Cesarean Section for High-Risk Births: Short- and Long-Term Consequences for Breech Births

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Abstract

Cesarean sections (C-sections) are the most commonly performed surgical procedures in industrialized countries. While they can be potentially lifesaving in cases of high-risk pregnancies, as with any surgical procedure, they can pose complications, and little is known about their long-term consequences for the mothers and children involved. In this paper, I use a sample of “at-risk” births—namely, breech births, in which the fetus is presented with its head upward instead of downward—to study the causal impact of C-sections on the health of infants and on the health, subsequent fertility, and labor market outcomes of mothers. Because selection into C-section may be endogenous, I exploit an information shock to doctors in 2000, in which a new study about the benefits of planned C-sections for breech births led to a sharp 23% increase in planned C-sections. This increase occurred across the board: I find no evidence of a shift in the composition of women receiving C-sections following the shock. I then use this information shock in a reduced form pre-post analysis and as an instrument for C-sections in a 2SLS analysis of Swedish birth, in-patient, and labor market register data associated with births taking place between 1997 and 2003. I find that an increase in C-sections among breech births led to strong improvements in child health originating from both short- and long-term improvements, as indicated by higher Apgar scores at birth and fewer nights hospitalized during ages 1-7. The estimates suggest that the medical intervention almost completely narrowed the gap in health between breech and cephalic (normal position) births. I find no significant impact on maternal health at birth or subsequent births, nor on maternal labor market outcomes. Though marginally insignificant, estimates suggest a potential negative impact on future fertility.

Keywords: fertility, maternal health, child health, birth technology, labor market response

JEL Codes: J13, I11, I12, I38, J24.
1 Introduction

There are large disparities in early-life health both within and across countries. These disparities stem from a multitude of factors, including health at birth, parental investments, and childhood environment (Haenfler and Johnson, 2002). It is widely recognized that early life conditions have long-lasting impacts on future socioeconomic outcomes (Almond et al., 2017). Given that investments in early stages play a greater role in the production of human capital than do investments later in life, medical intervention at birth could function as an efficient means for narrowing gaps in later life outcomes (Almond and Currie, 2010; Cunha and Heckman, 2007). While many medical interventions early in life, especially among high-risk births, are considered to improve immediate health and long term health and educational performance (Almond et al., 2010; Bharadwaj et al., 2013, 2017; Breining et al., 2015; Cutler and Meara, 2000; Daysal, 2015), the returns to care of low risk births may be less clear (Almond and Doyle, 2011). In light of the potential negative consequences of increases in medicalization of childbirth (Costello and Osrin, 2005) and because of the rapid increase in medical spending on infants compared with older individuals (Cutler and Meara, 2000), a better understanding of medical interventions at birth is important.

A large proportion of children in OECD countries begin their lives through a medical intervention, as around 28% of all births are delivered via Cesarean section (C-section). This intervention is traditionally prescribed for high-risk pregnancies, especially in cases of breech births (i.e., with the head facing upward instead of downward). In most populations, 3-4% of all babies are presented in breech position at term (Herbst and Thorgren-Jerneck, 2001). While the reasons for term breech presentation are unknown, it is associated with poorer birth outcomes compared with the normal (cephalic) fetal position (Hofmeyr et al., 2001).¹ Breech presentation births are riskier, since a fetus positioned with its head upward experiences a more difficult passage through the birth canal and is thus more likely to suffer from complications including oxygen deficiency during a vaginal delivery (Kotaska et al., 2009).

The global incidence of C-section has dramatically increased from the 1970s until today, with C-section rates now exceeding 30% in many countries, including Australia, China, Italy, and the United States (Gibbons et al., 2010), and with rates up to 50% in countries such

¹The risk of breech presentation is associated with higher maternal age, multiple births, preterm delivery, contracted pelvis, uterine anomalies, and placenta previa (a condition where the placenta covers the uterus). There are also a number of pregnancy complications that are associated with breech presentation: short umbilical cord, fetal malformation, oligohydramnios (too much amniotic fluid in the uterus) and hydramnios (too little amniotic fluid in the uterus), (Leyon et al., 2008).
as Brazil, Iran, and Mexico (Temmerman, 2016). Because the strong increase in C-section rates worldwide cannot be attributed solely to demographic or maternal health changes, this suggests that C-sections also are performed for nonmedical reasons, possibly driven by supply-side incentives which lead to suboptimal use of the procedure (Betran et al., 2015; Currie and MacLeod, 2008; Currie, J. and MacLeod, W. B., 2017; Halla et al., 2016; Johnson and Rehavi, 2016). The use of C-section is widely recognized by the medical society as a lifesaving measure for mother and child when medically indicated. However, for low-risk births, C-section may lead to higher morbidity and mortality than vaginal birth (Clark et al., 2008). C-section delivery is also associated with adverse health outcomes for subsequent pregnancies (Daltveit et al., 2008) and lower future fertility (Gurol-Urganci et al., 2013; O’Neill et al., 2013).^2

Despite C-section being the most common surgical procedure in industrialized countries, many questions remain regarding the causal and long-run impact on the health of children and on the health, future fertility, and labor market outcomes of mothers. These questions can be difficult to assess not only because of the lack of detailed data on long-term outcomes, but also because the choice of delivery mode is endogenous to maternal and child outcomes, with any preexisting conditions likely being correlated with the outcomes of the procedure. This study overcomes both of these issues and aims to causally identify the impact of C-section on maternal and child outcomes among high-risk births consisting of breech births. To obtain reliable information on both long- and short-run outcomes, I use Swedish register data. To overcome the intrinsic endogeneity issues, I explore an exogenous increase in C-section attributed to an information shock to the medical establishment on the benefits of C-section among term breech births.^3 Specifically, I use a pre-post analysis wherein the timing of the birth, before or after the information shock, creates a sharp discontinuity in the probability of planned C-section amongst breech births, allowing me to capture the causal impact of the procedure on subsequent maternal and child outcomes.

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^2The negative association between C-section and future fertility has still not been fully explained but has been posited to be due to factors such as physiological channels (Hurry et al., 1984), psychological channels (Lobel and DeLuca, 2007; Rowlands and Redshaw, 2012), and maternal preferences (Bhattacharya et al., 2006; Norberg and Fantano, 2016; Tollánes et al., 2007). C-section could affect future fertility outcomes for a number of reasons. First, complications from the surgery procedure may cause involuntary infertility (biological channels) (Hurry et al., 1984). Second, the time for recovery from C-section compared with vaginal birth is usually longer. Third, if C-section is considered more traumatic than vaginal delivery, then the psychological cost of childbearing increases with C-sections, reducing the willingness of mothers to have subsequent births (psychological channels) (Lobel and DeLuca, 2007; Rowlands and Redshaw, 2012). Fourth, maternal preferences may also be a contributing factor (Bhattacharya et al., 2006; Norberg and Fantano, 2016; Tollánes et al., 2007). In contrast, Smith et al. (2006) find that the negative association between C-section and future fertility is strongly diminished when controlling for maternal characteristics.

^3This approach follows other studies using a medical information shock as a source of variation in treatment (Anderberg et al., 2011; Jensen and Wüst, 2015; Price and Simon, 2009).
The information shock I study in this paper occurred in August 2000, at the annual meeting of the Swedish College of Obstetricians and Gynecologists. During this meeting, preliminary results from a large-scale international randomized control trial by Hannah et al. (2000), called the Term Breech Trial, were presented (Alexandersson et al., 2005). The new evidence suggested that planned C-section delivery should be the preferred delivery mode for singleton term breech births. This led to a substantial and immediate increase in planned C-sections for breech births in Sweden (Herbst, 2005) as well as in multiple industrialized countries (Sharoni et al., 2015). This information shock has had a strong and long-lasting impact on medical practice worldwide. To quote Glezerman (2006), “Rarely in medical history have the results of a single research project so profoundly and so ubiquitously changed medical practice as in the case of this publication (TBT).” This was also the case for Sweden, which exhibited a stark rise in planned C-sections for breech births, from 47% to over 60% between 2000 and 2001.

This paper makes important contributions to the previous literature regarding the impact of C-sections on child and maternal outcomes in high-risk births. First, most previous studies, particularly those in the biomedical literature, suffered from endogeneity issues, small sample sizes, or both. The information shock to the medical society in 2000 allows me to credibly identify the causal impact of C-section, since using Swedish register data provides a much larger sample size and is unique in that it allows visibility into the universe of breech births, alongside a rich set of maternal covariates. Second, previous studies with a causal interpretation either focus on short- and mid-run health outcomes (Jensen and Wüst, 2015) or are limited to maternal outcomes regarding future fertility and labor market outcomes without being able to examine the intermediary effects on health outcomes for both mother and child (Halla et al., 2016). By exploring exogenous variation in C-section and detailed Swedish register data, this

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4 Preliminary results from a retrospective cohort study by Herbst and Thorsgren-Jerneck (2001) on the benefits of planned C-section were also presented at the annual meeting in 2000. For a detailed discussion of evidence based changes in delivery mode due to the Term Breech Trial, see Alexandersson et al. (2005).

5 These countries include Denmark, Australia, UK, Netherlands, Malaysia, Finland, and Saudi Arabia (Sharoni et al., 2015).

6 This study also relates to the literature on C-section and incentives and information (Currie, J. and MacLeod, W. B., 2017; Johnson and Rehavi, 2016), as well as Borra et al. (2014), which studies the effect of removing child benefits on timing of births (scheduling of induced labor and C-section). The elimination of child benefits led to a rise in low birthweight children and neonatal mortality.

7 A study with a more robust design is Norberg and Pantano (2016). Using multiple data sources and estimation techniques, they find a negative association between C-section and future fertility (corresponding to a reduction by 17%), which is at least partly attributed to maternal preferences.

8 Jensen and Wüst (2015) use the publication of the term breech trial as exogenous variation in C-section (see Section 2). Halla et al. (2016) use exogenous variation in emergency C-section, originating from supply-side incentives to accelerate deliveries across weekdays, to assess the effect on fertility in Austria. Their findings suggest that emergency C-section at first birth reduces fertility by approximately 17% and causes a temporary rise in maternal employment such that income increases by 14%. Card et al "The Health Effects of Cesarean Section: Evidence From the First Year of Life", examine the short-run impact of C-section on child health.
study considers a broader set of outcomes and a longer time horizon compared with previous studies. To the best of my knowledge, this is the first study to analyze the causal impact of C-section on outcomes such as child health up to age 7, maternal health outcomes during any subsequent pregnancy, and labor market outcomes including income from both sickness and parental benefits. Thus, relative to previous studies, this paper provides a more extensive analysis by studying the impact of C-section on both short- and long-run impacts on child health and maternal health, future fertility, and labor market responses. Third, the analysis in this paper sheds light on possible heterogeneous effects across socioeconomic status and health indicators, which is important given that breech births constitute a particular high-risk group, implying a possible social gradient in the response to altered delivery mode.

The results from this study show that the information shock led to a substantive and significant increased use of planned C-section deliveries by 11 percentage points among singleton breech births at term, roughly corresponding to a 20% increase. This increase was not restricted to any particular group of women with breech births, but was found among all women below age 35, all educational levels, and both normal-weight and overweight women. No change in delivery mode was found for pregnancies with normal fetal position. Importantly, I find no evidence of changes in the composition of mothers receiving a planned C-section or in the proportion of breech births being reported. Likewise, I find no other discontinuities when examining placebo dates.

The reduced form estimates from the pre-post analysis suggest that the information shock improved child health among breech births, as measured by a summary index of various short- and long-term health measures by 0.104 standard deviations, almost completely closing the gap in child health between breech and normal-position births. This increase in child health is driven by both improvements in health at birth and during childhood, indicated by higher Apgar scores, and fewer nights hospitalized during ages 1-7. Thus, the increase in C-sections improved child health in both the short and the long run. While the beneficial impacts of the shock on children are clear, there appears to be little impact on mothers. I find no significant impact of the information shock on maternal health at birth or at subsequent births. I also find an insignificant negative impact on future fertility (in terms of both the total number of future births and the probability of no future birth) in most specifications. However, because

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9 Child health is measured by a summary index according to Anderson (2008) consisting of Apgar score, infant mortality, and hospitalization during the first year of life and ages 1-7.

10 Apgar stands for appearance, pulse, grimace response, activity, respiration. This score is an assessment made by a physician 1, 5, and 10 minutes after birth. A score of 10 indicates perfect health and 1 extremely poor health.
these estimates are consistent across specifications and are occasionally marginally significant, I cannot rule out a potential negative impact. Furthermore, I do not find any effects on labor market outcomes for the mother when analyzing income from labor earnings, sickness and parental benefits.

In addition to the reduced form analysis, I estimate a two-stage least squares model using the information shock as an instrumental variable for planned C-section. While the reduced form analysis provides the causal impact of the information shock on all breech births, the two-stage least squares estimates provide the causal impact of C-sections that are generated by the information shock. That is, this analysis gives us the local average treatment effect of C-section on compliers. The two-stage least squares estimates suggest that the change from vaginal delivery to planned C-section improved child health by 0.93 standard deviations, which is driven by an increase in Apgar score of 0.58 units and by 5.9 fewer hospital nights.

The results are robust to a number of sensitivity checks, including alternative specifications (using quadratic trends, cubic trends and triangular kernel and a smaller window of time), non-weighted indices, and a difference-in-differences design using births with normal fetal position (cephalic births) as controls.

In summary, this study suggests that the increase in planned C-sections for breech births improves child health. However, it appears to have limited consequences for maternal health and labor market outcomes, but a possible negative effect on future fertility. These findings should be particularly relevant for countries with low rates of planned C-section for breech births. Singleton breech births at term represent a reasonably large share (3-4%) of all births. Thus, interventions that can improve health among this high-risk group are important. The results from these exercises show that the gap in child health between this risk group and normal births nearly vanishes in the face of this medical intervention. Moreover, this study contributes to the general literature on the causal effects of C-section, and although it focuses primarily on breech births, the results may be of interest for other high-risk groups as well.

The paper is structured as follows. Section 2 presents a description of breech birth in the Swedish context and outlines the information shock to the medical society. In Sections 3 and 4, the data and empirical strategy are described. Sections 5 and 6 present and discuss the results. Section 7 concludes the study.
2 Background

2.1 Breech presentation and delivery mode

Multiple biomedical studies suggest that planned C-section deliveries reduce the risk of perinatal and neonatal morbidity and mortality in breech births (Betran et al., 2015; Cheng and Hannah, 1993; Gifford et al., 1995; Herbst, 2005; Herbst and Thorngren-Jerneck, 2001). However, this association does not necessarily provide a causal interpretation because of the correlation between the choice of delivery and birth outcomes (Hannah et al., 2000). This research position is reflected in the lack of consensus within the medical society on the optimal delivery mode for breech births (Glezerman, 2006; Goffinet et al., 2006; Sharoni et al., 2015; Turner, 2006).

A milestone within the medical literature regarding delivery mode for breech birth deliveries at term was the publication of the Term Breech Trial by Hannah et al. (2000). This large-scale international randomized controlled trial was conducted across 121 hospitals in 26 countries, covering 2,088 women randomly assigned to either a planned C-section or planned vaginal delivery. The results showed that perinatal and neonatal mortality as well as severe neonatal morbidity were significantly lower in breech births delivered with planned C-section (1.6%) than with planned vaginal delivery (5.0%). Moreover, the reduction in mortality and morbidity risks were higher in countries with already low neonatal death rates. No significant differences in maternal mortality or severe maternal morbidity were found between planned C-section and planned vaginal delivery. The study was terminated prematurely because of findings of statistical differences in perinatal outcomes between the two groups, making it unethical to continue the randomization (Hannah et al., 2000). While the Term Breech Trial had a strong and long-lasting impact on medical care in multiple countries (Sharoni et al., 2015), the results of the study did not remain unchallenged. Strong criticism has been directed toward the implementation of the trial by Glezerman (2006) and Turner (2006).

Two follow-up studies were conducted two years after the Term Breech Trial, assessing the impact of planned C-sections for breech births on child outcomes (Whyte et al., 2004) and maternal outcomes (Hannah et al., 2004). These studies were conducted using survey data collected from questionnaires directed to the mother and child from a subsample of women from the Term Breech Trial sample. No significant impact was found on either child health

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11Women were eligible if the fetus was a singleton, was alive and had a weight below 4,000 grams at gestational age 37 weeks or beyond. Births with known fetal anomalies were excluded from the trial.

12Glezerman (2006) argues that most cases of the neonatal mortality and morbidity are unrelated to the delivery mode.

13The current study differs from these previous studies in that rich register data on long-term outcomes beyond
(Whyte et al., 2004) or maternal health or fertility (Hannah et al., 2004). These results were surprising with regard to the Term Breech Trial, which showed a strong positive health effect for babies delivered by planned C-section.

A more recent study supporting the findings of the Term Breech Trial is Jensen and Wüst (2015), which examines the impacts of the Term Breech Trial on child and maternal health in Denmark. By using the Term Breech Trial as exogenous variation in the likelihood of C-section among high-risk pregnancies, Jensen and Wüst (2015) find that child health improves. The results suggest that C-section among breech presentation pregnancies is associated with 4 percentage points higher Apgar score, 6 percentage points lower probability of an Apgar score below 7 and approximately seven fewer visits to the doctor over the first three years of life. They also find that C-section does not affect maternal health other than increasing hospitalization by 2.3 days.

2.2 The Swedish context

In Sweden, prenatal care is provided free of charge and includes ultrasounds, physical examinations, and sampling of biomarkers, as well as birth classes. While midwives usually carry out these tasks, pregnant women may also access care by an obstetrician or gynecologist (OB/GYN), which is a necessity for prescription medications or medical procedures. Most women have their first visit at a maternity unit during gestational weeks 6-12. From week 20, women are advised to have monthly checkups until week 30, after which biweekly checkups are advised (Vårdguiden, 2017). Prenatal care attendance in Sweden is very high. Only 0.4% of all women visit less than three times, and only 9.4% register later than gestational week 15 (Buckens et al., 1999).

Near the end of the pregnancy, around weeks 36-37, the fetal position is examined by a midwife at the prenatal care unit. If the fetal position is suspected to be breech or deviates from normal presentation in some other way, the woman is referred to a specialist maternity
care unit, where the OB/GYN tries to manually turn the baby into a cephalic position using a procedure called “external cephalic version”. If this is successful (and if the baby stays in cephalic position until delivery) vaginal delivery is attempted following the normal procedures. Approximately 50% of all external cephalic versions are unsuccessful. In such cases, a planned C-section is usually scheduled 7-10 days before the expected day of delivery (based on the date of last period and ultrasound examination). Vaginal delivery can be attempted if certain criteria are fulfilled, including normal fetal growth, pelvis size, spontaneous start of delivery, and abundant amniotic fluid. However, not all breech presentations are identified prior to birth. If a breech position is discovered at the time of delivery, the decision-making process is similar to that when discovered before (Karolinska Universitetssjukhuset, 2016).

2.3 Information shock to the medical society

In 2000, new scientific evidence became available, suggesting that planned C-section is the preferred delivery mode for singleton breech presentation births at term. In Sweden, the debate within the medical society on the preferred delivery mode for breech births began before the publication of the Term Breech Trial, at the annual meeting of the Swedish College of Obstetricians and Gynecologists (SFOG) in August 2000 (Alexandersson et al., 2005). The annual meeting started with a symposium on “Term breech: C-section or vaginal delivery?” where preliminary results from the Term Breech Trial by Hannah et al. (2000) were presented as evidence in favor of planned C-section as preferred delivery mode.

The next piece of evidence was presented by Herbst and Thorngren-Jerneck (2001), consisting of preliminary results from a cohort study in Sweden, suggesting that planned C-section is the preferred delivery mode from breech births at term. Because of the new evidence presented at the annual meeting, the Swedish medical society of perinatal medicine organized an extra meeting in Stockholm in December 2000 together with other medical societies of perinatal medicine from Scandinavia.

Although no new guidelines were issued, multiple sources suggest that the dissemination of new evidence on preferred delivery mode by Hannah et al. (2000) and Herbst and Thorngren-Jerneck (2001) find that babies delivered by planned vaginal delivery had lower Apgar scores (3-5%) and exhibited higher neonatal neurological morbidity (3%). Another study by Herbet (2005) on perinatal and infant mortality among babies in breech presentation at term in Sweden, using the Medical Birth Registry for the period 1991-2000, finds that breech babies delivered by C-section exhibit lower perinatal and infant mortality.
Jerni (2001) caused a strong increase in planned C-sections. First, an immediate poll of SFOG members after the symposium on breech births at the annual meeting showed an increased support for planned C-section compared with vaginal birth. Second, the data show an evident pattern of altered Swedish obstetric practice regarding delivery mode among breech presentation births attributed to new evidence-based recommendations (Axandersson et al., 2005), consistent with many other industrialized countries at this time (Sharoni et al., 2015).

In Figure 1, trends in C-section among breech births at term are presented. The trends show a sharp increase in the rate of planned C-section, from approximately 47% in 2000 to over 60% in 2001 (Figure 1b). The trends at the monthly level (see Figure 2) display how C-section increased after the annual meeting in August 2000. Based on residency, trends in probability of C-section for breech births at term are presented by county in Figures A1, A2 and A3. The increase is the sharpest in some of the most populated counties. From 2001 onward, approximately 70% of breech-presentation pregnancies have been delivered by planned C-section in Sweden. During this period, the prevalence of breech births is constant (see Figures 3 and 4) and no increase in C-section for normal-position births can be found either by graphical examination (see Figure 5) or in the regression analysis (see columns 3-4 in Table 1).

Since the information shock took place at an internal medical gathering rather than in the public media, the increase in C-section can be thought of as mainly supply side driven. That is, a woman giving birth to a baby in breech presentation at term after the annual meeting in 2000 was more likely to be recommended a planned C-section than a vaginal birth. While there are regional differences in planned C-section, residential sorting due to demand for a planned C-section is less likely given that expectant mothers learn late in the pregnancy (weeks 36-37) about the fetal position of the child, thereby making it difficult to plan ahead. Given that information on internal hospital routines can be hard to access as an outsider and that expectant mothers in Sweden have a limited ability to choose the hospital at which to give birth, it is thus reasonable to believe that the increase in C-sections can be attributed to supply-side change due to the new evidence provided to the medical society. Finally, in the Swedish context, there is no (known) financial incentive for the individual doctor to choose one specific delivery

19 National guidelines for specific selection criteria on mode of delivery for breech presentation pregnancies have been available in Sweden since 1974. During the 1980s and 1990s, studies from several countries (including Sweden) on preferred delivery mode for breech presentation pregnancies showed increasing support for planned C-section. However, the evidence was not conclusive, which led to different medical practices across Swedish hospitals (Herbst, 2005).

20 Nearly 50% of the OB/GYNs at the annual meeting voting in favor of routinely planned C-section. When the same question was asked, but with the stipulation that the OB/GYNs should imagine that the patient was a family member or oneself, two-thirds voted in favor of routine planned C-section (internal newsletter of SFOG, "Medlemsbaldet nr 4, 2000").
mode over another.

3 Data

3.1 Data description

I use Swedish administrative population-level data to study the impacts of C-section on child and maternal outcomes. I use data for all births in Sweden between 1973 and 2011 from cohorts born between 1940 and 1985 (including their children and parents) which are identified via the Swedish Multi-generational Registry (Flergenerationsregistret) and the Swedish Medical Registry (Svenska födelseregistret). Based on this sample, covering more than 98% of all births in Sweden during 1973-2011, multiple data registries on health and labor market outcomes are combined, and data are complete for the period 1991-2011.

Information on pregnancy and birth outcomes is obtained from the Swedish Medical Birth Registry. The Swedish Medical Registry is provided by the National Board of Health and Welfare and contains information on all births in Sweden since 1973 (beyond 22 weeks of gestational age and including both stillbirths or live births). This registry provides detailed information on pregnancy, delivery and postpartum conditions, including maternal characteristics (maternal age, height, and weight), previous health conditions (diabetes, asthma, and epilepsy) and pregnancy behavior (tobacco usage and prenatal visits). In addition, it also provides extensive data on perinatal and neonatal outcomes for the child, including fetal position, gestation, birth weight, health at birth, malformation, surgeries, and medical diagnoses and treatments. There is detailed information, for each birth, regarding medical interventions during delivery such as C-section, induction of labor, and operative procedures such as the use of forceps and vacuum extraction.

I particularly focus on delivery mode, whether vaginal delivery or C-section delivery. As C-section can be either a planned or emergency surgical procedure, information about the indication (whether a planned or emergency C-section) for the procedure is of interest. The birth registry lacks detailed information about the indication for C-section before 2000. Instead, it provides information on whether delivery started or ended with C-section. For this reason, deliveries that started with C-sections are used as a proxy for planned C-section, and deliveries that end with C-sections (after attempting vaginal delivery) are used as a proxy for emergency C-section. Deliveries of term births that start with C-section are considered a good proxy for planned C-section (Källén et al., 2005).
In order to define treatment status, I need to identify whether the birth occurred before or after the information shock. Information on the exact date of birth is unfortunately not available. As an approximation for date of birth, I use the discharge date from the maternity unit minus the number of average hospital nights for corresponding delivery mode. In the year 2000, the number of nights spent at the hospital after delivery by C-section was, on average, four nights, compared with two nights for vaginal delivery (The Swedish National Board of Health and Welfare, 2003). There are other important variables for this analysis. These include fetal position, in which breech birth is defined as complete, frank, or footling breech,\(^{21}\) Apgar score at 5 minutes, indicating the general health condition of the newborn baby five minutes after the delivery, and maternal complications postpartum, which are identified via the ICD-10 classification system. In particular, complications include diagnoses of postpartum hemorrhage (severe blood loss) and maternal sepsis (infection).\(^{22}\)

Data on hospitalization are obtained from the National Patient Registry, provided by the National Board of Health and Welfare. Using this registry, I obtain information on inpatient care at all Swedish hospitals since 1987, including length of each hospital stay. Because of data availability, I use the mother’s discharge date from the maternity unit, via the Medical Birth Registry, as a proxy for the date of delivery. Thus, for the mother, I can observe hospitalization only after readmission to the hospital. Mortality data are identified using the Cause of Death Registry, which is provided by the National Board of Health and Welfare and includes information on all deaths of registered residents in Sweden since 1961. The diagnoses of causes of death are coded according to the ICD system.

Data on labor market outcomes are obtained from the Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA), which is provided by Statistics Sweden and contains annual information on education and earnings for all individuals above age 16 starting from 1991. To assess the impact of birth technology on labor market responses, I focus on the following variables: income from gainful employment, defined as total annual gross earnings (in cash) and net income from active business; income from parental leave, defined as the total annual income from parental leave (this includes income from parental allowance, temporary parental leave, and child care allowance); income from sick leave, defined as the total annual income resulting from illness, injury, or rehabilitation (including a sick pay period of 14

\(^{21}\)ICD-10: O80.1, O83, O64.1, P03.0, or codes defined by Swedish Medical Birth Registry: MAG00, MAG03, MAG10, MAG11, MAG20, or MAG96.

days); income from unemployment benefit, defined as the total annual income from unemployment benefits. All income variables are expressed by annual amount of 100 SEK. Education is measured by the highest level of educational attainment (levels 1 to 7).

3.2 Main outcome variables and multiple hypothesis testing

The outcomes are chosen based on data availability and to enable comparisons to previous results (Hannah et al., 2000, 2004; Herbst, 2005; Herbst and Thorngren-Jerneck, 2001; Hofmeyr et al., 2001; Jensen and Wüst, 2015). Since I test a large number of outcome variables, the analysis is prone to type 1 errors. To account for this potential issue, I compute summary indices as suggested by Anderson (2008), combing multiple outcomes into one measure for child health, maternal health at birth, maternal health at subsequent birth, and labor market outcomes. The indices are computed as follows: The direction of each outcome is oriented in the same direction, such that a higher value indicates a better outcome. All outcomes are standardized, subtracting the mean and dividing it by the standard deviation of the control group. For each category of interest, an index is created using the standardized variables weighted by the inverse of the covariance matrix. This means that variables with lower correlation with the other variables within the category provide new information and will therefore obtain a higher weight than variables with high correlation. The index is computed in such a way that mean in the control group is zero with standard deviation one. The following indices are computed:

1. **Child health index**: Apgar score (scale 1-10, positively coded), Apgar score below 7 (negatively coded), infant mortality (negatively coded), nights hospitalized (inpatient admission overnight) within the first year of life (negatively coded), and between ages 1 and 7 (negatively coded).

2. **Maternal health index**: Maternal sepsis (negatively coded) and postpartum hemorrhage (negatively coded), number of nights hospitalized postbirth (inpatient admission overnight within one year of birth, negatively coded).

3. **Maternal health at subsequent birth index**: Maternal sepsis (negatively coded) and postpartum hemorrhage (negatively coded), number of nights hospitalized postbirth within

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23 Level 1 is primary education less than 9 years, level 2 is primary education of 9 years, level 3 is secondary education at most 2 years, level 4 is secondary education of 3 years, level 5 is tertiary education less than 3 years, level 6 is tertiary education 3 years or more, and level 7 is graduate studies.

24 See Anderson (2008).

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one year from birth (negatively coded), and emergency C-section (negatively coded) at subsequent birth.

4. **Maternal labor market index**: Annual labor income (in 100 SEK is positively coded), parental benefits (negatively coded), and sickness benefits (negatively coded).

In addition, fertility outcomes using a fixed time period of 8 years after birth are analyzed focusing on the total number of future births, a binary measure of any future birth, and birth spacing. Finally, effects on income from gainful employment, sickness benefits, and parental benefits are analyzed separately.\textsuperscript{25} The issue of multiple comparisons is further addressed by controlling for **false discovery rates (FDR)**, which is the proportion of type I errors. Corrected p-values are estimated using the step-up procedure suggested by Benjamini and Hochberg (1995). While FDR has the disadvantage of a higher number of false positives than with alternative methods (for example, family wise error rate), the advantage is that it yields higher power.\textsuperscript{26}

### 3.3 Sample and descriptive statistics

For this analysis, data from multiple registers are combined for the time period August 1997 to August 2003 (i.e., 36 months before and after the information shock). The sample consists of 522,606 births. I further restrict the sample to mothers with a singleton birth, in which the fetus is presented in breech position at term (gestational age equal to 37 weeks or above).\textsuperscript{27} Multiple births and preterm births are omitted from the analysis since the information shock of preferred delivery mode considers only singleton breech births at term. I cannot observe whether external cephalic version was attempted. Thus, my sample consists of fetuses in breech presentation, in which births with successful external cephalic version are implicitly omitted from the sample. The final sample of breech babies covers 13,208 births (of which 34 are stillbirths and 1,107 are babies with malformations).\textsuperscript{28}

To illustrate how breech births are related to normal (cephalic) births at term, I present summary statistics in Table 2 of unconditional means and standard deviations in child and

\textsuperscript{25}Since a significant proportion of the sample earns an income of zero, I use an inverse hyperbolic sine transformation $\log(1 + (y_i^2 + 1)^{-1})$ analogue to Burbidge et al. (1988). This transformation has an analogous interpretation to the standard logarithmic transformation (of the percentage change in income) but is defined at zero.

\textsuperscript{26}Bonferroni corrected p-values, the most conservative alternative, will also be reported for comparison.

\textsuperscript{27}According to the Swedish National Board of Health, breech presentation is identified by maternal diagnosis by ICD-10 codes O80.1, O83, O64.1, and P03.0. Breech implies breech or footling position.

\textsuperscript{28}During this period, there are 406,448 singleton term births with normal presentation. Subsamples of different time periods around the information shock are also used for the analysis. I exclude births with no information on year of birth or date of discharge (577 observations) as well as observations without information on gestational age (48 observations), since these variables are pertinent for defining treatment status.
maternal characteristics among breech births (columns 1-3) and normal position births (columns 4-6). A t-test of differences in means between breech and normal births is presented (column 7) together with its p-values (column 8). This table shows a clear pattern in that singleton babies presented in breech at term tend to have poorer health outcomes at birth than babies in normal presentation. On average, birth weight is 250 grams lower for babies in breech presentation and gestational age is one week shorter. Breech babies are less likely to be male (0.46 compared with 0.51), suggesting negative selection of male fetuses in utero and more likely to suffer from fetal malformation (8% compared with 3%). Apgar score is lower in absolute terms as well as for the dichotomous measures of low health at birth (below score 7). The infant mortality rate is higher for breech babies, at 3.2 deaths per 1,000 live births, compared with normal position babies, at 1.3. Other health indicators show a similar pattern in which babies in breech presentation exhibit inferior health compared with those in normal presentation. These differences may not be due only to breech position but also to delivery mode and underlying maternal characteristics. The differences in child health remain when comparing child health between breech vaginal birth and normal vaginal birth.

Maternal health outcomes show a similar pattern of adverse health and obstetric outcomes. A striking difference between breech and normal position births is the delivery mode. Among breech births, planned C-section delivery is the more common method (55.5%) compared with emergency C-section (26.6%). In comparison, among normal position births, 3.9% of all deliveries are planned C-sections, and 4.5% are emergency C-sections. Mothers with breech births have higher educational attainment and higher annual labor income (114,792 SEK compared with 100,000 SEK) prior to birth, but no statistical differences are seen for the amount of sickness benefits prior to birth. This suggests that women having breech births are not disadvantaged in terms of education and income compared with mothers with normal position births. Finally, in panel D, the indices confirm the summary statistics presented, showing that child and maternal health are poorer among breech births (by 0.039, -0.02, -0.01) compared with normal position births (0.106, 0.016, 0.157). This is, however, not the case for the labor market index, which exhibits better outcomes (0.106) compared with normal births (-0.003).

Birth outcomes, delivery mode, and fertility outcomes for first-time mothers with term breech singleton births are compared before and after the information shock in Table 3.

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29 The samples of normal position births include singleton births at term (born in week 37 or later).
30 For example male fetuses are less likely to survive under distress (Almond and Mazumder, 2011).
31 These differences also remain when holding gestational age constant, regressing breech status on child health. These results are available on request.
32 This simple pre-post comparison does not account for trends and covariates, which will follow in the empirical
Columns 1 and 2 display variable averages, 36 months before and after the annual meeting in August 2000, respectively, and a t-test of the difference between means with p-values in brackets below, is presented in column 3. In Panel A, the summary statistics document a strong increase in all C-sections, which can be attributed mainly to the strong increase in planned C-sections, from 47% to 65% compared with the smaller and less significant decrease in emergency C-sections from 29% to 27%. The induction of labor decreased from 2% to 0.8%, which is consistent with a higher use of C-section deliveries. Child health outcomes are presented in Panel B and suggest an overall improvement in health. Health at birth measured by the absolute level of Apgar score as well as a dichotomous measure of low Apgar score (below 7) is improved. While the infant mortality rate and number of hospital nights are lower in the post period, these differences are not significantly different from zero. There is no clear pattern of changes in maternal health at birth, maternal health at subsequent births or fertility outcomes within a fixed time period of eight years,\textsuperscript{33} presented in Panels C, D, and E. Maternal labor market outcomes appear to be improved, presented in Panel F, when comparing unconditional means. The summary indices are presented in Panel G.

These outcomes for the full sample are further explored by graphical examination, which confirms the summary statistics presented in Table 3. Trends in delivery mode and child and maternal outcomes among breech births at term are presented in Figures 1, 2, 6, 7, and 8. These graphs show monthly level (as well as yearly level for C-section) trends around the information shock, where 0 is the month of information shock. The red vertical dashed line indicates the month of the information shock, and each dot represents the average rate of C-section on a monthly basis. Figures 1 and 2 show a sharp increase in C-section among breech births at term, which is driven by an increase in planned C-section deliveries compared with emergency C-sections.\textsuperscript{34} The proportion of breech presentation births during this period appears to be constant across the cutoff, which is important for the identification strategy used in this project. Moreover, no discontinuous increase in any type of C-section can be detected among normal position births (see Figure 5).\textsuperscript{35} Thus, these graphs confirm the summary statistics.

\textsuperscript{33}It should be noted that all subsequent pregnancies are likely to be endogenous to the first birth. See Section 6 for a longer discussion.

\textsuperscript{34}The proportion of emergency C-sections are presented in Figure A4.

\textsuperscript{35}The regression analysis confirms this finding and is further elaborated in Tables 1 and 5.
4 Empirical analysis

The aim of this paper is to study the causal impact of C-section on child and maternal outcomes. The intrinsic endogeneity problem when studying this relationship is that delivery mode tends to be correlated with prebirth characteristics of mother and child. Thus, a simple correlation between outcomes and delivery mode will suffer from selection bias—it is likely that important, but unobservable, prebirth maternal and child characteristics differ systematically between C-section births and other births. For example, such maternal characteristics may involve unobserved preferences, behavior, and health conditions that can affect both delivery mode and outcomes. To overcome these issues, I use an identification strategy based on a pre-post design. In short, I compare outcomes among breech births occurring before the information shock with outcomes among breech births occurring after the information shock. Thus, births delivered before the information shock function as a control group for births delivered after. The key identifying assumption required for this empirical strategy to be valid is that the information shock is exogenous to the timing of the birth. In other words, I can identify the causal impact of an increased proportion of C-sections if prebirth maternal and child characteristics are constant before and after the information shock.

I start by examining the impact of the information shock on delivery mode, obstetric care, and outcomes for singleton breech births at term, which is estimated according to Equation 1 using ordinary least squares model.

\[
Y_{it} = \alpha_1 + \alpha_2 \text{lnf oShock}_t + f(t) + X_{it} \delta + \epsilon
\]

(1)

The outcome variables are denoted by \(Y\) across individual \(i\) and time \(t\). The variable \(\text{lnf oShock}_t\) is a binary variable equal to one if birth occurs after the 25 of August 2000 and zero if birth occurs before.\(^{36}\) Split time trends \(f(t)\) are included, consisting of a first-order polynomial of normalized daily calendar time away from the information shock in August 2000, allowing for different slopes across the cutoff. The calendar time is normalized such that the cutoff date, 25 of August 2000, is zero where treatment is positive to the right of this threshold. By including \(f(t)\), I allow for different trends (slopes) before and after the information shock. In certain specifications, a full set of child and maternal characteristics \(X_{it}\), consisting of binary measures of birth order, maternal age, county of residency, quarter of birth, nationality (born in Sweden

\(^{36}\) Date of birth is not available. Instead, I use the discharge date as an approximation for date of birth. More information is available in Section 3.
or not), tobacco usage during the first trimester, sex of the baby, educational attainment, mean income, and income from sickness benefits before giving birth, is included.\textsuperscript{37} The idiosyncratic error term is denoted \[ \xi \] clustered on the discrete values of the assignment variable, day-month-year, suggested by Lee and Card (2008).\textsuperscript{38} Robustness checks are conducted with respect to the choice of polynomials, kernel, and time period.

The effect of planned C-section can be captured by a two-stage least squares model (2SLS) using the information shock as an instrumental variable (IV) for planned C-section. The IV strategy is analogue to a fuzzy regression discontinuity design (Lee and Lemieux, 2010) using calendar time as the running variable. The estimated effect is thus the local average treatment effect (LATE) (Angrist and Pischke, 2009), which can be interpreted as the average treatment effect on “compliers”—that is, the breech presentation births delivered by C-section due to altered routines following the information shock. The IV analysis is described by Equation 2, where the relationship between various outcomes $Y_t$ and delivery mode, which can be attributed to the information shock, is established.

$$Y_{1t} = \beta_1 + \beta_2 P(\text{C-section}_{1t} = 1) + g(t) + X_{1t}\theta + \xi_{1t}$$ (2)

The predicted likelihood of C-section due to the information shock is expressed by $P(\text{C-section}_{1t} = 1)$ and estimated according to Equation 1. Trends, time-varying controls, and the error term are handled analogously to Equation 1, such that each variable included in the first stage is included in the second stage. The regression, expressed by Equation 2, is estimated by a linear probability model using a 2SLS method where the estimated effect can be interpreted as the local average treatment effect on compliers.

In addition to the date of birth being independent of the information shock, the IV strategy is valid provided that the following assumptions are satisfied (Angrist and Pischke, 2009): First, the exclusion restriction implies that the information shock affects outcomes only via a higher likelihood of having had a C-section and not other medical practices and treatments. Second, the instrument must be relevant such that the information shock is strongly correlated with the adaptation of a new delivery practice—that is, C-section among breech pregnancies. Finally, monotonicity implies that the information shock should have either a positive or zero treatment effect (such that C-section is more likely after the information shock but never less likely).

\textsuperscript{37}Information on birth hospital or birth county is unfortunately not available; instead the baby’s registered county of residence is used as an approximation for birth county.

\textsuperscript{38}There is an ongoing debate about clustering when using time as the running variable; see Hausman and Rapson (2017). The results are robust to alternative clustering on the level of the mother.
While we can test the assumption of the existence of a strong and significant first stage and monotonicity, we cannot test whether the exclusion restriction is satisfied. It is possible that the information shock led to increased awareness of the risks associated with breech births, resulting in improved care for all breech births in terms of not only more planned C-sections but also other treatments.\textsuperscript{39} Maternal selection is an additional potential issue for identification. These potential issues are further discussed in section 5.1.1.

5 Results

5.1 Effects on C-section and obstetric care

The sharp increase in planned C-sections among breech births is presented visually in Figures 1 and 2, and in regressions estimated according to Equation 1 presented in Table 1 (columns 1-2). The results indicate that the information shock to the medical society had a strong significant impact of approximately 11 percentage points on the probability of planned C-section among breech births. The estimate and precision remain very robust to the inclusion of maternal and child characteristics such as maternal weight, height, nationality, tobacco use during the first trimester, and sex of the baby, as well as age, birth order, birth-quarter, and county fixed effects.\textsuperscript{40} F statistics for each regression are presented in Table 1. The F statistics with and without controls are 39.4 and 39.1 (see columns 1-2), respectively.\textsuperscript{41} Thus, the results imply that there is a strong significant effect of the information shock to the medical society on the proportion of C-sections among breech births corresponding to a 23% increase when compared with the mean of the dependent variable in the pretreatment period.

While an increase in planned C-sections among breech presentation births is expected, there should be no impact on the proportion of planned C-sections among births with normal fetal position.\textsuperscript{42} This is tested analogously to breech births and presented in Table 1 (columns 3-4). The estimates are both statistically insignificant and small in magnitude, with a F statistics of 0.4 and 0.2. Hence, the results show no indication of altered delivery mode among normal position births. These results suggest not only that there were no changes in delivery mode

\textsuperscript{39}For instance, I cannot observe whether breech births were attended by more midwives and senior OB/GYNs or received improved care in general.

\textsuperscript{40}As birth timing is not exogenous (Quintana-Domeque et al., 2016), seasonality is controlled for using birth-quarter fixed effects.

\textsuperscript{41}An indicator of having a weak instrument is an F statistics below 10, which is perceived as a “rule of thumb” as suggested by Staiger and Stock (1994).

\textsuperscript{42}Analogous to the sample of singleton term breech births, the sample of normal position births excludes preterm births (< gestational week 37), multiple births, and births in fetal positions other than prostrate neck or head presentations.
among normal position births but also that the rise in C-sections among breech births did not crowd out C-sections for nonbreech births (due to constraints in the surgical team at the hospital).\textsuperscript{43}

Panel A of Table 4 demonstrates the robustness of the first-stage results to alternative functional form and time period. These specifications include quadratic trends (column 1), cubic trends (column 2),\textsuperscript{44} a triangular kernel that places more weight on observations close to the cutoff and less on those farther away (column 3) and alternative sample of a shorter time period of a 12-month window before and after the information shock (column 4) as well as a shorter time period of a 300-day window (column 5).\textsuperscript{45} A full set of fixed effects and maternal and child characteristics are included. These estimates of 0.11-0.13 are very similar to the baseline estimate of 0.11 with an F statistic above 10.

To get a better understanding of the effect of the information shock, the impact on supplementary or intermediate medical interventions during delivery for breech births is examined and presented in Panel B, Table 4. The results are estimated analogously to the baseline specification, expressed by Equation 1, with a full set of covariates and fixed effects. The results imply that the information shock had no statistically significant impact on emergency C-sections (column 1), indicating that the rise in planned C-sections originated from women who would otherwise have given birth by vaginal delivery. There is no significant impact on induced labor (column 2) or the usage of forceps or vacuum extractor (column 4) but a strong significant increase in the use of spinal anesthesia (column 3), which has a similar estimate (0.13) to the increase in planned C-sections (0.11). The strong increase in the usage of spinal anesthesia is an automatic response to the increase in C-sections, since spinal anesthesia is routinely used during planned C-section. Finally, the likelihood of having an episiotomy,\textsuperscript{46} a surgical procedure used at vaginal birth (column 5), drops by 5.7 percentage points, which is expected, since this procedure is not necessary during a C-section.

In Sweden, a planned C-section due to a breech pregnancy is usually scheduled 7-10 days before the expected date of delivery (determined by last date of menstruation and ultrasound). This means that having a planned C-section may decrease the gestational length, which could

\textsuperscript{43}Similarly, the information shock suggests that planned C-section was the preferred delivery mode for singleton breech birth at term only, which is why we expect to see no impact on either breech twins or preterm breech. Consistent with this, no significant impact is found for either of these two groups. These results are presented in Table A1.

\textsuperscript{44}There is an ongoing debate regarding the use of higher polynomials greater than two; see Gelman and Imbens (2014) for a detailed discussion.

\textsuperscript{45}Three hundred days is the optimal bandwidth that minimizes the mean squared error suggested by Calonico et al. (2014).

\textsuperscript{46}Surgical incision made in the perineum to widen the opening of the vagina for a faster delivery.
affect the fetal growth in the late stage of the pregnancy (Borra et al., 2014).\footnote{Birth weight (as well as other growth indicators) is positivity correlated with later-life outcomes including education and income (Bharadwaj et al., 2017).} In Panel C, I investigate how the information shock affected gestational age in weeks (column 1), birth weight in kilograms (column 2), head circumference in centimeters (column 3), and length of the baby in centimeters (column 4). I find that gestational age decreases by nearly 0.136 weeks, and the baby’s length decreases by 0.124 centimeters on average. This result should be considered when investigating the impact of planned C-section on child health.

### 5.1.1 Validity of the first stage

There are a number of potential threats to the identification. First, a potential issue is that the information shock could have led to changes in the frequency of breech births being reported. Similarly, if there were fewer attempts to turn the fetus to a normal position (external cephalic version) due to the information shock, the proportion of breech births would increase and possible selection issues could arise. By examining the proportion of breech births around the time of the shock I may alleviate this concern. In Figures 3 and 4, the proportion of breech births is presented. The trend in the proportion of breech births exhibits a highly constant development over time including the time of the information shock in 2000. Additionally, this is formally tested in Table 5, which confirms that the proportion of breech births remained unchanged at the time of the information shock.\footnote{Manipulation of the running variable is less likely for several reasons: the fertility decision was made before any knowledge of the information shock was available: it is unlikely that women would be able to delay or move the delivery to an earlier date: the preliminary results presented to the medical society were not announced in the public media.} Moreover, a McCrary test shows no evidence of a discontinuity in the number of breech births at the time of the information shock. The McCrary regression result for the information shock is -0.023 (se 0.13) and is visually presented in Figure A5.

Second, the absence of maternal selection to C-sections is important for the validity of the instrumental variable approach as well as for the interpretation of the reduced form treatment effect. Maternal selection to C-section can be both demand and supply driven and it may be difficult to distinguish between the two. However, demand-driven selection—that is mothers’ demand for C-section after having accessed new information on the preferred delivery mode for breech births—can be considered less likely given that the information shock was targeting OB/GYNs during an internal meeting and, to the best of my knowledge, not announced to the public media. Also, the medical society reacted to preliminary findings of two studies, not
yet available to the public. Breech presentation is discovered late in the pregnancy, making it difficult to plan ahead such that residential sorting can be considered less likely. Nevertheless, maternal selection is further examined.

To investigate maternal selection, a balancing test of covariates across the discontinuity is conducted, testing for compositional changes by running regressions with maternal characteristics as the outcome variables and the information shock as the explanatory variable. The results are presented in Panel A, Table 6 and suggest that for breech mothers, there was no significant change in observable maternal characteristics such as age, height, weight, educational attainment, labor income, or sickness benefits before birth at the time of the information shock.\textsuperscript{49} I also test for compositional changes among maternal characteristics on mothers receiving a planned C-section, presented in Panel B, Table 6. Similarly, no significant impact on maternal characteristics is observed across the information shock. In addition, I regress the likelihood of having a planned C-section on a fully interacted model, in which the maternal characteristics are interacted with the treatment status (post information shock). The results are presented in Table A2 and show that none of these interactions are significantly different from zero except for height. The conclusion from these exercises is that based on observable characteristics, I find no persistent evidence in favor of changed maternal characteristics. This can alleviate concern to some extent regarding both selection and demographic changes at the time of the information shock.

Finally, I conduct placebo regressions for examining discontinuities at other points in the distribution of the running variable. More specifically, by using a bandwidth of 12 months before and after the placebo date, I examine whether there are any discontinuities in the proportion of planned C-section on 25 of August in one to three years before or after 2000. By doing this, I also check for seasonality in planned C-section to rule out that planned C-sections usually increase during this time of year. The results are presented in Table 7 and show no signs of significant changes in the probability of planned C-section at any of the placebo dates.

5.1.2 Heterogeneous effects of the first stage

In this section, I examine heterogeneous effects of the information shock on the probability of planned C-section for different subgroups of birth order, age interval, educational level, and

\textsuperscript{49}Since fertility choices are made nine months before delivery, it is unlikely that the information shock would have caused demographic changes.
body mass index (BMI) classification.\textsuperscript{50} To understand the treatment effect, it is important to analyze which women (with breech births) were more likely to have a C-section due to the information shock—in other words, to identify whether the marginal woman can be confined to a specific high- or low-risk type indicated by observable characteristics.

Heterogeneous effects of the information shock across birth order, age, BMI, and socio-economic status (SES) indicated by educational level are examined and presented in Table 8.\textsuperscript{51} The heterogeneous analysis across birth order, presented in Panel A, Table 8 (columns 1-3), shows a positive significant impact on both first- and second-time mothers. The treatment effects across age groups are presented in Panel A, Table 8 showing a significant impact for all age groups except for women age 35 and over (columns 4-8).

The treatment effects across educational levels is presented in Panel B, Table 8. The estimates indicate that the treatment effect is significant across all educational levels (columns 1-3), primary, secondary and tertiary education, with estimates of 0.090, 0.107, and 0.144, respectively. While the magnitudes across educational levels differ slightly, with higher likelihood of planned C-section for women with more education, these differences are statistically different only for mothers with secondary and tertiary education. Finally, the treatment effects across BMI classification levels are presented in Panel B, Table 8.\textsuperscript{52} These results suggest that the treatment effect is largest among women in the normal weight range and overweight women (columns 5-6). For obese women no significant impact is found, which is expected, since these women are likely to “always-takers”. An increase in the probability of planned C-section is identified for first- and second-time mothers, all educational levels, women under age 35, and both normal and overweight women. This indicates that a broad category of women had a planned C-section due to the information shock.

The results suggest that the information shock had less impact on C-section among women at risk (older women and obese women). These women already exhibit a higher rate of planned C-section of approximately 60% and are more likely to be always-takers. Finally, these results suggest that the monotonicity assumption is satisfied, implying that the information shock had either a positive or null effect but never a negative effect on the probability of planned C-section.

\textsuperscript{50}BMI classification according to World Health Organization (2000): underweight < 18.5, normal range 18.5 to 24.9, overweight 25 to 29.9 and obese ≥ 30.

\textsuperscript{51}These observables are chosen because of data availability and because birth order, age, BMI, and SES are considered important determinants for delivery mode (Ecker et al., 2001; Sehie et al., 2001; Sheiner et al., 2004).

\textsuperscript{52}The number of underweight women was only 292, so they are not reported separately. The estimated impact on planned C-section among underweight women is 0.067, which is not statistically significant.
5.2 Effects on health, fertility and labor market outcomes

5.2.1 Baseline results

i) Reduced form analysis

The baseline results on child and maternal health, subsequent fertility outcomes, and labor market outcomes are presented in Table 9. For each specification, I present estimates for the full sample and first-time mothers. The reason for focusing on first-time mothers, in addition to the full sample, is that future fertility outcomes could be endogenous to the first birth. The effect of the information shock is estimated according to Equation 1 and includes a full set of covariates and fixed effects.

Starting with the impact on child health presented in Table 9, the reduced form effect of the information shock suggests a significant increase in child health for the full sample of 0.104 standard deviations (SD) (Panel A, column 1). For first-time mothers, the estimate is 0.087 SD (Panel B, column 1). The health outcomes are further scrutinized separately and presented in Panel A, Table 10. When looking at the separate outcomes of the child index, there seems to be a consistent pattern of improved infant and child health by higher Apgar score, lower probability of low Apgar score, lower infant mortality, and fewer nights hospitalized within the first year of life and during ages 1-7. Yet the only significant effects (below 5% significance level using conventional p-values and below 10% using FDR), seem to originate from a higher level in absolute Apgar score by 0.07 unit change (column 1) and lower number of nights hospitalized during ages 1-7 by 0.67 nights (column 5). This result is interesting, since it suggests that the information shock improved both short- and long-term health for children.

Turning to the effects on maternal health, presented in Table 9, the results for the full sample and first-time mothers do not show any significant impact on maternal health (column 2, Panels A-B). The maternal health outcomes are presented separately in Panel B, Table 10. While these separate estimates indicate a lower risk of sepsis and postbirth hospital nights (readmission), none of these effects are significantly different from zero, meaning that we cannot infer any significant impact on maternal morbidity. For women having at least one more birth within eight years after her breech birth, potential effects on maternal health outcomes are analyzed in Table 9 (column 3). The estimated effect on maternal health at subsequent births suggests no significant impact for either the full sample or first-time mothers. When examining each outcome separately in Panel C, Table 10, no significant impact can be found for any of the outcomes.
The impact on future fertility outcomes is investigated and presented in Table 9 (columns 4-6). These estimates suggest a negative but insignificant impact on future fertility measured by total number of future births and a binary measure of the probability of not having another birth. Compared with the mean of the outcome in the pretreatment period, the estimates suggest a reduction in fertility by 4.5%, but insignificantly so. No significant impact is found for birth spacing.

The effects on the labor market index are explored and presented in Table 9 (column 7).\textsuperscript{53}\textsuperscript{54} No significant impact is found for either the full sample (Panel A) or for first time mothers (Panel B). In Table 10, the incomes from labor earnings, sickness benefits, and parental benefits within five years after giving birth are examined separately.\textsuperscript{55}\textsuperscript{56} The results suggest that there was no significant impact on any of the labor market outcomes. In addition to using the average impact within five years from giving birth, event studies are carried out, examining the impact for each year separately, one through five years after the information shock, presented in Figure A6. Similarly to the previous results, no significant effect is found on any of the labor market outcomes for either the full sample or first-time mothers.

The results are further analyzed using alternative functional form and period presented in Table 11, such that all results are reestimated using quadratic and cubic trends (Panels A-B), triangular kernel (Panel C), and for a smaller window of 12 months before and after the information shock (Panel D). These results show that the estimates on child health (ranging from 0.117 to 0.194 SD) are consistent across specifications (and to the baseline specification of 0.104 SD). Similarly to the baseline results, the impacts on fertility, maternal health, birth spacing, and labor market outcomes remain insignificantly different from zero regardless of the specification.

\textit{ii) 2SLS results}

The reduced form estimates capture the overall impact of the information shock on all breech births. In addition, I want to capture the causal impact of C-section using the information

\textsuperscript{53}C-section alone does not qualify a woman for sickness benefits from the Swedish Social Insurance Agency. Moreover, the level of sickness and parental benefits depend on labor income (individually set in proportion to the labor earnings the year before giving birth). However, all Swedish residents receive a minimum amount of benefits when sick or becoming a parent.

\textsuperscript{54}Three sources of income are analyzed: labor income, income from sickness benefits and income from maternity leave. Unfortunately, data on labor supply (e.g., working hours) are not available. Income data are available only on an annual basis. I am currently in the process of accessing new data with more suitable labor market outcomes to study the full implications from the increase in C-sections.

\textsuperscript{55}Similar results are found for three, five and seven year averages after giving birth.

\textsuperscript{56}All income variables are transformed using inverse hyperbolic sine transformation, providing a similar interpretation as log transformation of percentage change.
shock as an instrument. Provided that the exclusion restriction is satisfied, in other words, that
the information shock affects outcomes only through higher likelihood of C-section, the impact
of C-section attributed to the shock (the effect on complying women) can be estimated using
2SLS. The 2SLS model is estimated according to Equation 2 and is presented in Table 12.

The 2SLS results for the full sample (Panel A) suggest that child health significantly im-
proved by 0.93 SD for the full sample of those who obtained a C-section due to the information
shock and by 0.68 SD for first-time mothers. If we compare the estimated effects on child
health to the gap in health between breech and normal position births in the pretreatment
period, having a planned C-section would improve health beyond this gap.

The 2SLS estimates are presented in Table 13, for each outcome separately, showing that
the improvement in child health is mainly driven by higher Apgar score (Panel A, column
1) by 0.58 units and fewer nights spent at the hospital (Panel A, column 5) by 5.9 nights,
both significant below a 5% level when considering the conventional p-values. When correcting
for false discovery rate, however, none of the estimates remain significant. Nevertheless, the
estimates are all large in magnitude and show positive improvements in child health for each
separate outcome.

No significant effects are found for maternal health at birth or at any subsequent births,
future fertility, or maternal labor market outcomes for either the full sample or first-time mothers
(Panel A-B, Table 12, columns 2-7). Similarly, no significant impact on any separate outcome
is found, as presented in Table 13. Nonetheless, the fact that the magnitude is large—that is,
no precisely estimated zero effects—makes the interpretation difficult. A longer discussion is
provided in Section 6. These results are insensitive to choice of polynomial, kernel, and time
period, as presented in Table A3, with the exception of estimated impact on the child health
index, Panel D (column 1), which exhibits a larger magnitude than the baseline.

5.2.2 Alternative strategy

As an alternative approach for dealing with issues including other interventions occurring at
similar time for all births, demographic changes, correlation between season of birth, and matern-
al and child characteristics, I report the Difference-in-Difference (DiD) estimates, comparing
outcomes for breech births with those for normal position births before and after the informa-
tion shock. While there are multiple plausible identification strategies, I conduct a DiD analysis
to examine the consistency of the estimates across models.
The DiD is estimated according to:

\[ Y_{it} = \gamma_1 + \gamma_2 (Breech \times InfoShock)_{it} + \gamma_3 Breech_i + \pi_i + X_{it} \mu + \varepsilon_{it} \]  

(3)

in which Breech is a binary variable equal to one if breech and zero if singleton normal position birth at term. \( \gamma_2 \) is the parameter of interest (DiD estimate), capturing the relative change in outcomes for breech births compared with normal position births due to the information shock. The interaction term Breech \( \times \) InfoShock is equal to one if a birth is a breech birth born post the information shock and zero otherwise. \( \pi \) indicates day-month-year fixed effects, accounting for time factors. The vector of maternal and child control variables \( X_{it} \) and the error term \( \varepsilon \) are handled analogously to Equation 1.

Additionally, I combine the IV strategy with the DiD approach using the information shock as an instrument for planned C-section and normal position births as a control group.\(^57\) When conducting a pre-post analysis, a possible scenario that would invalidate the chosen identification includes unobserved factors affecting the outcomes as well as treatment. Under the assumption of parallel trends of breech and normal births, the causal impact of the information shock can be captured using a DiD approach. In a pre-post analysis, other interventions are a possible threat to the identification. For instance, if there was a general change in obstetric care, in addition to the information shock, for all births, a DiD approach would account for this.\(^58\) Under the assumption of common trends in the pretreatment period, the DiD approach should provide results consistent with those of the pre-post analysis.

The trust we can invoke in DiD estimates depends on whether the identifying assumption of parallel trends is satisfied. To explore the plausibility of the parallel trend assumption, I test for differences in the pretreatment trends in the outcome variables by conducting multiple event studies. For the event studies, I fully interact a binary indicator of breech presentation with the years before and after the information shock such that each coefficient represents an interaction term between year and breech birth. The year of treatment, 2000, is the omitted base category following general convention. The results are presented in Figures A7 and suggest a highly significant sharp increase in C-sections as well as significant improvements in child health after the information shock but no impact on any other outcomes. Importantly, the event studies also suggest that pretrends in the outcome variables are not significantly different between breech

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\(^57\)The DiD results can be compared with the reduced form baseline results (Table 14), and the DiD-IV approach with the IV baseline results (Table 15), provided that the time period is the same across specifications.

\(^58\)The protocol and internal newsletter from SPOG’s annual meeting in 2000 do not suggest that any other delivery practices were discussed or changed for either breech or normal births.
and normal positions. That is, out of eight outcomes, only one coefficient for one outcome (maternal health) is significantly different from zero. Hence, these tests indicate that there are common trends in the outcome variables in the pretreatment period.

The DiD estimates are presented in Table 14, suggesting a strong significant increase in probability of C-section by 15.7 percentage points for the full sample (Panel A, column 1) and by 17.4 percentage points for first-time mothers (Panel B, column 1). These estimates are somewhat higher than those of the pre-post analysis (11 percentage points). The impact on child health suggests a positive impact of 0.094 SD for the full sample (Panel A, column 2) and 0.1 SD for first-time mothers (Panel B, column 2). The overall results support the findings in the baseline model. The magnitude of the child health estimates is similar to that of the pre-post analysis but the DiD estimates exhibit a slightly higher effect size and precision for first-time mothers. Unlike the pre-post analysis, a marginal significant negative impact on fertility is found for the full sample as well as first-time mothers, by 0.019 and 0.026 births, respectively, which corresponds to a reduction in future fertility by 2-3% when compared with the mean of the dependent variable. Similarly to the pre-post analysis, no significant impact is found for birth spacing, maternal health, or labor market outcomes. In addition, I include breech-specific pretrends, Table A4, which shows similar results to the DiD estimates without the trends but with slightly larger estimates for child health (0.139 and 0.117 SD) and fertility outcomes (-0.042 and -0.044).

Turning to the combined 2SLS model and DiD estimates presented in Table 15, in which the information shock is used as an instrument for planned C-section and normal position births are used as a control group, these estimates suggest that planned C-section strongly improves child health by 0.6 SD for the full sample and 0.58 SD for first-time mothers. As with the baseline 2SLS results, the magnitude of the estimates is large and suggests that planned C-section would more than compensate for the difference between breech and normal positions in the pretreatment period. There is also a marginally significant negative impact on the number of subsequent births (0.12 for the full sample and 0.15 for first-time mothers), suggesting a reduction in future fertility (by 19% and 14%, respectively, when compared with the control mean).

In summary, using an alternative estimator of DiD, with normal position births as a control group, confirms the findings of the pre-post analysis while providing slightly more precision.
5.3 Additional robustness and sensitivity

A number of robustness and sensitivity checks are conducted for the baseline reduced form results. I consider alternative dates for the information shock using alternative cutoffs, including the date of publication of the Term Breech Trial and the date of the extraordinary Nordic OB/GYN meeting held following the publication of the Term Breech Trial.\textsuperscript{59} To do this, I first remove observations between the annual meeting of SFOG in August and each of the alternative dates separately, since these births are at least partially treated in line with the documented response from the medical society according to Alexandersson et al. (2005). First, I use the date of the publication of the Term Breech Trial by Hannah et al. (2000), presented in Panel A, Table A5, and show that the results are robust but with a slightly lower estimate for child health of 0.08 SD (compared with the baseline of 0.10). Then I use the date of the extra OB/GYN meeting held in December 2000, presented in Panel B, which suggests that the results are similar to the baseline results but with a marginally significant negative estimate for the number of future births by 0.042.

Because of data availability, I use the discharge date from the maternity unit minus the number of average hospital nights for the corresponding delivery mode (four nights for C-section and two nights for vaginal delivery) as an approximation of the date of birth. This procedure may, however, result in a measurement error. To deal with this potential issue, I exclude a small window across the information shock, dropping births one week before and after the shock. The results are presented in Panel C, Table A5, and are similar to the baseline results, showing a positive significant impact on child health by 0.097 SD (compared with the baseline 0.104 SD).

The trends in C-section by county in Figures A1, A2 and A3, suggest variation in the response to the information shock across counties. This leads to the question of whether there is in fact a stronger effect in counties that exhibit the greatest increase in C-sections. To address this question first, I omit all but five of the largest counties,\textsuperscript{60} which exhibited the greatest increase in C-sections. The results are presented in Panel D Table A5 and provide similar estimates to the baseline results (child health 0.131). These results suggest that even in counties with a greater increase in C-sections, the impact on maternal health and labor market outcomes remains insignificant. Second, I control for county-specific split trends. The results are presented in Panel E, Table A5 and show that the results are robust to the inclusion

\textsuperscript{59}An extraordinary Nordic OB/GYN meeting was held in December 2000 in Stockholm as a result of the publication of the Term Breech Trial by Hannah et al. (2000) (Alexandersson et al., 2005).

\textsuperscript{60}Stockholm, Västergötaland, Skåne, Jönköping, and Halland.
of trends but with higher precision for the fertility outcome, showing a marginally significant negative impact on the number of future total births by 0.046.

Finally, when constructing the summary index according to Anderson (2008), more weights are attached to variables with less correlation to the other variables within that category (that is, variables with “new information” are given more emphasis). The results are reestimated for the indices but now summarized using uniform weights and presented in Panel A, Table A6. Using equal weights provides results similar to the baseline results. For child health, the estimated effect by 0.087 SD is slightly smaller compared with the baseline (0.104 SD). Turning to the variables constructing the index, if binary measures of hospitalization (equal to one if hospitalized at least one night and zero otherwise) are used instead of continuous measures (number of nights hospitalized), how would it affect the estimates? The results, presented in Panel B, Table A6, are similar to the baseline results but with a slightly smaller estimated effect of 0.081 for the child health index. When further examining the binary measures of hospitalization, presented in Panel C, Table A6, the results yield smaller estimates with less precision for child health compared with the main results (see Table 10). That is, it is the number of total hospital nights that is affected by the information shock rather than the likelihood of being hospitalized at least one night.\(^{61}\)

6 Discussion and interpretation of the results

Previous studies have suggested that health at birth for breech babies is improved when delivered by planned C-section (Hannah et al., 2000; Herbst, 2005; Herbst and Thorngren-Jerneck, 2001; Jensen and Wüst, 2015). In line with this literature, the findings in this study suggest that child health among singleton breech births is improved by planned C-section as the delivery mode. The improvements in child health stem from higher Apgar scores and also a decrease in the number of nights hospitalized during ages 1-7, implying both short- and long-term positive impacts on birth and childhood health. The long-term impact, up to age 7, is an important aspect not previously studied. To interpret the impact of the reduced form estimates on a general index of child health, planned C-section closes the gap in child health between children in breech and normal positions by nearly 100%.\(^{62}\)

\(^{61}\)Further analysis on the impact of the information shock on nights hospitalized during childhood is provided in Panel A, Table A7, which shows a negative and significant impact of nights hospitalized in ages 0-3 and onward among breech babies. No impact (as expected) is found among normal position babies.

\(^{62}\)The unconditional difference in means in the child health index between breech and normal position births, before the information shock, is approximately 0.1 SD.
The 2SLS estimates suggest that planned C-section among breech births leads to higher Apgar scores by the magnitude of a 0.58 unit increase (a magnitude similar to that of Jensen and Wüst (2015) and 5.9 fewer nights hospitalized during ages 1-7. In terms of economic cost per child, 5.9 fewer hospital nights would, save, on average, 14,400 SEK per night and 84,960 SEK in total. Regarding the improvements in Apgar score, while it is hard to evaluate the economic meaning of a 0.58 unit increase in Apgar score in the absolute level, the Apgar score is a good predictor of health during infancy and childhood, including infant mortality and neurological disorders during childhood (Casey et al., 2001; Li et al., 2011; Moster et al., 2001). There is a positive association between Apgar score and cognitive development (Odd et al., 2008). Figlio et al. (2014) find that a 1-unit increase in Apgar score maps to 0.8 SD higher average test scores in reading and math.

In line with the findings of previous studies, Hannah et al. (2000) and Jensen and Wüst (2015), I find no significant impact on maternal health at birth. Moreover, I find no evidence of a significant impact on maternal health at future births, which is of particular interest, since these outcomes have not previously been examined causally. However, one has to consider that any future birth is endogenous to the previous, such that the impact on health outcomes at future birth is relevant to a selected sample and may not reflect the effect of planned C-section if all women had a future birth. While I find no evidence of a significant impact on maternal health at birth or future births, the magnitudes of the estimates, and the 2SLS estimates in particular, are not precisely estimated zeros. Although I cannot infer whether precision would increase with a larger sample size, the estimates are sensitive across specifications and never marginally significant, which suggests that the estimates may not be interpreted as different from zero.

The results regarding future fertility (in terms of both the total number of subsequent births and the probability of not having another birth within a fixed time period of eight years) suggest a negative impact on future fertility, yet not significantly different from zero. These estimates are, however, consistent across most specifications and marginally significant in some specifications (i.e., when controlling for county-specific pretrends, using alternative dates of the information shock and in the DiD model). That is, we cannot rule out that there may be a negative impact on subsequent fertility. While a null result on future fertility is in line with

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63The 2SLS estimate for Apgar score is 0.42 in Jensen and Wüst (2015).
64Jensen and Wüst (2015) find that C-section leads to a longer hospital stay after giving birth by 2.4 nights but has no impact on infections or other complications. Because of data availability, my outcome consists of readmission to the hospital within the first year of birth, and thus my result on hospitalization cannot be compared with that of Jensen and Wüst (2015).
Hannah et al. (2004), these results are not completely comparable since my time period is four times longer than that of Hannah et al. (2004), who examine fertility within two years from giving birth. Likewise, the study by Halla et al. (2016) examines the impact of emergency C-section for low-risk births, which not only applies to a different population but also considers a different treatment (emergency C-section is associated with greater risks for mother and child compared with planned C-section).

Finally, I find no impact on maternal labor market responses, which may be for multiple reasons. Halla et al. (2016) hypothesize that lower future fertility is the main channel explaining their findings of higher female labor market participation after having a C-section in the Austrian setting. My results, however, do not suggest a highly significant impact on future fertility. Even if there were a negative impact on future fertility, it does not necessarily translate into a positive impact on labor outcomes because of differences in a potential “childbearing penalty” on the Swedish labor market compared with the Austrian setting.

The results from this exercise should be interpreted with regard to the risk margin of women delivering with planned C-sections due to the information shock. Among singleton breech births, 47% were already being delivered with planned C-sections before August 2000. Therefore, the marginal births were most likely not the highest risk births since the proportion of planned C-sections among obese or older women was already high, and no significant effect of the information shock was found on these groups. It is therefore noteworthy that the impact on child health is substantial—especially since the increase in planned C-sections appears to be attributed to fewer vaginal births rather than emergency C-section.

Regarding external validity, when interpreting the results, one should also consider the fact that breech births constitute a particular high-risk group. The effects from marginal planned C-sections are compared with those of high-risk vaginal births within this group, which may not be generalizable to births with normal presentation. While we cannot extrapolate the results regarding improved child health from more planned C-sections to normal births, it is plausible that medical interventions improving health at birth could have long-term consequences for child health (in terms of lower morbidity). Finally, breech births constitute a fairly large group across most populations worldwide, which can be easily identified. Breech births are a continuous high-risk group in need of extra medical interventions. Yet the preferred delivery mode continues to be a controversial topic with substantial variation in planned C-sections across industrialized countries. The findings in this paper are thus policy relevant, suggesting that countries with lower proportions of planned C-sections among breech births could improve child health.
By doing a simple back-of-the-envelope calculation, the costs of having a planned C-section can be explored. In Sweden, the average cost of a planned C-section ranges from 54,135 to 88,635 SEK, depending on how complicated the procedure is compared with 30,984 to 47,572 SEK per vaginal birth.\textsuperscript{65} The average cost of inpatient care per hospital night for children is 14,400 SEK. While switching from vaginal birth to planned C-section would increase the cost at birth (by 12,000 SEK per night), taking into account the reduction in hospitalization during childhood plus the average number of extra hospital nights for mothers who had a C-section, would save as much as 19,897 to 54,397 SEK per birth.\textsuperscript{66}

7 Conclusion

In this study, I have presented evidence that an increase in planned C-sections, among the high-risk group of breech births, can lead to significant improvements in child health without affecting maternal health at birth or any subsequent births or labor outcomes, but with a potential negative impact on future fertility. To overcome the intrinsic endogeneity issue of selection into C-section, I use exogenous variation from an information shock of new scientific evidence to the medical society. This shock led to a precipitous rise in planned C-sections for breech births by 23%. By using detailed Swedish register data for the time period 1997-2003, I use this shock in a reduced form pre-post analysis and as an instrumental variable in a 2SLS model. The detailed Swedish register data enables me to examine the impact of planned C-section on a broader set of outcomes not previously examined as well as for a longer time period.

The increase in planned C-sections appears to originate from fewer vaginal births rather than emergency C-sections. No impact on planned C-sections is found for normal position births. Importantly for identification, I find no evidence of any changes in composition among mothers receiving planned C-sections following the information shock. Moreover, I find no change in the proportion of breech births reported (i.e., no manipulations) or any discontinuities at other placebo dates.

The reduced form results show that the increase in planned C-section, following the information shock, closed the gap in child health between breech and normal presentation births

\textsuperscript{65}Information regarding average costs can be found in Table A8. The cost of each procedure depends on whether the birth is complicated. There is no standard rate for a breech vaginal birth. However, a breech vaginal birth is considered complicated and in need of extra resources such as a senior OB.

\textsuperscript{66}Since I cannot measure whether planned C-sections leads to longer hospitalization for mothers, I use the average hospital stay for a C-section, which is two nights longer for a C-section than for a vaginal birth.
nearly completely. Using a general index on health outcomes, child health is improved by 0.10 SD. These improvements are found both immediately at birth (higher Apgar score by 0.07) and during childhood (fewer nights hospitalized, during ages 1-7 by 0.67). Turning to the 2SLS estimates, planned C-section (among complying mothers) leads to a strong improvement in the child health index by 0.93 SD. This improvement includes a 0.58 unit increase in Apgar score and a reduction in hospital stay by nearly 6 nights. No significant impact was found for maternal labor market outcomes, maternal morbidity at birth, or maternal morbidity at any future births. Although the estimates on future fertility are insignificant in most specifications, because the estimates are consistent across specifications and methods, and in some specifications marginally significant, a potential reduction in future fertility cannot be ruled out. These results are robust to a number of robustness and sensitivity checks, including alternative specifications (using quadratic trends, cubic trends, triangular kernel, and a smaller window of time), nonweighted indices, and the use of DiD design using births with normal fetal position as controls.

This study shows how increased use of C-section among breech births can improve child health in both the short and long run, implying that improved health at birth has a lasting impact during childhood.
References


**Karolinska Universitetssjukhuset (2016): “Vändningsförsök,” Karolinska Universitetssjukhuset.**


8 Figures and Tables

Figure 1: Yearly trends in C-sections for breech births

(a) Yearly data, all C-sections

(b) Yearly data, planned C-section

Note to Figure 1: The data are obtained from the Swedish Medical Birth Registry. Annual trends in all C-sections and planned C-section among singleton breech births at term (≥ 37 gestational weeks) are presented in Figures 1a and 1b. The red vertical line indicates the date of the information shock to the Swedish medical society.
Figure 2: Monthly trends in C-sections for breech births

(a) Monthly data, all C-sections

(b) Monthly data, planned C-section

Note to Figure 2: The data are obtained from the Swedish Medical Birth Registry. Monthly trends in all C-sections and planned C-section among singleton breech births at term (≥37 gestational weeks) are presented in Figures 2a and 2b. The red vertical line indicates the date of the information shock to the Swedish medical society.