The Effect of Hospital Maternity Ward Closures on Maternal and Infant Health*

Emily Battaglia†

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Abstract

In recent years, many hospitals, primarily in rural areas, have eliminated maternity care. I estimate the impact of maternity ward closures on birth outcomes in the United States using national Vital Statistics data. Increased travel distance following closure can lead to decreased utilization of prenatal care or an increase in out-of-hospital births. At the same time, women may be exposed to providers with better practices. The closures appear to create benefits: I document a large decline in Cesarean births among low-risk women, with null effects on infant outcomes. My findings suggest hospitals that close maternity wards were over-performing Cesareans.

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†Department of Economics, University of Delaware, Email: emilylb@udel.edu

Since the early 2000s, hundreds of hospitals have closed or are at risk of closing in the United States. When hospitals are financially strained, they may eliminate their least profitable services. Maternity care is often one of the first services to be eliminated due to high costs and low reimbursements. As a result, nine percent of counties lost maternity services between 2004 and 2014 (Hung et al. (2017)), and today, almost half of counties have low or no access to maternity care (March of Dimes (2020)).

In this paper, I study the impacts of rural maternity ward closures on the health outcomes of women and infants.[1] Depending on the context, maternity ward closures may have either positive or negative effects on maternal health. On the one hand, closures may result in reduced access to care and generate adverse health consequences. Large increases in travel distance could lead to decreased utilization of prenatal care and an increase in births occurring in hospitals lacking maternity wards or even outside hospitals, increasing the chances of complications for both the mother and the newborn.[2] Adverse health consequences are especially concerning in the U.S. context, given levels of infant and maternal mortality as well as Cesarean rates well above levels in other rich countries. Policymakers have been increasingly concerned about maternal health, leading to several bills aimed at improving access to maternal healthcare being presented to Congress.[3]

On the other hand, the closure of maternity wards could improve health outcomes. When a maternity ward closes, women are shifted to other hospitals and exposed to the delivery

[1]In this manuscript, I use "rural" to describe the maternity ward closures that occur in counties that lose all maternity care services. Section 1.3 highlights that these counties are less populous than non-closure counties. I do not restrict closures to areas that meet the definition of "rural" from any specific federal agency and use rural only to describe this type of closure.

[2]Several recent articles have discussed these concerns. For some examples, see https://www.npr.org/sections/health-shots/2016/02/24/467848568/more-rural-hospitals-are-closing-their-maternity-units, https://www.usnews.com/news/healthiest-communities/articles/2019-06-13/what-happens-when-rural-communities-lose-their-hospital-maternity-care, and https://www.cnn.com/2023/04/07/health/maternity-units-closing/index.html.

[3]For a brief description of bills introduced in 2019 and 2020, see https://www.kff.org/womens-health-policy/fact-sheet/analysis-of-federal-bills-to-strengthen-maternal-health-care/.

practices and resources of that hospital. Delivery practices vary greatly between hospitals, with Cesarean delivery rates ranging from 19 percent to 48 percent across hospitals (Card et al. (2019)). If the hospital that closes is of lower quality, the benefits of shifting to an alternative hospital may outweigh the costs of reduced access to local care.

To study the relationship between rural maternity ward closures and birth outcomes, I use national birth certificate records from the National Center for Health Statistics (NCHS) from 1996 to 2018. These data provide the universe of births, with rich details on characteristics of the pregnancy, labor, and birth outcomes. The restricted-access files contain additional information on county of residence and county of birth, allowing me to precisely identify when a woman's residence county loses access to maternity care. Using this information, I identify counties that go from having a hospital with a maternity ward to having no hospitals with a maternity ward, an event that is mostly concentrated in rural areas.

To quantify how rural maternity ward closures affect women and infants, I adopt a matched difference-in-differences approach exploiting variation in the timing of closures, defined as the year when a county loses all maternity services. Using detailed demographic and economic characteristics at the county level, I construct a matching algorithm to find a set of counties that do not lose maternity services to form a control group. I then compare the evolution of health outcomes for women and infants in treated and comparison counties around the time of the maternity ward closure. I also show that my results are robust to a non-matching difference-in-differences approach following Callaway and Sant'Anna (2021).

I do not find evidence of adverse impacts on infant health. I can rule out relatively small deleterious effects on low birth weight and preterm birth. While I cannot rule out small increases in infant mortality due to a small baseline mortality rate, the null effects on other infant health outcomes provide reassuring evidence that closures do not harm infants.

Likewise, I do not find evidence that rural maternity ward closures harm maternal health—if anything, birth outcomes appear to improve. I find that women residing in counties that experience a maternity ward closure have significant *reductions* in Cesarean births relative to those in matched control counties. Further, I find support for the idea that local provider practice plays an important role in the health impact of maternity ward closures. The reduction in Cesarean births is concentrated among women who move to providers with a lower propensity to perform a Cesarean following closure.

The reduction in Cesarean deliveries is driven by women with low medical risk factors. Because Cesarean births are major abdominal surgeries and are associated with an increased risk of maternal morbidity, they should be reserved for women who are unable to have a safe vaginal delivery. I show that maternity ward closures are associated with lower rates of Cesarean births for women predicted to be at low risk for complications, calculated as a function of age and other medical attributes, and no changes in rates for high-risk women, suggesting that women benefit from the new providers.

This paper contributes to the expansive literature studying maternal and infant health. Several papers study how policies and environments impact health outcomes (Aizer et al. (2007), Almond et al. (2011), Almond et al. (2012), Evans and Garthwaite (2014), Chen et al. (2016), and Kuziemko et al. (2018)). Others investigate the impact of access to hospitals and clinics on utilization of care (Currie and Reagan (2003) and Lu and Slusky (2016)). I complement this literature by documenting how access to hospital-based maternity services in a woman's local area impacts birth outcomes.

In addition, this paper is related to the literature on Cesarean birth. Currie and MacLeod (2017) find that improved decision-making among providers could reduce Cesarean births for low-risk women. Other papers study the health impacts of Cesarean deliveries, often finding an association between Cesarean birth and respiratory issues (Costa-Ramón et al. (2018), Costa-Ramón et al. (2020), and Card et al. (2019)). In my paper, I document a strong reduction in Cesarean deliveries concentrated among low-risk women. I provide suggestive evidence that this reduction is a result of provider practices, indicating the delivery patterns of the doctor at birth play an important role in determining the mode of delivery following maternity ward closures in rural areas.

Several papers have studied the relationship between maternity ward closures and birth outcomes (Lorch et al. (2013), Avdic et al. (2018), Hung et al. (2018), Hussung (2018), and Kozhimannil et al. (2018)). The results in this literature are mixed, with some papers finding adverse effects with others finding no or even positive effects. Avdic et al. (2018) studies maternity ward closures in Sweden using a quasi-experimental design and finds adverse effects on maternal health but improvements in fetal health. Kozhimannil et al. (2018) uses an interrupted time series design and finds women in rural counties not adjacent to urban areas see increases in out-of-hospital birth, births in hospitals without an obstetric unit, and preterm birth. In addition to focusing on a longer time frame and utilizing an alternative empirical strategy, I investigate the effects by maternal risk factors and provider practice styles. I also explore potential spillover effects and heterogeneity across types of women.

In a concurrent paper, developed simultaneously and independently to this paper, Fischer et al. (2023) analyze the health impacts of rural maternity ward closures using a two-way fixed effects model. In contrast to Fischer et al. (2023), this paper adopts a different definition of closures and a matched difference-in-differences design to quantify the impacts of closures. Despite the differences in empirical strategies, both papers find similar results: no adverse effects on infant health outcomes and reductions in Cesarean births. Our works provide complementary evidence rejecting that maternity ward closures have had negative effects.

This paper is also related to the broader literature studying general hospital closures. The literature on hospital closures often focuses on utilization and mortality, and the results are mixed. Buchmueller et al. (2006) find increased mortality from heart attacks and unintentional injuries in urban closures. Joynt et al. (2015) find no effect on utilization or mortality. Avdic (2016) studies closures in Sweden and finds increased mortality from heart attacks, but effects are short-lived. Gujral and Basu (2019) find no general impact of closure, but increased mortality with rural closures. Carroll (2019) finds both decreased utilization and increased mortality with rural closures. Petek (2022) finds decreased utilization with no effect on mortality. Other studies (Alexander and Richards (2023) and Vogler (2020)) focus on the economic consequences of hospital closures, finding generally negative effects on economic outcomes such as employment. This paper complements this literature by focusing on the closing of maternity wards. Hospitals will often eliminate obstetric care while keeping other sections of the hospital intact. Childbirth is the leading cause of hospitalization and disparities are especially pronounced, so understanding whether closing maternity wards leads to improved or worsened maternal and infant outcomes is essential.

1 Data

1.1 Birth Certificate Data

The main analysis in this paper utilizes the U.S. Cohort Linked Birth/Infant Death Data Files provided by the National Center for Health Statistics (NCHS) for the years 1996 through 2018 (National Center for Health Statistics (2018)).[4] The vital statistics data contain information on maternal and infant demographic characteristics such as race, ethnicity, education, and age. The data also contain details of the pregnancy and birth, including prenatal care, health risk factors, complications, and method of delivery. Maternal health outcomes are limited in the birth certificate data. Some measures of Severe Maternal Morbidity were added in the 2003 revision and states adopted the revised certificate over the next several years.[5] Due to the limited information, this paper focuses on prenatal care, induction, and cesarean birth as measures of maternal health.[6] Information on the infant's health, such as gestational age, birth weight in grams, and mortality within one year of birth, are also

[4]Cohort-linked birth and death certificates were not available for 2003 and 2004. The data for 2003 and 2004 are from the U.S. Natality Detail Files (National Center for Health Statistics (2004)).

[5]Though states began adopting the revision as early as 2003, data on maternal morbidity is not available in the data files until 2011.

[6]Maternal morbidity would allow a more direct measure of a maternal outcome, but the data coverage is too limited in this context. Other data sources, like claims data, would allow for a better analysis of maternal morbidities, but would be limited to a selected group. Birth certificate data, on the other hand, allows for an analysis on all births in the United States over a long time horizon.

available in the data. In addition, the restricted-access files contain relevant geographic information, including county of residence and county where the birth occurs.

In the NCHS data, I identify when a county experiences a "complete" loss of maternity services. I classify a county as having lost all maternity services if I observe a drastic reduction in hospital births. I count the total number of hospital births occurring in a county in a given year and calculate 3-year averages. A county "loses services" in year n if the 3-year average in years $n-1$, $n-2$, and $n-3$ is more than 15 hospital births while the 3-year average in years n, $n+1$, and $n+2$ is less than 5 hospital births. Importantly, this method does not identify counties that have other providers of maternity care after a hospital closes its maternity ward. Since most urban counties have more than one hospital providing maternity care, this method mostly identifies rural counties and I refer to these closures as rural closures. Figure 1 displays the number of counties offering maternity care over time. The number of counties losing services is fairly consistent across years, with around 18 closures each year. I also probe robustness to the thresholds chosen in this definition in Section 4.4.

My method of identifying closures represents an improvement over previous works that rely on the American Hospital Association's Annual Survey. The Annual Survey includes a hospital's self-reported data that can be used to infer whether maternity services are available, such as the number of births, obstetric beds, and bassinets. Relying solely on the Annual Survey can introduce inaccuracies in identifying closures. With a response rate of around 80 percent, identifying the precise year in which a maternity ward closes can be challenging if a hospital does not fill out the survey during the closure period. Moreover, hospital consolidations and mergers can lead to hospitals seemingly "dropping out" of the survey, since, in most cases, only the parent hospital responds to the survey. In contrast, birth certificate records provide an administrative count of the number of hospital births within a county, allowing precise identification of closure. This approach, however, comes with the tradeoff of not allowing me to observe intensive margin changes within a country.

Figure 2 plots the average number of births in a county around the year of closure. The average number of births leading up to a closure is around 160 births per year. There is a significant drop in the number of births in the year before closure due to closures occurring at various points in calendar time.[7] Upon closure, births in treated counties drop to zero, confirming a large "first stage." Though births drop dramatically in treatment counties, a county that closes its maternity ward could still see a small number of births post-closure due to isolated events. In particular, a woman may show up to the emergency room to deliver in a hospital that does not typically provide maternity services or a woman may (intentionally or unintentionally) give birth out of a hospital within the county.

1.2 Other Data

I utilize additional sources of data to augment my analysis. I use County Business Patterns to obtain the number of establishments in a county in 1995. I obtain county-level population, per capita income, and per capita transfers in 1995 from the BEA's Regional Economic Information System. I use the BLS's Local Area Unemployment Statistics to obtain the unemployment rate in 1995. I utilize the 1995 Intercensal data to recover county-level racial and gender composition and the 2000 Census to obtain information on education levels.

1.3 Characteristics of the Sample

Table 1 reports summary statistics for various groups in the NCHS data. Column 1 presents summary statistics for counties that close their maternity ward at any point between 1996 and 2018 ($N = 414$), Column 2 presents summary statistics for counties without any maternity services from 1996 through 2018 ($N = 1,081$), and Column 3 presents summary statistics for counties providing maternity services continuously from 1996 to 2018 ($N = 1,580$). Counties that experience a closure have a smaller population than counties that provide maternity

[7] For example, a closure in July will be identified in the following year (t). The births in the year prior ($t-1$) will decrease relative to two years prior ($t-2$) since births only occurred from January-June in the year prior to closure but occurred for the entire calendar year two years prior.

services continuously, but are larger than counties that never offered maternity services during the sample period. The closure counties are generally small and rural, with an average population of around 22,000. Relative to the counties that always had maternity services, counties that lose services or never had services have fewer women of childbearing age, a higher share Black, and a lower share of college completion. In addition, the unemployment rate is higher and the county has fewer establishments. In Appendix Table A1, using records from the AHA Annual Survey, I show the hospitals that close tend to be smaller, as measured by the number of births and the number of beds, as well as tend to provide less specialized birthing care, as measured by the presence of a neonatal intensive care unit (NICU).[8]

2 Background on Maternity Ward Closures

Maternity wards typically provide birth services, including prenatal, labor, delivery, and recovery services. Maternity wards can also provide additional services, such as lactation support and gynecological care. A primary goal in obstetric care is to deliver the baby as safely as possible for both the mother and the baby, and the pace of closures in recent years has led to concern in various media sources.[9]

If childbirth is the most common reason for hospitalization, why would a hospital close its maternity ward? There are at least three primary factors that contribute to this decision. First, providing labor and delivery is expensive. Labor and delivery require high staffing needs, with low patient-to-nurse ratios, and the need for obstetricians, pediatricians, and anesthesiologists to be on call 24/7. Maternity wards also require expensive surgical and monitoring equipment. Since Medicaid covers a significant portion of births, reimbursement

[8]Closures are identified in the AHA data by observing a hospital indicating maternity services are no longer offered. AHA data can be problematic for the reasons discussed in Section 1.1, but it is better suited to describing characteristics of hospitals than any other data source available.

[9]For example, see https://www.nytimes.com/2023/02/26/health/rural-hospitals-pregnancy-childbirth.html, https://www.pbs.org/newshour/show/maternity-care-deserts-grow-across-the-us-as-obstetric-units-shut-down, and https://carolinapublicpress.org/27485/mountain-maternity-wards-closing/.

rates are often low. A second motivating factor for closing maternity wards relates to staffing and recruitment issues. With a growing shortage of obstetricians and nurses, especially in rural areas, recruiting and retaining the necessary staff can be challenging.[10] The third factor is the low birth volume. To justify the costs of operating a maternity ward, hospitals need to deliver a significant number of babies each year. Kozhimannil et al. (2022) estimate that maternity wards need at least 200 births per year to break even. These factors together have led some financially-strained hospitals to close their maternity wards. This paper investigates how these closures impact health outcomes through several channels, including changes in distance, changes in quality, and spillovers in surrounding areas.

Women whose local maternity ward closes will have a change in the travel distance to the nearest maternity ward. The increase in travel distance could negatively impact health outcomes if out-of-hospital births increase. In the United States, out-of-hospital birth is more dangerous and results in higher mortality compared to hospital birth (Grünebaum et al. (2020)). In addition, some women may experience reduced access to prenatal care in their county of residence if closures lead to obstetricians leaving the area or if prenatal care was provided in the hospital. This could lead to longer travel distances for prenatal care, potentially decreasing women's utilization of prenatal care. Regular prenatal care can identify potential obstetric complications, and pregnancies with no or limited prenatal care are associated with increased morbidity and mortality (Moore et al. (1986), Twizer et al. (2001), and Vintzileos et al. (2002)). Increased travel distance could also impact the procedures performed during the birth. In particular, women and/or providers may schedule inductions to minimize uncertainty regarding traveling far distances while in labor. An increase in inductions could result in an increase in Cesareans via the "cascade of interventions," where more medical interventions are performed following an induction, ultimately resulting in a Cesarean (Lewis et al. (2019)). However, an increase in inductions could also decrease the

[10] See https://www.aamc.org/news/labor-pains-ob-gyn-shortage, https://www.beckershospitalreview.com/care-coordination/as-birth-rates-increase-ob-gyn-shortage-worsens.html, and https://www.richmondfed.org/publications/research

use of Cesarean birth. In a recent RCT, Grobman et al. (2018) find a reduction in Cesarean birth with elective inductions at 39 weeks gestation. The impact of travel distance is likely to be large for rural closures. The average travel distance to a maternity ward following closure for a woman in a rural area in my sample is more than 30 miles.

In addition to the change in travel distance, there may also be a change in the quality of the closest hospital. Women may be exposed to higher-quality hospitals and providers if the hospital that closes its maternity ward is of lower quality. For rural women, the potential quality improvements may be large. The hospital data from the AHA Annual Survey, summarized in Table A1, suggests that rural hospitals are small and do not provide advanced neonatal care. No rural hospital that closed its maternity ward had a Neonatal ICU. In addition, the number of births in rural hospitals is relatively small, with just more than 150 births per year before closure. If there is "learning by doing" in maternity care, the doctors in rural areas will be less experienced than those in areas that oversee more births.[11]

In addition to the women residing in counties that experience a closure, there could potentially be spillover effects on the women at the nearby hospitals. If the closure of a nearby maternity ward creates a strain on the surrounding hospitals, there could be decreases in the quality of care. The impact of spillovers is likely small for rural closure. With slightly more than 150 births per year before closure, these women may easily find beds in surrounding areas without much impact. In addition, spillovers need not only be negative. If there is "learning by doing" in maternity care, the providers in the spillover hospitals will become better in this regard. Though given the relatively small increase in the number of potential patients a doctor may see, this channel is unlikely to be large. This section highlights that, for rural closures, most impacts are likely to be concentrated among the women residing in counties that experience a closure, with competing positive and negative forces, while women in the surrounding areas are unlikely to be impacted.

[11]Several papers have studied "learning by doing" in medical care, though none have focused on maternity care. See Bridgewater et al. (2004), Contreras et al. (2011), Halm et al. (2002), and Vickers et al. (2007) for examples.

3 Empirical Strategy

The goal of this study is to estimate the reduced-form impact of losing access to hospital-based maternity services on the health outcomes of women and their newborns. To assess the impact of losing hospital-based maternity services, I employ a matched difference-in-differences design. Counties that offer hospital-based maternity services in 1996 and lose those services between 2002 and 2012 (and do not re-gain those services) serve as the treated counties in the analysis. Counties that continually provide maternity services from 1996 to 2018 serve as the potential control group.

3.1 Matching Procedure

I implement a matching procedure to generate balance along observable characteristics between treatment and control areas. To be eligible for inclusion in the matching procedure, treatment counties must experience a closure of hospital-based maternity services between 2002 and 2012. As the baseline specification will incorporate a six-year analysis window, counties that lose services outside of the 2002 to 2012 range are not included in the analysis. Potential control counties must have continual services from 1996 to 2018. Counties that never provide maternity services from 1996 to 2018 cannot serve as a control in the baseline analysis and are excluded from the matching procedure. I utilize this group as an additional control in the Appendix.

I use a parsimonious set of characteristics to match each treated county to a counterfactual control county. Treated counties are matched to non-adjacent counties within the same state. It is important to match within the same state as many health policy decisions (e.g. Medicaid/Medicare policies and medical malpractice laws) occur at the state level and these policies can impact pregnancy and birth outcomes (Aizer et al. (2007), Currie and MacLeod (2008), and Kuziemko et al. (2018)). Within-state matching ensures treatment and control counties are similar along observable characteristics and experience the same broader health policy environment. However, allowing for unrestricted matching within the state would be problematic as it could create a treatment-control pair that are geographic neighbors. The control could then be impacted by the closure through potential spillover effects. Matches are restricted to nonadjacent counties to avoid control county contamination.

I use propensity score matching and match based on pre-closure characteristics: levels of population, the number of establishments, the unemployment rate, median household income and transfers, percent Black, percent female aged 18 to 44, and percent with a bachelor's degree or higher. All matching data comes from 1995 data, with the exception of the percent with a bachelor's degree, which comes from the 2000 Census. I intentionally avoid matching on outcome variables. The set of matching variables is chosen so treatment and control counties are of a similar size, with similar demographic profiles and economic activity. Each county that experiences a maternity ward closure is matched to the county with continuous maternity services with the closest propensity score.[12] Control counties are assigned the same "closure" date as their matched closure county. Results are robust to alternative matching specifications, presented in Section 4.4, including matching on trends and adjusting the set of variables in the match. I then use the observably similar control county to estimate the counterfactual outcome paths for the treated county had the closure not occurred.

Table 2 assesses the balance between treatment and control counties following the matching procedure. Columns 1 and 2 display the characteristics of the treated and control counties while Column 3 displays the p-value for the difference. Panel A displays variables that are directly targeted in the matching procedure. Panel B includes characteristics that are not specifically targeted in the matching procedure. While I refer to the closures as "rural," I do not follow any specific definition of rurality. However, since most definitions of rural incor-

[12] Median household transfers are not available for independent cities in Virginia. Treated counties in Virginia are matched to potential control counties in Virginia based on all other characteristics. I also ensure each potential control is not associated with more than one closure county. Matching is completed without replacement, with the priority order determined based on the timing of closure. For example, for closures in Alabama, 2002 closures are matched first, followed by 2003 closures, and so on.

porate population, which is a targeted characteristics, more than 80% of closure and control counties are rural according to Office of Management and Budget's 2003 definition. In addition, I intentionally avoid matching on potential outcome variables, such as the number of medical doctors. Using 2001 data from the Health Resources and Services Administration's Area Health Resource File, treatment and control counties have a similar number of family medicine doctors per capita, though treatment counties have half as many obstetricians per capita. Table 2 highlights that treatment and control counties are more similar to each other than treatment counties are to the entire sample in Table 1. Notice that the matching algorithm does not fully eliminate differences between treated and control counties. My identification strategy, however, does not require balance on covariates. It relies on parallel trends between treatment and control counties.

3.2 Baseline Specification

To estimate the impact of closure on birth outcomes, I compare changes in the outcomes of interest for treated and control counties around the time of a treated county's closure. I estimate a fully dynamic matched difference-in-differences regression of the form:

$$Y_{ct} = \sum_{\tau \neq -1} \left[\theta_\tau \alpha_\tau + \beta_\tau \left(Treat_c \times \alpha_\tau \right) \right] + \gamma_c + \gamma_t + \varepsilon_{ct}, \tag{1}$$

where Y_{ct} is the average outcome variable for births occurring to women residing in county c and time t, and τ is the year relative to (the treatment county's) loss of services. $Treat_c$ is an indicator equal to 1 for counties that experience a loss of hospital-based maternity services, α_τ are event time fixed effects, γ_c are county fixed effects, γ_t are calendar time fixed effects, and ε_{ct} is an error term. I weight all regressions by the number of births to residents of a county.[13] Standard errors are clustered at the county level.

The coefficients of interest are β_τ, which represent the treat-control differences in outcome

[13]Unweighted regressions are quantitatively similar and are available in the Appendix.

Y at event time τ. I omit $\tau = -1$, so each β_τ represents the treat-control difference at event time τ, relative to the same difference at event time -1. I focus on the β_τ coefficients from event time -6 to 6, where the treatment and control counties are fully balanced. Effects from event time $\tau < -6$ and $\tau > 6$ are accumulated and the coefficients are not reported.

When presenting the results, I typically plot all β_τ coefficients to observe both pre-trends and the evolution of treatment effects through time. In addition, I summarize the treatment effects by reporting the post-period average of the β_τ coefficients (i.e., $\overline{\beta} = \frac{1}{7}\sum_{\tau=0}^{6} \beta_\tau$), which represents the average treatment effect in the post-period. I also report an early treatment effect (β_0) and a late treatment effect (β_5).

The dependent variables of interest can be split in to three categories: birthing location, infant health outcomes, and pregnancy and birth outcomes. Birthing location outcomes are the share of births occurring out of county, the share of births occurring out of hospital, and the share of births occurring in a hospital with a maternity ward. Infant health outcomes include the share of births low birth weight, the share of births preterm, the share of births with a low Apgar score, and the infant mortality rate. Pregnancy and birth outcomes include the share of births with no prenatal visits, the share of births with low (≤ 10) prenatal visits, the share of births induced, and the Cesarean birth rate.

Since maternal mortality is rare in rich countries, Cesareans can be used as a metric of how closures impact maternal health. The American College of Obstetricians and Gynecologists (ACOG) highlights that the rapid increase in Cesarean births without a concurrent increase in maternal or fetal morbidities suggests that Cesarean births may be overutilized in the United States. ACOG provides guidelines for doctors to reduce primary Cesarean births. The guidelines highlight that, for most pregnancies, Cesarean delivery, a major abdominal surgery, carries a greater risk of maternal morbidity and mortality than vaginal delivery (ACOG (2014)). Thus, if the Cesarean rate rises without an underlying justification (e.g., improvements in infant health or an increase in the Cesarean rate among high-risk women), this suggests more women are exposed to an increased risk of maternal morbidities without any clear benefits. Likewise, if the Cesarean rate falls without any subsequent harms (e.g., infant health is no worse off and high-risk mothers still receive Cesareans), it suggests fewer women are unnecessarily exposed to a risk factor of maternal morbidities.

3.3 Identification

The identifying assumptions underlying my estimation strategy are as follows: First, both closure and non-closure counties had similar time trends before the treated county's loss of service. Second, in the absence of the loss of service, closure counties would have continued to follow the same trends as those in the non-closure counties.

Under these assumptions, I interpret the β_τ coefficient as the causal effect of losing maternity services on outcome Y. Importantly, identification of this causal effect comes from differences between the closure and non-closure counties. Even though the closures themselves are occurring at different calendar times, the effects are estimated as differences between treated and control counties rather than solely leveraging variation in timing.

One concern with the identifying assumptions underlying this empirical strategy is that areas that experience a loss of hospital-based maternity services are different from areas that do not. For example, a county that loses access to maternity services may be on a declining economic path, and this may create a fundamental difference in the type and health of the women residing in that county. Matching on observables helps address this concern by ensuring that treatment and control areas have similar demographic and economic characteristics before the closure. In addition, I plot the coefficients from estimates of Equation (1) to assess the presence of pre-trends. To assess potential changes in composition, I estimate Equation (1) using the log of the number of births occurring to residents of a closure county (i.e., fertility) and various demographic characteristics. The results, presented in Appendix Figure A1, do not suggest any changes in fertility or composition.

A related concern is that the control group is selected from the set of counties that always provide maternity services. In particular, areas that continually provide maternity services may be on a different trajectory because they start out larger and more economically connected relative to counties that close their maternity services. I address this concern by checking robustness to the choice of control group using two alternative control groups. First, I select control counties from the set of counties that never provided maternity care from 1996 to 2018. Second, I split each state into "early closures" and "late closures," where the late closures close at least 4 years after the early closures. My results are robust to both alternative control groups. I prefer the control group chosen in the main specification since it maximizes the sample of closure counties and avoids the possibility of a control county being treated before my sample period. I additionally check robustness to the matching strategy by utilizing a non-matching strategy following recent advancements in the difference-in-differences literature using the estimator from Callaway and Sant'Anna (2021). Details of these and other robustness checks are discussed in Section 4.4.

Another threat to the identifying assumption would be the presence of a shock that impacts closure areas, and not control areas, occurring at the same time as the closure. Since most major health policy decisions occur at the state level (rather than a county or zip code level), I mitigate this concern by restricting matches to nonadjacent counties within the same state. The differences in calendar time of closures as well as the within-state matching make it unlikely that the effects are driven by the treated areas experiencing a concurrent shock unrelated to the hospital closure.

4 Main Results

4.1 Birthing Location

I first consider the impact of the closure on the birthing location. Since the county no longer offers maternity services, nearly all women living in the county should give birth in a county other than their county of residence. There could still be a small number of births occurring within the county if women give birth out-of-hospital or in a hospital that no longer provides maternity services (i.e., deliver in the emergency room). Figure 3 plots the treat-control differences from estimating Equation (1) with the share of births occurring out-of-county (Panel (a)), the share of births occurring out-of-hospital (Panel (b)), and the share of births occurring in a hospital with an operating maternity ward (Panel (c)).

Following the closure, there is a significant increase in the number of births occurring outside the closure county, as expected. Even before closure, more than three-fourths of women were bypassing their local hospital and giving birth outside of their county of residence.[14] This suggests that the perceived benefit (i.e., higher quality doctors or hospitals) of the out-of-county hospital outweighed the cost of increased travel distance for a majority of women before closure. In addition, hospitals have varying levels of maternity care and neonatal care. Women who may need (or desire being close to) more specialized services may bypass a smaller local hospital in order to obtain a different level of care.[15] Nonetheless, the share of births occurring out-of-county rises significantly and indicates that after closure nearly 100 percent of births occur out-of-county for women residing in a treatment county.

Following closure, there is a modest increase in out-of-hospital birth and a decrease in births occurring in a hospital with a maternity ward. With 99 percent of births in closure counties occurring in hospitals with maternity care, the magnitude of this drop is economically small. Panels (a) through (c) highlight that following closure, nearly all women who reside in a closure county give birth out-of-county, with only small decreases in the share giving birth in a location with maternity care.

The results for this subsection, and the two that follow, are summarized in Table 3.

[14]The out-of-county birth rate is significantly higher in closure counties than in other counties with an active maternity ward. The out-of-county birth rate in control counties is around 44% and in non-control counties with an active maternity ward is 32%. The high out-of-county birth rate (and low total number of births) can be a contributing factor in a hospital's decision to cease maternity care.

[15]Maternity care ranges from Level I (basic care) to Level IV (Regional Perinatal Health Care Centers). Neonatal care ranges from Level I (Well Newborn Nursery) to Level IV (Regional Neonatal Intensive Care Unit). While I am unable to identify levels of maternity and neonatal care in the NCHS data, hospitals that close are smaller and unlikely to have the specialty care seen in higher levels of care.

Column 1 presents the β_0 coefficients, Column 2 presents the β_5 coefficient, and Column 3 presents the post-period average of the β_τ coefficients (i.e., $\overline{\beta} = \frac{1}{7}\sum_{\tau=0}^{6}\beta_\tau$). Presenting an early, late, and average coefficient allows me to observe how the coefficients evolve over time. The point estimates in Panel A show an increase in the out-of-county birth rate by around 18 percentage points after closure for the treated counties, indicating the out-of-county birth rate is near 100% following closure. While the share of women giving birth in a hospital with a maternity ward falls significantly, the point estimates suggest less than a 1 percentage point decrease in the year of closure before rebounding to around a 0.5 percentage point decrease in later periods. These numbers are small relative to a baseline of nearly 99%.

The county-level estimates can be interpreted as intent-to-treat (ITT) effects. Since around 75 percent of women in a closure county bypassed their local hospital before closure, the effects on complier women who only give birth out of county after closure are approximately 4 times larger than the ITT estimates.[16]

4.2 Infant Health

When a maternity ward closes, women have to travel farther distances for delivery. The increase in travel distance in rural areas is likely to be large, as discussed in Section 2. This could negatively impact infant health if there are reductions in prenatal care or increases in out-of-hospital births. Pregnancies with limited prenatal care and out-of-hospital births could lead to complications and negative impacts on infant health (Moore et al. (1986), Twizer et al. (2001), Vintzileos et al. (2002), and Grünebaum et al. (2020)). In this section, I investigate if the closures have any impact on various measures of infant health.

[16] Appendix Table A2 displays characteristics of women who reside in closure areas who give birth in-county prior to closure (compliers) and women who reside in closure areas and give birth out-of-county prior to closure. Complier women are younger, less educated, less likely to be married, more likely to be Black, and more likely to be foreign born. Complier women also have fewer risk factors: they are less likely to have had a previous Cesarean, be having multiples, to have a breech presentation, and to have either blood pressure disorders or diabetes.

There are no clear trends that would suggest a negative impact on infant health. Figure 4 plots the treat-control differences from estimating Equation (1) using the share of births that are low birth weight (less than 2500 grams), the share of births with an Apgar score below 7, the share of births preterm (less than 37 weeks gestation), and the infant mortality rate as the dependent variables.[17] Table 3 presents the early (β_0), late (β_5), and post-period average ($\overline{\beta}$) coefficients. Additional outcomes, including as log of birthweight and share of births full-term, are available in Online Appendix Figure B1. I can rule out relatively small deleterious effects on low birth weight and preterm birth. The upper bound of the 95% confidence interval for low birth weight, 0.001, suggests I can reject increases in low birth weight of more than about 1.3 percent. While the point estimates for preterm birth suggest a decrease, the event study estimate shows a noisy pre-period as well. Due to the small baseline infant mortality rate, I cannot rule out even relatively large increases in infant mortality. However, the null effects on other infant health outcomes provide reassuring evidence that the closures did not harm infants.

4.3 Outcomes of Pregnancy and Birth

Maternity ward closures could indicate potential threats to maternal health if they reduce prenatal care, even in the absence of negative effects on infants. In addition, maternity ward closures could impact medical interventions during delivery, such as induction or Cesarean birth. This section explores the impact of closures on these channels.

The increased travel distance can impact maternal outcomes through decreased utilization of prenatal care. When a county loses its maternity ward, the women in the county may also lose their access to prenatal care if the obstetricians relocate to other areas or if prenatal care was provided in the hospital. Panels (a) and (b) of Figure 5 plot the treat-control dif-

[17] The Apgar score assesses a newborn's color, heart rate, reflexes, muscle tone, and respiration. Scored out of 10, a score of 7 or more is considered "reassuring," while scores below 7 are considered abnormal (Burd et al. (2014)).

ferences in the share of pregnancies with no prenatal care and the share of pregnancies with low ($\leq$ 10) prenatal visits. Both figures show a general increase in the share of pregnancies with low or no prenatal care. For the share of pregnancies with low levels of prenatal care, the average point estimate of 0.024 from Table 3 suggests a 6 percent increase in the share of pregnancies with low prenatal visits.[18]

One possible explanation for a decrease in prenatal care utilization is that obstetricians also leave the county when the maternity ward closes. This could make it harder to receive in-county prenatal care, leading some women to forgo some appointments. To assess this possibility, I utilize data from the Health Resources and Services Administration's Area Health Resource File on the number of obstetricians in a county.[19] Appendix Figure A2 shows suggestive evidence of a decrease in the number of obstetricians per 10,000 population following a maternity ward closure. This provides some insight into why prenatal care visits decrease following a closure. Addressing this decrease could also be an avenue for policymakers to consider alternative solutions to maternity ward closures.[20]

To avoid potentially lengthy drives to the closest hospital with a maternity ward during active labor, women may elect to have an induction.[21] Elective inductions can usually be scheduled at 39 weeks gestation and are associated with a decreased risk of Cesarean birth in post-term deliveries past 41 weeks of gestation. Earlier inductions may be associated

[18]Additional outcomes, including the total number of prenatal visits and whether prenatal care began in the first trimester, are available in Online Appendix Figure B2. Note that the 2003 birth certificate revision, which was rolled out slowly among states, changed the way information on prenatal care timing was obtained. Information on prenatal care timing across the 1989 and 2003 birth certificate revisions are not considered comparable, so data on prenatal care timing should be interpreted cautiously.

[19]Since the number of obstetricians in a county is not available until 2001, I shorten the pre-period to 4 years, rather than 6 years, and look at closures from 2005 to 2012, rather than from 2002 to 2012.

[20]For example, policymakers could provide incentives for OBGYNs to practice in closure counties on a limited (e.g., 1 day per week) basis or to provide telemedicine appointments. While investigating these possibilities is beyond the scope of this paper, this is a fruitful area for future research.

[21]Women (and their doctors) may schedule an elective induction at the intended birth hospital to eliminate uncertainties regarding when labor will occur, which could alleviate concerns around not reaching the farther hospital in time and also avoid traveling lengthy distances while uncomfortable in labor.

with an increased risk of Cesarean birth (Caughey et al. (2009)). In a recent RCT, Grobman et al. (2018) find that Cesarean birth decreases with elective inductions at 39 weeks gestation. Panel (c) of Figure 5 shows suggestive evidence of an increase in inductions following closure, though the pre-period displays an upward trend in inductions.

Panel (d) of Figure 5 plots the treat-control differences in the share of births delivered via Cesarean. The post-period differences are significantly negative. The share of births delivered via Cesarean decreases for women residing in closure counties by approximately 2 percentage points following closure, equivalent to a 6 percent decrease. I find similar results for an unweighted specification in Appendix Figures A3 to A5. In Section 5, I further explore the reductions in Cesareans and whether they have a positive or negative impact on women.

4.4 Robustness of Primary Results

The baseline results relied on matching a treatment group of closure counties with a control group of non-closure counties. In Table 4, I present results making changes to (1) the control group, (2) the matching strategy, and (3) the treatment group. Each cell in Table 4 represents the post-period average $\overline{\beta}$ coefficient from estimating Equation 1. The dependent variables are listed in the row while the column identifies the robustness check. Column 1 reports the baseline results from Column 3 in Table 3.

Columns 2 and 3 adjust the definition of the control group. In the baseline analysis, the control group is selected from counties that have an operating maternity ward during the entire study period. In Column 2, the control group is chosen from counties that never have an operating maternity ward during the study period. While these two groups of counties may appear similar, this comparison is potentially problematic as it is possible the "always closed" counties had an operating maternity ward prior to the start of the study period. In Column 3, the sample of "closure counties" is split into "early closure" and "late closures," where late closures occur at least 4 years after the early closures. The control group in this column is the set of late closure counties. While this allows for treatment and control counties that experience the same shock (and thus may be more similar along unobservable dimensions), this analysis limits the pre- and post-period analysis to four years. Nevertheless, the results are similar across control groups. Event study estimates are presented in Online Appendix Figures B3 to B8.

Columns 4 through 7 adjust the matching strategy. The baseline matching strategy in Column 1 matches on pre-closure data as discussed in Section 3.1. Column 4 eliminates the matching strategy and instead utilizes recent advancements in the difference-in-differences literature to employ the estimator from Callaway and Sant'Anna (2021).[22] The results are similar to the baseline results. The only exception is the result on induction, with the Callaway and Sant'Anna (2021) estimator showing a significant increase in inductions. Event study estimators are available in Online Appendix Figures B12 to B14.

Columns 5 through 7 adjust the main matching strategy from the baseline specification. While the baseline results match on the levels of the matching variables in the baseline period, Column 5 instead matches on the baseline trends to account for the possibility that closure counties were on a downward trajectory prior to closure. Column 6 matches on the data from the year prior to closure rather than on the data prior to any closure in the sample. For instance, to find a counterfactual for a closure in 2012, I rely on the data from 2011 instead of the baseline data. This adjustment accounts for the possibility that the baseline data may not be adequate for longer time frames. Column 7 includes obstetricians per capita in 2001 as one of the matching variables to mitigate concerns that closure and control counties have different baseline levels of obstetric care. Regardless of the choice of matching variables, my results are generally quantitatively and qualitatively similar. Event study estimate are available in Online Appendix Figures B15 to B23.

The final set of robustness checks to the baseline strategy adjusts the definition of "closure" counties. As discussed in Section 1.1, closure counties are identified using the NCHS

[22]The decomposition from Goodman-Bacon (2021) is presented in Online Appendix Figures B9 to B11. The decomposition shows the majority of the weight is coming from treated vs. never treated comparisons, with a relatively small weight coming from the later vs. earlier comparisons.

data and require an average of 5 or fewer hospital births to occur in a county following closure. Column 8 (Column 9) adjusts this definition by allowing for an average of 2 or fewer (8 or fewer). The point estimates are similar to the baseline results. Event study estimates are available in Online Appendix Figures B24 to B29.

Taken together, the results of this section provide reassuring evidence that the baseline findings from Section 4 are not driven by the choice of control group, the matching procedure, or the definition of closure. Thus far, my results indicate that the out-of-county birth rate nears 100% following closure, with a small (but significant) decrease in the share of births in a hospital with a maternity ward. I also find a significant decrease in the Cesarean birth rate, along with null effects on measures of infant health, following closure.

5 Analysis of Reduction in Cesarean Birth

The results from the main analysis suggest that the closure of a small maternity ward reduces Cesarean deliveries for women residing in closure counties. Since Cesarean delivery carries a greater risk of severe maternal morbidity, the reduction in Cesarean deliveries could be a benefit of closure if it reduces unnecessary procedures. However, the reduction could be a cost of closure if it reduces Cesareans among women who cannot safely deliver vaginally. To investigate this, I study whether the decrease in the rate of Cesarean births occurs among high- or low-risk women. In addition, I explore the role of provider delivery practices in explaining the reduction in Cesarean births.

5.1 Results by Maternal Risk Factors

Cesarean birth is major surgery. As with other surgeries, Cesareans come with serious risks, such as infection, hemorrhage, and blood clots. In addition, Cesareans also have the potential to create long-term effects, such as damage to reproductive organs. Cesarean birth in one pregnancy often leads to future Cesarean births, with more than three-quarters of women with a history of Cesarean birth having a repeat Cesarean with future births (Osterman et al. (2020)). However, a Cesarean birth can also be a life-saving surgery and allow an infant to be born safely when a vaginal birth is otherwise unsafe. To minimize the potential risks and maximize the benefits, Cesareans should be performed only on women and infants who would face worse outcomes if delivery were to occur vaginally.

Since I cannot determine how women would have fared in their counterfactual delivery, I instead investigate if the reduction in Cesarean births occurs among both high- and low-risk women. If women who are observably high-risk experience a reduction in Cesarean deliveries following the maternity ward closure, the closure is impacting women for whom the costs of not receiving Cesareans are very high. On the other hand, if reductions are concentrated among women for whom Cesareans are less appropriate, this could suggest that unnecessary Cesareans have been reduced. In particular, ACOG highlights the rapid increase in Cesarean deliveries since the 1990s as evidence that Cesarean births may be overused among low-risk women (ACOG (2014)).

To assess risk levels, I follow Currie and MacLeod (2017) and estimate the following logistic model:

$$\text{Prob}\,(C_i = 1) = F(\beta X_i), \tag{2}$$

where C_i is an indicator if the birth was delivered via Cesarean and X_i are purely medical observable risk factors available consistently in the birth certificate data. The inputs used in the logit regression are the mother's age, birth order, previous Cesarean, the plurality of birth, breech presentation, blood pressure disorders (eclampsia, chronic hypertension, and gestational hypertension), and diabetes. I estimate the model on all births in the closure counties and the corresponding matched control counties.

The distribution of the estimated propensity scores, which can be viewed as the "appropriateness for a Cesarean," is displayed in Figure 6. The figure shows that most women who do not deliver via Cesarean have a propensity score below 0.30. For women who do deliver via Cesarean, there is a lot of mass both above 0.80 and below 0.30, highlighting that a considerable number of women with minimal observable risk factors receive a Cesarean.

I investigate how the reduction in Cesareans changes by the appropriateness for a Cesarean in Figure 7. Based on the distribution of Figure 6, I split women above and below the 0.30 cutoff based on their propensity scores derived from estimating Equation (2). I then re-estimate Equation (1) separately for both high- and low-risk women. The coefficients for the low-risk women are displayed in Panel (a), and for the high-risk women in Panel (b). The results from these figures are summarized in Table 5.

The decrease in the share of births delivered via Cesarean is only visible for women with low levels of risk. These women are the least appropriate candidates for a Cesarean, with an estimated propensity score of less than 0.30. The average post-period coefficient of -0.011 indicates that closure is associated with a reduction in the rate of Cesarean birth of roughly 1 percentage point. With a Cesarean rate of 16.3 percent for low-risk women, this represents a 6 percent decrease. High-risk women, on the other hand, do not experience a reduction in Cesarean births, as seen in Panel (b) of Figure 7.[23]

Since the reduction in Cesarean births is driven by low-risk women, the decrease in Cesarean births can be viewed as a benefit of closure. It would be worrying if the decrease was concentrated among the riskiest women, but this is reassuringly not the case. While I am unable to study outcomes such as maternal morbidity or mortality due to data limitations, I view the reduction in Cesarean births as a benefit since the reduction is concentrated among low-risk women and there are no adverse outcomes for infants.

[23]There is growing evidence that some factors on birth certificate data is misreported (Lydon-Rochelle et al. (2005), Martin et al. (2013), Luke et al. (2018), and Gemmill and Leonard (2022)). For the factors used in this analysis, there are cited concerns about diabetes and hypertensive disorders. I repeat the analysis without those factors and find similar results in Online Appendix Figure B30 and Online Appendix Table B1.

5.2 Impact of Provider Practice

A potential explanation for the reduction in Cesarean deliveries could be that providers in the hospitals that close have a higher propensity to perform Cesareans. There is considerable variation in the use of Cesarean birth across hospitals, ranging from 19 percent to 48 percent (Card et al. (2019)). If women are shifted from hospitals with a high Cesarean rate to hospitals with a low Cesarean rate, there could be a reduction in Cesarean deliveries due to exposure to different provider practices.

I begin by identifying what county women who experience a closure deliver in following closure. Since women may give birth in a number of counties following closure due to a combination of personal preference, geographic location, and insurance and provider networks, there could be several potential "receiving" counties. To have one receiving county per closure county, I create a "weighted receiving county," where the weights are determined by the share of closure county births occurring in each receiving county.[24]

To investigate if closure counties perform relatively more Cesareans, I plot the raw rates of Cesarean birth in closure and receiving counties leading up to the closure of the maternity ward in Figure 8. Panel (a) plots the average Cesarean rate in a closure county and a receiving county leading up to closure. Panel (b) plots the average Cesarean rate among low-risk women (i.e., women with a propensity score of less than 0.30) in a closure county and a receiving county leading up to closure, while Panel (c) plots the Cesarean rates among high-risk women. All panels are weighted by the relevant number of births occurring in a county. Closure counties have higher rates of Cesarean births.

To investigate the role of provider practice, I split my sample into three groups: (1) receiving county has a higher rate of Cesarean birth, (2) receiving county has a lower rate of Cesarean birth, and (3) receiving county has an approximately equal rate of Cesarean

[24] In particular, the set of potential receiving counties are the counties that have at least one birth from the closure county in each of the 5 years following closure. The weights are determined by dividing the number of births to women residing in counties that experience a closure in a specific receiving county by the total number of births to closure women in all potential receiving counties in the year following closure.

birth. To create these three groups, I first calculate the difference in the pre-closure rate of Cesarean births occurring in the closure and receiving counties. I then split this difference into terciles. The group where the receiving county has a higher rate has an average difference of 10.0 percentage points (range: 3.2 to 33.1 percentage points). The group where the receiving county has a lower rate has an average difference of −9.9 percentage points (range: −3.3 to −57.0 percentage points). The group where the closure and receiving county have approximately equal rates has an average difference of 0.0 percentage points (range: −3.3 to 3.0 percentage points). I re-estimate Equation (1) separately on each of the three groups.

I find the strongest reductions in Cesarean births when women shift from areas with a high rate of Cesarean births into areas with a low rate of Cesarean births. The point estimates for each tercile are shown in Figure 9 and summarized in Table 6. In Panel (a), where women are shifted from areas with high Cesarean rates to areas with low Cesarean rates, the average post-period coefficient suggests maternity ward closure is associated with approximately a 2.5 percentage point (7.6 percent) decrease in the rate of Cesarean birth following closure, relative to the matched control counties. I do not find a strong decrease in the other groups. The results from this section suggest that provider practice is important. The Cesarean rate decreases the most for women residing in counties that have a higher rate of Cesarean birth before closure relative to the receiving county.

6 Additional Results

6.1 Results by Access to Care

My results show that rural maternity ward closures do not lead to negative effects on health outcomes. To reconcile my null results with the concerns presented in the media, I perform a heterogeneity analysis looking at differential access to alternative maternity care. There may be negative effects of hospital closures in more remote areas where travel time to the nearest alternative is high.

To study if outcomes vary between more and less remote areas, I first determine what options women have following the maternity ward closure. I use two definitions of available alternatives since I am unable to observe a woman's exact residence in the birth certificate data. In the first measure, I use the AHA Annual Survey to determine how many hospitals provide maternity care in the counties surrounding the county that experiences a closure. In the second measure, I estimate the average distance a woman in a closure county would need to travel to the next closest hospital with a maternity ward. To do this, I use the center of population calculated by the U.S. Census Bureau based on the 2000 Census to get the population-weighted centroid of a closure county. I then calculate the travel distance to the nearest maternity ward using the hospital location information provided in the AHA Annual Survey. As discussed in Section 1.1, it can be challenging to identify which services a hospital provides in the AHA data due to nonresponse and mergers. Nevertheless, the AHA is the only data source that will enable an analysis on the number of nearby facilities and distances to facilities, so I use the information provided in the AHA to proxy for access.

I split the sample at the median level of access and estimate Equation (1) separately on counties above and below the median. Results for selected outcomes are displayed in Figure 10 and summarized in Tables 7 and 8. The remaining outcomes are available in Online Appendix Figures B31 to B33. The definition of access in panels (a), (c), and (e) is the number of hospitals with a maternity ward in adjacent counties, and above median access means the adjacent counties have an above-median number of hospitals with maternity wards. In panels (b), (d), and (f), I alternatively define access as the distance to the nearest hospital with a maternity ward, and above median access means the travel distance to the next closest maternity ward is small.

Before closure, a majority of women in both groups gave birth out-of-county. In more remote areas if there are not as many good options nearby, a woman may be more inclined to stick with her local hospital. On the other hand, a closure county that has more access to alternatives would likely have higher levels of out-of-county births before closure. If a woman does not need to travel very far or has many outside options, it will be easier for her to bypass her local hospital. If more women give birth in-county before closure, a maternity ward closure could have a larger impact compared to areas where fewer women give birth in-county. The dependent variable in panels (a) and (b) of Figure 10 is the share of births occurring out-of-county. In the period before closure, around 75 percent of women in low-access areas gave birth out of county compared to 81 percent of women in high-access areas. Interestingly, even if there are not as many nearby options, a majority of women are still bypassing the local hospital.

When access to alternatives is limited, women may be more likely to give birth outside of a maternity ward (e.g., a home birth or in a hospital without a maternity ward). Panels (c) and (d) plot the treat-control difference for the share of births occurring in a hospital with a maternity ward. The plot indicates the decrease in the share of births occurring in hospitals with a maternity ward is roughly similar, regardless of access to alternatives.

Since rates of Cesarean births significantly decreased in the baseline results, I plot the effect on Cesarean births by access levels in panels (e) and (f). Both levels of access see similar reductions in the rate of Cesarean births of around 4 to 6%.

While the baseline analysis and the analysis on heterogeneity by access to care do not suggest a negative effect, it is possible that a small group of women experience extreme adverse outcomes that are masked by the overall null effect. However, closures only affect complier women, who are already lower risk than women giving birth out of county prior to closure. Therefore, given the null effects for women in areas with lower levels of access and the relatively low-risk composition of complier women, it is unlikely that closures would have a significantly negative effect on birth outcomes.

6.2 Effects of Closure on Receiving Women

Having established the baseline impacts on women residing in the closure counties, I now turn to another potentially impacted group: women residing in the receiving counties. Women residing in the receiving counties could be impacted if the closure of a nearby hospital results in overcrowding, which could negatively impact the quality of care. However, as discussed in Section 2, this channel is likely to be small for rural closures since the number of births in a hospital before closure is relatively small. The results from estimating Equation (1) on the sample of receiving counties and their controls are summarized in Table 9. Detailed regression plots are available in Online Appendix Figures B34 to B36.

Since the number of women giving birth in a closure county is small relative to the receiving counties, closures are unlikely to generate overcrowding or other negative spillover effects. Out-of-county and out-of-hospital births could increase, and utilization of prenatal care could decrease, if receiving women were faced with more strained hospitals. However, the point estimates are small and insignificant, suggesting no effect. In addition, I find no impacts on the remaining outcomes for pregnancy, birth, or infant health. These results suggest rural closures can be easily absorbed into surrounding areas with little impact.

6.3 Results by Subgroup

Maternal and infant health in the United States lags behind other peer countries. Within the United States, disparities in maternal and infant health exist along racial, ethnic, and socioeconomic lines. The infant mortality rate for Black infants in 2018 was 10.8 per 1,000 live births, compared to 4.6 for non-Hispanic white infants (Ely and Driscoll (2020)). Maternity ward closures also disproportionately occur in counties with higher proportions of non-Hispanic Black women and lower median household incomes (Hung et al. (2017)).

In this section, I investigate if the loss of services exacerbated any existing disparities by looking at results across various subgroups. I look at heterogeneity by race and ethnicity (non-Hispanic Black and Hispanic), education (high school or below and more than college), and age (under 20 years old and more than 35 years old). I estimate Equation (1) on the sample of births in a county of the specified demographic characteristic, ensuring the analysis sample is fully balanced by dropping treat-control county pairs that lose balance in the subsample. The post-period average treat-control differences are summarized in Table 10, and the full regression plots are available in Online Appendix Figures B37 to B46.

Looking across the different samples, no demographic subgroup is particularly impacted by the maternity ward closures. The results for most demographic groups are consistent with the results found on average. Advanced maternal age (older than 35 years) is considered riskier than births in the 20 to 34 age range, with a higher prevalence of obstetric complications, maternal morbidities, and adverse infant health outcomes (Lisonkova et al. (2017)). I do not observe changes in out-of-hospital birth or birth in a hospital with a maternity ward for women aged above 35, suggesting that this group of "riskier" women is still delivering in a hospital with a maternity ward and an obstetrician.

7 Conclusion

This paper studies the impact of losing access to hospital-based maternity care on health outcomes for women and infants in rural areas. Advocates argue that increased travel distances harm women and infants by increasing out-of-hospital birth, reducing prenatal care, and increasing elective inductions, resulting in the "cascade of interventions" that ultimately ends in a Cesarean birth. Alternatively, maternity ward closures could benefit women if closures expose women to higher-quality providers and better-resourced hospitals.

To estimate the causal effect of maternity ward closures on birth outcomes, I employ a matched difference-in-differences design. I do not find support for the concerns raised above and instead find that closures appear to create a net benefit. I do not find that closures are associated with adverse health outcomes for infants. My results suggest the rate of Cesarean births decreases. Local provider practice plays an important role in the decrease in Cesarean births. Women who shift from areas that perform relatively more Cesarean births see the largest reductions. In addition, the decrease in Cesarean births is concentrated among low-risk women, suggesting the closures reduced unnecessary Cesarean procedures.

These results suggest the concern surrounding "maternity care deserts" may be missing an important component. It is important to have access to high-quality care for rural women, but the maternity ward closures that have naturally occurred in these areas do not have significant negative impacts on women or infants. Most women are bypassing these hospitals and are opting for an out-of-county birth before closure, suggesting that women already perceive the benefits of a different hospital to outweigh the costs of increased travel. Given the evidence on the costs of Cesarean birth, the results suggest the benefits of reductions in Cesarean birth likely outweigh the costs, especially given the null effects on infant health.[25]

A limitation of this study is the inability to study outcomes not present on the birth record. Closures could lead to adverse outcomes in the form of challenges with transportation or childcare, lack of communication between providers in the residence and delivery counties, and maternal stress due to the closure. The results of this paper suggest the benefits shifting to a higher-quality provider outweigh the costs of increased distance as measured by the outcomes on the birth certificates. However, future research and policy programs should address the potential adverse effects of these alternative outcomes.

The findings of this paper offer several takeaways for policy considerations. Closures are not always negative, and it may not be a worthwhile policy effort to ensure that all hospitals continue to provide maternity services without also considering the quality of the maternity ward. At the same time, while the results of this paper suggest null or positive effects of maternity ward closures, it is also possible that, as more maternity wards close, detrimental effects on maternal and infant health could arise. Policymakers need to balance the quality of existing maternity wards with access to care for women in areas with no maternity unit.

[25] Costs of Cesarean birth include financial costs, as well as health costs to the mother or infant. Cesarean births are more expensive than vaginal births (e.g., Podulka et al. (2011); Johnson et al. (2020)). A primary health concern for infants from Cesarean birth is respiratory complications (e.g., Hansen et al. (2008); Thavagnanam et al. (2008); Tollånes et al. (2008)). Some health costs to the mother include a higher risk of needing a blood transfusion, a higher risk of severe morbidity or mortality, and a higher risk of placenta complications in future pregnancies (e.g., Clark and Silver (2011)). See Card et al. (2019) for a full summary of recent literature on the costs of Cesarean birth.

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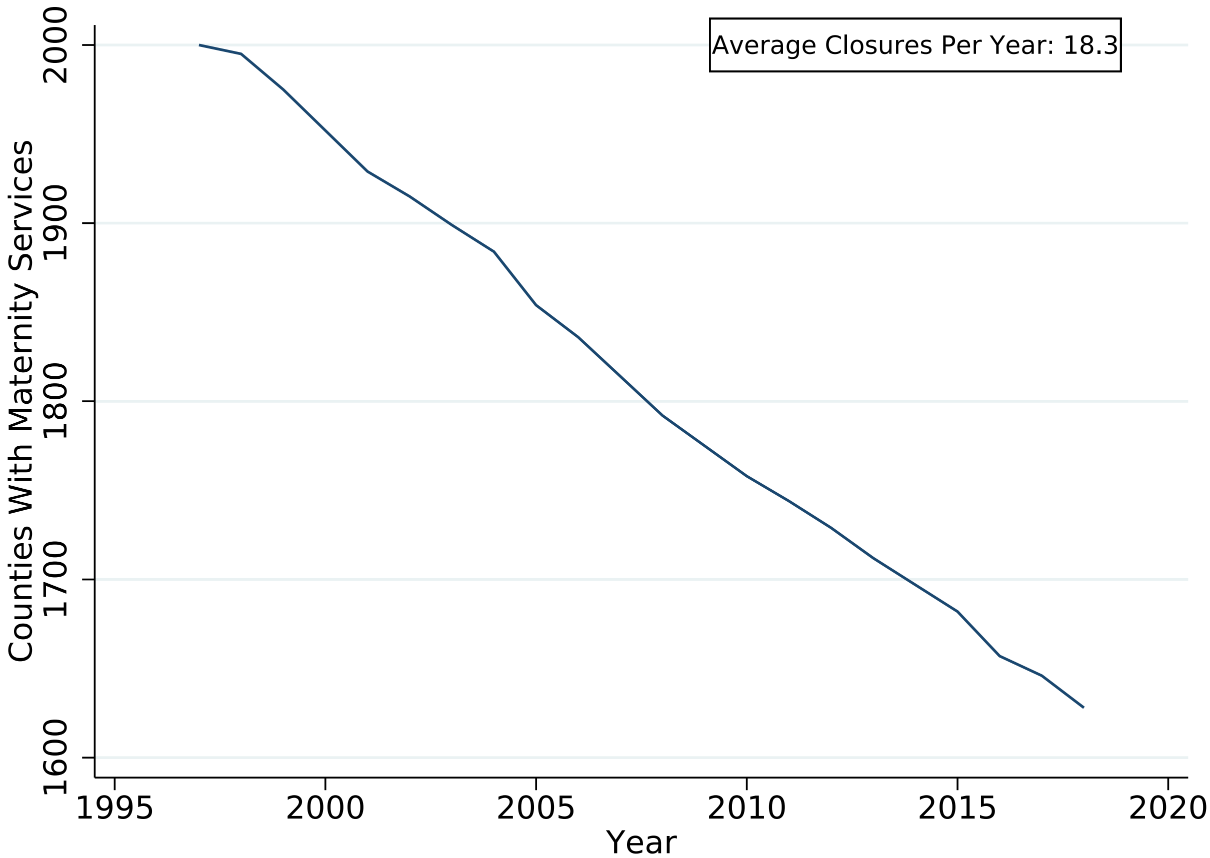
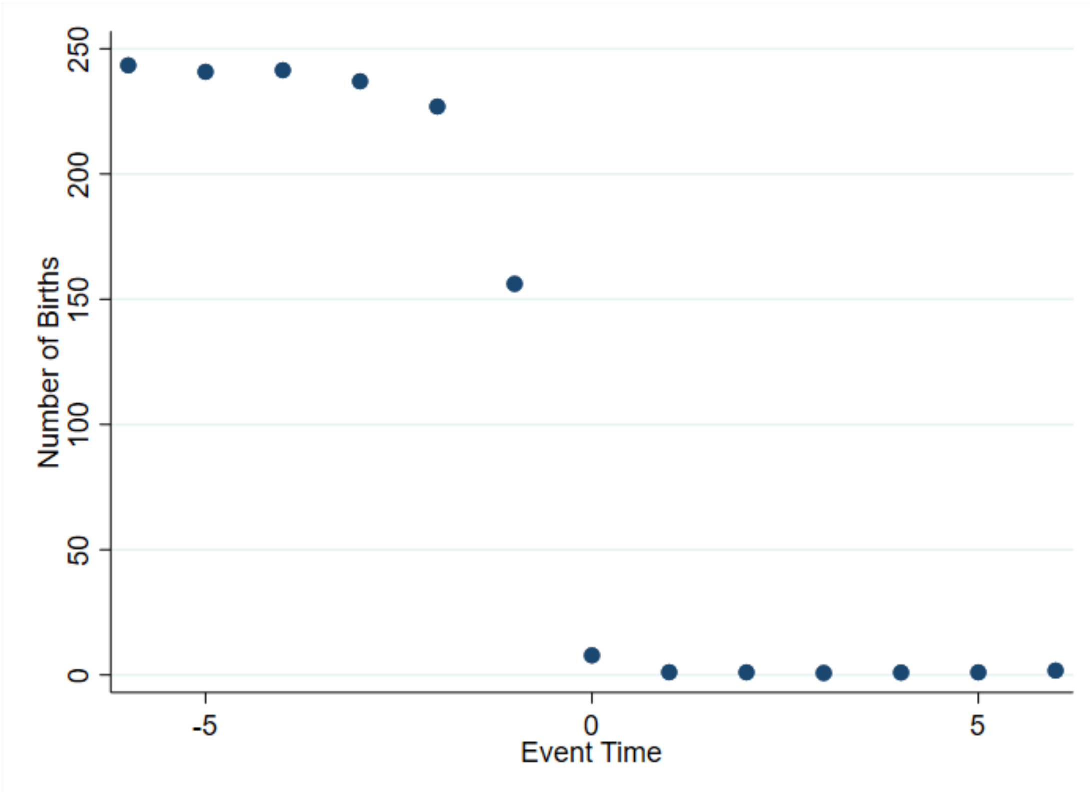
Figure 1: Number of Counties with Maternity Services



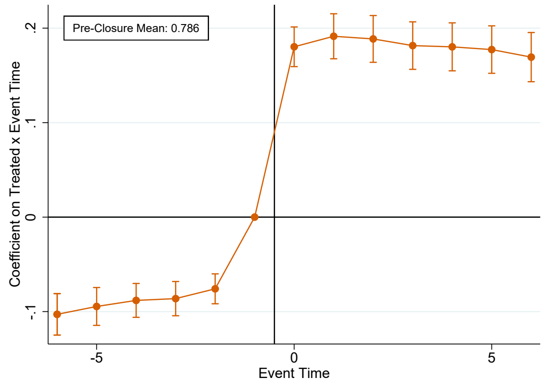
Note: This figure displays the number of counties with maternity services from 1997 to 2018. Counties are identified as offering maternity services based on the presence of hospital births in the county in the Vital Statistics data.

Figure 2: Births Occurring in a County Around Closure

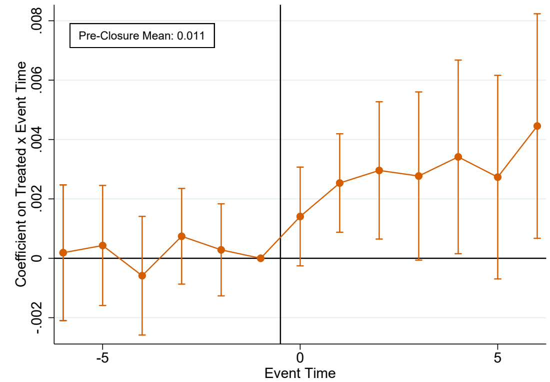


Note: This figure plots the average number of hospital births occurring in a county around the time of a county's identified year of closure. The sample consists of counties that experience a loss in maternity care services between 2002 and 2012. Since closures can occur at any point during the year, the drop observed at $t-1$ stems from the "partial closure" year.

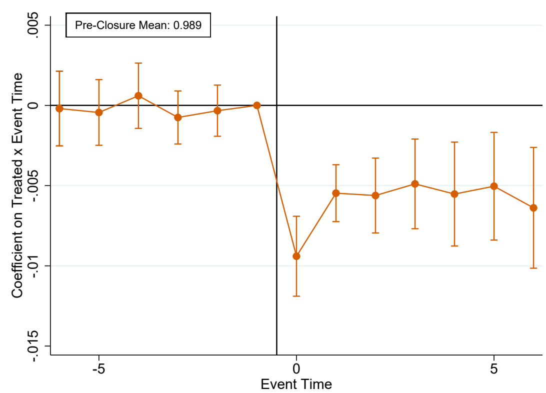
Figure 3: Estimated Impact of Closure on County Births



(a) Resident Births Occurring Out of County



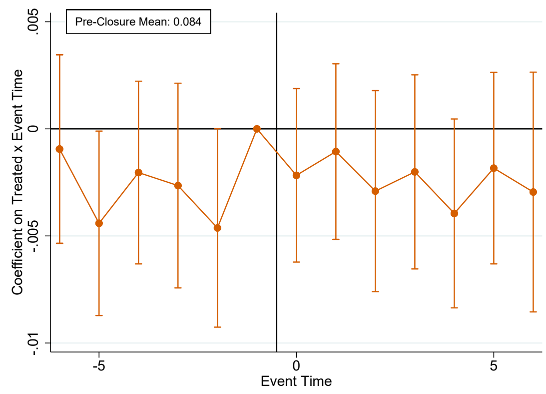
(b) Resident Births Occurring Out of Hospital



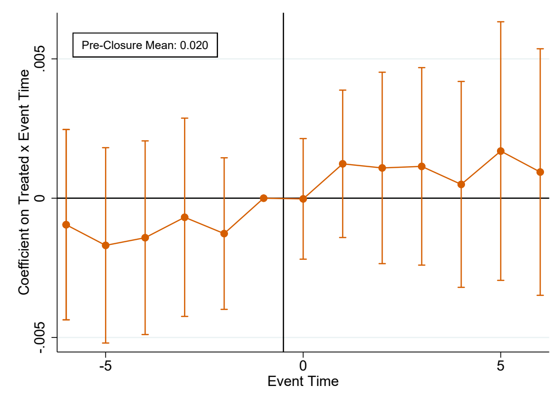
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level.

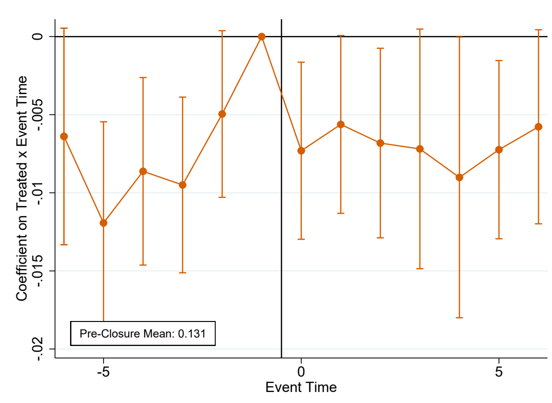
Figure 4: Estimated Impact of Closure on Infant Health



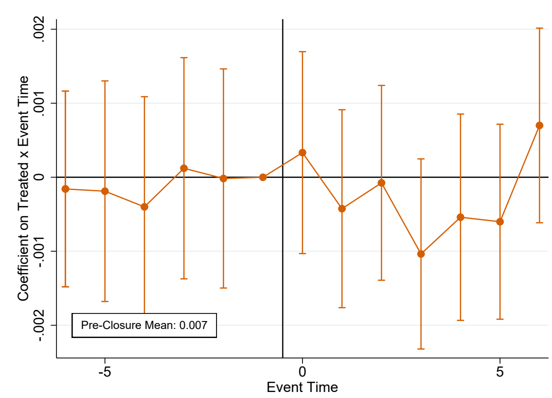
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



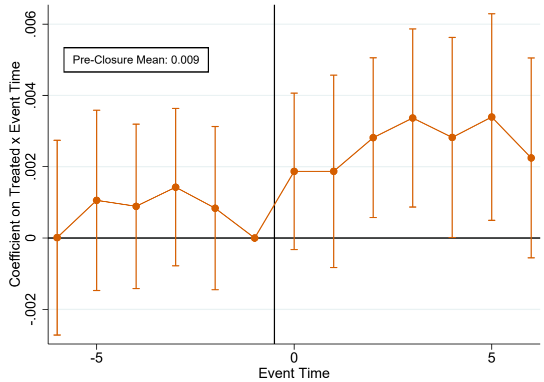
(c) Share of Births Preterm



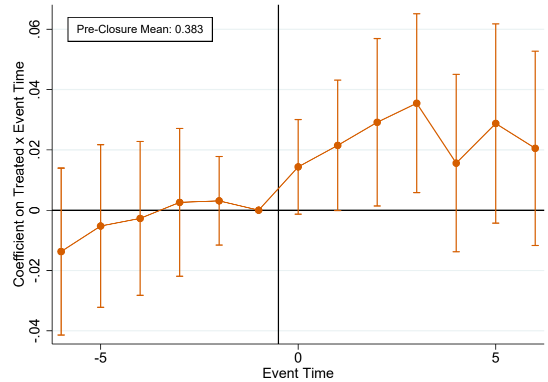
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level.

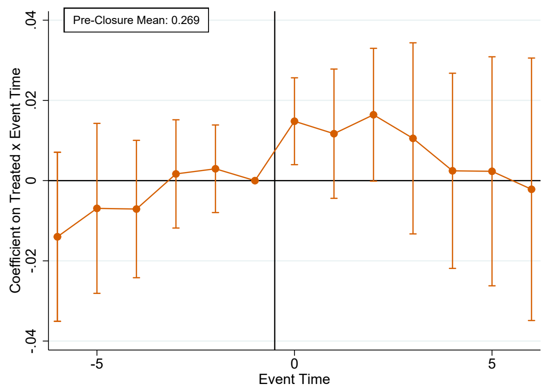
Figure 5: Estimated Impact of Closure on Pregnancy and Birth Outcomes



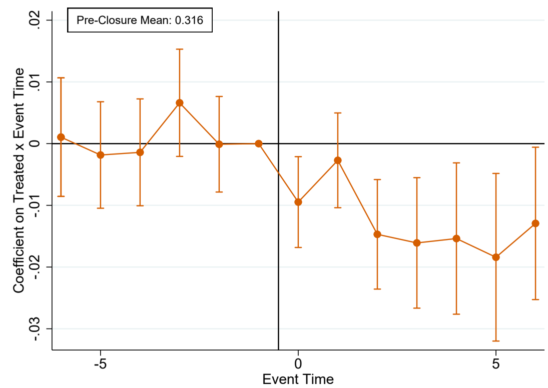
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



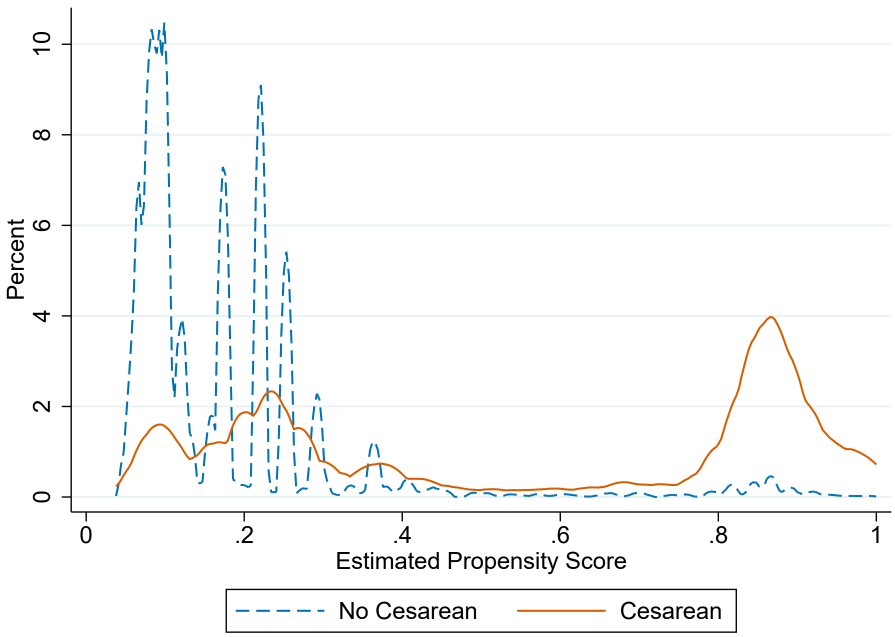
(c) Share of Births Induced



(d) Share of Births Delivered Via Cesarean

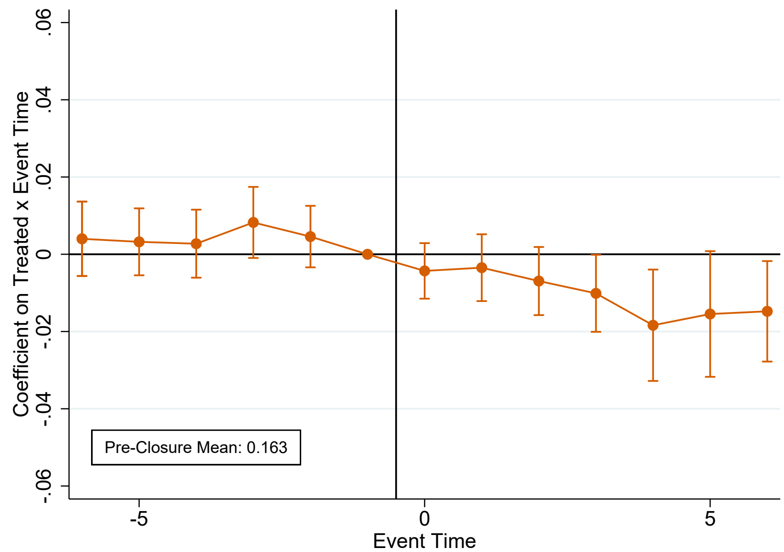
Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level.

Figure 6: Distribution of Estimated Propensity Scores by Delivery Method

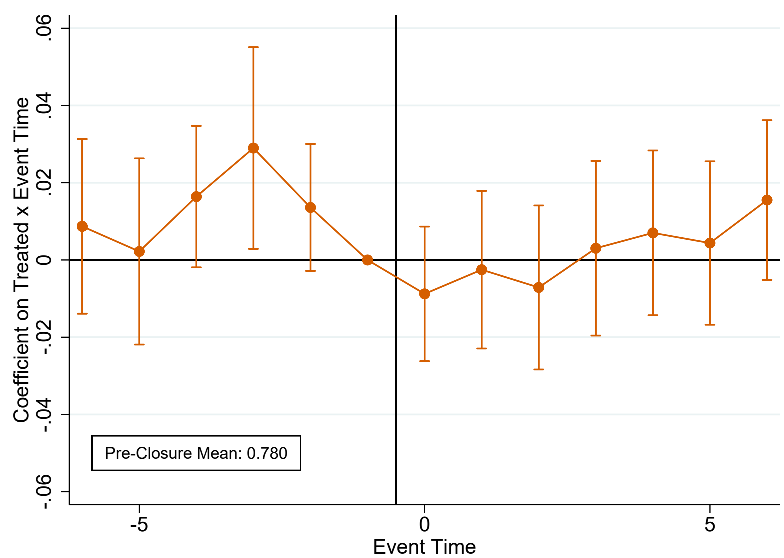


Note: This figure plots the kernel density of the estimated propensity scores from estimating Equation (2) for women who did deliver via Cesarean and for women who did not deliver via Cesarean. The sample consists of all women who reside in the closure and control counties.

Figure 7: Estimated Impact of Closure on Share of Births Delivered Via Cesearean by Pregnancy Risk



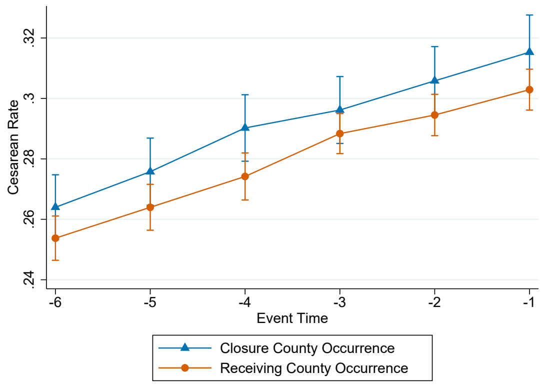
(a) Low-Risk Women



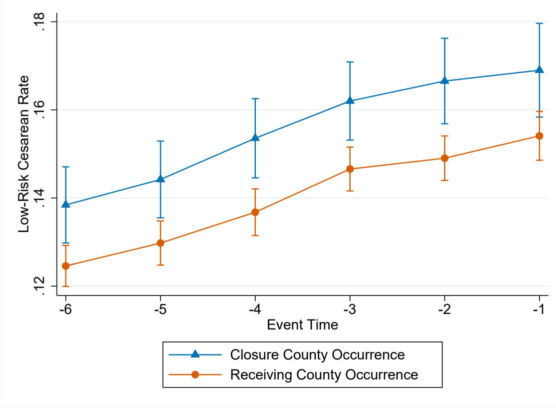
(b) High-Risk Women

Note: In Panels (a) and (b), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in both panels is the share of births delivered via Cesearean. Panel (a) is estimated on the sample of births in a county that falls below a predicted probability of Cesarean (PPC) of 0.30. Panel (b) is estimated on the sample of births in a county that falls above a PPC of 0.30. Observations are at the county-event time level and are clustered at the county level.

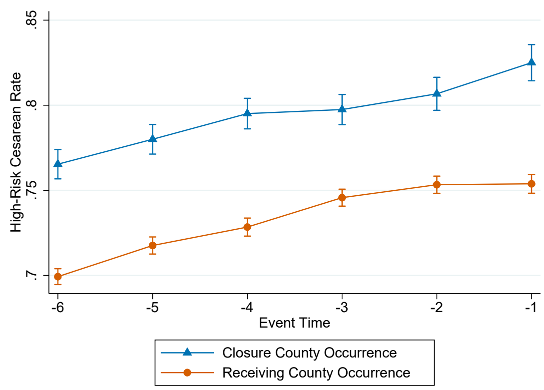
Figure 8: Rate of Cesarean Sections in Closure and Receiving Counties



(a) Cesarean Rate, Weighted By Births



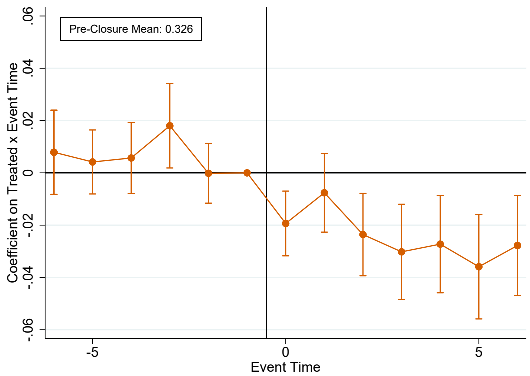
(b) Low-Risk Cesarean Rate, Weighted By Births



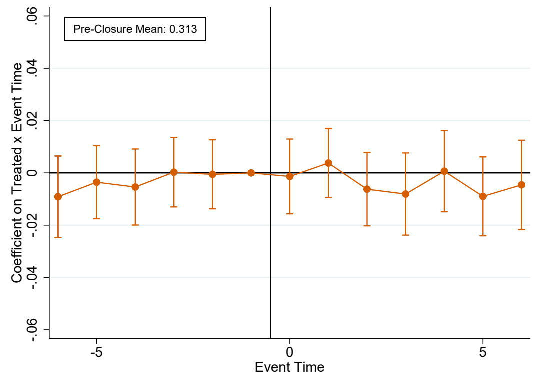
(c) High-Risk Cesarean Rate, Weighted By Births

Note: Each panel plots the Cesarean rates of closure counties and receiving counties in the years prior to closure. Panel (a) plots the average Cesarean rate of closure counties and receiving counties. Panel (b) plots the average low-risk Cesarean rate of closure counties and receiving counties and Panel (c) plots the average high-risk Cesarean rate of closure counties and receiving counties, where the cutoff for “low” vs. “high” risk is a predicted probability of a Cesarean of 0.30.

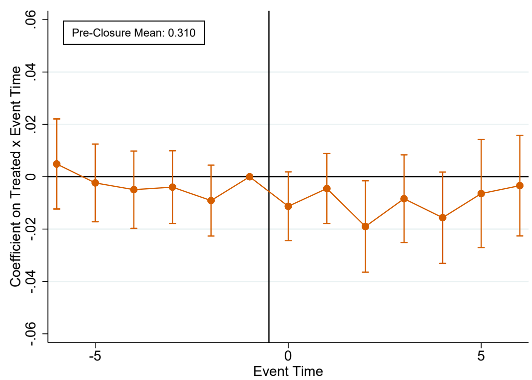
Figure 9: Impact of Closure on Cesarean Rates by Initial Differences in Sending and Receiving Counties



(a) Receiving County Cesarean Rate < Closing County Cesarean Rate



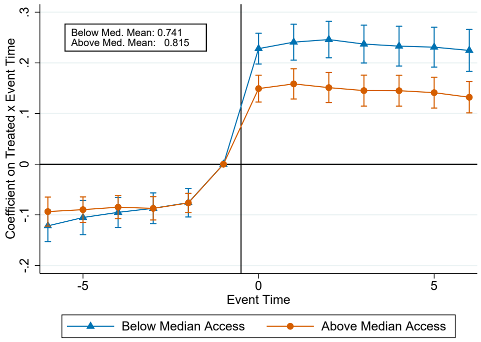
(b) Receiving County Cesarean Rate = Closing County Cesarean Rate



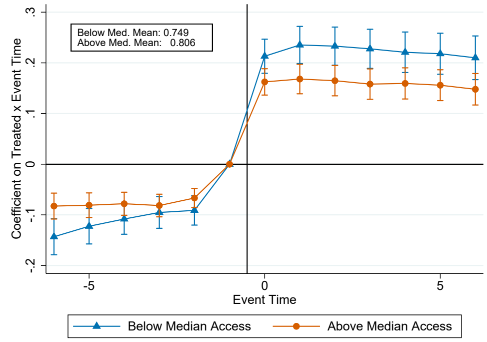
(c) Receiving County Cesarean Rate > Closing County Cesarean Rate

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in all panels is the share of births delivered via Cesarean. Each panel is estimated on the sample of births where the receiving county has a lower rate of Cesarean birth (Panel (a)), roughly the same rate of Cesarean birth (Panel (b)), or a higher rate of Cesarean birth (Panel (c)). Observations are at the county-event time level and are clustered at the county level.

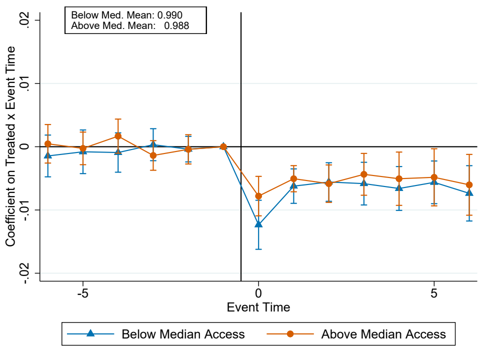
Figure 10: Estimated Impact of Closure on Selected Outcomes by Access to Alternatives



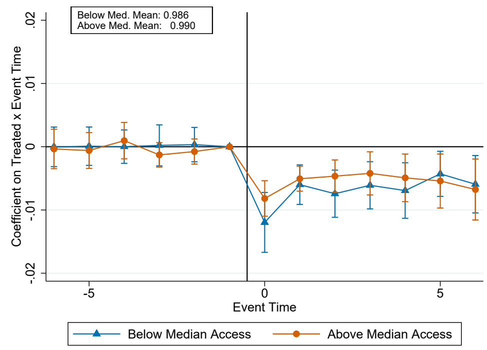
(a) Out-of-County Births, Number of Adjacent Options



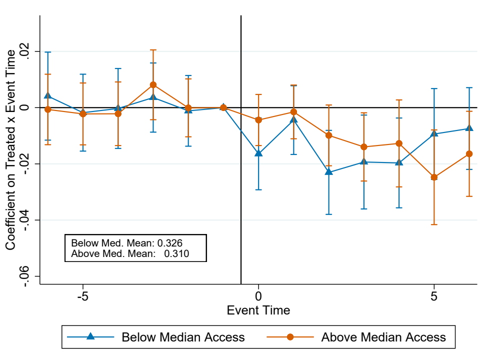
(b) Out-of-County Births, Distance to Alternative



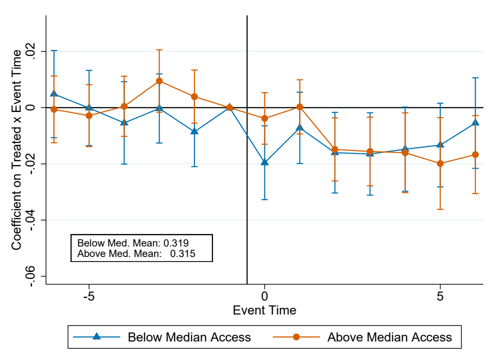
(c) Births in Hospital with Maternity Ward, Number of Adjacent Options



(d) Births in Hospital with Maternity Ward, Distance to Alternative



(e) Cesarean Rate, Number of Adjacent Options



(f) Cesarean Rate, Distance to Alternative

Note: Each point represents the treat-control difference from estimating Equation (1) by above/below median access to alternatives. The dependent variable in Panels (a) - (b) is the share of births occurring out of county, in Panels (c) - (d) is the share of births occurring out of hospital, and in Panels (e) - (f) is the share of births delivered via Cesarean. For each dependent variables, the sample is split above/below median based on access to available alternatives, measured as the number of hospitals with maternity wards in adjacent counties (Panels (a), (c), and (e)) or as the distance to the nearest hospital with a maternity ward (Panels (b), (d), and (f)). Observations are at the county-event time level and are clustered at the county level.

Table 1: Summary Statistics

	(1) Closure	(2) Never Open	(3) Always Open
Population	22,725	13,988	151,669
% Female 18-44	19.9	19.7	21.7
% Black	8.8	9.6	8.2
% College	19.0	18.3	25.7
Unemployment Rate	6.1	6.2	5.7
Number of Establishments	484	267	3,840
Per Capita Income	17,631	17,198	20,411
Per Capita Transfers	3,626	3,511	3,300
N	414	1,081	1,580

Note: This table displays summary statistics for counties that experience a maternity ward closure between 1996 and 2018 (Column 1)), counties that are always open between 1996 and 2018 (Column 2), and counties that are never open between 1996 and 2018 (Column 3). Data is for the year 1995 and comes from various sources: the County Business Patterns, the BEA's Regional Economic Information System, and the Census. The college completion data is from the 2000 Census.

Table 2: Summary Statistics of Matched Treatment and Control Counties

	(1) Treated	(2) Control	(3) p-value
Panel A: Matched Characteristics			
Population	21,709	31,081	0.1318
	(18,765)	(87,757)	
Pct. Female 18-44	19.9	20.1	0.3834
	(2.4)	(1.9)	
Pct. Black	8.6	8.7	0.9539
	(15.7)	(14.7)	
Pct. College	19.5	18.9	0.2670
	(6.0)	(5.1)	
Unemployment Rate	5.9	6.4	0.0939
	(2.7)	(3.3)	
No. of Establishments	470	616	0.0457
	(371)	(983)	
Per Capita Income	17,814	17,588	0.3348
	(2,467)	(2,312)	
Per Capita Transfers	3,579	3,592	0.8344
	(613)	(631)	
Panel B: Not Matched Characteristics			
Rural Status	80.4	88.0	0.0319
	(39.8)	(32.5)	
Fam. Med. MDs Per 10,000 (2001)	3.2	3.4	0.6090
	(2.3)	(2.3)	
OBGYNs Per 10,000 (2001)	0.3	0.6	0.0003
	(0.7)	(0.9)	
N	209	209	

Note: This table reports descriptive statistics of counties that experience a complete loss in maternity care services (treated counties, Column (1)) and their matched control counties (Column (2)). Column (3) reports the p-value from a t-test on the means. Counties are matched using propensity score matching as described in the text using pre-closure data. In Panel A, all data is from 1995 except "Pct. College," which reflects the percent with a bachelor's degree in the 2000 Census. In Panel B, rural status uses the 2003 definition of rurality from OMB and data on the number of MDs comes from the HRSA's 2001 AHRF.

Table 3: Estimated Effects of Closure

	(1)	(2)	(3)
Panel A: Birthing Location			
Share Out-of-County Births [0.786]	0.180***	0.177***	0.181***
	(0.011)	(0.013)	(0.012)
Share Out-of-Hospital Births [0.011]	0.001*	0.003	0.003**
	(0.001)	(0.002)	(0.001)
Share In Hospital w/ Maternity [0.989]	-0.009***	-0.005***	-0.006***
	(0.001)	(0.002)	(0.001)
Panel B: Characteristics of Pregnancy and Birth			
Share With One or Fewer Prenatal Visits [0.009]	0.002*	0.003**	0.003**
	(0.001)	(0.001)	(0.001)
Share With Low Prenatal Visits ($\leq$ 10) [0.383]	0.014*	0.029*	0.024**
	(0.008)	(0.017)	(0.012)
Share Induced [0.269]	0.015***	0.002	0.008
	(0.006)	(0.015)	(0.010)
Share C-Section [0.316]	-0.009**	-0.018***	-0.013***
	(0.004)	(0.007)	(0.004)
Panel C: Infant Health			
Share Low Birth Weight [0.084]	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
Share Apgar Less Than 7 [0.020]	-0.000	0.002	0.001
	(0.001)	(0.002)	(0.001)
Share Preterm [0.131]	-0.007**	-0.007**	-0.007***
	(0.003)	(0.003)	(0.003)
Infant Mortality Rate [0.007]	0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
Observations	9,607	9,607	9,607
Clusters	418	418	418
County FE	Yes	Yes	Yes
Event Time FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table presents results from estimating Equation (1). Each row represents a separate regression with the dependent variable specified in the row. The estimated effects in Columns 1, 2, and 3 correspond to β_0, β_5, and the post-period average of the β_τ coefficients. The treatment group's average of the dependent variable in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.

Table 4: Robustness of Baseline Results

	(1) Baseline	(2) Always Closed	(3) Late Closure	(4) Calloway-Sant'Anna	(5) Trend	(6) Year Before	(7) Include OBGYNs	(8) Closure Def. ≤ 2	(9) Closure Def. ≤ 8
Panel A: Birthing Location									
Share Out-of-County Births	0.181***	0.197***	0.159***	0.202***	0.182***	0.181***	0.195***	0.142***	0.160***
	(0.012)	(0.011)	(0.016)	(0.007)	(0.012)	(0.013)	(0.013)	(0.014)	(0.011)
	[0.786]	[0.787]	[0.684]	[0.786]	[0.786]	[0.786]	[0.786]	[0.838]	[0.808]
Share Out-of-Hospital Births	0.003**	0.000	0.000	0.002***	0.002**	0.001	0.001	0.002**	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.011]	[0.011]	[0.011]	[0.015]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]
Share In Hospital w/ Maternity	-0.006***	-0.004***	-0.004***	-0.010***	-0.005***	-0.004***	-0.004***	0.002*	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.989]	[0.989]	[0.989]	[0.985]	[0.989]	[0.989]	[0.989]	[0.983]	[0.989]
Panel B: Characteristics of Pregnancy and Birth									
Share With One or Fewer Prenatal Visits	0.002*	0.001	0.002	0.001	0.002**	0.002*	0.002*	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.009]	[0.009]	[0.010]	[0.012]	[0.009]	[0.009]	[0.009]	[0.009]	[0.010]
Share With Low Prenatal Visits (≤ 10)	0.043**	0.011	0.012	0.014***	0.017	0.019*	0.020**	0.020	0.013
	(0.017)	(0.011)	(0.014)	(0.005)	(0.011)	(0.010)	(0.010)	(0.012)	(0.011)
	[0.382]	[0.383]	[0.397]	[0.388]	[0.382]	[0.382]	[0.382]	[0.377]	[0.385]
Share Induced	0.008	0.010	0.018*	0.011***	0.019**	0.016**	0.018**	0.013*	0.003
	(0.010)	(0.009)	(0.010)	(0.004)	(0.008)	(0.008)	(0.008)	(0.007)	(0.009)
	[0.269]	[0.270]	[0.264]	[0.273]	[0.269]	[0.269]	[0.269]	[0.275]	[0.276]
Share C-Section	-0.013***	-0.018***	-0.010*	-0.015***	-0.014***	-0.011***	-0.012***	-0.013***	-0.011**
	(0.004)	(0.006)	(0.006)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
	[0.316]	[0.317]	[0.305]	[0.307]	[0.316]	[0.316]	[0.316]	[0.317]	[0.315]
Panel C: Infant Health									
Share Low Birth Weight	-0.002	-0.003*	0.001	-0.002	-0.004**	-0.003	-0.004**	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	[0.084]	[0.084]	[0.082]	[0.082]	[0.084]	[0.084]	[0.084]	[0.081]	[0.083]
Share Apgar Less Than 7	0.001	0.001	0.000	-0.000	0.002	-0.002	-0.001	-0.001	0.002
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.020]	[0.020]	[0.016]	[0.020]	[0.020]	[0.020]	[0.020]	[0.020]	[0.020]
Share Preterm	-0.007***	-0.004*	-0.000	0.000	-0.004*	-0.004	-0.004*	-0.006**	-0.007***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
	[0.131]	[0.131]	[0.132]	[0.125]	[0.131]	[0.131]	[0.131]	[0.129]	[0.131]
Infant Mortality Rate	-0.000	0.001*	-0.001	0.001	0.001	0.000	-0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.007]	[0.007]	[0.007]	[0.006]	[0.007]	[0.007]	[0.007]	[0.006]	[0.006]
Observations	9,607	9,518	4,827	71,781	9,564	9,564	9,607	8,599	9,564
Clusters	418	414	210	3,124	416	416	418	374	416

Note: This table presents results from estimating Equation (1). Each estimate represents a $\overline{\beta}_\tau$ coefficient from a separate regression with the dependent variable specified in the row. Column 1 reproduces the baseline results. Column 2 changes the control group to counties that never have an open maternity ward during the study period. Column 3 changes the control group to counties that experience a closure later in the sample period. Column 4 employs a Calloway and Sant'Anna style regression. Column 5 matches on the 3-year trend of matching variables. Column 6 matches on the matching variables values in the year prior to closure. Column 7 includes OBGYNs per capita as a matching variable. Column 8 changes the closure definition to allow for 2 or fewer hospital births in a closure county following closure. Column 9 changes the closure definition to allow for 8 or fewer hospital births in a closure county following closure. The treatment group's average of the dependent variable in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. All regressions include county, event time, and birth year fixed effects. Stars report statistical significance: *** = p-value $<$ 0.01, ** = p-value $<$ 0.05, * = p-value $<$ 0.1.

Table 5: Estimated Effect of Closure on Cesarean Rates by Pregnancy Risk

	(1)	(2)	(3)
Panel A: Below Median Risk			
Estimated Effect [0.163]	-0.004	-0.016*	-0.011**
	(0.004)	(0.008)	(0.004)
Observations	9,557	9,557	9,557
Clusters	418	418	418
Panel B: Above Median Risk			
Estimated Effect [0.780]	-0.009	0.004	0.002
	(0.009)	(0.011)	(0.008)
Observations	9,531	9,531	9,531
Clusters	418	418	418
County FE	Yes	Yes	Yes
Event Time FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table presents results from estimating Equation (1) with the dependent variable being the rate of Cesarean births in a county. Panel A estimates (1) for low-risk women (Predicted Probability of Cesarean ≤ 0.30) and Panel B estimates (1) for high-risk women (PPC > 0.30). The estimated effects in Columns 1, 2, and 3 correspond to β_0, β_5, and the post-period average of the β_τ coefficients, respectively. The treatment group's average Cesarean rate in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.

Table 6: Estimated Effect of Closure on Cesarean Rates by Differences in Closure and Receiving County

	(1)	(2)	(3)
Panel A: Receiving County Has Lower C-Section Rate			
Estimated Effect [0.326]	-0.019***	-0.036***	-0.025***
	(0.006)	(0.010)	(0.007)
Observations	3,174	3,174	3,174
Clusters	138	138	138
Panel B: Receiving County Has Similar C-Section Rate			
Estimated Effect [0.313]	-0.001	-0.009	-0.004
	(0.007)	(0.008)	(0.006)
Observations	3,171	3,171	3,171
Clusters	138	138	138
Panel C: Receiving County Has Higher C-Section Rate			
Estimated Effect [0.310]	-0.011*	-0.006	-0.010
	(0.007)	(0.010)	(0.007)
Observations	3,174	3,174	3,174
Clusters	138	138	138
County FE	Yes	Yes	Yes
Event Time FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table presents results from estimating Equation (1) with the dependent variable being the rate of Cesarean births in a county. Each row represents a separate regression of Equation (1) based on initial differences in Cesarean rates between closure and receiving counties. The estimated effects in Columns 1, 2, and 3 correspond to β_0, β_5, and the post-period average of the β_τ coefficients, respectively. The treatment group's average Cesarean rate in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value $<$ 0.01, ** = p-value $<$ 0.05, * = p-value $<$ 0.1.

Table 7: Estimated Effects of Closure on Women By Alternatives in Adjacent County

	Above Median Access			Below Median Access		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Birthing Location						
Share Out-of-County Births	0.149***	0.141***	0.146***	0.228***	0.231***	0.234***
	(0.013)	(0.015)	(0.015)	(0.015)	(0.020)	(0.018)
	[0.815]	[0.815]	[0.815]	[0.741]	[0.741]	[0.741]
Share Out-of-Hospital Births	0.001	0.003	0.003*	0.003**	0.003*	0.003***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
	[0.012]	[0.012]	[0.012]	[0.010]	[0.010]	[0.010]
Share Share In Hospital w/ Maternity	-0.008***	-0.005**	-0.006***	-0.012***	-0.006***	-0.007***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
	[0.988]	[0.988]	[0.988]	[0.990]	[0.990]	[0.990]
Panel B: Characteristics of Pregnancy and Birth						
Share With One or Fewer Prenatal Visits	0.002	0.004*	0.003*	0.001	0.003	0.002*
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
	[0.009]	[0.009]	[0.009]	[0.010]	[0.010]	[0.010]
Share With Low Prenatal Visits (≤ 10)	0.014	0.024	0.020	0.015	0.041*	0.032*
	(0.011)	(0.025)	(0.018)	(0.011)	(0.022)	(0.017)
	[0.367]	[0.367]	[0.367]	[0.404]	[0.404]	[0.404]
Share Induced	0.022***	0.004	0.010	0.003	0.001	0.006
	(0.007)	(0.020)	(0.013)	(0.009)	(0.014)	(0.010)
	[0.263]	[0.263]	[0.263]	[0.280]	[0.280]	[0.280]
Share C-Section	-0.004	-0.025***	-0.012**	-0.016**	-0.009	-0.014**
	(0.005)	(0.009)	(0.005)	(0.006)	(0.008)	(0.006)
	[0.310]	[0.310]	[0.310]	[0.326]	[0.326]	[0.326]
Panel C: Infant Health						
Share Low Birth Weight	-0.003	-0.004	-0.003	-0.000	0.001	-0.001
	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
	[0.081]	[0.081]	[0.081]	[0.089]	[0.089]	[0.089]
Share Apgar Less Than 7	-0.002	-0.001	-0.002	-0.003*	-0.002	-0.003
	(0.004)	(0.005)	(0.004)	(0.002)	(0.003)	(0.002)
	[0.020]	[0.020]	[0.020]	[0.020]	[0.020]	[0.020]
Share Preterm	-0.006*	-0.008**	-0.008**	-0.008	-0.005	-0.005
	(0.003)	(0.004)	(0.003)	(0.005)	(0.005)	(0.004)
	[0.127]	[0.127]	[0.127]	[0.137]	[0.137]	[0.137]
Infant Mortality Rate	0.001	-0.000	0.000	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.006]	[0.006]	[0.006]	[0.008]	[0.008]	[0.008]
Observations	4,370	4,370	4,370	5,237	5,237	5,237
Clusters	190	190	190	228	228	228

Note: This table presents results from estimating Equation (1) for women based on their access to alternatives in adjacent county. Each row represents a separate regression of Equation (1) with the dependent variable specified in the row. The sample in columns 1-3 are counties with above-median access and in columns 4-6 are counties with below-median access. The estimated effects in Columns 1/4, 2/5, and 3/6 correspond to β_0, β_5, and the post-period average of the β_τ coefficients, respectively. The treatment group's average of the dependent variable in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.

Table 8: Estimated Effects of Closure on Women By Travel Distance to Nearest Maternity Ward

	Above Median Access			Below Median Access		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Birthing Location						
Share Out-of-County Births	0.162***	0.156***	0.159***	0.213***	0.218***	0.223***
	(0.013)	(0.015)	(0.015)	(0.017)	(0.021)	(0.019)
	[0.806]	[0.806]	[0.806]	[0.749]	[0.749]	[0.749]
Share Out-of-Hospital Births	0.002**	0.004*	0.004**	-0.000	0.000	0.002
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
	[0.010]	[0.010]	[0.010]	[0.014]	[0.014]	[0.014]
Share Share In Hospital w/ Maternity	-0.008***	-0.005**	-0.006***	-0.012***	-0.004**	-0.007***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
	[0.990]	[0.990]	[0.990]	[0.986]	[0.986]	[0.986]
Panel B: Characteristics of Pregnancy and Birth						
Share With One or Fewer Prenatal Visits	0.002	0.003*	0.003*	0.002	0.003	0.003**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
	[0.008]	[0.008]	[0.008]	[0.011]	[0.011]	[0.011]
Share With Low Prenatal Visits ($\leq$ 10)	0.015	0.008	0.011	0.013	0.054**	0.039**
	(0.011)	(0.023)	(0.017)	(0.012)	(0.022)	(0.016)
	[0.359]	[0.359]	[0.359]	[0.424]	[0.424]	[0.424]
Share Induced	0.015**	-0.004	0.008	0.012	0.012	0.007
	(0.007)	(0.019)	(0.013)	(0.008)	(0.014)	(0.010)
	[0.263]	[0.263]	[0.263]	[0.282]	[0.282]	[0.282]
Share C-Section	-0.004	-0.020**	-0.012**	-0.020***	-0.013*	-0.013**
	(0.005)	(0.008)	(0.005)	(0.007)	(0.008)	(0.006)
	[0.315]	[0.315]	[0.315]	[0.319]	[0.319]	[0.319]
Panel C: Infant Health						
Share Low Birth Weight	-0.003	-0.004	-0.003	-0.000	0.002	-0.000
	(0.003)	(0.003)	(0.002)	(0.004)	(0.004)	(0.003)
	[0.084]	[0.084]	[0.084]	[0.083]	[0.083]	[0.083]
Share Apgar Less Than 7	0.001	0.002	0.002	-0.003	-0.002	-0.004*
	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
	[0.019]	[0.019]	[0.019]	[0.023]	[0.023]	[0.023]
Share Preterm	-0.007*	-0.010***	-0.010***	-0.008*	-0.003	-0.002
	(0.004)	(0.004)	(0.003)	(0.005)	(0.005)	(0.004)
	[0.132]	[0.132]	[0.132]	[0.129]	[0.129]	[0.129]
Infant Mortality Rate	0.001	-0.000	0.000	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.006]	[0.006]	[0.006]	[0.008]	[0.008]	[0.008]
Observations	4,686	4,686	4,686	4,921	4,921	4,921
Clusters	204	204	204	214	214	214

Note: This table presents results from estimating Equation (1) for women based on their travel distance to the closest maternity ward following closure. Each row represents a separate regression of Equation (1) with the dependent variable specified in the row. The sample in columns 1-3 are counties with above-median access and in columns 4-6 are counties with below-median access. The estimated effects in Columns 1/4, 2/5, and 3/6 correspond to β_0, β_5, and the post-period average of the β_τ coefficients, respectively. The treatment group's average of the dependent variable in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.

Table 9: Estimated Effects of Closure on Women in Receiving Counties

	(1)	(2)	(3)
Panel A: Birthing Location			
Share Out-of-County Births [0.102]	-0.003	0.009	0.002
	(0.007)	(0.010)	(0.008)
Share Out-of-Hospital Births [0.005]	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Share In Hospital w/ Maternity [0.994]	0.001	0.005**	0.003
	(0.001)	(0.002)	(0.001)
Panel B: Characteristics of Pregnancy and Birth			
Share With One or Fewer Prenatal Visits [0.009]	0.002	0.001	0.001
	(0.002)	(0.002)	(0.001)
Share With Low Prenatal Visits ($\leq$ 10) [0.390]	0.003	0.031	0.023
	(0.007)	(0.036)	(0.024)
Share Induced [0.273]	0.009	0.013	0.013
	(0.012)	(0.016)	(0.012)
Share C-Section [0.291]	0.002	0.005	0.006
	(0.005)	(0.010)	(0.009)
Panel C: Infant Health			
Share Low Birth Weight [0.088]	-0.001	-0.001	0.001
	(0.002)	(0.002)	(0.002)
Share Apgar Less Than 7 [0.018]	-0.001	0.002	0.001
	(0.001)	(0.003)	(0.002)
Share Preterm [0.138]	-0.004*	-0.006*	-0.004
	(0.002)	(0.004)	(0.003)
Infant Mortality Rate [0.006]	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.000)
Observations	4,324	4,324	4,324
Clusters	188	188	188
County FE	Yes	Yes	Yes
Event Time FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table presents results from estimating Equation (1) for women residing in receiving counties as described in the text. Each row represents a separate regression of Equation (1) with the dependent variable specified in the row. The estimated effects in Columns 1, 2, and 3 correspond to β_0, β_5, and the post-period average of the β_τ coefficients, respectively. The treatment group's average of the dependent variable in event time $\tau = -1$ is displayed next to the dependent variable in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.

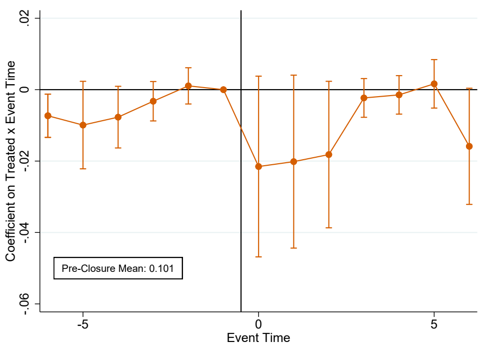
Table 10: Estimated Effects of Closure on Women By Demographic Subgroup

	US-Born Black (1)	US-Born Hispanic (2)	High School & Below (3)	College & Above (4)	Less Than 20 Years (5)	More Than 35 Years (6)
Panel A: Birthing Location						
Share Out-of-County Births	0.316***	0.155***	0.228***	0.066***	0.269***	0.133***
	(0.033)	(0.023)	(0.014)	(0.010)	(0.016)	(0.013)
	[0.655]	[0.822]	[0.744]	[0.906]	[0.715]	[0.830]
Share Out-of-Hospital Births	0.005***	0.004	0.005**	0.001	0.002	0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)	(0.003)
	[0.002]	[0.006]	[0.014]	[0.009]	[0.003]	[0.022]
Share In Hospital w/ Maternity	-0.012***	-0.009***	-0.009***	-0.003	-0.006***	-0.004
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
	[0.998]	[0.994]	[0.985]	[0.991]	[0.997]	[0.978]
Panel B: Characteristics of Pregnancy and Birth						
Share With One or Fewer Prenatal Visits	0.003	0.009***	0.002*	0.001	0.004**	0.002
	(0.004)	(0.004)	(0.001)	(0.001)	(0.002)	(0.002)
	[0.017]	[0.009]	[0.013]	[0.003]	[0.009]	[0.009]
Share With Low Prenatal Visits ($\leq$ 10)	0.084***	0.085***	0.047***	0.064***	0.049***	0.047**
	(0.028)	(0.026)	(0.017)	(0.024)	(0.016)	(0.024)
	[0.440]	[0.473]	[0.437]	[0.285]	[0.443]	[0.372]
Share Induced	0.020	-0.006	-0.002	0.001	0.014	0.005
	(0.017)	(0.017)	(0.012)	(0.011)	(0.012)	(0.013)
	[0.207]	[0.233]	[0.273]	[0.274]	[0.288]	[0.240]
Share Cesarean	-0.018*	-0.049***	-0.012**	-0.007	-0.015**	-0.013
	(0.010)	(0.018)	(0.005)	(0.007)	(0.007)	(0.009)
	[0.334]	[0.314	[0.298]	[0.332]	[0.250]	[0.416]
Panel C: Infant Health						
Share Low Birth Weight	0.011	-0.015	-0.001	0.002	0.003	-0.006
	(0.007)	(0.010)	(0.003)	(0.004)	(0.004)	(0.006)
	[0.149]	[0.088]	[0.092]	[0.063]	[0.093]	[0.100]
Share Apgar Less Than 7	0.003	-0.006	0.001	-0.002	-0.001	-0.001
	(0.004)	(0.006)	(0.002)	(0.003)	(0.002)	(0.003)
	[0.029]	[0.024]	[0.022]	[0.017]	[0.025]	[0.023]
Share Preterm	-0.003	-0.017	-0.004	-0.009*	-0.000	-0.010
	(0.007)	(0.011)	(0.003)	(0.005)	(0.005)	(0.007)
	[0.205]	[0.135]	[0.137]	[0.111]	[0.139]	[0.159]
Infant Mortality Rate	0.001	-0.006**	0.000	0.001	-0.001	-0.001
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)
	[0.013]	[0.010]	[0.007]	[0.003]	[0.009]	[0.007]
Observations	3,334	3,216	8,672	8,667	9,235	8,916
Clusters	146	141	378	378	402	388

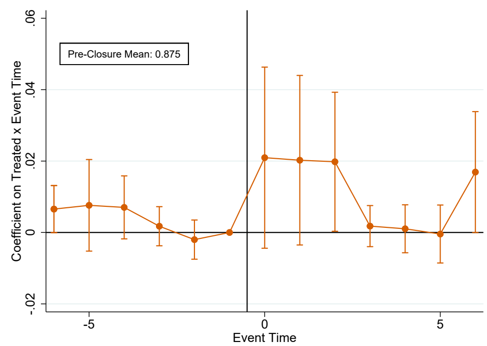
Note: This table presents results from estimating Equation (1) for women based on their demographic subgroup. Each coefficient represents the $\overline{\beta}_\tau$ coefficient from a separate regression with the dependent variable specified in the row and the sample specified in the column. The treatment group's average of the dependent variable in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.

Appendix A Additional Results

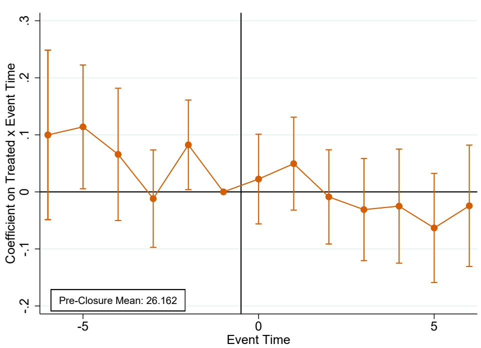
Figure A1: Estimated Impact of Closure on Composition



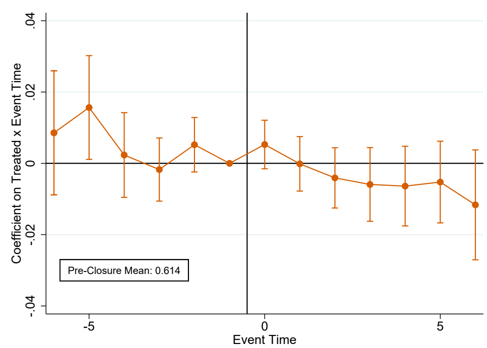
(a) Share Black



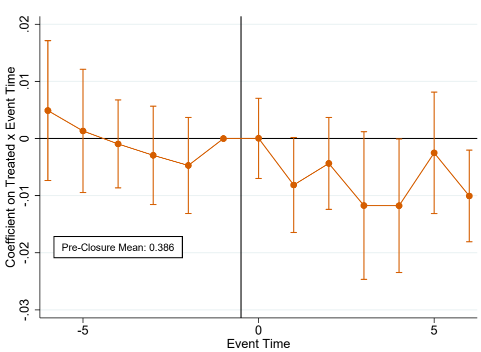
(b) Share White



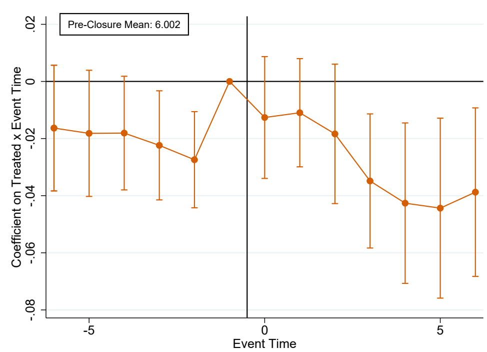
(c) Age



(d) Share Married



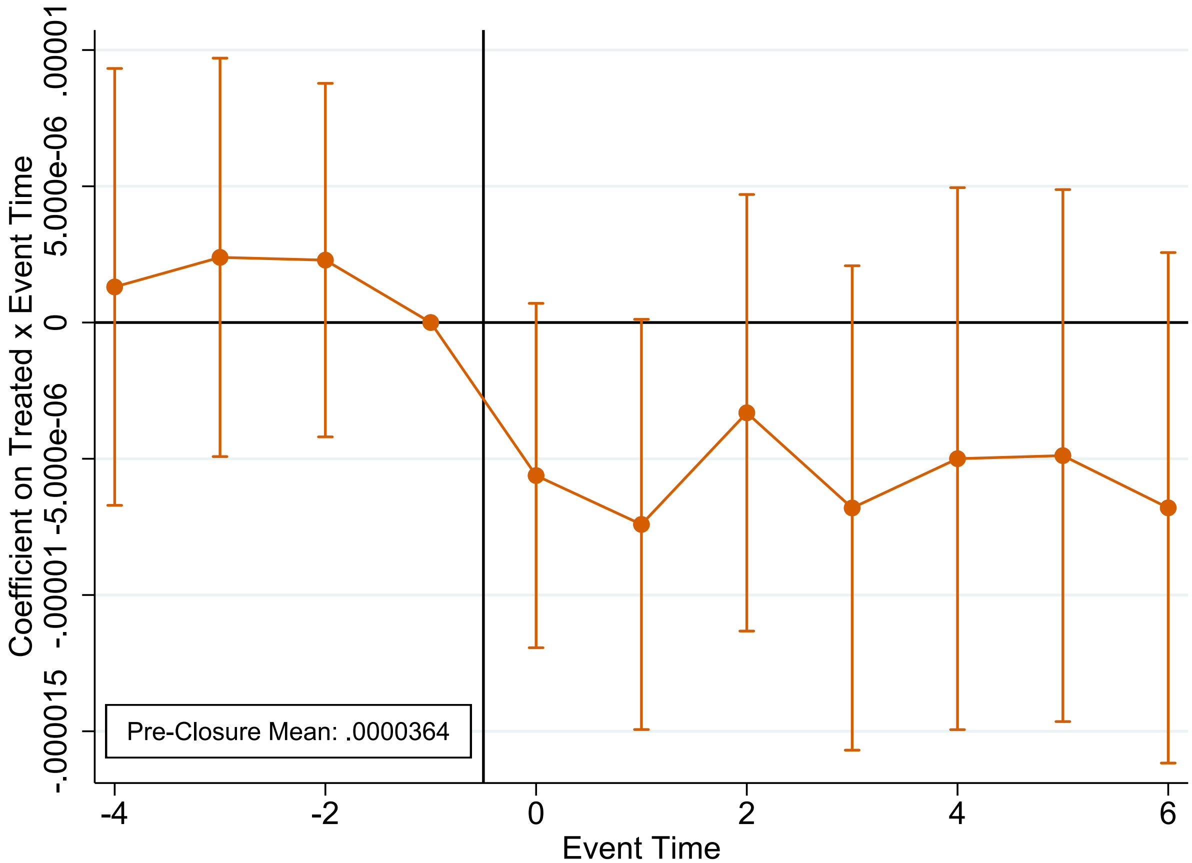
(e) Share First Birth



(f) Log of Births to Residents

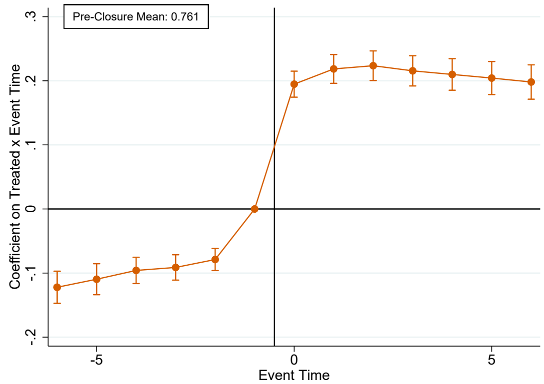
Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births to Black women (Panel (a)), the share of births to white women (Panel (b)), age at birth (Panel (c)), the share of births to married women (Panel (d)), the share of first births (Panel (e)), and the log of births to residents of a county (Panel (f)). Observations are at the county-event time level and are clustered at the county level.

Figure A2: Estimated Impact of Closure on OBGYNs per 10,000 Population

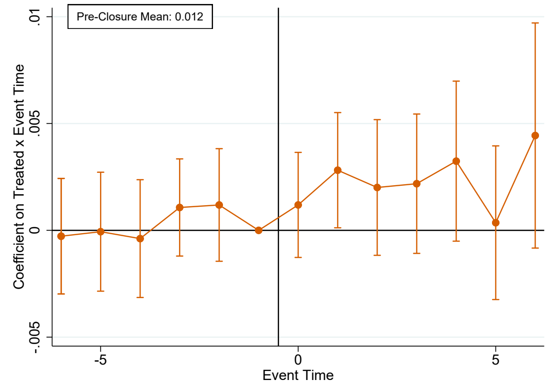


Note: Each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the number of OBGYNs per 10,000 population. Observations are at the county-event time level and are clustered at the county level. Data on the number of OBGYNs are from the Health Resources and Services Administration's Area Health Resource File beginning in the year 2001.

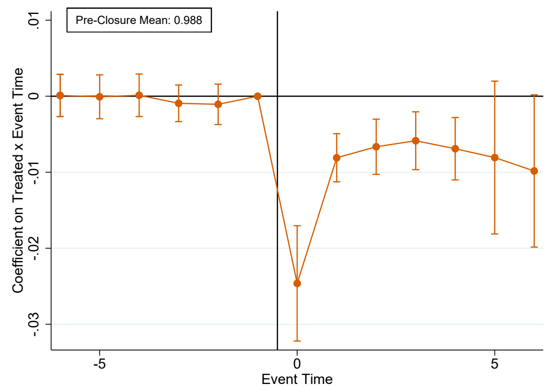
Figure A3: Estimated Impact of Closure on County Births, Unweighted



(a) Resident Births Occurring Out of County



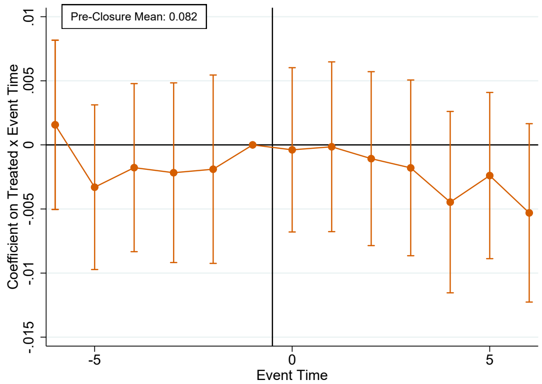
(b) Resident Births Occurring Out of Hospital



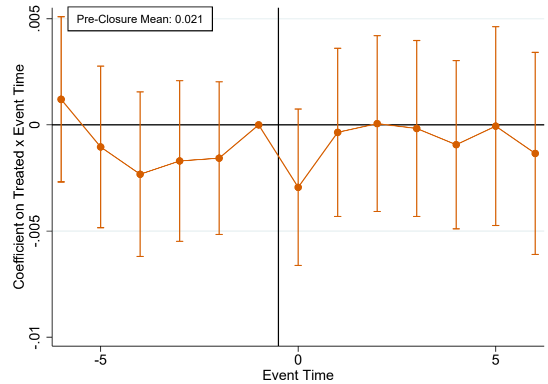
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level.

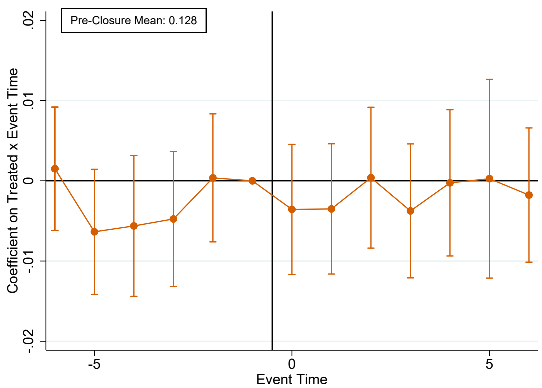
Figure A4: Estimated Impact of Closure on Infant Health, Unweighted



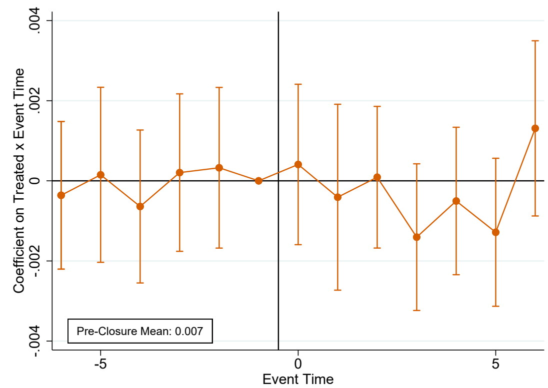
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



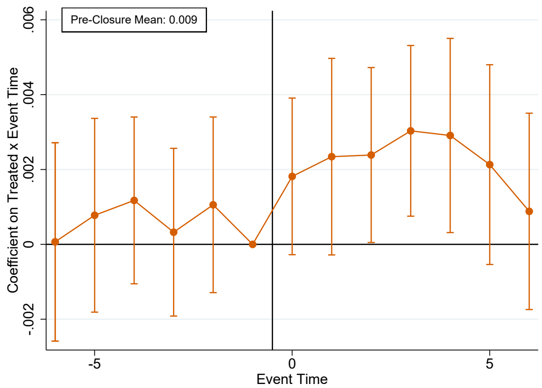
(c) Share of Births Preterm



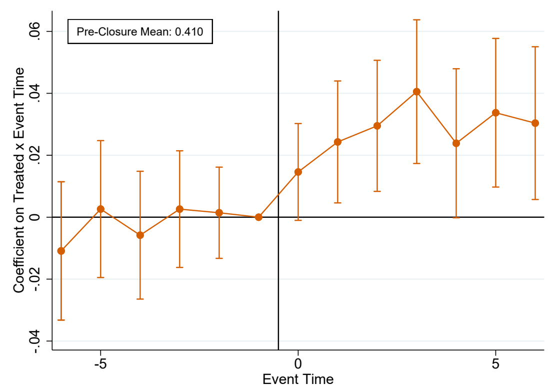
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births born with an Apgar score of 6 or below, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level.

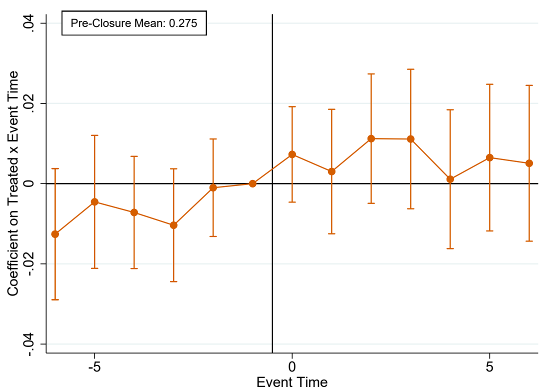
Figure A5: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Unweighted



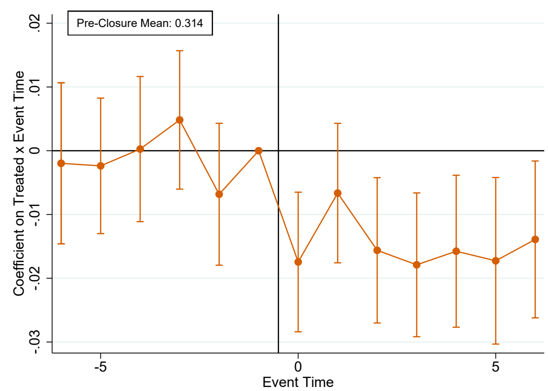
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



(c) Share of Births Induced



(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level.

Table A1: Summary Statistics by Hospital Category

	(1) Rural Closures	(2) Rural Non-Closures
Bed Size	57.08	111.00
	(44.57)	(110.75)
Number of Births	108.59	523.64
	(119.87)	(642.68))
Has Neonatal ICU	0.00	0.03
	(0.00)	(0.17)
N	166	1091

Note: This table compares characteristics of hospitals in the sample. Column 1 displays characteristics of hospitals that were the sole provider of maternity care in their county in 2002 and close by 2012. Column 2 displays characteristics of hospitals that were the sole provider of maternity care in their county in 2002 and are still open in 2012. Hospital characteristics and provision of maternity care services are based on a hospital's self-report from the American Hospital Association's Annual Survey.

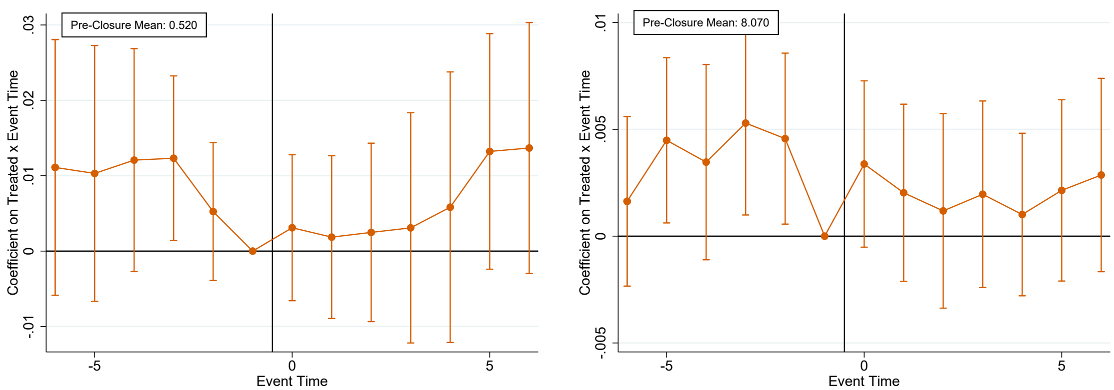
Table A2: Characteristics of Closure Women by Type of Birth Before Closure

	(1) In-County Birth	(2) Out-of-County Birth	(3) p-value
Age	25.2	26.5	0.0000
	(1.8)	(1.4)	
College Or Above	0.1062	0.2043	0.0000
	(0.1042)	(0.0979)	
Married	0.5420	0.6807	0.0000
	(0.1828)	(0.1208)	
White	0.8388	0.8872	0.0000
	(0.2434)	(0.1682)	
Black	0.1310	0.0799	0.0000
	(0.2382)	(0.1561)	
Foreign Born	0.0847	0.0527	0.0000
	(0.1250)	(0.0737)	
Previous Cesarean Birth	0.1451	0.1717	0.0000
	(0.0919)	(0.0709)	
Multiples	0.0118	0.0382	0.0000
	(0.0217)	(0.0334)	
Breech	0.0413	0.0539	0.0000
	(0.0622)	(0.0462)	
Blood Pressure Disorders	0.0598	0.0723	0.0000
	(0.0534)	(0.0415)	
Diabetes	0.0359	0.0451	0.0000
	(0.0404)	(0.0375)	
Any Risk Factor	0.2303	0.2841	0.0000
	(0.1028)	(0.0806)	

Note: This table compares characteristics of closure women who give birth in county prior to closure (Column 1) to closure women who give birth out of county prior to closure (Column 2). Column 3 displays the p-value for the difference.

Online Appendix

Figure B1: Estimated Impact of Closure on Additional Infant Outcomes

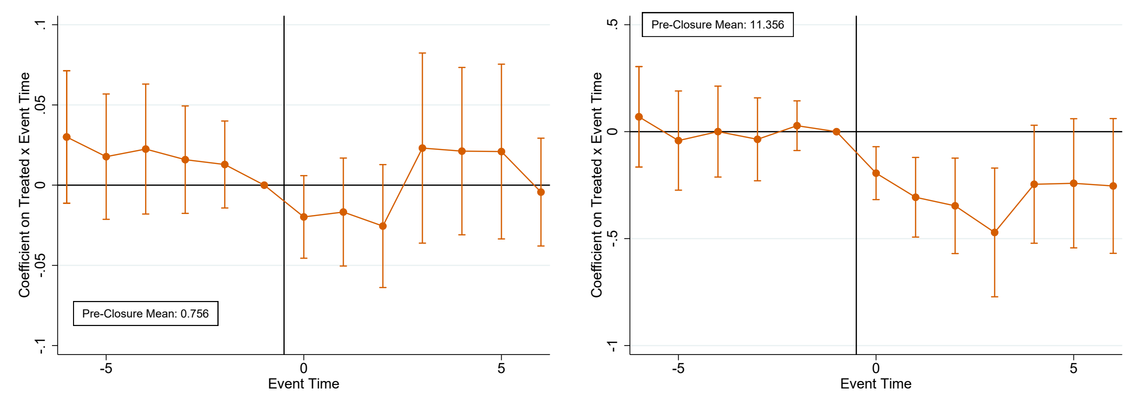


(a) Full Term Births

(b) Log of Birthweight

Note: In Panels (a) and (b), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births born full-term (between 39 weeks and 0 days gestation and 41 weeks and 6 days gestation) and in Panel (b) is the log of birthweight. Observations are at the county-event time level and are clustered at the county level.

Figure B2: Estimated Impact of Closure on Additional Birth Outcomes

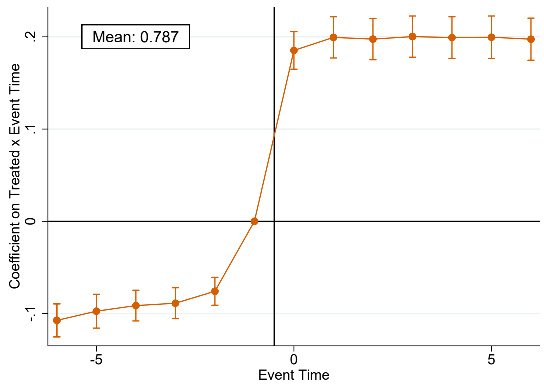


(a) Prenatal Began First Trimester

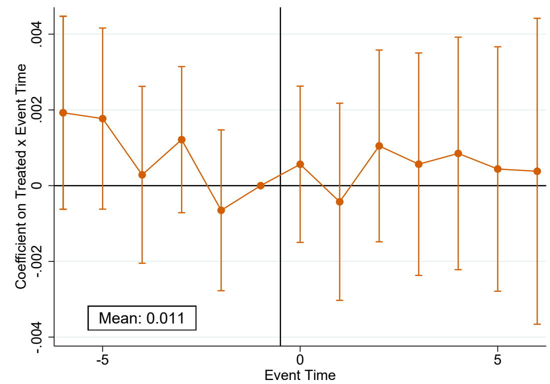
(b) Total Prenatal Visits

Note: In Panels (a) and (b), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is whether prenatal care began during the first trimester and in Panel (b) is the total number of prenatal visits. Observations are at the county-event time level and are clustered at the county level.

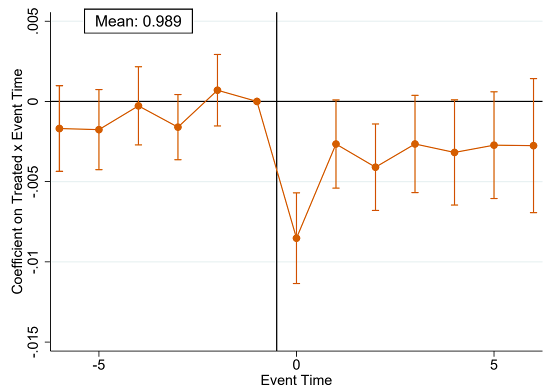
Figure B3: Estimated Impact of Closure on County Births, Control Never Provided Maternity Care



(a) Resident Births Occurring Out of County



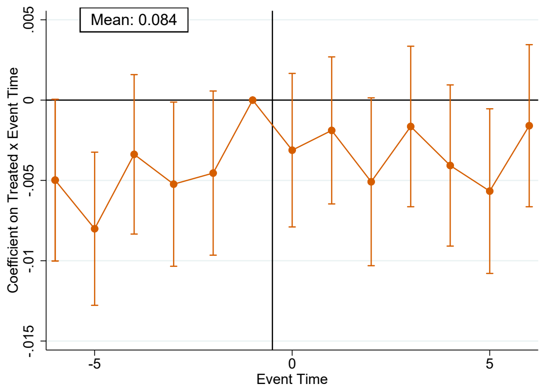
(b) Resident Births Occurring Out of Hospital



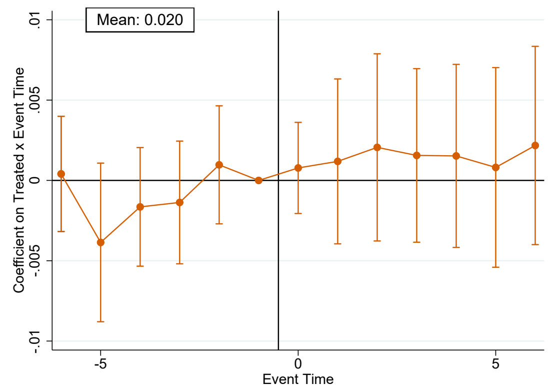
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level. The control counties are selected from counties that never provided maternity services from 1996 to 2018.

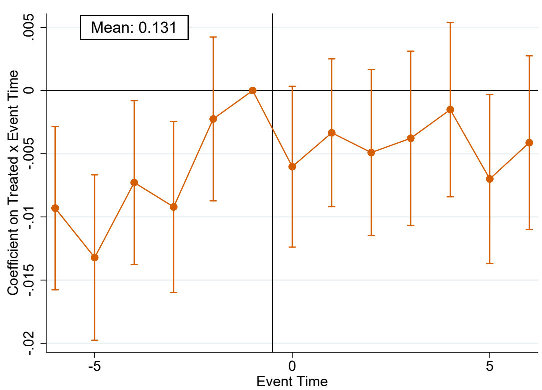
Figure B4: Estimated Impact of Closure on Infant Health, Control Never Provided Maternity Care



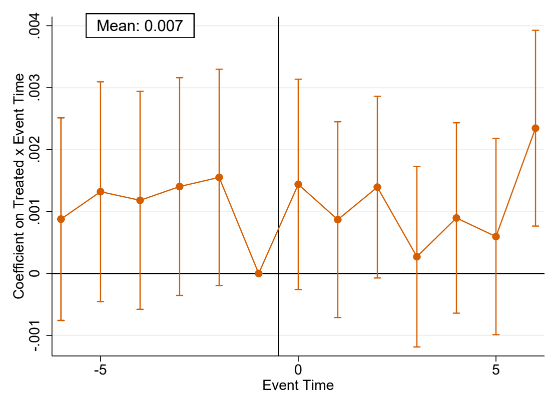
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



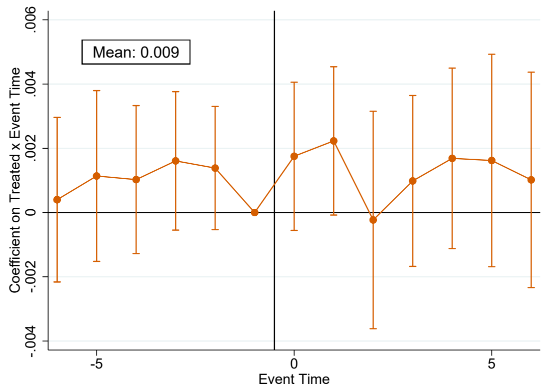
(c) Share of Births Preterm



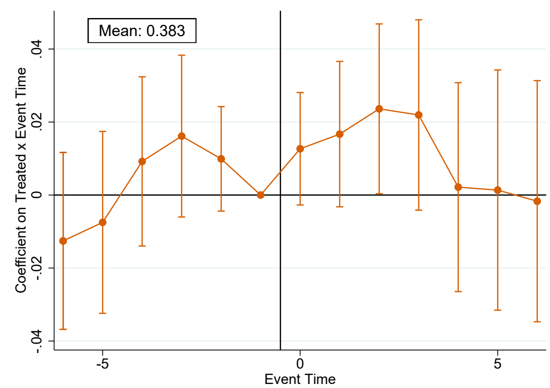
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The control counties are selected from counties that never provided maternity services from 1996 to 2018.

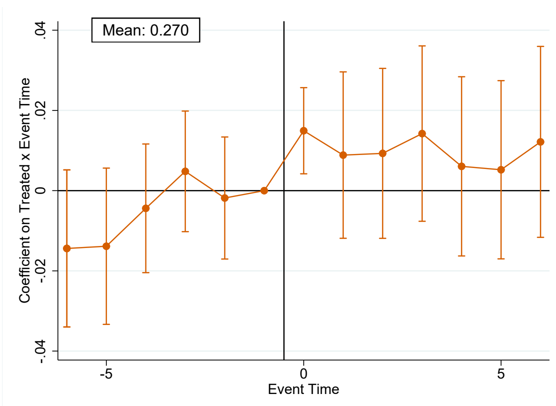
Figure B5: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Control Never Provided Maternity Care



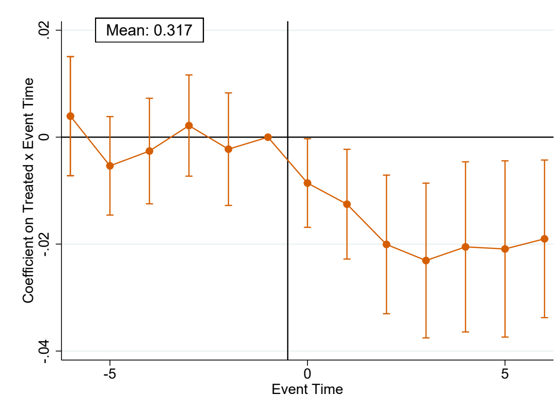
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



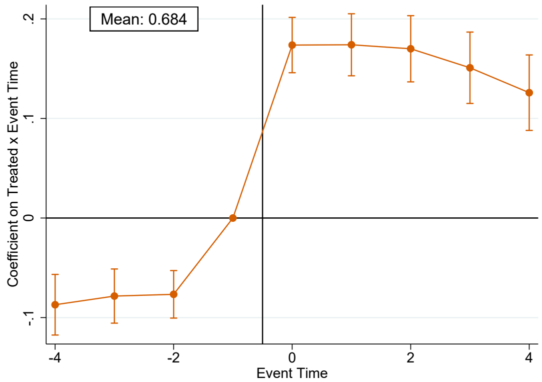
(c) Share of Births Induced



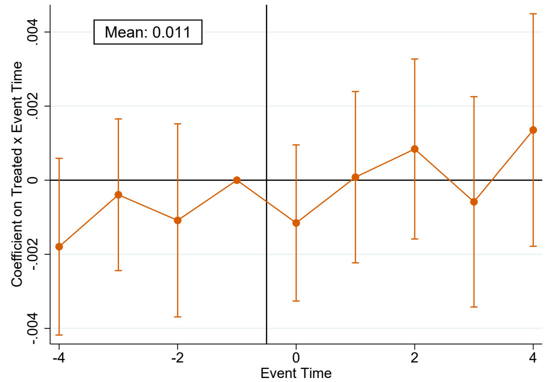
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The control counties are selected from counties that never provided maternity services from 1996 to 2018.

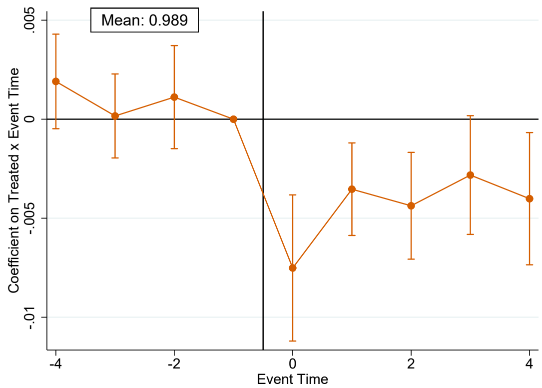
Figure B6: Estimated Impact of Closure on County Births, Control Closes Later



(a) Resident Births Occurring Out of County



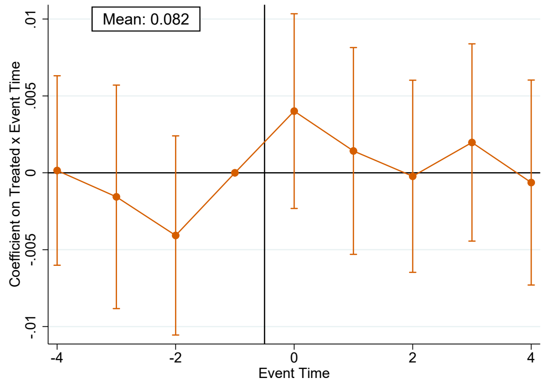
(b) Resident Births Occurring Out of Hospital



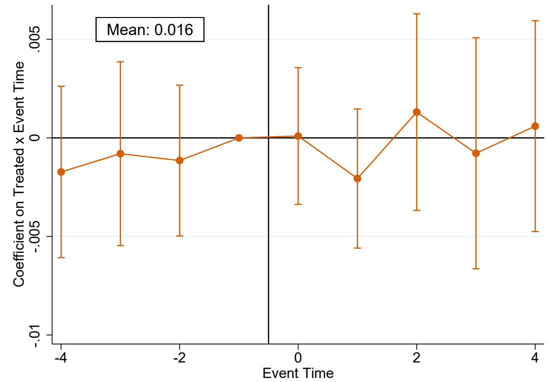
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) and (b), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the number of births occurring within a county at event time τ and in Panel (b) is the share of births occurring to residents of a county occurring outside of the residence county. Observations are at the county-event time level and are clustered at the county level. The control counties are selected from counties that close within a state at least four years later.

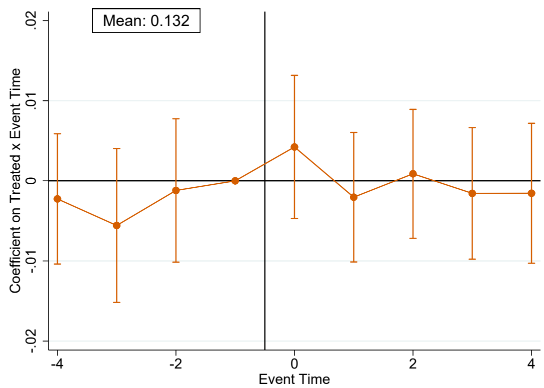
Figure B7: Estimated Impact of Closure on Infant Health, Control Closes Later



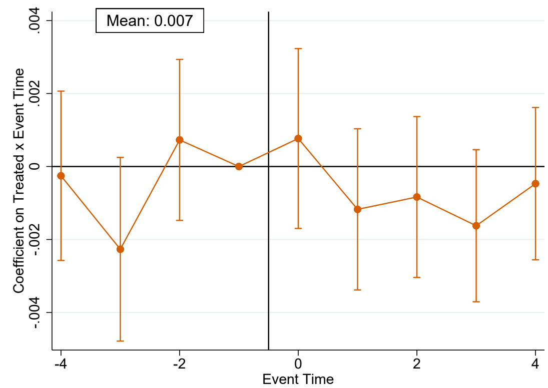
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



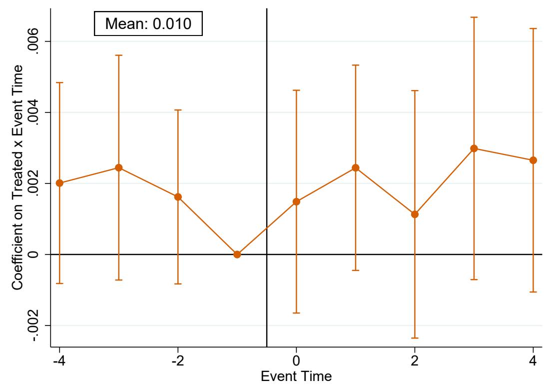
(c) Share of Births Preterm



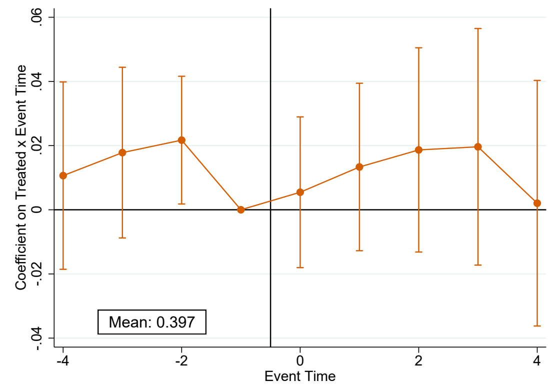
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The control counties are selected from counties that close within a state at least four years later.

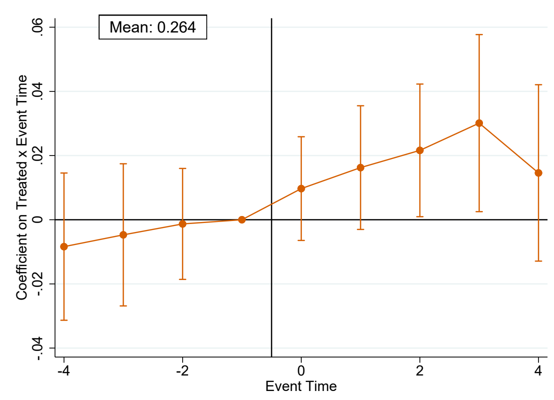
Figure B8: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Control Closes Later



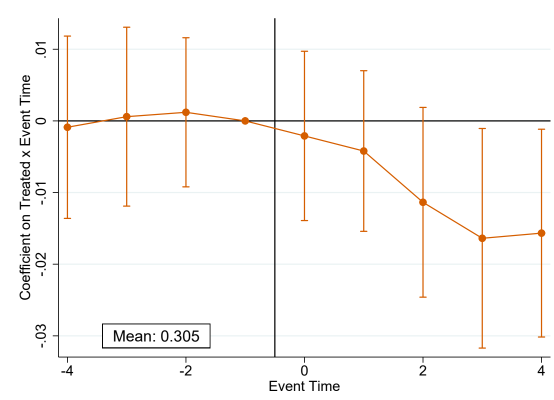
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



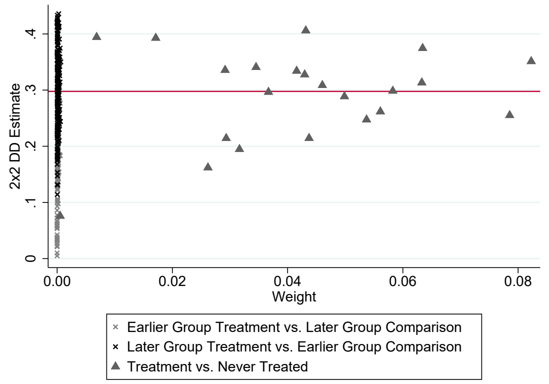
(c) Share of Births Induced



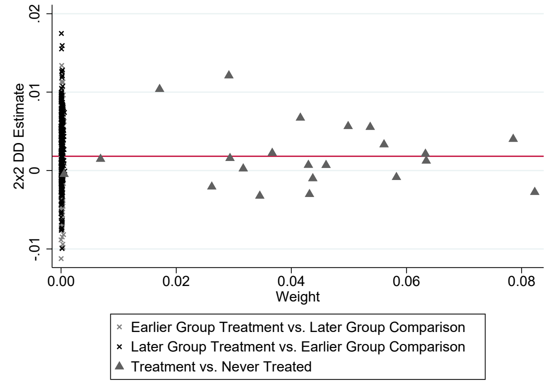
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The control counties are selected from counties that close within a state at least four years later.

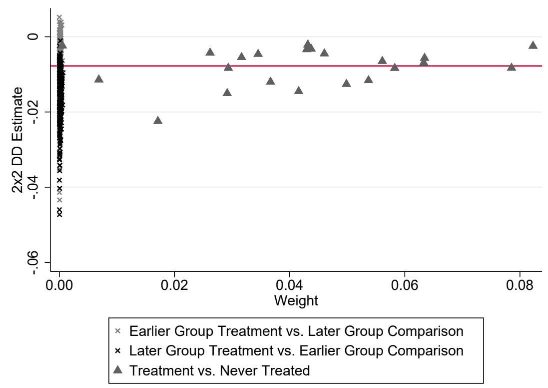
Figure B9: Goodman-Bacon Decomposition on County Births



(a) Resident Births Occurring Out of County



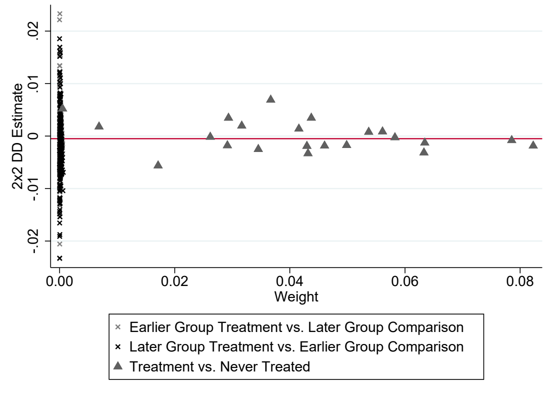
(b) Resident Births Occurring Out of Hospital



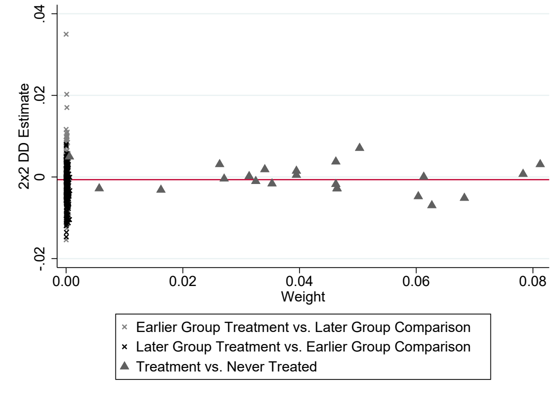
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: Panels (a) - (c) present the Goodman-Bacon (2021) decomposition on the the share of out-of-county births (Panel (a)), the share of out-of-hospital births (Panel (b)), and the share of births occurring in a hospital with a maternity ward (Panel (c)).

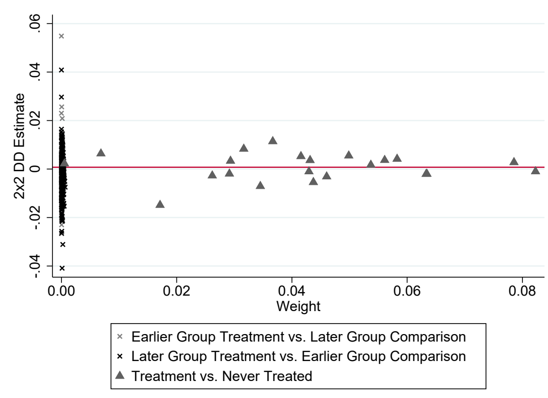
Figure B10: Goodman-Bacon Decomposition on Infant Health Outcomes



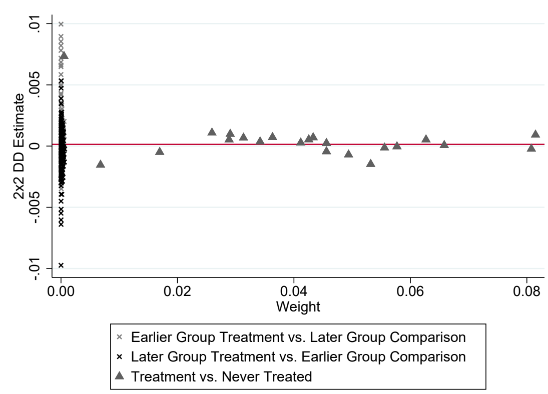
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



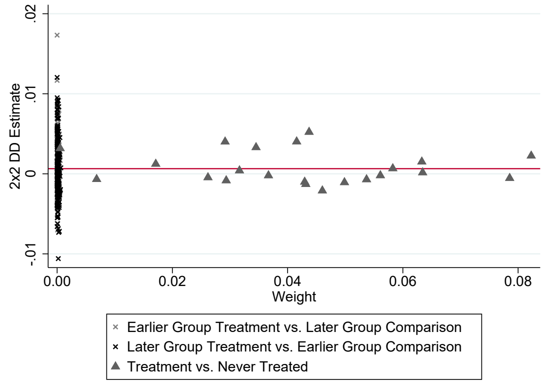
(c) Share of Births Preterm



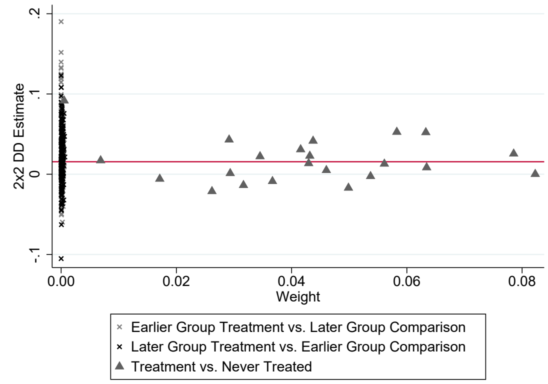
(d) Infant Mortality Rate

Note: Panels (a) - (d) present the Goodman-Bacon (2021) decomposition on the the share of low birthweight births (Panel (a)), the share of births with a low Apgar score (Panel (b)), the share of births preterm (Panel (c)), and the infant mortality rate (Panel (d)).

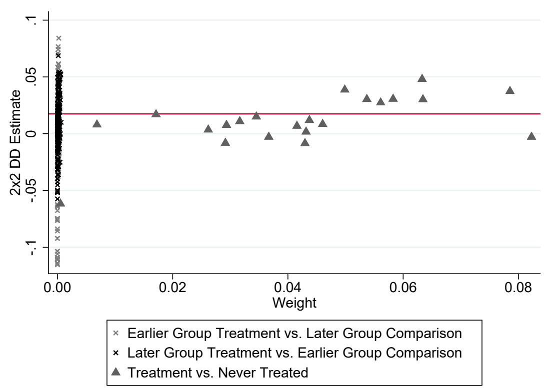
Figure B11: Goodman-Bacon Decomposition on Birth Outcomes



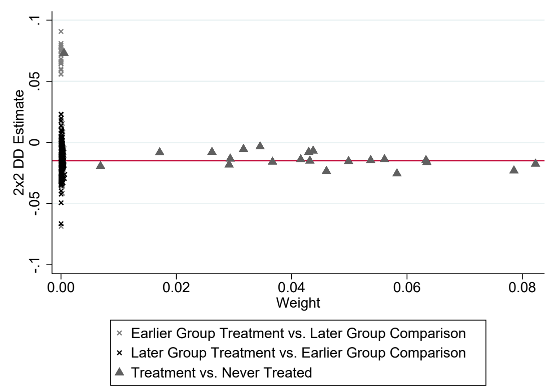
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



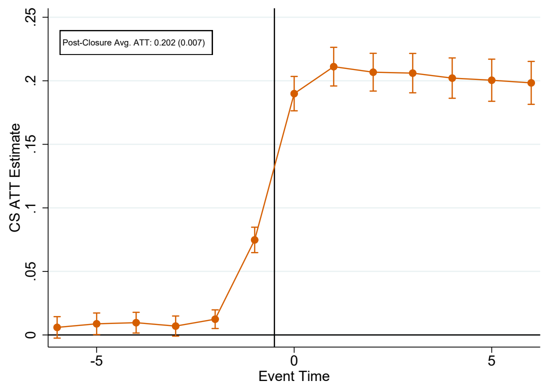
(c) Share of Births Induced



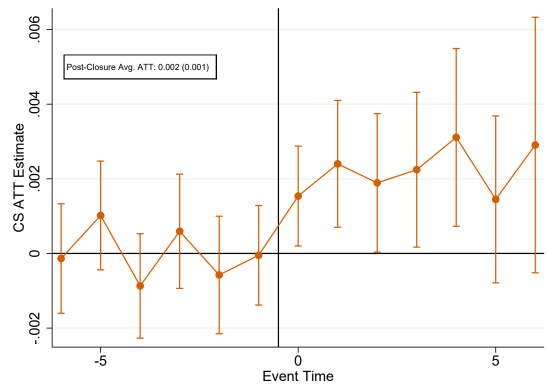
(d) Share of Births Delivered Via Cesarean

Note: Panels (a) - (d) present the Goodman-Bacon (2021) decomposition on the the share of pregnancies with 1 or fewer prenatal visits (Panel (a)), the share of pregnancies with 10 or fewer prenatal visits (Panel (b)), the share of births induced (Panel (c)), and the Cesarean birth rate (Panel (d)).

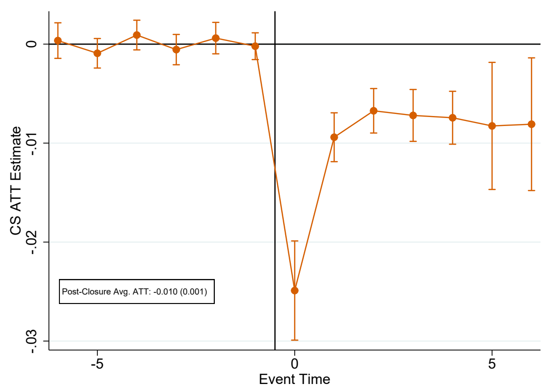
Figure B12: Estimated Impact of Closure on County Births, Callaway and Sant'Anna Estimator



(a) Resident Births Occurring Out of County



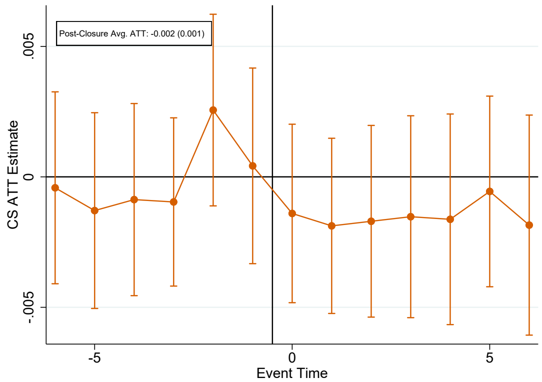
(b) Resident Births Occurring Out of Hospital



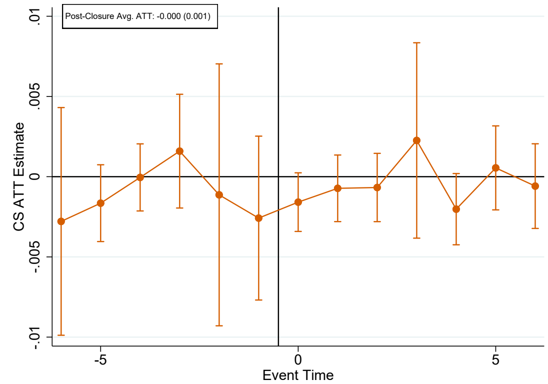
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) and (b), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1) using the Callaway and Sant'Anna (2021) estimator. The dependent variable in Panel (a) is the number of births occurring within a county at event time τ and in Panel (b) is the share of births occurring to residents of a county occurring outside of the residence county. Observations are at the county-event time level and are clustered at the county level. The aggregate ATT for the post-period is displayed in the box.

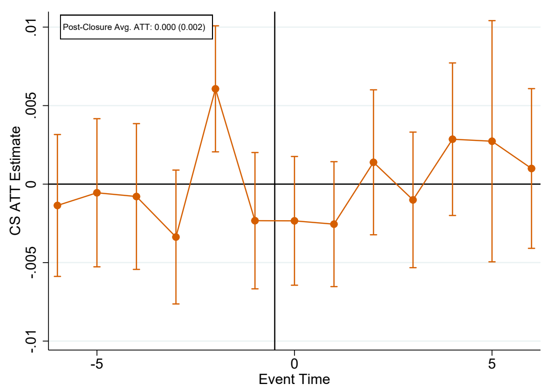
Figure B13: Estimated Impact of Closure on Infant Health, Callaway and Sant'Anna Method



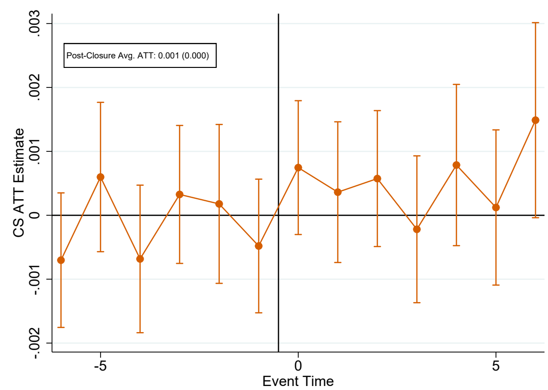
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



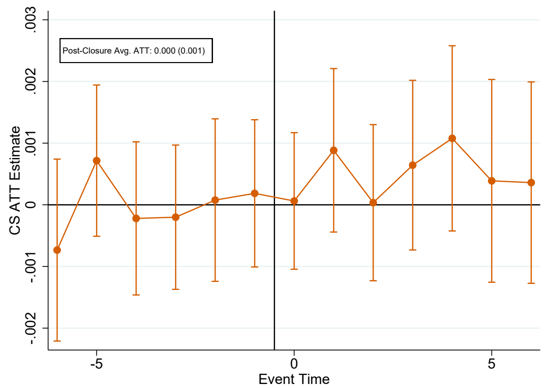
(c) Share of Births Preterm



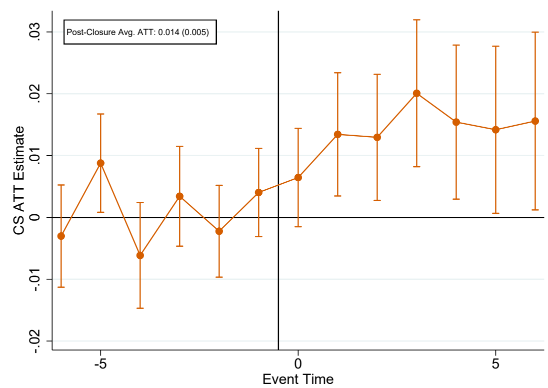
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1) using the Callaway and Sant'Anna (2021) estimator. The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The aggregate ATT for the post-period is displayed in the box.

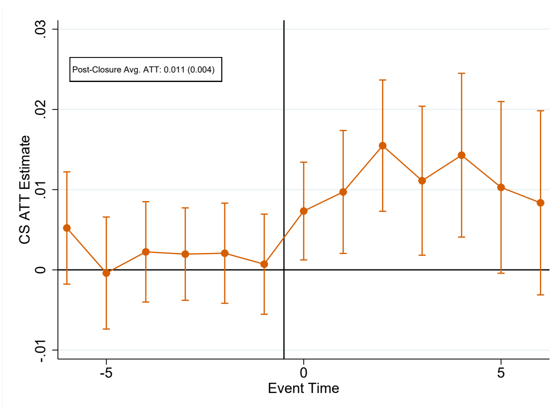
Figure B14: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Callaway and Sant'Anna Method



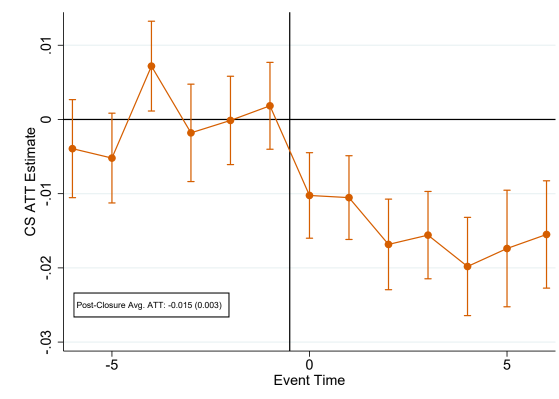
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



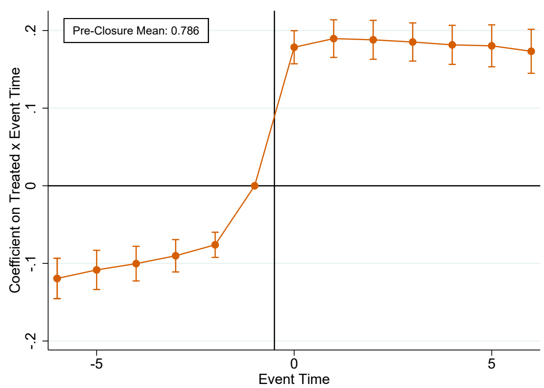
(c) Share of Births Induced



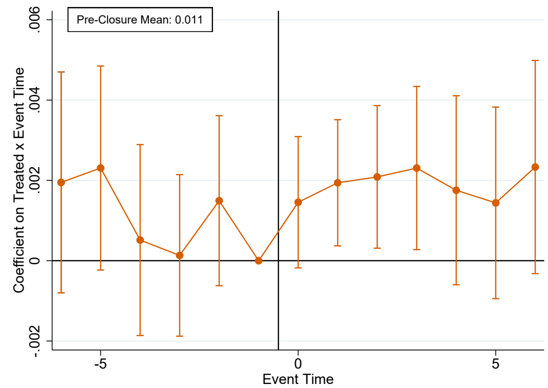
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1) using the Callaway and Sant'Anna (2021) estimator. The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The aggregate ATT for the post-period is displayed in the box.

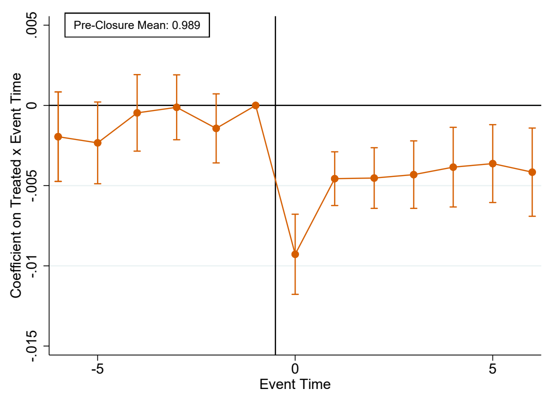
Figure B15: Estimated Impact of Closure on County Births, Matching on Trends



(a) Resident Births Occurring Out of County



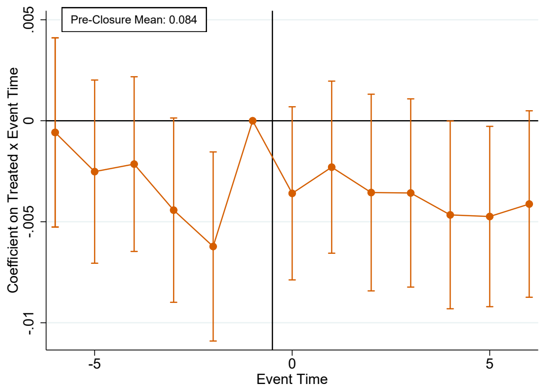
(b) Resident Births Occurring Out of Hospital



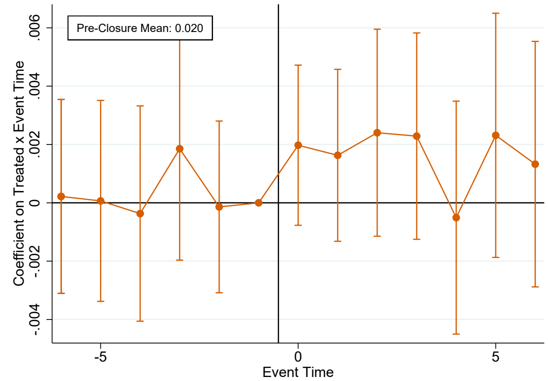
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level. The matching procedure matches on baseline trends using data from 1999 to 2001.

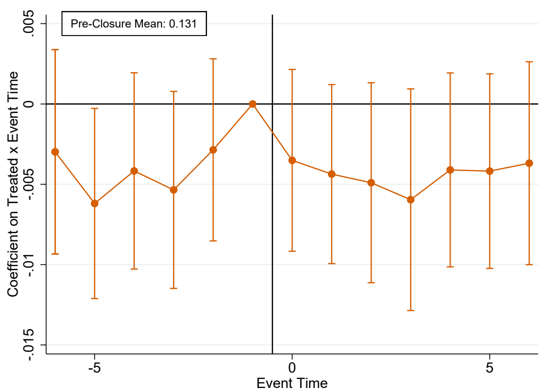
Figure B16: Estimated Impact of Closure on Infant Health, Matching on Trends



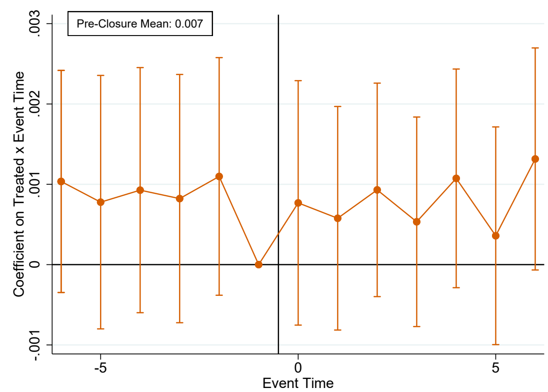
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



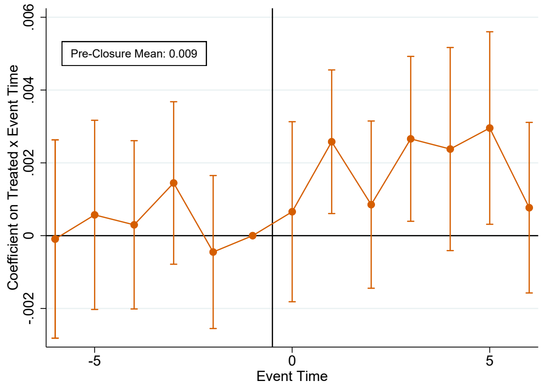
(c) Share of Births Preterm



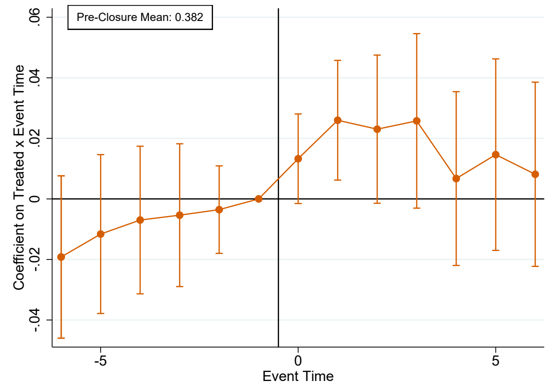
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The matching procedure matches on baseline trends using data from 1999 to 2001.

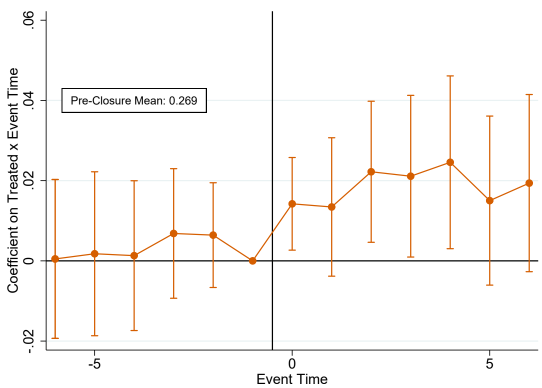
Figure B17: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Matching on Trends



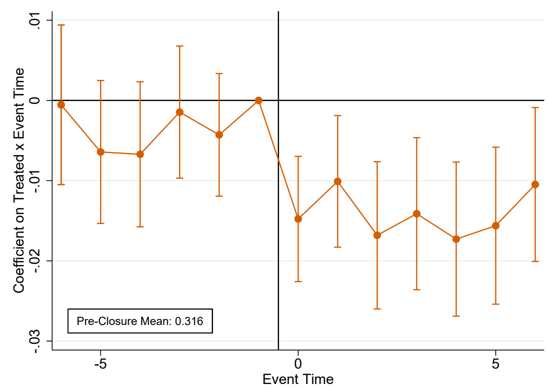
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low (≤ 10) Prenatal Visits



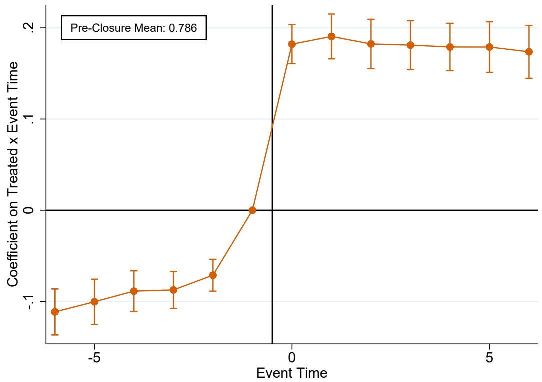
(c) Share of Births Induced



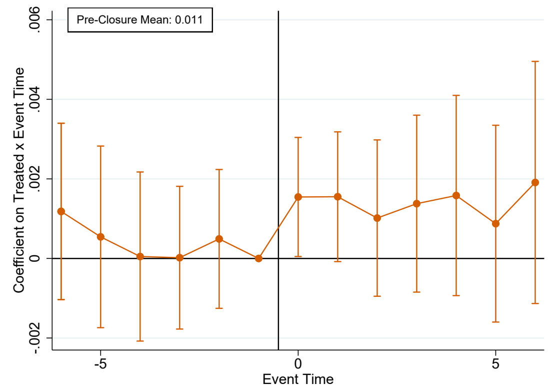
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The matching procedure matches on baseline trends using data from 1999 to 2001.

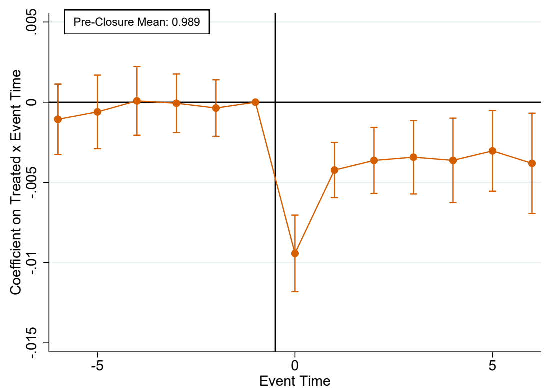
Figure B18: Estimated Impact of Closure on County Births, Matching on Year Before Closure



(a) Resident Births Occurring Out of County



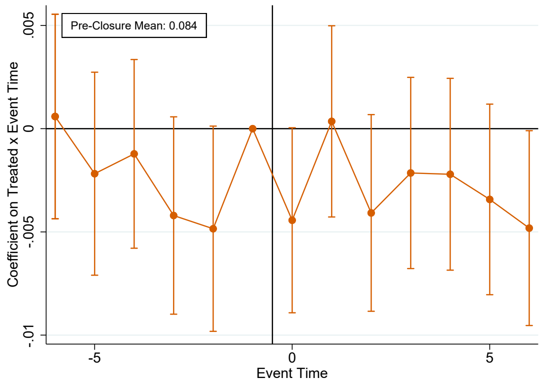
(b) Resident Births Occurring Out of Hospital



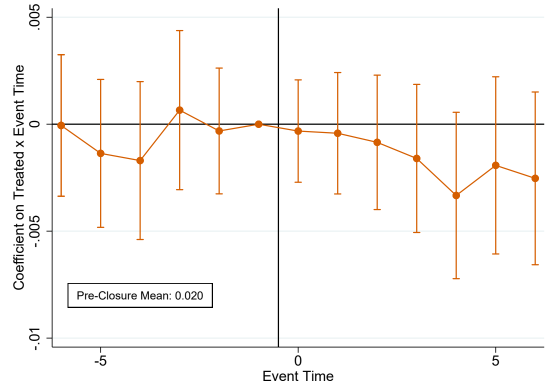
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level. The matching procedure matches on the year prior to closure.

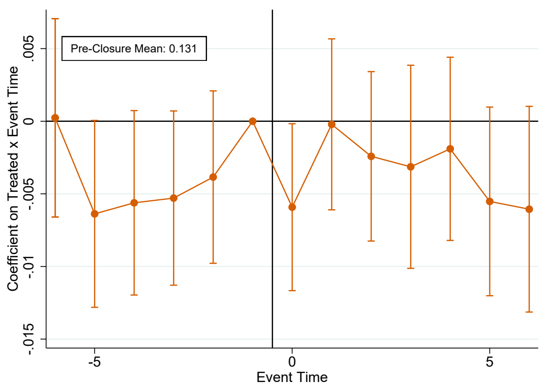
Figure B19: Estimated Impact of Closure on Infant Health, Matching on Year Before Closure



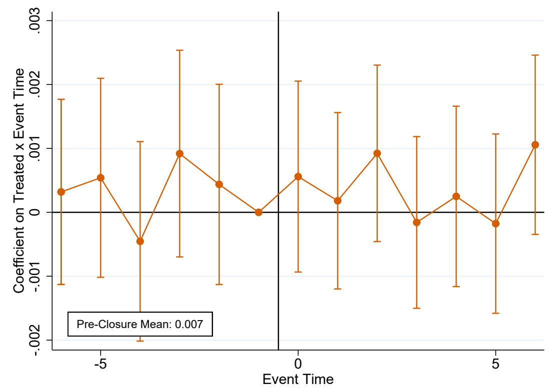
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



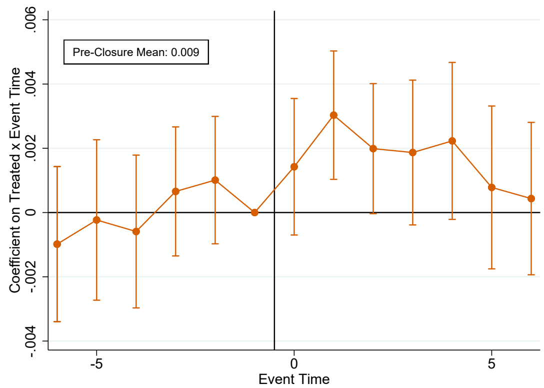
(c) Share of Births Preterm



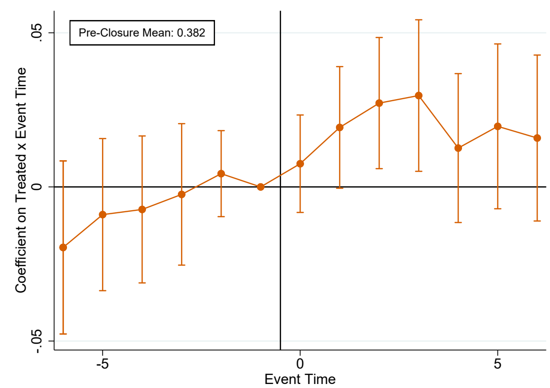
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The matching procedure matches on the year before closure.

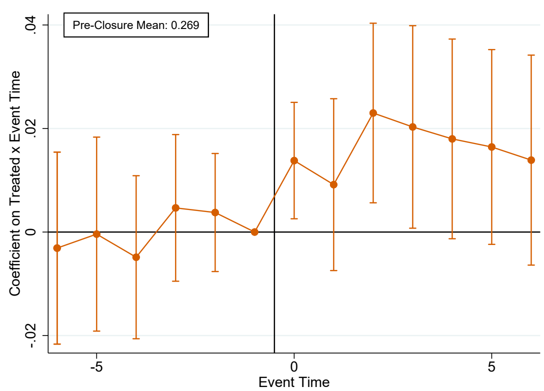
Figure B20: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Matching on Year Before Closure



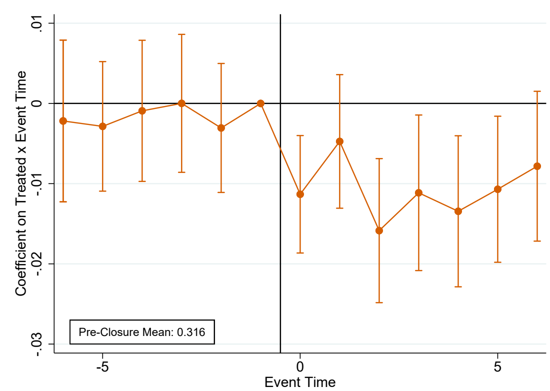
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



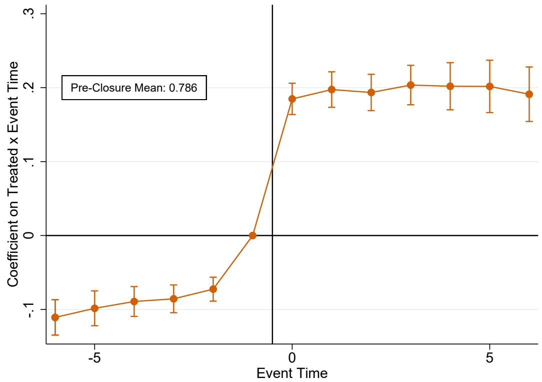
(c) Share of Births Induced



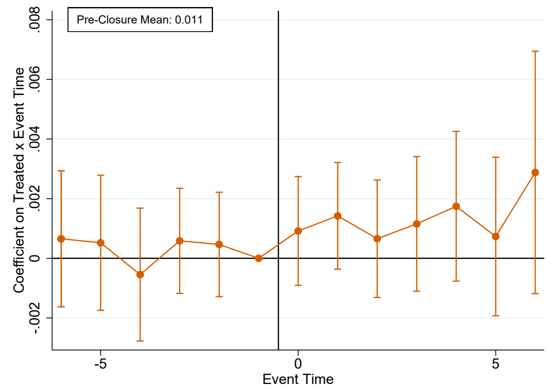
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The matching procedure matches on the year before closure.

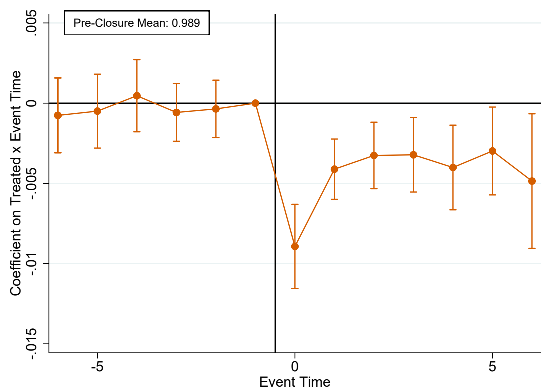
Figure B21: Estimated Impact of Closure on County Births, Include OBGYN in Match



(a) Resident Births Occurring Out of County



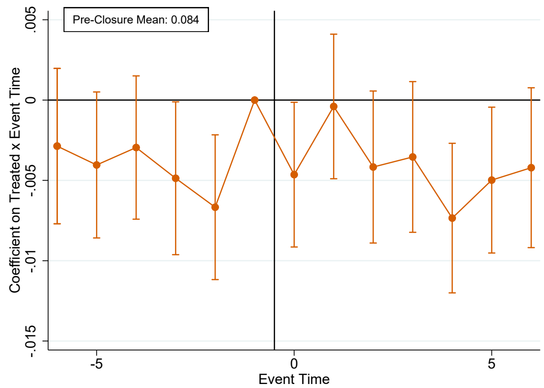
(b) Resident Births Occurring Out of Hospital



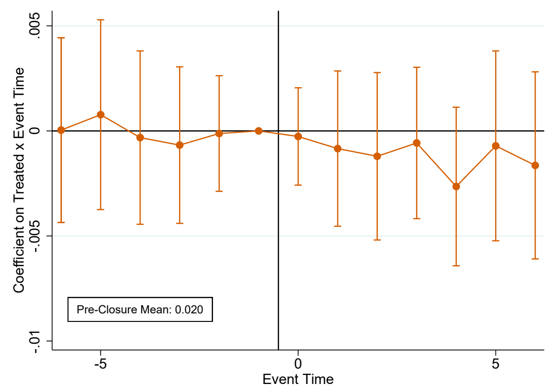
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level. The matching procedure includes the number of OBGYNs per 10,000 population in 2001 as a matching variable.

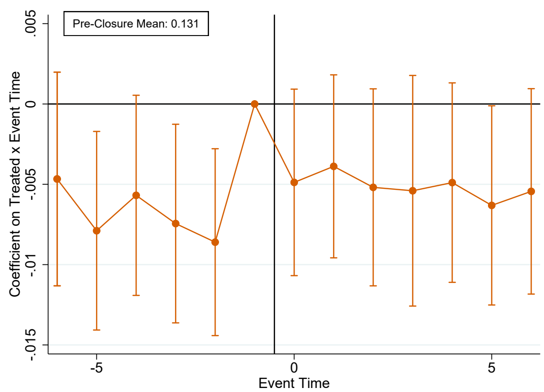
Figure B22: Estimated Impact of Closure on Infant Health, Include OBGYN in Match



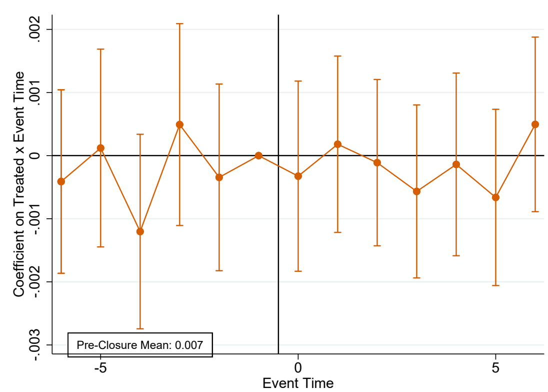
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



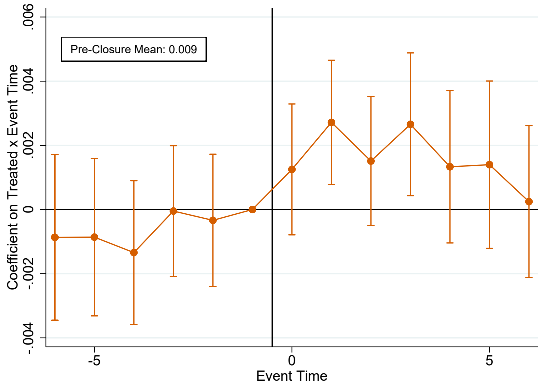
(c) Share of Births Preterm



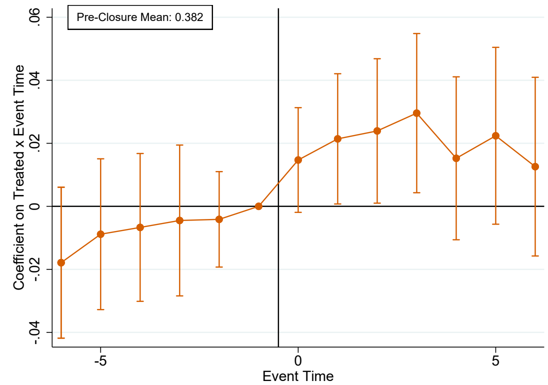
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The matching procedure includes the number of OBGYNs per 10,000 population in 2001 as a matching variable.

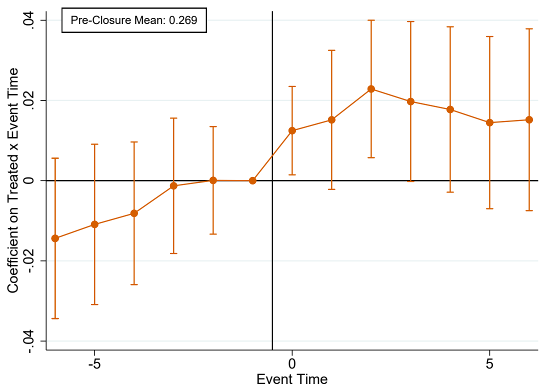
Figure B23: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Include OBGYN in Match



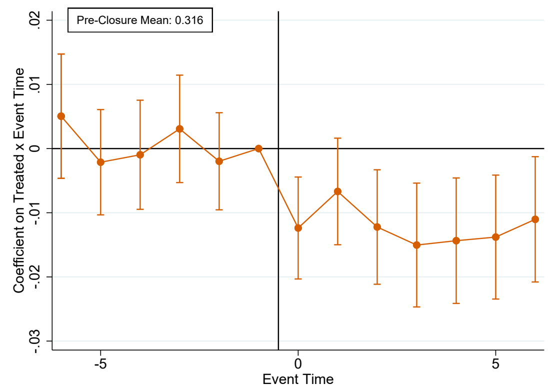
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits



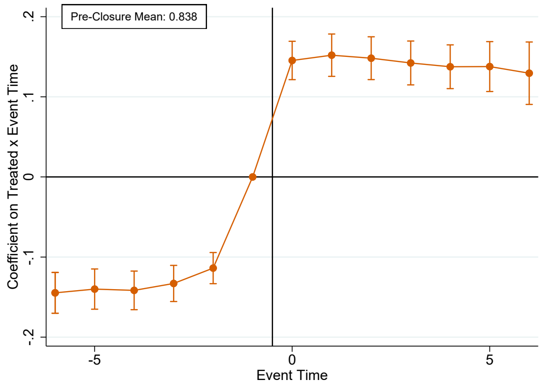
(c) Share of Births Induced



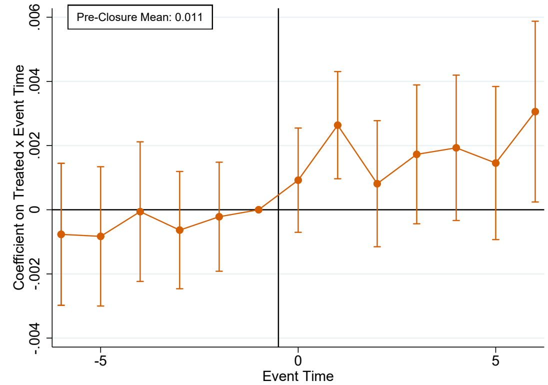
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The matching procedure includes the number of OBGYNs per 10,000 population in 2001 as a matching variable.

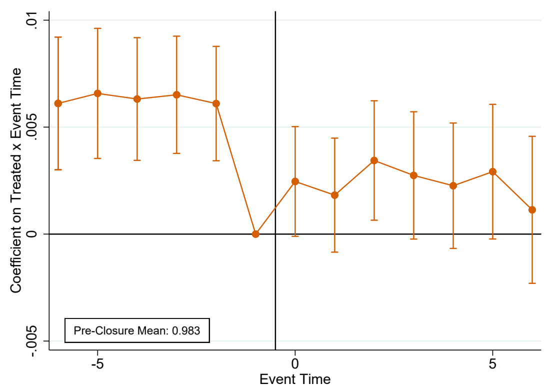
Figure B24: Estimated Impact of Closure on County Births, Closure Definition ≤ 2



(a) Resident Births Occurring Out of County



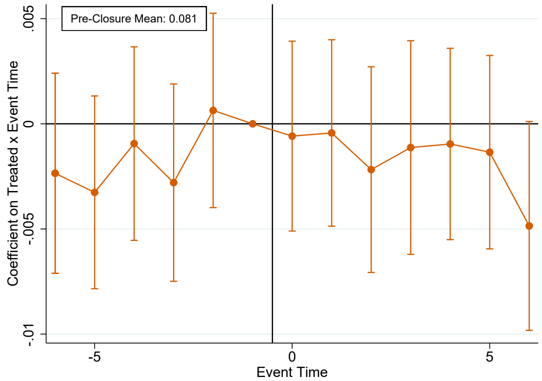
(b) Resident Births Occurring Out of Hospital



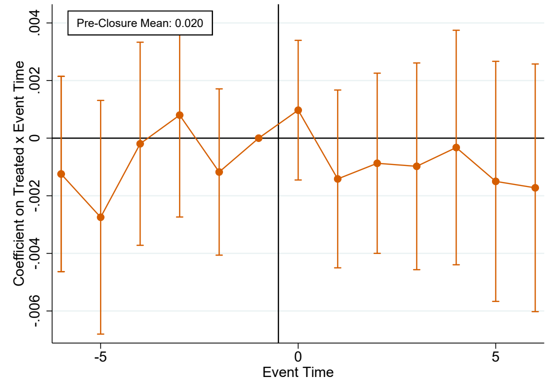
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level. The definition of a hospital closure allows for an average of 2 hospital births post-closure.

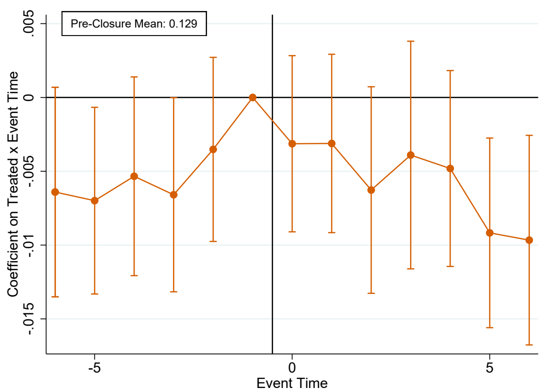
Figure B25: Estimated Impact of Closure on Infant Health, Closure Definition ≤ 2



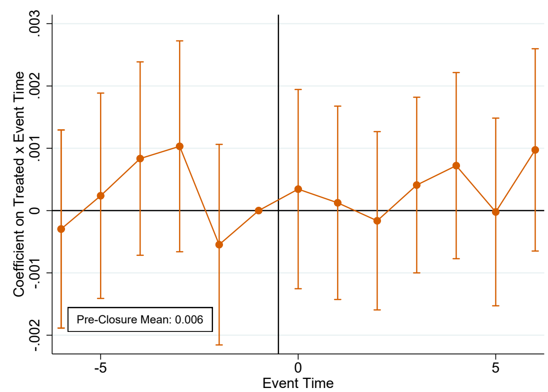
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



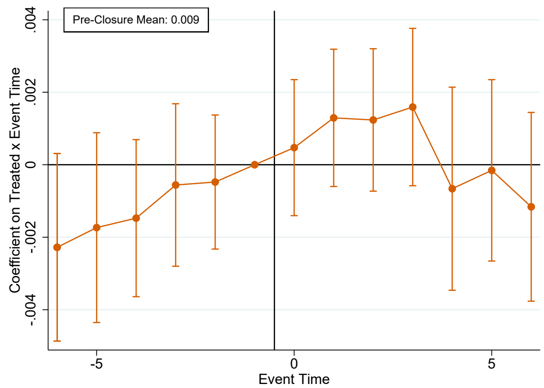
(c) Share of Births Preterm



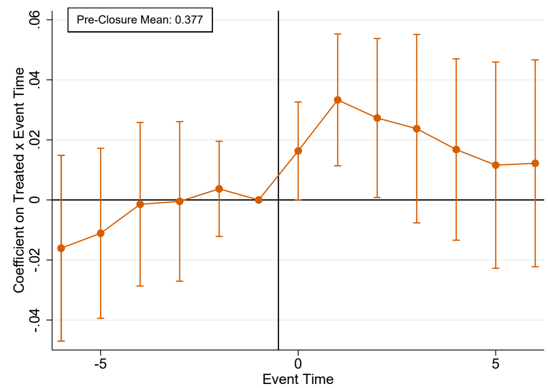
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The definition of a hospital closure allows for an average of 2 hospital births post-closure.

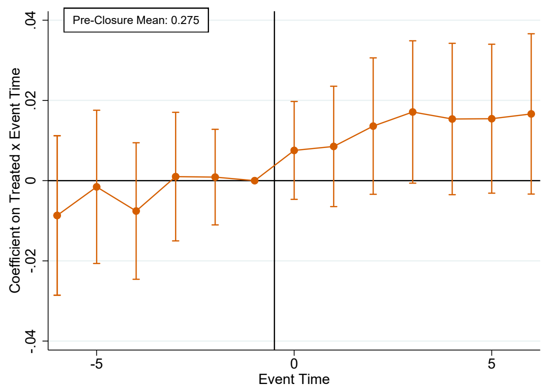
Figure B26: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Closure Definition ≤ 2



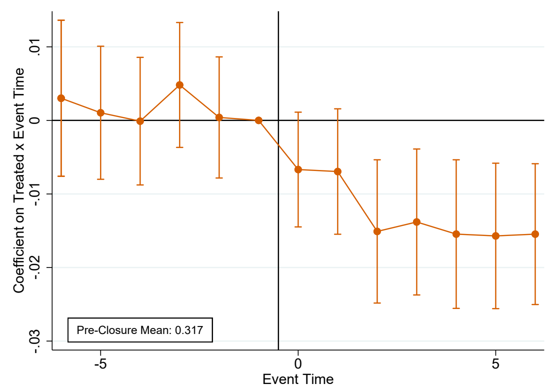
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low (≤ 10) Prenatal Visits



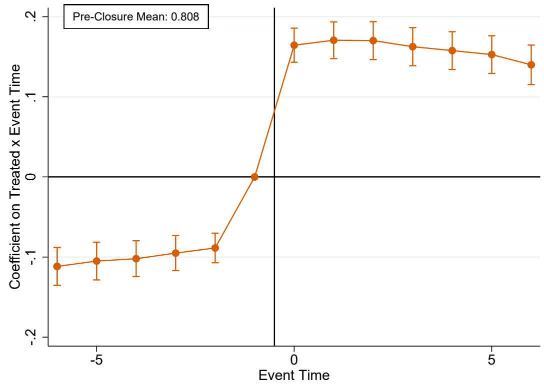
(c) Share of Births Induced



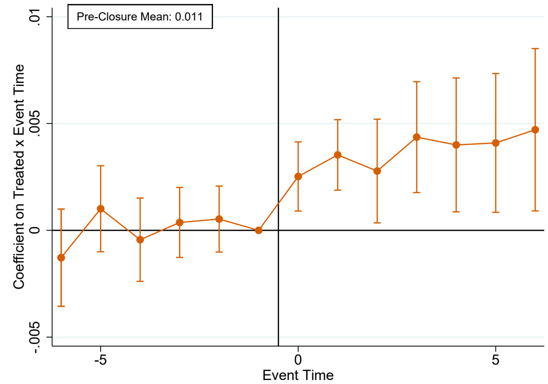
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The definition of a hospital closure allows for an average of 2 hospital births post-closure.

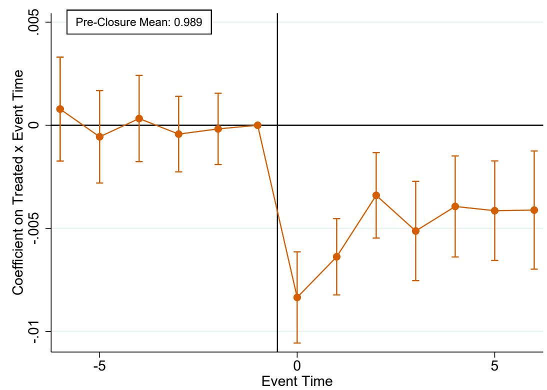
Figure B27: Estimated Impact of Closure on County Births, Closure Definition ≤ 8



(a) Resident Births Occurring Out of County



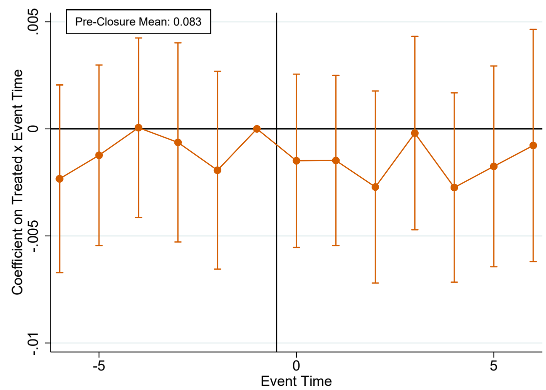
(b) Resident Births Occurring Out of Hospital



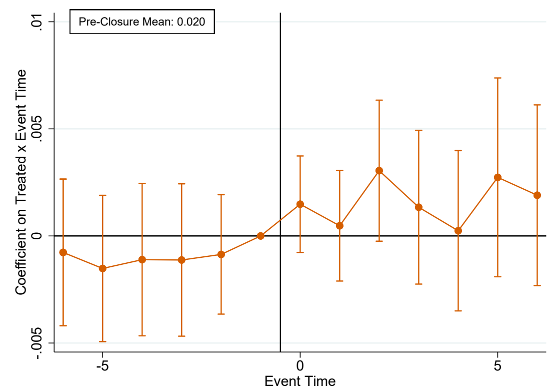
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. Observations are at the county-event time level and are clustered at the county level. The definition of a hospital closure allows for an average of 8 hospital births post-closure.

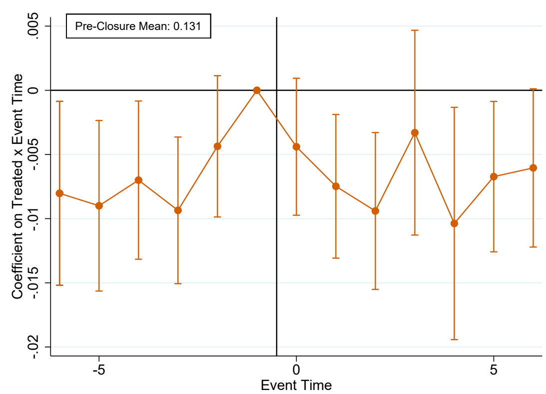
Figure B28: Estimated Impact of Closure on Infant Health, Closure Definition ≤ 8



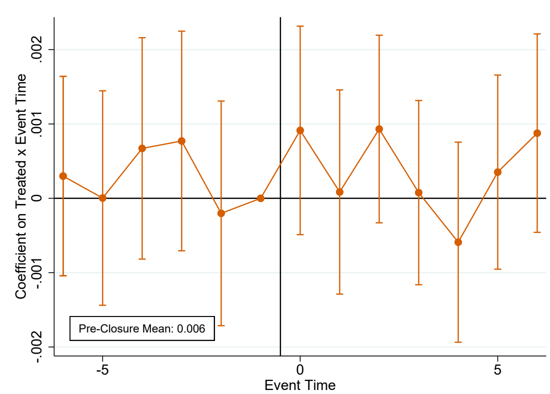
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



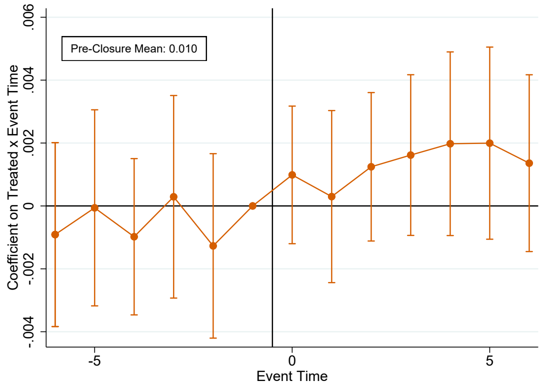
(c) Share of Births Preterm



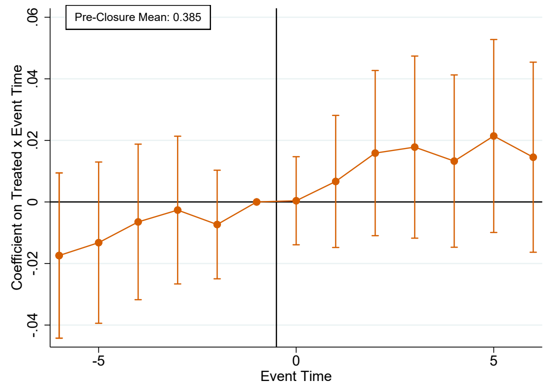
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score less than or equal to 6, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. Observations are at the county-event time level and are clustered at the county level. The definition of a hospital closure allows for an average of 8 hospital births post-closure.

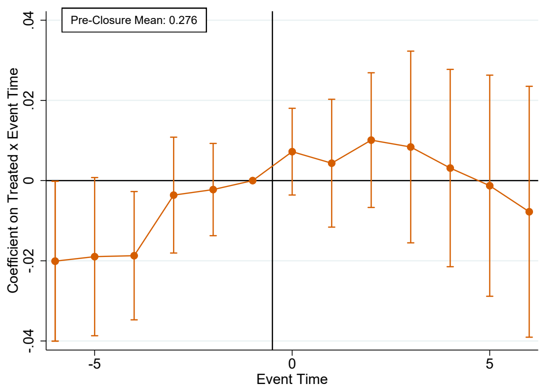
Figure B29: Estimated Impact of Closure on Characteristics of Pregnancy and Birth, Closure Definition ≤ 8



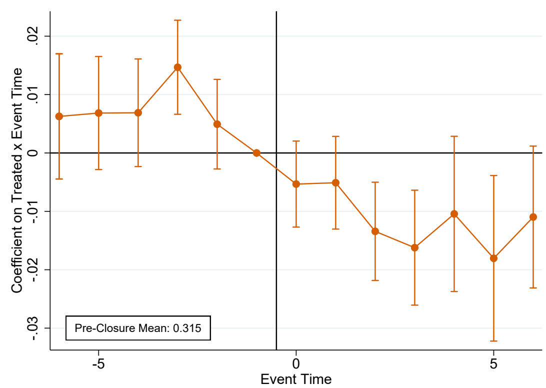
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) Share of Pregnancies with Low (≤ 10) Prenatal Visits



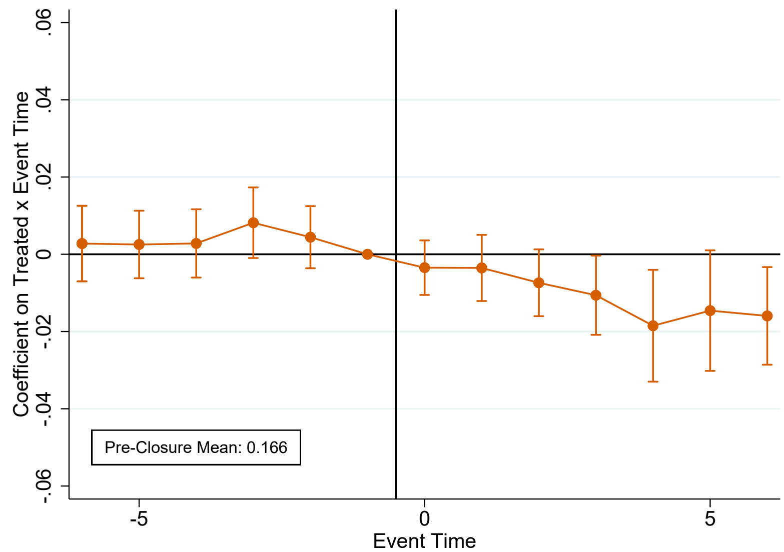
(c) Share of Births Induced



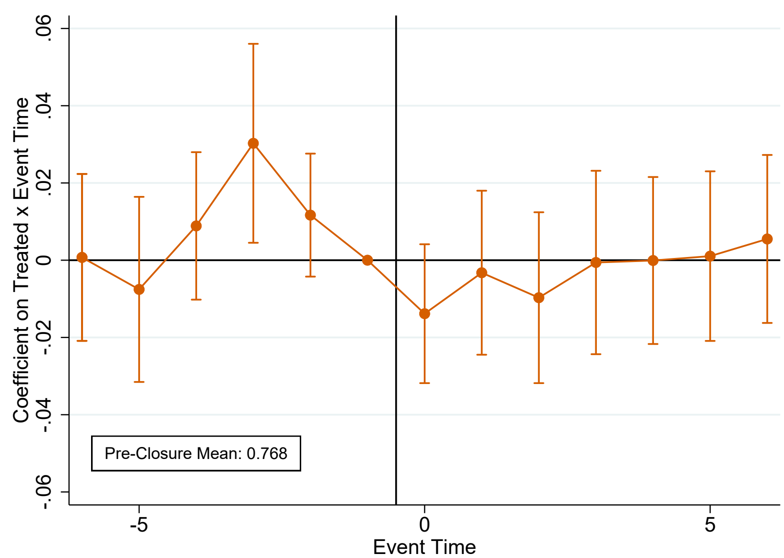
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. Observations are at the county-event time level and are clustered at the county level. The definition of a hospital closure allows for an average of 8 hospital births post-closure.

Figure B30: Estimated Impact of Closure on Share of Births Delivered Via Cesearean by Pregnancy Risk (Without Diabetes or Hypertensive Disorders)



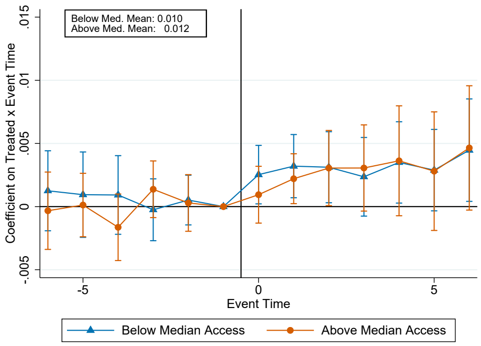
(a) Low-Risk Women



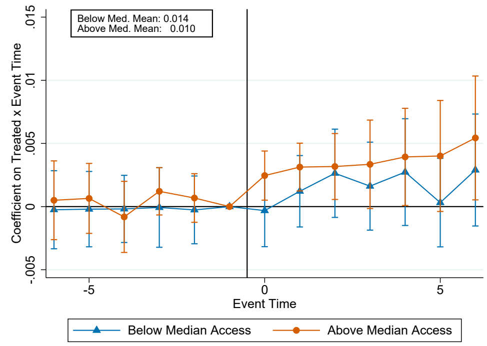
(b) High-Risk Women

Note: In Panels (a) and (b), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in both panels is the share of births delivered via Cesearean. Panel (a) is estimated on the sample of births in a county that falls below a predicted probability of Cesarean (PPC) of 0.30. Panel (b) is estimated on the sample of births in a county that falls above a PPC of 0.30. Observations are at the county-event time level and are clustered at the county level. The PPC is estimated as described in the main text, without using presence diabetes or hypertensive disorders as an input.

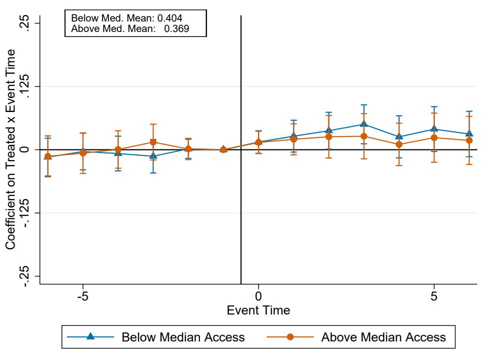
Figure B31: Estimated Impact of Closure by Access to Alternatives



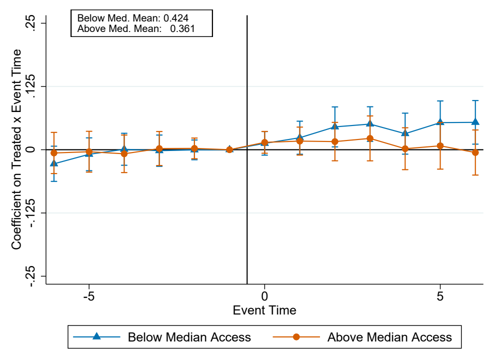
(a) Out-of-Hospital Births, Number of Adjacent Options



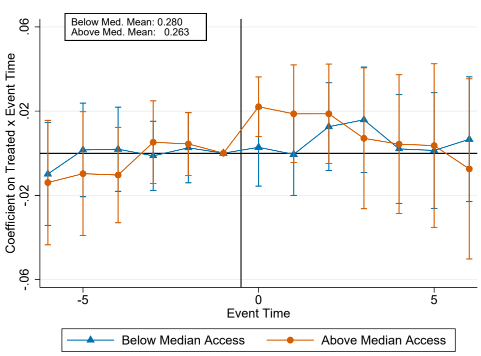
(b) Out-of-Hospital Births, Distance to Alternative



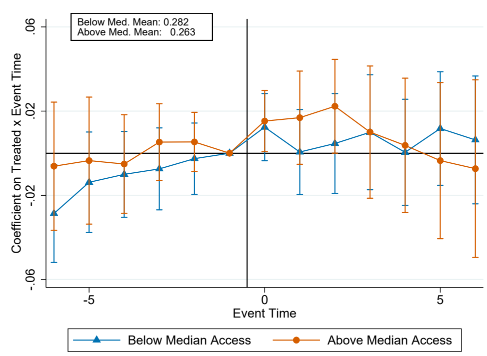
(c) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits, Number of Adjacent Options



(d) Share of Pregnancies with Low ($\leq$ 10) Prenatal Visits, Distance to Alternative



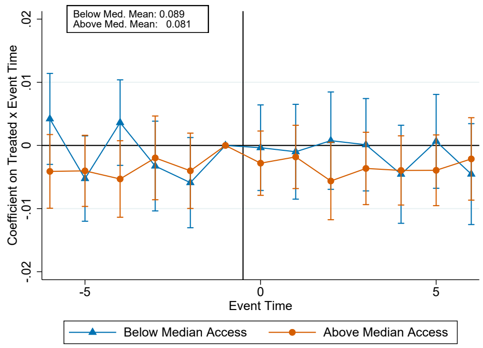
(e) Share of Births Induced, Number of Adjacent Options



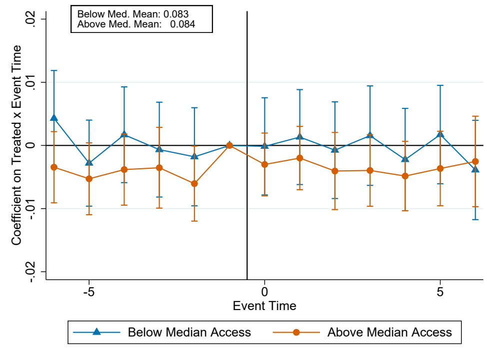
(f) Share of Births Induced, Distance to Alternative

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1) by above/below median access to alternatives. The dependent variable in Panels (a) - (b) is the number of births occurring outside of a hospital, in Panels (c) - (d) is the share of pregnancies with 10 or fewer prenatal visits, and in Panels (e) - (f) is the share of births induced. For each dependent variables, the sample is split above/below median based on access to available alternatives, measured as the number of hospitals with maternity wards in adjacent counties (Panels (a), (c), and (e)) or as the distance to the nearest hospital with a maternity ward (Panels (b), (d), and (f)). Observations are at the county-event time level and are clustered at the county level.

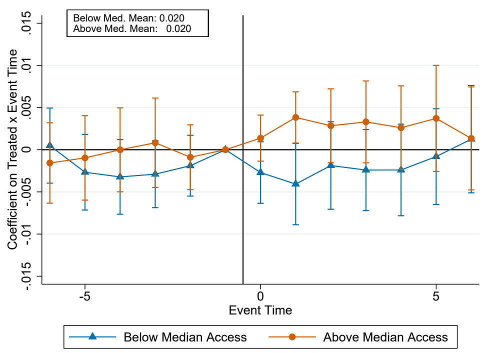
Figure B32: Estimated Impact of Closure by Access to Alternatives



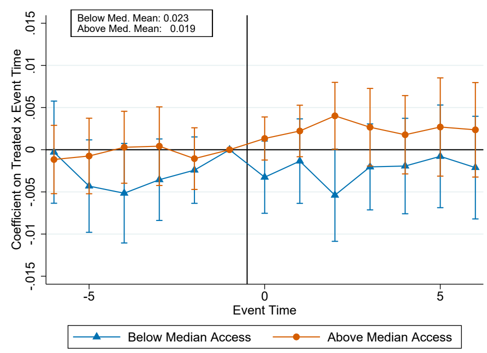
(a) Share of Births Low Birth Weight, Number of Adjacent Options



(b) Share of Births Low Birth Weight, Distance to Alternative



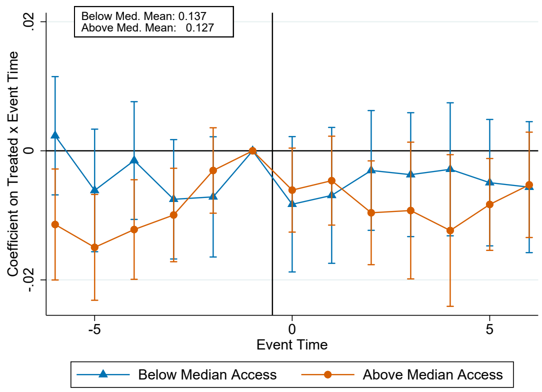
(c) Share of Births With Apgar ≤ 6, Number of Adjacent Options



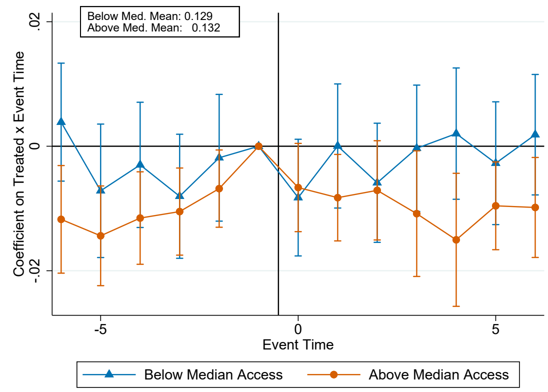
(d) Share of Births With Apgar ≤ 6, Distance to Alternative

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1) by above/below median access to alternatives. The dependent variable in Panels (a) - (b) is the share of births low birth weight and in Panels (c) - (d) is the share of births with an Apgar score less than or equal to 6. For each dependent variables, the sample is split above/below median based on access to available alternatives, measured as the number of hospitals with maternity wards in adjacent counties (Panels (a) and (c)) or as the distance to the nearest hospital with a maternity ward (Panels (b) and (d)). Observations are at the county-event time level and are clustered at the county level.

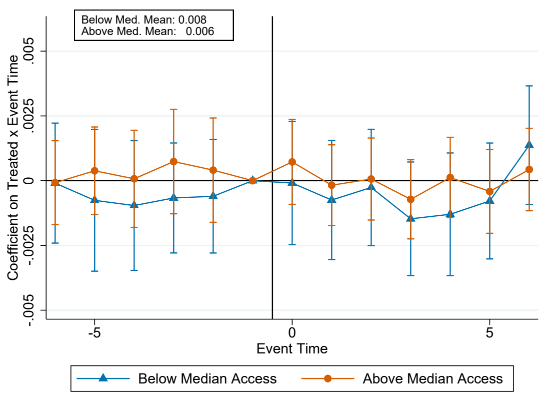
Figure B33: Estimated Impact of Closure by Access to Alternatives



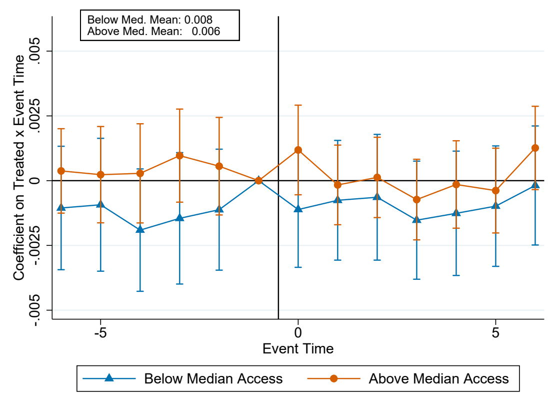
(a) Share of Births Preterm, Number of Adjacent Options



(b) Share of Births Preterm, Distance to Alternative



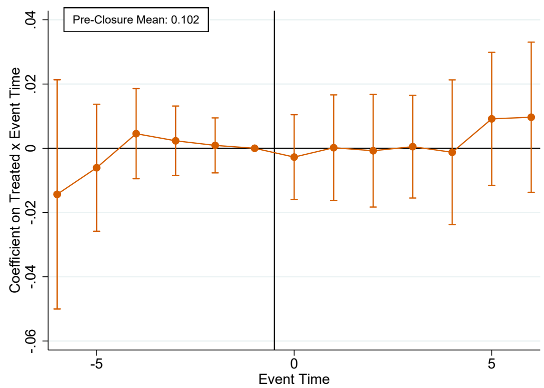
(c) Infant Mortality Rate, Number of Adjacent Options



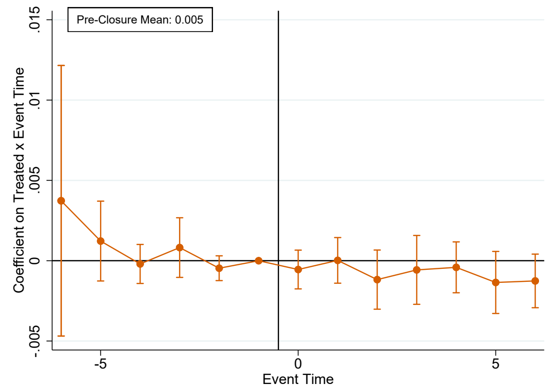
(d) Infant Mortality Rate, Distance to Alternative

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1) by above/below median access to alternatives. The dependent variable in Panels (a) - (b) is the share of births preterm and in Panels (c) - (d) is the infant mortality rate. For each dependent variables, the sample is split above/below median based on access to available alternatives, measured as the number of hospitals with maternity wards in adjacent counties (Panels (a) and (c)) or as the distance to the nearest hospital with a maternity ward (Panels (b) and (d)). Observations are at the county-event time level and are clustered at the county level.

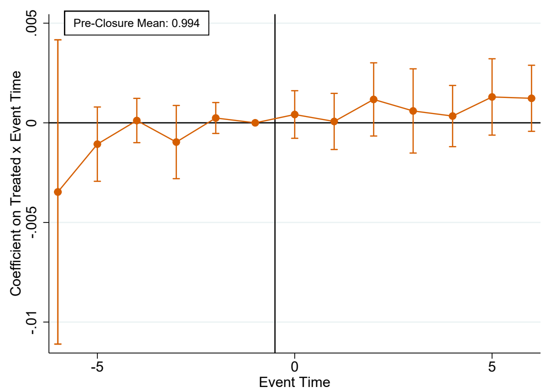
Figure B34: Estimated Impact of Closure on County Births in Receiving Counties



(a) Resident Births Occurring Out of County



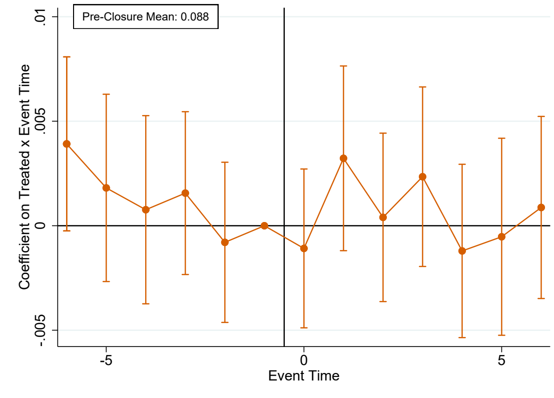
(b) Resident Births Occurring Out of Hospital



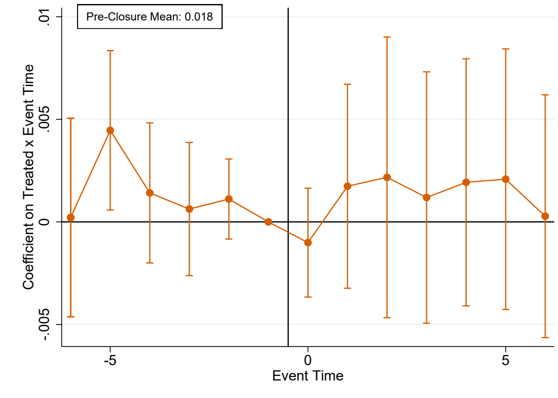
(c) Resident Births Occurring In a Hospital with Maternity Care

Note: In Panels (a) - (c), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating Equation (1). The dependent variable in Panel (a) is the share of births occurring to residents of a county occurring outside of the residence county, in Panel (b) is the share of births occurring outside of a hospital, and in Panel (c) is the share of births occurring in a hospital with an active maternity ward. The sample consists of "receiving counties" as described in the text. Observations are at the county-event time level and are clustered at the county level.

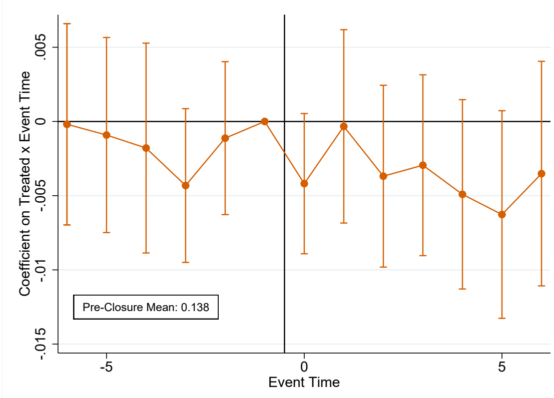
Figure B35: Estimated Impact of Closure on Infant Health in Receiving Counties



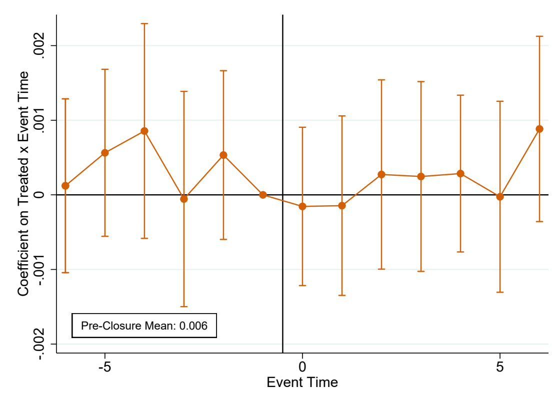
(a) Share of Births Low Birth Weight



(b) Share of Births With Apgar ≤ 6



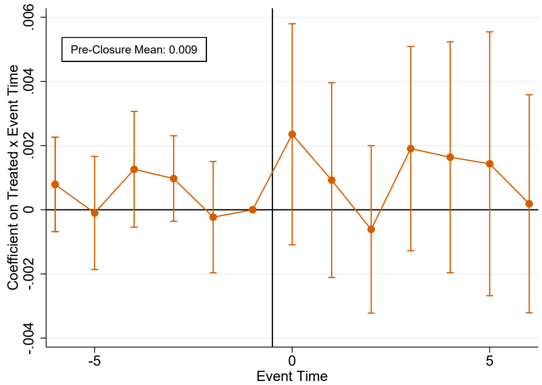
(c) Share of Births Preterm



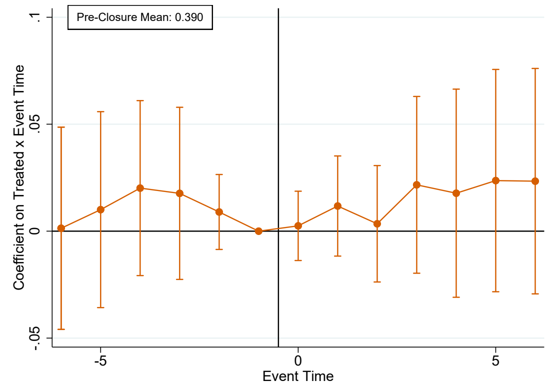
(d) Infant Mortality Rate

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births low birth weight (< 2500 grams), in Panel (b) is the share of births with an Apgar score of 6 or below, in Panel (c) is the share of births preterm (< 37 weeks gestation), and in Panel (d) is the infant mortality rate. The sample consists of "receiving counties" as described in the text. Observations are at the county-event time level and are clustered at the county level.

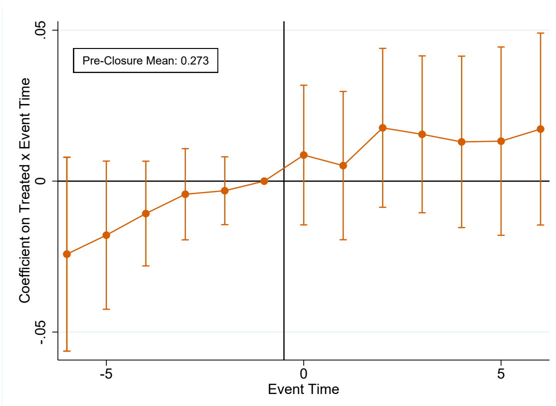
Figure B36: Estimated Impact of Closure on Characteristics of Pregnancy and Birth in Receiving Counties



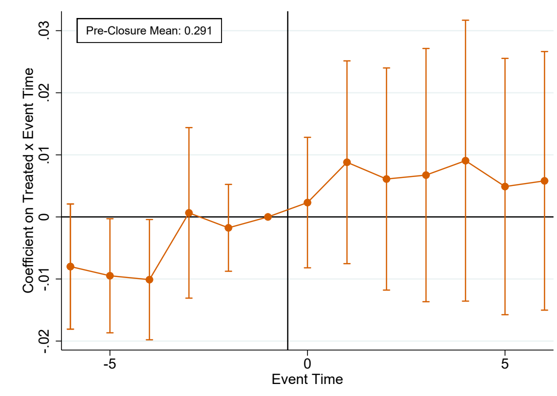
(a) Share of Pregnancies with 1 or Fewer Prenatal Visits



(b) hare of Pregnancies with Low (≤ 10) Prenatal Visits



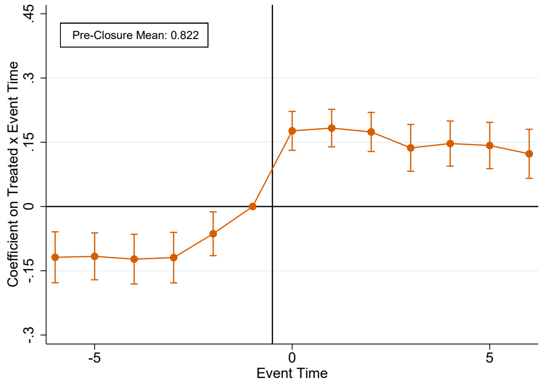
(c) Share of Births Induced



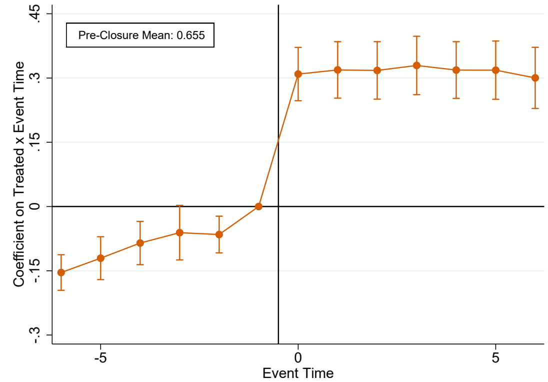
(d) Share of Births Delivered Via Cesarean

Note: In Panels (a) - (d), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable in Panel (a) is the share of births occurring outside of a hospital, in Panel (b) is the share of pregnancies with one or fewer prenatal visits, in Panel (c) is the share of births induced, and in Panel (d) is the share of deliveries that occur via a Cesarean. The sample consists of "receiving counties" as described in the text. Observations are at the county-event time level and are clustered at the county level.

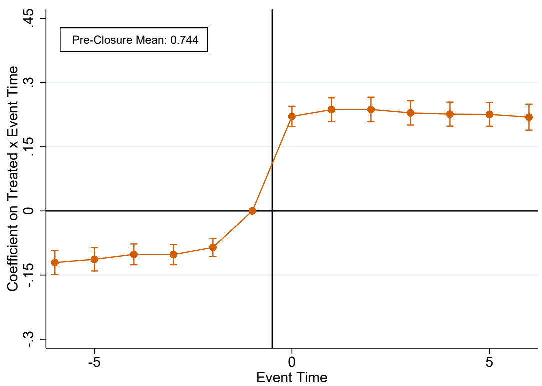
Figure B37: Estimated Impact of Closure on Out-of-County Birth by Subgroup



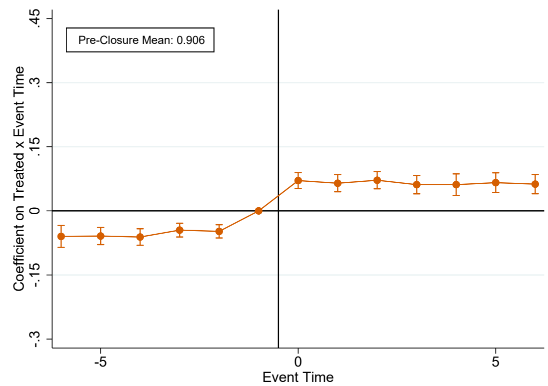
(a) Non-Black Hispanic



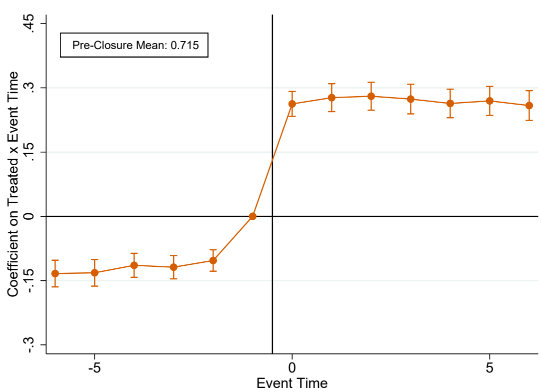
(b) Black



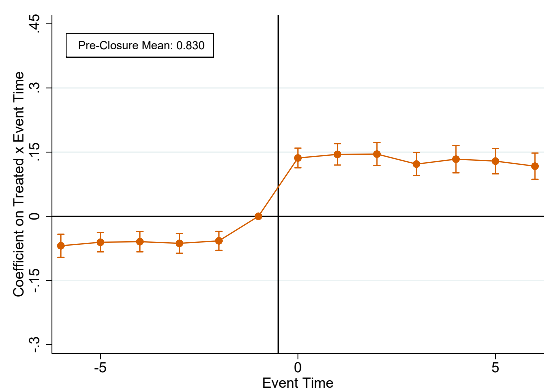
(c) High School or Below



(d) College or Above



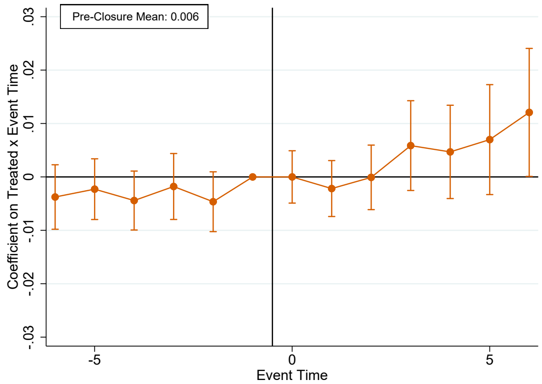
(e) Less Than 20 Years Old



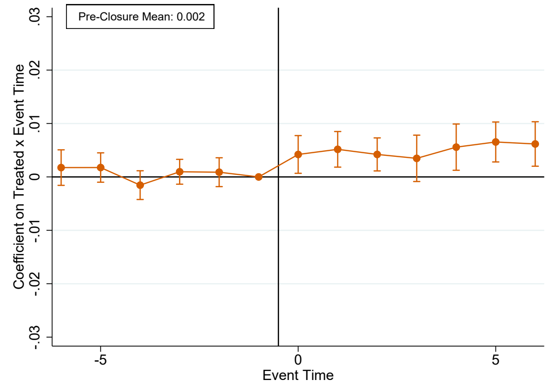
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births occurring out of county. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

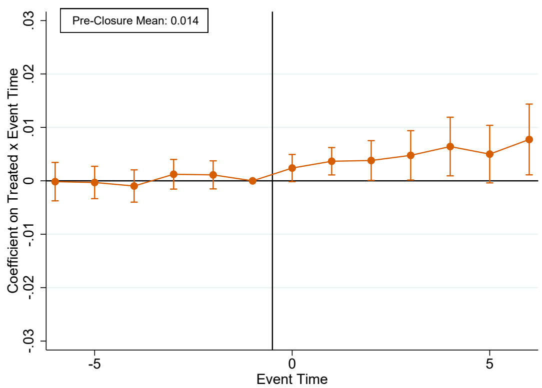
Figure B38: Estimated Impact of Closure on Out-of-Hospital Birth by Subgroup



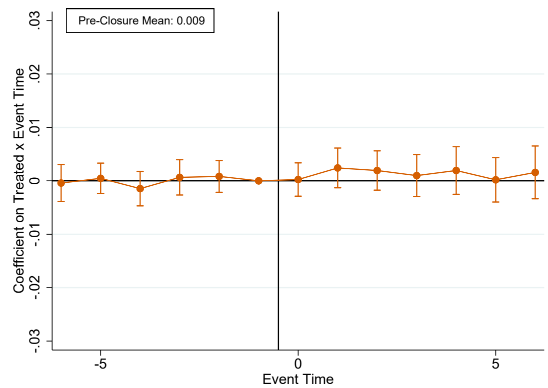
(a) Non-Black Hispanic



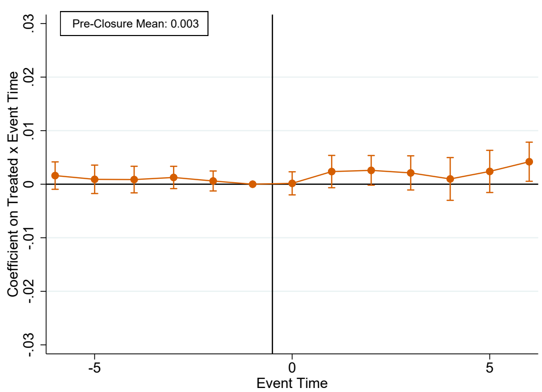
(b) Black



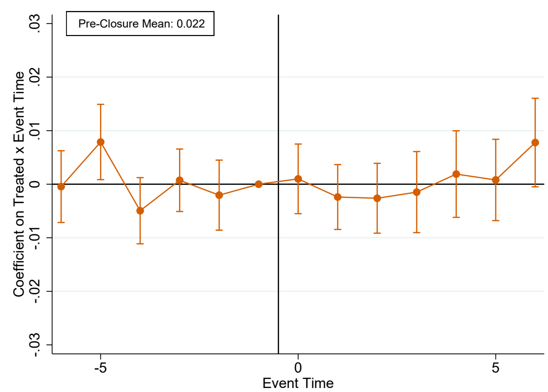
(c) High School or Below



(d) College or Above



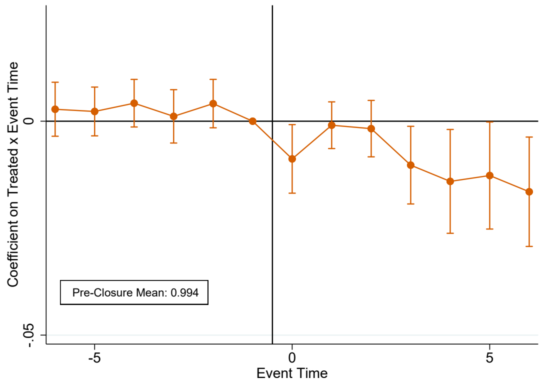
(e) Less Than 20 Years Old



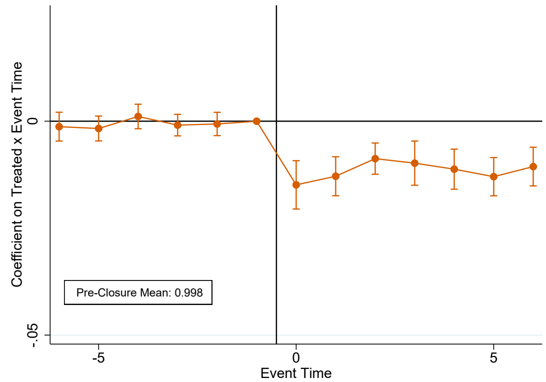
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births occurring out of hospital. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

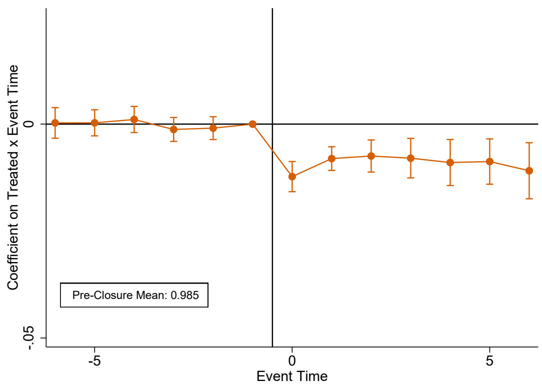
Figure B39: Estimated Impact of Closure on Share of Births in Hospital with Maternity Ward by Subgroup



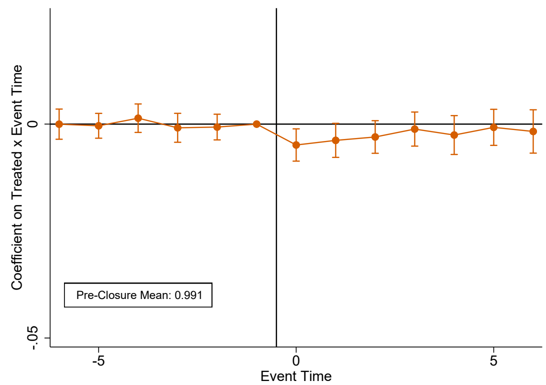
(a) Non-Black Hispanic



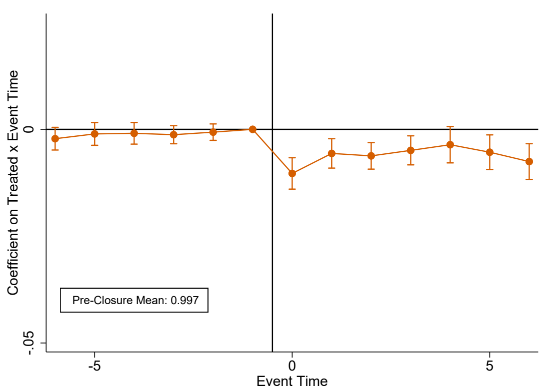
(b) Black



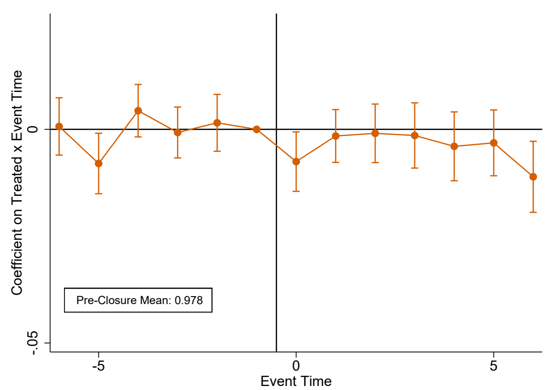
(c) HS or Below



(d) College or Above



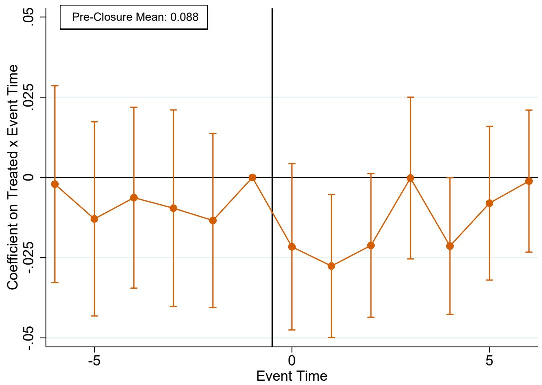
(e) Less Than 20 Years Old



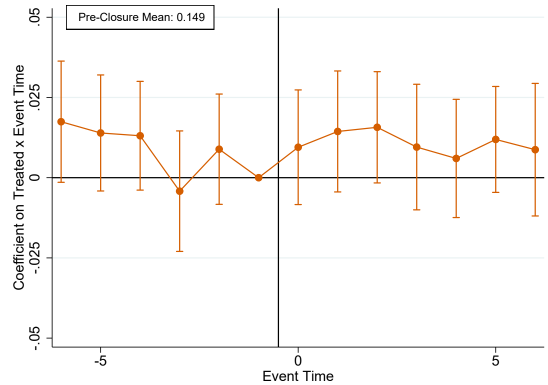
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births occurring in a hospital with a maternity ward. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

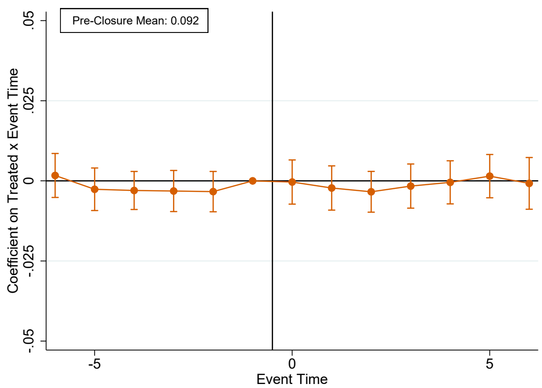
Figure B40: Estimated Impact of Closure on Share of Births Low Birth Weight by Subgroup



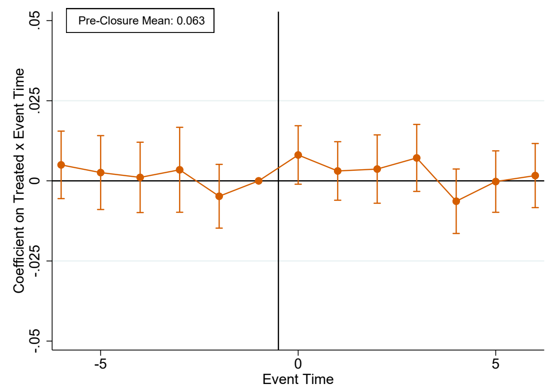
(a) Non-Black Hispanic



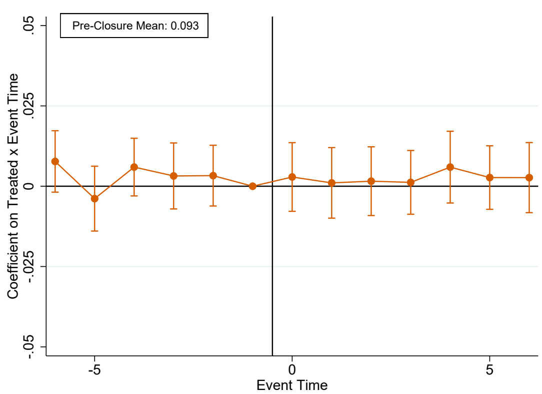
(b) Black



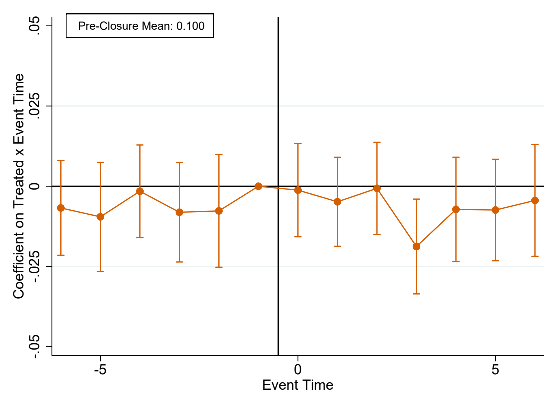
(c) High School or Below



(d) College or Above



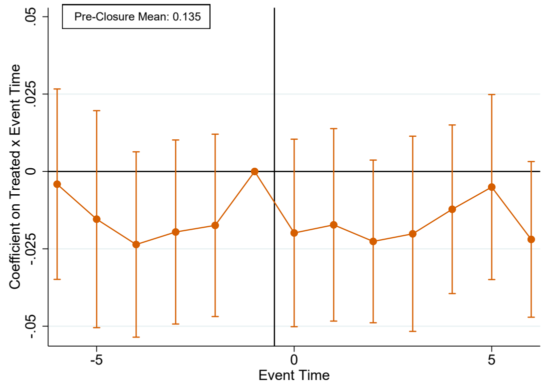
(e) Less Than 20 Years Old



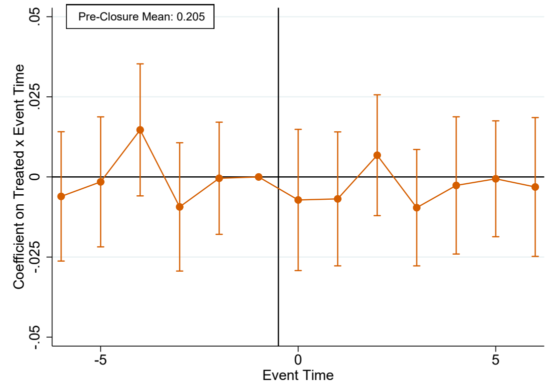
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births low birth weight. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

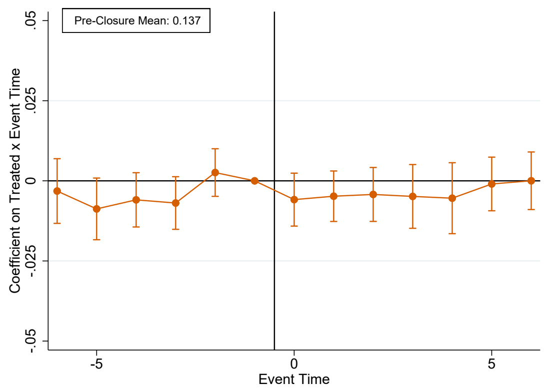
Figure B41: Estimated Impact of Closure on Share of Births Preterm by Subgroup



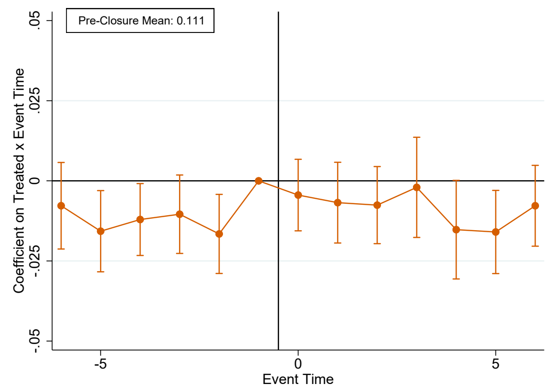
(a) Non-Black Hispanic



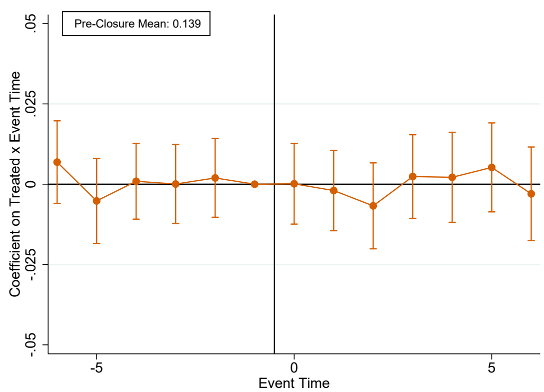
(b) Black



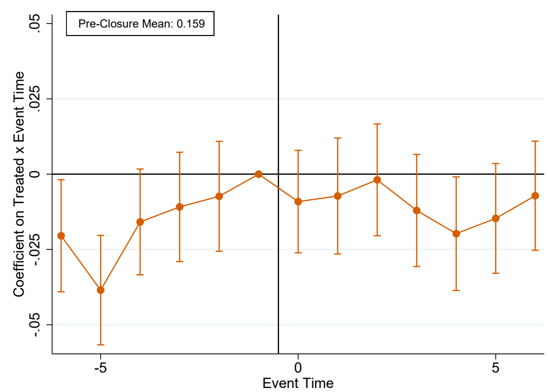
(c) High School or Below



(d) College or Above



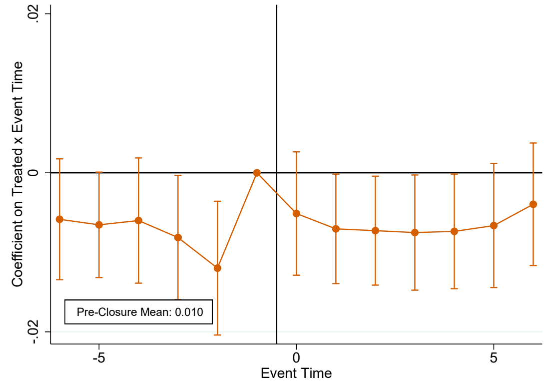
(e) Less Than 20 Years Old



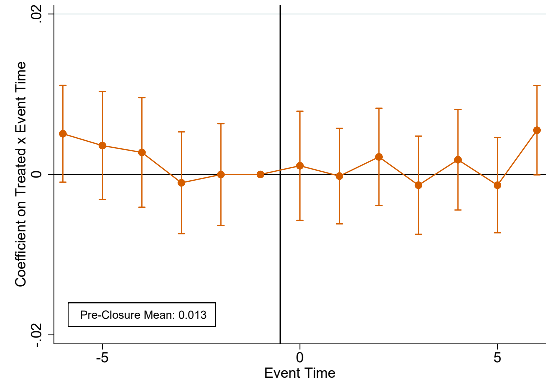
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births preterm. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

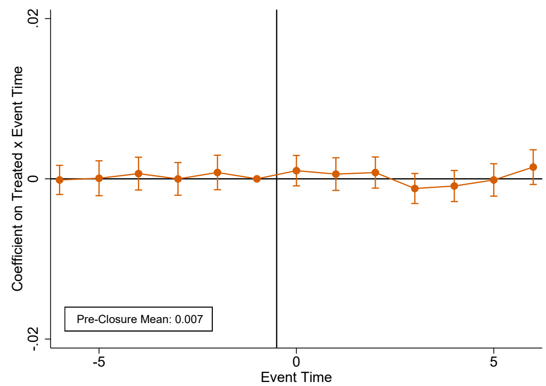
Figure B42: Estimated Impact of Closure on Infant Mortality Rate by Subgroup



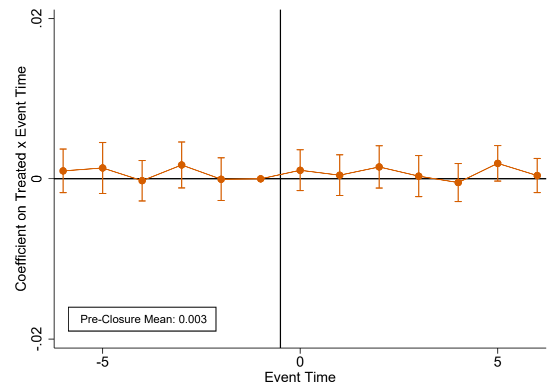
(a) Non-Black Hispanic



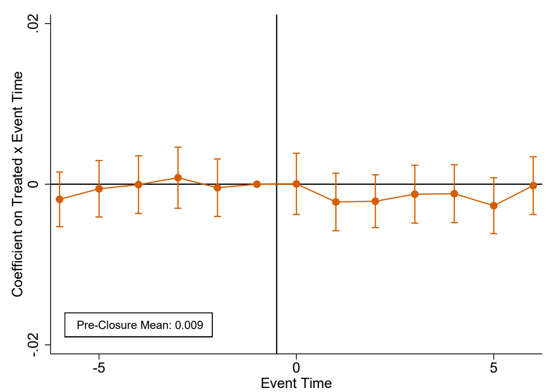
(b) Black



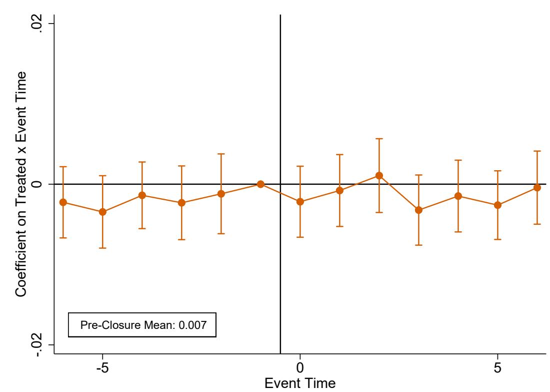
(c) High School or Below



(d) College or Above



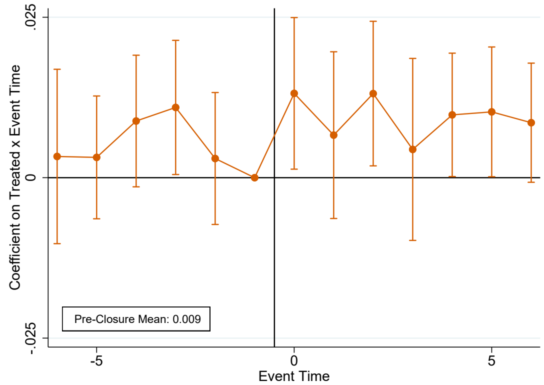
(e) Less Than 20 Years Old



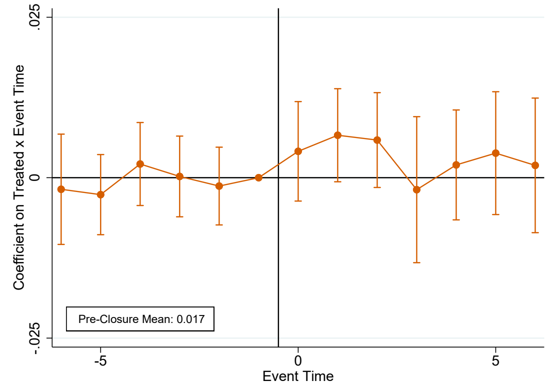
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the infant mortality rate. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

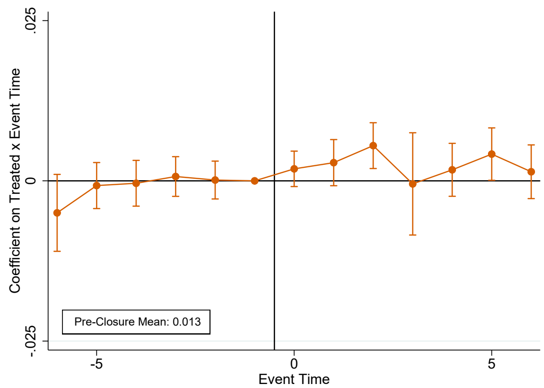
Figure B43: Estimated Impact of Closure on Pregnancies with 1 or Fewer Prenatal Visits by Subgroup



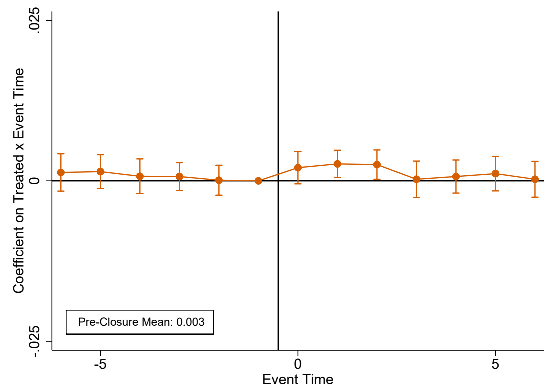
(a) Non-Black Hispanic



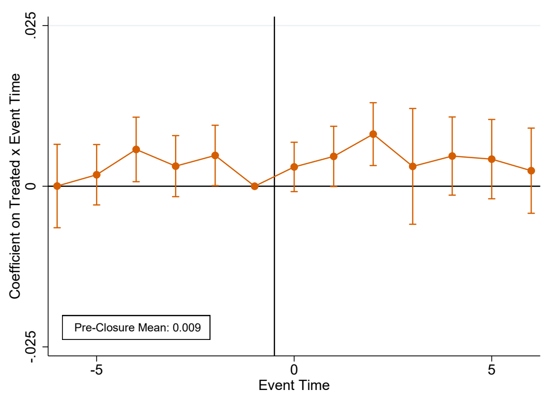
(b) Black



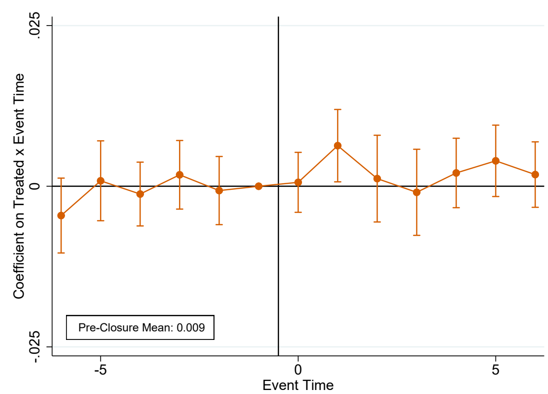
(c) High School or Below



(d) College or Above



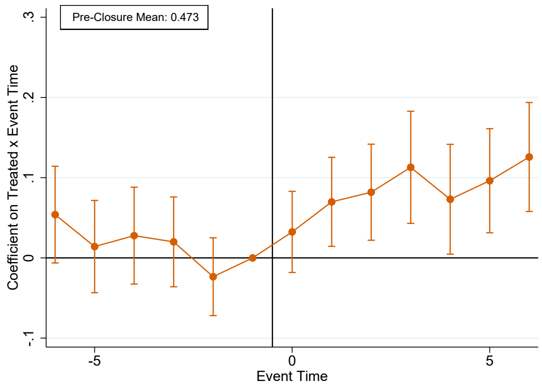
(e) Less Than 20 Years Old



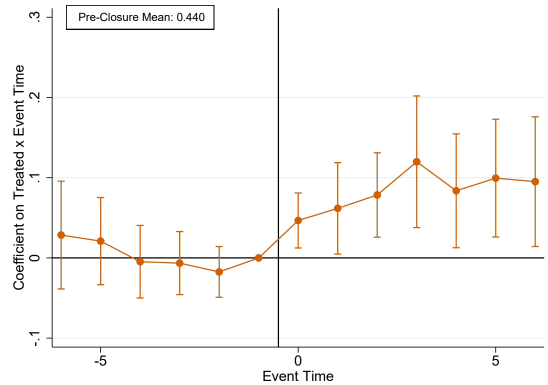
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of pregnancies with 1 or fewer prenatal visits. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

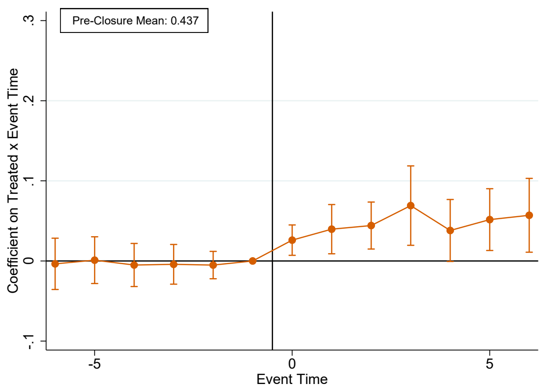
Figure B44: Estimated Impact of Closure on Pregnancies with Low ($\leq$ 10) Prenatal Visits by Subgroup



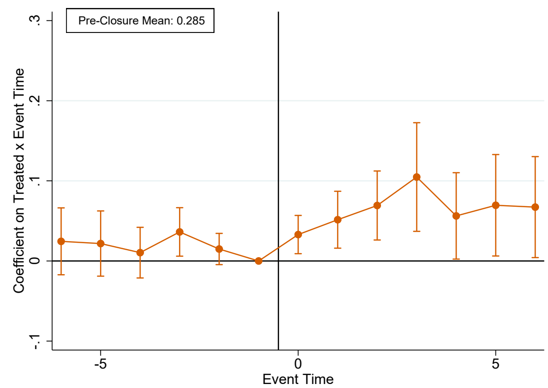
(a) Non-Black Hispanic



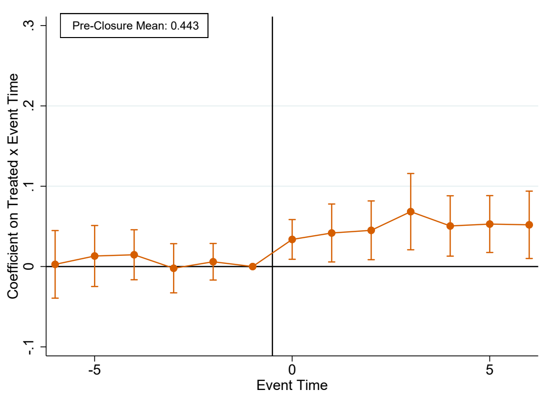
(b) Black



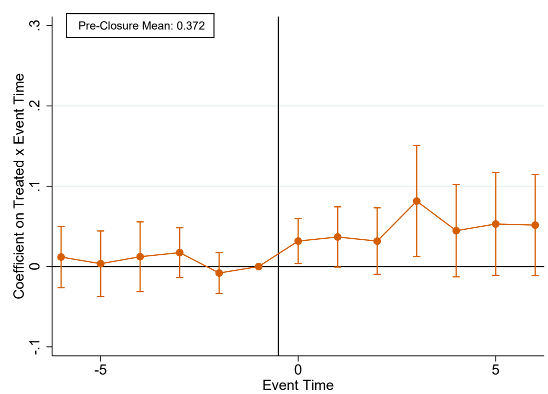
(c) High School or Below



(d) College or Above



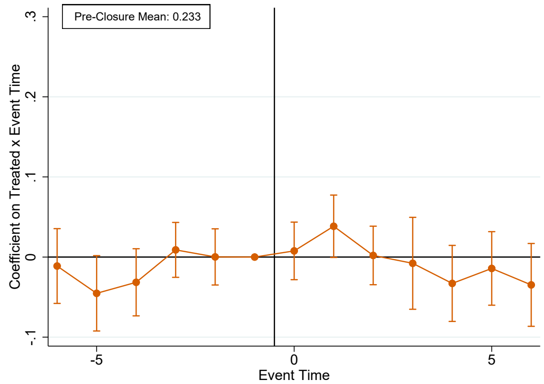
(e) Less Than 20 Years Old



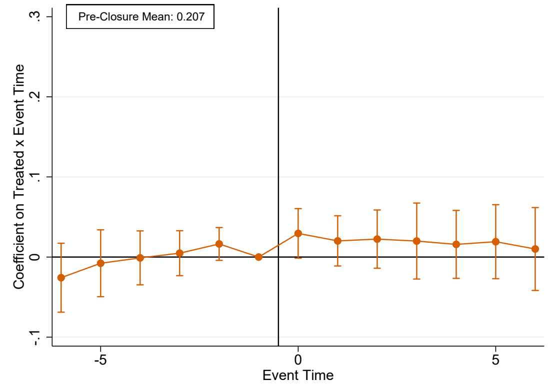
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of pregnancies with low ($\leq$ 10) prenatal visits. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

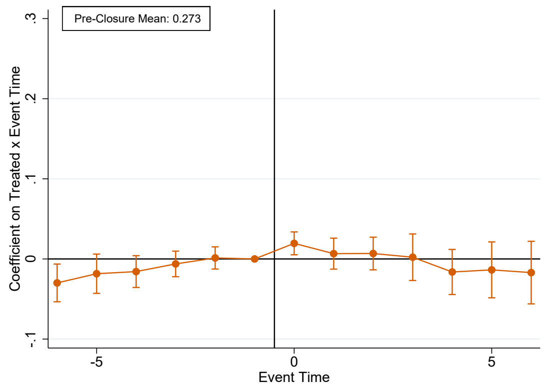
Figure B45: Estimated Impact of Closure on Share of Births Induced by Subgroup



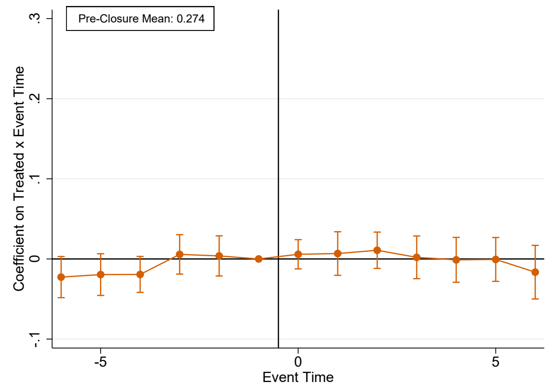
(a) Non-Black Hispanic



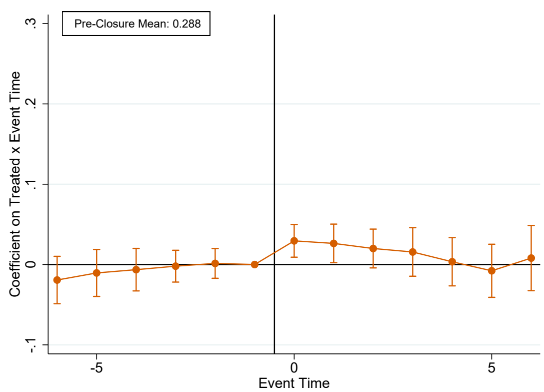
(b) Black



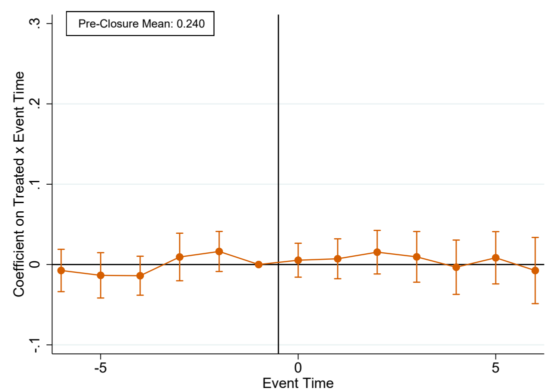
(c) High School or Below



(d) College or Above



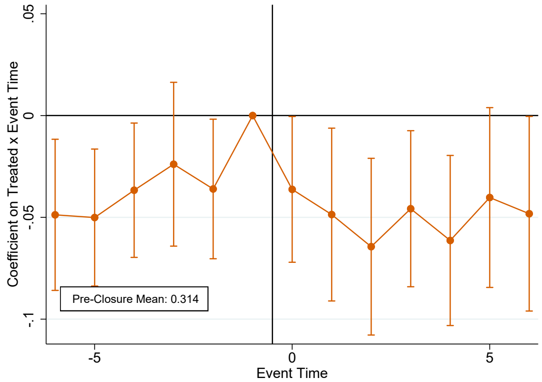
(e) Less Than 20 Years Old



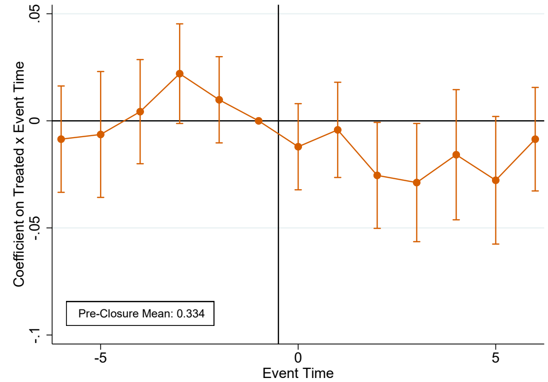
(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births induced. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level

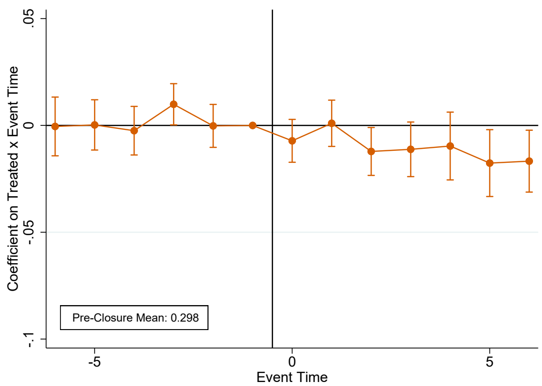
Figure B46: Estimated Impact of Closure on Cesarean Rate by Subgroup



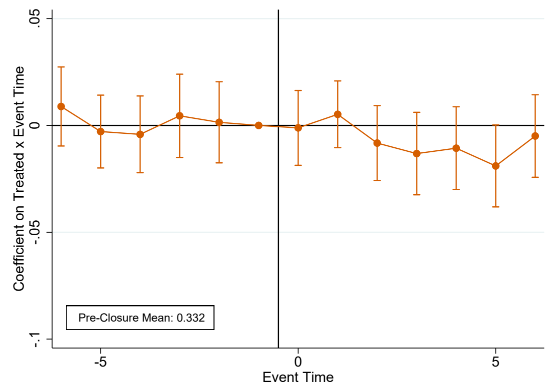
(a) Non-Black Hispanic



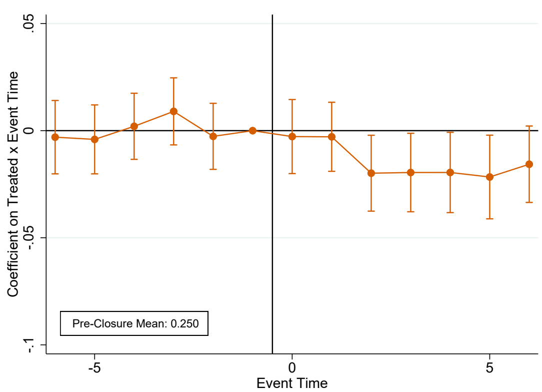
(b) Black



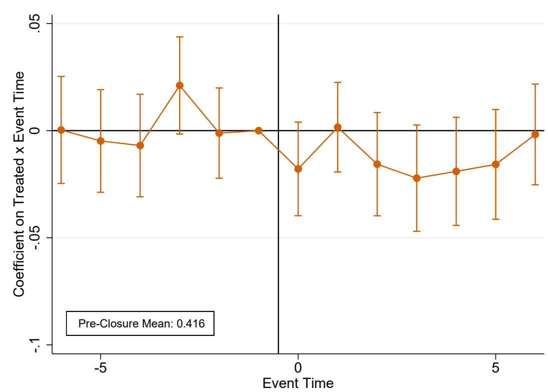
(c) High School or Below



(d) College or Above



(e) Less Than 20 Years Old



(f) More Than 35 Years Old

Note: In Panels (a) - (f), each point, and the associated 95 percent confidence interval, represents the treat-control difference from estimating equation (1). The dependent variable is the share of births delivered via Cesarean. Each panel is estimated on the sample of birth certificates from each county meeting the demographic characteristic listed. Observations are at the county-event time level and are clustered at the county level.

Table B1: Estimated Effect of Closure on Cesarean Rates by Pregnancy Risk

	(1)	(2)	(3)
Panel A: Below Median Risk			
Estimated Effect [0.166]	-0.003	-0.015*	-0.011**
	(0.004)	(0.008)	(0.004)
Observations	9,556	9,556	9,556
Clusters	418	418	418
Panel B: Above Median Risk			
Estimated Effect [0.768]	-0.014	0.001	-0.003
	(0.009)	(0.011)	(0.009)
Observations	9,529	9,529	9,529
Clusters	418	418	418
County FE	Yes	Yes	Yes
Event Time FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table presents results from estimating Equation (1) with the dependent variable being the rate of Cesarean births in a county. Panel A estimates (1) for low-risk women (Predicted Probability of Cesarean ≤ 0.30) and Panel B estimates (1) for high-risk women (PPC > 0.30). The estimated effects in Columns 1, 2, and 3 correspond to β_0, β_5, and the post-period average of the β_τ coefficients, respectively. The PPC is estimated as described in the text, without using the presence of diabetes or hypertensive disorders as inputs. The treatment group's average Cesarean rate in event time $\tau = -1$ is displayed in brackets. Standard errors are clustered at the county level. Stars report statistical significance: *** = p-value < 0.01, ** = p-value < 0.05, * = p-value < 0.1.