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Convenience Effect on Birth Timing Manipulation: Evidence from Brazil

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Dissertação de Mestrado apresentada ao Programa de Pós-Graduação em Economia da Indústria e Tecnologia, Instituto de Economia, Universidade Federal do Rio de Janeiro, como requisito parcial à obtenção do título de Mestre em Economia

Orientador: Rudi Rocha de Castro

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Resumo

SPINOLA, Paula de Souza Leão, **Convenience Effect on Birth Timing Manipulation: Evidence from Brazil**. Dissertação (Mestrado em Economia da Indústria e Tecnologia) – Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.

Neste estudo, investigamos se motivações de conveniência desempenham papel relevante na manipulação do momento de nascimento no Brasil. Construímos painéis de nascimentos por hospitais com o intuito de verificar se existe deslocamento de partos de dias inconvenientes para dias convenientes. Os resultados mostram que partos de baixo risco que teriam ocorrido espontaneamente em dias inconvenientes são antecipados para dias convenientes, principalmente através do agendamento de cesarianas. Interpretamos tal resultado no âmbito de hospitais de financiamento público como uma forte evidência do efeito de conveniência de médicos na manipulação do momento de nascimento uma vez que as mulheres normalmente não participam do processo de tomada de decisão e os médicos não enfrentam outros incentivos para induzir partos cesáreos - tais como motivações financeiras ou medo de litígio.

Palavras-chave: Economia da saúde, Cesariana – Parto, Efeito conveniência.

Abstract

SPINOLA, Paula de Souza Leão, **Convenience Effect on Birth Timing Manipulation: Evidence from Brazil**. Dissertação (Mestrado em Economia da Indústria e Tecnologia) – Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.

In this study, we investigate whether convenience motivations play any relevant role in birth timing manipulation in Brazil. We construct daily panels of births by hospitals in order to verify if deliveries have been shifted from inconvenient to convenient days. We find that low-risk births that would have otherwise occurred after spontaneous labor on inconvenient days are anticipated to convenient days mainly through the scheduling of cesarean sections. We argue that such finding within the public healthcare system consists of strong evidence on physicians' convenience effect as women normally do not participate in the decision-making process and physicians face no other incentives to induce cesarean deliveries – such as financial motives or fear of litigation.

Keywords: Health economics, Cesarean section (c-section), Convenience effect.

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1 Introduction

According to the United Nations Children's Fund, Brazil ranked first place with the highest cesarean section rate among 139 countries in the world for the period of 2007-2012.[1] In 2009, the number of surgical births surpassed those occurred through the vaginal canal. During the years of 2012-2014, cesarean delivery (CD) corresponded to 57% of all registered births in the country. CD rates were 42% and 89% of all births occurred in public and private funded hospitals, respectively. Another less but still invasive medical intervention is labor induction. This is a technique used to bring on or speed up contractions and thus anticipate vaginal births. For the period of 2012-2014, 33% of all registered normal deliveries in the country occurred after induced labor. The induction rates among vaginal births were 31% in public funded health facilities, and 46% in private funded units. In other words, only 29 out of 100 births in Brazil occurred according to the way nature intended, through a spontaneous (non-induced) vaginal delivery. In private funded health facilities, this corresponded to only 6 out of 100 births.[2]

Such medical interventions (CD and labor induction) allow for manipulation in the timing of birth. Although birth timing can be altered due to medical reasons (e.g., when labor could be dangerously stressful or in case of post-term pregnancies), the existing evidence suggests that it is also manipulated for reasons other than the health of the fetus or of the mother. Mothers' incentives to intervene in the timing of their deliveries are usually financial when compensations are involved, such as baby bonuses (Gans and Leigh, 2009a) or tax savings (Dickert-Conlin and Chandra, 1999), or even related to cultural issues (Lo, 2003). Doctors' incentives tend to be determined by risk aversion (Fabbri et. al, 2015) or convenience (Gans et al., 2007) motives. In addition, physicians' incentives to perform CD unrelated to timing could also induce birth timing manipulation since the latter increases significantly the likelihood of this method of delivery.

Causal evidence of physicians' convenience effect on birth timing manipulation is very challenging to identify. As far as we know, Gans et al. (2007) is the only study to provide evidence on it. The authors explore the impact of annual obstetricians and gynecologists' conference on the number of births in the United States and Australia and show that the number of births is systematically lower during the conference days. The

[1] Source: http://data.un.org/Data.aspx?q=cesarean&d=SOWC&f=inID%3a219

[2] CD rates extracted from the Brazilian National System of Information on Birth Records (Datasus/SINASC).

authors also point to evidence suggesting that births are anticipated to the period preceding conferences in the US. However, no evidence on the mechanisms is provided as they do not have data on type of birth procedure.

Other important studies to investigate the physicians' behavior in birth timing manipulation are Brown (1996) and Lefèvre (2014). The authors test for concentration of unplanned CD at convenient times. Unplanned CD occur after spontaneous labor and thus should be uniformly distributed in case there are no incentives other than the medical protocol operating. As mothers arrive randomly after the onset of labor, a concentration of unplanned CD at convenient times would reveal physicians' incentives. Brown (1996) points to a higher probability of unplanned CD on Fridays from 3 to 9pm in the US. Lefèvre (2014) finds evidence of a small increase on the likelihood of unplanned CD for the period surrounding Monday public holidays (starting 7 days before it and ending 7 days afterwards). As she finds no effects for the public holidays itself, the increase comes from the periods before and/or after them. Both findings suggest that physicians induce CD in the labor room during convenient moments. Thus, physicians' convenience motivations as well as other incentives correlated to convenient moments could be at play.

Convenient times usually coincide with times when it might be safer to deliver. It is also during non-leisure days and usual business hours that the largest capacity of hospital staff is on-shift and medical staff is fresher. If this is the case, then doctors who are risk-averse or altruistic might have preferences to allocate complex deliveries on those moments when risk can be minimized. Fabbri et al. (2015) provide evidence of risk aversion attitudes for a sample of women admitted at the onset of labor in a public hospital in Italy. Although the admission should be distributed homogeneously across time, they show that the higher the level of risk involved, the lower is the probability that the delivery occurs in late night and early morning shifts. Those are 'inconvenient' shifts, also believed to be times when the hospital is less prepared to receive high-risk cases.

Risk aversion attitudes could also lead physicians to avoid the manipulation of high-risk births for non-medical reasons. Schulkind and Shapiro (2014) show that the higher the likelihood of having the birth anticipated, the greater is probability of newborns having low birth weight and smaller 5th minute APGAR. Borra et al. (2016a) and Borra et al. (2016b) examine the effect on neonatal and longer-term health outcomes and show evidence of an increase in the newborn's hospitalization rates during the first 3 weeks of life as well as during their first 33 months of life. Thus, risk aversion attitudes can act in favor and against manipulation of birth timing.

The goal of this paper is to test whether convenience effects play any relevant role in birth timing manipulation in Brazil. More specifically, we investigate if births that would have occurred after spontaneous labor during inconvenient times are anticipated to convenient times. We intend to isolate the convenience effect from potential risk aversion attitudes and physicians' demand for CD (irrespective of timing) by adopting a few strategies. First, we propose a new type of inconvenient days that may attenuate risk aversion attitudes in manipulating the timing of births: business days in-between holidays. As these are business days, hospitals should be fully-staffed. However, risk-averse physicians may still manipulate the timing of births in order to eliminate the possibility of women going spontaneously into labor on the surrounding leisure days. Second, we analyze our results by hospital funding. Public funded hospitals provide a context where physicians have no incentives to perform CD and women do not actively participate in the decision-making process. This scenario enables us to isolate the physicians' convenience and risk aversion motivations from physicians' induced demand for CD. Third, we further investigate our results by level of risk. While birth timing manipulation motivated by convenience should happen mostly among low-risk births, timing manipulation guided by risk aversion should be concentrated in high-risk births – as in this case the goal is to minimize the risk of low quality hospital services.

Our main source of data is the Brazilian National System of Information on Birth Records (Datasus/SINASC), which includes high quality variables such as indicators of induced labor and CD before labor. We construct a daily panel of births by hospitals and match it with monthly data from the National Registration of Health Facilities (Datasus/CNES). This allows us to extract information on hospital funding. We focus on the period of 2012-2014.

We find that births that would have otherwise occurred through non-induced vaginal deliveries and CD after spontaneous labor on inconvenient days in public funded hospitals were anticipated mainly through planned CD. The timing manipulation comes from low-risk births, which indicates that births are being anticipated due to physicians' convenience purposes. Regarding private funded hospitals, all of the anticipated births would have otherwise occurred through unplanned CD on inconvenient days. This finding eliminates the possibility of physicians' induced demand for CD (irrespective of timing) confounding our results. Although the anticipation of deliveries is concentrated among low-risk births, there also exists timing manipulation of high-risk births. Thus, in this case risk aversion attitudes could confound our interpretations of convenience effects. Moreover, it is also difficult to argue that the convenience motivations are guided by physicians since mothers may also play a role throughout the decision-making process within the private healthcare system.

This study contributes to the literature of birth timing manipulation and physicians' demand for leisure effects in different ways. First, we believe to have isolated the convenience effect in a cleaner way. Second, the results are based on a high quality dataset, which covers the universe of all registered births in the country, includes direct information on the nature of labor and is not linked to physicians' remuneration. Most studies use information from subjective hospital records' diagnosis, which usually involves incentives to fraud and only cover a sample of deliveries (Lefèvre, 2014; Fabbri et al., 2015). Third, as far as we know this is the first study to investigate convenience causal effects in the country with the highest CD rate in the world.

The remainder of the paper is organized as follows. Section 2 explores the conceptual background within the theory, the empirical literature and our institutional setting. Section 3 describes the data. Section 4 presents our methodology. Section 5 reports our results, and the final section concludes.

2 Conceptual Background

2.1 Method of Delivery, Nature of Labor, and Expected Timing of Birth

Births can occur through two different procedures, CD or normal delivery. The first is a surgical procedure in which delivery occurs through incisions made in the mother's abdomen and uterus. The second one is a physiological process through which the baby is pushed outwards by the labor process. Labor by its turn can be categorized by uterine contractions followed by cervical dilatation. CD can occur before or after labor whereas normal deliveries can only occur after the onset of labor.

CD can be recommended in advance for medical reasons (e.g. mother's chronic conditions or infections in the vaginal canal, fetal position) or after spontaneous labor in case of failure in the progress or complications (e.g. uterine rupture, fetal distress). The first case is usually scheduled for the period around the due date, and thus is called planned or scheduled CD. The second is called unplanned or emergency CD as it is not anticipated before the onset of labor. In case of post-term pregnancies or other reasons that make it riskier for the baby to remain inside the mother's uterus, and considering that a CD is not medically required (e.g. although it is not always the case, a large baby can also be a medical reason for a CD), labor should be induced through medications or other methods. Hence, labor induction can be also scheduled for medical reasons. Although labor is only induced when a normal delivery is intended, an emergency CD could still take place. Finally, elective CD and elective labor induction can be performed without any medical reason, due to mothers' or physicians' incentives, and can be planned in advance (planned or scheduled CD) or decided in the labor room (unplanned CD).

There are five combinations between method of delivery and nature of labor: (i) CD before labor, (ii) CD after induced labor, (iii) CD after spontaneous labor, (iv) normal delivery after induced labor (also known as induced vaginal delivery) and (v) normal delivery after spontaneous labor (also known as non-induced vaginal delivery).

Regarding the expected timing of birth, CD before labor allows for the greatest manipulation once it does not depend on the process of labor. Indeed, this is a birth procedure inherently associated with timing manipulation once it is mostly scheduled. Labor induction also provides the physicians with some control over the timing of births around the final period of pregnancies as they allow for the anticipation or acceleration of labor. Thus, CD after induced labor and, in a lesser extent, induced vaginal deliveries also allow for timing intervention. In contrast, non-induced vaginal deliveries allow for no timing manipulation once no medical technology is involved throughout the process. Non-induced vaginal births are thus expected to follow the nature's uniform distribution. Finally, CD after spontaneous labor allows for some manipulation as the physiological process of labor can be interrupted at any time through surgical incisions. Although complications during spontaneous labor could prompt an emergency CD, they should also be randomly distributed while elective CD after labor can be decided at any time.

Regular business hours are arguably more convenient than off-hours on leisure days for both physicians and mothers. However, a concentration of procedures that allow for scheduling (CD before labor or after induced labor and, in a lesser extent, induced vaginal deliveries) at convenient times does not necessarily imply that convenience is the reason behind the fact. Medical issues or other physicians' and mothers' incentives could be the real factors inducing those birth procedures and the manipulation of their timing. On the other hand, a concentration of unplanned CD among women that labored during convenient times (e.g. end of the physicians' shift) constitutes evidence of induced demand for this method of delivery in the labor room. In particular, as women arrive randomly after the onset of labor, there should be no selection of women with preferences for CD arriving at convenient times. Hence, the induced demand for CD at the labor room should be attributed exclusively to physicians. In order to isolate the convenience effect we need to make sure that other incentives correlated to convenient moments are not operating simultaneously.

Convenient times are usually coincidentally safer times to deliver. During non-leisure days and usual business hours, hospitals operate with larger staff capacity and the staff is fresher. Physicians should have incentives to shift complex birth procedures to moments when risk can be minimized. Thus, a concentration of invasive procedures during convenient times may be justified by convenience or risk aversion motivations. On the other hand, physicians' risk aversion attitudes should avoid the manipulation of high-risk births for non-medical reasons (e.g. in order to suit their own convenience or the parents' preferences). This could increase the inherent risk (e.g. higher probability of low birth weight). Therefore, risk aversion attitudes may act in both directions.

Parents may also intervene in birth timing manipulation due to non-medical motives in case they extract positive utility from such manipulation. This could be the case whenever related financial compensations are in place. When the threshold of eligibility periods for financial compensations falls within the final period of pregnancies, mothers have incentives to shift the timing of their delivery in order to qualify for the benefit. Besides, parents might also respond to cultural beliefs in case they have preferences to allocate (avoid) their deliveries on specific dates, such as auspicious (inauspicious) days.

The timing of births may be manipulated by inducing labor or scheduling CD. Inducing labor is only possible close to the period women would spontaneously go into labor whereas CD can be performed at any time since it does not depend on the process of labor. Given the flexibility it provides, manipulation tends to occur through the performance of CD (either directly scheduling it or performing it after trying to induce labor without success). Thus, physicians might rely on the timing manipulation of births in order to assure the performance of CD in case they have incentives for this method of delivery regardless of the timing the birth takes place. In this case, birth timing manipulation would work as a mean to induce CD. If birth timing manipulation comes through a change in the method of delivery from vaginal birth to CD in contexts where physicians have incentives to perform this method of delivery, physicians' induced demand for CD could also be one of the factors causing the timing manipulation. Physicians' incentives to induce this method of delivery irrespective of its timing usually come from financial motivations or fear of litigation. The first is relevant when they are paid per procedure and the remuneration fee for CD is higher. The fact that CD is usually less time demanding than vaginal births broadens even more the remuneration/hour differential in favor of CD. The second is usually applicable when physicians face high likelihood of being sued by patients. This scenario could encourage physicians to adopt defensive medicine when choosing the method of delivery.

2.2 Manipulation of the Timing of Birth: Empirical Evidence

Several studies have documented relatively higher CD rates during standard weekdays and lower rates during weekends and public holidays. Cohen (1983) finds fewer births on Saturdays in Israel, where Saturday is a holiday but Sunday is a working day. Although he presents no data on method of delivery, the author argues that the results are likely to be driven by CD or induction of labor. Using data from military hospitals in the US, Brown (1996) finds a lower a lower likelihood of CD during weekends. The author argues to have eliminated the physicians' financial incentives as well as the fear of litigation's effect on CD once military obstetricians are salaried personnel and are mostly insulated from lawsuits. Working on data from three Greek hospitals, Mossialos et al. (2005) find that CD are less likely to occur on Sundays. Gans and Leigh (2008) find that CD and induction rates explain four fifths of the share of births shifted off weekends in Australia. Finally, Lefèvre (2014) finds a lower likelihood of CD during Monday public holidays in the US.

Brown (1996) and Lefèvre (2014) further look specifically into unplanned CD. None of them documents a statistically significant effect of weekends or public holidays in the likelihood of unplanned CD. However, when looking at interactions between weekdays and the time of shifts, Brown (1996) provided the first evidence of manipulation of the timing of unplanned CD. He finds that unplanned CD is significantly higher on Fridays from 3pm to 9pm. Lefèvre (2014) investigates manipulation of the timing of birth in a different way. She tests for an increase in the likelihood of CD during the 15-day period surrounding Monday public holidays. Physicians with demand for leisure preferences would have incentives to anticipate births in order to avoid being disturbed during their leisure time. She does not observe any increase in the likelihood of planned CD for the whole period. However, when restricting her sample to women who had labored, she shows that there is a slightly higher probability of unplanned CD during the same period. Her finding suggests that induced demand might occur in the labor room. Unfortunately, she does not investigate on which days the increase occurs. Physicians' behavior guides the findings of Brown (1996) and Lefevre (2014) since their results are driven by unplanned CD. However, neither of the authors isolate the convenience effect from the possibility of risk aversion.

Although the available evidence usually suggests that CD are induced by physicians due to convenience specifically, the identification of causal evidence is very challenging. The same is true for the physicians' convenience effect on birth timing manipulation. It is hard to isolate convenience motivations from risk aversion, and it may be difficult to prove that the former is guided by physicians and not parents. Perhaps the clearest evidence on physicians' convenience effects comes from Gans et al. (2007). They explore the impact of annual obstetricians and gynecologists' conference on the number of births in the United States and Australia for the period of 1990-2001. Excluding public holidays from their sample, and controlling for a rich set of time effects isolate the possibility of risk aversion effects confounding their results. The authors document a decrease in the number of births during conference days for both countries, as well as an increase during the five-day period before the conferences in the US. Unfortunately, they do not have data on the type of birth procedure to provide further evidence that medical intervention is used to anticipate births due to physicians' convenience.

Fabbri et al. (2015) investigate convenience and risk aversion attitudes in short-run manipulation of the time of births after spontaneous labor at a public hospital in Italy. Although the admission should be distributed homogeneously across time, they show that the higher the level of risk involved (which means higher likelihood of CD) the higher is the probability of delivery in afternoon or evening shifts, and the lower is the probability of delivery in late night or early morning shifts. Since the level of risk also affects positively the likelihood of delivering on the day after admission, they interpret that physicians tend to postpone instead of anticipate high-risk births. In this case, they argue that the manipulation of the timing of birth should be mainly driven by risk aversion.

Lo (2003) provides evidence suggesting that mothers also play a role in manipulating timing of birth for non-medical motives. The author shows that CD are more likely to be performed on auspicious days within the Chinese lunar calendar. They claim that this is driven by parents' preferences as Chinese people generally believe that choosing the right days for important life events can change a person's fate. More recently, Gans and Leigh (2012) investigate if physicians accommodate mothers' preferences in manipulating the time of birth. The authors make two main assumptions. The first is that parents prefer to avoid inauspicious days for their child's birth (April 1 and February 29), when there are systematically fewer births in Australia. The second is that physicians prefer to avoid working on weekends. Parental aversion to having their children born on inauspicious days is likely to lead to an increase in the number of births on the day before and after them. In case the day before or after the inauspicious day falls on a weekend, parents generally prefer to schedule the delivery for dates the doctors would like to avoid. Restricting their sample to the auspicious day, the day before and the day after, they find that the physician in favored in 75% of the eventual conflicts that might arise. Thus, they show that parents may be able to persuade their doctors to move birth dates based on non-medical reasons.[3]

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[3] Gans and Leigh (2009b) showed that the first weeks of the year 2000 had a negative impact on the number of births. This might be caused by strategic timing of conceptions by parents in March-April of 1999 or agreements between doctors and parents to shift the timing of births into the new millennium. The finding of a negative impact also on the number of deaths provides support for the second argument once it

A number of other studies provide substantial evidence that expectant mothers also manipulate the timing of their deliveries due to economic incentives. Dickert-Conlin and Chandra (1999) and Schulkind and Shapiro (2014) investigate if parents anticipate births from January to December in order to apply for an incremental year of tax savings in the US. Borra et al. (2016b) explore the cancelation of a €2,500 baby bonus in December 2010 announced seven months before by the Spanish government in order to examine if parents anticipated deliveries in order to receive the benefit. Finally, Gans and Leigh (2009a) investigate if parents postponed deliveries in order to be eligible for the $3000 “Baby Bonus” introduced in mid-2004, and announced two months earlier in Australia. All of them show that parents do manipulate the timing of birth in order to qualify for financial benefits. Schulkind and Shapiro (2014) and Borra et al. (2016b) indicate that the anticipation of births comes entirely from shifting the timing of CD, whereas Gans and Leigh (2009a) show that part of the postponed births had their procedure changed from CD or induced vaginal birth to non-induced vaginal births. In other words, Gans and Leigh (2009a) show that the incentive to postpone the timing of births made parents avoid scheduling birth procedures in advance, as they would normally do.

All the papers cited above but the first also investigate the health effects of birth timing manipulation due to non-medical reasons. Schulkind and Shapiro (2014) investigate the effect on health at birth. They point out that babies born in December or January from families with higher potential of tax savings have greater probability of having low birth weight as well as having a smaller 5th minute APGAR score if compared to those born in October or November.[4] Borra et al. (2016a) and Borra et al. (2016b) examine the effect on neonatal and longer-term health outcomes. The first paper shows that children born close to the benefit cancellation date suffered unusually high hospitalization rates in their first 3 weeks of life. The second paper indicates that those babies experienced a sizeable increase in the hospitalization rates during the first 33 months of life, especially due to respiratory disorders. Finally, Gans and Leigh (2009a)

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reinforces that parents make use of medical technology in order to intervene in the timing of natural events according to their own preferences.

[4] The Apgar scores come from a test given 1 and 5 minutes after birth that quickly assesses the infant’s health through activity (muscle tones), pulse (heart rate), grimace (reflex irritability), appearance (skin color), and respiration (breathing rate and effort). The 1-minute score determines how well the baby tolerated the birthing process. The 5-minute score tells the doctor how well the baby is doing outside the mother's uterus.

provide evidence that the postponement of births caused an increase in the likelihood of newborns having high birth weight (above 4.0kgs), which are less likely to be healthy. Using only part of their sample, they show no effect on infant mortality.

As mentioned in the last section, the likelihood of a CD is significantly higher for births occurred through timing intervention as compared to those occurred after spontaneous labor. Birth timing manipulation could thus help physicians induce CD whenever they have incentives to do so. It is important to understand the physicians' induced demand for CD (irrespective of timing) in order to assess whether this could be playing a role in the timing manipulation of births. Gruber et al. (1999) and Dubay et al. (1999) are examples of studies showing evidence on the effect of physicians' financial incentives and fear of malpractice claims on the use of CD. Investigating a scenario where physicians are remunerated per procedure, the first paper finds that an exogenous rise in the differential fee in favor of CD causes an increase in the CD rate. Dubay et al. (1999) indicate that malpractice claims' risk, measured by malpractice premiums, have a positive effect on the use of CD.

Regarding specifically Brazil, there are studies that document a lower frequency of CD on inconvenient moments. For instance, Gomes et al. (1999) find a lower likelihood of CD on Sundays in a southeastern Brazilian municipality. However, there is virtually no evidence on the distribution of unplanned CD during convenient and inconvenient times. Also, there are no causal investigations of physicians and mothers' preferences affecting the timing of births. The existing evidence is usually restricted to fieldworks within the medical literature, which typically investigates correlations between method of delivery and potential determinants. Those studies often document that women's socio-economic status is positively correlated to preference for CD, as in Domingues et al., 2014. The authors also point out that convenience is not a frequent reported justification for women's preference for CD and that the latter increases in the course of the prenatal period.[5] Hopkins (2000) provide evidence from a post-partum survey that physicians

5 Domingues et al. (2014) interviewed over 23,000 women during the years of 2011-2012 in 266 different hospitals throughout the country and showed that convenience is not usually a reason that justifies mother's preference for CD. Less than 3% (8%) of women assisted in public (private) funded hospitals mentioned convenience as one of the reasons for choosing CD over vaginal delivery. In addition, mothers' preference for CD has gone up from 36% in the beginning of the prenatal period to 68% in the end of this period among women on first pregnancy in private funded hospitals.

often encourage women to choose CD during the prenatal period, especially in private hospitals.

According to the evidence above, anticipation of births from inconvenient to convenient times could be driven by three main incentives, which may be operating simultaneously. They are convenience motivations, physicians' risk aversion and physicians' induced demand for CD irrespective of timing (in case of a change in the method of delivery).

In this paper, we test whether convenience effects play any relevant role in birth timing manipulation in Brazil. More specifically, we investigate if births that would have otherwise occurred spontaneously during inconvenient moments are anticipated because of the convenience motive. Our challenge is to make sure risk aversion or incentives to perform CD (irrespective of timing) are not confounding our results. We try to do this by adopting a few strategies and looking into different subsamples. First, we look at a new type of inconvenient days that may attenuate potential risk aversion attitudes that encourage birth timing manipulation in search of a better quality of medical care: business days in-between holidays. Although hospitals should be fully-staffed on those days, risk-averse physicians may still manipulate the timing of births in order to eliminate the possibility of women going spontaneously into labor on the surrounding leisure days. Second, we estimate the effects separately by level of risk. As risk aversion attitudes should be mostly expressed among high-risk births, we are able to understand in which direction risk aversion is operating by comparing the number of high-risk births moved away to that of low-risk births. Third, we also investigate the results separately by hospital funding. Convenience motivations, physicians' risk aversion and incentives for CD vary considerably between the public and the private healthcare systems. They will be discussed in detail in the next section.

2.3 Institutional Setting

Since 1985, the World Health Organization recommends a CD rate between 10 and 15%. Gibbons et al. (2010) argue that a CD rate above 15% is usually not related to additional benefits for the mothers and neonates, and that high CD rates could be associated with negative consequences to health outcomes. Brazil departed from the level of 15% in CD rates in the year of 1970. In 1980, the rate had doubled, while in 2009 it reached 50%. Since then it has continued to increase. Between 2012 and 2014, the CD corresponded to 57% of all registered births.[6]

Hospital births in Brazil can take place in public or private facilities. Public units usually have 100% of the beds affiliated to the publicly funded healthcare system, SUS, which is free and universal in coverage. Private facilities can have none, all, or some of its capacity reserved for SUS patients. In the remainder of this study, we define as *private* (*public) funded hospitals* those with 0% (100%) of obstetric beds reserved to SUS. Hospitals with any figure between 0% and 100% of its obstetric beds to SUS are included in our full sample.

Public funded hospitals are paid per procedure according to a reference table updated on a monthly basis.[7] Remuneration of deliveries in private funded hospitals varies according to the health facility, insurance company and patient. Although hospitals that provide SUS services are remunerated per procedure, the same is usually not true for its physicians, especially in government-owned hospitals. In order to work in public units and be a civil servant, doctors must have passed an exam. As civil servants, they have a contract for a fix number of hours/week (usually 20 or 40 hours/week) and receive a fixed monthly salary regardless of the number and type of procedures they perform. Obstetricians can work for inpatient services (conducting medical appointments, mainly prenatal visits), outpatient services (performing deliveries and other obstetric surgeries) or both of them. Obstetricians in outpatient public services are expected to be on duty for a shift of 12h or 24h. Although such contracts with a fixed number of hours and salaries are also common in the private sector (especially for young physicians), there is not a rule. In the private sector, there are also doctors with no employment contract who usually work independently as gynecologists and go to hospitals only when patients are waiting for them ready to deliver (usually for a scheduled CD).

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[6] CD rates for the years of 1970 and 1980 were obtained from Gomes et al. (1999), based on data from the National Security Medical Service (INAMPS) - which just covered those who contributed to social security at that time. CD rates for the remaining years were extracted from the Brazilian National System of Information on Birth Records (Datasus/SINASC), available since mid-1990 for all registered births in the country.

[7] There are, basically, four birth procedures in the SUS reference table: vaginal delivery, vaginal delivery for high-risk gestations, cesarean section (with or without tubal ligation) and cesarean section for high-risk gestations. Only some hospitals have license for the performance of high-risk deliveries. During the period of 2012-2014, the referred value paid for each of these procedures did not suffered any change in nominal terms. The values paid for cesarean sections were maintained 23% and 44% higher than for vaginal births, respectively for low and high-risk procedures. There is no fee for inducing labor.

Therefore, physicians working for the public healthcare services have no incentives to induce CD due to economic motivations once their remuneration is not linked to the type and number of procedures they perform. They also have fewer incentives to manipulate the timing of births due to convenience purposes once they are expected to be present at work for a fixed amount of hours/week and thus have less control over how they schedule their day.

Additionally, physicians working at public funded hospitals usually face lower likelihood of being called to court due to medical errors as well as lower likelihood of being condemned for a number of reasons. First, they always have employment contracts. This provides the patient with the option to sue the hospital directly (which, according to the Brazilian law, is less demanding than suing individuals). Besides, physicians working for SUS can transfer some responsibility to the contractor in case they are sued alone. Second, the likelihood of being proved guilty tend to be lower when providing public services because patients assisted by SUS services are usually represented in civil justice by public defenders instead of private lawyers. The former usually have fewer incentives to win lawsuits once their remuneration is not linked to performance. Finally, patients' rights within the public healthcare system are not reinforced by the Consumer Protection Code once they are not considered consumers as they do not pay for the healthcare service. Holding constant the physicians' altruism across the public and private healthcare systems, the former are expected to be less risk-averse than the latter. Hence, physicians providing public services have fewer incentives to adopt CD as a defensive medicine practice as well as to avoid birth timing manipulation for non-medical reasons such as convenience motives.

Regarding expectant mothers, their preferences and role throughout the decision-making process tend to vary based on funding of the healthcare system used. As mentioned in the last section, mothers assisted at the public sector tend to have lower preferences for CD. In addition, public funded healthcare services usually provide women with less power of choice. First, they cannot choose the physician who will assist them according to their own preferences. Besides, they are usually assisted by physicians as well as nurses during the prenatal period, and typically have a different doctor for their delivery. This makes the patient-physician relationship less personal and centralizes the decision-making in one agent, the physician. Women in the private sector, on the other hand, are better able to choose the doctors who will deliver their babies in the way they want. However, as expectant mothers are usually assisted by the same doctor during prenatal care and delivery, doctors may have more opportunity to encourage expectant mothers to change their minds according to their own preferences.

It is important to assess how each of the incentives cited above are set within the healthcare systems in Brazil since they help us understand the reasons behind birth timing manipulation. For instance, in the private sector physicians have strong incentives to induce CD (irrespective of timing) and mothers are more likely to intervene in the decision-making process. This could lead physicians to accommodate a mother’s request to anticipate the delivery date whenever the performance of a CD is ensured. In such circumstance, mothers’ convenience as well as physicians’ incentives for CD unrelated to timing play a role in the birth timing manipulation.

This paper takes advantage of two different contexts within the same country in order to investigate the convenience effect on birth timing manipulation. We argue that the public healthcare system tends to isolate the physician’s convenience motivations in a better way. First, physicians have no or few incentives to induce CD irrespective of timing (due to financial motives or fear of litigation). Second, women have less power to enforce their will and thus physicians are the main agent in the decision-making process. Consequently, physicians’ convenience and/or risk aversion could be causing the birth timing manipulation. In order to test for the former, we will investigate whether such manipulation is coming from low-risk births. Additionally, it is also interesting to investigate the results within the private healthcare system once the convenience effect is expected to be greater. In this case, however, we need to make sure that the birth timing manipulation did not involve a change in the method of delivery since physicians face strong incentives to induce CD. It should also be noted that we are not able to distinguish the physicians’ from the mothers’ convenience motivations in such scenario.

3 Data

3.1 Data Sets

Our analysis is based on a daily panel of births per hospital. The main source of data is the Brazilian National System of Information on Birth Records (Datasus/SINASC), which includes the universe of all registered live births in Brazil at the birth level. It contains information on: (i) birth characteristics such as date, hospital code, method of delivery (normal vs CD) and nature of labor (with vs without labor in case of CD, and induced vs non-induced labor); (ii) gestation and pregnancy characteristics, such as type of pregnancy, gestational length, number of prenatal visits, gestational month of prenatal care initiation as well as the number of previous deliveries; (iii) maternal socio-economic characteristics, such as age, education attainment, marital status, race and, finally; (iv) newborn characteristics and health outcomes, such as gender, detected anomaly, position in utero prior to birth, birth weight and APGAR scores.

Although the dataset is available since the mid-1990s, some of the essential variables for this study were included gradually from 2010 onwards. In 2010, a new standardized birth declaration form progressively replaced the existing one. The new form kept most of the old fields, and launched a new set of uniquely rich variables, such as indicators of whether cesarean sections were performed before or after labor, and whether labor was induced or not. In 2010, over 90% of registered births still did not include those variables. This percentage dropped to 50% in the following year, and to only 10% in 2012. Therefore, our analysis will focus on the period of 2012 through 2014.

The recently added variables allow us to discriminate between CD performed before labor, after labor induction and after spontaneous labor as well as to discriminate between vaginal deliveries after labor induction and after spontaneous labor. The high quality of these variables contributes greatly to the reliability of the reported results. Most studies in the literature are based on questionable assumptions regarding such variables and unreliable sources. For example, Halla et al. (2016) consider that all CD performed before 39 weeks of gestational length occurred before labor. Lefèvre (2014) and Fabbri et al. (2015) interpret the status of labor from the reported International Code of Diseases' diagnosis during hospitalization. This clearly disregards the subjectivity of ICD diagnosis as well as the wide range of important aspects involved other than labor – which is usually prioritized according to the physician who is responsible for filling it in. More importantly, hospital records and diagnosis may involve physicians' incentive to misreport invasive procedures as well as over report complications and serious diagnosis in order to justify unnecessary invasive and more expensive procedures. In the dataset used in this project, this information comes from a direct Yes or No answer field in a standard form. Besides that, the SINASC dataset is not directly linked with physicians' and hospitals' payments.

In order to identify if the hospital is affiliated to the public healthcare system or not, we matched our hospital-daily panel with monthly data from the National Registration of Health Facilities (Datasus/CNES) using the hospital code as the key variable. This second source of information contains data on all registered Brazilian health facilities' infrastructure and human resources. We extract data on the proportion of obstetric beds affiliated to SUS, regardless the status of public or private units. This makes it possible to construct separate subsamples of hospitals with 100% and 0% of beds affiliated to SUS (public and private funded units, respectively). We also extract covariates that indicate the hospitals' level of complexity and specialization (existence of neonatal unit as well as number of obstetrician/gynecologists, neonatologists and anesthetists).

In order to investigate the heterogeneous effect on the manipulation of the timing of birth by level of risk, we construct subsamples of high and low-risk births based on observable variables within both public and private funded hospitals. We classify high-risk births as those with any of the following five conditions: multiple pregnancy, newborn with congenital anomaly, newborn in breech or shoulder positions before birth, birth weight below 2.5kgs or above 4.0kgs, gestational length below 37 or above 41 weeks or mother's age below 18 or above 35 years old.

3.2 Sample Selection

The original SINASC dataset contains a universe of 8,789,075 registered births for the period 2012-2014. Restricting our sample to births at hospitals excluded 2% of observations from the original raw microdata. We drop only less than 1% of observations when keeping only deliveries with informed mode of delivery. Selecting observations with information on the occurrence and type of labor required us to exclude other 11% of the remaining observations. Regarding this latter selection, we dropped specifically: (i) CD with no data concerning whether labor had occurred or not and (ii) CD after labor as well as vaginal deliveries with no information about whether labor had been induced or not. The raw dataset contained some observations of CD with information of absence of labor simultaneously with information of induced labor. It is unknown if, in those cases, labor was induced without success or if these should be exclusive conditions. We consider them as valid observations of CD before labor (3% of CD in the remaining dataset). Finally, when constructing our daily panel, we only kept hospitals with 10 or more births for every month in the period of 2012-2014. In this case, we keep 75% of all deliveries prior to this stage.[8]

In our main analysis, we keep only Mondays and Fridays that are close to public holidays by one day as well as those away from public holidays by more than 7 days. Days during the atypical period of December 15 - January 7 were also excluded. We end up with a panel of 1,407 hospitals summing up a total number of 1,232,373 deliveries occurred in 216 days. When selecting by type of hospital, we end up with 617 public and 235 private funded facilities, with a total number of 545,568 and 239,678 deliveries, respectively.[9] Within public funded hospitals, 229,943 deliveries were classified as high-risk, and 295,643 deliveries as low-risk. Within private funded hospitals, these figures were 82,996 and 150,808, respectively.[10]

3.3 Descriptive Statistics

Table 1 displays descriptive statistics for our main analysis. The full sample as well as public and private funded hospitals subsamples are presented. The first column of each sample corresponds to standard Mondays and Fridays, which are all Mondays and Fridays away from any public holiday by more than 7 days. The second column of each sample corresponds to Mondays preceding Tuesday public holidays or Fridays following Thursday public holidays. There are 210 standard Mondays/Fridays (convenient days) and 6 Mondays/Fridays between public holidays and weekends (inconvenient days), 5 of which are Fridays.

The descriptive statistics suggest that the lower average number of births on inconvenient days as compared to convenient days are mainly driven by private funded hospitals. The difference is restricted to scheduled CD at public funded hospitals, whereas

[8] Given the order in which we select our dataset, this corresponds to hospitals with at least 10 births/month for which new birth records forms were filled out from January 2012 to December 2014.

[9] The difference between the total number of deliveries from the full sample and the sum of deliveries in public and private funded hospitals corresponds to births occurred in hospitals that serve both SUS and private payers (insurance companies and patients without insurance) in at least one of the months of the period of 2012-2014.

[10] The difference between the total number of deliveries and the sum of the high and low risk deliveries for both public and private funded hospitals corresponds to observations with at least one of the conditions necessary for the level of risk classification not informed when all the others point to low-risk birth.

the difference in the number of births is also statistically significant for CD after labor induction and CD after spontaneous labor at private funded units.

Regarding our control variables, expectant mothers tend to have similar average socio-economic characteristics between the two types of Mondays and Fridays. Women assisted at public funded hospitals on inconvenient Mondays and Fridays present a lower proportion of previous CD. This is consistent with the lower number of CD performed on these days, once a previous CD usually increases the probability of a new CD. Besides, mothers also present a lower share of more than 6 prenatal visits on inconvenient Mondays and Fridays. Indeed, we observe a statistically significant 3 percentage points higher proportion of high-risk births (according to our own classification) on inconvenient days in private funded hospitals. In those units, the proportion of gestational length lower than 37 weeks as well as the proportion of birth weight below 2.5kgs and above 4.0kgs is higher on inconvenient days. In public funded units, there is a higher proportion of older women on inconvenient days. Finally, APGAR scores are lower on inconvenient Mondays and Fridays for public funded hospitals.

Table 1: Summary Statistics

	Full Sample			100% SUS			0% SUS		
	Standard Mon/Fri	Mon/Fri Near Hol.	Diff.	Standard Mon/Fri	Mon/Fri Near Hol.	Diff.	Standard Mon/Fri	Mon/Fri Near Hol.	Diff.
Average Num. of Daily Deliveries									
Total Num. of Deliveries	4.06	3.76	***	4.10	4.01	-	4.75	3.84	***
Num. of Deliveries Before Labor (100% CD)	1.36	1.13	***	0.66	0.61	**	3.24	2.52	***
Num. of Deliveries After Labor Induction	0.75	0.76	-	0.96	0.98	-	0.33	0.29	-
Num. of Deliveries After Spontaneous Labor	1.96	1.87	***	2.47	2.42	-	1.18	1.03	***
Num. of ND	2.05	2.11	*	2.98	3.00	-	0.57	0.58	-
Num. of CD	2.84	2.53	***	2.02	1.89	***	4.94	4.14	***
Num. of ND After Labor Induction	0.61	0.62	-	0.79	0.82	-	0.23	0.22	-
Num. of CD After Labor Induction	0.14	0.13	-	0.17	0.16	-	0.10	0.08	**
Num. of ND After Spontaneous Labor	1.09	1.09	-	1.65	1.64	-	0.26	0.25	-
Num. of CD After Spontaneous Labor	0.86	0.79	***	0.82	0.78	-	0.92	0.77	***
Gestation and Pregnancy									
% of Num. Prenatal Visits = 0	0.02	0.02	-	0.03	0.03	-	0.02	0.02	-
% of Num. Prenatal Visits = 1-3	0.07	0.07	-	0.10	0.11	-	0.02	0.01	-
% of Num. Prenatal Visits = 4-6	0.26	0.27	***	0.33	0.34	-	0.14	0.16	**
% of Num. Prenatal Visits > 6	0.66	0.64	***	0.54	0.53	*	0.83	0.81	**
% of 1st Prenatal Visit Until the 3rd Month of Pregnan	0.78	0.78	-	0.70	0.70	-	0.90	0.90	-
Num of Weeks of Gestational Length	38.50	38.48	-	38.66	38.66	-	38.16	38.06	***
Newborn Birth Weight	3194	3190	-	3206	3203	-	3176	3165	-
% of Male Newborn	0.51	0.51	-	0.51	0.51	-	0.51	0.52	-
Num of Previous Pregnancies	1.24	1.25	-	1.48	1.49	-	0.83	0.84	-
Num of Previous Normal Deliveries	0.77	0.79	*	1.07	1.10	-	0.27	0.28	-
Num of Previous Cesarean Deliveries	0.35	0.34	***	0.29	0.28	*	0.43	0.43	-
% of Previous Cesarean Deliveries	0.28	0.26	***	0.22	0.21	**	0.36	0.35	-
Mother									
Age	26.05	25.84	***	24.62	24.53	-	29.11	28.98	-
% of White Mothers	0.40	0.40	-	0.22	0.22	-	0.61	0.61	-
% of Years of Education < 4	0.05	0.05	**	0.07	0.08	-	0.00	0.01	-
% of Years of Education = 4-7	0.22	0.22	*	0.29	0.29	-	0.04	0.05	-
% of Years of Education = 8-11	0.57	0.57	-	0.58	0.58	-	0.50	0.51	-
% of Years of Education > 11	0.17	0.16	***	0.06	0.05	-	0.45	0.44	-
% of Married	0.60	0.60	*	0.55	0.55	-	0.72	0.72	-
Risk Factors									
% of Twin+ Pregnancy	0.01	0.01	*	0.01	0.01	**	0.02	0.02	-
% of Identified Congenital Anomaly	0.01	0.01	-	0.01	0.01	-	0.01	0.01	-
% of Breech Fetal Position	0.04	0.04	-	0.03	0.03	-	0.04	0.05	-
% of Shoulder Fetal Position	0.00	0.00	**	0.00	0.00	-	0.00	0.00	-
% of Newborn Birth Weight < 2.5kg	0.08	0.08	-	0.08	0.08	-	0.07	0.09	***
% of Newborn Birth Weight > 4.0kg	0.05	0.05	-	0.05	0.05	-	0.03	0.04	**
% of Gestational Length < 37 Weeks	0.11	0.12	**	0.12	0.12	-	0.10	0.11	**
% of Gestational Length > 41 Weeks	0.04	0.04	-	0.05	0.05	-	0.02	0.01	-
% of Mothers Younger than 18 Years Old	0.09	0.10	**	0.13	0.14	-	0.02	0.02	-
% of Mothers Older than 35 Years Old	0.09	0.09	**	0.07	0.06	**	0.14	0.14	-
% of High-Risk Delivery (Any of Above)	0.41	0.41	-	0.44	0.44	-	0.35	0.38	***
Health Outomes									
1st Minute APGAR (0 to 10)	8.32	8.30	**	8.19	8.14	***	8.49	8.47	-
5th Minute APGAR (0 to 10)	9.35	9.34	*	9.28	9.26	*	9.45	9.44	-
Dif. Between 5th and 1st Minute APGAR	1.04	1.04	-	1.09	1.11	*	0.96	0.96	-

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: Datasus/SINASC and Datasus/CNES. Self-elaboration.

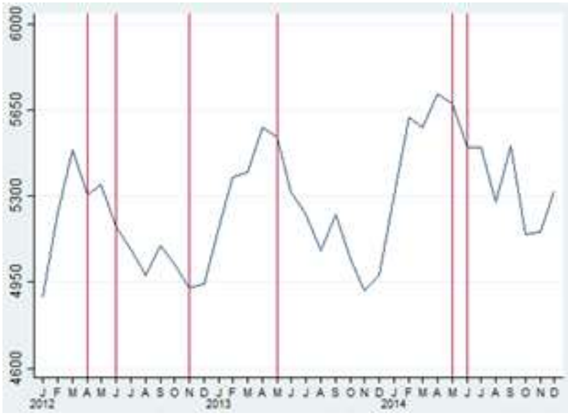
4 Empirical Strategy

In this paper we compare the number of births on weekdays in-between holidays to the number of births on regular weekdays. In our sample, we consider six dates between public holidays and weekends. They are a Monday preceding a Tuesday public holiday (May 1, 2012) and five Fridays succeeding Thursday public holidays (June 7, 2012; November 15, 2012; May 30, 2013; May 1, 2014; June 19, 2014). Three of these Tuesday and Thursday holidays took place on fixed dates holidays (May 1, labor day, and November 15, Proclamation of the Brazilian Republic) and the other three took place on a variable date holiday (Corpus Christi, a religious holiday which always falls on a Thursday 60 days after Easter Sunday). Two other Tuesday holidays and one other Thursday holiday fell during the atypical period of December 15 to January 7, and thus were not included in the analysis. Although there also exists public holidays at the statewide and municipal levels, we consider only national public holidays in our sample. Figure 1 illustrates the average number of daily deliveries by month in Brazil for the period of 2012-2014. Panel A corresponds to our full sample, while Panel B and C correspond to births in the public and private funded hospitals subsamples. The six vertical lines indicate Mondays (April 30, 2012) preceding Tuesday public holidays, and Fridays (June, 8, 2012; November 16, 2012; May 31, 2013; May 2, 2014; June 20, 2014) following Thursday public holidays.

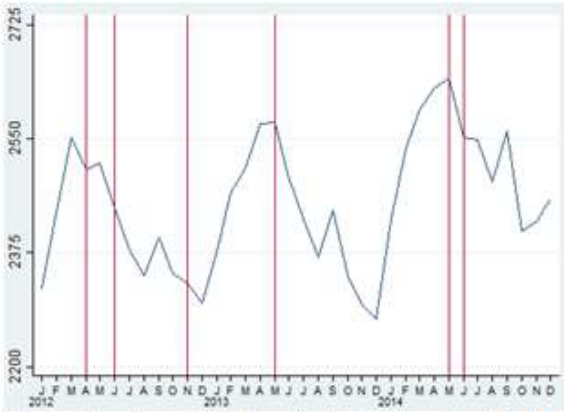
The inconvenient days cited above are regular business days, when hospitals should be fully-staffed and medical staff tends to be fresher. However, it does not mean we have eliminated risk aversion attitudes that encourage birth timing manipulation in search of a better quality of medical care. As the timing of spontaneous labor is uncertain and uniformly distributed during the final period of pregnancies, the probability that it occurs on a public holiday, on the inconvenient business day, on Saturday or Sunday is the same. Thus, risk-averse doctors might still have incentives to anticipate deliveries based on their fear that women might spontaneously go into labor on leisure days (public holidays or weekends), which may be correlated to lower quality of medical care.

Figure 1: Average Number of Daily Births by Month in Brazil for the Period of 2012-2014

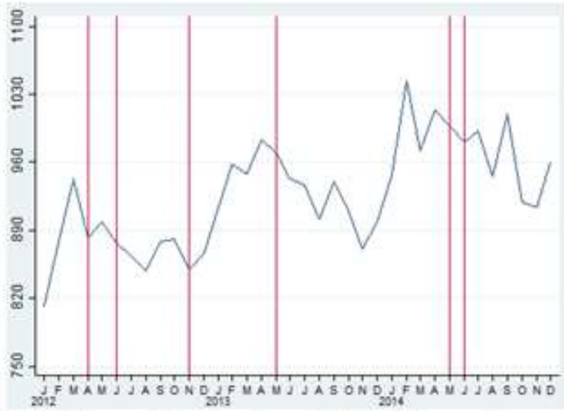
Panel A: Full Sample



Panel B: Public Funded Hospitals



Panel C: Private Funded Hospitals



Notes: The six vertical lines indicate Mondays (April 30, 2012) preceding Tuesday public holidays, and Fridays (June, 8, 2012; November 16, 2012; May 31, 2013; May 2, 2014; June 20, 2014) following Thursday public holidays.

Source: Datasus/SINASC. Self-elaboration.

We begin by investigating if births have been moved away from inconvenient days. Our baseline empirical strategy estimates the reduced-form effects of Mondays and Fridays in-between holidays on the daily number of births collapsed at the hospital-by-day level. In our baseline specification, we restrict our sample to births on business Mondays and Fridays. More specifically, we maintain in our sample only Mondays preceding Tuesday public holidays, and Fridays following Thursday public holidays, as well as Mondays and Fridays away from any public holiday by more than 7 days. The baseline specification follows the equation:

$$NumDel_{hymd} = \alpha + \beta T^{\sim H}_{ymd} + \rho_d + \gamma_y + \theta_m + \delta_h + X'_{hd}\lambda + \epsilon_{hymd} \quad (1)$$

where h indexes hospital, y indexes year, m is a subscript for month, and d is a subscript for the day of delivery (Monday or Friday). Our main dependent variable is simply the total number of births at the hospital-day level. We further break the computation of this variable by nature of labor and method of delivery. The term $T^{\sim H}_{dym}$ is a dummy that equals to 1 for Mondays preceding Tuesdays public holidays, and Fridays following Thursdays public holidays, and it equals to 0 for standard Mondays and Fridays. The terms γ_y, θ_m, and δ_h indicate, respectively, year, month and hospital of birth fixed effects. The term ρ_d is a dummy for Mondays. Additionally, the regression includes several control variables at the hospital-day level, expressed above as X_{hd}. This term contains (i) mean characteristics of all deliveries in hospital h on day d regarding the gestational period (indicators of multiple pregnancy, number of prenatal visits, a dummy for prenatal care within the first three gestational months); (ii) characteristics of the expectant mothers (indicators of white race, married status, age below 18 and above 35 years old, 12 or more years of education and previous cesarean deliveries); (iii) and characteristics of the newborns (indicators of gender, detected anomalies and breech or shoulder presentations). Gestational length and birth weight were not included once they can be endogenous variables in case of deliveries being anticipated or delayed due to the proximity of public holidays. The term also includes monthly variant hospital characteristics of human resources (number of obstetrician/gynecologists, neonatologists and anesthetists) and infrastructure (indicator of newborn unit). We run the regressions for the full sample as well as restricted to subsamples of public (private) funded hospitals, low-risk births at public (private) funded hospitals, and high-risk births at public (private) funded hospitals.

The term β is our coefficient of interest. It measures the difference in the number of deliveries on Mondays and Fridays close to public holidays compared to Mondays and Fridays away from public holidays, controlling for fixed effects and a uniquely rich set of covariates. We first hypothesize that $\beta < 0$ for the total number of deliveries. This effect should be mainly driven by a decrease in the number of scheduled CD since this should reflect the combination of method of delivery and nature of labor that allows for the greater manipulation in the timing of birth. However, this only indicates that the number of scheduled CD is lower during inconvenient periods (business days close to public holidays) as compared to convenient periods (business days away from public holidays). These births might have occurred through the same procedure before or after the inconvenient days, or through a different birth procedure.

We are particularly interested in the sign of β for the total number of births after spontaneous labor. If $\beta < 0$, we should thus observe an increase in the number of deliveries with medical intervention (scheduling CD or inducing labor) during the period before leisure days. In order to test for the rise of medical interventions during convenient days before the leisure period, we recreate our sample to include all weekdays that are away from Fridays following Thursday holidays by less than 7 days or away from any other public holidays by more than 7 days. We then test manipulation of the timing of birth in the vicinity of Fridays following Thursday holidays by running the regression below:

$$NumDel_{hymd} = \alpha + \sum_{n=1}^{7} \gamma^n \, BefT^{\sim H}{}_{ymd}^{n} + \sum_{n=1}^{7} \delta^n \, AftT^{\sim H}{}_{ymd}^{n} + \beta T_{ymd}^{\sim H} + \rho_d + \gamma_y + \theta_m + \delta_h + X'_{hd}\lambda + \epsilon_{hymd} \quad (2)$$

Where the term $BefT^{\sim H}{}_{ymd}^{n}$ is a dummy that equals to 1 for dates that are n days before Fridays following Thursday holidays, and 0 otherwise. Analogously $AftT^{\sim H}{}_{ymd}^{n}$ equals to 1 for dates that are n days after Fridays following Thursday holidays, and 0 otherwise. As our recreated sample includes all days of week, ρ_d indicates weekday fixed effect. All other covariates are defined as in the first regression.

In every sample where we find $\beta < 0$ for deliveries after spontaneous labor, we should also observe $\gamma > 0$ for at least one day before the leisure period when running the regression for the number of scheduled CD or deliveries after induced labor. This would indicate that women who would have otherwise gone spontaneously into labor during inconvenient periods had their deliveries anticipated to convenient moments through medical interventions. This result should reveal that incentives other than the medical protocol are at play in our empirical setting. According to the existing empirical evidence, they could be convenience, risk aversion or induced demand for CD (irrespective of timing). Estimating the coefficients for our subsamples of public and private funded hospitals as well as high and low-risk births will help us investigate whether the convenience effect is particularly relevant in our context.

When looking at our public funded hospital subsample, we isolate physicians' convenience and risk aversion, as detailed in Section 2.3. We then analyze the results by level of risk in order to investigate which incentive is guiding the anticipation of births. We provide evidence on the physicians' convenience effect in case the results are driven by low-risk births. In such circumstance, risk aversion would operate in a way to avoid birth timing manipulation once it is guided by non-medical motives. If the results are driven by high-risk births, then risk aversion would be the main determinant of birth timing manipulation. It would indicate that such manipulation is mainly guided by an attempt to escape from lower quality hospital services. Finally, if the results do not vary across the low and high-risk births subsamples, both incentives would be at play and we would not be able to say which one is dominant.

Regarding our private funded hospital subsample, we need to make sure that birth timing manipulation did not occur through a change of birth procedure from vaginal delivery to CD. In case there is such a change, induced demand for CD unrelated to timing may confound our results on the causes of birth timing manipulation (e.g. physicians could accommodate such manipulation in order to ensure the performance of CD). Thus, if that is the case, we will not be able to proceed with our analysis. In case there is not such change of birth procedure, we investigate the results by level of risk as we do for the public funded hospital subsample. The only difference is that we will not be able to determine if the convenience motivations are guided by physicians, mothers or both.

5 Results

5.1 Main Results

Tables 2, 3 and 4 present our main results. Each panel corresponds to a different dependent variable, and each column corresponds to a different sample. Table 2 reports the effects of Mondays and Fridays close to public holidays on the number of births by nature of labor. This includes deliveries before labor (only applicable to CD), after induced labor and after spontaneous labor, which altogether represent 100% of births. Table 3 details the effects on the number of deliveries after induced labor by method of delivery (CD and normal delivery). Table 3 does the same for the number of deliveries after spontaneous labor. In order to make the comparison easier, Panel A in Tables 3 and 4 replicates the results from the bottom of Table 2 (Panels C and D) before breaking the effects by method of delivery.

Table 2 reports a 6% decrease in the total deliveries considering all hospitals in the sample (Table 2, Panel A, column 1). The result is mainly driven by CD before labor (Table 2, Panel B, column 1), as expected. This is the combination between method of delivery and nature of labor that allows for the highest discretion in the manipulation of the timing of birth. Finally, we observe a 4% decrease in the number of births after spontaneous labor in our full sample (Table 2, Panel D, columns 1). When breaking our results by method of delivery, we find a 2% decrease in the number of non-induced vaginal births and a 6% decrease in the number of unplanned CD (Table 4, Panels B and C, column 1). Looking at our subsamples by hospital funding, we observe that the decrease of non-induced vaginal births is entirely driven by public funded hospitals (Table 4, Panels B, columns 2 and 3). In case such deliveries have been anticipated through scheduled CD or CD after induced labor, the change of method of delivery should not be a problem since physicians do not face incentives to induce CD within the public healthcare system.

Within our public funded hospitals subsample, the effect on the number of births after spontaneous labor vanishes when we look at high-risk births. The decrease in the number of both non-induced vaginal births and unplanned CD comes entirely from low-risk births (Table 4, columns 4 and 5). This is a circumstance where risk aversion eliminates birth timing manipulation among high-risk births. Both our findings of a decrease driven by low-risk births and a decrease in the number of non-induced vaginal births strongly contribute to our identification of the convenience effect in birth timing manipulation. Low-risk births may still contemplate some high-risk births since our classification is based on observable variables. However, non-induced vaginal births correspond to undeniable low-risk births once they constitute the simplest combination of method of delivery and nature of labor that should be avoided in the presence of any risk factor. In addition, as women do not actively participate in the decision-making process among public funded hospitals, the convenience effect should be attributed to physicians.

Finally, we are able to further investigate the convenience effect within private funded health facilities since the decrease in the number of births after spontaneous labor comes entirely from CD. When looking at the results by level of risk, we find again that the decrease comes entirely from low-risk births (Table 4, Panel A, columns 6 and 7). However, further looking at the results by method of delivery and level of risk, we observe a decrease in the number of unplanned CD in both low-risk and high-risk samples (Table 4, Panel C, columns 6 and 7). We should note that the effects of high-risk births are slightly lower in magnitude and less robust if compared to the effects for low-risk births. Thus, risk aversion attitudes offset convenience motivations even though they do not eliminate them. Convenience motives may be enormous among private funded hospitals mainly for two reasons. First, physicians' convenience incentives are greater as they tend to have more control on how they schedule their day as compared to public funded heath units. Second, mothers' convenience may be added to that of physicians since the private healthcare system may allow the patients to interfere in the decision-making process and enforce their preferences.

In the next section we will test for a rise in scheduled CD and labor induction in the days before the leisure period in order to confirm that births have been anticipated.

Table 2: Effect of Monday and Fridays Close to Public Holidays on the Number of Daily Deliveries by Nature of Labor

				100% SUS		0% SUS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ful Sample	100% SUS	0% SUS	Low-Risk	High-Risk	Low-Risk	High-Risk
Panel A: Total Num. of Deliveries							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.320	-0.223	-0.729	-0.143	-0.085	-0.504	-0.290
	(0.034)***	(0.050)***	(0.092)***	(0.041)***	(0.040)**	(0.075)***	(0.060)***
Mean Dep. Var.	5.118	5.284	5.711	3.446	2.945	4.025	2.781
Effect on Dep. Var in %	-6%	-4%	-13%	-4%	-3%	-13%	-10%
Panel B: Num. of Deliveries Before Labor (CD)							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.198	-0.082	-0.543	-0.032	-0.064	-0.387	-0.229
	(0.021)***	(0.023)***	(0.076)***	(0.018)*	(0.019)***	(0.064)***	(0.050)***
Mean Dep. Var.	1.712	0.855	3.910	0.489	0.563	2.775	1.901
Effect on Dep. Var in %	-12%	-10%	-14%	-7%	-11%	-14%	-12%
Panel C: Num. of Deliveries After Labor Induction							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.023	-0.022	-0.053	-0.020	-0.005	-0.035	-0.017
	(0.016)	(0.028)	(0.023)**	(0.024)	(0.021)	(0.020)*	(0.017)
Mean Dep. Var.	0.957	1.257	0.404	0.895	0.633	0.317	0.163
Effect on Dep. Var in %	-2%	-2%	-13%	-2%	-1%	-11%	-10%
Panel D: Num. of Deliveries After Spontaneous Labor							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.099	-0.120	-0.134	-0.092	-0.016	-0.083	-0.044
	(0.025)***	(0.042)***	(0.051)***	(0.034)***	(0.032)	(0.040)**	(0.036)
Mean Dep. Var.	2.448	3.172	1.397	2.062	1.749	0.933	0.717
Effect on Dep. Var in %	-4%	-4%	-10%	-4%	-1%	-9%	-6%
Num of Observations	225,744	96,779	40,517	80,063	70,572	36,188	28,162
Health Facility FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES

Notes:

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Each estimation controls for mean characteristics of all daily deliveries performed in a given hospital regarding the gestational period (indicators of multiple pregnancy, 1-3, 4-6 and 7 or more prenatal visits, and initiation of prenatal care within the first three gestational months), the expectant mothers (indicators of white race, married status, age below 18 and above 35 years old, 12 or more years of education and previous cesarean deliveries) and the newborns (indicators of gender, detected anomalies and breech or shoulder presentations). It also includes monthly variant hospital characteristics of human resources (number of obstetrician/gynecologists, neonatologists and anesthetists) and infrastructure (indicator of newborn unit).

Low and High-Risk classifications are detailed in the Data Section.

Source: Datasus/SINASC and Datasus/CNES. Self-elaboration.

Table 3: Effect of Monday and Fridays Close to Public Holidays on the Number of Daily Deliveries After Induced Labor by Method of Delivery

				100% SUS		0% SUS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ful Sample	100% SUS	0% SUS	Low-Risk	High-Risk	Low-Risk	High-Risk
Panel A: Num. of Deliveries After Labor Induction							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.023	-0.022	-0.053	-0.020	-0.005	-0.035	-0.017
	(0.016)	(0.028)	(0.023)**	(0.024)	(0.021)	(0.020)*	(0.017)
Mean Dep. Var.	0.957	1.257	0.404	0.895	0.633	0.317	0.163
Effect on Dep. Var in %	-2%	-2%	-13%	-2%	-1%	-11%	-10%
Panel B: Num. of ND After Labor Induction							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.012	-0.003	-0.022	-0.004	0.002	-0.013	-0.005
	(0.015)	(0.025)	(0.019)	(0.022)	(0.019)	(0.018)	(0.014)
Mean Dep. Var.	0.779	1.033	0.285	0.740	0.514	0.226	0.114
Effect on Dep. Var in %	-2%	0%	-8%	-1%	0%	-6%	-4%
Panel C: Num. of CD After Labor Induction							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.011	-0.019	-0.031	-0.016	-0.008	-0.021	-0.012
	(0.007)*	(0.011)*	(0.011)***	(0.010)	(0.009)	(0.010)**	(0.009)
Mean Dep. Var.	0.178	0.223	0.119	0.155	0.119	0.0914	0.0493
Effect on Dep. Var in %	-6%	-9%	-26%	-10%	-7%	-23%	-24%
Num of Observations	225,744	96,779	40,517	80,063	70,572	36,188	28,162
Health Facility FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES

Notes:
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Each estimation controls for mean characteristics of all daily deliveries performed in a given hospital regarding the gestational period (indicators of multiple pregnancy, 1-3, 4-6 and 7 or more prenatal visits, and initiation of prenatal care within the first three gestational months), the expectant mothers (indicators of white race, married status, age below 18 and above 35 years old, 12 or more years of education and previous cesarean deliveries) and the newborns (indicators of gender, detected anomalies and breech or shoulder presentations). It also includes monthly variant hospital characteristics of human resources (number of obstetrician/gynecologists, neonatologists and anesthetists) and infrastructure (indicator of newborn unit).
ND stands for Normal Delivery.
Low and High-Risk classifications are detailed in the Data Section.

Source: Datasus/SINASC and Datasus/CNES. Self-elaboration.

Table 4: Effect of Monday and Fridays Close to Public Holidays on the Number of Daily Deliveries After Spontaneous Labor by Method of Delivery

				100% SUS		0% SUS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ful Sample	100% SUS	0% SUS	Low-Risk	High-Risk	Low-Risk	High-Risk
Panel A: Num. of Deliveries After Spontaneous Labor							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.099	-0.120	-0.134	-0.092	-0.016	-0.083	-0.044
	(0.025)***	(0.042)***	(0.051)***	(0.034)***	(0.032)	(0.040)**	(0.036)
Mean Dep. Var.	2.448	3.172	1.397	2.062	1.749	0.933	0.717
Effect on Dep. Var in %	-4%	-4%	-10%	-4%	-1%	-9%	-6%
Panel B: Num. of ND After Spontaneous Labor							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.031	-0.053	0.001	-0.046	0.003	-0.005	0.010
	(0.017)*	(0.032)*	(0.021)	(0.027)*	(0.024)	(0.016)	(0.019)
Mean Dep. Var.	1.359	2.111	0.306	1.417	1.108	0.209	0.155
Effect on Dep. Var in %	-2%	-3%	0%	-3%	0%	-2%	6%
Panel C: Num. of CD After Spontaneous Labor							
Dummy for Mon before Tue Holiday or Fri after Thu Holiday	-0.067	-0.067	-0.134	-0.046	-0.019	-0.078	-0.054
	(0.018)***	(0.025)***	(0.048)***	(0.019)**	(0.021)	(0.037)**	(0.032)*
Mean Dep. Var.	1.089	1.061	1.091	0.645	0.641	0.723	0.561
Effect on Dep. Var in %	-6%	-6%	-12%	-7%	-3%	-11%	-10%
Num of Observations	225,744	96,779	40,517	80,063	70,572	36,188	28,162
Health Facility FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES

Notes:
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Each estimation controls for mean characteristics of all daily deliveries performed in a given hospital regarding the gestational period (indicators of multiple pregnancy, 1-3, 4-6 and 7 or more prenatal visits, and initiation of prenatal care within the first three gestational months), the expectant mothers (indicators of white race, married status, age below 18 and above 35 years old, 12 or more years of education and previous cesarean deliveries) and the newborns (indicators of gender, detected anomalies and breech or shoulder presentations). It also includes monthly variant hospital characteristics of human resources (number of obstetrician/gynecologists, neonatologists and anesthetists) and infrastructure (indicator of newborn unit).
ND stands for Normal Delivery.
Low and High-Risk classifications are detailed in the Data Section.

Source: Datasus/SINASC and Datasus/CNES. Self-elaboration.

5.2 The Timing of Birth and Anticipation of Deliveries

Our results so far indicate a decrease in the number of births after spontaneous labor on Fridays (and Mondays) close to a public holiday. In this section, we present the results of our analysis on the timing of birth in the vicinity of Fridays following holidays in comparison to regular dates. The coefficients found in this section for Fridays following holidays are close to those depicted in the last section, in which the sample also includes a Monday preceding holidays. The goal of this analysis is to help us better understand whether and how these births are anticipated, by scheduled CD or induced labor.

The coefficients of each day around the Fridays following holidays are plotted in Figures 2 and 3, respectively, for public and private funded hospitals. Panel A considers the subsample of low-risk births, while Panels B corresponds to high-risk births. For each panel, we present the coefficients for regressions with the following dependent variables: number of total deliveries, deliveries before labor, after labor induction and after spontaneous labor as well as number of CD and vaginal deliveries after induced labor and after spontaneous labor.

In public funded hospitals, we observe that low-risk births after spontaneous labor are in fact anticipated. We find a positive effect on the number of CD deliveries before labor and an increase in the number of CD after induced labor restricted to the previous Monday (Figure 2, Panel A). This indicates that the anticipation of births that would have been delivered after spontaneous labor by CD or vaginal delivery most likely occurred through the scheduling of a CD, the most invasive procedure of all.

Regarding the private funded hospitals, we observed a decrease of both low and high-risk births after spontaneous labor on Fridays following Thursday holidays, as depicted in the last section.[11] The results are driven by unplanned CD. For the subsample of low-risk births, Panel A of Figure 3 indicates that the anticipation of low-risk births occurred exclusively through planned CD. In this case, the anticipation of births changed the nature of labor but not the method of delivery. For the sample of high-risk births, we also find a small increase in labor induction practices on the days preceding the leisure period (Figure 3, Panel B). The last finding comes from induced vaginal births on the previous Monday and, in a lesser extent, from CD after induced labor on the previous Tuesday. It is worth noting that part of the increase in the number of scheduled CD and deliveries after induced labor on the days before Thursday holidays may also accommodate the anticipation of births that would have otherwise taken place after spontaneous labor on other inconvenient days (Thursday holidays or the following weekend) as well as a shift in the time of planned CD or labor inductions from such days.

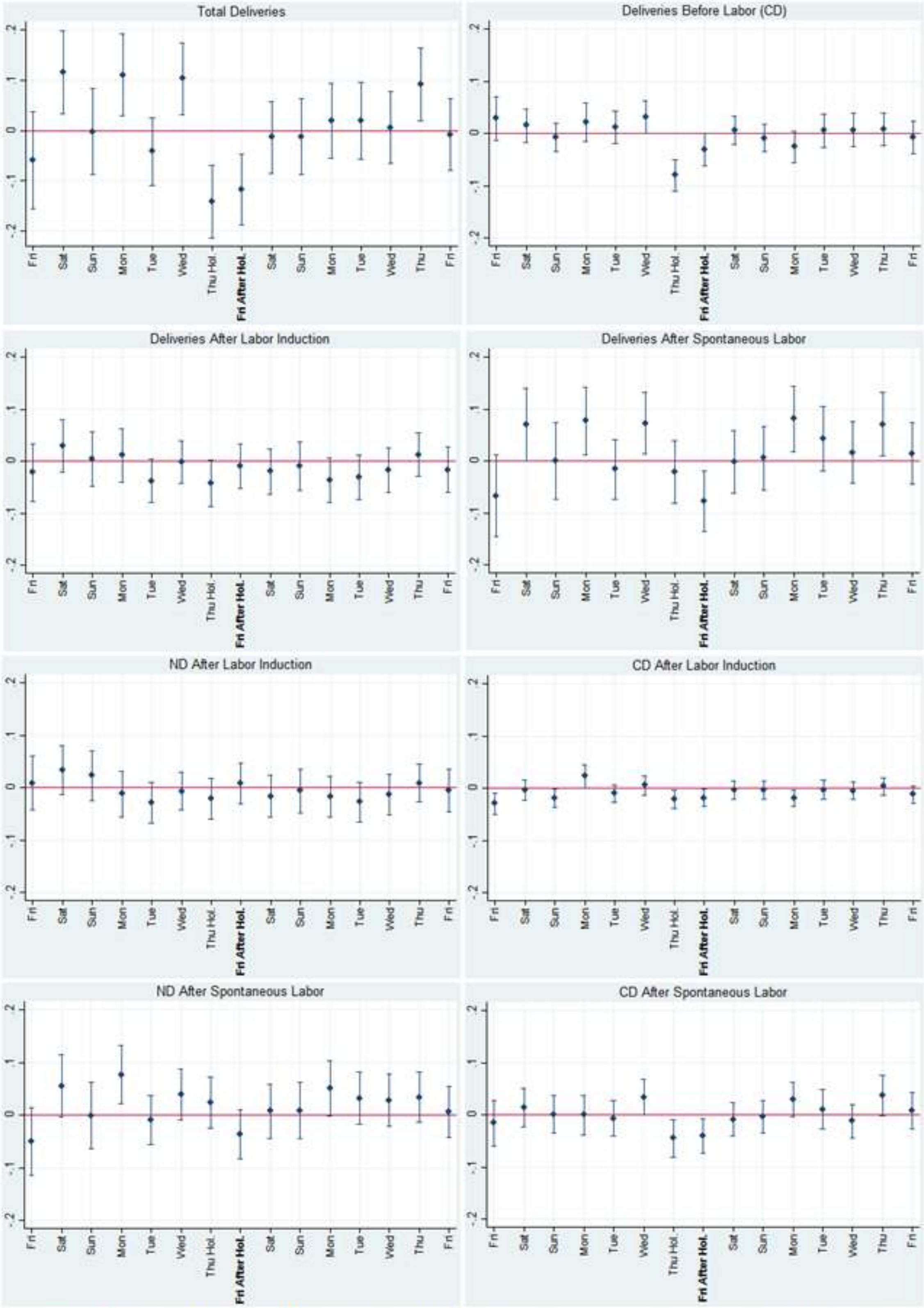
Therefore, our findings indicate that birth timing manipulation is driven by the convenience effect instead of risk aversion attitudes. Deliveries that would have occurred spontaneously are anticipated most likely through scheduled CD. We believe to have provided evidence that the convenience motivation is guided by physicians within the

[11] Although in the last section the decrease in the number of high-risk CD after spontaneous labor was significant at the level of 10%, the coefficient depicted in this section for Fridays following holidays is not anymore statistically different from zero at this level.

public healthcare system. Regarding private funded hospitals, the convenience motivations might come from the physician, the expectant mother or both of them.

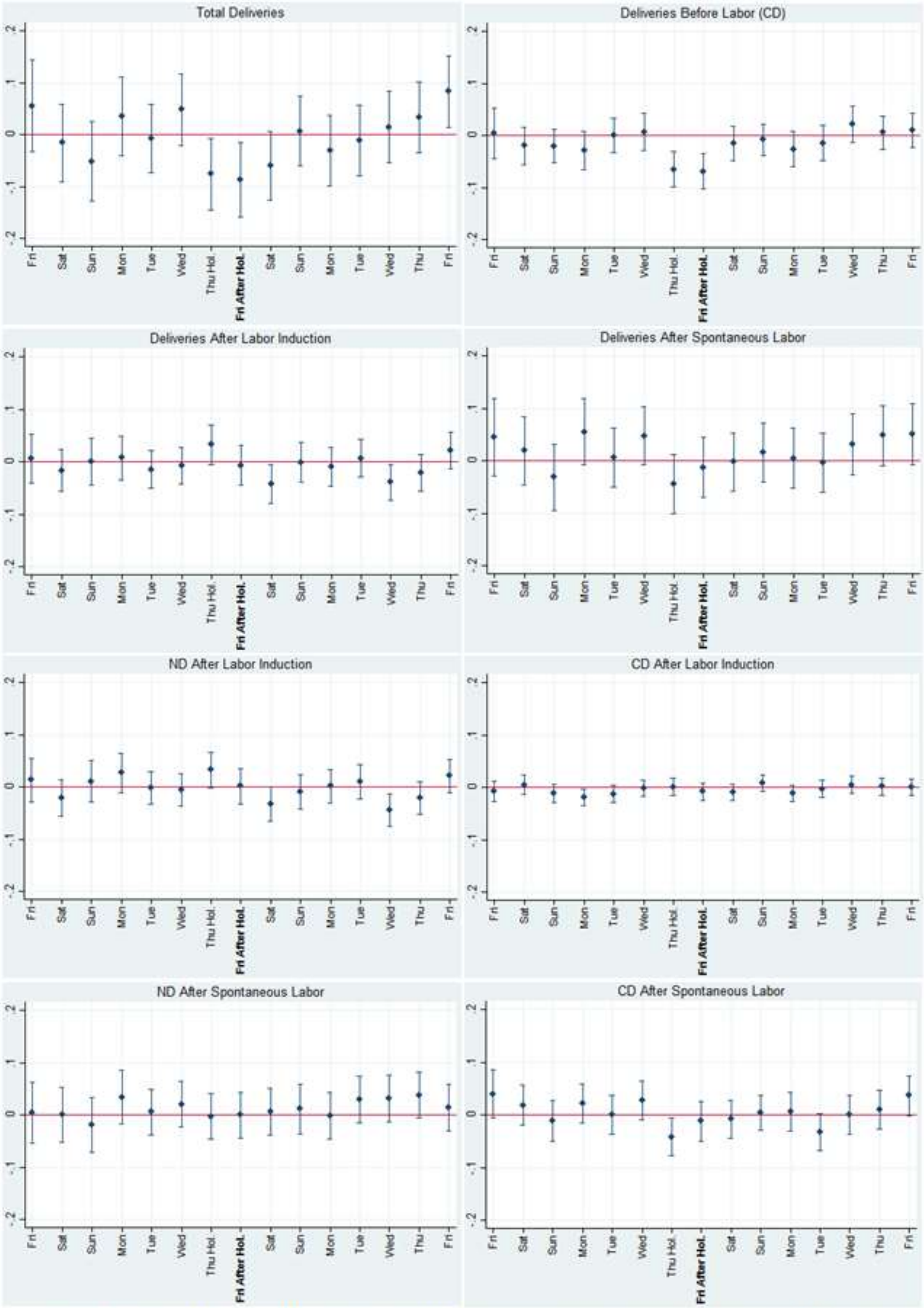
Figure 2: Effect of Fridays Following Thursday Public Holidays on the Number of Daily Deliveries at Public Funded Hospitals (100% SUS) – Range of 7 Days Before and After Friday (with 90% CI)

Panel A: Low-Risk Births



Notes: ND stands for Normal Delivery. Low and High-Risk classifications are detailed in the Data Section.

Panel B: High-Risk Births

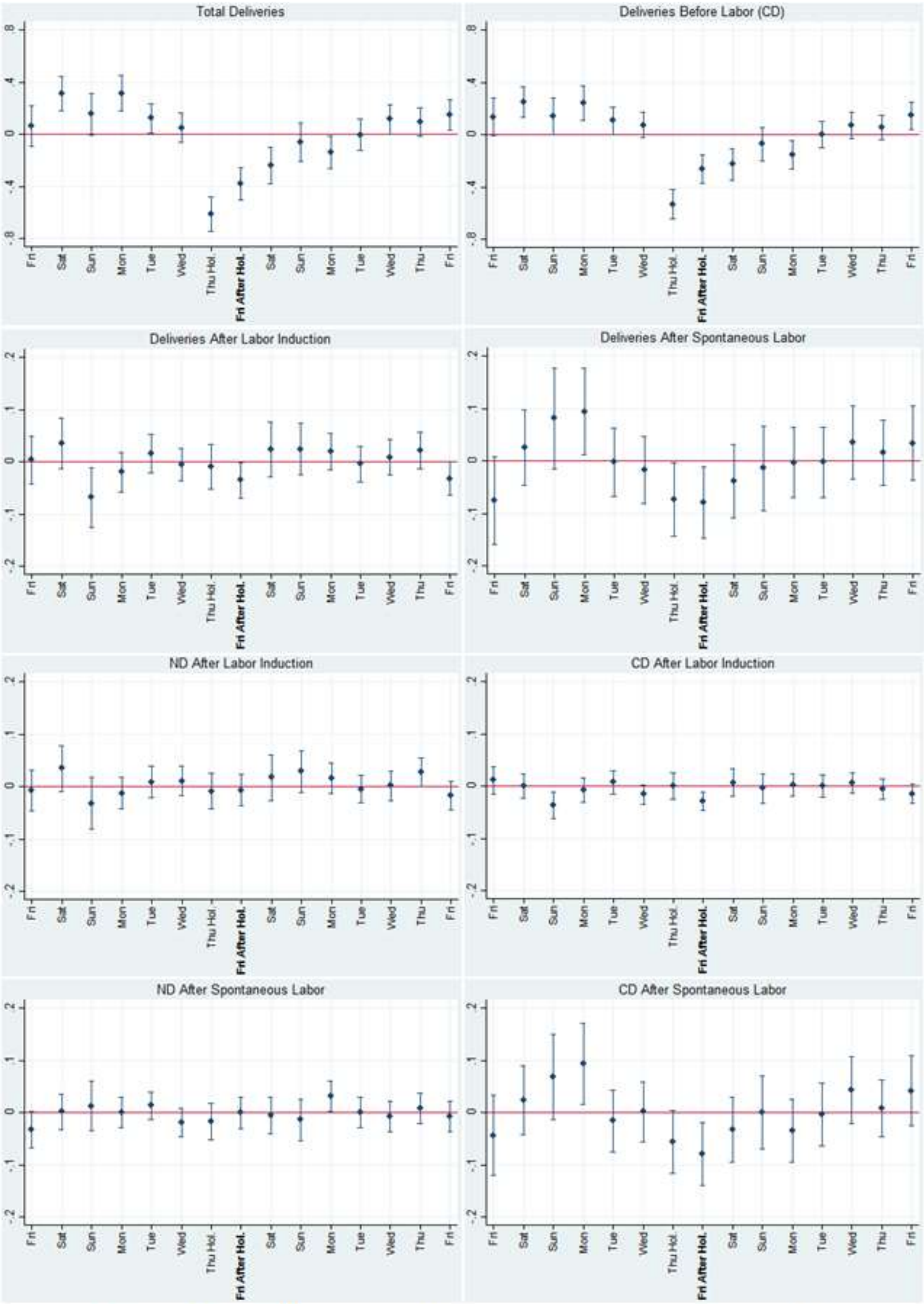


Notes: ND stands for Normal Delivery. Low and High-Risk classifications are detailed in the Data Section.

Source: Datasus/SINASC and Datasus/CNES. Self-elaboration.

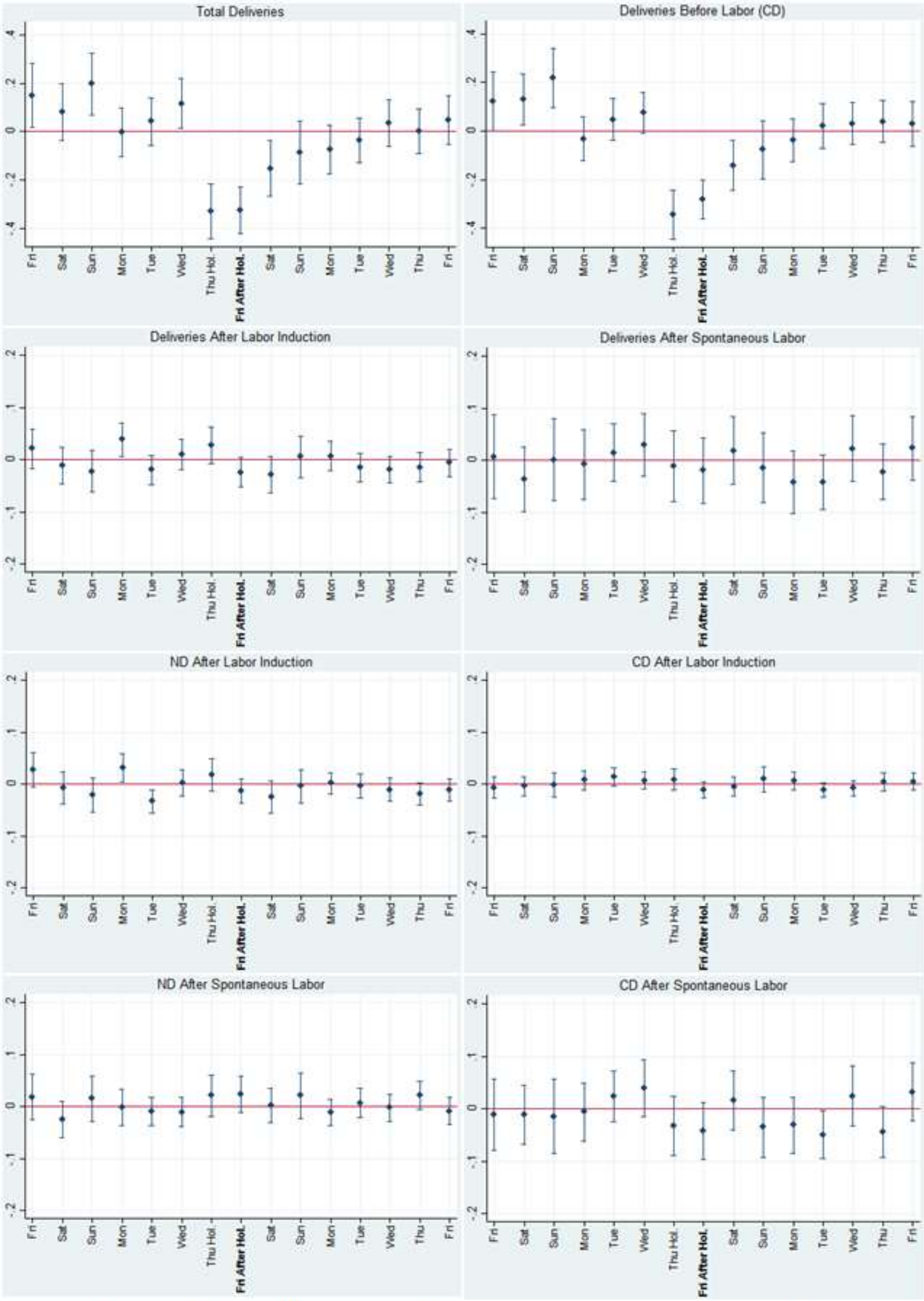
Figure 3: Effect of Fridays Following Thursday Public Holidays on the Number of Daily Deliveries at Private Funded Hospitals (0% SUS) – Range of 7 Days Before and After Friday (with 90% CI)

Panel A: Low-Risk Births



Notes: ND stands for Normal Delivery. Low and High-Risk classifications are detailed in the Data Section.

Panel B: High-Risk Births



Notes: ND stands for Normal Delivery. Low and High-Risk classifications are detailed in the Data Section.

Source: Datasus/SINASC and Datasus/CNES. Self-elaboration.

6 Conclusion

Brazil is the country with the highest rate of invasive birth procedures in the world. Such procedures allow for manipulation of the timing of deliveries regardless of the existence of medical risk factors. Thus, attention should be highlighted not only to the determinants of CD and induction of labor but also to the determinants of birth timing manipulation itself.

We believe this is the first study to isolate the physicians' convenience effect on birth timing manipulation. Our results indicate that physicians working at public funded hospitals anticipate low-risk births due to convenience purposes. Besides, we find that physicians introduce medical technology in births that would have otherwise occurred through a non-induced vaginal delivery. The fact that such physicians should not have incentives to induce CD (neither financial or due to fear of litigation) reassures that physicians' induced demand for this method of delivery is not confounding our results. It is also worth noting that we find evidence of physicians' convenience effect within the public healthcare system even though public physicians are paid a fixed monthly salary to work for a fixed number of hours. Further studies should focus on the physicians' convenience effect specifically within the private sector. In theory, private physicians are expected to extract more utility from manipulating the timing of births to accommodate their personal calendars given that they are not always required to be at work and have more flexibility on how they plan their days.

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