Early Elective Deliveries and Birth Outcomes: Evidence from Oregon's Hard-Stop Policy*
(Job Market Paper)

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Abstract

A growing number of cesareans and inductions in the U.S. are performed before the pregnancy reaches full term despite the lack of a medical indication necessitating early delivery. These "early elective deliveries (EEDs)" have been identified as a public health concern, though a link between EEDs and poor birth outcomes has not been established. In 2011, Oregon hospitals committed to a voluntary *Hard-Stop Policy* to curb the rise in EEDs. I first show that the Hard-Stop Policy led to a substantial reduction in the prevalence of EEDs, decreasing EED rates by 30% and leading to an increase in gestational age and birth weight. I then use this exogenous change in EED rates to estimate the effects of EEDs on newborn health. Results indicate that the reduction in EEDs had no effect on the likelihood of a neonatal intensive care unit (NICU) admission, the use of assisted ventilation, or the probability of a low Apgar score. The likely explanation for these findings is that the Hard-Stop Policy mostly shifted 38-week elective cesareans, which had the largest share among EEDs and involved relatively "healthier" mothers, to the 39^{th} week of pregnancy. This case illustrates an example of how changes in behavior through substitution influence a policy's effect on outcomes.

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1 Introduction

In 2017, 52 percent of all live births in the United States involved a cesarean section or an induction.[1] A growing number of these obstetric interventions are *elective*, that is, lack medical indication (Oshiro et al., 2009). Furthermore, almost 25 percent of these births are *early term*, occurring during the 37^{th} or 38^{th} weeks of gestation. The increase in *early elective deliveries* has been a public health concern and a policy focus on a national level, as the practice is often associated with poor birth outcomes (Tita et al., 2009; Doan, Gibbons and Tudehope, 2014; Ehrenthal et al., 2011). However, despite a large body of health research, causal evidence on the effect of early elective deliveries (EEDs) on birth outcomes is limited.

To estimate the effect of EEDs on birth outcomes is challenging, because omitted factors, such as mother's socioeconomic status or pre-conception health, are likely to bias the estimates derived from cross-sectional comparisons. Recent studies have exploited variation in the timing and location of EED policies to overcome this challenge.[2] For example, Buckles and Guldi (2017) use county level early term induction rate and 39/38–week ratio as instruments.[3] Byanova (2015) and Dahlen et al. (2017) use Texas Medicaid Payment Reform in 2011, denying payment for EEDs, as a quasi-experiment.[4] Interestingly, Byanova (2015) finds substitution from inductions towards scheduled cesareans among *non-Medicaid* population as a result of the Payment Reform and interprets this as a suggestive evidence of physician-induced demand as a response to a negative financial shock. A key contribution of my paper is to examine the behavioral response to a change in incentives, when the Policy applies to the entire population of mothers regardless of their type of health insurance.

I also propose an alternative strategy to estimate the effect of early elective deliveries (EEDs) on birth outcomes. Instead of using variation across states in the timing and location of EED policies, I focus on a single statewide policy and exploit the variation in the probability of mothers being affected by it. Specifically, I predict the risk of having an EED for each mother based on her

[1] Author's calculation using Natality data from the National Center for Health Statistics, 1989–2017.

[2] Schulkind and Shapiro (2014) use a different type of policy, child tax benefits rewarding births that occur just before the new year, as a natural experiment to estimate the effect of small changes in the timing of deliveries on birth outcomes. They find an increase in December births leading to a decline in average birth weight and Apgar scores.

[3] Buckles and Guldi (2017) find that early term inductions (used as a proxy for EEDs) lower birth weight and increase the risk of birth injury and required ventilation.

[4] Byanova (2015) finds an increase in birth weight and no change in neonatal complications following a 18.5 % decline in Medicaid-paid early elective deliveries. Dahlen et al. (2017) find 10-14% decrease in early elective deliveries leading to increases in gestational age by almost a day and birth weight by about 31 grams on average.

demographic and pregnancy characteristics, assuming that these characteristics are not correlated with the Policy's timing. The predicted EED risk is not endogenous to the Policy, while the actual practice of EEDs is, and provides a counterfactual to the Policy regime, since the prediction relies on pre-policy correlations between EEDs and mother's demographic and pregnancy characteristics. The identification comes from the difference between mothers' outcomes who are more likely to have an EED, and therefore more likely to be affected by the policy, and the outcomes of mothers who are less likely to have an EED, before and after the policy.

Oregon provides a plausible quasi-experiment required for the identification. In 2011, Oregon hospitals providing maternity care committed to a voluntary *Hard-Stop Policy*[5] to eliminate early elective deliveries (EEDs). The Policy provides the necessary exogenous variation (a decline, in this case) in the practice of EEDs to identify its effect on birth outcomes. My study is not the first to explore Oregon's Hard-Stop Policy. Snowden et al. (2016) use logistic regressions to compare the use of EEDs and birth outcomes before and after the Policy.[6] Muoto et al. (2018) examine the changes in the pattern of cesareans and birth outcomes after the Policy by controlling for time trends.[7] However, the simple differences over time are potentially biased by secular trends at the state level. For example, their study period coincides with a 10 percent increase in available NICU beds in Oregon.[8] A potential improvement in NICU rate may have been masked by the increase in available NICU beds (Carroll, 2015).

I start by examining the decline in early elective deliveries (EEDs) induced by the Policy. Among mothers with the highest risk of having an EED, the Policy reduced the share of EEDs by 6.3 percentage points, translating into a 30 percent decrease. Gestational age at birth increased by almost a day and birth weight increased by 17 grams on average, with 34 grams among mothers without a high school degree. The increase in average birth weight alone is a significant outcome of the Policy, given recent evidence of its favorable long-term effects on socioeconomic status and health (Almond, Currie and Duque, 2018; Almond and Currie, 2011; Barker, 1990; Black, Devereux and Salvanes, 2007; Royer, 2009). For example, Black, Devereux and Salvanes (2007) find that a

[5] The policy requires hospital administration's review and approval for scheduled cesareans and inductions before 39 weeks in the absence of a documented medical indication.

[6] The authors find that the rate of early elective inductions decrease from 4.0% to 2.5%, and early elective cesareans decrease from 3.4% to 2.1%. They do not find any change in NICU admissions, stillbirths, or assisted ventilation.

[7] The authors control for linear time trends and use an interrupted time series model. They find a decline in early term scheduled cesareans, however the results for NICU and assisted ventilation are sensitive to model specification.

[8] Author's calculations using American Hospital Association Survey.

10 percent increase in birth weight raises later full-time earnings by about 1 percent.

Next, I analyze whether the Policy reduced serious health risks. *Early term* births are associated with an increased risk of respiratory complications for the newborn due to lack of fetal lung maturity (Tita et al., 2009). These complications are not reported on birth certificates, which are compiled by the National Center of Health Statistics into Natality Detail Files and constitute the main data source of this study. Therefore, I use admission to Neonatal Intensive Care Unit (NICU) as a plausible indicator of respiratory complications along with other neonatal morbidities such as infections, seizures, and hypoglycemia (low blood sugar). The use of assisted ventilation and low Apgar score[9] (< 7) also signal the presence of respiratory and other complications. I do not find any changes in the rate of NICU admissions, the use of assisted ventilation, or the prevalence of low Apgar score after the implementation of the Policy.

One interesting aspect of the The Hard-Stop Policy is that it reduced the rate of early elective deliveries (EEDs) mainly by *shifting cesareans* from the 38^{th} to 39^{th} week of pregnancy, leaving the rate of overall cesareans unchanged. Elective cesareans performed at the 38^{th} week had the largest share among all EEDs[10], which explains the concentration of the Policy's impact on these deliveries. Furthermore, this shift was likely to involve "healthier" mothers with no medical indication, who had similar birth outcomes with mothers having a cesarean at the 39^{th} week of pregnancy. Therefore, despite an increase in gestational age, these newborns on average continue to be exposed to the same risks associated with cesarean section[11], which is a likely explanation for the lack of improvement in the rate of neonatal complications. The Hard-Stop Policy did not reduce the *health care expenditures* related to child birth in Oregon. This is not surprising since the Policy did not affect the use of the two most expensive types of care related to child birth: Cesarean Sections and NICU admissions.[12]

In conclusion, the results indicate that early elective deliveries (EED) decrease birth weight by shortening gestation. Elective cesareans performed at the 38^{th} week of pregnancy, which constitute

[9] Apgar score ranges between 0 and 10; based on the color, heart rate, reflexes, muscle tone and respiration of the neonate. An Apgar score between 7 and 10 is referred to as *reassuring*, a score between 4 and 6 is considered as *moderately abnormal*, and a score between 0 and 3 is considered as being *low*.

[10] 39% among EEDs and 72% among all early elective cesareans.

[11] Such as impaired lung function, lower body temperature, hypoglycemia (lower blood sugar), difficulty in breast feeding, and low levels of blood pressure (Hyde et al., 2012).

[12] In 2016, the average charge for a cesarean section in Oregon was $20,800, while a vaginal delivery cost around $11,300. The care for a full term neonate with major problems costs around $28,000 on average, while the charges can reach to as high as $190,000 in case of extreme immaturity or respiratory distress syndrome. Data Source: HCUPnet, Healthcare Cost and Utilization Project. Agency for Healthcare Research and Quality, Rockville, MD. https://hcupnet.ahrq.gov/ (accessed May 13, 2019)

the largest share of EEDs, do not lead to an increase in the risk of neonatal complications. From a policy perspective, Oregon's Hard-Stop Policy successfully reduced EEDs, leading to an increase in gestational age and birth weight; though the Policy did not reduce the overall share of medically unnecessary procedures by replacing them with spontaneous vaginal births. Last but not least; this study does not measure potential long-term benefits of a reduction of EEDs on cognition and adult health, as small gains in gestational age during late pregnancy might play a crucial role in the development of fetal brain and heart.

2 Background

2.1 Early Elective Deliveries

A delivery is considered to be *early term* if it occurs during the 37^{th} or 38^{th} weeks of pregnancy; and *elective* if it involves a cesarean or an induction[13] that is not justified by a medical condition. *Early Term* is a fairly new classification. In 2013, the American College of Obstetricians and Gynecologists[14] (ACOG) introduced new gestational age categories for births occurring at and beyond 37 weeks of gestation, all of which were formerly referred to as "term" deliveries. ACOG (2013a) points to the recent evidence of variation in neonatal outcomes within term deliveries as a basis for the new categorization. The Committee recommends the label "term" to be replaced by *early term* (for 37 and 38 weeks of gestation), *full term* (for 39 and 40 weeks of gestation), *late term* (for 41 weeks of gestation), and *post term* (for 42 weeks of gestation and beyond).

Elective refers to the absence of a medical condition justifying an obstetric procedure or intervention. These conditions, published by both ACOG and the Joint Commission[15], include but are not limited to maternal hypertension and diabetes (both chronic and gestational), preeclampsia, fetal intolerance, growth restriction, and congenital anomalies. One difference between the two organizations' lists of conditions is noteworthy, because of its potential effect on

[13] Induction of labor is performed by stimulating uterine contractions using medical or surgical methods to achieve vaginal delivery before the spontaneous onset of labor (ACOG, 2019). However, in some cases labor fails to progress and a cesarean section follows the induction of labor.

[14] The American College of Obstetricians and Gynecologists, founded in 1951, is a professional membership organization with activities including to produce the College's practice guidelines and other educational material.

[15] The Joint Commission is an independent, and non-profit organization that accredits and certifies more than 21,000 health care organizations and programs in the United States.

the estimation of early elective delivery (EED) rate. ACOG (2013b) lists prior classical cesarean as a condition that warrants early term delivery, while leaving the breech presentation (fetus is not presented head-first) out. The Joint Commission[16] does the opposite and includes breech presentation as a medical indication while excluding prior cesarean. Previous studies differ in their choice of Organization as a reference.[17]

2.2 Trends in (Early) Elective Deliveries

The share of cesareans and inductions among all live births in the U.S. has nearly doubled over the last 30 years, reaching 52 percent in 2017 (see Figure1). The increase in *early term* cesareans and induction was even greater, rising from 5.3% in 1989 to 14.7% by 2007. A growing share of these obstetric interventions is elective, given that it is unlikely for the medical conditions necessitating their use to increase at the same rate (Oshiro et al., 2009). Starting in late 2000s, nationwide policy efforts including payment reforms, regulations, quality measures, and educational campaigns seem to have changed the course of the trend in the practice of early term cesareans and induction. Their share declined from 14.7% to 11.7% between 2007 and 2014.

Previous studies explored the factors contributing to the increase in (early) elective deliveries. For example, Rouhe et al. (2013) show that *fear of vaginal birth* is a common reason for mothers to prefer a cesarean. On the physician and health care provider side, *financial incentives*, as a result of differential reimbursement of cesareans and normal births, lead to elective procedures (Gruber, Kim and Mayzlin, 1999; Allin et al., 2015; Kozhimannil et al., 2018*a*). Brown (1996) and Costa-Ramon et al. (2018) show that *demand for leisure*, and Lefevre (2014) shows that *scheduling convenience* also affect physicians' decisions to perform elective deliveries. Physicians may also choose cesarean over normal birth to avoid potential complications during vaginal birth, which could to be the subject of a *lawsuit* (Lawthers et al., 1992; Keeler and Brodie, 1993; Currie and MacLeod, 2008; Clark et al., 2018). Finally, both mothers' and physicians' *lack of information* on the risks of early term delivery may lead to an early elective delivery (Johnson and Rehavi, 2016; Oshiro et al., 2013).

[16] See https://manual.jointcommission.org/releases/TJC2013A/AppendixATJC.html; accessed November 3, 2018

[17] Byanova (2015) and Buckles and Guldi (2017) refer to ACOG's Committee Opinion, while Fowler et al. (2014), Dahlen et al. (2017), Snowden et al. (2016), Muoto et al. (2018) use the Joint Commission's list of conditions to define early elective deliveries.

2.3 Early Elective Delivery Policies

2.3.1 Institutions, Initiatives, and Policies

Over the last decade, there has been a nationwide effort in the U.S. to prevent early elective deliveries (EEDs). These efforts vary in size, location, focus area, and institutions involved. Byanova (2015) and Buckles and Guldi (2016) provide comprehensive summaries of these EED policies and initiatives. I complement their work by focusing on the leading institutions, major policies and initiatives, and how they address specific factors contributing to an increase in EEDs.

A major focus area of EED policies and initiatives has been providing mothers and members of the health care community with information on the risks associated with EEDs. The American College of Obstetricians and Gynecologists (ACOG) has been the leading organization for more than 30 years in conveying the latest evidence and practice guidelines related to EEDs to physicians and health care providers (ACOG, 2013c)[18]. Educational campaigns such as "Strong Start for Mothers and Newborns" by the Centers for Medicare & Medicaid Services (CMS), and "Babies Are Worth the Wait" by March of Dimes, also played a crucial role in closing the information gap among expecting mothers and raising awareness about the potential risks associated with EEDs.

The Joint Commission (the largest accrediting body in health care in the U.S.) introduced EED rate as a quality measure in 2010, incentivizing hospitals to reduce its practice. CMS and March of Dimes joined this effort by designating EED reduction as one of focus areas among Hospital Engagement Networks, and initiating nationwide hospital based quality improvement programs. The Leapfrog Group, a non-profit organization working toward increasing quality and safety in health care, began collecting data on EEDs through hospital surveys in 2010. The Group's reports based on these surveys increased awareness on the practice of EEDs among health care providers and the general public, encouraging hospitals to take action.

Medicaid agencies in certain states changed their reimbursement policies to curb the financial incentives leading to elective procedures related to child birth. For example, Minnesota's Medicaid Program introduced a blended payment policy in 2009, which pays the same rate for uncomplicated births regardless of the delivery method. Texas Medicaid started to refuse payment for early elective deliveries (EEDs) in 2011. The Washington Health Care Authority, in 2015, announced that the

[18]This publication is updated and replaced by Committee Opinion No.765, published in 2019.

State's Medicaid Program will no longer reimburse EEDs.

2.3.2 Oregon's Hard-Stop Policy

In 2011, Oregon hospitals providing maternity care committed to a voluntary Hard-Stop Policy to eliminate EEDs. The Policy requires hospital administration's review and approval for scheduled cesareans and inductions before 39 weeks in the absence of a documented medical indication.

Oregon's Hard-Policy is unique in many aspects. First of all, while similar policies exist at the hospital or health care network level, Oregon's is the first statewide policy. Second, compliance was *voluntary*, displaying hospitals' commitment to reduce the practice of EEDs. Third, the Policy's *coverage* grew rapidly. The Policy became effective in September 2011 with 17 Portland Metropolitan Area hospitals and by 2012 almost all hospitals in Oregon providing maternity care were committed to the Policy (Snowden et al., 2016). Lastly, the Policy's influence is not limited a certain sub-population, such as Medicaid patients in case of payment reforms, but all deliveries regardless of insurance type are subject to Policy's regulations.

3 Conceptual Framework

Deliveries following a medical indication are trivial for the purpose of this study since they leave little room for the mother or the physician to decide on the timing and the method of the delivery. For pregnancies with no medical indication, I develop a model to motivate the empirical analysis. Although patient preferences and demand play an important role in early elective deliveries, for simplicity, I only use preferences of the physician as the patient's agent.

Assume that the physician has the following separable utility function;

$$U(Y, H) = V(Y) + W(H) \tag{1}$$

where Y denotes the total net income of the physician earned by delivering newborns, with $U_Y > 0$ and $U_{YY} < 0$; while H is a negative birth outcome for the newborn, such as low birth weight or NICU admission, from which the physician derives negative utility and therefore tries to avoid, with $U_H < 0$ and $U_{HH} < 0$.

The total net income of the physician is given by;

$$Y = \big(eed \times B \times \boldsymbol{E}\big[Y_{eed}\big]\big) + \big((1 - eed) \times B \times \boldsymbol{E}\big[Y_{full}\big]\big) \tag{2}$$

The first part of the right-hand side of Equation (2) represents total net income from early elective deliveries. The variable eed denotes the percentage of early elective deliveries, B is the total number of births and $\boldsymbol{E}\big[Y_{eed}\big]$ stands for the average net income the physician earns from each early elective delivery. The second part of the right-hand side of Equation (2) represents total net income from full term deliveries.

Cesarean sections (representing almost half of the EEDs) are reimbursed at a higher rate than spontaneous vaginal births. Furthermore, the physician's opportunity cost of a full term spontaneous vaginal birth is higher, since its timing is unpredictable and may cost the physician leisure time or other professional activities such as clinic visits. In some cases, Y_f might even be zero if the physician misses the delivery and another on-call physician delivers the baby. Therefore, given the probability that a spontaneous vaginal delivery increases as the pregnancy proceeds from early term to full term, I assume $\boldsymbol{E}\big[Y_{eed}\big] \geq \boldsymbol{E}\big[Y_{full}\big]$.

The number of newborns with the specified negative birth outcome can be written as follows;

$$H = (r_{eed} \times eed \times B) + (r_{full} \times (1 - eed) \times B) \tag{3}$$

where r_{eed} and r_{full} stand for the risk of the negative health outcomes for early term elective and full term deliveries. The relative magnitudes of r_{eed} and r_{full} are the main focus of this study. Previous medical literature argues that $r_{eed} \geq r_{full}$ for most of the health outcomes.

The physician chooses the share of early elective deliveries that maximizes the utility function given by Equation (1). The optimal share of elective deliveries, eed^*, satisfies the following first order condition;

$$U_Y(eed^*)\boldsymbol{E}\big[(Y_{eed} - Y_{full})\big] + U_H(eed^*)(r_{eed} - r_{full}) = 0 \tag{4}$$

The following comparative statics exercises display the motivation behind different policy efforts targeting early elective deliveries. Differentiating Equation (4) with respect to the expected income differential between early elective deliveries and full-term deliveries returns the following expression;

$$\frac{d(eed^*)}{\boldsymbol{E}\big[(Y_{eed} - Y_{full})\big]} \gtreqless 0 \tag{5}$$

The sign of the above derivative is ambiguous and depends on the magnitudes of the substitution and income effects. Assuming that the substitution effect dominates the income effect, the sign will be positive implying that a decline in the expected income differential between early elective deliveries and full term deliveries will decrease the share of early elective deliveries. Medicaid's payment reforms, such as denying payment for EEDs in Texas and reimbursing medically unnecessary cesareans at the same rate as spontaneous vaginal births in Minnesota, are examples of policies motivated by the effect of income differentials on the practice of EEDs.

Next, I fully differentiate Equation 4 with respect to the difference between the risk of a negative birth outcome associated with early elective and full term deliveries.

$$\frac{d(eed^*)}{d(r_{eed} - r_{full})} < 0 \tag{6}$$

The share of early elective deliveries (EEDs) decreases as the risk differential (or mothers' and physicians' beliefs about the risk differential) gets larger. This constitutes the basis of policy efforts to increase awareness about the risk factors associated with early term births.

Instead of addressing incentives related to early term and elective deliveries, Hard-Stop policies directly target eed^* through regulations, as in the case of Oregon. A hundred percent compliance to a Hard-Stop policy implies that $eed^* = 0$, that is, total elimination of EEDs. The overall prevalence of a specific negative birth outcome before and after the policy can be written as follows.

$$r_b = (eed_b \times r_{eed}) + ((1 - eed_b) \times r_{full}) \tag{7}$$

$$r_a = ((1 - p) \times eed_b \times r_{eed}) + (p \times eed_b \times r_{full}) + ((1 - eed_b) \times r_{full}), \tag{8}$$

where r_b and r_a are overall prevalence of the negative health outcome before and after the policy, eed_b is the share of early elective deliveries before the policy and p is the percentage of early elective deliveries prevented.[19] The term $(p \times e_b \times r_{full})$ in Equation (8) represents the treatment on the treated. These are newborns who would have been exposed to the average risk of r_{eed} in the absence of the policy since their mothers would have had an elective delivery (EED). After the implementation of the Policy, these newborns were delivered full term and thus exposed to the average risk of a full term birth (r_{full}) where $(r_{full} < r_{eed})$.

The difference in the risk of a specific negative birth outcome before and after the policy can be written as;

$$(r_a - r_b) = -(eed_a - eed_b) \times (r_{full} - r_{eed}). \tag{9}$$

Equation (9) represents the basic idea behind the identification strategy that I employ in the following analyses. I observe the variation in the prevalence of the negative birth outcome before and after the policy, that is, $(r_a - r_b)$. The predicted risk of having an EED provides the necessary variation in the probability of having an EED before and after the policy $(e_a - e_b)$ to estimate the effect of EEDs on risk factors compared to full term deliveries, given by $(r_{full} - r_{eed})$.

4 Data and Empirical Strategy

4.1 Data

The data used in this study are provided by the National Center for Health Statistics. The Center's *Natality Data*, compiled from birth certificates, consist of the universe of all live births in the United States and include detailed information on maternal, pregnancy, and newborn characteristics along with various birth outcomes. I use restricted-use geographic identifiers at the state and county level to identify births occurring in Oregon. The sample period extends from 2008 to 2017, and includes 462,060 live births.[20] I exclude preterm births (less than 37 weeks of gestation), given

[19]Notice that p can be written as $\frac{-(e_a - e_b)}{e_b}$ where e_a is the share of early elective deliveries after the policy.

[20]The choice of the sample period is based on the 2003 Revision in birth certificates, which provides more detailed information on birth outcomes including neonatal complications after birth. Oregon started to report according to the 2003 Revision in 2008.

they are not subject to an early elective delivery, and pose a distinct set of risk factors and health implications. I also omit out-of-hospital deliveries, multiple-gestation pregnancies (more than one fetus), and births with missing information that is crucial to empirical analysis, such as gestational age at birth or method of delivery. The final sample consists of 389, 343 live births.

The definition of an early elective delivery (EED) differs among previous studies depending on the availability of data on the medical conditions justifying an early term intervention. I use a broad definition in this study. I consider a delivery to be *early* and *elective* if it occurs at the 37^{th} or 38^{th} week of pregnancy and the birth certificate lacks the indication of maternal hypertension and diabetes (both chronicle and gestational), preeclampsia, trial of labor, and any congenital anomalies of the newborn. This definition is likely to overestimate the EED rate; since conditions possibly justifying an early term intervention (such as fetal intolerance, prolonged labor and premature rupture of the membranes), are not used because of their discontinuity in the Natality Data. As a results, the estimates on the decline in EEDs will represent the lower bounds.

I use a large set of maternal and pregnancy characteristics; first to predict mothers' risk of having an early elective delivery (EED), and second to account for potential confounders and increase precision while identifying the effect of EEDs on birth outcomes. These characteristics include maternal age, race/ethnicity, education, marital status, smoking behavior; and conditions related to pregnancy and delivery, such as prior cesarean delivery, presentation of the fetus (breech position), prenatal care utilization and attendant at birth.

The share of early elective deliveries (EEDs) among all *term* births (births at 37^{th} week and beyond) is a primary outcome of interest. The plausibly exogenous change (a decline, in this case) in the share of EEDs after the Policy facilitates the identification of the effect on birth outcomes and also reveals the Policy's effectiveness in reducing the practice of EEDs. The change in the share of EEDs, if large enough, should affect average gestational age at birth, by definition. I use *gestational age at birth* as an outcome variable both in continuous (in weeks) and discrete (gestational age categories of early term, full term, late term, and post term) form. Similarly, I use newborn's *birth weight* as a continuous outcome variable, and to define additional binary outcome variables, *low birth weight* (birth weight<2,500 grams) and *macrosomia* (birth weight>4,000 grams).[21]

[21] Fetal macrosomia increases the risk of labor abnormalities, shoulder dystocia, birth trauma, and permanent injury to the neonate (ACOG, 2016).

Early elective delivery (EED) policies are expected to reduce the need for additional care associated with neonatal complications. Birth certificates do not directly report these complications, however, they contain information on certain types of neonatal care and treatment required in case of a complication. For example, I use admission to *Neonatal Intensive Care Unit (NICU)* as a plausible indicator of respiratory complications and other neonatal morbidities such as infections, seizures, and hypoglycemia (low blood sugar). The immediate use of *assisted ventilation* after birth also signals the presence of neonatal respiratory complications. The Apgar score is a convenient measure of the newborn's health immediately after birth (ACOG, 2015).[22] Therefore, I use low Apgar score (< 7) as an additional indicator of a potential neonatal complication after birth.

Table 1 presents the summary statistics for outcome variables, maternal characteristics, and pregnancy conditions before (2008–2010) and after (2011–2017) the implementation of the Hard-Stop Policy. The difference in the average maternal age and education between these periods is noteworthy. The average maternal age in the post-policy period exceeds the average in the pre-policy period by almost a year. The share of mothers with no high school degree decreased from 20 percent in the pre-policy period to 15 percent in the post-policy period. This decline coincides with a 4 percentage point increase in the share of mothers with a college degree.

4.2 Empirical Strategy

I rank mothers according to their predicted risk of having an early elective delivery (EED), which depends on the mothers' demographic and pregnancy characteristics and therefore is not correlated with the Policy, and use this variation in a difference-in-differences setup. This identification strategy posits that the Hard-Stop Policy is more likely to affect mothers with a high risk of having an EDD. The prediction of the EED risk is based on the location and timing of the birth, pregnancy conditions, and maternal characteristics. Below, I explain my empirical strategy in more detail.

[22] Apgar score ranges between 0 and 10; based on the color, heart rate, reflexes, muscle tone and respiration of the neonate. An Apgar score between 7 and 10 is referred to as *reassuring*, a score between 4 and 6 is considered as *moderately abnormal*, and a score between 0 and 3 is considered as being *low*.

4.2.1 Predicted Risk of Early Elective Delivery

I start by estimating the partial correlations between the binary dependent variable, early elective delivery (EED), and the independent variables, location and timing of the delivery, pregnancy conditions and maternal characteristics. The logistic regression uses only pre-policy years (2008 to 2010), so that the predicted risk of EED represents the counterfactual to the Policy's regime. The estimating equation takes the following form;

$$EED_{icmd} = \alpha + \boldsymbol{\beta X_{icmd}} + \gamma_c + \delta_m + \eta_d + \epsilon_{icmd}. \tag{10}$$

The binary variable EED_{icmd} is equal to one, if delivery i, in county c, in month m, and day d is early and elective. The vector $\boldsymbol{X_{icmd}}$ consists of maternal characteristics and pregnancy conditions. Maternal characteristics include mother's age, education, race, ethnicity, marital status, country of origin and smoking behavior. Pregnancy conditions consist of previous cesarean, breech position, birth order, number of prenatal care visits, and the month prenatal care began. County fixed effects and time fixed effects, which include month and day of the week fixed effects, are represented by γ_c, δ_d, and η_d. I cluster robust standard errors at the county level. Next, I use these partial correlations to predict the EED risk for each mother, including those who gave birth after the Policy. By doing so, I implicitly assume that the correlations constituting the basis of these predictions stay plausibly constant over time.

4.2.2 Difference–in–Differences

The predicted risk of having an early elective delivery (EED), denoted as $Risk_{eed}$, replaces the binary treatment variable in the traditional 2×2 difference-in-differences model. However, instead of using $Risk_{eed}$ as a continuous variable, which imposes linearity in treatment intensity, I use a more flexible approach in the main specification by assigning mothers into quartiles based on $Risk_{eed}$.[23] The discrete variable, $Quart_q$, becomes the new interaction term in the difference-in-differences specification, with the first quartile consisting of mothers with the lowest EED risk.

[23] The specification and associated results, where $Risk_{eed}$ used as a continuous measure of treatment intensity, are presented in the Appendix (Table B1 and B2).

The specification follows;

$$H_{icy} = \alpha + \sum_{q=2}^{4} \beta_q Post_y \times Quart_q + \sum_{q=2}^{4} \gamma_q Quart_q + \boldsymbol{\kappa X_{icy}} + \delta_c + \theta_y + \eta\big(County_c \times t_y\big) + \epsilon_{icy} \quad (11)$$

where H_{icy} denotes a birth outcome of delivery i occurring in county c, and in year y. The binary variable $Post_y$ turns on starting in 2011, as the Policy becomes effective. The timing of the Policy is interacted with $Quart_q$, which indicates mother's quartile based on her EED risk. Mothers with the lowest risk of EED, that is, assigned to the first quartile, represent the excluded category. The vector $\boldsymbol{X_{icy}}$ consists of the same maternal characteristics and pregnancy conditions used in Equation (10). I use county and time fixed effects, which include year, month and day of the week fixed effects, and denoted by δ_c and θ_y, to account for baseline differences among counties and statewide temporal shocks. The specification also includes county specific linear time trends, $\big(County_c * t_y\big)$ to allow differential pre-trends among counties.

The coefficient of interest is β_q. For example, β_4 displays the difference in the outcome variable between the fourth and first quartile, that is, between mothers with the highest and lowest risk of having an early elective delivery, before and after the Policy. I conduct event studies to display pre-trends among comparison groups and also to explore how the effect of the Policy evolves over time. The estimating equation for the *event study* takes the following form;

$$H_{icy} = \alpha + \sum_{y=2008}^{2017} \sum_{q=2}^{4} \beta_{yq} \Big(\boldsymbol{I}(Year = y) \times Quart_q\Big) + \boldsymbol{\kappa X_{icy}} + \delta_c + \epsilon_{icy}. \quad (12)$$

The excluded year is 2010, a year before policy implementation, and the excluded quartile is the first quartile, which consists of mothers with the lowest EED risk, as before. The coefficient of interest is β_{yq}. Small and statistically insignificant $\beta_{2008,4}$ and $\beta_{2009,4}$ would imply that the pre-policy trends in the fourth and first quartiles are parallel. Coefficients from $\beta_{2011,4}$ through $\beta_{2017,4}$ display the effect of the Hard-Stop Policy on the mothers in the fourth quartile compared to the mothers in the first quartile over time.

5 Results

5.1 Treatment Intensity

The likelihood of an early elective (EED) increases with previous cesarean, breech presentation (fetus is not presented head-first), advanced maternal age (> 35), and occurrence during weekdays. The full set of covariates is presented in the Appendix, Table A1. Based on the partial correlations, I predict the risk of EED for each mother in the sample. The distribution of the predicted EED risk, shown in Figure 2, is right-skewed with a mean of 9.2 percent and median of 6.5 percent, and has a range mainly falling between 0 and 50 percent. This variation is used as a treatment intensity measure and facilitates the identification of the EEDs' effect on birth outcomes.

The histogram in Figure 3 presents the actual EED rates for each quartile, which are based on predicted risk of EED, for the pre-policy period (2008–2010). The actual rate of EEDs is 20.5 percent in the fourth quartile, formed by mothers with the highest EED risk; while the actual rate of EEDs is only 3 percent in the first quartile, which consists of mothers with the lowest risk. These results seem to support the use of predicted risk as a measure of treatment intensity in the first stage, though whether comparison groups have parallel pre-trends needs to be still verified. One concern is the effect of temporal changes in the selection into motherhood and pregnancy conditions on the predicted risk of EED. Buckles and Guldi (2017) compare the actual and predicted rate of early term inductions (ETIs) for counties to ensure that the reduction in the ETI rate does not result from a change in demographic characteristics of mothers. I use a similar analysis to show that the decline in EEDs is not affected by changes in maternal characteristics or pregnancy conditions. Figure 4 compares the actual rate and the predicted risk of EED over time and shows that the actual rate starts to decline after the Policy comes into effect in 2011, while the predicted EED risk stays fairly stable.

5.2 Main Results

I present the results for each outcome variable starting with the associated *event study* followed by the point estimates from the *difference-in-differences* specification. The comparison of pre-policy trends, provided by event studies, demonstrate whether parallel pre-trend requirement of the difference-in-differences methodology is met. Unless otherwise noted, the results reflect the effect of the Policy on mothers with the highest EED risk, in the fourth quartile; compared to mothers with the lowest EED risk, in the first quartile. In Tables 2, 3, and 4, I also include the results for the second and third quartiles to show the response of the effect as treatment intensity (the average predicted risk of EED) increases.

I start with the *share of early elective deliveries* (EED). The event study in Figure 5 shows that the trend in the practice of EEDs were parallel for the treatment and control groups during the pre-policy period, given the point estimates for years 2008 and 2009 – compared to 2010 – are small in magnitude and statistically not different from zero.[24] The decline in EEDs is about 3.2 percentage points in 2011 and increases over time reaching 7.0 percentage points in 2016. The difference-in-differences (DD) results in Table 2 point to an average of 6.3 percentage points decline in the share of EEDs among mothers with the highest EED risk. This translates into a 30 percent decrease, considering the 20.5 percent pre-policy EED rate for this group.

The decline in EEDs is expected to be followed by an increase in *gestational age at birth*, given EEDs shorten the gestation period by definition. Figure 6.A presents the event study displaying the similar pre-policy trend between the first and the fourth quartiles, and the following increase in gestational age. On average, gestational age at birth increased by almost a day. This result is consistent with Dahlen et al. (2017), where they find 0.11–0.12 week (almost a day) increase in Texas after Medicaid's Payment Reform denying reimbursement for EEDs. *Birth weight* is closely related to gestational age. I find a 17 grams increase in average birth weight after the Policy. There was no change in the prevalence of *low birth weight* ($<$ 2500 gr), however, *macrosomia* (birth weight $>$ 4000 gr) went up by 0.9 percentage points, indicating an 8 percent increase.

Early elective delivery (EED) policies are expected to lessen the need for additional care for newborns, by preventing neonatal complications such as respiratory morbidities. Panels D, E, and F of Figure 6 present the event study results associated with *NICU admissions*, the immediate use of *assisted ventilation* after birth and *low Apgar score.* Event studies for all three of these variables indicate that the parallel pre-policy trend between the first and fourth quartiles remained unchanged after the Policy, implying the lack of any improvement in the prevalence of neonatal complications.

[24] The pre-policy period is limited to three years because of data availability. Oregon started to report according to 2003 Revision of birth certificates in 2008, therefore certain variables are available only after 2008.

Byanova (2015) has a similar finding related to Medicaid's Payment Reform in Texas, where she finds no change in NICU admissions or the rate of low Apgar score.

Next, I examine the changes in the *timing* and the *method* of deliveries. Figure 7 presents the event studies and Table 3 presents the difference-in-differences (DD) results of the Policy's effect on the timing of deliveries. The Policy diminished the share of early term deliveries by 6.0 percentage points (about 17 percent), while increasing the share of full term and post term deliveries by 4.6 and 1.2 percentage points.[25] The increase in post term deliveries can be seen as an unintended consequence of the Policy since these deliveries are often associated with adverse birth outcomes. Figure 8 and Table 4 present the results for the overall rate of cesareans, inductions and spontaneous vaginal deliveries[26]. Figure 8.A demonstrates the lack of change in the overall rate of cesarean sections. Panels B and C illustrate a decrease in overall inductions and an increase in spontaneous vaginal deliveries, however, Table 4 shows that these changes on average do not reach conventional levels of statistical significance. The lack of change in the overall rate of cesareans is surprising, considering their large share in EEDs. I examine cesareans by gestational age at birth, using both gestational age categories and specific week of delivery, to further investigate this lack of change in the overall cesarean rate.

Figures 9 and 10 show that the Policy reduced EEDs mostly by *shifting cesareans* from early term to full term, and the majority of this shift took place between the 38^{th} and 39^{th} weeks of pregnancy. This response to the restrictions of the Hard-Stop Policy explains the lack of a change in the overall cesarean rate and also provides a plausible explanation why there is no improvement in the prevalence of neonatal complications. Elective cesareans, which were postponed from the 38^{th} to 39^{th} week of pregnancy, involved "healthier" mothers, who do not have a medical condition such as diabetes or hypertensive disorders, by definition of *elective* delivery. Furthermore, birth outcomes of these mothers, including neonatal complications, were on average better than the outcomes of medically indicated 38-week cesareans, and similar to the birth outcomes of 39-week cesareans. For example, the average NICU admission rate is 6.36% for medically indicated 38-week cesareans, 4.35% for elective 38-week cesareans and 4.13% for all 39-week cesareans. Therefore, shifting elective cesareans from the 38^{th} to 39^{th} week of pregnancy did not lead to an improvement in the prevalence

[25] Gestational age categories for term births follow; early term (37 and 38 weeks of gestation), full term (39 and 40 weeks of gestation), late term (41 weeks of gestation), and post term (42 weeks of gestation and beyond).

[26] Vaginal deliveries without induction.

of neonatal complications, as it exposes the newborn to the same risks associated with cesarean section[27], despite the increase in gestational age at birth.

In sum, I find a substantial reduction in the EED rate after the Hard-Stop Policy, which is followed by a small increase in average gestational age and birth weight. The reduction in the EED rate was mainly driven by a shift in the timing of elective cesareans from the 38^{th} to the 39^{th} week of pregnancy. This shift has dominated the Policy's effect on birth outcomes, since elective cesareans performed at the 38^{th} week of pregnancy had the largest share among EEDs. The fact that 38-week elective cesareans involved "healthier" mothers also explains the lack of improvement in the prevalence of neonatal complications after the Policy.

5.3 Heterogeneous Effects

The Policy's effect on birth outcomes may differ for certain subpopulations of mothers. For example, younger mothers, who are more likely to have their first child and less likely to have a previous cesarean could be affected less by the Policy's restrictions. Kozhimannil et al. (2018*b*) find that Oregon's Hard-Stop Policy reduced racial disparities in early elective cesareans, given the decline among African American mothers was larger. Maternal education might also play a role by raising the mother's knowledge about the risks of EEDs. For example, Johnson and Rehavi (2016) find that physician mothers are 10 % less likely to receive a cesarean section. Lastly, anecdotal evidence suggests that elective cesareans are more likely to be scheduled for weekdays, suggesting that the Policy should affect these deliveries the most. In this section, I explore these probable heterogeneous effects by maternal *age*, *education*, *race*, and the *day of the week* delivery occurs.

Table 5 displays the effects by maternal age. I separate the sample into five age groups: less than 20, 20–25, 25–30, 30–35, and more than 35. All subgroups, except mothers younger than 20, exhibit a decline in the share of EEDs. The magnitude of the decline is increasing in maternal age; from 4.9 percentage points for mothers between 20 and 25, to 8.7 percentage points for mothers older than 35. The average birth weight increases only for mothers between 30 and 35 (26 grams), although the increase in average gestational age is similar for all subgroups (almost a day). One possible explanation for this heterogeneity is the Policy's differential effects on gestational age

[27]Such as impaired lung function, lower body temperature, hypoglycemia (lower blood sugar), difficulty in breast feeding, and low levels of blood pressure (Hyde et al., 2012).

categories. The decline in *early term* deliveries for mothers between 30 and 35 is followed by an increase in late term deliveries (highest average birth weight among term deliveries). The increase in NICU admissions for mothers older than 35 is likely to be the result of the increase in early term spontaneous vaginal deliveries for this group after the Policy.

I construct four subgroups based on level of education: less than high school, high school degree, some college, and college degree. Table 6 presents the point estimates by education level. All subgroups display a decline in earl elective deliveries (EEDs) followed by an increase in gestational age. The increase in birth weight is especially large for mothers with no high school degree (34 grams) and for mothers with college degree (37 grams); while there is no change in birth weight for mothers with some college education. Once again, the Policy's effect on gestational age categories seems to be influencing this differential effect on birth weight. For mothers with some college education, the decline in early term deliveries coincides with a decrease in late term deliveries, with the highest average birth weight, and an increase in post term deliveries, among which the birth weight begins to decrease as the gestational period gets longer.

Oregon's population is relatively homogeneous in term of race, with 85 percent white according to 2016 estimates of the American Community Survey.[28] The study sample has a similar distribution with 88.9 percent white, 2.9 percent black, 1.9 percent American Indian or Alaskan Native, and 6.3 percent Asian or Pacific Islander. As a consequence, the sample sizes of minorities are small, however, the subpopulation of Asian or Pacific Islander provides suggestive evidence on the effect of cesareans on neonatal complications after birth. Asians and Pacific Islanders constitute the only subpopulation exhibiting a decline in the overall rate of cesarean sections after the Policy. Table 7 displays the decrease in the use of immediate assisted ventilation after birth and the prevalence of low Apgar score following the decline in cesarean sections.

Anecdotal evidence suggests that elective obstetric procedures are more likely to be scheduled during weekdays. Table 8 shows that the decline in EEDs is larger among deliveries occurring during weekdays (7.0 percentage points) compared to deliveries occurring during weekends (2.9 percent), and provides suggestive evidence that scheduling convenience was playing a role in the rise of EEDs. Furthermore, the decline in early term cesareans is mainly responsible for the decline in EEDs among weekday deliveries, while the decline in EEDs among weekend deliveries takes place

[28]Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates.

through a decrease in early term inductions.

6 Robustness Checks

I test the robustness of my results by using different methods of identifying early elective delivery (EED) risk, alternative definitions of gestational age and EED, and different sample specifications. Table 9 presents the results of these analyses, where the first column represents the point estimates from the baseline model. In general, the results seem to be robust to alternative specifications, definitions, and samples. In none of these models, including the baseline model, there is a statistically significant change in neonatal complications after birth.

First, I use county of occurrence as the only predictor of EED risk to make sure that the results are not driven by county specific characteristics (related to the pre-policy share of EEDs) that may be correlated both with policy implementation and birth outcomes. The results in column 1 of Table 9 reflect the comparison of outcomes in counties with the highest (9.4 percent on average) and lowest (5.7 percent on average) pre-policy EED rates. I find no change in the share of EEDs in counties with the highest pre-policy EED rates. In fact, there is a decline in the average birth weight and an increase in low birth weight rate for these counties. This implies that the pre-policy EED rate of a county, in which the delivery occurs, does not alone determine the predicted EED risk of a mother.

Next, I exclude previous cesarean and breech presentation, both of which are strong predictors of EED, from the logistics regression to test whether these covariates are dominating the prediction of EED risk and driving the results. Column 2 of Table 9 indicates that this is not the case. The results for the decline in EEDs and its effect on birth outcomes are similar to the baseline estimates.

The American College of Obstetricians and Gynecologists includes previous cesarean and the Joint Commission includes breech presentation as conditions that justify early term elective deliveries. Column 3 of Table 9 presents results –where EED is defined in a way that both of these conditions are considered to be a justifying medical indication. The decline in the share of EEDs is smaller (3.3 percentage points) than the baseline estimate (6.3 percentage points), however, larger in percentage change (35 percent vs 30 percent). The increases in gestational age at birth and birth weight are similar to the baseline results.

Natality data provide two different measures of gestational age. In the baseline model, I use gestational age at birth based on the last normal menstrual period. Although this method mostly agrees with the clinical estimation of gestational age, discrepancies between these variables may affect the definition of gestational age categories, and therefore the share of early elective deliveries (EEDs). To make sure that this is not the case, I redo the analysis by using gestational age at birth based on clinical estimation. Column 4 exhibits similar results to the baseline model, implying that the differences in the estimation of gestational age has a minimal effect.

Column 5 of Table 9 presents the point estimates from the sample excluding mothers with previous cesarean delivery and carrying breech babies. The results indicate that the decline in the early elective deliveries and the increase in gestational age are similar to the baseline model, however, the average increase in birth weight is small and not statistically significant. This suggests that mothers with previous cesarean or breech presentation are the ones who mainly benefit from the Policy in terms of their newborns' birth weight.

Main results show that the Hard-Stop Policy reduced the share of early elective deliveries (EEDs) by shifting cesareans from the 38^{th} to 39^{th} week of pregnancy, however, post term deliveries also increase. To make sure that the increases in gestational age at birth and birth weight are solely driven by the increase in post term deliveries, I reestimate the baseline model by excluding post term deliveries from the sample. The increase in gestational age persists, although smaller in magnitude. The decline in EEDs and increase in birth weight are almost identical to the baseline model, implying that the replacement of early term deliveries by full term deliveries is driving the results associated with birth weight.

As a falsification check, I use variables, which are not likely to be affected by the Hard-Stop Policy, as outcome variables. Table 10 displays that the prevalence of breech presentation, smoking behavior, or the rate of pre-pregnancy diabetes do not change with the implementation of the Policy.

7 Discussion

The introduction of new gestational age categories among term births (37 weeks of gestation and beyond) was premised on the evidence that associated neonatal outcomes vary depending on the timing of delivery within this period (ACOG, 2013a). However, putting deliveries that occur at the 37^{th} and 38^{th} week of gestation under one category as *early term* seems to contradict with the intention of this new categorization, since the variation in outcomes such as NICU admission, use of assisted ventilation, and low Apgar score – all of which indicate a neonatal complication – is largest between neonates born at the 37^{th} and the 38^{th} weeks of gestation (see Figure 11).

This categorization inevitably affects evaluation of policies and initiatives that target early elective deliveries (EED), as evident in this study. I find a meaningful decline in the share of EEDs after Oregon's Hard-Stop Policy with no influence on outcomes indicating neonatal complications after birth. Nevertheless, a closer look at the timing of deliveries reveals that the decline in EEDs mainly occurred through a shift from 38 week cesareans to 39 week cesareans; leaving the share of 37 week cesareans and inductions, with the highest rate of neonatal complications, unchanged. Furthermore, 38-week elective cesareans involved "healthier" mothers with similar birth outcomes with mothers who had a cesarean delivery at the 39^{th} week of pregnancy. Therefore, the lack of improvement in the prevalence of neonatal complications in Oregon should not be evaluated as the lack of influence of EEDs on neonatal complications, but as a consequence of the behavioral response to the Policy's restrictions.

Medical research has shown similar findings of small gains in gestational age not affecting neonatal complications at birth (Little et al., 2014; Hutcheon et al., 2015).[29] In a Danish study, Glavind et al. (2013) conducted a randomized controlled trial, where participants are randomly assigned to elective cesareans scheduled one week apart. A comparison between the 38^{+3} weeks group (cesarean scheduled 11 days before the due date) and 39^{+3} weeks group (cesarean scheduled 4 days before the due date) does not exhibit a statistically significant difference in neonatal complications.

Furthermore, the prevalence of neonatal complications decrease in gestational age, however, the relationship is not linear, as the rate of complications tends to increase again once pregnancy progresses towards late term and post term. Therefore, an improvement in adverse birth outcomes seems to be more likely to be achieved by the optimal timing of births rather than just by reducing early elective deliveries (EEDs). The increase in post term deliveries in Oregon after the Hard-Stop Policy provides an example for such unintended consequences.

[29] An exception to these studies is Tita et al. (2009), where the authors find that even deliveries occurring during the last 3 days before 39 weeks display slightly worse outcomes compared to deliveries at 39 completed weeks.

Early elective delivery (EED) policies are expected to prevent early term and unnecessary obstetric procedures. However, their effect on the overall rate of unnecessary procedure use is ex-ante uncertain, since the decline in EEDs may occur mainly through a shift in the timing of deliveries. For example, in the case of Oregon, the decline in EEDs after the Hard-Stop Policy takes place mainly by a shift in the timing of cesareans from the 38^{th} to 39^{th} week of pregnancy, leaving the overall cesarean rate unchanged. This shift, while increasing the average gestational age at birth, does not reduce the average exposure to the higher risk of complications associated with cesarean delivery. In other words, a potential improvement through replacing elective cesareans by spontaneous vaginal births is not realized with the implementation of the Policy.

Early elective delivery (EED) policies also have a potential impact on healthcare expenditures related to child birth[30], given they are expected to eliminate medically unnecessary procedures and reduce the amount of care newborns require after birth. The hospital inpatient data from the Healthcare Cost and Utilization Project (HCUP) do not indicate such a decline in hospital charges for Oregon during the study period. The average hospital charges related to pregnancy, childbirth and postpartum per patient increased almost 50 percent in real terms, while the charges related to the care of newborns and neonates per patient increased by almost 70 percent over this study's sample period. This is not surprising since the Policy does not affect the two most expensive types of care related to child birth: Cesarean Sections and Neonatal Intensive Care Unit (NICU). In 2016, the average charge for a cesarean section in Oregon was $20,800, while the charge for a vaginal delivery was around $11,300. The care for a full term neonate with major problems costs around $28,000 on average, while the charges can reach to as high as $190,000 in case of extreme immaturity or respiratory distress syndrome.

Finally, future work should also focus on the potential long-term effects of early elective deliveries (EEDs). The long-term favorable effects of increases in birth weight on socioeconomic status and health later in life are well established (Almond, Currie and Duque, 2018; Almond and Currie, 2011; Barker, 1990; Black, Devereux and Salvanes, 2007; Royer, 2009). Furthermore, the period of late gestation is critical for fetal brain development and cognition during childhood, given 50 percent of the increase in the cortical volume takes place between 34 and 40 weeks of gestation (Adams-Chapman, 2006). Previous studies have documented a higher likelihood of

[30] Byanova (2015) and Kozhimannil et al. (2018*a*) document reduction in costs related to childbirth in Texas and Minnesota after Medicaid Payment Reforms.

special education need (MacKay et al., 2010), relatively poor literacy and numeracy (Searle et al., 2017) and lower third grade reading and mathematics scores (Noble et al., 2012), for children born early term. Therefore, the Hard-Stop Policy is likely to yield favorable long-term consequences through the increase in birth weight and gestational age at birth.

8 Conclusion

This study estimates the effect of early elective deliveries (EEDs) on birth outcomes by leveraging a plausibly exogenous decline in the practice following Oregon's 2011 Hard-Stop Policy. The research design ranks mothers according to their predicted risk of having an EED and uses this variation as a measure of treatment intensity in a difference-in-differences setup. The identification comes from comparing outcomes of mothers with the highest and lowest EED risks, before and after the Policy.

I find that early elective deliveries (EEDs) reduce birth weight by shortening the gestational period. A 30 percent decline in the share of EEDs after the Policy causes the average gestational age at birth to increase by almost a day and the average birth weight to increase by 17 grams. Birth outcomes such as Neonatal Intensive Care Unit (NICU) admission, use of assisted ventilation, and low Apgar score (< 7), which indicate the presence of a neonatal complication, do not exhibit a decline after the Policy. The likely explanation for these results is that the reduction in the EED rate was mainly driven by a shift in the timing of elective cesareans from the 38^{th} to the 39^{th} week of pregnancy. This shift has influenced the Policy's effect on birth outcomes because of the large share of 38-week elective cesareans in EEDs and the fact that these deliveries involved "healthier" mothers.

From a policy perspective, Oregon's Hard-Stop Policy successfully reduced the share of early elective deliveries and increased both gestational age at birth and birth weight on average, however, did not reduce the overall share of medically unnecessary procedures by replacing them with spontaneous vaginal births. The Policy had no significant effect on health expenditures related to child birth in Oregon, since two of the most expensive types of care – cesarean section and NICU admission – were unaffected.

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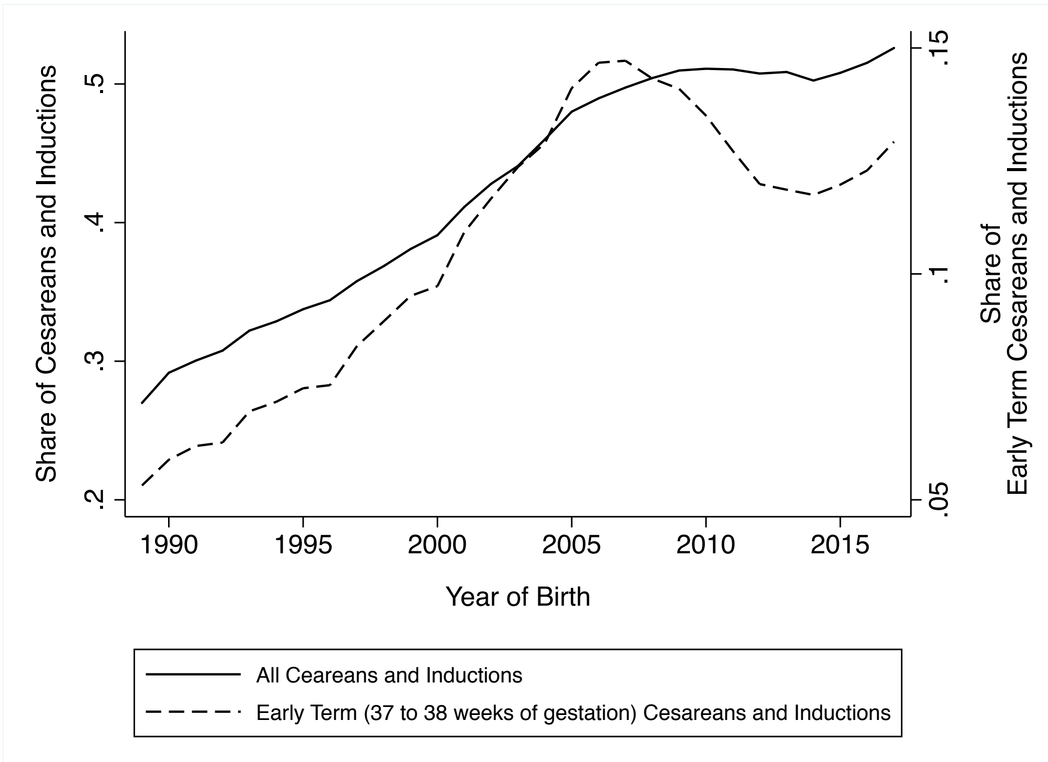
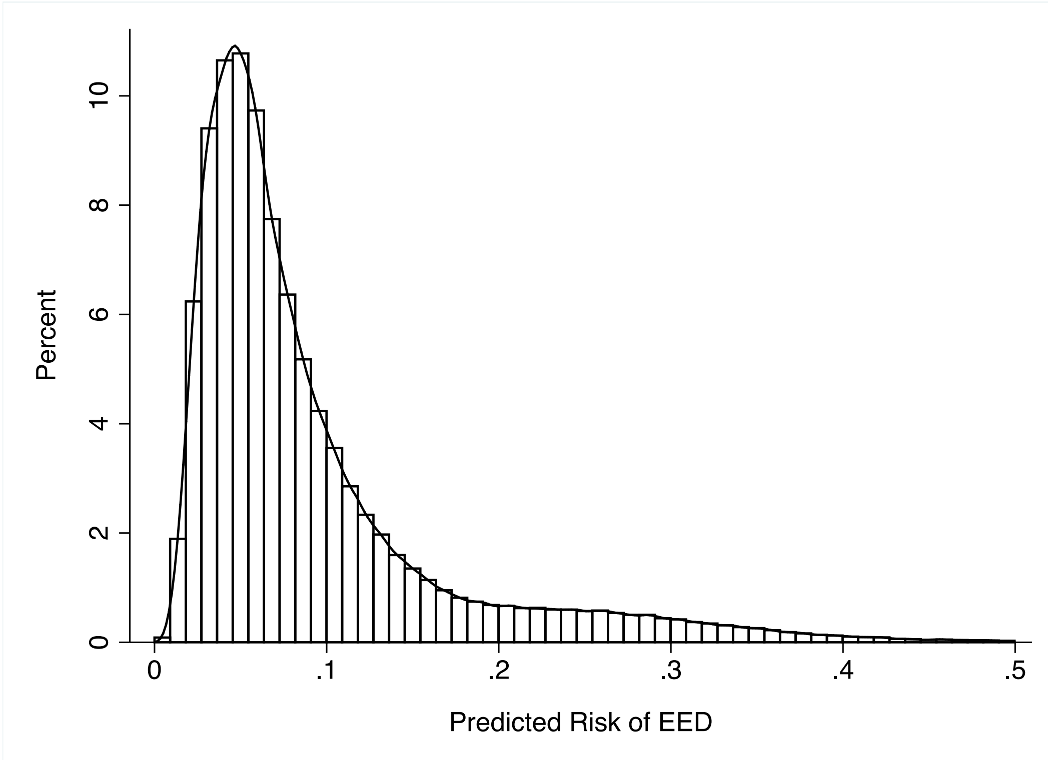
Figures and Tables

Figure 1: Cesareans and Inductions in the United States, 1989–2017



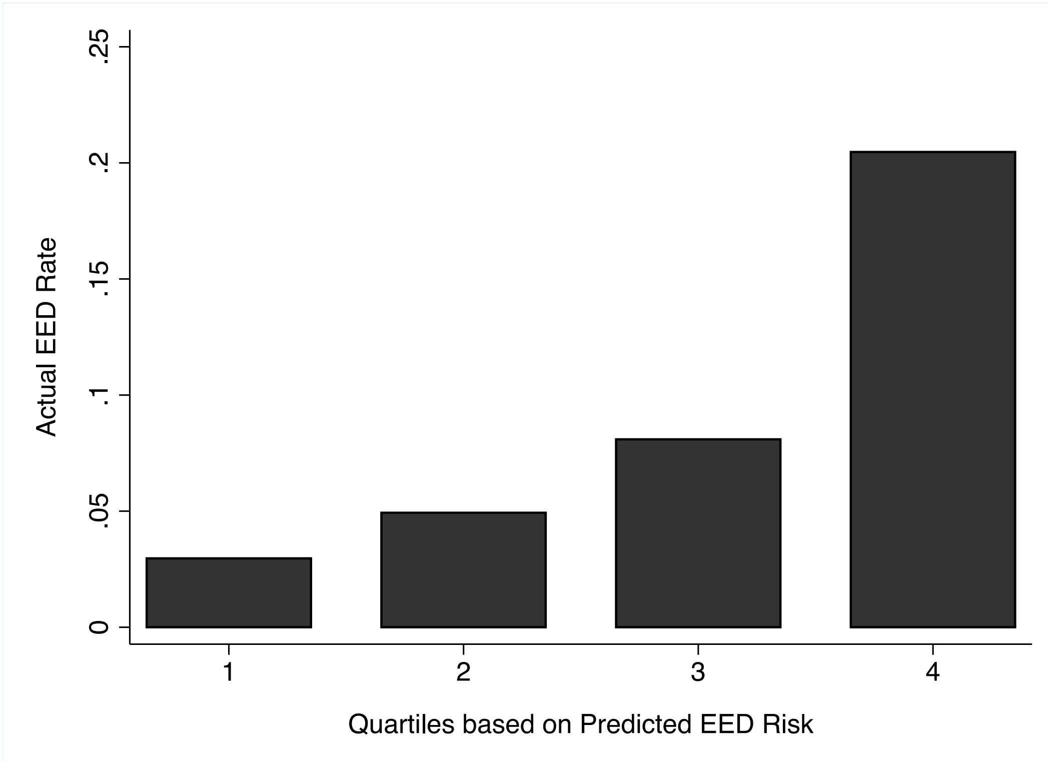
NOTES. - Data Source: Natality Data from the National Center of Health Statistics, 1989–2017. The Figure demonstrates the share among all live births, including pre term (less than 37 weeks of gestation) deliveries. In some cases, when labor fails to progress, cesarean section follows the induction of labor. These cases are considered as a cesarean to avoid double counting.

Figure 2: Distribution of Predicted Early Elective Delivery (EED) Risk



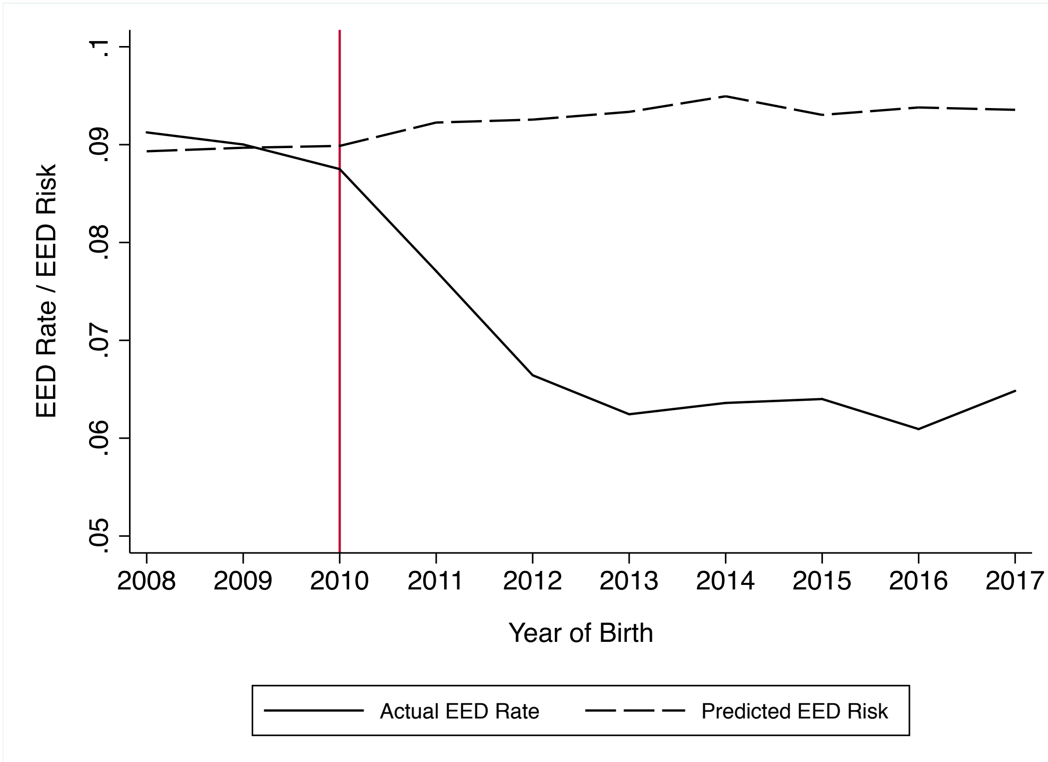
NOTES. - The risk of having an early elective delivery (EDD) is predicted by using the partial correlations from the following logistic regression; $EED_{ict} = \alpha + \boldsymbol{\beta X_{ict}} + \gamma_c + \delta_t + \epsilon_{ict}$, where the binary variable EED_{ict} is equal to one, if the delivery i, in county c, at time t is early and elective. The vector $\boldsymbol{X_{ict}}$ consists of maternal characteristics and pregnancy conditions. Maternal characteristics include mother's age, education, race, ethnicity, marital status, country of origin and smoking behavior. Pregnancy conditions include previous cesarean, breech position, birth order, number of prenatal care visits, and the month prenatal care began. County fixed effects and time fixed effects are represented by γ_c and δ_t. I also use month and day of the week fixed effects. I cluster standard errors at the county level.

Figure 3: Early Elective Delivery (EED) Rate conditional on Predicted EED Risk



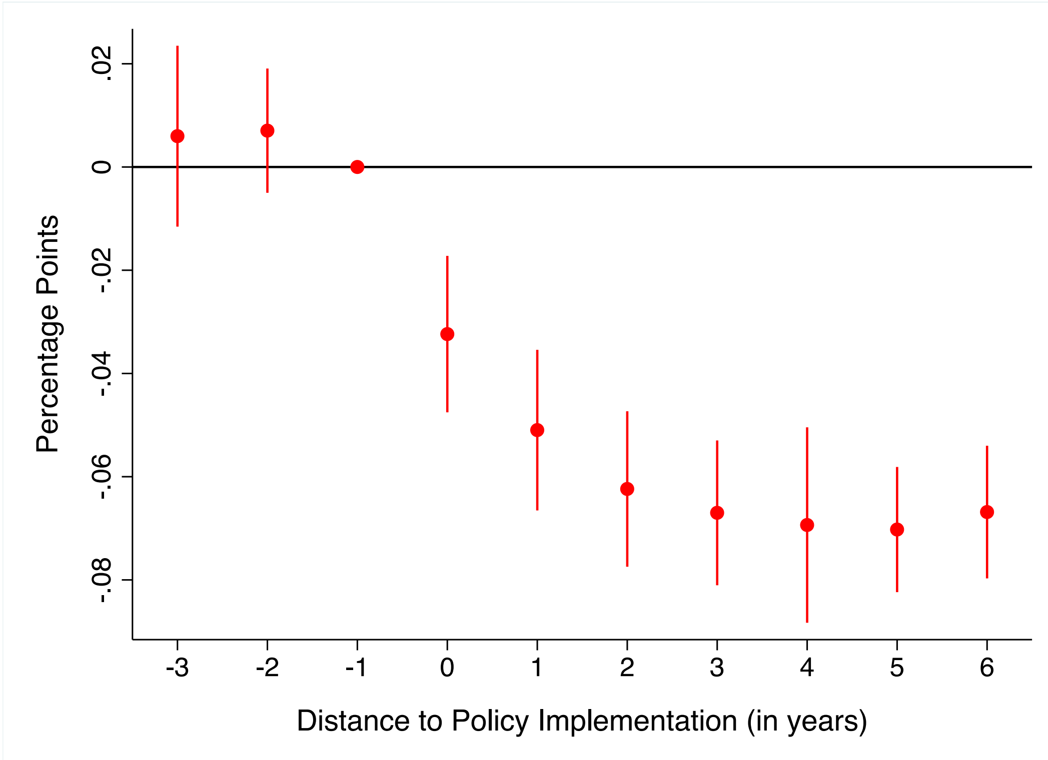
NOTES. - The quartiles are based on mothers' predicted risk of having an early elective delivery (EED); first quartile consisting of mothers with the lowest EED risk. Actual EED rate displays the share of EEDs among term births (at 37 weeks of gestation and beyond) within the quartile.

Figure 4: Actual Share and Predicted Risk of Early Elective Delivery (EED), 2008–2017



NOTES. - The actual EED rate reflects the share of early elective deliveries among all term births (at 37 weeks of gestation and beyond) for each year. The predicted EED risk is based on maternal characteristics and pregnancy conditions. The vertical line at 2010 marks the year before the Hard-Stop Policy is implemented.

Figure 5: The Effect of the Hard-Stop Policy on Early Elective Deliveries (EEDs)

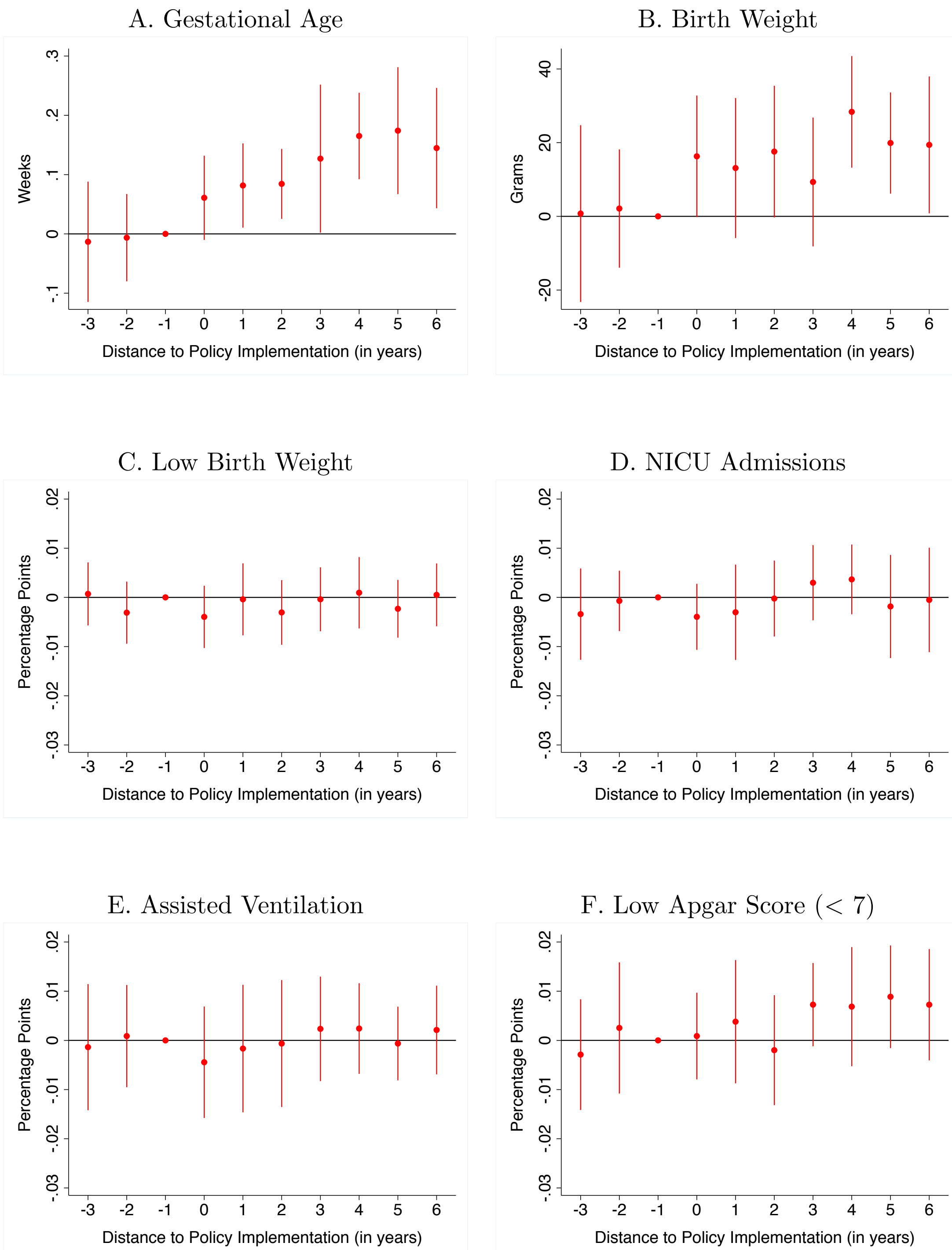


NOTES. - The event study is specified as follows;

$$H_{icy} = \alpha + \sum_{y=2008}^{2017} \sum_{q=2}^{4} \beta_{yq} \Big(\boldsymbol{I}(Year = y) \times Quart_q \Big) + \boldsymbol{\kappa X_{icy}} + \delta_c + \eta \big(County_c \times t_y \big) + \epsilon_{icy},$$

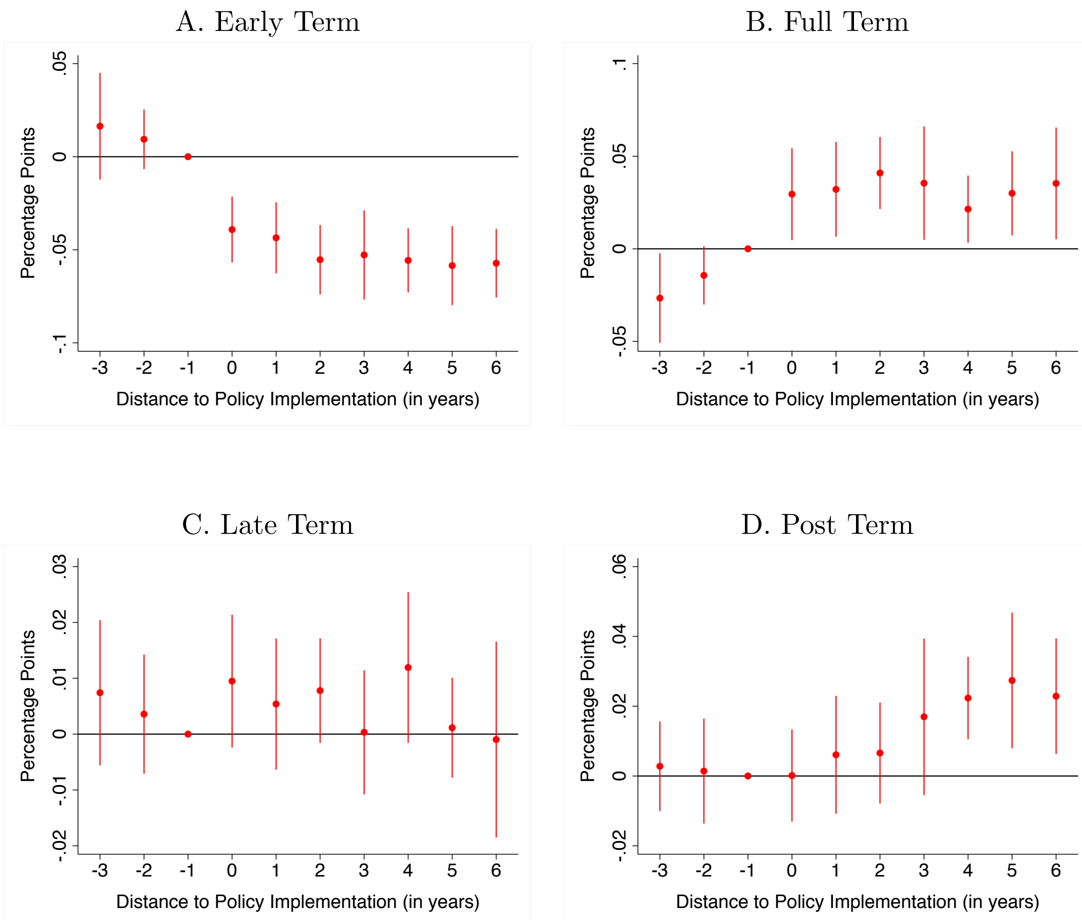
where H_{icy} denotes a birth outcome of delivery i occurring in county c, and in year y. The binary variable $\boldsymbol{I}(Year = y)$ turns if the observation belongs to the associated year and is interacted with $Quart_q$, which indicates mother's quartile based on her EED risk. Mothers with the lowest risk of EED (the first quartile) and the year before the Policy (2010) are excluded categories. The vector $\boldsymbol{X_{icy}}$ consists of maternal characteristics and pregnancy conditions. Maternal characteristics include mother's age, education, race, ethnicity, marital status, country of origin and smoking behavior. Pregnancy conditions include previous cesarean, breech position, birth order, number of prenatal care visits, and the month prenatal care began. I use county and year fixed effects, denoted by δ_c and θ_y, to account for baseline differences among counties and statewide temporal shocks. I also use month and day of the week fixed effects. The specification also includes county specific linear time trends, $\big(County_c * t_y\big)$ to allow differential pre-trends among counties. The vertical lines represent 95 percent confidence intervals.

Figure 6: The Effect of Hard-Stop Policy on Birth Outcomes



NOTES. - Same as Figure 5.

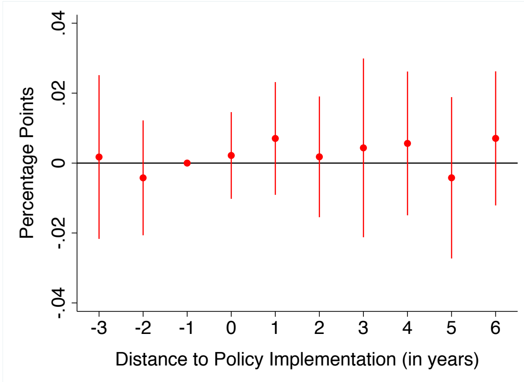
Figure 7: The Effect of the Hard-Stop Policy on Gestational Age Categories



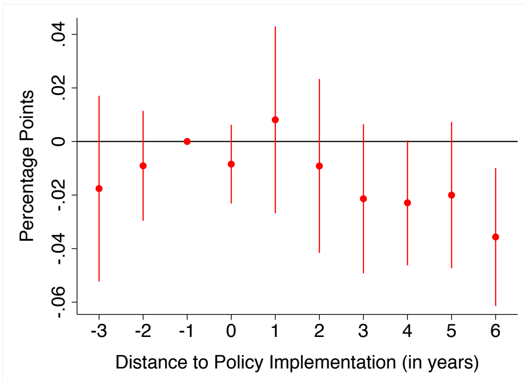
NOTES. - Same as Figure 5. Gestational age categories for term births follow; early term (37 and 38 weeks of gestation), full term (39 and 40 weeks of gestation), late term (41 weeks of gestation), and post term (42 weeks of gestation and beyond).

Figure 8: The Effect of the Policy on the Method of Delivery

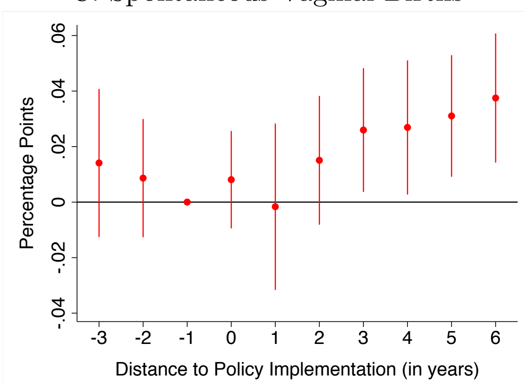
A. Cesarean Sections



B. Inductions

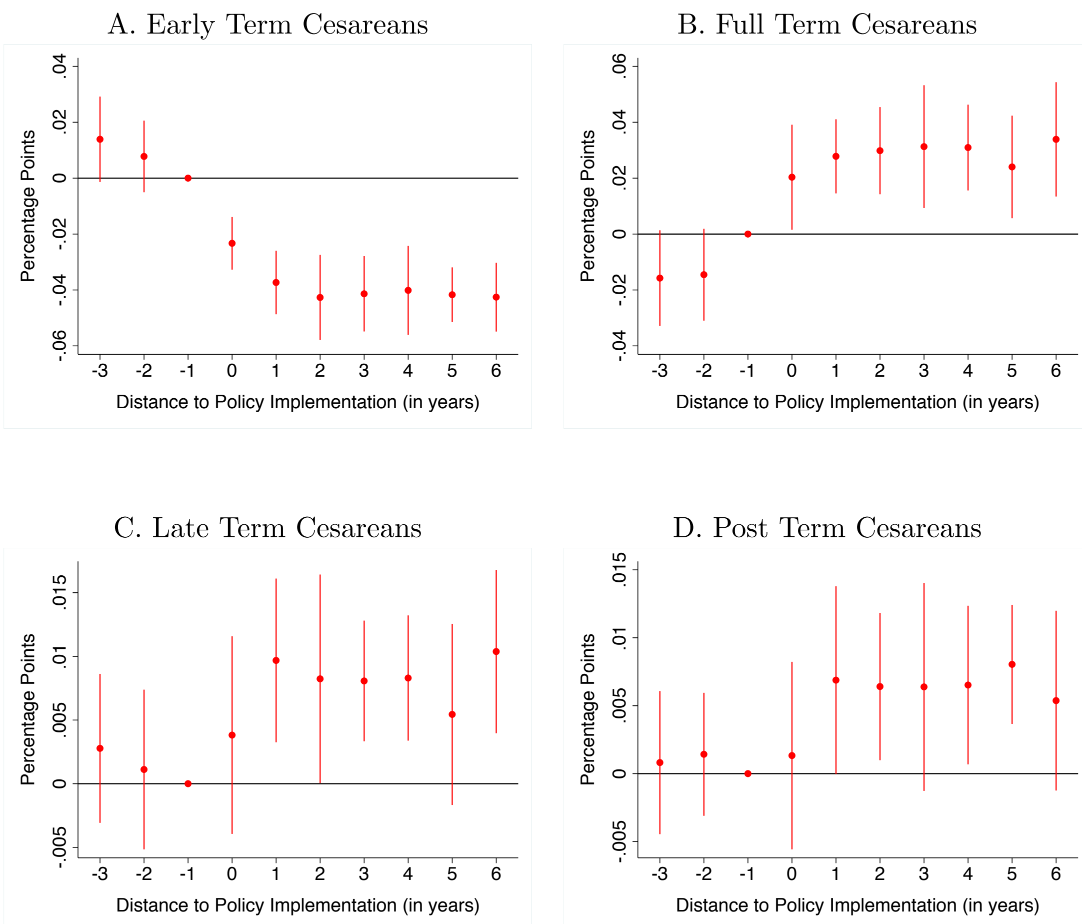


C. Spontaneous Vaginal Births



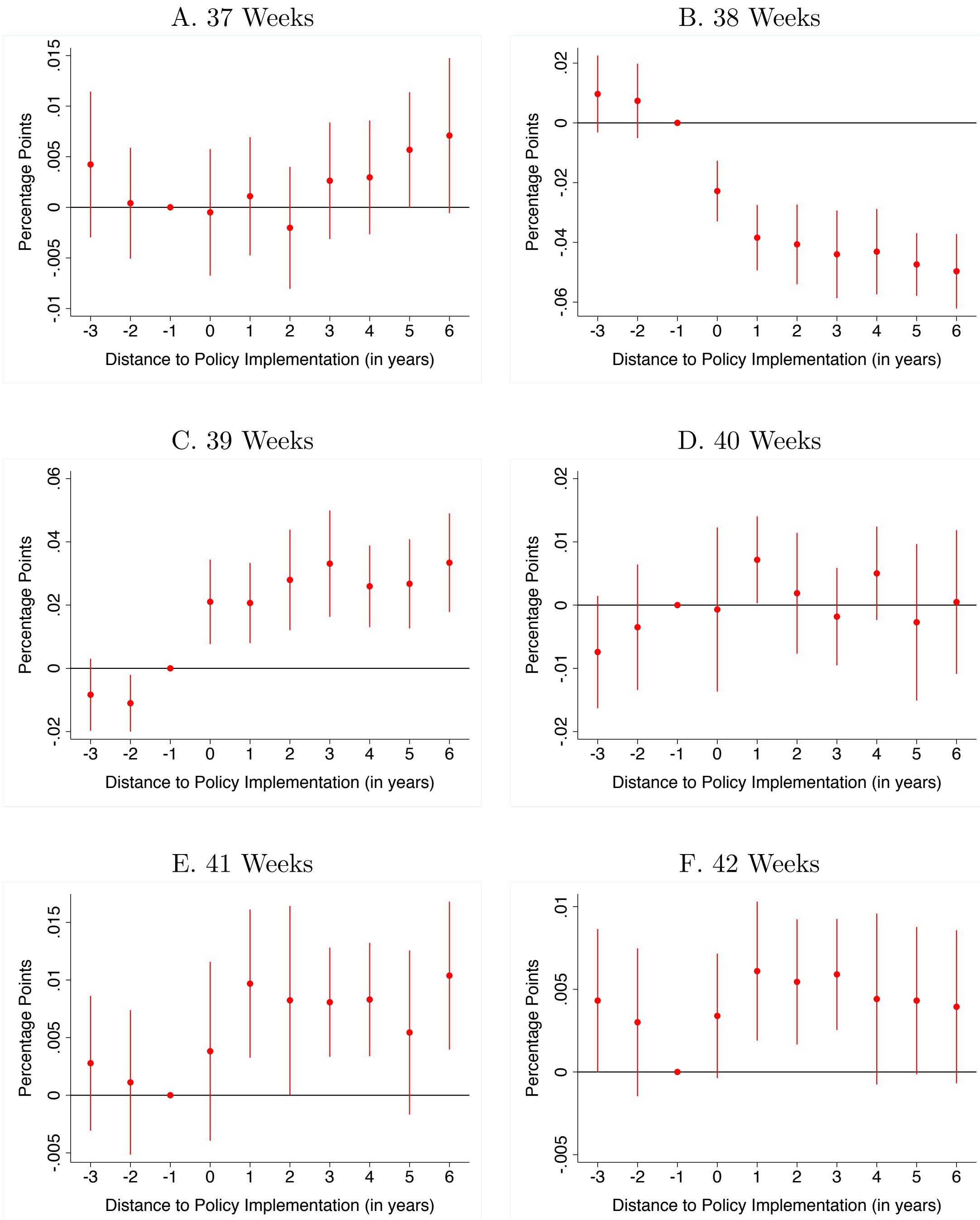
NOTES. - Same as Figure 5.

Figure 9: The Effect of the Hard-Stop Policy on Cesareans
by Gestational Age Categories



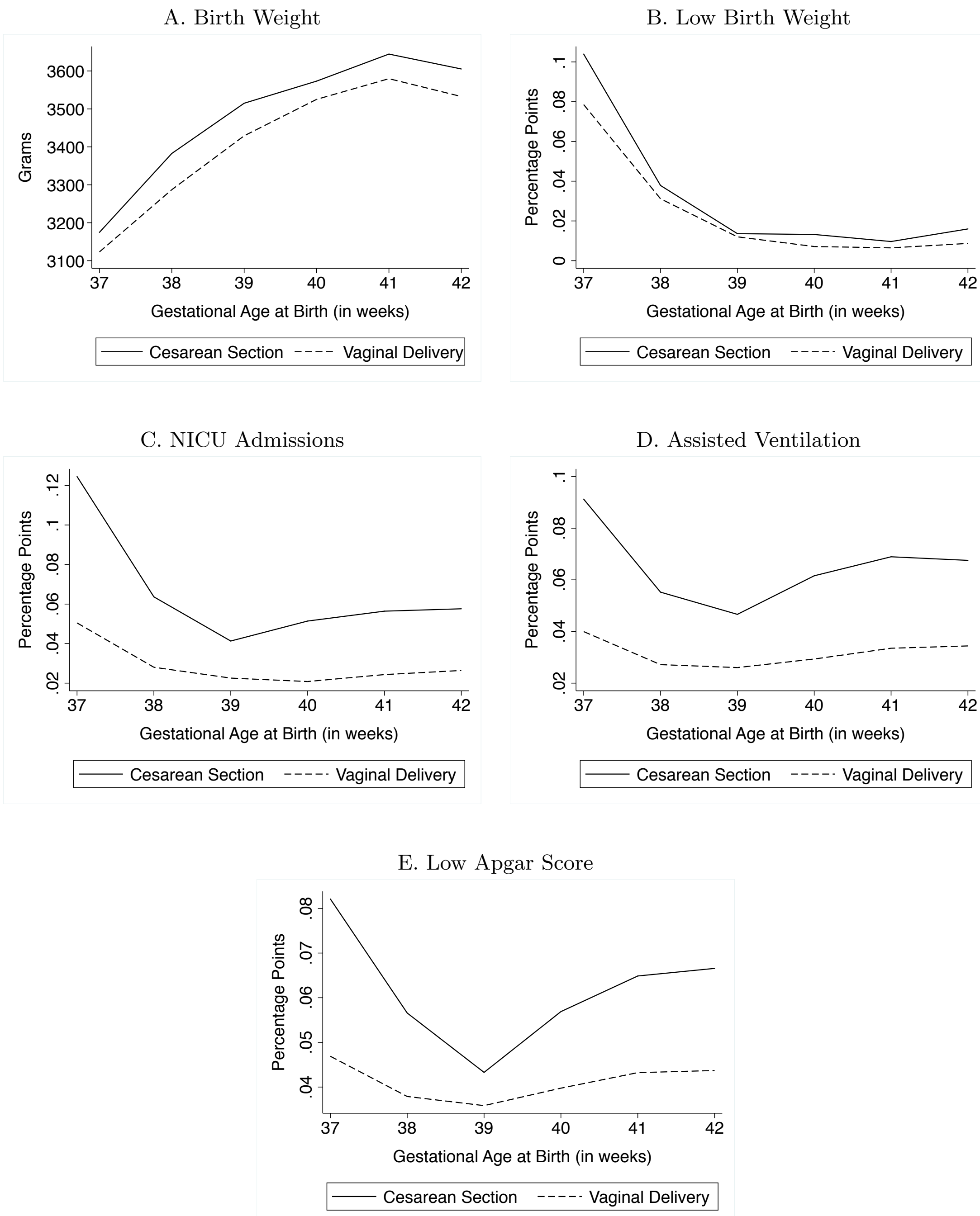
NOTES. - Same as Figure 5. The analysis includes all cesareans including the ones following an induction.

Figure 10: The Effect of Hard-Stop Policy on Cesarean Sections
by Gestational Age in Weeks



NOTES. - Same as Figure 5.

Figure 11: Birth Outcomes by Delivery Method and Gestational Age in Weeks



NOTES. - The Figure presents the prevalence of each outcome among all term (37 weeks of gestation and beyond) births.

Table 1: Summary Statistics

	Before Hard-Stop Policy (2008–2010)		After Hard-Stop Policy (2011–2017)	
	Mean	Standard Deviation	Mean	Standard Deviation
Share of Early Elective Deliveries	0.0896	0.0008	0.0655	0.0005
Early Elective Cesareans	0.0476	0.0006	0.0347	0.0004
Early Elective Inductions	0.0420	0.0006	0.0308	0.0003
Gestational Age at Birth (in weeks)	39.43	0.00	39.46	0.00
Birth Weight (in grams)	3451.20	1.34	3447.84	0.90
Low Birth Weight	0.0199	0.0004	0.0205	0.0003
NICU Admission	0.0329	0.0005	0.0346	0.0004
Assisted Ventilation	0.0370	0.0005	0.0379	0.0004
Low Apgar Score	0.0473	0.0006	0.0425	0.0004
Macrosomia	0.1118	0.0009	0.1114	0.0006
Mother's Age	27.63	0.02	28.61	0.01
Mother's Education				
Less than High School	0.2004	0.0012	0.1466	0.0007
High School Degree	0.2434	0.0012	0.2252	0.0008
Some College	0.2974	0.0013	0.3266	0.0009
College Degree	0.2588	0.0013	0.3016	0.0009
Mother's Race and Ethnicity				
White	0.8954	0.0009	0.8873	0.0006
Black	0.0262	0.0005	0.0300	0.0003
Asian / Pacific Islander	0.0585	0.0007	0.0644	0.0005
Hispanic Origin	0.0255	0.0005	0.0253	0.0003
Married	0.6414	0.0014	0.6418	0.0009
Smoking during Pregnancy	0.1146	0.0009	0.0993	0.0006
First Birth	0.4177	0.0014	0.4055	0.0009
Previous Cesarean	0.1179	0.0009	0.1337	0.0007
Breech Position	0.0350	0.0005	0.0322	0.0003
Observations	120,680	120,680	268,663	268,663

NOTES. - Data Source: Natality Data from the National Center of Health Statistics, 2008–2017. The means and standard deviations are calculated only for term births (37 weeks of gestation and beyond). An early elective delivery is defined as a cesarean or an induction occurring at the 37^{th} or 38^{th} week of pregnancy, in the absence of maternal hypertension and diabetes (both chronicle and gestational), preeclampsia, trial of labor, and any congenital anomalies of the newborn.

Table 2: The Effect of the Hard-Stop Policy on EEDs and Birth Outcomes

Outcome	2^{nd} Quartile	3^{rd} Quartile	4^{th} Quartile
Early Elective Delivery	-0.0057**	-0.0155***	-0.0630***
	(0.0025)	(0.0024)	(0.0052)
Gestational Age	0.0350*	0.0673***	0.1208***
	(0.0185)	(0.0228)	(0.0232)
Birth Weight	-0.2185	3.1260	16.8271**
	(3.8600)	(4.2767)	(6.3492)
Low Birth Weight	0.0004	0.0025*	-0.0006
	(0.0011)	(0.0013)	(0.0013)
NICU Admissions	0.0014	0.0009	0.0006
	(0.0014)	(0.0013)	(0.0024)
Assisted Ventilation	0.0020	-0.0006	-0.0002
	(0.0024)	(0.0025)	(0.0032)
Low Apgar Score	0.0040	0.0038	0.0044
	(0.0025)	(0.0028)	(0.0032)
Observations	389,343	389,343	389,343

NOTES. - The specification follows;

$$H_{icy} = \alpha + \sum_{q=2}^{4} \beta_q Post_y \times Quart_q + \sum_{q=2}^{4} \gamma_q Quart_q + \boldsymbol{\kappa X_{icy}} + \delta_c + \theta_y + \eta\big(County_c \times t_y\big) + \epsilon_{icy}$$

where H_{icy} denotes a birth outcome of delivery i occurring in county c, and in year y. The binary variable $Post_y$ turns on starting in 2011, as the Policy becomes effective. The timing of the Policy is interacted with $Quart_q$, which indicates mother's quartile based on her EED risk. Mothers with the lowest risk of EED, that is, assigned to the first quartile represent the excluded category. The vector $\boldsymbol{X_{icy}}$ consists of maternal characteristics and pregnancy conditions. Maternal characteristics include mother's age, education, race, ethnicity, marital status, country of origin and smoking behavior. Pregnancy conditions include previous cesarean, breech position, birth order, number of prenatal care visits, and the month prenatal care began. I use county and year fixed effects, denoted by δ_c and θ_y, to account for baseline differences among counties and statewide temporal shocks. I also use month and day of the week as two separate fixed effects. The specification also includes county specific linear time trends, $\big(County_c * t_y\big)$ to allow differential pre-trends among counties. I cluster standard errors at the county level. The coefficient of interest is β_q. For example, β_4 displays the difference in the outcome variable between the fourth and first quartile, that is, between mothers with the highest and lowest risk of having an early elective delivery, before and after the Policy. Robust standard errors are in parentheses. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$.

Table 3: The Effect of the Hard-Stop Policy on Gestational Age Categories

Outcome	2^{nd} Quartile	3^{rd} Quartile	4^{th} Quartile
Early Term	-0.0060	-0.0123***	-0.0599***
	(0.0044)	(0.0037)	(0.0053)
Full Term	-0.0008	-0.0021	0.0464***
	(0.0028)	(0.0040)	(0.0069)
Late Term	-0.0012	0.0028	0.0019
	(0.0032)	(0.0036)	(0.0030)
Post Term	0.0080**	0.0116***	0.0116**
	(0.0039)	(0.0041)	(0.0050)
Observations	389,343	389,343	389,343

NOTES. - Same as Table 2. Gestational age categories for term births follow; early term (37 and 38 weeks of gestation), full term (39 and 40 weeks of gestation), late term (41 weeks of gestation), and post term (42 weeks of gestation and beyond).

Table 4: The Effect of the Hard-Stop Policy on the Method and Timing of Delivery

Panel A. Cesarean Section

Outcome	2^{nd} Quartile	3^{rd} Quartile	4^{th} Quartile
All Term Cesarean Sections	0.0097**	0.0078**	0.0039
	(0.0038)	(0.0037)	(0.0056)
Early Term Cesarean Sections	-0.0029	-0.0041*	-0.0453***
	(0.0018)	(0.0020)	(0.0028)
Full Term Cesarean Sections	0.0078**	0.0051	0.0381***
	(0.0031)	(0.0038)	(0.0045)
Late Term Cesarean Sections	0.0019	0.0034*	0.0062**
	(0.0021)	(0.0020)	(0.0023)
Post Term Cesarean Sections	0.0029*	0.0034**	0.0049***
	(0.0014)	(0.0015)	(0.0017)

Panel B. Induction

Outcome	2^{nd} Quartile	3^{rd} Quartile	4^{th} Quartile
All Term Inductions	0.0016	-0.0063	-0.0050
	(0.0046)	(0.0083)	(0.0077)
Early Term Inductions	-0.0023	-0.0065**	-0.0145***
	(0.0027)	(0.0029)	(0.0044)
Full Term Inductions	0.0004	-0.0032	0.0084
	(0.0033)	(0.0056)	(0.0059)
Late Term Inductions	-0.0020	-0.0010	-0.0052**
	(0.0023)	(0.0027)	(0.0020)
Post Term Inductions	0.0055**	0.0044**	0.0062***
	(0.0023)	(0.0017)	(0.0018)

Panel C. Spontaneous Vaginal Delivery

Outcome	2^{nd} Quartile	3^{rd} Quartile	4^{th} Quartile
All Term Spontaneous Vaginal Deliveries	-0.0049	0.0051	0.0114
	(0.0036)	(0.0070)	(0.0090)
Early Term Spontaneous Vaginal Deliveries	-0.0008	-0.0008	0.0009
	(0.0043)	(0.0042)	(0.0034)
Full Term Spontaneous Vaginal Deliveries	-0.0082**	-0.0034	0.0046
	(0.0035)	(0.0063)	(0.0060)
Late Term Spontaneous Vaginal Deliveries	0.0016	0.0029	0.0030
	(0.0024)	(0.0027)	(0.0024)
Post Term Spontaneous Vaginal Deliveries	0.0024	0.0064**	0.0030
	(0.0036)	(0.0031)	(0.0035)
Observations	389,343	389,343	389,343

NOTES. - Same as Table 2. Gestational age categories for term births follow; early term (37 and 38 weeks of gestation), full term (39 and 40 weeks of gestation), late term (41 weeks of gestation), and post term (42 weeks of gestation and beyond).

Table 5: The Effect of the Hard-Stop Policy on EEDs and Birth Outcomes by Maternal Age

	Mother's Age				
Outcome	< 20	$20 - 25$	$25 - 30$	$30 - 35$	> 35
Early Elective Delivery	-0.0204 (0.0129)	-0.0486*** (0.0069)	-0.0659*** (0.0041)	-0.0756*** (0.0089)	-0.0870*** (0.0104)
Gestational Age	0.0964 (0.0649)	0.1148*** (0.0375)	0.1115*** (0.0391)	0.1249** (0.0468)	0.1197*** (0.0271)
Birth Weight	-7.5777 (17.5710)	11.7658 (11.5443)	14.9347 (10.3785)	26.4482*** (6.4792)	10.9032 (13.6969)
Low Birth Weight	0.0074 (0.0062)	0.0016 (0.0021)	-0.0034 (0.0025)	-0.0007 (0.0019)	0.0013 (0.0028)
NICU Admissions	0.0004 (0.0117)	-0.0020 (0.0049)	-0.0031 (0.0038)	0.0046 (0.0033)	0.0103*** (0.0032)
Assisted Ventilation	0.0032 (0.0068)	-0.0025 (0.0044)	-0.0031 (0.0037)	0.0028 (0.0038)	0.0042 (0.0040)
Low Apgar Score	0.0109 (0.0091)	0.0008 (0.0055)	0.0023 (0.0049)	0.0050 (0.0046)	0.0041 (0.0052)
Observations	25,289	84,263	114,446	104,058	60,966

NOTES. - Same as Table 2. Each point estimate is from a separate regression for the associated outcome and subgroup, and reflects β_4 of Equation (11), that is, the effect on the fourth quartile (mothers with the highest EED risk) compared to the first quartile (mothers with the lowest EED risk).

Table 6: The Effect of the Hard-Stop Policy by Maternal Education

	Mother's Education			
Outcome	Less than High School	High School Degree	Some College	College Degree
Early Elective Delivery	-0.0644***	-0.0558***	-0.0699***	-0.0748***
	(0.0083)	(0.0059)	(0.0057)	(0.0081)
Gestational Age	0.1786***	0.1259***	0.1606***	0.0995***
	(0.0429)	(0.0279)	(0.0360)	(0.0292)
Birth Weight	33.6165***	19.9953**	2.9841	37.1549***
	(11.5592)	(7.7044)	(8.9599)	(9.7882)
Low Birth Weight	0.0010	-0.0037	0.0018	-0.0026
	(0.0041)	(0.0035)	(0.0017)	(0.0022)
NICU Admissions	0.0047	-0.0041	-0.0019	0.0033
	(0.0054)	(0.0035)	(0.0032)	(0.0059)
Assisted Ventilation	0.0024	-0.0059	0.0022	-0.0022
	(0.0040)	(0.0036)	(0.0041)	(0.0052)
Low Apgar Score	0.0091	-0.0000	0.0019	0.0004
	(0.0067)	(0.0040)	(0.0047)	(0.0064)
Observations	63,502	89,878	123,622	112,270

NOTES. - Same as Table 2. Each point estimate is from a separate regression for the associated outcome and subgroup, and reflects β_4 of Equation (11), that is, the effect on the fourth quartile (mothers with the highest EED risk) compared to the first quartile (mothers with the lowest EED risk).

Table 7: The Effect of the Hard-Stop Policy by Maternal Race

	Mother's Race			
Outcome	White	Black	Alaskan Native	Asian
Early Elective Delivery	-0.0648***	-0.1115***	-0.0996***	-0.0721***
	(0.0056)	(0.0249)	(0.0190)	(0.0088)
Gestational Age	0.1154***	0.3158***	0.2734*	0.2205***
	(0.0246)	(0.0824)	(0.1440)	(0.0264)
Birth Weight	17.4361***	2.9484	-0.0209	23.6501
	(5.9977)	(40.9500)	(31.2830)	(21.4450)
Low Birth Weight	-0.0003	-0.0051	-0.0208**	0.0052
	(0.0014)	(0.0074)	(0.0097)	(0.0052)
NICU Admissions	0.0007	0.0286**	-0.0055	-0.0051
	(0.0027)	(0.0097)	(0.0136)	(0.0056)
Assisted Ventilation	0.0010	-0.0069	0.0023	-0.0128*
	(0.0029)	(0.0092)	(0.0187)	(0.0072)
Low Apgar Score	0.0040	0.0078	0.0015	-0.0106**
	(0.0031)	(0.0064)	(0.0217)	(0.0051)
Observations	346,454	10,884	7,072	24,096

NOTES. - Same as Table 2. Each point estimate is from a separate regression for the associated outcome and subgroup, and reflects β_4 of Equation (11), that is, the effect on the fourth quartile (mothers with the highest EED risk) compared to the first quartile (mothers with the lowest EED risk).

Table 8: The Effect of the Hard-Stop Policy by Day of the Weekday

	Day of the Week	
Outcome	Weekday	Weekend
Early Elective Delivery	-0.0696*** (0.0060)	-0.0286*** (0.0078)
Gestational Age	0.1499*** (0.0234)	0.0398 (0.0580)
Birth Weight	16.6201* (8.6283)	14.3812* (7.5946)
Low Birth Weight	-0.0022* (0.0013)	-0.0006 (0.0027)
NICU Admissions	0.0001 (0.0031)	0.0004 (0.0056)
Assisted Ventilation	-0.0010 (0.0034)	0.0028 (0.0050)
Low Apgar Score	0.0043 (0.0034)	-0.0004 (0.0044)
Observations	302,444	86,782

NOTES. - Same as Table 2. Each point estimate is from a separate regression for the associated outcome and subgroup, and reflects β_4 of Equation (11), that is, the effect on the fourth quartile (mothers with the highest EED risk) compared to the first quartile (mothers with the lowest EED risk).

Table 9: Robustness Checks

	Model						
Outcome	Baseline	(1)	(2)	(3)	(4)	(5)	(6)
Early Elective Delivery	-0.0630***	-0.0083	-0.0555***	-0.0331***	-0.0637***	-0.0388***	-0.0652***
	(0.0052)	(0.0058)	(0.0050)	(0.0028)	(0.0076)	(0.0030)	(0.0059)
Gestational Age	0.1208***	-0.0758*	0.1159***	0.1528***	0.1081***	0.1022***	0.0749***
	(0.0232)	(0.0401)	(0.0245)	(0.0241)	(0.0247)	(0.0238)	(0.0106)
Birth Weight	16.8271**	-20.2526*	16.8134**	14.3616***	18.4108**	7.9022	17.4293**
	(6.3492)	(11.4012)	(6.1491)	(4.9106)	(7.4064)	(4.6948)	(7.4127)
Low Birth Weight	-0.0006	0.0043**	-0.0002	0.0005	-0.0014	0.0011	-0.0007
	(0.0013)	(0.0018)	(0.0013)	(0.0014)	(0.0017)	(0.0014)	(0.0015)
NICU Admission	0.0006	0.0002	0.0018	0.0025	0.0003	0.0015	0.0005
	(0.0024)	(0.0039)	(0.0031)	(0.0030)	(0.0027)	(0.0034)	(0.0024)
Assisted Ventilation	-0.0002	0.0097	0.0007	0.0031	0.0002	-0.0012	-0.0000
	(0.0032)	(0.0066)	(0.0031)	(0.0034)	(0.0032)	(0.0035)	(0.0033)
Low Apgar Score	0.0044	-0.0040	0.0037	0.0037	0.0041	0.0043	0.0055
	(0.0032)	(0.0096)	(0.0032)	(0.0030)	(0.0034)	(0.0033)	(0.0033)
Observations	389,343	389,345	389,493	389,493	384,560	328,376	359,544

NOTES. - Same as Table 2. Each point estimate is from a separate regression for the associated outcome and subgroup, and reflects β_4 of Equation (11), that is, the effect on the fourth quartile (mothers with the highest EED risk) compared to the first quartile (mothers with the lowest EED risk).

Each column presents the results of a different model, where;
(1) Occurrence County is used as the only predictor.
(2) Previous cesarean and breech presentation are excluded as predictors of EED risk.
(3) Previous Cesarean and breech presentation are considered as medical conditions justifying EED.
(4) Clinical estimation (instead of last menstrual period) of gestational age is used to determine gestational age at birth.
(5) Mothers with previous cesarean and breech babies are excluded from the sample.
(6) Post term deliveries are excluded from the sample.

Table 10: Falsification Checks: The Effect of the Policy on Placebo Outcomes

Outcome	2nd Quartile	3rd Quartile	4th Quartile
Breech Position	-0.0000**	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)
Smoking	-0.0000**	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)
Pre-Pregnancy Diabetes	0.0007	0.0005	0.0013
	(0.0010)	(0.0010)	(0.0018)
Observations	389,343	389,343	389,343

NOTES. - Same as Table 2. Each point estimate is from a separate regression for the associated outcome and subgroup, and reflects β_4 of Equation (11), that is, the effect on the fourth quartile (mothers with the highest EED risk) compared to the first quartile (mothers with the lowest EED risk).

Appendix

A Covariates of Early Elective Delivery

Table A1: Covariates of Early Elective Delivery, 2008-2010
(# of Observations: 389,343)

Mother's Age		Day of the Week	
Less than 20	0.0068** (2.05)	Monday	0.0123*** (4.08)
Between 20 and 25	0.0054** (2.38)	Tuesday	0.0206*** (6.57)
Between 25 and 30	Reference Category	Wednesday	0.0227*** (6.68)
Between 30 and 35	0.0031 (1.19)	Thursday	0.0247*** (7.48)
More than 35	0.0122*** (2.69)	Friday	0.0315*** (7.60)
Mother's Education		Saturday	0.0068*** (2.84)
Less than High School	-0.0033 (-0.86)	Sunday	Reference Category
High School Degree	Reference Category	Attendant	
Some College	0.0068** (2.42)	Doctor of Medicine	Reference Category
College Degree	0.0015 (0.72)	Doctor of Osteopathy	0.0012 (0.23)
Mother's Race		Certified Nurse Midwife	-0.0365*** (-7.31)
White	Reference Category	Previous Cesarean	0.0668*** (8.89)
Black	0.0049 (1.00)	# of Previous Cesareans	0.0164*** (6.96)
Alaskan Native	0.0068** (2.42)	Breech Position	0.0821*** (13.13)
Asian	0.0015 (0.72)	First Birth	-0.0477*** (-8.38)
Prenatal Care Visits		Care began 1^{st} Trimester	0.0258*** (12.18)
No Visits	-0.0153 (-1.08)	Smoking	0.0004 (0.10)
Less than 9 Visits	0.0256*** (5.20)	Mother born in the U.S.	0.0155** (2.57)
Between 10 and 16 Visits	Reference Category	Hispanic Origin	-0.0080*** (-2.65)
More Than 16 Visits	-0.0139*** (-3.00)		

NOTES. - The specification follows; $EED_{ict} = \alpha + \boldsymbol{\beta X_{ict}} + \gamma_c + \delta_t + \epsilon_{ict}$. The logistic regression uses pre-policy years (2008 to 2010), where the binary variable EED_{ict} is equal to one, if the delivery i, in county c, at time t is early and elective. The vector $\boldsymbol{X_{ict}}$ consists of maternal characteristics and pregnancy conditions. Maternal characteristics include mother's age, education, race, ethnicity, marital status, country of origin and smoking behavior. Pregnancy conditions include previous cesarean, breech position, birth order, number of prenatal care visits, and the month prenatal care began. County fixed effects and time fixed effects (month and day of the week) by γ_c and δ_t. I cluster robust standard errors at the county level. z-values are in parentheses. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

B Continuous Measure of Predicted EED Risk

Table B1: The Effect of the Hard-Stop Policy on EEDs and Birth Outcomes

Outcome	
Early Elective Delivery	-0.3571*** (0.0312)
Gestational Age	0.5176*** (0.0800)
Birth Weight	94.5114*** (24.3979)
Low Birth Weight	-0.0088* (0.0046)
NICU Admissions	-0.0024 (0.0110)
Assisted Ventilation	-0.0017 (0.0171)
Low Apgar Score	0.0100 (0.0101)
Observations	389,343

NOTES. - The specification follows;

$$H_{icy} = \alpha + \beta Post_y * Risk_{eed_i} + \gamma Risk_{eed_i} + \boldsymbol{\kappa X_{icyq}} + \delta_c + \theta_{yq} + \eta\big(County_c * t_{yq}\big) + \epsilon_{icyq}$$

where H_{icy} denotes a birth outcome of delivery i occurring in county c, and in year y. The binary variable $Post_y$ turns on starting in 2011, as the Policy becomes effective. The timing of the Policy is interacted with $Risk_{eed}$, a continuous measure of EED risk ranging between 0 and 1. The vector $\boldsymbol{X_{icy}}$ consists of maternal characteristics and pregnancy conditions. Maternal characteristics include mother's age, education, race, ethnicity, marital status, country of origin and smoking behavior. Pregnancy conditions include previous cesarean, breech position, birth order, number of prenatal care visits, and the month prenatal care began. I use county and year fixed effects, denoted by δ_c and θ_y, to account for baseline differences among counties and statewide temporal shocks. I also use month and day of the week as two separate fixed effects. The specification includes county specific linear time trends, $\big(County_c * t_y\big)$ to allow differential pre-trends among counties. Robust standard errors clustered at the county level are in parentheses. $^*p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

The coefficient of interest is β and reflect the Policy's effect as the predicted EED risk goes from 0 to 1. In other words, it demonstrates the effect of the Policy on a mother, who would definitely have an EED in the absence of the Policy.

Table B2: The Effect of the Hard-Stop Policy on the Method and Timing of Delivery

Panel A. Cesarean Section	
Outcome	
All Term Cesarean Sections	0.0147 (0.0365)
Early Term Cesarean Sections	-0.3225*** (0.0257)
Full Term Cesarean Sections	0.2684*** (0.0394)
Late Term Cesarean Sections	0.0453*** (0.0101)
Post Term Cesarean Sections	0.0235*** (0.0079)
Panel B. Induction	
Outcome	
All Term Inductions	-0.0078 (0.0436)
Early Term Inductions	-0.0115 (0.0145)
Full Term Inductions	0.0228 (0.0294)
Late Term Inductions	-0.0265*** (0.0057)
Post Term Inductions	0.0074*** (0.0026)
Panel C. Spontaneous Vaginal Delivery	
Outcome	
All Term Spontaneous Vaginal Deliveries	0.0379 (0.0385)
Early Term Spontaneous Vaginal Deliveries	0.0168 (0.0108)
Full Term Spontaneous Vaginal Deliveries	0.0106 (0.0243)
Late Term Spontaneous Vaginal Deliveries	0.0058 (0.0088)
Post Term Spontaneous Vaginal Deliveries	0.0046 (0.0100)
Observations	389,343

NOTES. - Same as Table B1. Gestational age categories for term births follow; early term (37 and 38 weeks of gestation), full term (39 and 40 weeks of gestation), late term (41 weeks of gestation), and post term (42 weeks of gestation and beyond).