Association of “Baby Friendly” Hospital Designation with Delivery Modality and Morbidity

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HIGHLY PRELIMINARY AND INCOMPLETE—DO NOT CITE WITHOUT PERMISSION

Abstract

The Baby Friendly Hospital Initiative is designed to increase breastfeeding rates by altering hospital practices that discourage early initiation of breastfeeding. These efforts indirectly encourage hospitals to reduce the rate of cesarean delivery. I investigate the association between Baby Friendly hospital status and delivery modalities and maternal health. In difference-in-difference models, I find that Baby Friendly status is associated with a significant increase in vaginal deliveries for high-risk mothers and a decrease for high risk mothers and these results are due to a shift in how mothers are treated after they attempt labor. The shift in behavior, conditional on attempting labor, does not appear to be associated with increased maternal morbidity since the rate of preventable complications is lower after designation than before, especially for mothers who deliver vaginally. I consider several alternative explanations including patient preferences, but I cannot rule out changes in physician preferences and sorting between hospitals.

JEL Codes: I11

Keywords: maternal health, baby friendly, morbidity

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Introduction

Medical decision-making is complex and treatment decisions may be affected by external factors that are unrelated to the clinical status of the patient including physician financial incentives (Gruber & Owings, 1996) and malpractice risk (Currie & MacLeod, 2008; Durrance & Hankins, 2018; Gimm, 2010). In this paper I investigate the effect of institutional norms on decision-making in the context of labor and delivery, although my focus is on implications for maternal, rather than infant health. The change in norms that I study comes about from a hospital choosing to be designated as a "Baby Friendly" hospital. The shift to a Baby Friendly designation indicates that a hospital places a special emphasis on promoting breast feeding and adhere to the "Ten Steps to Successful Breastfeeding" (see Appendix Table 1 for a list of the ten steps). These steps include some factors that are unlikely to affect medical decision-making, including providing information and training to hospital staff, while other factors, specifically the emphasis on initiation of breastfeeding within one hour of birth, are likely to have profound effects on medical decision making by discouraging procedures that would disrupt that goal.

The World Health Organization launched the Baby Friendly Hospital Initiative in 1991 as part of a series of activities designed to increase breastfeeding initiation and continuation. Since the early 2000s, the fraction of mothers who deliver at Baby Friendly hospitals in the United States has risen ten-fold from 1.8 percent in 2004 to 18.3 percent in 2013. Despite the rapid diffusion of the Baby Friendly hospital model, the effects on infant and maternal health outcomes remains largely unexamined outside of a small number of studies that may not generalize to developed countries or the United States in particular.

In this paper, I study the relationship between Baby Friendly designation and inpatient maternal health outcomes **[TBD-Infant health]** using data from the Healthcare Cost and Utilization Project's

National Inpatient Sample. Using a series of difference-in-difference models, I make two contributions to the literature. First, I show that delivery methods differ between Baby Friendly and non-Baby Friendly hospitals. Second, I document how patterns of maternal morbidity change with a Baby Friendly designation.

For all mothers, I find no evidence that Baby Friendly status is associated with delivery modalities. However, this null effect arises because effects for high and low-risk mothers are in opposite directions—high-risk mothers are 2.4 percentage points more likely to deliver vaginally, while low-risk mothers are 1.2 percentage points less likely to do so. These results do not reflect an increase in attempts at labor, but rather an increase in vaginal deliveries among women who choose to attempt labor. To the extent that patient preferences and clinical status govern the decision to attempt labor, while physician and hospital preferences and clinical status govern the decision to continue with labor or undergo an unplanned c-section, then my results indicate that physician and hospital preferences shift to discourage unplanned c-sections.

Looking at complication rates, I find significant reductions in preventable complications and almost no change in non-preventable complications associated with Baby Friendly status. The reduction in preventable complications is almost entirely due to a decrease in preventable complications among mothers who deliver vaginally.

Background

The Baby Friendly Hospital Initiative

The World Health Organization's Baby Friendly Hospital Initiative is intended to encourage hospitals to reform practices that discourage the initiation of breast feeding. To promote these goals, the WHO has sponsored national organizations that undertake the review and designation process on its behalf. In the United States this function is performed by BabyFriendly USA. In order to be designated as Baby Friendly, a hospital must ten “steps” listed in **Error! Reference source not found.**. In several cases, these steps are merely administrative (e.g. steps 1-3). However, other steps affect how physicians and hospital staff jointly manage care for both a mother and her baby.

Most notably, from the perspective of a physician seeking to deliver a baby, is the emphasis on helping mothers initiate breastfeeding within one hour of birth. Because cesarean delivery has been shown to reduce the rate of breastfeeding initiation (Prior et al., 2012), the emphasis on breastfeeding and early initiation would be expected to lead hospitals to discourage c-sections in favor of vaginal deliveries. Previous research supports this hypothesis with Baby Friendly hospitals reporting lower rates of c-sections in Italy (Di Mario, Cattaneo, Gagliotti, Voci, & Basevi, 2013) and [tk—other cases?].

[TK—Associations with maternal health, BF, etc.]

Model of Modality Choice

Motivated by the fact that Baby Friendly hospitals should discourage c-section delivery, I develop a model of how patients and physicians choose a delivery method. I assume that patients and physicians make decisions governing labor and delivery in two steps. In the first step they choose whether to deliver by planned c-section or if the mother will attempt labor with this decision based on a noisy signal of suitability of cesarean delivery. If the mother chooses a trial of labor, then the physician observes additional information that was unavailable to him[1] when they were choosing between a planned delivery and a trial of labor. Based on this updated information, the physician and mother may

[1] Because mothers are all female, I refer to physician using male pronouns as a grammatical convenience.

decide upon an unplanned c-section, rather than continuing to deliver vaginally. Figure 1 presents this process graphically.

Formally, I assume that mothers have an underlying benefit, w, of delivering by c-section rather than vaginally (in other words, the benefit of vaginal delivery has been normalized to 0) and physicians observe a noisy signal w^* of a mother's benefit from cesarean delivery. Based on the initial w^*, the patient and her physician decide to either perform a planned c-section or to attempt labor, at which point the error is resolved and the physician observes w. The expected utility of a planned c-section is $E[w|w^*] + \gamma + \Delta p$, where γ is a preference parameter and Δp is the fee differential between cesarean and vaginal deliveries. If the physician chooses a trial of labor then his expected utility is $\Pr(w + \gamma + \Delta p \geq 0|w^*) \times (E[w|w^*, w \geq -\gamma - \Delta p] + \gamma + \Delta p)$.

The comparative statics of interest are how the decision to attempt labor and the decision to perform an unplanned c-section vary with a decrease in γ. Conditional on attempting labor, a decrease in γ makes unplanned c-sections less attractive conditional on w. However, this incentive effect is confounded by a change in the distribution of w given a trial of labor since a decrease in γ also reduces the physician's utility of a planned c-section. As a result, one would expect fewer mothers to receive a planned c-section and more mothers to attempt labor, with these marginal moms having higher values of w^* after a hospital becomes Baby Friendly. The magnitude of the shift towards attempted labor depends on the density of w^* near the cutoff implied by my model—if there are relatively few women there then there will only be a small change in attempts of labor and one would expect to find a large shift towards vaginal delivery conditional on labor. Conversely, if there are many women who are shifted by the Baby Friendly designation from a planned c-section to attempting labor then the effect on unplanned c-sections is ambiguous since the composition of the set of women who are attempting labor has shifted to be higher risk.

Data

I used hospital discharge data from the 2003-2011 National Inpatient Sample (NIS), which is a 20% random sample of hospitals in as many as 46 states conducted by the Agency for Healthcare Research and Quality. These data include the admitting diagnosis along with up to 25 other diagnoses and an array of up to 25 procedure codes for each discharge. Using these codes and an established algorithm (Kuklina et al., 2008), I identified maternal discharges for labor and delivery. I also constructed indicators for 16 comorbid conditions that are predictive of delivering by c-section (Asch, Nicholson, Srinivas, Herrin, & Epstein, 2009; Johnson & Rehavi, 2016). Finally, I constructed an indicator for a mother meeting the Society for Maternal Fetal Medicine's definition of a high-risk pregnancy (Armstrong, Kozhimannil, McDermott, Saade, & Srinivas, 2016).

Using procedure codes and the diagnosis-related group assigned to the discharge, I identified the modality by which mothers delivered—either a vaginal delivery or by cesarean section. I also identified trials of labor using previously established algorithms (Card, Fenizia, & Silver, 2018; Gregory, Korst, Gornbein, & Platt, 2002; Henry, Gregory, Hobel, & Platt, 1995; Johnson & Rehavi, 2016), which allowed us to classify c-sections into those that were, and were not, planned. Following Johnson and Rehavi (2016) and Currie and MacLeod (2008) I defined indicators for non-preventable and preventable complications, birth trauma, maternal infections , and post-partum hemorrhages. Rehavi and Johnson (2016) use a more conservative definition of birth trauma than does Asch et al. (2009), so I constructed indicators for each type labeled as narrow and broad, respectively. Online appendix table XX lists the definitions of the comorbid conditions, my definition of high-risk pregnancy, modalities, and morbidity.

I identified Baby Friendly hospitals, by comparing the name, city, and state of each hospital with a list of Baby Friendly designated hospitals maintained by BabyFriendlyUSA. Because 19 states that contribute to the NIS do not allow AHRQ to release names, I dropped discharges from those states. To reduce the size of the dataset, I also dropped discharges from states that did not have a Baby Friendly designated hospital between 2003 and 2011. After dropping mothers with multiple gestation and who are delivering either pre-term or post-term, my resulting sample includes almost three million discharges in 1083 hospitals in 16 states. In the sample there were 2.1 million discharges in 855 hospitals that never had the Baby Friendly designation, 764,943 discharges in 201 hospitals before the hospital achieved a Baby Friendly designation, and 77,231 discharges in 33 hospitals after the hospital was designated as Baby Friendly. My sample includes 14 hospitals, with 63,587 discharges, where I observe the hospital both before and after Baby Friendly designation.

The first three columns of Table 1 presents the means of the demographic characteristics of mothers who deliver at a hospital that was never designated as Baby Friendly, prior to designation, and after designation. The average mother was around 28 years of age at delivery and was most likely to be covered by private insurance. High-risk pregnancies represent about a quarter of the data, with a large fraction of those high-risk pregnancies reflecting a previous c-section. For the most part, maternal characteristics were similar across all three columns, indicating that it is unlikely that there are significant differences on observable characteristics among mothers choosing different types of hospitals.

The remaining columns report difference-in-difference coefficients and p-values from a regression of each variable on state and year fixed effects along with an indicator for ever being a Baby Friendly hospital or for after versus before Baby Friendly designation (conditional on hospital fixed effects). There are few statistically significant differences on observable demographic characteristics between hospitals that do not pursue a Baby Friendly designation and those that do (column 5). The most notable differences are that hospitals that seek Baby Friendly designation serve a greater share of women with Medicaid, rather than private insurance, a greater share of Hispanic, rather than White mothers, and attract more women from the third income quartile. The second panel demonstrates that hospitals that do and do not seek Baby Friendly status treat a comparable share of high-risk mothers, based on the Society of Maternal and Fetal Medicine's definition. There are, however, differences for several comorbid conditions including the presence of hypertension or eclampsia, pelvic abnormalities, oligohydramnios, and fetal anomalies. In order to quantify the significance of these differences, the last panel of Table 1 reports changes in the predicted probabilities of various events from an OLS regression that includes the controls listed in Table 1 and state and year fixed effects. Mothers at hospitals that never sought Baby Friendly status are slightly more likely to attempt delivery, but rates of vaginal delivery prior to receiving Baby Friendly status are higher in hospitals that seek designation than in those hospitals that do not.

Columns (6) and (7) report differences for ever Baby Friendly hospitals before versus after designation. Across demographic characteristics there was a reduction in white and black mothers, with an increase in mothers of other races, and an increase in the share of mothers who live in high income zipcodes. The only differences among clinical variables are a decrease in hypertension rates, an increase in pelvic abnormalities, and an increase in the share of mothers with polyhydramnios. The net effect of these differences on the predicted probabilities are minimal, with very imprecisely estimates increases in attempted labor and vaginal delivery.

Empirical methods

Event Study

My main approach is to implement a difference-in-differences model, however, the identifying assumption of such a model is that the unobserved trends in the dependent variable for treated units in the absence of treatment are parallel to the observed trends in the untreated units (Lee & Kang, 2006).

To test this assumption, I estimate event studies comparing trends in my dependent variables by years before versus after a hospital changes status conditional on controls:

$$y_{mhst} = \sum_{\tau \neq -1} \mu_\tau + \sigma_h + \tau_t + X_m \beta + \epsilon_{mhst} \quad (1)$$

Where μ_τ is a set of coefficients for pairs of years before ($\tau < 0$) and after ($\tau > 0$) a hospital was designated as Baby Friendly (I omit the year of designation because hospitals were designated as Baby Friendly throughout the year), σ_h and τ_t are hospital and year fixed effects, and X_m is a vector of mother characteristics.

Difference-in-Differences

I identify the effect of Baby Friendly hospital designation on an outcome using the specification:

$$y_{mhst} = X_m \Gamma + \sigma_h + \tau_t + \beta BF_{ht} + \epsilon_{mhst} \quad (2)$$

Where BF_{ht} is an indicator that a hospital has a Baby Friendly designation and X_m is a set of mother characteristics, including age, payer type, race/ethnicity (including an indicator for missing race), zipcode-level income quartile, and comorbid conditions. The identifying assumption under which β has a causal interpretation is that counterfactual trends in hospitals that are designated as Baby Friendly are parallel to time trends in hospitals that are not Baby Friendly. I use my event study model to assess if this assumption is reasonable.

Results

Association of Baby Friendly designation with delivery modality

Event Study

Figure 2 presents my event study estimates for delivery modalities. Panel a demonstrates that the probability of vaginal delivery decreased after hospitals were designated as Baby Friendly, relative to the reference category of the two years prior to designation. However, I also find that Baby Friendly hospitals had lower vaginal delivery rates before, as well as after, designation, relative to all other hospitals. Separating out my results by risk type indicates that there were two distinct effects at work with high risk mothers being more likely to deliver vaginally, while low-risk mothers are marginally less likely to deliver vaginally in the post period. In the graphs that stratify by risk type, I also find significant evidence of a differential trend in the pre-period for ever Baby Friendly hospitals. Panels c and d provide noisy estimates of changes in attempts of labor which are suggestive of no effect of Baby Friendly status on changes in when mothers attempt labor. The implication is that there is no effect on *planned* c-section rates, since if a mother does not attempt labor then she will deliver by planned cesarean.

Panels e and f plot the outcomes of an attempted labor—the rate of vaginal deliveries among women who attempted labor (panel e) and the rate of unplanned c-sections across all women, which captures changes in attempted labor as well as changes in unplanned c-sections conditional on attempting labor. These panels demonstrate that Baby Friendly designation was associated with a reduction in vaginal delivery among low-risk mothers who attempted labor and an increase in unplanned c-sections. Among high-risk moms, for whom attempts of labor are infrequent, my estimates indicate that vaginal deliveries, conditional on attempting labor, increase, but there is no evidence of a change in the rate of unplanned c-sections for these women.

Overall, the event study estimates demonstrate that there are few differences between Baby Friendly and non-Baby Friendly hospitals prior to designation. The one exception is for vaginal deliveries, where mothers at Baby Friendly hospitals appear to have been less likely to deliver vaginally prior to designation than in a non-Baby Friendly hospital, relative to the two years before designation. My estimates also indicate that there are substantial differences how Baby Friendly designation is associated with my outcomes for high and low-risk women.

Difference-in-differences

Table 2 presents my main difference-in-differences results for choice of delivery modality (each panel uses a different dependent variable indicated by the row label). The first three columns present results for all mothers using progressively richer specifications with column (2) including demographic characteristics and column (3) adding in the comorbid conditions listed in Table 1. Columns (4) and (5) repeat the specification in column (3) but restrict to low- and high-risk mothers, respectively. The top panel demonstrates that for all mothers, there was no significant change in the probability of vaginal delivery associated with Baby Friendly designation. However, this effect was driven by a decrease in vaginal deliveries among low-risk mothers and an increase in vaginal deliveries among high-risk mothers. The increase in vaginal deliveries among high-risk mothers is particularly large since on average only 14% of mothers who are classified as high-risk will deliver vaginally, so that 2.4 percentage point increase corresponds to 17 percent increase in the share of high-risk mothers who are delivering vaginally.

In the second panel I find that Baby Friendly designation is associated with an increase in attempted labor, and, therefore, a decrease in planned c-sections, in a model that only includes state and year fixed effects. However, including demographic controls eliminates this positive association between Baby Friendly status and attempted labor and the point estimate is further attenuated with the inclusion of comorbidities, indicating that mothers at Baby Friendly hospitals are more likely to have comorbid conditions that are positively correlated with attempting labor. I also find no association between Baby Friendly designation and attempted labor among mothers with either a low- or high-risk pregnancy.

I also find no relationship between Baby Friendly status and the rate of vaginal deliveries among mothers who attempted labor. But, as with the case of vaginal deliveries, the null effect in the full samples masks significant heterogeneity by risk classification—low-risk mothers are less likely to delivery vaginally if they attempt labor, while high-risk mothers are more likely to do so. The associations with Baby Friendly status are quite large for high-risk mothers, with a Baby Friendly hospital increasing vaginal deliveries among women who attempt labor by almost nine percentage points, or 16% of the mean. The increase in vaginal deliveries among high-risk mothers is consistent with the Baby Friendly designation encouraging those mothers to deliver vaginally, in a setting in which there are very few, if any, mothers who switch from a planned c-section to attempting labor.

The final panel demonstrates that there is no relationship with unplanned c-sections among all mothers, but that there is an increase in unplanned c-sections among low-risk mothers associated with Baby Friendly designation. This increase in entirely consistent with the reduction in vaginal deliveries among mothers who attempt labor. The increase in unplanned c-sections for low-risk mothers is small, in levels, but represents a significant increase, relative to the mean, with Baby Friendly designation associated with a 19% increase in unplanned c-sections.

Association of Baby Friendly designation with maternal morbidity

Table 3 presents results of estimating equation (2) for either non-preventable (odd numbered columns) or preventable (even-numbered columns) complications across all mothers, restricting to low-risk mothers, and restricting to high-risk mothers. The first panel presents results for all mothers in the indicated group, regardless of treatment modality. Overall, Baby Friendly designation is associated with a reduction in preventable complication rates for all three groups of mothers and with an increase in non-preventable complications among high-risk mothers. Baby Friendly designation is associated with a

30% reduction in preventable complications for low-risk mothers and a 13% reduction for high-risk mothers.

To gain additional insight into how these reductions in complication rates are achieved, the next panel presents the association with Baby Friendly status among mothers who underwent a planned c-section. Among these women, Baby Friendly status was associated with a higher rate of non-preventable complications, but there was no relationship with preventable complications. One might be tempted to interpret the direction of causality as running from Baby Friendly status to the increase in non-preventable complications, but an alternative hypothesis is that physicians at Baby Friendly hospitals are more likely to perform a planned c-section when mothers exhibit one of these non-preventable complications that make attempting labor particularly risky. Augmenting my base regression model with the main effect for any non-preventable complication and an interaction with my post dummy, I find that in Baby Friendly hospitals, the interaction effect indicates that mothers with a non-preventable complication are 4.5 percentage points more likely to deliver by planned c-section.

The alternative to a planned c-section is to attempt labor and the third panel demonstrates that Baby Friendly designation was associated with a reduction in preventable complications, but not non-preventable complications, for all mothers and both risk groups. Among those women who attempt labor, I find the large reductions in preventable complications associated with Baby Friendly status and, among high-risk moms, a decrease in non-preventable complications as well. Finally, I find a positive relationship between Baby Friendly designation and non-preventable complications among women who deliver by unplanned c-sections. As was the case with planned c-sections, it is unlikely that these differences are caused by Baby Friendly designation, but rather an indication of differences in how conditions are managed during the labor and delivery process.

Resource use during labor and delivery following Baby Friendly designation

Table 4 presents the association between Baby Friendly status and the logarithm of the length of stay. The key result, across all specifications and samples, is that the length of stay associated with c-sections, regardless of type, decreases by 3 to 5 log points.

Table 5 reports the relationship between Baby Friendly status and procedure use, where the even numbered columns restrict to mothers who attempted labor. The first panel demonstrates a reduction in vacuum extractions associated with Baby Friendly status and this result persists across all risk groups. The only other significant effect is an increase in the rate of episiotomies among high-risk mothers.

Robustness

Table 6 presents two robustness checks of my results. First, I restrict my sample to hospitals that ever received Baby Friendly status since those hospitals may differ in unobservable ways from hospitals that have not received Baby Friendly status. My second check is to include a differential time trend for Baby Friendly hospitals. I implemented this approach by including a linear term in time until or since Baby Friendly designation.[2] Across samples and dependent variables my results are similar across all three specifications.

Potential Explanations and Hypotheses

[2] Traditionally this test is carried out by including unit (hospital) specific time trends, but we cannot use that approach since we only observe very few hospitals in three or more time periods. Without such data, my coefficient on post designation would be identified off of changes in the small number of hospitals that changed Baby Friendly status and were observed in three or more years.

In my analysis, I assumed that Baby Friendly status was uncorrelated with unobservable determinants of c-section rates and complications. This is a rather strong assumption and one that, with my current data, I cannot directly test. However, for some forms of selection on unobservables, I can derive testable implications. First, it implies that hospitals that are closer to Baby Friendly hospitals should experience an increase in the share of mothers with a preference for c-sections **[TBD]**. Second, Baby Friendly hospitals that are farther from non-Baby Friendly hospitals should experience a smaller change in maternal preferences **[TBD]**. Third, to the extent that more moms prefer vaginal delivery over cesarean, then there should be: i) an increase in volume at Baby Friendly hospitals; and ii) volume should be negatively correlated with c-section rates post designation. I also implemented a bounding exercise to understand how much selection is necessary in order to explain my results using the method described in Oster (Oster, 2016) **[TBD]**.

Table XX presents results of analyses of the change in hospital volumes after, versus before, Baby Friendly designation (online Appendix Figure YY presents the associated event studies) and the correlation between hospital volume and procedure choice in Baby Friendly and non-Baby Friendly hospitals, respectively.

Table ZZ presents results of this exercise in which I allow for selection on unobservables that is a fixed multiple of selection on observables.

Another alternative explanation is that hospitals that become Baby Friendly attract and/or credential a different set of providers than non-Baby Friendly hospitals. In principle, my HCUP data should be adequate to assess this possibility since I observe, in some states, physician identifiers. Unfortunately, because of the design of the sample, these data do not allow us to test if physicians are moving in response to a Baby Friendly designation. I leave this topic open for future work.

Discussion

I provide new evidence on the association between Baby Friendly hospital designation and delivery modalities and maternal morbidity. I find that Baby Friendly designation is associated with higher rates of vaginal delivery for high-risk mothers but lower rates for low-risk moms with the entirety of this effect due to differences in patient management after she starts labor. The shift towards vaginal delivery is associated with a reduction in preventable complications, suggesting that such a shift towards vaginal delivery for high-risk mothers is welfare improving.

Unfortunately, I cannot easily claim that my estimates are causal since I cannot control for the fact that mothers are endogenously choosing a hospital at which to deliver and the choice of hospital may be affected by Baby Friendly designation. For example, if mothers believe that Baby Friendly hospitals are more likely to attempt a vaginal delivery then mothers for whom that is important may be more likely to choose a Baby Friendly hospital.

Conclusions

Over the past almost thirty years, the World Health Organization's Baby Friendly Hospital Initiative has spread around the world. However, with few exceptions, little is known about the effect of the Baby Friendly Hospital Initiative on health outcomes. In this paper I studied the association between hospitals receiving a Baby Friendly designation and changes in delivery modalities and maternal morbidity. I found that Baby Friendly hospital designation was associated with an increase in deliveries by vaginal deliveries for high-risk women with a reduction in preventable complications. These results are supportive of expanding the use of Baby Friendly hospitals but should be interpreted with caution since I cannot control for patient or provider selection of hospitals.

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Appendix

Appendix Table 1: Ten Steps to Successful Breast Feeding

1. Have a written breastfeeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in the skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding within one hour of birth.
5. Show mothers how to breastfeed and how to maintain lactation, even if they are separated from their infants.
6. Give infants no food or drink other than breast-milk, unless medically indicated.
7. Practice rooming in - allow mothers and infants to remain together 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no pacifiers or artificial nipples to breastfeeding infants.
10. Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or birth center.

Figures and Tables

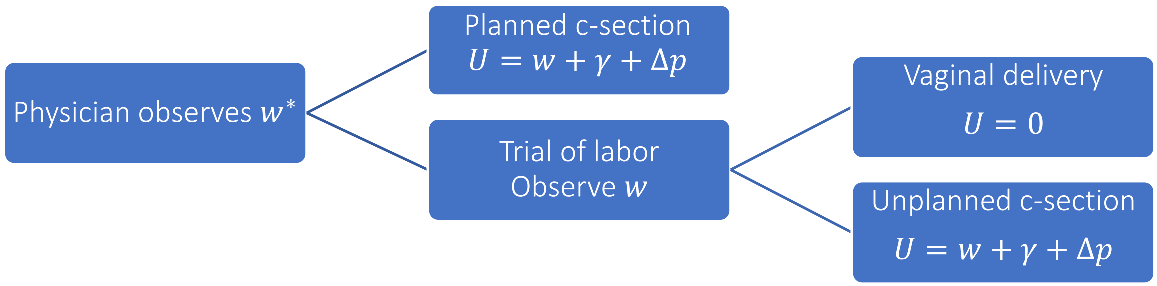

Figure 1: Sequence of observations and modality choice

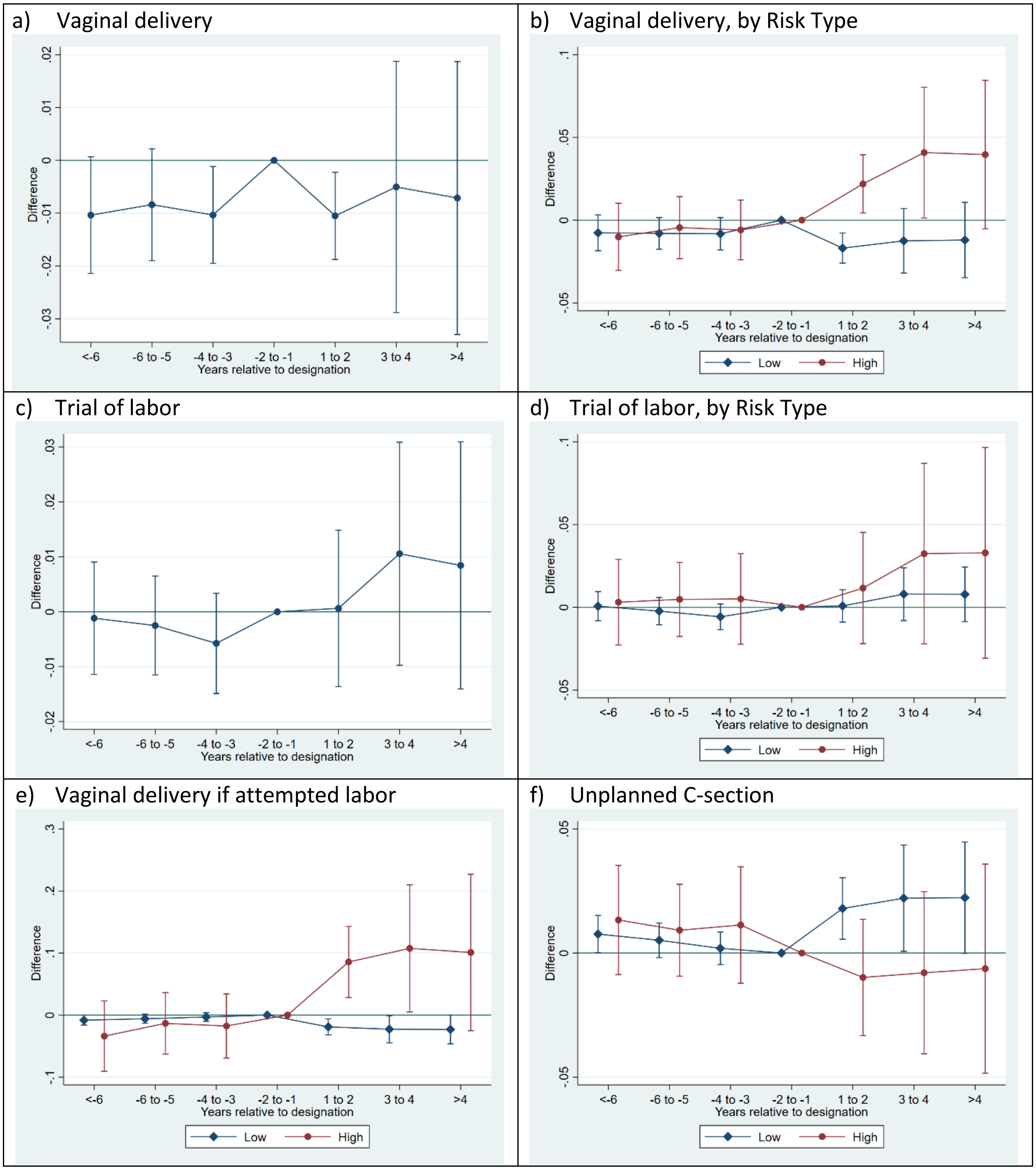

Figure 2: Event study estimates of treatment modalities and morbidity associated with Baby Friendly designation

Table 1: Means and covariate balance

	Means			DD Ever/Never		DD Post/Pre	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Never BF	Pre	Post	DD (SE)	P	DD (SE)	P
Mother Characteristics							
Age	28.2	28.1	28.5	-0.02 (0.2)	0.913	-0.2 (0.1)	0.161
Insurance status							
Medicaid	40.2	46.4	41.6	4.4 (2.7)	0.096	1.5 (2.5)	0.552
Private	54.6	48.5	53.0	-4.5 (3.0)	0.131	-2.0 (2.5)	0.434
All other	5.2	5.2	5.4	0.05 (0.6)	0.938	0.5 (0.7)	0.454
Race/ethnicity							
White	52.8	40.6	47.8	-7.4 (2.8)	0.007	-6.1 (1.9)	0.001
Black	11.8	10.9	7.5	1.8 (1.2)	0.137	-1.0 (0.6)	0.073
Hispanic	23.4	36.8	33.9	7.9 (2.6)	0.002	0.2 (2.7)	0.937
Other	11.9	11.7	10.9	-2.3 (1.4)	0.099	6.9 (2.6)	0.009
Income quartile							
First	22.5	24.6	15.6	3.0 (2.7)	0.263	-1.6 (1.2)	0.187
Second	25.6	23.4	22.8	-2.9 (1.6)	0.076	-1.8 (1.8)	0.332
Third	24.4	27.9	30.5	3.3 (1.7)	0.048	0.4 (2.0)	0.848
Fourth	27.4	24.1	31.1	-3.4 (2.7)	0.208	3.0 (1.4)	0.031
High risk pregnancy	22.8	23.0	22.3	0.5 (0.3)	0.116	-0.3 (0.6)	0.625
Comorbidities and Risk factors							
Previous c-section	16.8	17.2	16.8	0.4 (0.3)	0.150	-0.4 (0.5)	0.426
Hypertension or eclampsia	7.7	7.9	8.2	0.7 (0.3)	0.010	-1.0 (0.5)	0.046
Diabetes	6.6	7.1	7.1	0.4 (0.2)	0.064	0.7 (1.0)	0.481
Malpositioned fetus	5.4	5.4	5.3	0.1 (0.2)	0.437	-0.2 (0.4)	0.569
Pelvic abnormality	2.8	3.3	2.9	0.6 (0.2)	0.002	0.6 (0.3)	0.030
Asthma	2.7	2.5	2.9	-0.04 (0.2)	0.856	0.7 (0.5)	0.118
Oligohydramnios	2.4	2.8	2.4	0.5 (0.1)	0.000	-0.3 (0.5)	0.557
Abnormal thyroid function	2.1	2.0	2.4	0.006 (0.1)	0.954	-0.3 (0.3)	0.312
Isoimmunization	2.0	1.8	2.4	-0.002 (0.2)	0.991	0.9 (0.7)	0.192
Growth restriction	1.6	1.6	1.7	0.05 (0.07)	0.500	-0.4 (0.2)	0.117
Heart disease	0.8	0.8	0.6	0.06 (0.06)	0.322	-0.04 (0.2)	0.806
Polyhydramnios	0.6	0.6	0.6	0.05 (0.03)	0.158	-0.3 (0.1)	0.013
Herpes	0.5	0.4	0.6	-0.06 (0.05)	0.238	0.06 (0.1)	0.620
Uterine scar	0.2	0.2	0.2	0.002 (0.02)	0.931	0.04 (0.03)	0.201
Abnormal kidney function	0.2	0.2	0.2	0.004 (0.01)	0.724	-0.03 (0.04)	0.380
Fetal anomaly	0.1	0.2	0.1	0.06 (0.02)	0.000	0.03 (0.03)	0.433
Abnormal liver function	0.1	0.1	0.1	0.02 (0.01)	0.171	0.03 (0.04)	0.531
Predicted delivery modality							
Attempted labor	78.3	78.0	78.3	-0.5 (0.3)	0.078	0.4 (0.4)	0.375
Vaginal delivery	68.7	68.4	68.5	-0.6 (0.3)	0.052	0.4 (0.5)	0.381
Vaginal delivery if labor	82.2	82.0	82.0	-0.4 (0.2)	0.026	0.2 (0.3)	0.536

Source—Authors' analysis of National Inpatient Sample, 2003-2011.

Notes—Ever/Never difference-in-difference estimates are coefficients on an indicator for a hospital receiving Baby Friendly status from a regression with year and state fixed effects. Sample excludes hospital-years when the hospital is designated as Baby Friendly. Post/Pre difference-in-difference estimates are coefficients on a post indicator from a regression with year and hospital fixed effects. Standard errors and p-values based on covariance matrix that is clustered on hospital. Except for age, all coefficients and means have been multiplied by 100 for clarity.

Table 2: Choice of Labor and Delivery Modality

	All mothers			Low risk mothers	High risk mothers
	(1)	(2)	(3)	(4)	(5)
Vaginal Delivery	0.68	0.27	-0.50	-1.15*	2.37**
	(0.95)	(1.08)	(0.47)	(0.55)	(0.74)
N	2959415	2959415	2959415	2283458	675957
R-squared	0.019	0.039	0.429	0.084	0.180
Mean	0.687	0.687	0.687	0.849	0.139
Attempted Labor	1.52*	1.12	0.39	0.44	0.84
	(0.72)	(0.73)	(0.66)	(0.44)	(1.55)
N	2959415	2959415	2959415	2283458	675957
R-squared	0.016	0.041	0.529	0.064	0.262
Mean	0.782	0.782	0.782	0.935	0.264
Vaginal Delivery if Labored	-0.87	-0.94	-1.06	-1.67**	8.61***
	(0.84)	(0.92)	(0.67)	(0.64)	(2.56)
N	2314605	2314605	2314605	2136011	178594
R-squared	0.011	0.014	0.099	0.048	0.170
Mean	0.877	0.877	0.877	0.906	0.524
Unplanned C-section	0.89	0.90	0.93	1.64**	-1.49
	(0.60)	(0.64)	(0.65)	(0.60)	(1.04)
N	2959415	2959415	2959415	2283458	675957
R-squared	0.007	0.008	0.026	0.034	0.122
Mean	0.096	0.096	0.096	0.088	0.126
Year FE	Y	Y	Y	Y	Y
Hospital FE	Y	Y	Y	Y	Y
Demographic controls	X	Y	Y	Y	Y
Comorbidities	X	X	Y	Y	Y

Source--National Inpatient Sample

Notes—Each row is the coefficient on a post indicator from a regression of the dependent variable, which is indicated by the row label in a model that includes year and hospital fixed effects. Indicated models also include demographic controls—age group, payer, and income quartile fixed effects—and comorbid conditions which are in the second panel of Table 1. Standard errors clustered on hospital in round brackets.

+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table 3: Association with Maternal Morbidity and Preventable Complications

	All		Low-risk mothers		High-risk mothers	
	(1)	(2)	(3)	(4)	(5)	(6)
	Non-prev. comp.	Prev. comp.	Non-prev. comp.	Prev. comp.	Non-prev. comp.	Prev. comp.
All	0.85	-7.34*	0.32	-8.93**	0.94*	-1.65+
	(0.55)	(2.85)	(1.04)	(3.43)	(0.42)	(0.92)
R-squared	0.246	0.066	0.021	0.039	0.643	0.098
Mean	0.093	0.250	0.057	0.287	0.214	0.124
N	2959415	2959415	2283458	2283458	675957	675957
Planned c-section	1.71***	0.51	0.10	3.15	1.77**	-0.30
	(0.43)	(0.85)	(0.89)	(3.20)	(0.55)	(0.45)
R-squared	0.574	0.226	0.025	0.147	0.744	0.032
Mean	0.172	0.144	0.075	0.445	0.200	0.055
N	642840	642840	145635	145635	497205	497205
Attempted labor	0.50	-9.66*	0.35	-9.77*	-2.95	-7.65*
	(0.87)	(3.91)	(1.07)	(3.85)	(3.43)	(3.86)
R-squared	0.072	0.043	0.023	0.045	0.428	0.072
Mean	0.071	0.279	0.056	0.276	0.254	0.315
N	2314605	2314605	2136011	2136011	178594	178594
Vaginal delivery	-0.62	-11.1**	-0.72	-10.9**	-3.85*	-16.1**
	(0.80)	(3.83)	(0.95)	(3.76)	(1.91)	(5.99)
R-squared	0.039	0.049	0.031	0.049	0.346	0.060
Mean	0.042	0.256	0.037	0.254	0.147	0.297
N	2031661	2031661	1937931	1937931	93730	93730
Unplanned c-section	4.91+	-1.63	7.24*	-2.15	-1.89	1.04
	(2.83)	(4.17)	(2.83)	(4.11)	(6.23)	(3.85)
R-squared	0.189	0.105	0.118	0.072	0.456	0.156
Mean	0.281	0.442	0.242	0.488	0.372	0.335
N	284914	284914	199892	199892	85022	85022

Source--National Inpatient Sample

Notes--Dependent variable is indicated by column title. Each cell is from a separate regression with sample indicated by the row label. All models include hospital, year, payer, and income quartile fixed effects, indicators for mother's age group, and the comorbid conditions listed in Table 1. All coefficients and standard errors have been multiplied by 100 for interpretability. Standard errors clustered on hospital in round brackets.

* p<0.05, ** p<0.01, *** p<0.001

Table 4: Association with Log Length of Stay

	(1) All	(2) Low risk	(3) High risk
All	-0.012	-0.0041	-0.046***
	(0.015)	(0.018)	(0.010)
N	2953899	2278963	674936
R-squared	0.23	0.19	0.21
Mean	2.49	2.34	3.00
Planned C-section	-0.039***	-0.035**	-0.042***
	(0.0090)	(0.011)	(0.0093)
N	642460	145497	496963
R-squared	0.30	0.24	0.30
Mean	3.17	3.51	3.07
Attempted Labor	-0.0016	0.0014	-0.045***
	(0.016)	(0.018)	(0.011)
N	2309501	2131683	177818
R-squared	0.19	0.19	0.17
Mean	2.30	2.26	2.80
Vaginal Delivery	-0.0066	-0.0074	0.031
	(0.018)	(0.018)	(0.038)
N	2026615	1933611	93004
R-squared	0.19	0.19	0.16
Mean	2.11	2.10	2.20
Unplanned C-section	-0.030*	-0.030	-0.048***
	(0.014)	(0.019)	(0.014)
N	284824	199855	84969
R-squared	0.31	0.28	0.34
Mean	3.69	3.79	3.45

Source--National Inpatient Sample

Notes--Dependent variable is the length of stay. The sample for each column is indicated by the column header and the delivery modality by the row label. Each cell is from a separate Poisson regression that includes year, payer, and income quartile fixed effects, indicators for mothers age in 5 year age bands, and the comorbid conditions listed in Table 1. Standard errors clustered on hospital in round brackets.

* p<0.05, ** p<0.01, *** p<0.001

Table 5: Procedure use in labor and delivery

	Induction		Forceps		Vacuum extraction		Episiotomy	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All mothers	-0.021	-0.029	0.0020	0.0024	-0.023*	-0.031*	0.0061	0.0062
	(0.019)	(0.024)	(0.0013)	(0.0016)	(0.0094)	(0.013)	(0.016)	(0.020)
R-squared	0.13	0.14	0.015	0.018	0.022	0.044	0.076	0.078
Mean	0.14	0.18	0.0080	0.010	0.057	0.073	0.092	0.12
Low-risk mothers	-0.027	-0.030	0.0023	0.0025	-0.022+	-0.024+	0.0055	0.0042
	(0.022)	(0.024)	(0.0016)	(0.0017)	(0.012)	(0.013)	(0.020)	(0.021)
R-squared	0.12	0.15	0.017	0.018	0.024	0.026	0.074	0.081
Mean	0.17	0.19	0.0083	0.0089	0.061	0.065	0.12	0.12
High-risk mothers	-0.0017	-0.020	0.00070	-0.000034	-0.025***	-0.10***	0.011*	0.042*
	(0.0084)	(0.028)	(0.0011)	(0.0045)	(0.0043)	(0.022)	(0.0055)	(0.021)
R-squared	0.11	0.13	0.024	0.047	0.041	0.15	0.032	0.056
Mean	0.045	0.17	0.0069	0.026	0.044	0.17	0.016	0.059

Source--National Inpatient Sample

Notes--Dependent variable indicated by column group header, sample indicated by row title. Each cell is from a separate regression. Odd-numbered columns use all mothers in the sample, while even-numbered columns restrict to mothers who attempted labor. All models include age group, race, payer, income quartile, year, and hospital fixed effects, and comorbid conditions listed in table XX. Standard errors clustered on hospital in round brackets.

+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table 6: Robustness to alternative samples and fixed effects

	All mothers			Low-risk mothers			High-risk mothers		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Base	Ever BF	Time trends	Base	Ever BF	Time trends	Base	Ever BF	Time trends
Vaginal delivery	-0.50	-0.68	-0.66	-1.15*	-1.40*	-1.39*	2.37**	1.95*	1.77*
	(0.47)	(0.51)	(0.53)	(0.55)	(0.57)	(0.59)	(0.74)	(0.79)	(0.89)
R-squared	0.43	0.43	0.43	0.08	0.09	0.08	0.18	0.17	0.18
Attempted labor	0.39	0.76	0.48	0.44	0.59	0.44	0.84	1.77	0.57
	(0.66)	(0.67)	(0.75)	(0.44)	(0.44)	(0.49)	(1.55)	(1.57)	(1.73)
R-squared	0.53	0.53	0.53	0.06	0.06	0.06	0.26	0.24	0.26
Vaginal if labored	-1.06	-1.59*	-1.19+	-1.67**	-2.06**	-1.85**	8.61***	5.56+	7.61*
	(0.67)	(0.74)	(0.72)	(0.64)	(0.68)	(0.68)	(2.56)	(3.11)	(3.35)
R-squared	0.10	0.11	0.10	0.05	0.05	0.05	0.17	0.16	0.17
Unplanned c-section	0.93	1.49*	1.13	1.64**	2.03**	1.81**	-1.49	-0.13	-1.17
	(0.65)	(0.70)	(0.71)	(0.60)	(0.64)	(0.64)	(1.04)	(1.15)	(1.35)
R-squared	0.03	0.03	0.03	0.03	0.04	0.03	0.12	0.10	0.12
Non-prev. complication	0.85	0.71	0.35	0.32	0.25	0.18	0.94*	1.06+	0.40
	(0.55)	(0.56)	(0.58)	(1.04)	(1.01)	(1.07)	(0.42)	(0.60)	(0.51)
R-squared	0.25	0.25	0.25	0.02	0.01	0.02	0.64	0.64	0.64
Prev. complication	-7.34*	-5.99*	-7.58*	-8.93**	-7.42*	-9.18*	-1.65+	-0.78	-2.02*
	(2.85)	(2.69)	(3.00)	(3.43)	(3.24)	(3.61)	(0.92)	(0.96)	(1.02)
R-squared	0.07	0.06	0.07	0.04	0.04	0.04	0.10	0.09	0.10

Source--National Inpatient Sample

Notes--Dependent variable is indicated by row label. Each cell is from a separate regression with sample indicated by column group header and specification indicated by column title. Ever BF restricts to hospitals that are ever Baby Friendly, Time Trends adds a trend in until/after a hospital is designated as Baby Friendly with different before and after designation. All models include year, payer, and income quartile fixed effects, indicators for mothers age in 5 year age bands, and the comorbid conditions listed in Table 1. All coefficients and standard errors have been multiplied by 100 for interpretability. Standard errors clustered on hospital in round brackets.

* p<0.05, ** p<0.01, *** p<0.001