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ABSTRACT

In this paper, we test whether the Affordable Care Act Medicaid expansions are associated with in-hospital maternal morbidity. The ACA expansions may have affected maternal morbidity by increasing pre-conception access to health care, and by improving the quality of delivery care through enhancing hospitals' financial positions. We use difference-in-difference models in conjunction with event studies. Data come from individual-level birth certificates and state-level hospital discharge data. The results show little evidence that the expansions are associated with overall maternal morbidity or indicators of specific adverse events including eclampsia, ruptured uterus, and unplanned hysterectomy. The results are consistent with prior research showing that the ACA Medicaid expansions are not statistically associated with pre-pregnancy health or maternal health during pregnancy. Our results add to this story and find little evidence of improvements in maternal health upon delivery.

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Introduction

Against a backdrop of declining infant mortality rates, a discordant new trend has emerged in the United States -- maternal mortality (MM) and severe maternal morbidity (SMM) rates are rising. Maternal mortality has increased by an estimated 58 percent over the last two decades, and severe maternal morbidity, that is, unexpected severe complications of labor and delivery, increased by 170 percent during the same time period (WHO 2019; Premier 2019). These trends are unique to the U.S., with no other industrialized countries experiencing increases in maternal mortality in recent years (WHO 2019).

Rising rates of MM and SMM may highlight an unmet need for continuous and comprehensive health insurance coverage for women long before pregnancy begins and well after childbirth (Searing and Ross, 2019). This is particularly true for low-income older mothers, since both low SES and advanced maternal age are risk factors for adverse maternal outcomes (Gray et al. 2012; Dahal et al. 2017). Also, there is growing evidence about the importance of pre-conception health care for mothers (Johnson et al., 2006; Barry, 2011).

The primary source of insurance coverage for low-income mothers in the U.S. is Medicaid. Current federal law requires states' Medicaid programs to cover low-income pregnant women up to 138% of the federal poverty line (FPL) although many states' cutoffs exceed this minimum. As of 2018, Medicaid paid for 43% of all births (MACPAC, 2020). Prior to the Affordable Care Act (ACA) expansions, Medicaid only covered eligible pregnant women from conception to 60 days post-partum, leaving large numbers of low-income women uninsured and/or switching between insurance plans prior to conception and after the 60-day post-delivery period has ended (Daw et al., 2019).

In 2014 and later, under the Affordable Care Act, 39 states (including DC) expanded Medicaid thresholds to include childless low-income adults (KFF, 2020a). Although not targeted at new mothers specifically, ACA Medicaid expansions may have improved the continuity of Medicaid coverage from the pre-conception to the post-partum period by expanding eligibility to all adults with incomes below 138% of the FPL (Daw and Somers, 2019). This group previously had little access to Medicaid. Estimates based on pre-ACA expansion data suggest that more than half of women who had Medicaid-covered deliveries lost coverage in the months following childbirth; these women likely would retain coverage, and also likely would have had pre-conception coverage, if living in a state that expanded Medicaid under the ACA (Daw et al. 2017; KFF, 2013).

Expanding access to health insurance has the potential to increase women's access to and receipt of care prior to conception. Studies have shown that the ACA Medicaid expansions led to increases in Medicaid enrollment among women of reproductive ages, and if the new access to care results in the identification and management of chronic health conditions, women may enter pregnancy in better health (Johnson et al. 2018, Clapp et al., 2018; Geiger et al., 2021; Lyu and Wehby 2021). In addition, there is evidence that the ACA expansions have improved hospitals' financial positions (Dranove et al. 2017; Guth et al. 2020; Moghtaderi et al. 2020). Whether the financial improvements translate to improved health outcomes is still unknown; however, one study finds that ACA expansion is associated with improvements in nurse staffing ratios and decreases in readmission rates (Tarazi 2020).

The purpose of this paper is to test whether the ACA Medicaid expansions are associated with severe maternal morbidity. We envision that one causal pathway operates through women's increased enrollment in Medicaid during the pre-conception period, which in turn may affect health status during pregnancy and, ultimately, maternal health outcomes measured at the time of childbirth. Another potential pathway is Medicaid expansion improving quality of in-hospital care at delivery, leading to better outcomes at the time of childbirth. We use two sources of data on SMM: 1) individual-level data from the National Vital Statistics System Birth Certificates, and 2) state-level data on SMM rates from the Healthcare Cost and Utilization Project (HCUP). The advantage of the individual-level birth certificates data is the individual characteristics allow us to select a sample that is highly likely to be affected by the ACA Medicaid expansions. The disadvantage is the birth certificates contain only a limited set of SMM-related outcomes available for analyses. On the other hand, the state-level HCUP data provides high-quality information on SMM rates over time, but do not have information on local or individual characteristics. We use difference-in-difference models and event studies to evaluate the effects of the ACA Medicaid expansions. The results from both data sets are consistent and show little evidence that the expansions improved SMM.

Background

Severe maternal morbidity represents “unintended outcomes of the process of labor and delivery that result in significant short-term or long-term consequences to a woman’s health” (Kilpatrick et al 2016). The CDC identifies SMM through twenty-one diagnosis and procedure codes in combination with hospital discharge data to identify delivery hospitalizations (CDC 2022). In this study, we focus on SMM rather than maternal deaths since SMM is much more common, and maternal mortality is often hard to identify in existing data sources (MacDorman et al. 2016).

The medical causes of pregnancy-related morbidity and deaths include hemorrhage, hypertensive disorders of pregnancy, infection, embolisms, anesthesia complications, cardiovascular conditions, cardiomyopathy, cerebrovascular accident, and non-cardiovascular medical conditions (Creanga et al., 2015). What remains unknown is why SMM rates have been rising since the late 1990s (Creanga et al. 2012, 2014; Moaddab et al., 2014; Grobman et al. 2015). Much of the current research focuses on identifying individual-level, proximal risk-factors for SMM. Obesity, older maternal age, smoking, and comorbid chronic health conditions are all risk factors for SMM (Freese et al. 2020). Low socioeconomic status is also a risk factor, and racial disparities in SMM, which are well-documented, may be related to factors such as poor quality medical care and structural racism (Grobman et al. 2014; Howell et al. 2016; Liu et al. 2019). Geography may play a role in that women residing in the most urban and the most rural areas of the U.S. also have elevated rates of SMM (Luke et al. 2021).

The proximal correlates of SMM may be useful as markers to monitor for SMM, but we do not yet have a good understanding of why many women start pregnancy in poor health or what underlying factors affect labor and delivery and lead to SMM. In a comprehensive review of maternal deaths, researchers find that the most common factors underlying preventable maternal deaths are related to patients, providers, and systems of care (Building U.S. Capacity to Review and Prevent Maternal Deaths, 2018). Patient factors include chronic conditions such as obesity, and lack of knowledge of warning signs and the need to seek care. Provider factors include delay in diagnosis and effective treatment, missed diagnosis, and ineffective treatments. System factors include inadequate training, unavailable personnel, and lack of coordination between providers in patient management.

The ACA Medicaid expansions may influence the health of the mother entering pregnancy and the quality of care during labor and delivery. If the expansions lead to more affordable and accessable health care, women may enter pregnancy in better health. If the expansions also improve hospital finances and affect the available resources, this in turn could lead to better outcomes for women at delivery. However, it is not clear the extent to which these mechanisms could affect the relatively rare SMM outcomes, and thus we investigate the relationship empirically.

Medicaid: Medicaid is a public health insurance program that primarily serves low-income adults, pregnant women, children, and disabled individuals. Medicaid programs are administered by states under federal guidelines and are jointly funded by states and the federal government (Medicaid, 2020). In recent years, Medicaid paid for about 43% of births in the US, with tremendous variation across states (MACPAC, 2020). For example, as of 2018-2019, Medicaid paid for 28% of births in Utah but paid for 71% of births in New Mexico (KFF, 2020b). Differences in the percentages of Medicaid-covered births across states are due to differences in income eligibility and other Medicaid program characteristics (e.g., payment rates to providers, enrollment/renewal processes) across states, as well as to differences in the SES and demographic characteristics of mothers and economic conditions across states.

Eligibility for Medicaid for pregnant women originally was tied to eligibility for Aid to Families with Dependent Children (AFDC). However, starting in the mid-1980's, changes in federal law required states to cover larger populations of low-income pregnant women and children, ultimately allowing states to cover pregnant women and children up to 185% of the federal poverty line (FPL) (Gruber, 1996). Some states expanded eligibility further without matching funds from the federal government. For low-income parents, Medicaid eligibility also expanded, but remained stringent, at less than 100% of the FPL. As a result, particularly between 1989 and 1997, there was a large increase in the percent of pregnant women eligible for Medicaid, as all states increased thresholds, although to varying degrees and at different times. Although the expansions covered prenatal care and delivery, many women were uninsured before getting pregnant and after the delivery, critical time periods for health.

The passage of the Patient Protection and Affordable Care Act (ACA) in 2010 led to another period of state variation in Medicaid expansions, but in this period, expansions targeted non-elderly adults up to 138% of the FPL (although the expansions extended coverage up to 133% of the FPL, this translates into 138% for most applicants since states now use Modified Adjusted Gross Income for eligibility, which involves a 5% disregard of income) (NCSL 2011). Whereas during the prior expansions, states were expanding thresholds to varying levels, the ACA expansions involved more consistent expansions of thresholds across 39 states with most expansions occurring in 2014 or shortly after (see Table 1).

Unlike early expansions, the ACA expansions did not specifically target pregnant women, but they may still impact maternal health through expanded coverage to adults in the pre-conception period and post-delivery period. Studies have shown that the ACA Medicaid expansions led to increases in Medicaid enrollment among women of reproductive ages (Johnson et al. 2017, Clapp et al., 2018; Geiger et al., 2021; Lyu and Wehby 2021). If the new access to care results in the identification and management of chronic health conditions, women may enter pregnancy in better health. There is some evidence that the expansions accomplish these goals. Johnson et al. (2018) find that low-income women of reproductive age are more likely to have a personal doctor and less likely to face cost-based barriers to care after the Medicaid expansions. Myerson et al. (2022) finds that the expansion is associated with increased pre-conception health counseling and folic acid intake. However, this study along with Geiger et al. (2021), find no effects of the ACA expansions on diagnoses of diabetes or hypertension among low-income women of reproductive age.

Another pathway through which the ACA expansion may affect maternal health and SMM is via improved in-hospital financial positions and patient care. Previous research has shown that the Medicaid expansion reduced uncompensated care costs in hospitals, and that this effect was larger among hospitals that treat a disproportionate share of low-income individuals (Dranove et al. 2017; Camilleri 2018; Guth et al. 2020; Guth and Ammula 2021). Other studies find that the expansion is associated with improved hospital financial performance and improved operating margins, although the magnitude of the improvements may vary among urban and rural hospitals (Moghtaderi et al. 2020; Rhodes et al. 2020; Guth et al. 2020; Blavin and Ramos 2021; Guth and Ammula 2021). There is not much literature on how hospitals use the savings; however, Tarazi (2020) shows that the expansion is associated with improvements in nurse staffing ratios. Whether the financial improvements translate to improved health outcomes is still an open question. Tarazi (2020) finds decreases in 30-day Medicare readmission rates while Chatterjee et al. (2021) shows no improvements in hospital associated infections, mortality, and re-admission rates associated with the ACA expansion in safety-net hospitals. Nevertheless, the changes in the financial stability of hospitals and possible quality improvements may be a pathway through which the ACA expansions affect SMM.

Previous Literature on the Effects of the ACA Medicaid Expansions on Maternal Health.

While there exist hundreds of studies on the effects of ACA Medicaid expansions, only a few specifically focus on maternal health (Bellerose et al. 2022). Three recent papers are highly relevant to our study; studies by Palmer (2020), Margerison et al. (2021), and Eliason (2020), all of which address the question of whether the ACA Medicaid expansions affected different aspects of maternal health. Palmer (2020) and Margerison et al. (2021) both use the Vital Statistics birth certificate data to examine the effects of ACA Medicaid expansions on a variety of maternal and infant health outcomes. Margerison et al. (2021) examine measures of pre-pregnancy health (cigarette smoking, BMI, diabetes, hypertension); health and health behaviors during pregnancy (timing of prenatal care, cigarette smoking, diabetes, hypertension, eclampsia) and infant health outcomes (preterm birth and birth weight for gestational age). Palmer (2020) examines many of the same maternal and infant outcomes, along with use of anesthesia during childbirth, Cesarean section, NICU admission, and breastfeeding. Neither paper examines indicators of SMM other than eclampsia, which is studied by Margerison et al. (2021).

Palmer (2020) measures Medicaid expansion with a simulated eligibility measure reflecting the proportions of women in certain demographic groups who would be eligible under different state rules. She presents all results separately by race/ethnicity and finds that increasing the share of eligible women is associated with: 1) a small increase in first trimester prenatal care among Whites and Blacks; 2) reduced pre-pregnancy and third trimester smoking among Black women; and 3) an increase in C-sections among Black women. The Medicaid expansions are statistically unrelated to gestational diabetes and hypertension, use of anesthesia, NICU admissions, and breastfeeding.

Margerison et al. (2021) first measure Medicaid expansion by an indicator variable for conceptions that occurred at least a year post expansion versus conceptions that are timed within a year or less or no expansion. The authors also adjust the timing to reflect 6 months and 2-year windows. The second measure of expansion used is a simulated probability that the mother was

Medicaid eligible prior to pregnancy. The authors' primary conclusion is that there are no improvements in maternal and infant health outcomes associated with the expansions.

By contrast, Eliason (2020) finds that the ACA expansions are associated with reductions in the rate of growth of maternal morbidity. Using data from the National Center of Health Statistics Underlying Cause of Death files and a difference-in-difference framework, Eliason estimates a reduction in maternal deaths of about 7 per 100,000 in expansion states. One limitation to this study is concerns about the accuracy of cause-of-death information on the death certificates (MacDorman et al. 2016).

Our study adds to this literature by focusing on severe maternal morbidity. SMM is much more common than maternal mortality and has serious, long-term health implications for mothers and children. We recognize that the expansions can affect SMM through both pre-pregnancy health and improved quality of care at delivery. We utilize nuanced measures of Medicaid expansion by evaluating the effects of the different length of time eligible for women without children during the pre-conception period. We present some results among different groups of women in order to see if certain women can be affected differentially by the Medicaid expansion. Overall, our results concur with Palmer (2020) and Margerison et al. (2021) and differ from those of Eliason (2020). We find no evidence that the Medicaid expansions altered SMM as defined by the incidence of SMM conditions and by state SMM rates.

Data and Measures

Data on maternal health outcomes come from two sources. The first is individual-level data from the National Vital Statistics System Birth Certificates and the second is state-level data on SMM rates from Healthcare Cost and Utilization Project (HCUP). The advantage of the birth certificate data is that the individual-level data allows us to account for some individual characteristics as well as enabling us to select a sample that is likely to be affected by the ACA Medicaid expansions. The disadvantage is the limited number of health outcomes available (described below). The state-level HCUP data provides high-quality information on SMM rates over time, but without allowing us to include local or individual characteristics. The conclusions from this study will be drawn with consideration of both sets of results.

Birth Certificates: The National Vital Statistics System Birth Certificates provides individual-level data on adverse health outcomes associated with labor and delivery. Termed "SMM conditions", these items are components of the CDC's definition of SMM (CDC 2022). These outcomes include blood transfusion; ruptured uterus; unplanned hysterectomy; and eclampsia. We also include admission to intensive care unit, which is not part of the 21 diagnoses/procedures identified by CDC as part of SMM but nevertheless indicates that a serious adverse health event has occurred. The dependent variables we analyze are indicator variables for 1) the presence of any of these morbidities; 2) the presence of any of these morbidities excluding blood transfusion (as per an alternative definition of SMM from CDC); and 3) indicator variables for each component individually.

We used data for births occurring in 2011-2018. These years include both pre and post periods for the ACA Medicaid expansions. We do not use earlier years of the data because earlier revisions of the birth certificate forms resulted in many states with missing values for the maternal morbidity measures as states adopted the new form. This issue also necessitates the deletion of eight states from all models due to lack of data in 2011-2013 (details are in Table 1). The estimation sample consists of twenty treatment states and eighteen control states.

In the pre-conception period, women fall into two broad Medicaid eligibility categories based on family status. If the woman has no prior births, she falls into the eligibility group of childless adults. This is the group that is specifically targeted by the ACA Medicaid expansions. Depending on the state and year, low-income women in this group may have had no options for public health insurance and may have benefited from the ACA Medicaid expansion. Women with children fall into a different Medicaid eligibility category for parents. Again, depending on the state and year, low-income women in this group may have been already eligible for Medicaid, making the expansion less relevant for them. Using information on the birth certificate data on number of prior live births, we limit the sample to women who experience a first birth in order to help identify the group of women more likely to be affected by the ACA expansions.

We also limit the sample to women ages 21 and up to avoid teenage pregnancies and the different insurance eligibility rules for these young women. Further, we limit the sample to singleton births since mothers giving birth to multiple children are likely to face different pregnancy and delivery conditions. Limiting to singletons is also useful to eliminate the potentially confounding role of assisted reproductive technology that is more commonly used by older mothers. A difficulty to using birth certificate data is identifying women who are eligible for Medicaid. To address this, we limit the sample to women with fewer than four years of college, that is, those who have an associate degree, a high school degree, or less.[1] This limitation increases the likelihood that women in the sample are eligible for Medicaid, but we

[1] Beginning in 2014, the birth certificates report payment source for delivery. Using this information, we calculate that of all women on Medicaid, 87% have a high school degree or less, and 94% have less than a college degree. Looking at this another way, of the women with less than a college degree, 57% have Medicaid, and of the women with a high school degree or less, 61% have Medicaid.

have no way of knowing whether those who are eligible enroll in the program. Thus, we estimate intent-to-treat effects. In auxiliary models, we further restrict the sample to unmarried women who presumably do not have spousal income and therefore may be more likely to be Medicaid eligible. Lastly, we test some models where we limit the sample to mothers ages 26 and up in order to avoid the confounding issue of the dependent coverage provision of the ACA. However, none of these sample restrictions appreciably affects the results.

The birth certificates include a limited set of maternal demographic characteristics including age, race/ethnicity, marital status, years of education. These are included in all models, and observations with missing values are preserved with an indicator variable for missing. We also include method of delivery (C-section vs. vaginal birth) in order to account for conditions surrounding delivery. Using the mother's county of residence available on the birth certificates, we also include time-varying controls for county-level health resources and economic conditions: the number of primary care physicians and obstetrician/gynecologists per capita, hospital capacity measured by number of bassinets per capita, the county unemployment rate, county real per capita income, and the percent of the county population living in poverty. These county-level variables all come from the Area Health Resource File.

Table 2 shows the means of the dependent variables for our sample of women with first births along with the other included variables. SMM conditions are rare, with only 0.9% of women experiencing any of the conditions. Eclampsia is the most common with 0.3% of women experiencing this condition. About 23 percent of the sample is observed after the ACA expansions are in effect, with 6 percent of the women exposed for less than a year and 17 percent exposed for more than a year.

State Severe Maternal Morbidity Rates: The Healthcare Cost and Utilization Project provides 'fast stats' on SMM rates by state for the years 2010-2020 (HCUP May 2022). These data are drawn from the HCUP State Inpatient Databases, which contain the universe of state hospital inpatient discharge records for patients treated in community hospitals. Rates of SMM represent the experiences of female patients ages 12-55. The numerator is the number of discharges in the state with a diagnosis or procedure indicating SMM according to the definition of CDC (2022), excluding blood transfusion. The denominator is the corresponding number of discharges indicating an in-hospital delivery. HCUP provides SMM rates for all inpatient deliveries and by select patient and hospital characteristics. These sub-groups include age, expected payer, community income level, safety-net hospital status, hospital location/teaching status, and hospital delivery volume. Rates by race are also reported, but unfortunately not until 2016 which is after the enactment of the ACA Medicaid expansions. Four states (AK, DE, DC, and MS) also have no reported SMM rates prior to 2014 and are therefore excluded. Table 3 shows the means of these SMM rates and Figures 1a and 1b shows select rates over time. The upward trends in SMM for all women and for select subgroups can be clearly seen from these figures.

ACA Medicaid expansions.

The primary variables of interest reflect Medicaid access/eligibility in the pre-conception period. We focus on the pre-conception period in order to evaluate whether insurance in this period translates to improved maternal outcomes at delivery. The mechanism we envision here is improved health going into the pregnancy. The second mechanism of improved in-hospital care via financial improvement also likely requires a time lag due to the mismatch between fiscal and calendar years, and to allow for time for hospitals adjust to the change. Using ACA expansion status at the pre-conception period would allow at least a year for hospitals to respond to the new ACA-related revenue.

When using the birth certificate data, we are able to closely match the Medicaid expansion to the preconception period by determining the conception date based on birth date and gestation weeks. We create an indicator variable equal to 1 if the mother's state of residence had expanded Medicaid to childless adults at 138% of poverty by the time of conception. We then create two indicator variables capturing time of conception relative to expansion: (1) an indicator variable for whether the statutory eligibility began within one year prior to conception, and (2) an indicator variable for whether statutory eligibility began more than a year prior to conception. It is unknown how long before pregnancy a woman would need to begin insurance to help improve health going into pregnancy, which is why we include both the one- and two-year lookback. Since we are able to generate an approximate conception date, we can also calculate the number of months the expansion has been in effect. We use this variable in event studies to show more specifically how time before and after the ACA expansion affects SMM.

The HCUP SMM data do not allow us to observe the birth date or conception date so the match with the ACA expansion is based off of the year of the SMM event. Since we are targeting the mother's health status going into pregnancy, we specify a one-year lag in the ACA expansion date relative to the SMM event, and alternatively a two-year lag, in order to target the correct time periods. The one and two year lags also allow time for adjustments to hospital finances as a result of the expansion.

Information on the timing of the ACA expansion come from Kaiser Family Foundation (KFF 2020a). The list of expansion states includes the states that did not offer Medicaid to childless adults prior to the ACA, along with the seven states that offered Medicaid but at levels smaller than 138% of poverty. There are also five states that offered Medicaid at or above 138% of poverty prior to 2014. We excluded women living in these five states from all samples. Table 1 shows the expansion status and dates for all states. We test models that exclude the states that offered Medicaid prior to 2014 but at levels smaller than 138% of poverty. Results are not sensitive to this change.

Methods

We use a two-way fixed effects approach to test whether the ACA Medicaid expansions affect SMM. The estimation equation for the birth certificate data is as follows:

$$(1) \qquad SMM_{ist} = \beta_1 ACA\ Expansion_{sc} + \beta_2 X_{ist} + \beta_3 County_{st} + \gamma_s + \tau_t$$

The dependent variable (SMM_{ist}) is an indicator of SMM described above for mother *i* in state *s* and birth year *t*. The variable $ACA\ Expansion_{sc}$ represents one of the three forms of the Medicaid expansion variables described above based on the time of conception (c). That is, Medicaid expansion is defined first by whether the state had expanded by the time of conception; second by whether the state had expanded by less than a year and more than a year prior to conception; and third, by the number of months since expansion. The model includes the vectors of maternal characteristics (X_{ist}) and county characteristics (C_{st}), state fixed effects (γ_s), and year fixed effects (τ_t). We estimate linear probability models with robust standard errors clustered on state. Logit models yield very similar results. The estimated coefficient(s) on the ACA expansion captures the reduced-form intent-to-treat estimate of the effect of the expansion on outcomes. Our approach controls for various economic conditions that affect insurance coverage, but we cannot specifically control for other aspects of the ACA implemented at the same time as Medicaid expansions. However, as many aspects of the ACA applied to all states, our method nets out those common trends and evaluates the effects in the states that expanded relative to the pre-expansion period.

The estimation equation for the HCUP state-level data is as follows:

$$(2) \qquad SMM_{stg} = \beta_1 ACA\ Expansion_{st-1} + \beta_2 State\ Characteristics_{st} + \gamma_s + \tau_t$$

Here, SMM is the state-level rate, and the ACA expansion is an indicator variable for expansion one year prior to the SMM event (and alternatively two years prior). SMM is also analyzed among the select patient and hospital groups (g) as described above. State characteristics include the unemployment rate, real per capita income, and the percent of the state population living in poverty. These models are estimated with OLS with robust standard errors clustered on state. We also test models using the natural log of the SMM rates and results remain unchanged.

The current literature on the validity of TWFE difference-in-difference models identifies three potential problems: parallel trends, control group composition, and staggered timing/treatment heterogeneity (Goodman-Bacon 2021; Callaway and Sant'Anna 2021). We address these issues in a number of ways: We present event studies to show the effects of time leading up to the policy. The exclusion of the states with prior Medicaid for childless adults helps to keep the control group 'clean' and comprised of only non-adopting states. We also test models that exclude the states that offered Medicaid prior to 2014 but at levels smaller than 138% of poverty. Results are not sensitive to this change. Staggard timing is not an issue here as the majority of states expanded Medicaid in 2014. There are six states that expanded in 2015/2016 and two that expanded in 2019. These later two are only within the sample time frame for the state-level HCUP data that extends to 2020. We run auxiliary models that exclude the eight states with later dates and compare to the results to that of the full sample. Results remain unchanged.

Results

We present results from the birth certificates first. Figure 2 shows the effects of the ACA expansion by the time of conception on the probability of an SMM condition at delivery from the birth certificate data. The coefficients and confidence intervals are multiplied by 100 for ease of interpretation. Each row represents a regression with a different measure of SMM as the outcome. The results show that the ACA expansions have very small and statistically insignificant effects on most measures of SMM, indicating that the expansion is not successful in improving these maternal health outcomes at delivery. One result that stands out is that the coefficient on transfusion is positive and statistically significant, indicating that this procedure increases after the ACA expansion. The magnitude is also fairly substantial at a 25 percent increase over the mean. This is an unexpected result that requires further investigation (discussed below). Figure 3 is similar to Figure 2 except that the indictor for ACA expansion is separated into the two time periods reflecting less than one year prior to conception and for one or more years prior to the conception. Again, the coefficients on most measures are very small and statistically insignificant. Figure 4 tells the same story using months eligible.

Figures 5a-5g shows event studies using months as the unit of time, with thirty-six months before and forty-eight months after the policy shown (the endpoints include the accumulation of months beyond those dates). The results here confirm the more aggregated policy measures with no effects of the months since ACA expansion on the probability of any SMM (Figure 5a), any SMM excluding transfusion (Figure 5b), ruptured uterus (Figure 5c) and unplanned hysterectomy (Figure 5d). The graphs for eclampsia (Figure 5e) also shows statistically insignificant coefficients, however there is a clear downward trend to eclampsia following the ACA expansions.

The graph for transfusion shown in Figure 5f helps explain the positive coefficients shown in Figures 2, 3, and 4. Transfusions seem to be increasing after about three years post, with a positive and statistically significant coefficient showing up by the end of the period. The graph for ICU admission (Figure 5g) also shows a slight upward trend after the ACA expansion, although the coefficients are insignificant. It is not clear exactly how these increased rates of transfusions and ICU admissions might be interpreted. If taken at face value, these are negative outcomes and undesirable effects of the ACA expansions. This could occur if crowd-out of private insurance occurs and assuming private insurance generates better health outcomes than Medicaid. It is difficult to assess the health effects of the different types of insurance given the varying nature of private insurance costs and benefits prior to ACA. Also, there is currently mixed evidence on crowd-out with no consensus on whether it occurred or not (Guth et al. 2020). Conversely, if the increased rates of transfusion and ICU admissions mean that more women are getting lifesaving treatment and are less likely to die in childbirth, as shown in Eliason (2020), then these trends are not troubling. For example, transfusion is an appropriate medical response to hemorrhage, so observing more transfusions after Medicaid expansion may point to higher quality medical care upon delivery.

As mentioned previously, we generate results from alternative models: 1) excluding states that offered Medicaid prior to 2014 but at levels smaller than 138% of poverty; 2) excluding the eight states that passed the ACA after 2014; 3) limiting the sample to unmarried women only; 4) limiting the sample to mothers ages 26 and up. These results (available upon request) exhibit the same overall patterns as the main results already shown with small and statistically insignificant effects for all outcomes except for transfusion.

The results for the state-level SMM rates are show in Figures 6 and 7. The first row shows the result for the SMM rate among all women, with each subsequent row containing the results for a subgroup of women. Figure 6 lags ACA expansion by one year and Figure 7 lags the expansion date by two years. The results in both models show small and statistically insignificant effects of the expansion on SMM rates among all women and among all subgroups reported. Using logged rates does not change the conclusions. An event study is shown using SMM rates among all women in Figure 8. Again, this shows no statistically significant relationship between the ACA expansion and SMM rates in any time period.

As mentioned previously, we check for the sensitivity of the results to different classifications of expansion states. Specifically, we test models that exclude the states that offered Medicaid prior to 2014 but at levels smaller than 138% of poverty. We also run models that exclude the eight states that passed the ACA after 2014. The results are not sensitive to these changes and still show no statistically significant effects of the ACA on the measures of SMM.

Conclusions

In this paper, we test whether the ACA Medicaid expansions are associated with severe maternal morbidity as measured by state-level rates and by specific adverse health events at delivery. The causal pathways likely operate through two channels; women’s increased enrollment in Medicaid which may affect health status during pregnancy and childbirth, and improved quality of in-hospital care at delivery. We use difference-in-difference models in conjunction with event studies to evaluate the effects of the ACA Medicaid expansions. The results from both data sets are consistent and show little evidence that the expansions reduced

SMM or the indicator events including eclampsia, ruptured uterus, and unplanned hysterectomy. One puzzling result that arises is that Medicaid expansions are positively associated with blood transfusions. This result is not necessarily undesirable since it may simply indicate an appropriate medical response, although further research is warranted to delve into this result. Overall, the results are consistent with prior research from Palmer (2020) and Margerison et al. (2021) who both find that the ACA Medicaid expansions are generally not statistically associated with improvements in pre-pregnancy health nor maternal health during pregnancy. Our results add to this story and further find little evidence of improvements in maternal health upon delivery.

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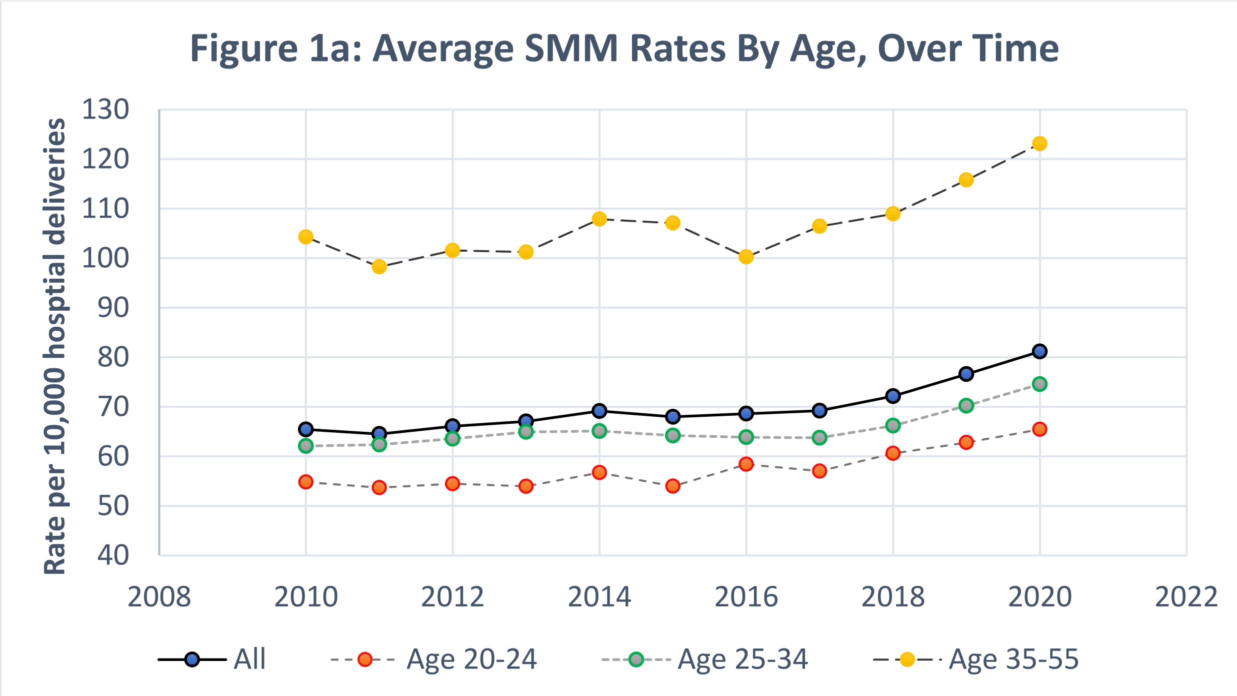


Figure 1a: Average SMM Rates By Age, Over Time
Rate per 10,000 hosptial deliveries
130
120
110
100
90
80
70
60
50
40
2008
2010
2012
2014
2016
2018
2020
2022
All
Age 20-24
Age 25-34
Age 35-55

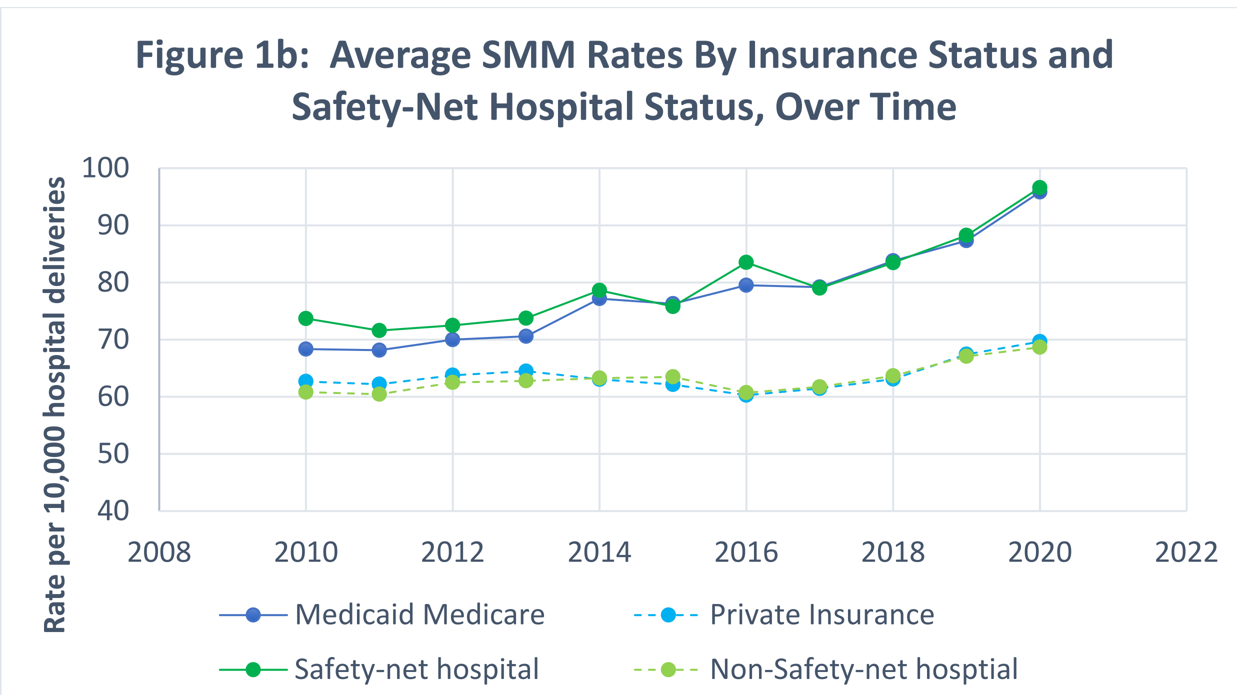
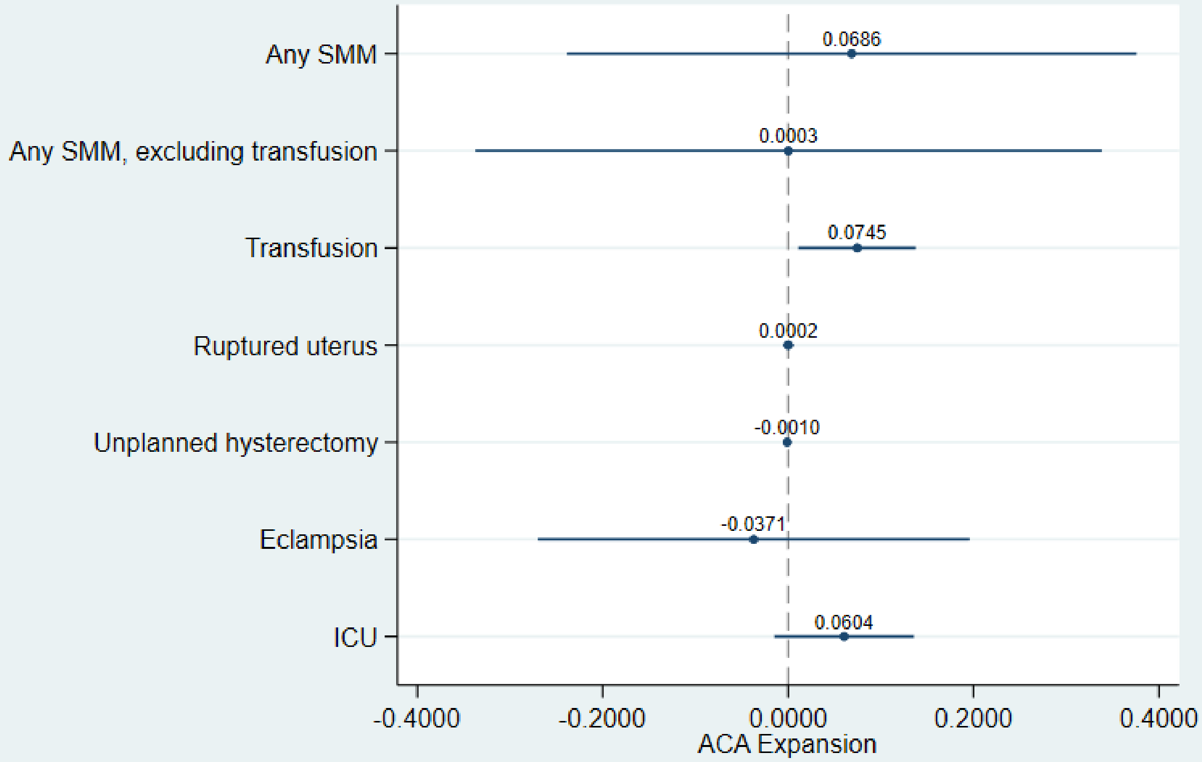


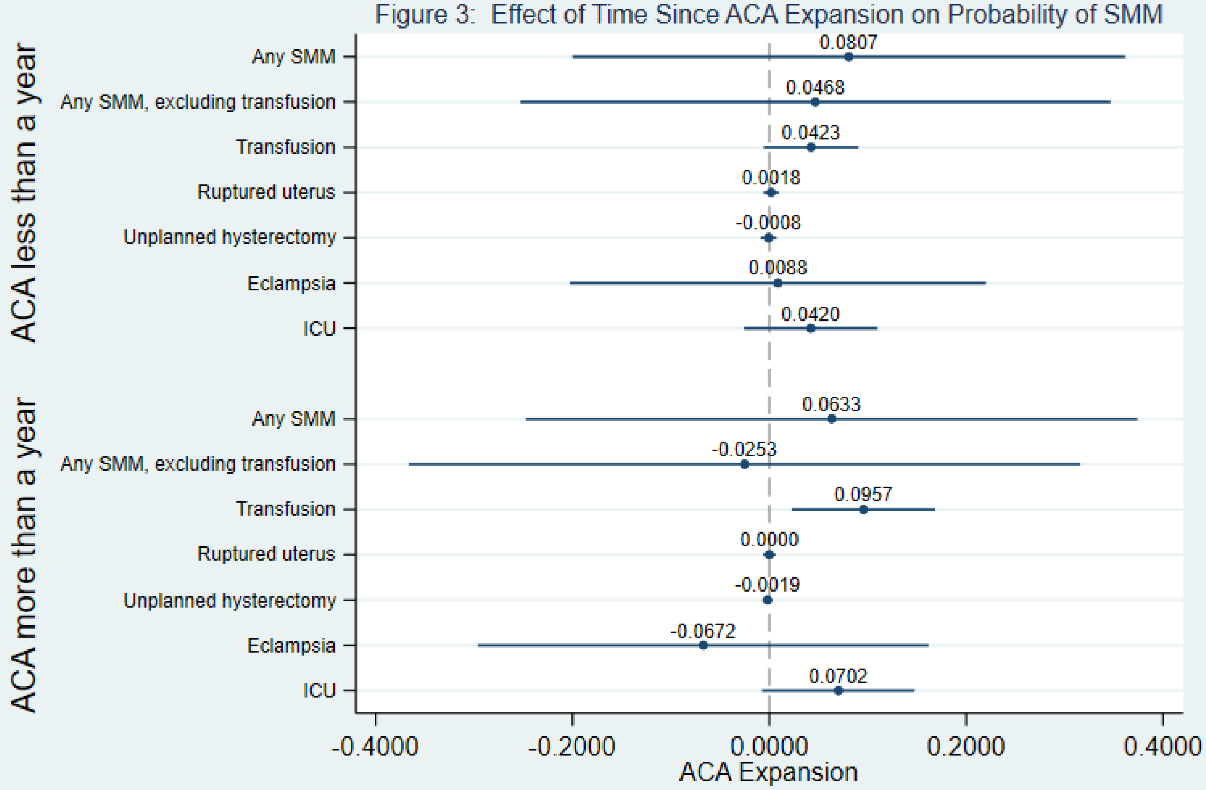
Figure 1b: Average SMM Rates By Insurance Status and Safety-Net Hospital Status, Over Time
Rate per 10,000 hosptial deliveries
100
90
80
70
60
50
40
2008
2010
2012
2014
2016
2018
2020
2022
Medicaid Medicare
Private Insurance
Safety-net hospital
Non-Safety-net hosptial

Figure 2: Effect of ACA Expansion on Probability of SMM



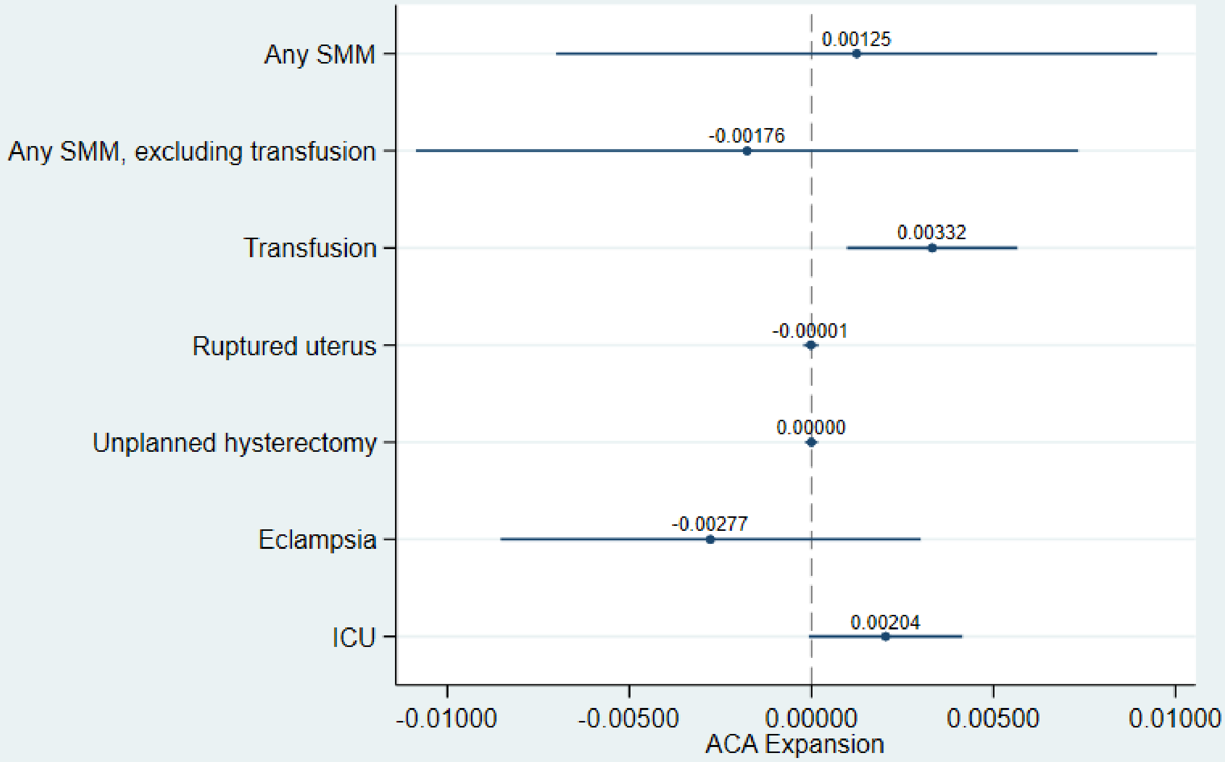
Notes: N=3,878,963. Coefficients multipled by 100. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 3: Effect of Time Since ACA Expansion on Probability of SMM



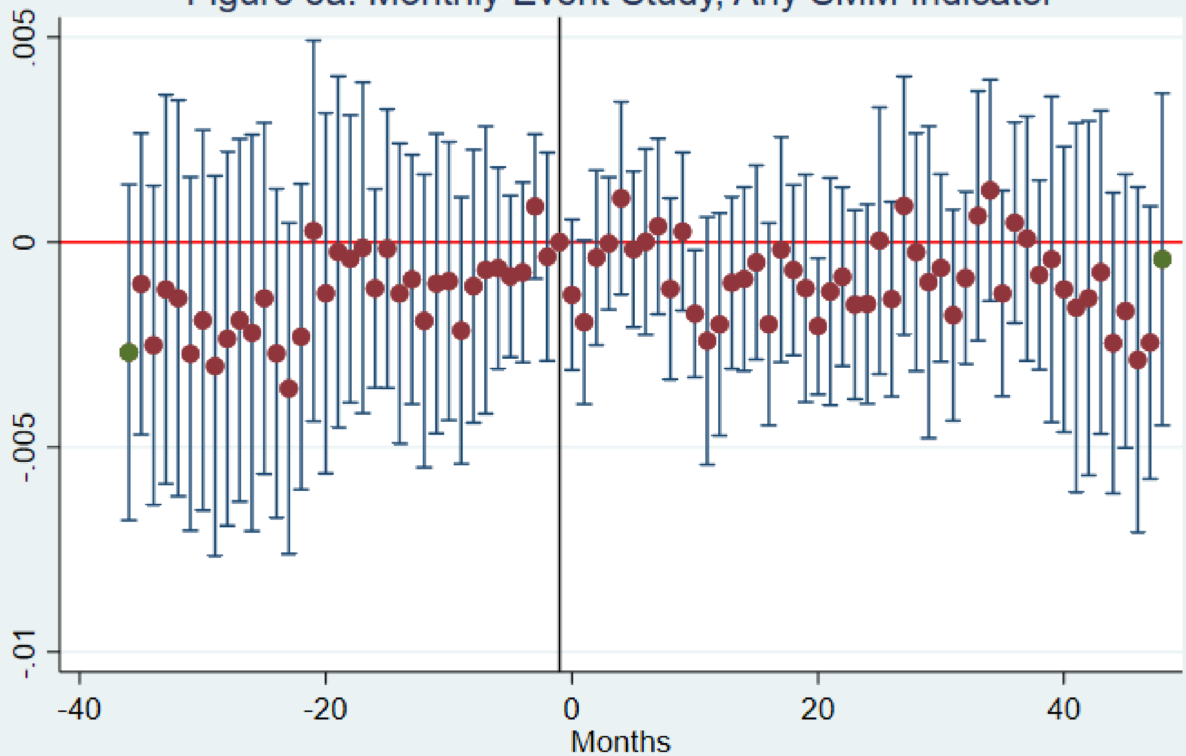
Notes: N=3,878,963. Coefficients multipled by 100. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 4: Effect of Months Since ACA Expansion on Probability of SMM



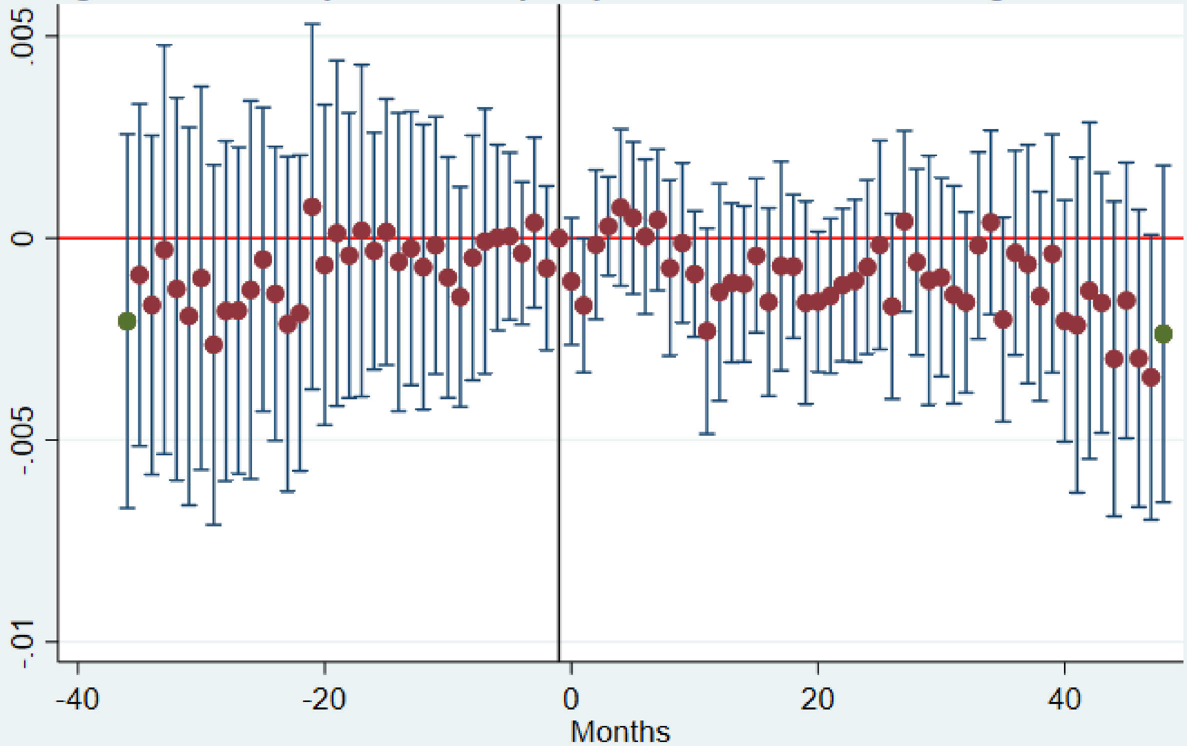
Notes: N=3,878,963. Coefficients multipled by 100. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 5a: Monthly Event Study, Any SMM Indicator



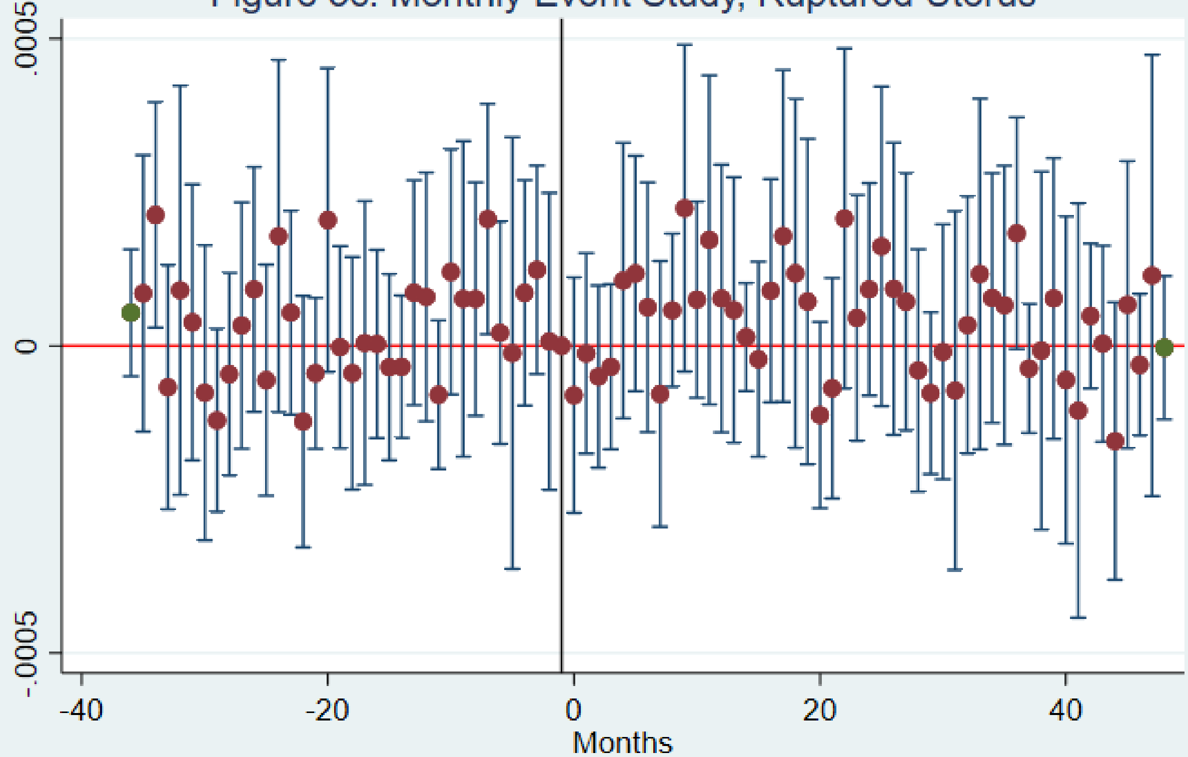
Notes: N=3,878,963. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 5b: Monthly Event Study, Any SMM Indicator, Excluding Transfusion



Notes: N=3,878,963. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 5c: Monthly Event Study, Ruptured Uterus



Notes: N=3,878,963. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

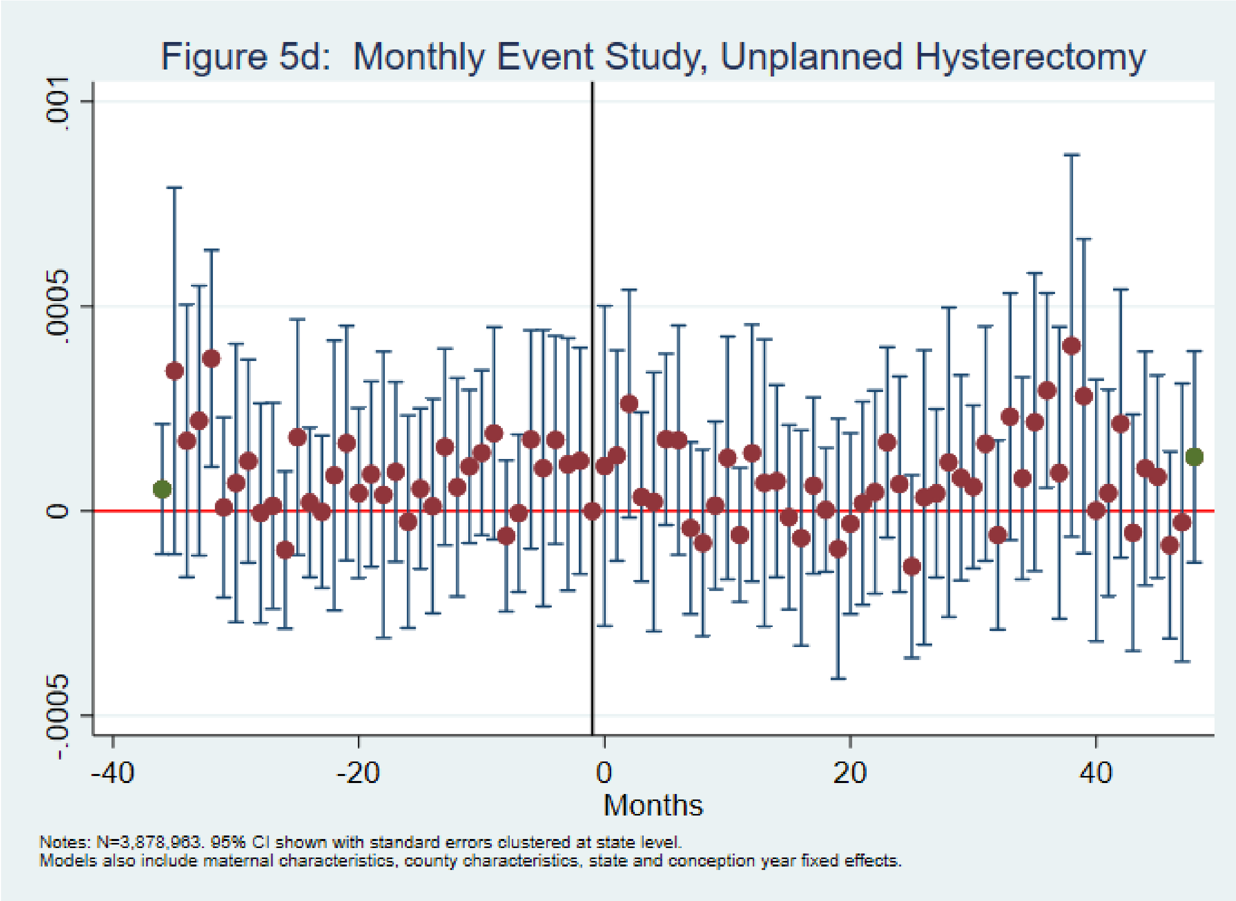


Figure 5d: Monthly Event Study, Unplanned Hysterectomy
.001
.0005
0
-.0005
-40
-20
0
20
40
Months
Notes: N=3,878,963. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

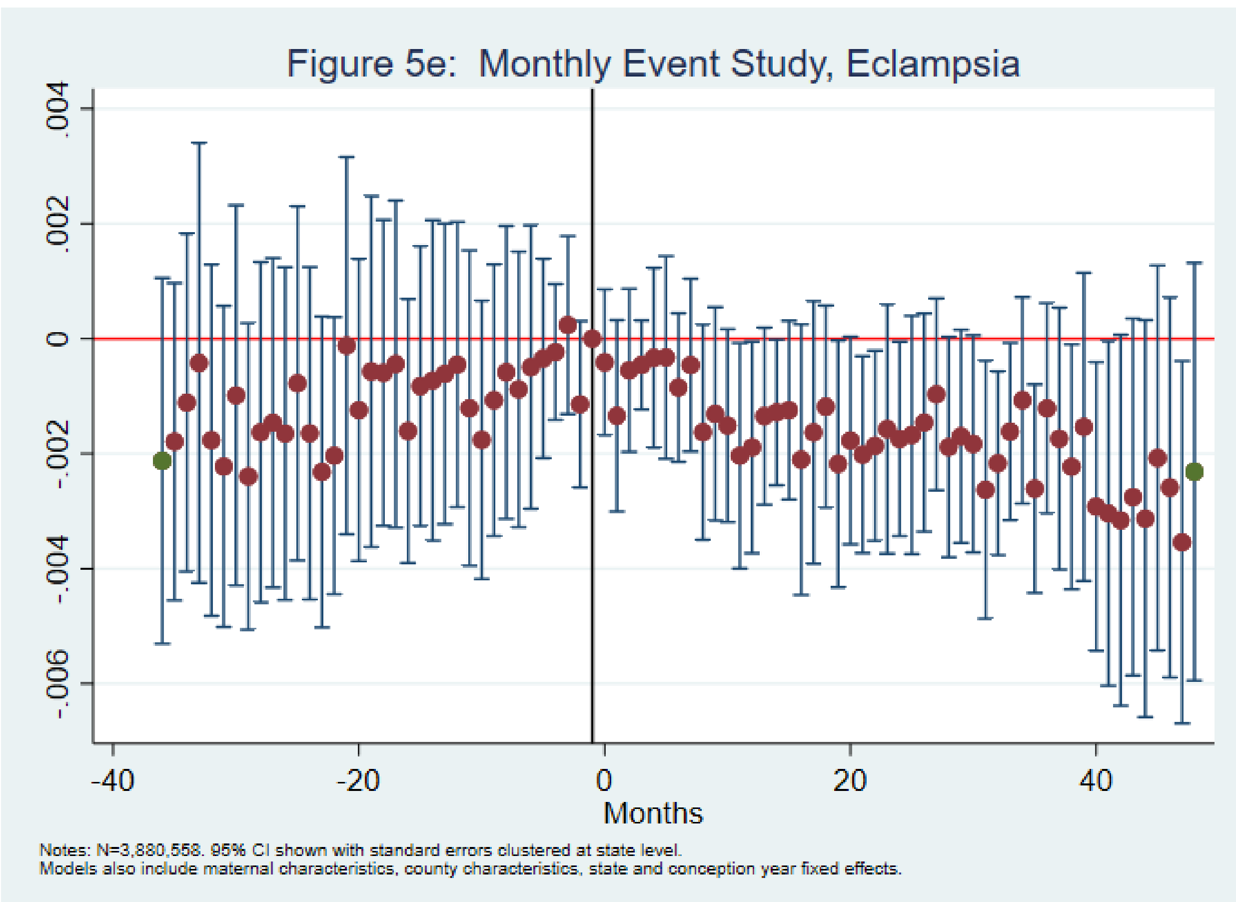
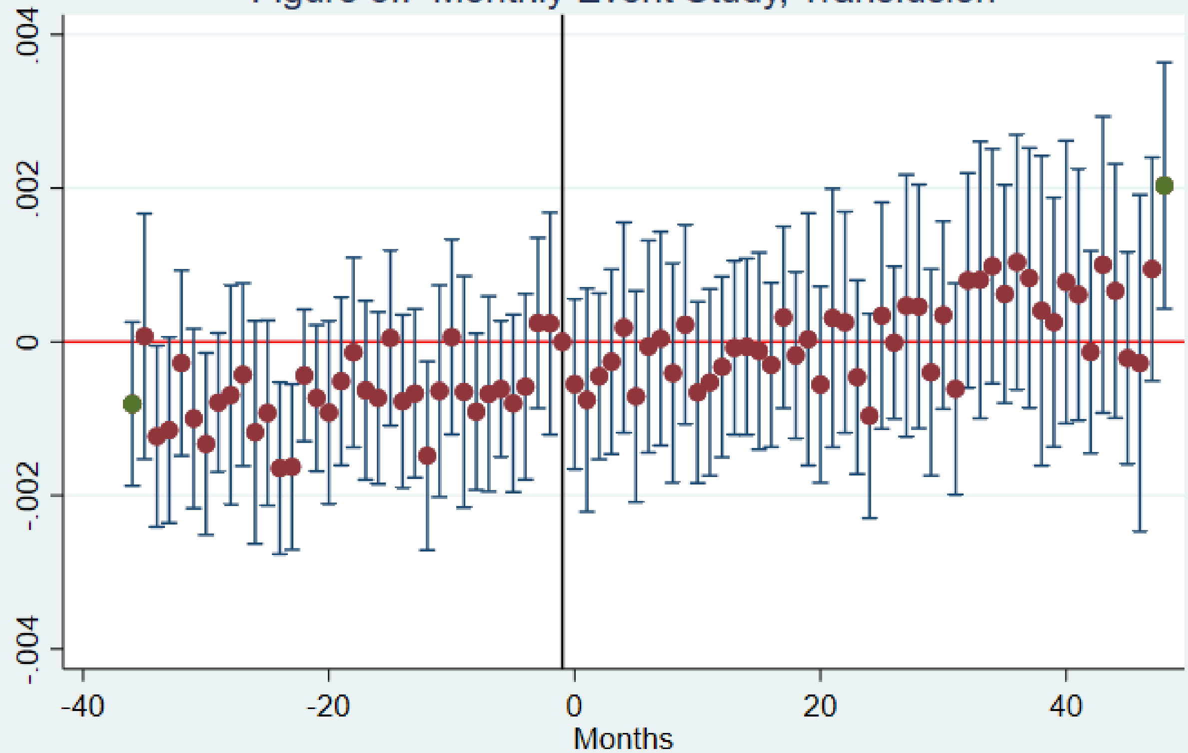


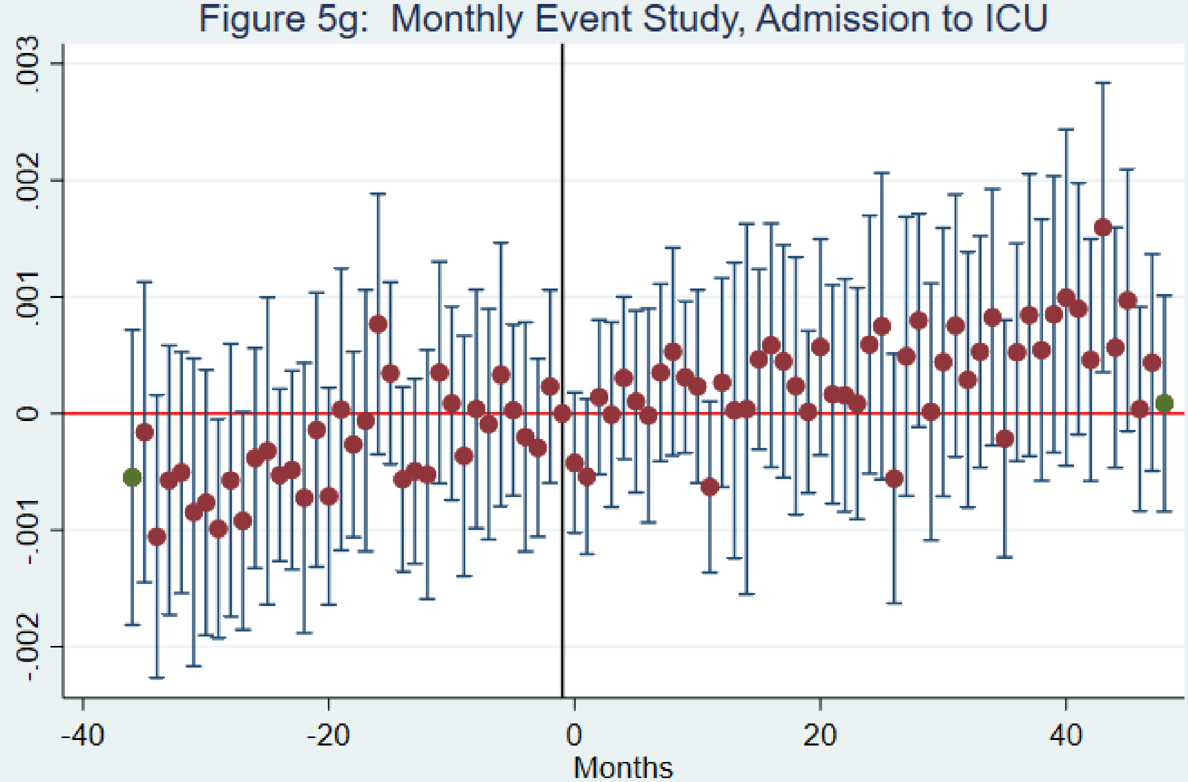
Figure 5e: Monthly Event Study, Eclampsia
.004
.002
0
-.002
-.004
-.006
-40
-20
0
20
40
Months
Notes: N=3,880,558. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 5f: Monthly Event Study, Transfusion



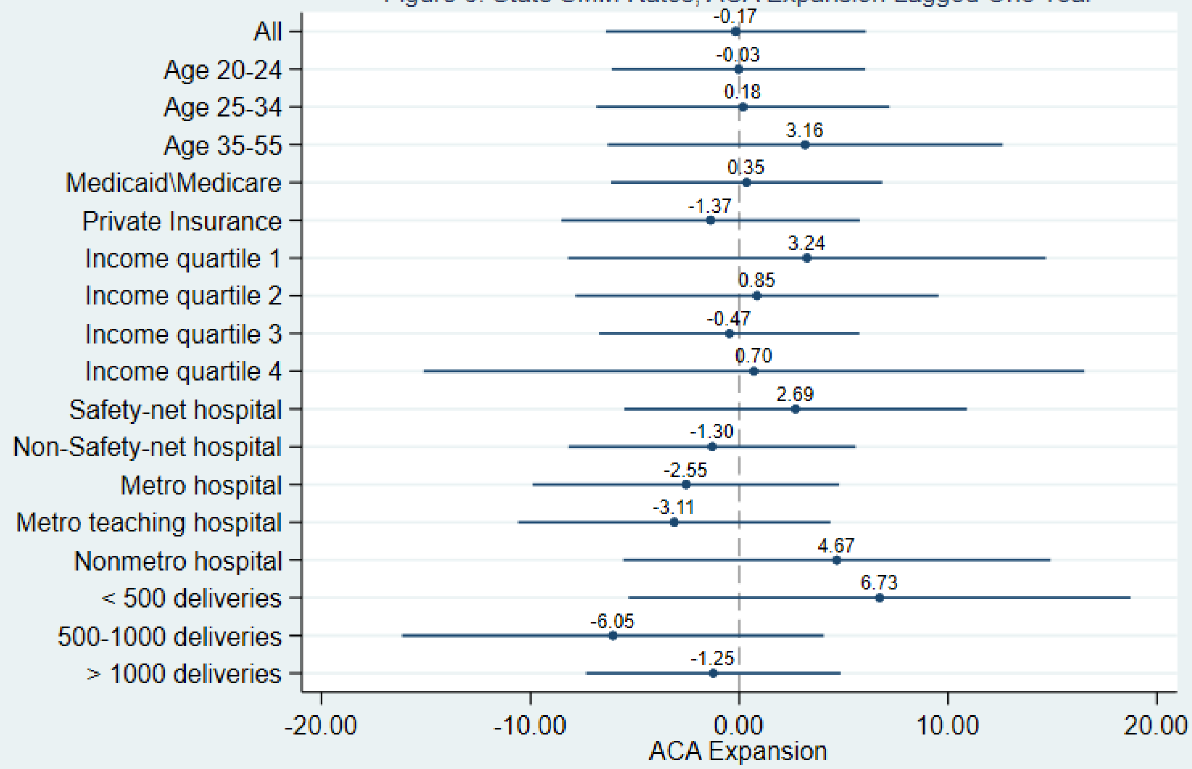
Notes: N=3,878,963. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 5g: Monthly Event Study, Admission to ICU



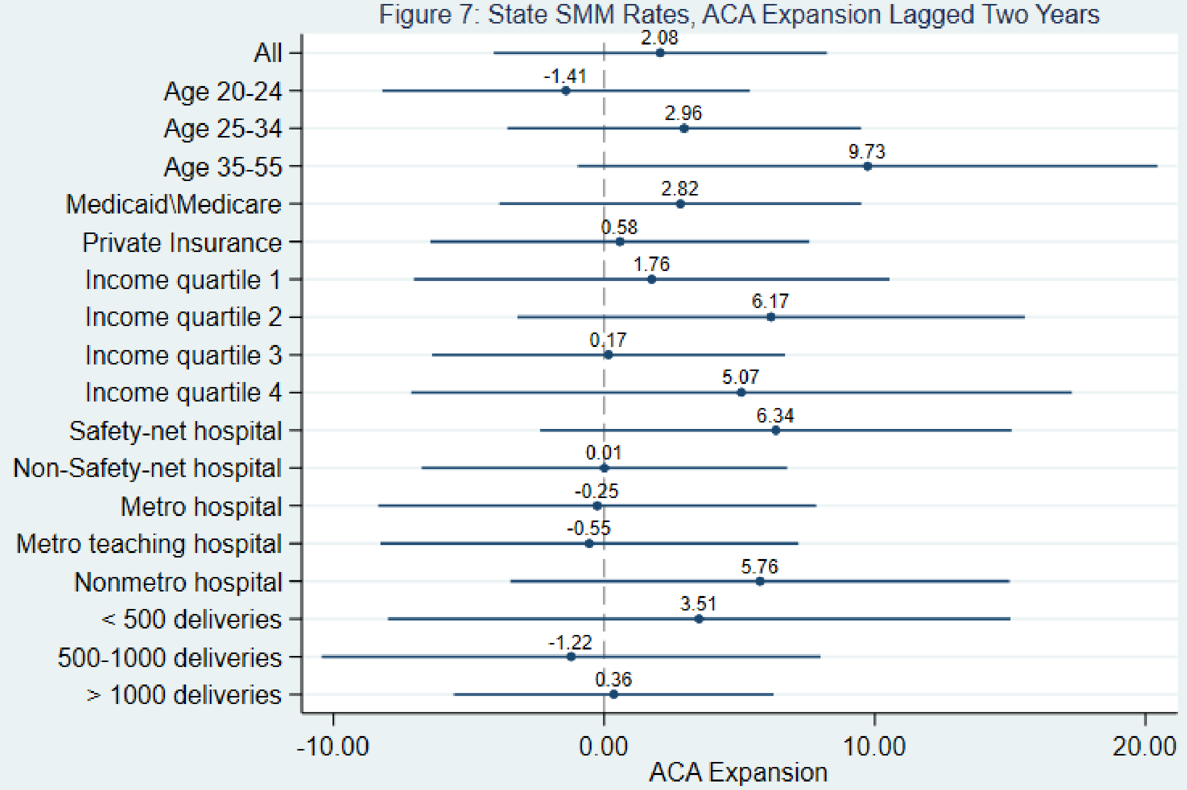
Notes: N=3,878,963. 95% CI shown with standard errors clustered at state level.
Models also include maternal characteristics, county characteristics, state and conception year fixed effects.

Figure 6: State SMM Rates, ACA Expansion Lagged One Year



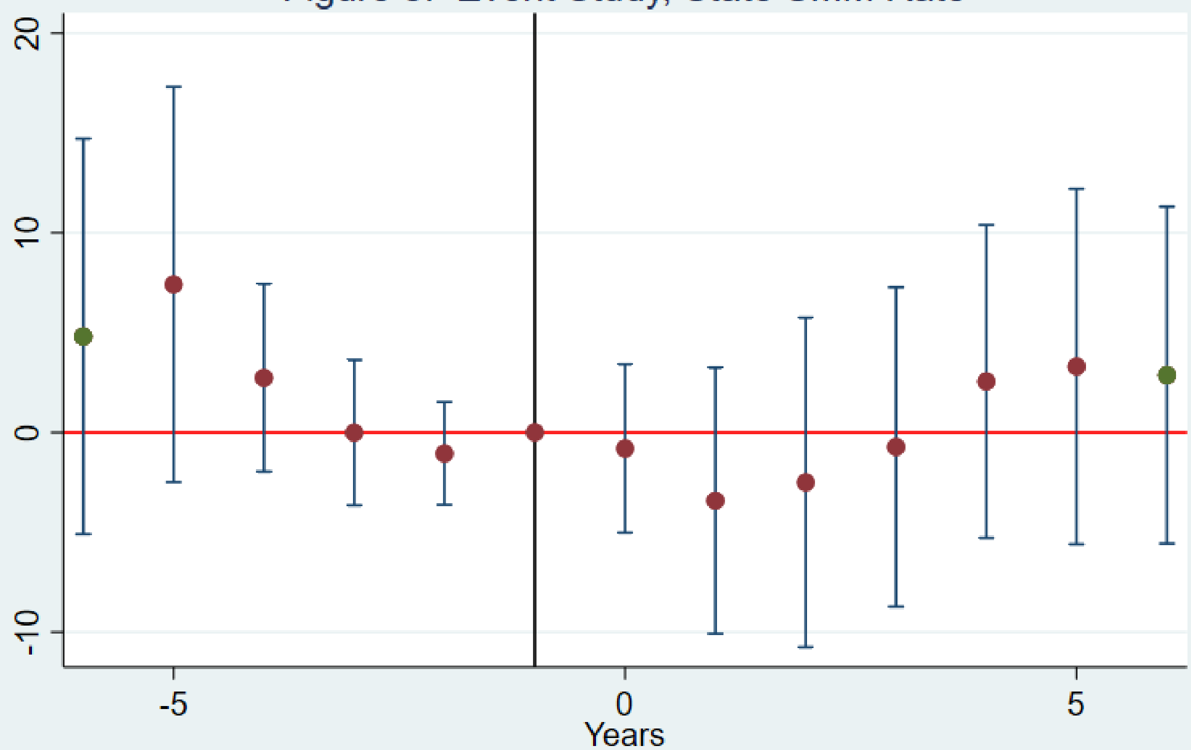
Notes: Sample sizes shown in Table 3. 95% CI with standard erros clustered at state level.
Models also include state unemployment rate, real per capita income, percent poverty, state and year fixed effects.

Figure 7: State SMM Rates, ACA Expansion Lagged Two Years



Notes: Sample sizes shown in Table 3. 95% CI with standard erros clustered at state level.
Models also include state unemployment rate, real per capita income, percent poverty, state and year fixed effects.

Figure 8: Event Study, State SMM Rate



Notes: N=476. 95% CI shown with standard errors clustered at state level.
Models also include state unemployment rate, real per capita income, percent poverty, state and year fixed effects.

Table 1: ACA Medicaid Expansion Dates

Expansion in 2014
Arkansas*, Illinois, Iowa, Kentucky, Maryland, Michigan (4/1/2014), Nevada, New Hampshire (8/15/1014), New Mexico, North Dakota, Ohio, Oregon, Rhode Island*, Washington, West Virginia
Expansion in 2014, but with prior Medicaid for childless adults at < 138% of poverty
Arizona*, Colorado, Connecticut*, Delaware, Hawaii*, New Jersey*, New York
Expansion in 2015
Alaska (9/1/2015), Pennsylvania, Indiana (2/1/2015)
Expansion in 2016
Montana, Louisiana (7/1/2016)
Expansion in 2019
Maine, Virginia
States with prior Medicaid for childless adults at >=138% of poverty
California, District of Columbia, Massachusetts, Minnesota, Vermont

Notes: Dates are as of January of the current year unless otherwise stated. States not listed are categorized as non-expansion states. States with prior Medicaid for childless adults at >=138% of poverty are excluded from all models. States with expansion dates in the second half of the year are considered in effect for the next calendar year for the state-level SMM models.

*States excluded from birth certificate analyses due to lack of pre-period data resulting from late adoption of new birth certificate form: Alabama, Arizona, Arkansas, Connecticut, Hawaii, New Jersey, Rhode Island, West Virginia.

Sources: Kaiser Family Foundation, Status of State Medicaid Expansion Decisions: Interactive Map. Available at: https://www.kff.org/medicaid/issue-brief/status-of-state-medicaid-expansion-decisions-interactive-map/
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Table 2: Summary Statistics, Birth Certificate Data

Variable	Mean	Std. Err.	Min	Max
Any SMM condition	0.009	0.09	0	1
Any SMM, no transfusion	0.006	0.08	0	1
Transfusion	0.003	0.06	0	1
Ruptured uterus	0.0001	0.01	0	1
Unplanned hysterectomy	0.0002	0.01	0	1
Eclampsia	0.003	0.06	0	1
Admission to ICU	0.002	0.04	0	1
ACA Medicaid expansion	0.23	0.42	0	1
Months since expansion	5.48	12.10	0	55
Expansion within one year prior to conception	0.06	0.24	0	1
Expansion more than a year prior to conception	0.17	0.37	0	1
Age	26.11	4.58	21	50
Married	0.47	0.50	0	1
Hispanic	0.20	0.40	0	1
Black	0.19	0.39	0	1
Other race	0.06	0.23	0	1
C-section	0.33	0.47	0	1
County unemployment	6.09	2.25	0.8	20
Real income per capita	189.45	56.05	0	1002
County percent poverty	15.50	5.48	2.6	57
County bassinets per 100,000 population	18.29	14.73	0	5895
County ob/gyn and physicians per 100,000 population	82.51	34.73	0	647
Missing value on Hispanic	0.50	0.50	0	1
Missing value on married	0.0001	0.01	0	1
Missing value on C-section	0.0004	0.02	0	1

N=3,878,963

Table 3: Summary Statistics, State-Level HCUP Data

SMM Rate	N	Mean	Std. Dev.	Min	Max
All	476	69.65	14.55	33.67	122.14
Age 20-24	476	57.34	15.56	10.27	118.23
Age 25-34	476	65.41	14.29	26.00	114.59
Age 35-55	476	106.55	26.74	15.55	251.57
Medicaid Medicare	465	77.58	17.28	25.53	134.76
Private Insurance	465	63.56	15.07	22.84	113.00
Income quartile 1	475	78.31	22.27	0.00	170.75
Income quartile 2	476	70.06	18.73	28.38	185.55
Income quartile 3	476	66.59	16.17	19.41	127.52
Income quartile 4	476	63.64	29.51	0.00	467.29
Safety-net hospital	476	79.46	23.11	6.03	179.17
Non-Safety-net hospital	476	63.11	15.54	13.96	114.28
Metro hospital	436	53.14	17.63	0.00	166.02
Metro teaching hospital	459	81.77	17.66	33.06	164.06
Nonmetro hospital	448	50.24	17.98	0.00	131.47
< 500 deliveries	473	56.21	25.98	0.00	251.68
500-1000 deliveries	452	52.87	20.49	7.95	184.09
> 1000 deliveries	454	75.26	15.81	32.16	128.43