

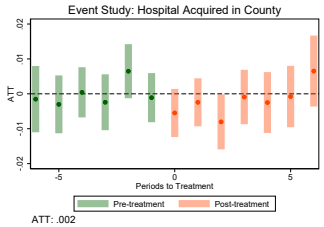
4.4.2 Treatments during Labor and Delivery

We examine the effects of an acquisition on the cesarean section rate, the induction rate, the labor augmentation rate, the anesthesia rate, and the rate of External Cephalic Versions (ECVs). Labor augmentation is a process to stimulate contractions once labor has already begun. An ECV is a procedure that attempts to flip a breech baby typically performed in a hospital due to some risks. We additionally examine whether steroids or antibiotics were given to the mother and whether forceps or a vacuum were used to assist in delivery.

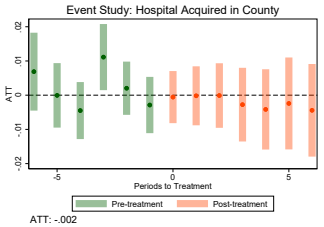
Our estimates are shown in Figure 9, with corresponding difference-in-difference estimates shown in Appendix Table A3. We find no evidence of changes in c-sections or induction, but there are increases in labor augmentation, anesthesia, and forceps use. There is an imprecisely estimated increase in the rate of ECV procedures. There is no evidence of effects on steroid, antibiotic, or vacuum use. Overall, there is evidence of acquisitions affecting some elements of care during labor and delivery.

Figure 9: Event Study Estimates of the Impact of Hospital Acquisition on Obstetrical Procedure Rates

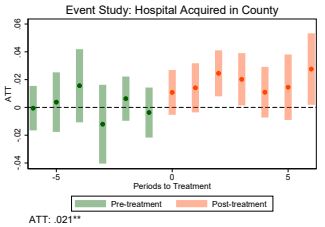
(a) Cesarean Section Rate



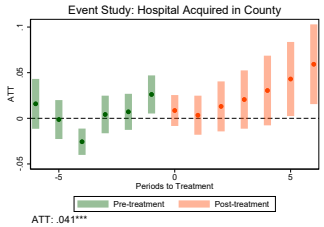
(b) Induction Rate



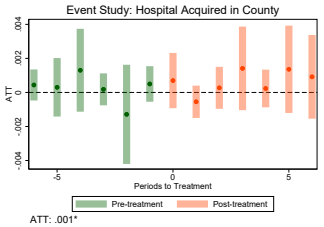
(c) Augmentation Rate



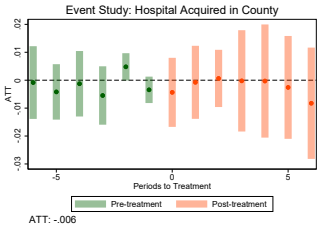
(d) Anesthesia Rate



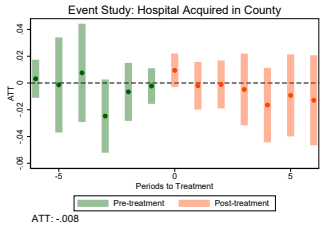
(e) ECV Rate



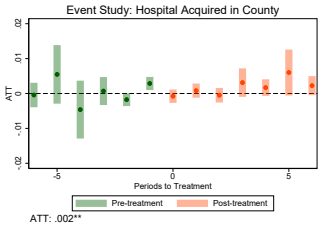
(f) Steroids Rate



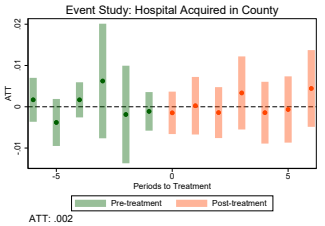
(g) Antibiotics Rate



(h) Forceps Rate



(i) Vacuum Rate



Notes: This figure reports estimates of the effect of a hospital being acquired on obstetric procedure rates at the county-level. Subfigure (a) examines cesarean section rate. Subfigure (b) examines the induction rate. Subfigure (c) examines the augmentation rate. Subfigure (d) examines anesthesia rate. Subfigure (e) examines the external cephalic version rate. Subfigure (f) examines the rate of steroids. Subfigure (g) examines the rate of antibiotics. Subfigure (h) examines the rate of forceps deliveries. Subfigure (i) examines the rate of vacuum deliveries.
Data source: NVSS

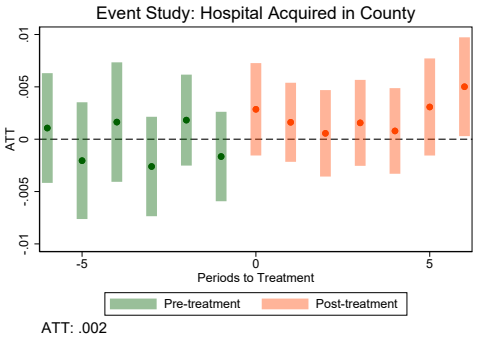
4.4.3 Infant Health

We study several infant health outcomes: whether the baby was born with low birth weight (LBW), defined as less than 2500g, whether the baby was born preterm (gestational age of less than 37 week), the 5 minute apgar score, the 10 minute apgar score[13], and any abnormal conditions. The abnormal conditions that are identified in the birth certificate data are whether assisted ventilation was required, NICU admission, whether the newborn was given surfactant replacement therapy, whether antibiotics were given, and whether the newborn had a seizure. We also examine whether the infant was transferred. Our estimates are shown in Figure 10, with corresponding difference-in-difference estimates shown in Table A5. We find no statistically significant evidence of changes in any of these measures of newborn health following to hospital acquisition.

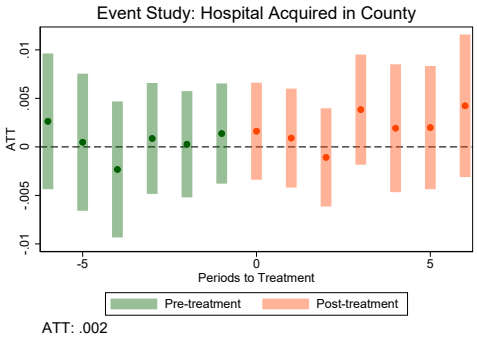
[13]The 10 minute apgar score is reported only for babies who had a 5 minute apgar score of less than 6

Figure 10: Event Study Estimates of the Impact of Hospital Acquisition on Infant Health Outcomes

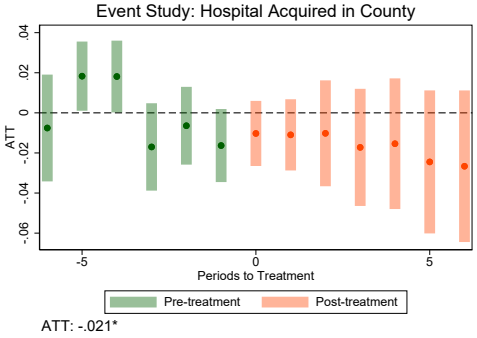
(a) Low Birth Weight



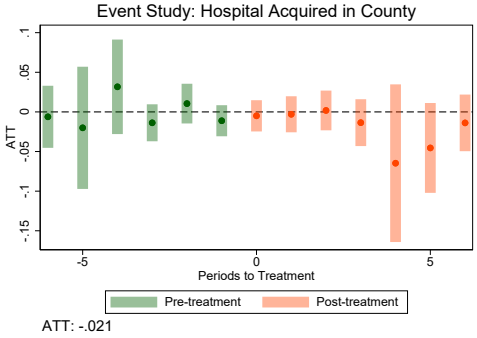
(b) Preterm



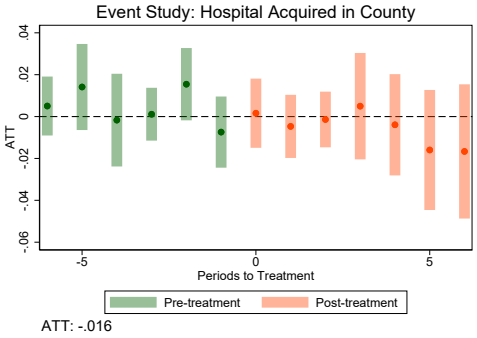
(c) 5 Minute Apgar



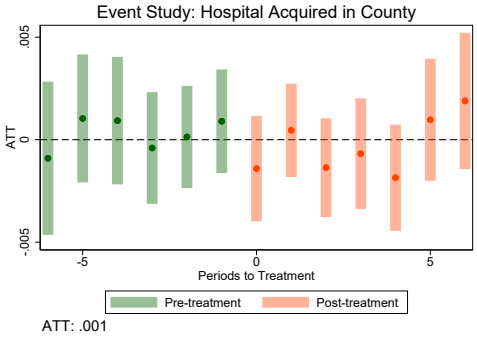
(d) 10 Minute Apgar



(e) Abnormal Conditions



(f) Infant Transferred



Notes: This figure reports estimates of the effect of a hospital being acquired on infant outcomes at the county-level. Subfigure (a) examines the fraction of infants who are born low birth weight (<2500g). Subfigure (b) examines the fraction of infants who are born preterm (¡37 week). Subfigure (c) examines the 5 minute apgar score. Subfigure (d) examines the 10 minute apgar score for babies who scored below a 6 on the 5 minute apgar). Subfigure (e) looks at abnormal conditions, which include whether assisted ventilation was required, NICU admission, whether the newborn was given surfactant replacement therapy, whether antibiotics were given, and whether the newborn had a seizure. Subfigure (f) looks at whether the infant was transferred between hospitals. Data source: NVSS

4.4.4 Infant and Maternal Mortality

Table 9: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Mortality

	(1) Infant Mortality	(2) Maternal Mortality	(3) Black Maternal Mortality	(4) Advanced Age Maternal Mortality
ATT	-0.627	-16.90	29.62	-122.0
	(0.490)	(13.91)	(79.98)	(157.2)
N	23481	23466	14366	22938
Outcome Mean	6.85	27.58	59.85	188.6

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents our estimated aggregated average treatment effects for the effect of hospital acquisition on mortality. Column 1 reports estimates for infant mortality, reported as deaths per 1,000 live births. Column 2 reports estimates for maternal mortality overall, reported as deaths per 100,000 live births. Column 3 reports estimates for Black mothers. Column 4 reports estimates for women of advanced maternal age (AMA).
Data source: NVSS

Table 9 presents the effects of the mergers on infant and maternal mortality. Column 1 gives estimates of the effect on infant mortality. Columns 2-4 report maternal mortality for the whole population and for two high-risk subgroups, Black women and women of advanced maternal age (AMA).[14] Across our four measures of mortality, we find no evidence of changes in mortality. The point estimates are all very imprecisely estimated, so the lack of evidence of impacts on mortality is due to the high variance of the estimates (as opposed to precisely estimated zeroes).

4.4.5 Are Merger-Induced Closures Like Other Closures?

To our knowledge, we are the first to consider the effects of rural hospital acquisitions on maternal and newborn health outcomes. However, an existing literature studies the effects of rural obstetric closures more broadly. We find important differences between our results and that of the prior literature, which makes clear that merger-induced closures can be very different phenomenon than other closures. In Table 10, we compare our results to those of Fischer et al. (2024) and Battaglia (2025), the two papers in the literature that study rural hospital obstetric closures in a setting similar to ours. There are a few key differences.

[14]Note that for sub-populations we restrict our sample to only counties with any births to women in these subpopulations.

Table 10: Comparison with Obstetric Closure Literature

Outcome	Effect of Acquisition	Effect of Obstetric Closure (Fischer et al. (2024) and/or Battaglia (2025))
Prenatal Care	No Effect	Decrease
Gestational Age	No Effect	Decrease
Inductions	No Effect	Increase
C-Sections	No Effect	Decrease
Infant Mortality	No Effect	No Effect
Maternal Morbidity	Increase	Decrease

We find no evidence that mergers lead to changes in prenatal care, contrasting with findings from the obstetric closure literature that finds a decrease in prenatal visits following obstetric closures. Additionally, we do not find increases in inductions or decreases in c-sections. We do find small increases in maternal morbidity.

There are a few reasons why our effects may be different from that of closures generally. Mergers may induce quality changes at hospitals that keep their obstetric unit open, systems may better be able to absorb displaced patients, and the shuttered units may be different than of a closure more generally. As shown in Figure 2, closures following mergers are at hospitals that are larger on average than hospitals that independently close their hospitals and are at hospitals that are closer to the next nearest obstetric unit.

4.4.6 Heterogeneous Effects

In this section, we explore whether outcomes differ for various sub-groups and for counties with different characteristics. For the former, we focus on differences based on race, insurance status, and education level. We are additionally interested in whether there are differential effects in low-income counties and in counties where the next nearest county with obstetric care is further.

Table 11 summarizes results for different sub-groups. For all statistically significant effects, we report the direction and significance level. A value of zero indicates that we fail to reject the null hypothesis. Full results are available in Table A6.

We find several sources of heterogeneity. Our increases in maternal morbidity are concentrated among white mothers, those without Medicaid coverage, and mothers with a high school education or less. For mothers with Medicaid, we find improvements in newborn health across a number of different measures.

These improvements in newborn health for Medicaid mothers are particularly interesting,

Table 11: Difference-in-Difference Estimates of the Effects of Hospital Acquisition for Medicaid Patients

	White	Non-White	Medicaid	Non-Medicaid	College	HS or Less
County of Residence	(-)***	(-)***	0	(-)***	0	(-)***
Has WIC	(+)**	0	(+)*	(+)***	0	(+)*
Maternal Morbidities	(+)***	0	0	(+)***	0	(+)*
Mother Transferred	0	0	(-)**	0	0	(-)***
Labor Augmentation	0	0	(+)*	0	0	(+)**
Anesthesia	(+)***	(+)*	0	(+)***	0	(+)***
LBW	0	0	(-)***	0	0	0
Preterm	0	0	(-)***	0	0	0
5 Min Apgar	(-)*	0	(+)*	0	0	0
10 Min Apgar	0	0	0	0	0	(-)**
Infant Abnormal Conditions	0		(-)***	0	0	0

Notes: This table reports difference-in-difference estimates of the effects of a hospital in your county of residence being acquired for various sub-population. Column (1) reports estimates for white mothers. Column (2) reports estimates for non-white mothers. Column (3) reports estimates for mothers with Medicaid at the time of birth. Column (4) reports estimates for mothers from all other payer types. Column (5) reports estimates for college-educated (or more highly-educated) mothers. Column (6) reports estimates for mothers with a high school education or less. (+) denotes a statistically significant positive coefficient. (-) denotes a statistically significant negative coefficient. 0 denotes that we fail to reject the null hypothesis that the coefficient is equal to zero. The p-value is shown with stars (* $<$ .1, ** $<$.05, *** $<$ .01).
Data source: NVSS

given that these mothers are less likely to have the location of their birth shifted by the merger. Given the absence of evidence of shifting birth locations for mothers with Medicaid, we divide the treated counties into two groups: those where the hospital subsequently closes its obstetric unit and those where there is no change in the obstetric care provided at the hospital. We estimate the effect of mergers separately conditioning on whether there was a closure.

Table 12, reports estimates from this analysis. We find no evidence of changes in infant outcomes resulting from acquisitions where the hospital closes its obstetric unit. However, we find evidence of improved infant health across a number of measures following acquisitions where the obstetric unit remains open. First, the probability that newborns are low birth weight declines by 4 percentage points. This represents an improvement of half a standard deviation. We additionally find a 4 percentage point decrease in the probability a newborn is born preterm. There is a small, noisy improvement in 5 minute apgar scores. We additionally find a 5 percentage point drop in infant abnormal conditions. These improvements may be due to better management or more or higher quality resources put in place by the acquiring

Table 12: Difference-in-Difference Estimates of the Effects of Hospital Acquisition for Medicaid Patients

	(1)	(2)	(3)	(4)	(5)
Panel A: Medicaid Patients, OB Units Close					
	LBW	Preterm	Apgar 5	Apgar 10	Abnormalities
ATT	-0.0104	-0.00726	0.0128	0.0452	-0.00782
	(0.0129)	(0.0148)	(0.0431)	(0.0825)	(0.0161)
N	10963	10963	10962	10962	10963
Outcome Mean	.09	.13	8.70	8.65	.11
	(1)	(2)	(3)	(4)	(5)
Panel B: No Change in OB Units					
	LBW	Preterm	Apgar 5	Apgar 10	Abnormalities
ATT	-0.0403***	-0.0415***	0.153*	0.113	-0.0474***
	(0.0152)	(0.0156)	(0.0849)	(0.0801)	(0.0161)
N	12652	12652	12651	12651	12652
Outcome Mean	.09	.13	8.71	8.65	.11

Notes: This table reports estimates of the effects of a hospital being acquired in a county on Medicaid patients. We classify acquisitions into two categories: those where the hospital closes its obstetric unit and those where there is no change to the obstetric unit.
Data source: NVSS

hospital.

In Appendix Table A7, we perform a similar exercise for non-Medicaid patients and find no evidence of impacts on infant health. There are several reasons why we might find the effects on infant health only for Medicaid patients. There is more potential room for improvement in health outcomes; on average, Medicaid patients have worse health outcomes than non-Medicaid patients. Additionally, Medicaid patients may be more limited in their choices of health care providers because of difficulty finding providers who accept Medicaid.

We additionally explore whether there are different effects in high and low income counties and in counties that are relatively closer versus farther from other obstetric units. We find no evidence of meaningful heterogeneity across either of these characteristics.[15]

[15]Results available on request.

4.5 Robustness Checks

Acquired hospitals may face different demographic trends, leading to biased estimates. For instance, hospitals in areas with declining populations or sagging economies may be more willing to entertain takeover offers from hospital systems. Reductions in deliveries, closures of obstetric units, and poorer birth outcomes might be due to demographics, rather than takeovers. To test for this, we run our event study specification examining demographic characteristics of the county.

In particular, we look at the log(population), median income, fraction of the population between 18-34, fraction of the population white, and fraction uninsured. We report our difference-in-difference estimates in Table 13. We find no evidence that counties with acquired hospitals were trending differently in population size, income, or race. We find that post-acquisition, the percent of the population 18-34 declines, but this effect is small (approximately 1 percent change). We additionally find a small change (less than 5 percent) in the percent uninsured. Thus, we think it is unlikely that our results are being driven by changes in county demographics in response to the merger.

Table 13: Hospital Acquisitions and County Level Demographics

	(1) Log(Population)	(2) Median Income	(3) % Pop 18-34	(4) % Pop White	(5) % Uninsured
ATT	-0.00181	100.3	-0.00174*	-0.00179	-0.00438**
	(0.00294)	(243.2)	(0.000920)	(0.00145)	(0.00185)
N	14370	14370	14370	14370	8411
Outcome Mean	9.22	42616.11	.19	.85	.13

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents our estimated aggregated average treatment effects for the effect of hospital acquisition on county-level demographic information.
Data source: US Census Bureau American Community Survey

We further look at the characteristics of mothers who live in the county. In particular, we examine age, education, race, and Medicaid status. We find no evidence that maternal age or Medicaid status are changing. There is a small increase in the percent without a high school diploma and a small decrease in the percent white. These estimates are shown in Table 14, with corresponding event study estimates shown in Appendix Figure B7.

It is also possible that target hospitals would have closed were it not for the acquisitions. This would cause problems for our main hospital-level regressions since closed hospitals in the control group would drop out of our sample over time. We address this in two ways.

Table 14: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Maternal Characteristics

	(1) Age	(2) Medicaid	(3) Less than HS	(4) College+	(5) White
ATT	0.0231	0.0172	0.0169***	0.00529	-0.00494*
	(0.0430)	(0.0122)	(0.00605)	(0.00450)	(0.00270)
N	19356	19356	19356	19356	19356
Outcome Mean	26.58	.34	.14	.16	.86
Outcome Std Dev	1.45	.26	.11	.12	.21

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports difference-in-difference estimates of the effect of a hospital being acquired in a county on county-level measures of maternal characteristics. Column (1) shows the estimate for average maternal age. Column (3) shows Medicaid enrollment. Column (4) shows the probability the mother has less than a high school eduction. Column (5) shows the probability the mother graduated college (including those with a graduate eduction). Column (6) shows the fraction of mothers who are white.
Data Source: NVSS

First, we estimate the effect of hospital acquisition health care resources at the county level as in Table A2. Because counties do not drop out of our sample, if the alternative was an entire hospital closure, this change in resources would be captured in our county-level estimates.

Second, we can test explicitly for whether acquisitions change the probability of hospital closures. We find no evidence that acquisitions change the probability of rural hospital closure.

5 Summary and Conclusions

While there has been extensive research on the impact of hospital mergers on prices and some research on quality, there is a paucity of evidence of the impact on access. This is especially important in the case of rural hospitals and particularly with regard to obstetric care. We provide evidence on the impacts of mergers on access and additional evidence of impacts on quality in the setting of rural obstetric care.

We find that while hospital mergers result in closures of obstetric units and reductions in local healthcare resources, there is mixed evidence of the effects on patients. In counties where a hospital is acquired, we find increased use of procedures that are suggestive of more-resourced care. However, we find small increases in maternal morbidity. At the same time, we

find no evidence in changes in newborn outcomes overall, though we do find improvements in newborn health for Medicaid patients following mergers where obstetrics units remain open. We find no evidence of changes in either infant or maternal mortality.

Our findings have important implications for antitrust analysis of rural hospital acquisitions. Antitrust enforcers must forecast the effects of mergers on prices, quality, and access. Prior studies suggest that rural acquisitions could lead to higher prices, even when the acquirer and target are not in the same geographic market (Dafny, 2009; Vistnes and Sarafidis, 2013; Lewis and Pflum, 2017). Antitrust enforcers might thus be skeptical of these deals. The fact that some acquisitions lead to obstetric unit closures, and prior research shows that obstetric unit closures harm access and quality, could add to skepticism towards these mergers.

Our findings suggest that antitrust enforcers evaluating these mergers pay particular attention to effects on patient outcomes. We find that acquisition-induced closures do not consistently result in poorer outcomes. Moreover, when acquisitions do not lead to obstetric unit closures, outcomes often improve, especially for Medicaid patients. Blocking these acquisitions might therefore result in poorer health outcomes, at least in some cases.

Policy makers might be tempted to require acquirers to continue to operate obstetric units at target hospitals as a means of maintaining access for rural communities. However, our results imply that this kind of strategy may not achieve the desired results, and can even prove counterproductive. Given that acquirers often do not close obstetric units until several years after an acquisition, it seems likely that some acquirers are uncertain about whether to continue operating obstetric units at the time of acquisition. Any requirement that they do so may discourage acquisitions, including those that would have ultimately benefited patients at the target hospitals.

There is substantially more work to be done examining the impacts of mergers on patient access. We hope our work inspires new research addressing this understudied and important issue.

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A Additional Tables

Table A1: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Obstetric Units

	(1) Not in System 2006	(2) Exclude Other Merger Activity	(3) Include Equal Sized Mergers
ATT	-0.0636**	-0.0911***	-0.0762***
	(0.0247)	(0.0235)	(0.0208)
N	10065	10728	15351
Outcome Mean	.43	.43	.44

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents our estimated aggregated average treatment effects for the effect of hospital acquisition on obstetric units. Column 1 reports our estimates from a restricted sample that consists of only hospitals that were independent as of 2006. Column 2 reports estimates from a sample that drop hospitals engaged in other merger activity during our sample window.
Data source: AHA Annual Survey of Hospitals

Table A2: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Healthcare Resources

	(1) OB Beds	(2) OB Hospitals	(3) Distance	(4) OBGYNS Per Cap	(5) Midwives Per Cap
ATT	-5.998***	-0.115***	1.297**	-0.0760***	0.00785
	(1.519)	(0.0239)	(0.536)	(0.0212)	(0.0144)
N	19053	19053	19020	11566	11541
Outcome Mean	17.2	.39	20.66	.19	.08

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports estimates of the effects of hospital mergers in rural counties on aggregate health care resources related to obstetric care.
Data source: AHA Annual Survey of Hospital, AHRF

Table A3: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Maternal Health Outcomes

	(1)	(2)	(3)	(4)	(5)
			Panel A		
	Smoker Before	Smoker During	Gest Diabetes	Gest HT	Eclampsia
ATT	-0.00439	0.0122**	0.00414**	0.00263	0.000394
	(0.0112)	(0.00605)	(0.00178)	(0.00188)	(0.000277)
N	14186	19356	19356	19356	19356
Outcome Mean	.21	.14	.04	.05	0
Outcome Std Dev	.12	.11	.04	.04	.01
	(1)	(2)	(3)	(4)	(5)
			Panel B		
	Month Prenatal Care	Num Prenatal	Has WIC	Morbidity	Transferred
ATT	0.00253	0.00389	0.0251**	0.00509**	-0.00292***
	(0.0555)	(0.0556)	(0.0123)	(0.00231)	(0.00106)
N	17452	19356	19354	14492	19356
Outcome Mean	3.2	10.89	.34	.02	.01
Outcome Std Dev	.54	1.27	.26	.04	.04

Notes: This table reports difference-in-difference estimates of the effect of a hospital being acquired in the mother's county of residence on maternal health outcomes. In Panel A, columns (1) and (2) examine smoking. Column (3) looks at the effects on gestational diabetes. Column (4) looks at the effects on gestational hypertension. Column (5) looks at the effects on eclampsia.
In Panel B, column (1) examines the month in which prenatal care is initiated. Column (2) examines the total number of prenatal visits. Column (3) examines severe maternal morbidity. Column (4) examines whether the mother was transferred during labor.
Data source: NVSS

Table A4: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Intervention Rates

	(1)	(2)	(3)	(4)	(5)
Panel A					
	C-Section	Induction	Augmentation	Anesthesia	ECV
ATT	0.00166	-0.00185	0.0208**	0.0407***	0.00111*
	(0.00324)	(0.00475)	(0.00982)	(0.0147)	(0.000580)
N	19356	19356	17609	19356	19356
Outcome Mean	.32	.3	.21	.54	0
Outcome Std Dev	.08	.1	.12	.28	.01
Panel B					
	Steriods	Antibiotics	Forceps	Vacuum	
ATT	-0.00577	-0.00840	0.00241**	0.00194	
	(0.00923)	(0.0124)	(0.00111)	(0.00385)	
N	17609	17609	17609	17609	
Outcome Mean	.02	.2	.01	.04	
Outcome Std Dev	.05	.13	.03	.05	

Notes: This table reports estimates of the aggregated ATT from the Callaway and Sant'Anna (2021) estimator for the effects of hospital acquisition. In Panel A, column (1) reports estimates for the effect on the cesarean section rate. Column (2) reports estimates for the induction rate. Column (3) reports estimates for labor augmentation. Column (4) reports estimates for anesthesia. Column (5) reports estimates for external cephalic version procedures.
In Panel B, column (1) reports estimates for steroids. Column (2) reports estimates for antibiotics. Column (3) reports estimates for forceps. Column (4) reports estimates from vacuum use.
Data source: NVSS

Table A5: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Infant Health Outcomes

	(1) LBW	(2) Preterm	(3) APGAR 5	(4) APGAR 10	(5) Abnormalities
ATT	0.00160	0.00170	-0.0213*	-0.0215	-0.0163
	(0.00138)	(0.00242)	(0.0123)	(0.0143)	(0.0123)
N	19356	19356	19352	14543	17607
Outcome Mean	.08	.12	8.77	8.66	.11
Outcome Std Dev	.04	.05	.24	.26	.11

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports difference-in-difference estimates of the effects of a hospital being acquired in the county the mother lives in on infant health outcomes. Column (1) examines the fraction of infants who are low birth weight (<2500g). Column (2) examines the fraction of infants who are preterm (<37 weeks). Column (3) examines 5 minute apgar scores. Column (4) examines 10 minute apgar scores for babies who scored below a 6 on the 5 minute test. Column (5) examines abnormal conditions, which include whether assisted ventilation was required, NICU admission, whether the newborn was given surfactant replacement therapy, whether antibiotics were given, and whether the newborn had a seizure.

Data source: NVSS

Table A6: Difference-in-Difference Estimates for Sub-Groups

	White	Non-White	Medicaid	Non-Medicaid	College	HS or Less
County of Residence	-.04***	-.036***	.004	-.024***	.008	-.036***
	(.008)	(.014)	(.017)	(.008)	(.013)	(.009)
Smoking Before	-.004	.004	.008	0	-.004	-.004
	(.011)	(.017)	(.011)	(.008)	(.007)	(.012)
Smoking During	.012*	.004	.004	.004	-.008	.012**
	(.006)	(.014)	(.011)	(.004)	(.006)	(.007)
Gestational Diabetes	.004**	.012**	0	.004	.004	.004**
	(.002)	(.005)	(.003)	(.002)	(.004)	(.002)
Gestational Hypertension	.004*	0	-.004	0	-.012	.004
	(.002)	(.006)	(.006)	(.003)	(.009)	(.002)
Eclampsia	0	0	0	0	0	0**
	(0)	(.001)	(.001)	(0)	(.001)	(0)
Month Prenatal Care Began	.016	.04	-.008	-.028	-.056	.028
	(.045)	(.084)	(.029)	(.031)	(.038)	(.053)
Number of Prenatal Visits	.024	-.184	.02	-.064	0	-.012
	(.054)	(.136)	(.118)	(.057)	(.113)	(.058)
WIC	.028**	.012	.02*	.028***	0	.024*
	(.011)	(.017)	(.011)	(.01)	(.009)	(.013)
Maternal Morbidities	.008***	0	0	.008***	.004	.004*
	(.002)	(.006)	(.002)	(.003)	(.003)	(.002)
Mother Transferred	0	-.004	-.02**	0	0	-.004***
	(.001)	(.003)	(.009)	(.001)	(.001)	(.001)
Cesarean Rate	.004	-.004	-.02*	-.004	-.024	0
	(.003)	(.015)	(.011)	(.005)	(.016)	(.003)
Induction	-.004	.004	.004	0	-.008	0
	(.005)	(.013)	(.009)	(.005)	(.013)	(.005)
Labor Augmentation	.012	.024	.016*	.012	.004	.02**
	(.01)	(.02)	(.008)	(.008)	(.011)	(.01)
Anesthesia	.04***	.032*	-.016	.052***	-.02	.044***
	(.015)	(.019)	(.012)	(.016)	(.014)	(.015)
ECV	0**	0	0	0	0	0**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Steriods	-.004	0	-.016**	-.004	-.008	0
	(.007)	(.01)	(.007)	(.006)	(.009)	(.008)
Antibiotics	.004	-.012	.016	-.004	-.016	0
	(.01)	(.021)	(.009)	(.011)	(.013)	(.012)
Forceps	0	.004	0	-.004	.004*	0
	(.001)	(.002)	(.001)	(.005)	(.002)	(.001)
Vacuum	0	.004	0	0	0	0
	(.004)	(.01)	(.004)	(.004)	(.007)	(.004)
LBW	0	-.008	-.036***	0	-.004	0
	(.002)	(.009)	(.013)	(.002)	(.01)	(.002)
Preterm	0	.012	-.036***	0	-.012	.004
	(.003)	(.009)	(.013)	(.003)	(.012)	(.003)
5 Min Apgar	-.024*	-.02	.128*	-.016	-.004	-.02
	(.012)	(.025)	(.07)	(.012)	(.027)	(.013)
10 Min Apgar	-.02	.072	.104	.02	.036	-.028**
	(.014)	(.07)	(.067)	(.046)	(.024)	(.014)
Infant Abnormal Conditions	-.008	-.02	-.04***	-.004	-.012	-.012
	(.011)	(.019)	(.013)	(.009)	(.012)	(.011)

Notes: This table reports difference-in-difference estimates of the effects of a hospital in your county of residence being acquired for various sub-population. Column (1) reports estimates for white mothers. Column (2) reports estimates for non-white mothers. Column (3) reports estimates for mothers with Medicaid at the time of birth. Column (4) reports estimates for mothers from all other payer types. Column (5) reports estimates for college-educated (or more highly-educated) mothers. Column (6) reports estimates for mothers with a high school education or less.
Data Source: NVSS

Table A7: Difference-in-Difference Estimates of the Effects of Hospital Acquisition on Infant Outcomes for Non-Medicaid Patients

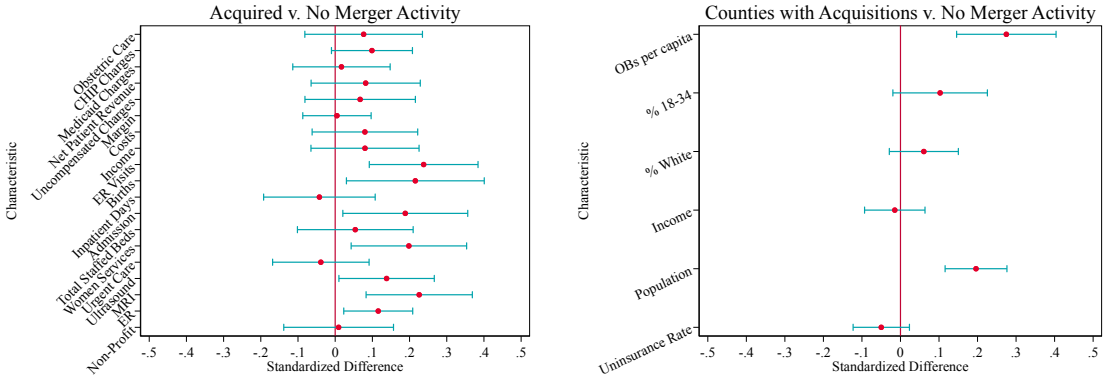
	(1)	(2)	(3)	(4)	(5)
Panel A: OB Units Close					
	LBW	Preterm	Apgar 5	Apgar 10	Abnormalities
ATT	0.00144	0.00947	0.0232	-0.00331	0.00430
	(0.00554)	(0.00632)	(0.0312)	(0.0334)	(0.0110)
N	11412	11412	11412	11138	11140
Outcome Mean	.07	.11	8.76	8.67	.1
	(1)	(2)	(3)	(4)	(5)
Panel B: No Change in OB Units					
	LBW	Preterm	Apgar 5	Apgar 10	Abnormalities
ATT	0.00124	-0.0000212	-0.0248*	0.0284	-0.00769
	(0.00265)	(0.00356)	(0.0128)	(0.0556)	(0.0106)
N	13302	13302	13302	12921	12923
Outcome Mean	.07	.11	8.76	8.67	.1

Notes: This table reports estimates of the effects of a hospital being acquired in a county on Medicaid patients. We classify acquisitions into two categories: those where the hospital closes its obstetric unit and those where there is no change to the obstetric unit. Data source: NVSS

B Additional Figures

Figure B1: Balancing Regression Estimates

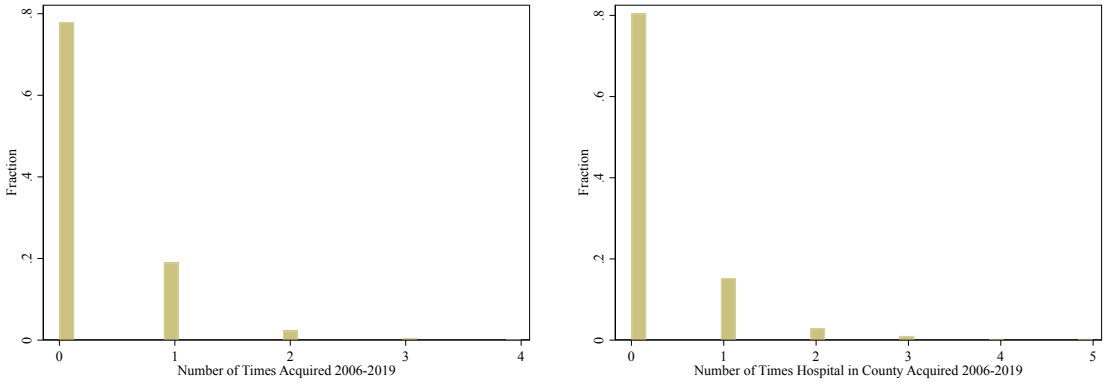
(a) Distribution of Hospital Acquisitions (b) Distribution of Acquisitions in Counties



Notes: This figure shows the estimated differences in characteristics between acquired and non-acquired hospitals (subfigure a) and between counties with acquired hospitals and without acquired hospitals (subfigure b) after time and state fixed effects have been residualized.
Data source: AHA Annual Survey of Hospitals, American Community Survey

Figure B2: Repeat Acquisitions

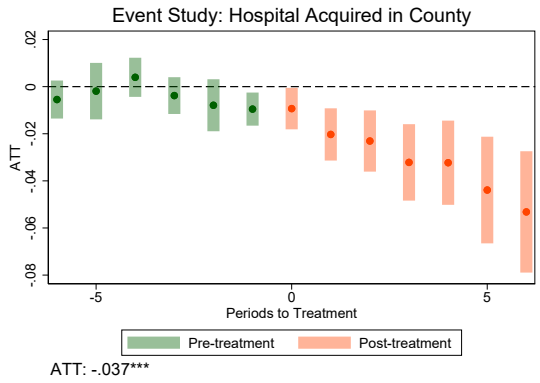
(a) Distribution of Hospital Acquisitions (b) Distribution of Acquisitions in Counties



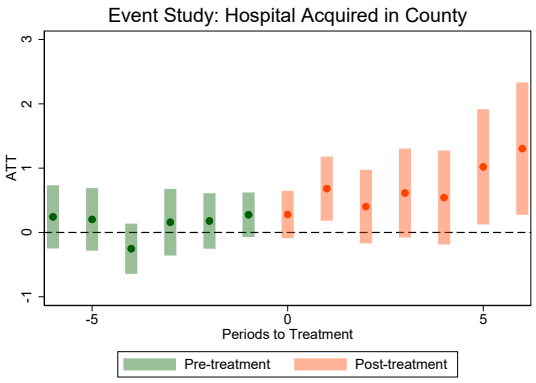
Notes: This figure shows the number of times each hospital is acquired (subfigure a) and that a county experiences the acquisition of a hospital located in it (subfigure b).
Data source: AHA Annual Survey of Hospitals

Figure B3: Event Study Estimates of the Impact of Hospital Acquisition on Patient Flows

(a) Birth in County of Residence

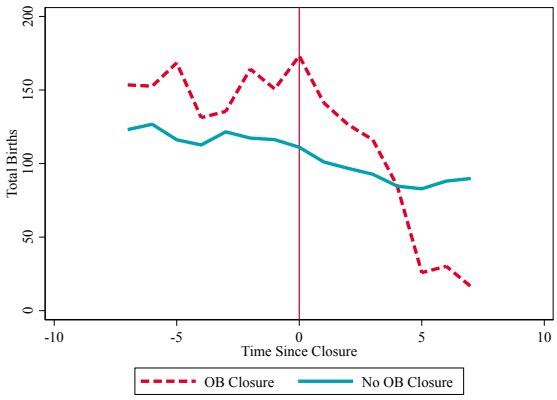


(b) Distance Traveled



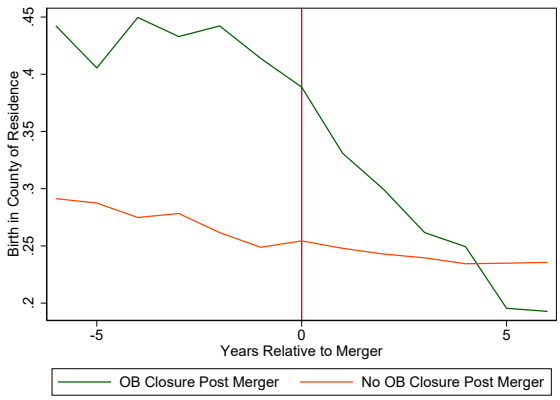
Notes: This figure shows the event study estimates of the impact on hospital acquisition in the county of residence on birth locations. Subfigure (a) reports estimates on the effect of giving birth in the county of residence. Subfigure (b) reports estimates of the distance traveled. Data source: AHA Annual Survey of Hospitals

Figure B4: Births at Acquired Hospitals



Notes: This figure shows the time series of births at hospitals that were acquired split by whether an obstetric unit closure followed the acquisition or not.

Figure B5: Births in county of residence by closure status

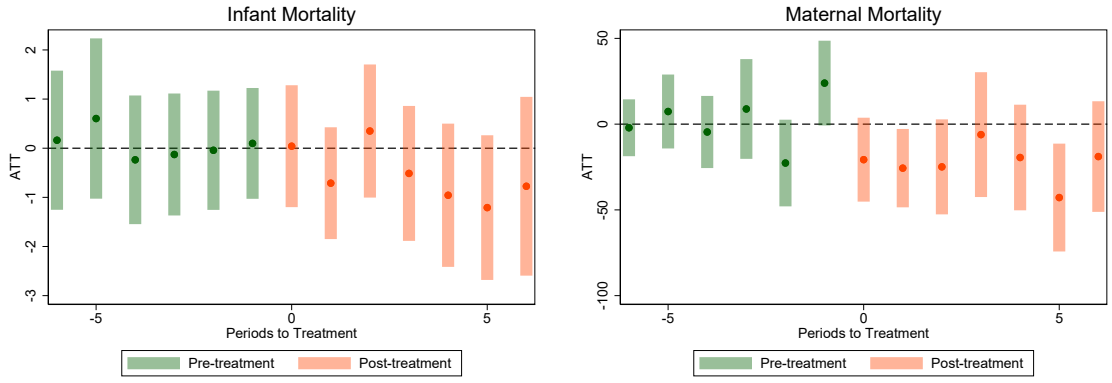


*Notes:*This figure shows the average probability that women who live in a county with an acquired hospital give birth in their county of residence, split by whether there is a closure of the obstetric unit in the 7 years following the merger.
Data source: NVSS

Figure B6: Event Study Estimates of the Impact of Hospital Acquisition on Mortality

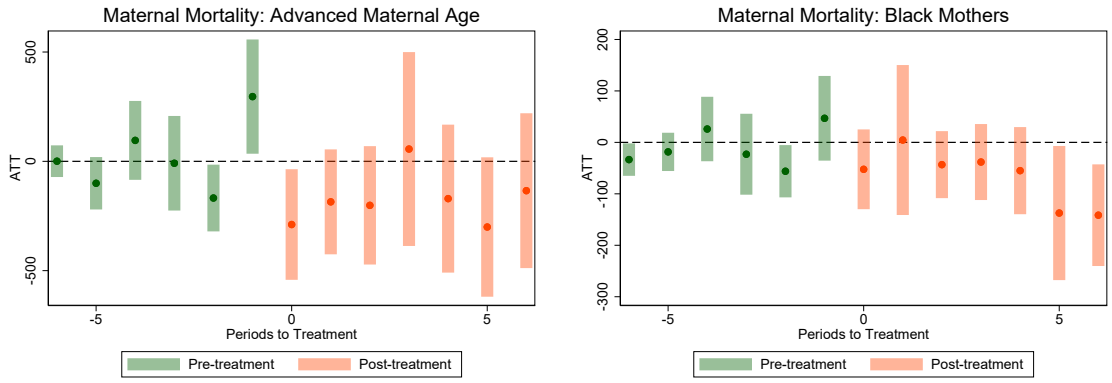
(a) Infant Mortality

(b) Maternal Mortality



(c) AMA Maternal Mortality

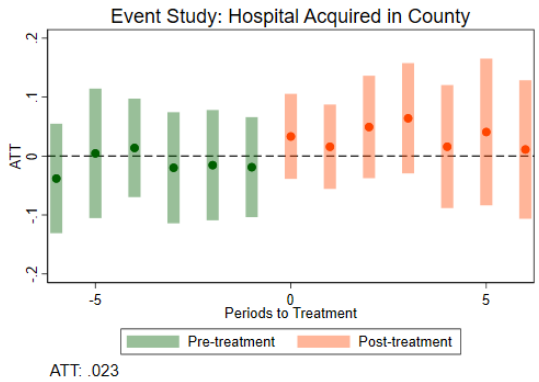
(d) Black Maternal Mortality



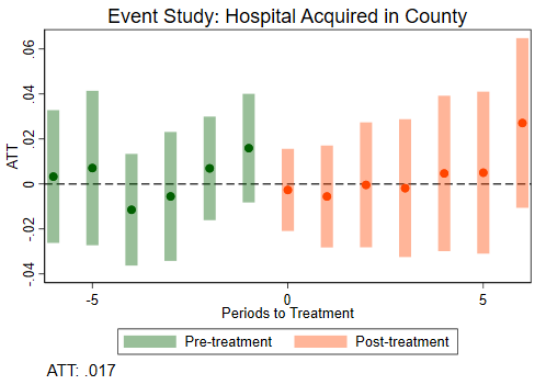
Notes: This figure shows the event study estimates of the impact on hospital acquisition in the county of residence on mortality. Subfigure (a) shows infant mortality (deaths per 1,000 births). Subfigure (b) shows maternal mortality (deaths per 100,000 births). Subfigures (c) and (d) focus on two high risk groups: mothers of Advanced Maternal Age and Black mothers.
Data source: NVSS

Figure B7: Event Study Estimates of the Impact of Hospital Acquisition on Maternal Characteristics

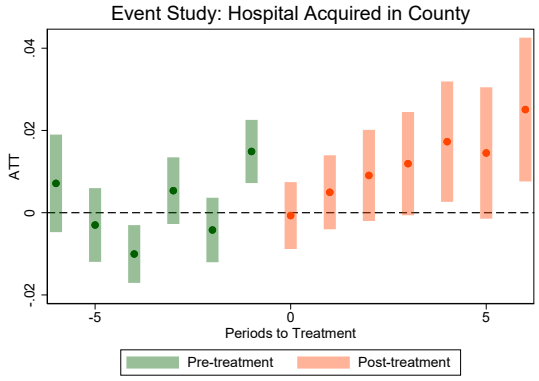
(a) Age



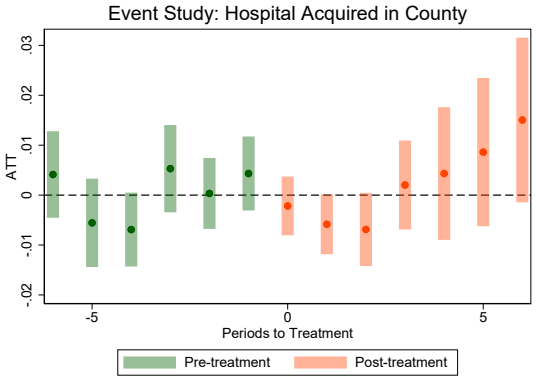
(b) Medicaid



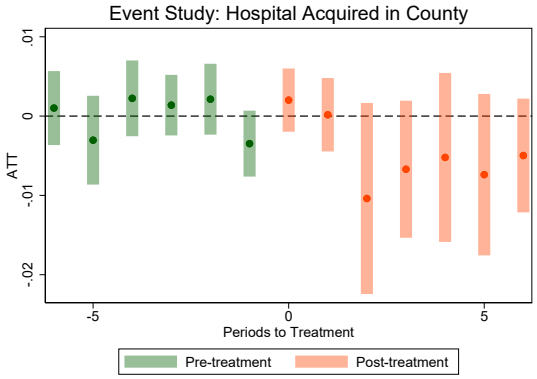
(c) Less than HS Education



(d) College Education or More



(e) White



Notes: This figure shows the event study estimates of the impact on hospital acquisition in the county of residence on maternal characteristics.
Data source: NVSS