Malpractice Law, Physicians' Financial Incentives, and Medical Treatment: How Do They Interact?*

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Abstract

The effects of malpractice law and financial incentives on physicians are typically studied independently. This paper shows that to make both positive and normative statements about medical malpractice liability, one must consider physicians' legal and financial incentives jointly. I develop a simple model to show that when treatment is unprofitable at the margin, liability mitigation lowers treatment levels; conversely when treatment is profitable, liability mitigation raises them. Motivated by this simple theoretical framework, I analyze the impact of a tort reform in Texas that mitigated malpractice liability. Consistent with the theory, the rate of C-sections among commercially insured mothers, which are considered profitable, increased by 2 percentage points relative to the rate of C-sections among mothers covered by Medicaid, for whom the procedure is thought to be unprofitable.

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1 Introduction

It is often argued that physicians face “too much” medical malpractice liability and deliver excessive, low-benefit treatment due to fear of being sued. This view is consistent with evidence from self-reported data suggesting that physicians alter their clinical behavior to deflect the threat of malpractice liability (Studdert et al., 2005, Reyes, 2010). Although a growing body of literature has been attempting to study this relationship in recent years, the mechanisms that drive the response of medical treatment to malpractice law remain poorly understood and the empirical evidence about the magnitude of the response is often mixed.

A separate body of literature studies physicians’ response to financial incentives. The theory and evidence in this area show that physicians tend to perform fewer procedures when they incur a cost for giving treatment, and, in contrast, tend to perform more procedures when treatment is profitable (see McGuire (2000) for a review of this literature).

This paper investigates the interaction between physicians’ financial incentives and their response to malpractice law in the context of childbirth. Using a simple model of physicians’ decision-making in the case of childbirth, I show that the role of medical malpractice liability in physicians’ decisions to perform C-sections, varies commensurate with the financial incentives they receive. When C-sections generate negative profits, physicians tend to perform too few of them; malpractice liability offsets this tendency and increases the number of C-sections performed. In contrast, when C-sections are profitable, physicians tend to perform unnecessary, low-benefit C-sections; malpractice liability offsets this tendency and mitigates the use of this procedure.

Consequently, the effect of a tort reform on the use of C-sections depends on physicians’ financial incentives. In particular, liability mitigation reduces the use of C-sections when they are unprofitable and raises it when C-sections are profitable. The intuition behind this outcome is that when C-sections are costly to physicians, they are prescribed excessively due to fear of legal liability. Consequently, less liability means fewer C-sections. Conversely, when C-sections are profitable, physicians tend to shower mothers with unnecessary, low-benefit C-sections—a tendency that a liability-mitigating reform would only exacerbate.

The distinction among physicians' financial incentives in the role they play in medical malpractice law is important because it emphasizes the crucial dependence of physicians' behavioral response to malpractice law on their financial incentives. If high healthcare expenditures are driven by fear of litigation, liability mitigation may help to curb excessive treatment. Conversely, if high healthcare expenditures are driven by the profitability of healthcare, mitigating liability will only make things worse.

I test the predictions of the model using a large tort reform that Texas introduced in September 2003 (hereinafter: "the reform"). The reform is an attractive case study because it limited the damages to which healthcare providers might be liable, substantially lowering the providers' liability risk (Hyman et al., 2009).

The main problem in subjecting the matter to empirical analysis is that financial incentives for physicians are not typically observed directly. To address this problem, I follow previous studies that invoke a distinction between commercially insured mothers and those insured by Medicaid, which is known to recompense physicians at lower rates than those provided by commercial insurers. I use the heterogeneity in physicians' financial incentives stemming from these differences in reimbursement generosity as a proxy for providers' financial incentives.

To study the prediction of the model, I estimate the effect of the reform on the likelihood of a woman's undergoing a C-section. Although in the aggregate the reform does not appear to have affected the overall incidence of C-sections, by analyzing its effect by type of insurance I find that, consistent with the theory, C-section rates increased by 2 percentage points among commercially insured mothers relative to mothers insured by Medicaid.

In another recent study, independent of my analysis, Avraham and Schanzenbach

(2009) show that in the case of heart patients, physicians' response to damage caps is consistent with the predictions of the theory propounded here. They find that while treatment intensity declines after a cap on non-economic damages is imposed, the probability of a by-pass increases.

The results of the present paper clearly show that the effect of malpractice law on medical treatment is best analyzed by considering the type of financial incentives at play. They also help to reconcile the gap between the modest effect of malpractice law typically measured in the literature and the evidence from self-reported data that defensive medicine is very common. In particular, I show that a small aggregate response to medical malpractice law may be the sum of offsetting responses associated with different financial incentives.

The rest of the paper is organized as follows: Section 2 reviews the literature, Section 3 presents a simple model of physicians' decision making, Section 4 describes the reform, Section 5 describes the data used for the study, the empirical design and the results, and Section 6 concludes.

2 Literature Review

The interaction between medical malpractice pressure and medical treatment has drawn much attention in the public and scientific discourses in recent decades, much of it based on the premise that physicians practice defensive medicine, i.e., provide low-benefit treatment due to fear of medical malpractice litigation.[1] Recently, a growing body of research has been attempting to better understand this issue by applying various identification strategies in order to examine the causal relation between medical treatment and liability pressure. Still, positive evidence about this issue remains inconclusive.

In the literature on the interaction between procedure utilization in childbirth and

[1] A well known early empirical study on the effect of liability pressure on treatment, Study (1990), found that total costs per discharge are larger in hospitals that have higher claim rates. See Kessler and Rubinfeld (2007) for more examples from early literature.

malpractice pressure, Dubay et al. (1999) found that the greater the malpractice pressure, measured in terms of malpractice premiums, the more C-sections physicians perform, especially on mothers of lower socioeconomic status, with no evidence of better outcomes. Converseley, Currie and MacLeod (2008), using tort reforms, found that Joint and Several Liability reforms reduce complications of labor and the use of procedures such as C-sections, whereas caps on non-economic damages increase them. Kim (2007) reported that the performance of C-sections and the use of ultrasound, forceps, and vacuum are *insensitive* to measures of liability pressure such as claims against obstetricians per number of births. Again, the positive evidence on this issue is mixed.

This is also true for studies in other contexts. In the case of heart patients, Kessler and McClellan (1996) examined the effect of malpractice pressure by studying the impact of two broad classes of tort reforms on medical costs and outcomes for a population of elderly heart patients. They found that while tort reforms have no significant effect on health outcomes, they significantly reduce medical costs, which the authors interpreted as evidence of the existence of defensive medicine.[2] Recently, however, Sloan and Shadle (2009) revisited these results and found no significant effect of tort reforms on medical decisions at all. Studying a broader class of patients, Baicker et al. (2007) found a relation between greater liability pressure and higher expenditure on diagnostic tests with no effect on mortality. Contrarily, Lakdawalla and Seabury (2012), using variation in the generosity of local juries to identify the causal impact of liability pressure on medical costs and mortality, found an association between liability pressure and improved outcomes (i.e. mitigation of patient mortality).

Overall, the lack of conclusive evidence in this literature provides strong motivation for the analysis in this study. By analyzing physicians' specific incentives we may better understand the interaction between medical treatment and malpractice law, reconcile

[2]Kessler and McClellan (2002a) extended their work and found that both managed care and liability reduce procedure use without affecting health outcomes. In another follow-up study, Kessler and McClellan (2002b) found that increases in malpractice pressure lead to significant increases in diagnostic expenditures but not in therapeutic expenditures.

ostensibly contradictory pieces of evidence, and advise policy makers about how tort reforms affect medical treatment.

3 Theory

To better understand the interaction among malpractice law, physicians' financial incentives, and the use of C-sections, I study below a model of a representative physician's behavior in the case of childbirth. I demonstrate that two types of over use of C-sections may occur and analyze how malpractice liability affects them.

3.1 Physician utility

The physician's utility function is assumed to include mothers' benefits and physician's financial incentives (as in Ellis and McGuire (1986)) and, additionally, the expected cost of medical malpractice liability.

3.1.1 Mother benefits

During a childbirth, mothers can receive one of two treatments j, a vaginal birth or a C-section, $j \in \{v, c\}$.

Mothers are heterogeneous in the severity of their condition, s, and it is assumed that the higher s is, the worse the mother's condition is. In the least severe case, i.e., the simplest delivery with no complications, s is normalized to be 0 and $s \in [0, \bar{s}]$. Let $G(s)$ denote the distribution of mothers' conditions: the share of cases in which mother's condition $\tilde{s}$ is less than or equal to s, and let $g(s)$ denote the density function of mothers' conditions. The number of mothers is normalized to unity; thus the total number of mothers with condition $\tilde{s} \leq s$, equals $G(s)$.

Mothers' dollar denominated medical benefits from a delivery, as a dependency of the treatment they receive and the severity of their condition, are denoted by $b(j, s)$. I assume that the following condition holds:

Condition 1 *$b(v,0) > b(c,0)$ and $\frac{\partial b(c,s)}{\partial s} > \frac{\partial b(v,s)}{\partial s}$ for all $s \geq 0$.*

The condition implies that for a simple delivery with no complications, a C-section has lower benefits than a vaginal birth and that the benefits from a vaginal birth rise more slowly than the benefits from a C-section with condition severity. Given Condition 1, there is a unique mother condition severity, s', such that the mother is indifferent between a vaginal birth and a C-section:

$$b(v,s') = b(c,s'). \tag{1}$$

When the mother has condition severity $s > s'$, a C-section has higher benefits than a vaginal birth and conversely, when the mother has condition severity $s < s'$, a C-section has lower benefits than a vaginal birth.

3.1.2 Physician profit

Profits, π^j, capture the physician financial incentives that are associated with procedure j during a childbirth and are assumed to take the following form:

$$\pi^j = f^j - c^j \tag{2}$$

where f and c denote the fee and cost that are associated with procedure j, respectively. That is, profit is assumed to be the difference between the fee that the physician receives for procedure j and the cost the physician incurs in performing that procedure.

3.1.3 Physician medical malpractice liability

The probability of facing medical malpractice liability, as a dependency of the treatment given and the severity of condition, is denoted by $p(j,s)$. As a benchmark, it is assumed that:

Condition 2 $p(v,s') = p(c,s')$ *and* $\frac{\partial p(v,s)}{\partial s} > \frac{\partial p(c,s)}{\partial s}$ *for all* $s \geq 0$.

Intuitively, this is a "perfect" medical malpractice liability system: when the physician's choice of procedure increases the mother's benefits it also decreases the likelihood of malpractice liability (and vice versa). Hence, ex-ante, it gives physicians incentives to provide care in a manner that alleviates the agency problem that arises in the physician-patient relationship (Danzon, 2000).

It is useful to discuss the association between this assumption and the real-world decision between a vaginal delivery and a C-section. The assumption has two implications: withholding a necessary C-section increases the likelihood of a lawsuit and performing an unnecessary C-section increases the likelihood of a lawsuit. With respect to the former, it seems intuitive that when physicians are worried about malpractice lawsuits they will tend to do more C-sections when such are needed due to fear of a lawsuit, i.e., in cases of a severe condition, withholding a C-section may be reason for a malpractice lawsuit. One may argue, however, that in reality, the latter part of the assumption is less compelling. Namely, it is much more difficult to base a lawsuit on the claim that a C-section was unnecessary; thus, medical malpractice law is unlikely to reduce the use of unnecessary C-sections. Nevertheless, one reason to think that fear of medical malpractice may reduce the tendency to perform unnecessary C-sections is that, relative to a vaginal birth, more things may go wrong during an unnecessary C-section, resulting in a malpractice lawsuit. Hence, unnecessary C-sections do increase exposure to malpractice litigation. Evidence form self-reported data suggests that physicians do perceive C-sections in this manner: in a survey among physicians, 66% of respondents report having reduced or eliminated the use of procedures due to fear of malpractice litigation (Paik et al., 2012).[3]

H is the expected cost of facing medical malpractice liability. Note that in practice physicians are typically insured against malpractice claims, hence the costs associated

[3]See Avraham and Schanzenbach (2009) for further discussion of this issue.

with litigation which enter H include time loss, damage to reputation and promotion, etc. (See discussion in Currie and MacLeod (2008)). For simplicity, providers are assumed to be risk-neutral with respect to medical malpractice liability.

3.2 Physicians' behavior

Physician's utility includes physician profits, mother's medical benefits and expected malpractice costs and is assumed to take the following form[4]:

$$u(j,s) = \pi(j) + \alpha b(j,s) - p(j,s) \cdot H \tag{3}$$

where α is the degree of physician altruism, i.e., the weight that the physician attaches to mothers' benefits from treatment. One can show that there exists a cut-off level of condition severity, s^c, such that $u(v,s) > u(c,s)$ for all $s < s^c$; conversely, $u(v,s) < u(c,s)$ for all $s > s^c$. The physician maximizes her total benefits from treatment by choosing the optimal cut-off:

$$\max_{s} \Pi(s) + \alpha B(s) - P(s) \cdot H \tag{4}$$

where, $\Pi(s) = \pi^v \cdot G(s) + \pi^c \cdot (1 - G(s))$, $B(s) = \int_0^s b(v,s)g(s)ds + \int_s^{\bar{s}} b(c,s)g(s)ds$ and $P(s) = \int_0^s p(v,s)g(s)ds + \int_s^{\bar{s}} p(c,s)g(s)ds$. The first-order condition is given by

$$\pi^c - \pi^v = \alpha(b(v,s^c) - b(c,s^c)) - (p(v,s^c) - p(c,s^c)) \cdot H. \tag{5}$$

To further simplify the first-order condition I denote $\pi^c - \pi^v$, $b(c,s) - b(v,s)$ and $p(c,s) - p(v,s)$ as $\Delta\pi$, $\Delta b(s)$ and $\Delta p(s)$, respectively. These terms can be interpreted as follows: $\Delta\pi$ captures the physician's net profits from choosing a C-section rather than a vaginal birth; $\Delta b(s)$ and $\Delta p(s)$ are the mother's relative benefits and the physician's relative

[4]The additivity assumption simplifies the presentation but does not drive the results.

medical malpractice liability cost from choosing a C-section rather than a vaginal birth, respectively. Note that given Conditions 1 and 2, $\Delta b(s)$ and $\Delta p(s)$ have opposite signs and they both equal zero when $s = s'$. Intuitively, when the mother's relative benefits from a procedure are positive, the probability of facing medical malpractice liability cost from choosing this procedure is lower. Using these new terms, I rewrite the first-order condition in Equation (5):

$$\Delta\pi = -\alpha\Delta b(s^c) + \Delta p(s^c) \cdot H. \tag{6}$$

This formulation illustrates that when setting the optimal mother's condition severity cut-off, the physician considers the procedure's relative costs and benefits; namely, the physician trades-off the net profit from choosing a C-section against both the mother's relative benefits and the physician's relative medical malpractice liability cost from choosing a C-section.

3.3 The role of medical malpractice liability

Using Equation 6, one may interpret the role of the medical malpractice system in the physician's choice between a C-section and a vaginal birth by totally differentiating Equation (6) w.r.t H.

$$\begin{aligned} 0 &= \frac{\partial s^c}{\partial H}(-\alpha\frac{\partial \Delta b(s^c)}{\partial s^c} + \frac{\partial \Delta p(s^c)}{\partial s^c} \cdot H) + \Delta p(s^c) \\ \frac{\partial s^c}{\partial H} &= -\Delta p(s^c)\backslash(-\alpha\frac{\partial \Delta b(s^c)}{\partial s^c} + \frac{\partial \Delta p(s^c)}{\partial s^c} \cdot H) \\ \Rightarrow sign\{\frac{\partial s^c}{\partial H}\} &= -sign\{\Delta b(s^c)\} \end{aligned} \tag{7}$$

where the third line follows from: (1) the denominator in the second line is negative; (2) $-sign\{\Delta b(s^c)\} = sign\{\Delta p(s^c)\}$.

Equation (7) shows that when $\Delta b(s^c)$ is positive—and $s^c > s'$, an increase in H decreases s^c towards s'. Conversely, when $\Delta b(s^c)$ is negative—and $s^c < s'$, an increase in

H increases s^c towards s'. Thus, a more stringent medical malpractice system "pushes" the condition cut-off, s^c, towards s' and alleviates the patient physician agency problem.

3.4 The Planner's problem

Mothers' benefits are assumed to be equal to the full social benefit of the treatment. I denote the social cost of a procedure as tc^j and assume that the social costs of a C-section are higher than those of a vaginal birth, i.e., $tc^c > tc^v$. One can write the social planner's problem, taking into account mothers' benefits and social costs of treatment, as follows:

$$\max_s B(s) - TC(s) \tag{8}$$

where, for a given s, $TC(s) = tc^v \cdot G(s) + tc^c \cdot (1 - G(s))$. The first-order condition of the planner's problem is given by:

$$tc^c - tc^v = -(b(c, s^*) - b(v, s^*)). \tag{9}$$

The social planner sets s^* such that the net social cost of a C-section for the marginal condition severity equals its net marginal benefit. Note that due to the higher social costs that are associated with a C-section, relative to a vaginal birth, the socially optimal condition severity cut-off between a vaginal birth and a C-section, s^*, is higher than the mothers' condition severity indifference level, i.e., $s^* > s'$.

3.5 Profitability and physicians' choice of treatment

One may distinguish between two types of financial incentives. The first is $\Delta\pi > 0$: when the fee differential between a C-section and a vaginal birth is larger than the cost differential, performing a C-section is profitable (the incentives are of the *positive-*

profit type). The second is $\Delta\pi \leq 0$: when the fee differential between a C-section and a vaginal birth is smaller than (or equal to) the cost differential, performing a C-section incurs negative profit (the incentives are of the *negative-profit* type).

Figure 1 illustrates the relation between profitability of C-sections and the physician's choice of mother condition severity cut-off, s^c. The figure depicts the mother's benefits from a C-section and a vaginal birth diagrams, $b(c, s)$ and $b(v, s)$, respectively. The two diagrams intercept at $s = s'$, the mothers' condition severity indifference level. When positive-profit incentives exist, physicians set $s^c < s'$, the *profit-seeking medicine region.*[5] Intuitively, so long as $s \geq s'$, the $b(c, s)$ diagram is above the $b(v, s)$ diagram and there is no trade-off in treatment provision: C-sections are profitable, mother benefits from a C-section are larger than the benefits from a vaginal birth and, likewise, medical malpractice liability cost of choosing a C-section is lower. Decreasing s^c increases mothers' benefits and profit and decreases the likelihood of malpractice liability. Only when $s^c < s'$—the $b(c, s)$ diagram is below the $b(v, s)$ diagram in this region—does a trade-off emerge. While additional treatment is profitable, it reduces mother benefits and increases the likelihood of being sued for malpractice.

Analogously, where negative-profit incentives exist, physicians set $s^c \geq s'$. It is easy to show that where this type of financial incentives exists, there exists a unique H^* at which the social optimum is attained; it is characterized by

$$\Delta\pi = -\alpha\Delta b(s^{c*}) + \Delta p(s^{c*}) \cdot H^*. \tag{10}$$

By implication, two regions of provision exist under negative-profits incentives. The first, when $H < H^*$, is the *under-provision region*,[6] $\bar{s} > s^c > s^*$, where too little care is provided due to low liability pressure and high treatment cost. The second, when $H > H^*$, is the *defensive medicine region*, $s^* > s^c > s'$, where low-benefit healthcare

[5] This type of behavior is also referred to as "induced-demand" (Gruber and Owings, 1996) or "offensive medicine" (Avraham, 2009).

[6] This region is also called "underuse" in the legal literature (Avraham, 2009).

is provided due to high liability pressure, as illustrated in Figure 1.

3.6 Financial incentives and the effect of tort reform

Now consider the effect of tort reform on physicians' behavior under the two types of financial incentives. The intuition underlying this effect follows from Equation 7, namely, a more stringent medical malpractice system "pushes" the condition cut-off, s^c, towards s'. When C-sections generate negative profits, financial considerations tend to decrease their use; malpractice law would offset this tendency, i.e., an increase in malpractice liability pressure would induce an increase in the use of C-sections. In contrast, when C-sections are profitable, financial considerations would tend to raise their use and malpractice law would mitigate it; thus, greater liability would diminish the use of C-sections. The following proposition captures this intuition:

Proposition 1. *The effect of an increase in expected malpractice liability costs depends on physicians' financial incentives. When physicians have negative-profit (positive-profit) incentives, an increase in the expected cost of malpractice liability increases (decreases) the use of C-sections.*

Proof of Proposition 1. The logic of the proposition is straight forward. For negative-profit incentives, physicians trade off the negative profit against the benefits that they gain by performing a C-section, which include both mothers' benefits and lower expected malpractice liability costs. The higher the cost of malpractice, the more C-sections physicians tend to perform. The logic behind positive-profit incentives is similar (See Appendix A for the proof).

The foregoing analysis distinguishes among three regions of treatment: under-provision, defensive medicine, and profit-seeking. It is important to distinguish among these regions of treatment in crafting optimal medical malpractice policy. In defensive medicine, physicians perform too many C-sections due to fear of lawsuits; this makes it desirable to reduce malpractice liability. In the profit-seeking medicine region, unnecessary C-sections are performed because they are profitable, despite the exposure to malpractice liability. In the under-provision region, few C-sections are performed due to their costs, despite the loss of mother benefits and the exposure to malpractice liability. In both of the last-mentioned cases, an increase in liability pressure is desirable.

The following corollary captures this intuition, showing that when C-sections are overprovided, it is important to distinguish between defensive-medicine and profit-seeking medicine.

Corollary 1. *The welfare effect of a liability-increasing tort reform when $s < s^*$ depends on physicians' financial incentives. When physicians have positive-profit (negative-profit) incentives, an increase in the expected costs of medical malpractice liability increases (reduces) social welfare.*

Proof of Corollary 1. A liability increasing tort reform moves society towards social optimum s^* when physicians have positive-profit incentives and away from social optimum s^* when physicians have negative-profit incentives. QED.

4 Background—the Texas Tort Reform

On June 1 2003, Texas passed a tort reform reducing malpractice liability by capping non-economic damages in medical malpractice claims. Texas law requires a constitutional amendment authorizing the legislature to limit noneconomic damages in healthcare liability claims. The voters passed the amendment on September 13, 2003 after months of fierce public debate on which the opposing sides spent some $20 million dollars (Roberson and Torbenson, 2007).

The reform imposed a cap on noneconomic damages[7] in medical malpractice suits

[7] "Noneconomic damages" means damages for physical pain and suffering, mental or emotional pain or

filed against physicians and licensed healthcare providers after September 1, 2003 to \$250,000.[8] It also made several changes in the procedures regarding medical malpractice claims. An important change was that a claimant must now file, within 120 days after the claim is filed, an expert report, a written report by an expert regarding her opinion on how the standard of care rendered by the physician or healthcare provider failed to meet applicable standards and the causal relationship this and the harm sustained by the claimant. Generally, such experts must be physicians or persons in the same occupation as the healthcare provider.

A recent study by Hyman et al. (2009) used claim level data to estimate the effect of the reform on jury verdicts, post-verdict payouts, and settlements. Using simulations based on medical malpractice cases closed in 1988–2004, the authors found that the cap affected 47-percent of verdicts and substantially reduced the mean of non-economic damages. They also found that in cases settled without trial, the noneconomic cap reduced the predicted mean total payout by 18 percent. Consequently the reform had a major alleviating impact on medical malpractice pressure in Texas. More generally, Avraham (2007) found that liability-mitigating reforms tend to reduce the number of cases and the average awards.

5 Empirical Analysis

The objective of the empirical analysis is to study the relationship between treatment intensity and tort reforms under different financial incentives. I exploit the natural experiment that was created in June 2003 when Texas instituted the aforementioned tort reform. Focusing on the use of C-sections, one of the most common medical procedures that is thought to be highly sensitive to physician incentives (Smarr, 1997),

anguish, loss of consortium, disfigurement, physical impairment, loss of companionship and society, inconvenience, loss of enjoyment of life, injury to reputation, and all other nonpecuniary losses other than exemplary damages.

[8] All the cap amounts mentioned here are nominal and not adjusted for inflation. A separate \$250,000 cap applies to each hospital, with total noneconomic damages capped at \$500,000 for all health care facilities.

I study the effect of the Texas reform on the decision to perform a C-section rather than a vaginal birth.

The main difficulty in doing the empirical analysis is that financial incentives for providers are typically unobservable, making it challenging to address this issue and test the predictions of the theory. As a first step toward addressing the problem, I take advantage of the fact that Medicaid reimbursement to physicians is much less generous than commercial insurance reimbursement and base my approach on a comparison between physicians' response to the reform among commercially insured mothers versus among those covered by Medicaid. Particularly, the national average difference in physician-fees between C-section and a vaginal birth ($f^c - f^v$) was \$723 among commercially insured mothers in 2004 (Chang, 2007) as against \$149 among Medicaid-insured mothers in 2003 (Zuckerman et al., 2009).[9] Based on the relative value units estimates of C-sections and vaginal births determined by CMS (Centers for Medicare and Medicaid Services), the difference in physicians' direct costs for doing these procedures ($c^c - c^v$) was roughly \$200 in 2003.[10] Combining these amounts we find that, on average, $\Delta\pi$ is negative under Medicaid (i.e. a negative-profit incentive exists) and positive under commercial insurance (a positive-profit financial incentive exists).[11]

C-sections are considered to be sensitive to the financial incentives that fee differentials create. Currie and Gruber (2001) showed that the smaller fee differentials between C-section and vaginal childbirth under Medicaid than under commercial insurance are associated with lower C-section rates among Medicaid mothers. Gruber et al. (1999) found that smaller fee differentials can explain between one half and three-quarters of

[9] Gruber, Kim, and Mayzlin (1999) report similar figures: on average, the national differential in fees in 1989 was \$561 for the privately insured and only \$127 for the Medicaid population.

[10] The calculation is based on a comparison between the non facility RVUs (excluding malpractice) of CPT 59400 (vaginal delivery) and 59510 (C-section), in 2003 in Dallas Tx. Note that this is a resource based measure of *physician* service value, which for a given service should be quite uniform across physicians regardless of their patient insurance type. The calculation was done using the online physician fee schedule search tool (http://www.cms.gov/apps/physician-fee-schedule).

[11] This approach is based on the premise that, on the margin, procedure choice is determined by the physician. Thus, it abstracts from the issue of hospital costs and incentives.

the difference between Medicaid and commercial C-section rates. Therefore, on the basis of this body of work, the decision to perform a C-section is potentially a good candidate for the study of providers' response to tort reforms under different financial incentives.

Relying on this approach, I study the change in the utilization of C-sections after the reform among mothers insured by commercial carriers relative to that among Medicaid mothers. The model predicts that after a liability-mitigating tort reform, C-section utilization among commercially insured mothers will increase relative to that among Medicaid mothers. I test this prediction using a standard differences-in-differences methodology:

$$\begin{aligned} C\text{-}section_{ist} = a + b_1 Time_t + b_2 Comm + b_3 Ref * Comm \\ + b_4 Char_{ist} + b_5 Hosp + \varepsilon_{ist} \end{aligned} \tag{11}$$

where $Time_t$ is a full set of time period dummies, namely, a vector of dummy variables for each quarter in the relevant time period, $Comm$ is an indicator of insurance type—that is, $comm = 1$ if a woman is insured by a commercial carrier and $comm = 0$ if a woman is insured by Medicaid, $Char_{ist}$ is a vector of mothers' personal characteristics,[12] and $Hosp$ is a vector of dummy variables for each hospital. The estimates of b_3, the coefficient of $Ref * Comm$, capture the relative effect of the reform on the probability of preforming a C-section on a commercially insured mother relative to a Medicaid mother.

Identification in this case is based on the claim that while treatment levels may vary between the two insurance types, the *difference* between the C-section rates of the two insurance types would have stayed constant absent the reform, i.e., they share a common trend. This assumption is supported by evidence that despite substantial

[12] These include age group, race and a dummy for high-risk that equals 1 if one of the following diagnoses exist: Previous C-section, breech position, early onset, polyhydramnios, oligohydramnios, obesity, diabetes, multiple gestation, distress, hypertension and hemorrhage.

local variation in the level of C-sections, the trend in C-section rates reflects factors that mothers of both insurance types share, such as clinical guidelines (see Epstein and Nicholson, 2009).

Of course, this assumption is not guaranteed. A key concern is that this assumption would be violated due to non-random selection of women into insurance types over time. As I noted above, I address this issue by including the woman's personal characteristics in the analysis. This inclusion should control for the differential trends that arise from changes in the characteristics of the two insurance-type groups over time. Additionally, the differences-in-differences approach identifies the interaction of the reform and physicians' financial incentives so long as there are no differential trends in procedure choice across insurance types. I evaluate the validity of the approach by comparing the changes in C-section rates among the two insurance types in the "treatment" state, Texas, with a comparison state, in which no similar reform took place, using a triple-difference methodology. California is a natural candidate for this purpose because it is the closest state to Texas in population, GDP and ethnic diversity; hence I use it as a comparison state in the analysis that follow.[13] I then further validate the identification assumption by a placebo analysis, estimating the effect of a fictitious reform in the first quarter of 2001. I proceed by examining alternative possible explanations to the results.

5.1 Data

I use deliveries in 2000-Q1–2007-Q4 for mothers aged 25-34,[14] culled from the Texas Public Use Data File (PUDF), and employed California Patient Discharge Data to obtain a control group. The data contain information on patient demographics, length

[13] I re-ran the analysis using the Nationwide Inpatient Sample from the Healthcare Cost and Utilization Project (HCUP), omitting California, as an alternative comparison group and the results were almost identical (see appendix B).

[14] I chose this age group because in Texas, 80% of mothers under age 25 are insured by Medicaid and 80% of mothers above age 34 are commercially insured. By focusing on the 25-34 cohort I generated a more comparable sample. However, including all mothers in the sample generated very similar results.

of stay, discharge status (alive or dead), diagnosis (including primary and secondary ICD-9CM and diagnosis related group (DRG) codes), source of payment, and procedure codes. The data also include discharge quarter and hospital identification number.

Table 1 presents descriptive statistics for commercially insured mothers and Medicaid mothers in Texas and in California. In both states, the share of African-Americans and Hispanics is higher among Medicaid mothers than among commercially insured mothers and Medicaid mothers are also more likely than the others to have undergone a previous C-section.

Figure 2, plotting C-section rates for Texas and California in 2000-Q1–2007-Q4, shows that the rates in Texas and California increased steadily during the sample period and were roughly 4 percentage points lower in California than in Texas. On the basis of the raw data, the Texas reform does not appear to have had a striking effect on aggregate C-section rates.

5.2 Results

5.2.1 Effects on C-section utilization

Figures 3 and 4 plot C-section rates for commercially insured mothers and Medicaid mothers in Texas and California. In Texas (Figure 3), before the reform, the rates were similar for both types of insurance and followed a similar time trend. After the reform, commercial insurance C-section rates appeared to grow faster than those of Medicaid. Thus, the C-section levels under the two types of insurances diverged. In California, in contrast (Figure 4), Medicaid and commercial C-section rates appeared to follow a similar trend, showing no evidence of a similar divergence.[15]

[15]Note that, Medicaid C-section rates were similar to commercial insurance C-section rates in Texas in the pre-reform period and they were higher than Commercial insurance C-section rates in California during the entire sample period, despite the stronger financial incentives to choose C-sections in commercially insured mothers. One possible explanation to this point is that, other things being equal, Medicaid mothers are more likely to undergo a C-section because the mother condition severity distribution in the two insurance types is different. Table 1 shows, for example, that the share of Medicaid mothers who previously undergone a C-section—which almost always imply a C-section—is 36% and 50% higher than this share in commercially

To validate the identification strategy, before turning to the estimation results, I inspect the evolution of the number of births by insurance type. Had an insurance-specific shock occurred in Texas around the time of the reform, it presumably would have affected the number of births. Therefore, a smooth trend in the number of births around the reform supports the causal interpretation of the results and alleviates the concern that they were driven by an insurance-specific shock. Figures 5(a)-(b) plot the number of births under Medicaid and under a commercial carrier in Texas and in California during the sample period, respectively. The figures show, in both states, an upward trend in the number of Medicaid births and a downward trend in the number of commercial-insurance births. In both insurance types the numbers of births in both states are parallel and appear to be quite smooth around the reform notwithstanding some seasonality. These figures show no evidence of an insurance specific shock to the number of births during the sample period.

The baseline regression estimation results are summarized in Columns (1)-(3) of Table 2. Consistent with the graphic illustration, the estimates reveal that after the reform, the overall incidence of C-sections among mothers insured by a commercial carrier increased by approximately 2 percentage points relative to mothers insured by Medicaid. The results are robust to the inclusion of hospital fixed effects (in column 2) and mothers' personal characteristics (in column 3), supporting the view that the results are not an artifact of non-random selection into insurance type over time. Columns (4)-(6) of Table 2 show the estimates from a placebo difference-in-difference analysis for the comparison state, California. The table shows no statistically significant evidence of a similar increase in the incidence of C-sections after the reform in this state.

insured mothers in Texas and California, respectively. Another explanation may be variation in C-section rates across hospitals. Some hospitals tend to treat mainly women under one of the insurance types: in roughly 10% of hospitals in the sample, 95% or more of the mothers are commercially insured and in about 5% of hospitals, 95% or more of the mothers are insured by Medicaid. Therefore, heterogeneity in C-section rates across hospitals might also explain this point.

Putting together the first two panels of Table 2, I construct a DDD ("triple" difference) estimate of the effect of the reform. Note that both within-state and within-insurance time trends are differenced out in the DDD. This estimate controls for both insurance-specific and state-specific shocks. Therefore, the identification assumption in the triple difference is that, during the sample period, there was no shock that affected only mothers under Medicaid and only in Texas. Since I am not aware of any insurance-specific shocks that had a differential effect on mothers under Medicaid in Texas around the time of the reform, this assumption appears plausible. Next, in the third panel of Table 2, I estimate a series of regression models with covariate sets corresponding to the foregoing difference-in-difference analysis. I estimate variants of the following DDD model:

$$\begin{aligned} C\text{-}section_{irst} = a &+ b_1 State_r + b_2 Time_t + b_3 Comm \\ &+ b_4 State_r * Time_t + b_5 Comm * Time_t + b_6 State_r * Comm \\ &+ b_7 Ref * Comm * State_r + b_8 Char_{ist} + b_9 Hosp + \varepsilon_{irst} \end{aligned} \tag{12}$$

where $State_r$ is a state indicator variable that equals 1 in Texas deliveries and zero in California deliveries. As in Equation 11, $Time_t$, is a full set of time period dummies, $Comm$ is an indicator of insurance type, $Char_{ist}$ is a vector of mothers' personal characteristics, and $Hosp$ is a vector of dummy variables for each hospital. The estimates of b_7, the coefficient of $Ref * Comm * State$, capture the relative effect of the reform on the probability of preforming a C-section by type of insurance.

Columns (7)-(9) of Table 2 show the results of this analysis. The DDD results reflect a statistically significant increase of 2-2.5 percentage points in C-section rates of commercially insured mothers relative to those of Medicaid mothers.

Placebo reform. In order to further validate the identification assumption, I check for unusual patterns in the period before the reform. A statistically significant treatment effect before the "treatment" would be evidence against the identification assumption because it would indicate that the trends had been diverging before the treatment. In Table 3, I replicate the analysis in Table 2, for a fictitious reform in the first quarter of 2001 using 1999-Q1–2000Q-4 as the pre-period and 2001-Q1–2002-Q4 as the post-period. Reassuringly, the table shows that the analysis of the fictitious reform had but small and insignificant effect on C-section rates in both Texas and California.[16]

5.2.2 The causal role of financial incentives

While the results are consistent with the theory of interaction between financial incentives and malpractice law, they may lend themselves to alternative explanations. In particular, one may suspect that the differential effect of the reform traces to two selection issues: selection of mothers of different socioeconomic statuses into the two insurance types and, selection of physicians with different characteristics into treating mothers of the two insurance types. Below I explore the role of these alternative explanations in generating the results.

The first issue is that mothers under Medicaid tend to be, by definition, lower in socioeconomic status than privately insured mothers. Assuming such mothers are much less likely to sue their physician and that socioeconomic status is observable to physicians, treatment of Medicaid mothers may be less sensitive to tort reforms. One way to examine this possibility is by controlling for the time-varying effect of socioeconomic status when estimating the impact of the reform. To do this, I use income data at the zip-code level from IRS records (2001) as a measure of a mother's socioeconomic status.[17] I divide the inpatient data into five income quintiles by the mothers' zip-codes and re-run the analysis in Table 2 controlling for the time-varying effect of zip-code level income. Table 4 displays the results. The estimates of the impact of the reform by insurance type are 1.9-2.3 percentage points, almost identical to those in the baseline analysis in Table 2. Therefore, these results show no evidence

[16] I further explore the results using the leads and lags analysis in Appendix B

[17] These data were recently used, for example, by Mian and Sufi (2011).

in support of the possibility that mothers' socioeconomic status affected the impact of the reform on the choice of C-sections.

The second alternative explanation is that physicians with different characteristics may self-select to treat mothers under the two insurance types. If this is so, the estimation results in Table 2 may capture cross-sectional differences in physicians' treatment patterns. One way to examine this is to add to the analysis physician fixed-effects which absorb the physician-level differences.[18] If the estimates are robust to this modification, it will provide additional support to the financial incentives hypothesis. Table 5 displays the results of this analysis. The table shows that, with physician fixed effects, the results remain almost identical to the results in Table 2, with roughly a 2 percentage points increase in C-sections among mothers insured by a commercial carrier relative to mothers insured by Medicaid.

Of course, these tests do not completely refute these alternative hypotheses. Mothers' socioeconomic status and physician characteristics may be the causes of the differential response to the reform. Future research, using a different identification strategy, might allow identification of the interaction of malpractice law and financial incentives in an environment where these issues are of less importance.

In sum, analysis of the response of C-section rates to the reform shows an increase in C-section rates of commercially insured mothers relative to mothers under Medicaid. The results support the view that the response to the reform depends on physicians' financial incentives.

6 Conclusions

This paper uses a simple model to show that the relationship between medical malpractice law and medical treatment, applied in the case of childbirth, depends crucially

[18]Note that physician identifiers are unavailable for California and therefore were not included in the previous section.

on the financial incentives that physicians are offered. Medical malpractice law has different effects on the ex-ante behavior of physicians, under different financial incentives. When high C-section utilization is driven by fear of litigation, reducing liability may help curb excessive treatment; conversely, when high C-section utilization trace to the profitability of providing the care, mitigating liability would only make things worse.

Using a large tort reform in Texas, I examined the effect of mitigating medical malpractice liability on the incidence of C-sections. I found that C-sections became more prevalent among commercially insured mothers relative to mothers insured by Medicaid. These results underscore the importance for policy makers of understanding physicians' legal and financial incentives when they consider the implementation of a tort reform.

Interestingly, Currie and MacLeod (2008) found an increase in C-section rates after similar reforms that capped non-economic damages. This is surprising, since C-sections are considered a more conservative and expensive treatment than vaginal births. The findings in this paper may be viewed as providing "micro foundations" for Currie and MacLeod's findings by showing that when C-sections are profitable, their rates of use are expected to increase after malpractice liability is mitigated. This response may offset other effects of the reform resulting in an overall increase in C-section rates.

Finally, the results of this study may help to reconcile the gap between the modest effects of the relationship between malpractice law and treatment, as typically measured in the literature, and the evidence from self-reported data, that defensive medicine is very common. In particular, the results show that a small aggregate response to malpractice law may be the sum of offsetting responses arising from different types of financial incentives.

References

Ronen Avraham. An Empirical Study of the Impact of Tort Reforms on Medical Malpractice Settlement Payments. *The Journal of Legal Studies*, 36(S2):183–229, 2007.

Ronen Avraham. Private regulation. *Harvard Journal of Law and Public Policy*, 34 (2), 2009.

Ronen Avraham and Max Schanzenbach. The impact of tort reform on intensity of treatment: Evidence from the heart patients. *Available at SSRN 1441957*, 2009.

Katherine Baicker, Elliott S. Fisher, and Amitabh Chandra. Malpractice Liability Costs And The Practice Of Medicine In The Medicare Program. *Health Affairs*, 26 (3):841–852, 2007.

Stella Chang. The healthcare costs of having a baby. *Thomson Healthcare, July*, 2007.

Janet Currie and Jonathan Gruber. Public health insurance and medical treatment: the equalizing impact of the medicaid expansions. *Journal of Public Economics*, 82 (1):63 – 89, 2001.

Janet Currie and W. Bentley MacLeod. First Do No Harm? Tort Reform and Birth Outcomes*. *Quarterly Journal of Economics*, 123(2):795–830, 2008.

Patricia M. Danzon. Liability for medical malpractice. *Handbook of Health Economics*, 1:1339–1404, 2000.

Lisa Dubay, Robert Kaestner, and Timothy Waidmann. The impact of malpractice fears on cesarean section rates. *Journal of Health Economics*, 18(4):491–522, 1999.

Randall P Ellis and Thomas G McGuire. Provider behavior under prospective reimbursement. Cost sharing and supply. *Journal of health economics*, 5(2):129, 1986.

Andrew J Epstein and Sean Nicholson. The formation and evolution of physician treatment styles: An application to cesarean sections. *Journal of health economics*, 28(6):1126–1140, 2009.

Jonathan Gruber and Maria Owings. Physician financial incentives and cesarean section delivery. *The RAND Journal of Economics*, 27(1):99–123, 1996.

Jonathan Gruber, John Kim, and Dina Mayzlin. Physician fees and procedure intensity: the case of cesarean delivery. *Journal of Health Economics*, 18(4):473 – 490, 1999.

David A Hyman, Bernard Black, Charles Silver, and William M Sage. Estimating the effect of damages caps in medical malpractice cases: evidence from Texas. *Journal of Legal Analysis*, 1(1):355–409, 2009.

Daniel Kessler and Mark McClellan. Do doctors practice defensive medicine? *The Quarterly Journal of Economics*, 111(2):353–390, 1996.

Daniel Kessler and Mark McClellan. Malpractice law and health care reform: optimal liability policy in an era of managed care. *Journal of Public Economics*, 84(2): 175–197, 2002a.

Daniel P Kessler and Mark B McClellan. How liability law affects medical productivity. *Journal of Health Economics*, 21(6):931–955, 2002b.

Daniel P. Kessler and Daniel L. Rubinfeld. Chapter 5 Empirical Study of the Civil Justice System. In A.M. Polinsky and S. Shavell, editors, *Handbook of Law and Economics*, volume 1 of *Handbook of Law and Economics*, pages 343 – 402. Elsevier, 2007.

Beomsoo Kim. The Impact of Malpractice Risk on the Use of Obstetrics Procedures. *The Journal of Legal Studies*, 36(S2):79–119, 2007.

Darius N. Lakdawalla and Seth A. Seabury. The welfare effects of medical malpractice liability. *International Review of Law and Economics*, 32(4):356 – 369, 2012.

Anup Malani and Julian Reif. Accounting for anticipation effects: An application to medical malpractice tort reform. *NBER Working Paper Series*, 16593, 2010.

Thomas G McGuire. Physician agency. *Handbook of health economics*, 1:461–536, 2000.

Atif Mian and Amir Sufi. House prices, home equitybased borrowing, and the us household leverage crisis. *The American Economic Review*, 101(5):2132–2156, 2011.

Myungho Paik, Bernard S. Black, David A. Hyman, and Charles Silver. Will tort reform bend the cost curve? evidence from texas. *Journal of Empirical Legal Studies*, 9(2): 173–216, 2012.

Jessica Wolpaw Reyes. The effect of malpractice liability on the specialty of obstetrics and gynecology. Working Paper 15841, National Bureau of Economic Research, March 2010.

Jason Roberson and Eric Torbenson. Tort reform: Debate still thrives over limit on damages in texas malpractice suits. *Dallas Morning News, The (TX)*, 2007.

Frank A Sloan and John H Shadle. Is there empirical evidence for Defensive Medicine? A reassessment. *Journal of health economics*, 28(2):481–491, 2009.

Lawrence E Smarr. Comparative Assessment of the PIAA Data Sharing Project and the National Practitioner Data Bank: Policy, Purpose, and Application. *Law AND Contemporary Problems*, 60:59, 1997.

David M Studdert, Michelle M Mello, William M Sage, Catherine M DesRoches, Jordon Peugh, Kinga Zapert, and Troyen A Brennan. Defensive medicine among high-risk specialist physicians in a volatile malpractice environment. *JAMA: the journal of the American Medical Association*, 293(21):2609, 2005.

The Harvard Medical Practice Study. *Patients, doctors, and lawyers : medical injury, malpractice litigation, and patient compensation in New York : a report.* The President and Fellows of Harvard College, Cambridge, Mass, first edition, 1990.

Stephen Zuckerman, Aimee F. Williams, and Karen E. Stockley. Trends In Medicaid Physician Fees, 2003-2008. *Health Affairs*, 28(3):w510–w519, 2009.

Table 1: Childbirth Sample Summary Statistics

	Texas		California	
	Medicaid	Commercial	Medicaid	Commercial
Age (median)	30-34	30-34	25-29	30-34
Mother Hispanic	64.1%	23.7%	64.8%	23.1%
Mother African American	10.5%	7.8%	4.4%	2.3%
Mother other race	25.4%	68.5%	30.8%	74.6%
Previous C-section	22.3%	16.3%	20.0%	13.3%
Breech	2.8%	3.4%	2.7%	3.3%
Early onset	7.3%	6.5%	6.2%	5.8%
Hemorrhage	1.6%	1.6%	1.7%	1.6%
Hypertension	4.5%	4.7%	3.4%	3.5%
Distress	0.2%	0.4%	0.6%	0.6%
Multiple gestation	0.9%	1.2%	0.8%	1.1%
Diabetes	1.2%	0.8%	0.9%	0.7%
Obesity	0.5%	0.3%	0.5%	0.4%
Oligohydramnios	3.1%	2.2%	2.5%	2.4%
Polyhydramnios	0.5%	0.7%	0.5%	0.4%
Observations	465,261	600,759	742,324	1,140,892

NOTE: The sample includes mothers aged 25-34 insured by a commercial carrier or by Medicaid in the 2000-Q1–2007-Q4 period using Texas and California inpatient data, respectively.

Table 2: Effect of a Liability Decreasing Reform, Diff in Diff Estimates: Tx and Ca

	DD Tx			DD Ca			DDD Tx & Ca		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Ref * Comm$	0.021**	0.020**	0.018**	-0.003	-0.003	-0.004	0.025**	0.023**	0.021**
	(0.006)	(0.005)	(0.005)	(0.003)	(0.002)	(0.003)	(0.007)	(0.005)	(0.006)
Age, race, risk	No	No	Yes	No	No	Yes	No	No	Yes
Hospital FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	1,066,020	1,066,020	1,064,995	1,883,216	1,883,216	1,691,571	2,949,236	2,949,236	2,756,566

NOTE: The results in columns (1)-(6) and (7)-(9) of this table show the estimates of Equations 11 and 12, respectively. Each regression includes a constant. The dependent variable in all models is the indicator for C-section. Standard errors clustered at the hospital level are reported in parentheses.

* Significant at 5%.

** Significant at 1%.

Table 3: Effect of a Liability Decreasing (Fictitious) Reform, Diff in Diff Estimates: Tx and Ca

	DD Tx			DD Ca			DDD Tx & Ca		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Ref * Comm$	0.007	0.004	0.002	-0.002	-0.002	0.001	0.009	0.007	0.002
	(0.009)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.009)	(0.005)	(0.005)
Age, race, risk	No	No	Yes	No	No	Yes	No	No	Yes
Hospital FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	612,996	612,996	612,559	863,921	863,921	777,890	1,476,917	1,476,917	1,390,449

NOTE: The results in columns (1)-(6) and (7)-(9) of this table show the estimates of Equations 11 and 12, respectively. Each regression includes a constant. The dependent variable in all models is the indicator for C-section. Standard errors clustered at the hospital level are reported in parentheses.

* Significant at 5%.

** Significant at 1%.

Table 4: Effect of a Liability Decreasing Reform, within Income Quintile

	(1)	(2)	(3)
$Ref * Comm$	0.022**	0.020**	0.021**
	(0.005)	(0.004)	(0.005)
Age, race, risk	No	No	Yes
Hospital FE	No	Yes	Yes
Observations	1,046,933	1,046,933	1,045,937

NOTE: The results in this table show the estimates of Equation 11 with an additional indicator for income group interacted with year-from-reform indicators. Each regression includes a constant. The dependent variable in all models is the indicator for C-section. Standard errors clustered at the hospital level are reported in parentheses.

* Significant at 5%.

** Significant at 1%.

Table 5: Effect of a Liability Decreasing Reform, with Physician Fixed Effects

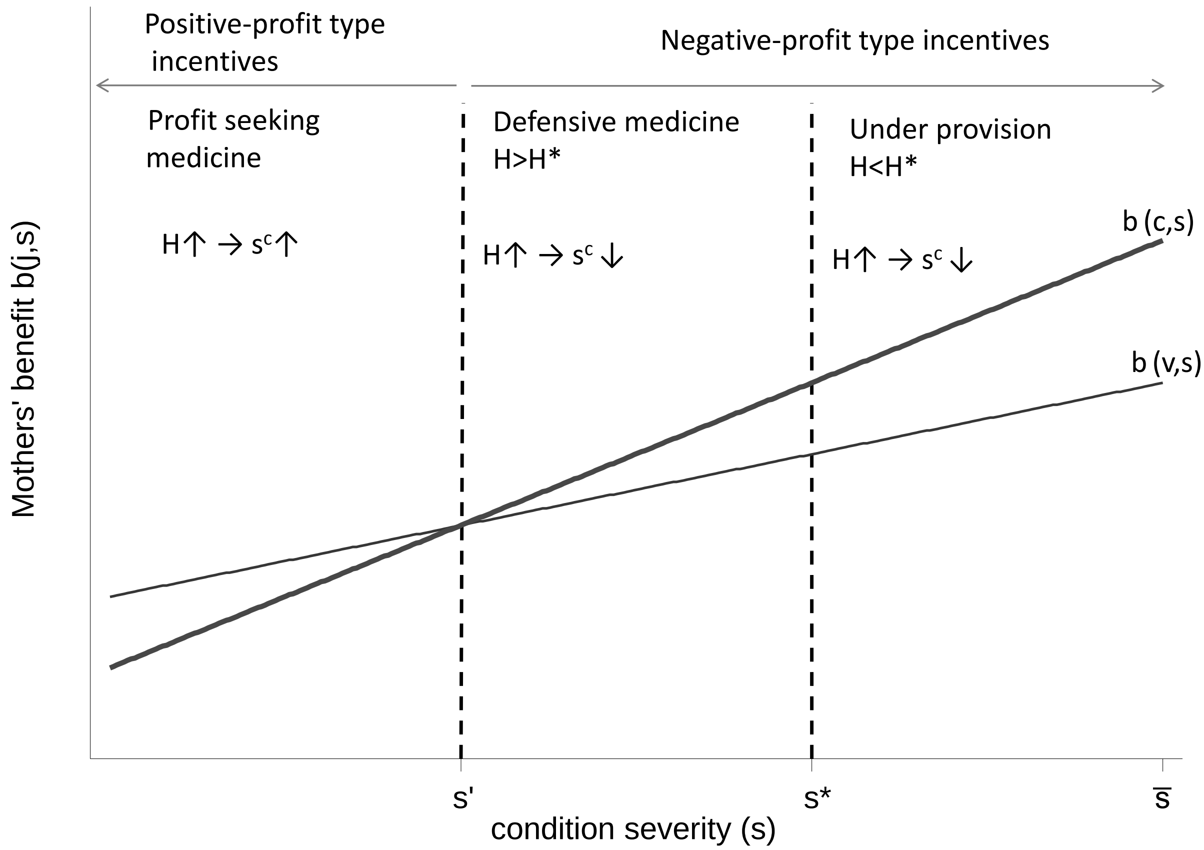
	(1)	(2)
$Ref * Comm$	0.023**	0.019**
	(0.002)	(0.002)
Age, race, risk	No	Yes
Observations	1,059,818	1,058,793

NOTE: The results in this table show the estimates of Equation 11. Each regression includes physician indicator variables. Each regression includes a constant. The dependent variable in all models is the indicator for C-section. Robust standard errors are reported in parentheses.

* Significant at 5%.

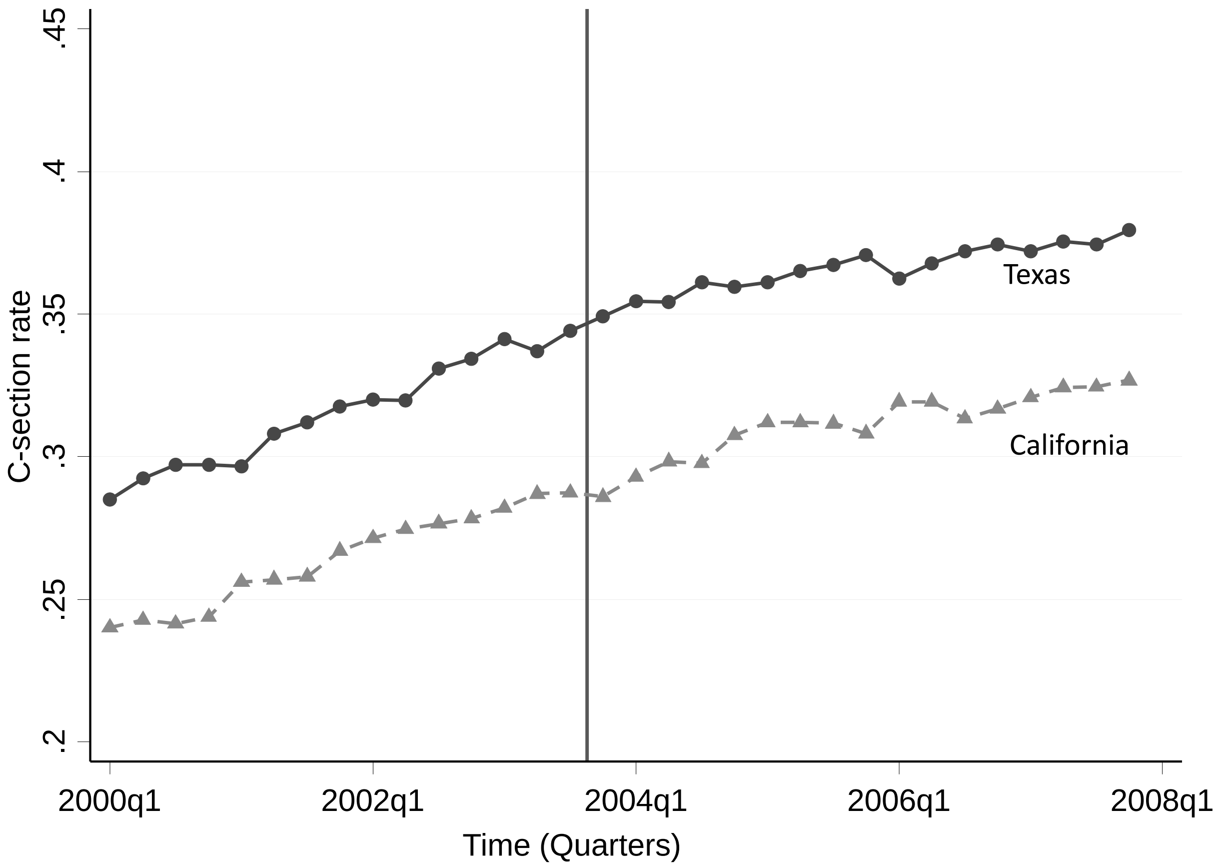
** Significant at 1%.

Figure 1: Effect of a Liability Increasing Reform on Treatment



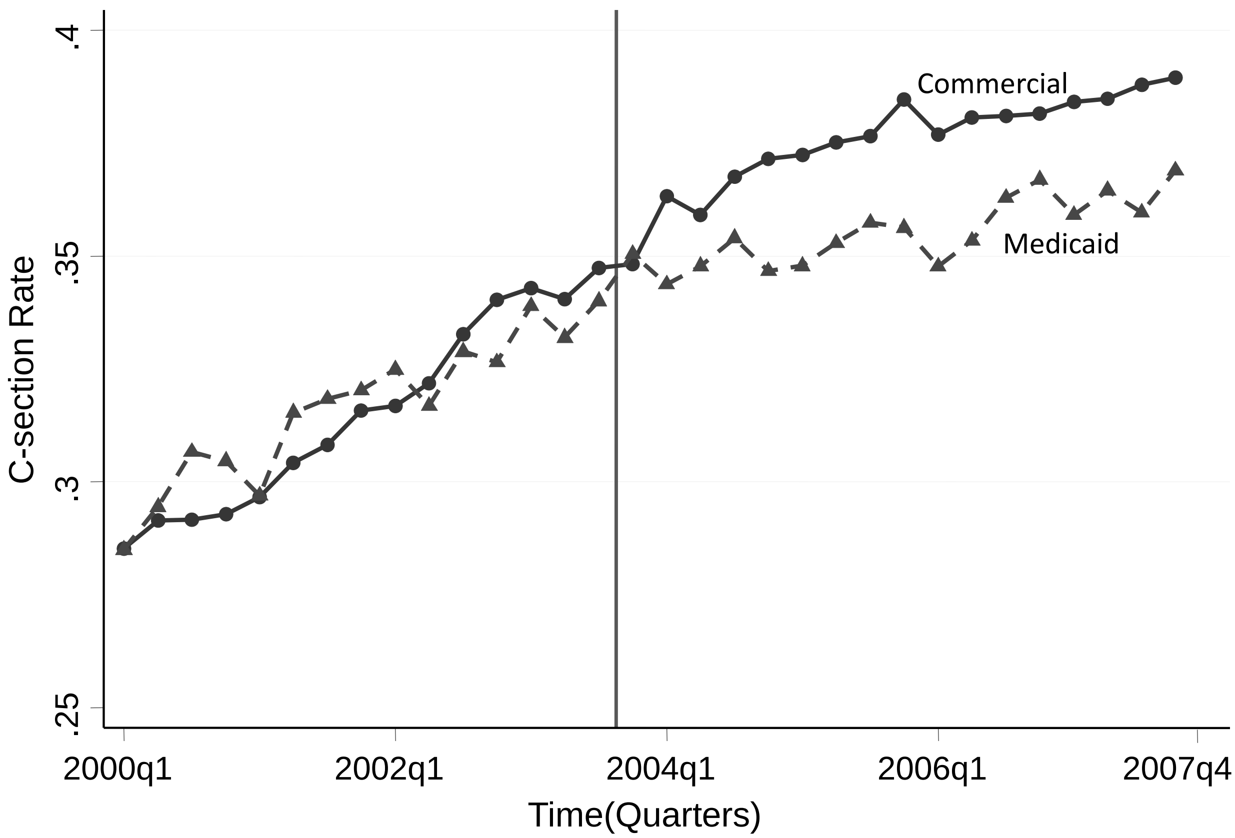
NOTE: This figure illustrates the response of a physician to a liability-increasing tort reform. The x-axis represents mother condition severity, s. The y-axis represents the mothers' benefits from a procedure. The figure depicts the mother's benefit from a C-section and from a vaginal birth diagrams, $b(c, s)$ and $b(v, s)$, respectively. The two diagrams intercept at $s = s'$, the mothers' condition severity indifference level. s^* is the mother codition severity cut-off above which the social planner would choose a C-section rather than a vaginal birth. There are two types of financial incentives: (1) *positive-profit*, in which C-sections are provided in the region $s < s'$, the *profit-seeking medicine region*, and (2) *negative-profit*, in which C-sections are provided in the region $s > s'$. Two regions of provision exist under negative-profits incentives: (1) the *under provision region*, where too little care is provided, i.e. $s^c > s^*$ and (2) the *defensive medicine region*, where too many C-sections are performed, i.e. $s^c < s^*$. Under positive-profit incentives, an increase in expected malpractice liability costs, H, increases the mother's condition cut-off, s^c, namely, physicians choose to perform C-sections when condition severity is higher and thus perform less C-sections. Conversely, when positive-profit incentives exist, such an increase decreases the mother's condition cut-off, s^c, implying the physicians perform more C-sections.

Figure 2: C-section Rate: Tx and Ca



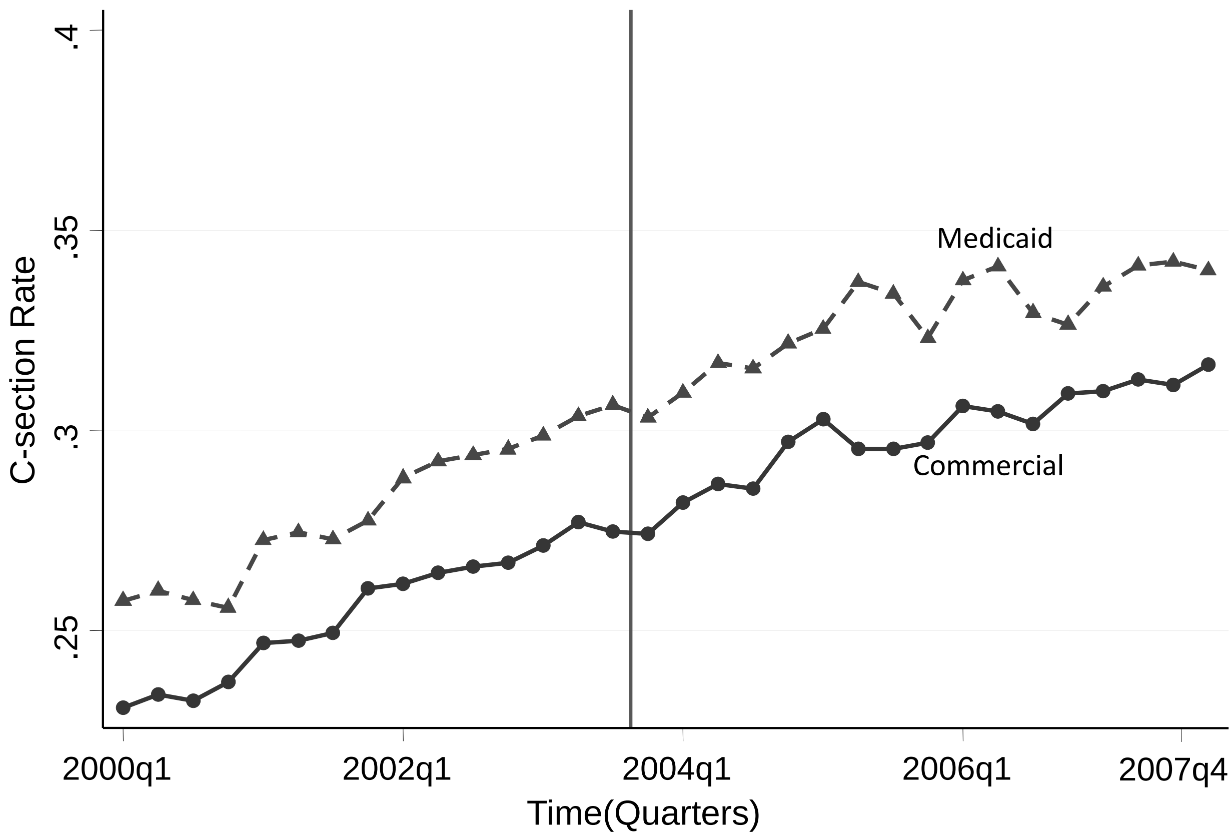
NOTE: This figure plots quarterly C-section rates in Texas and California for mothers aged 25-34. The solid vertical line (separating quarters 2003-Q3 and 2003-Q4) denotes the time at which the Texas reform was enacted. The figure was constructed using inpatient data from those two states.

Figure 3: C-section Rate, Medicaid vs. Commercial, Tx



NOTE: This figure plots quarterly C-section rates in Texas for mothers aged 25-34 insured by a commercial carrier and by Medicaid. The solid vertical line (separating quarters 2003-Q3 and 2003-Q4) denotes the time at which the Texas reform was enacted. The figure was constructed using Texas Inpatient Data.

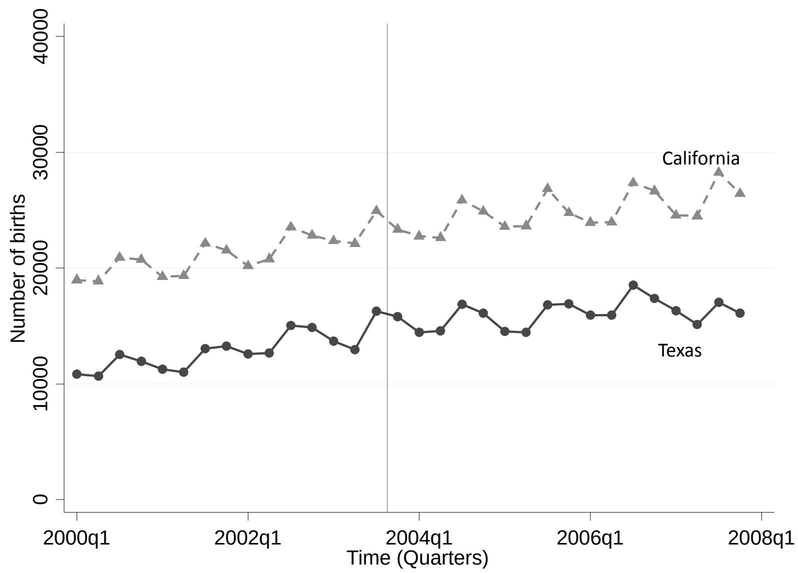
Figure 4: C-section Rate, Medicaid vs. Commercial, Ca



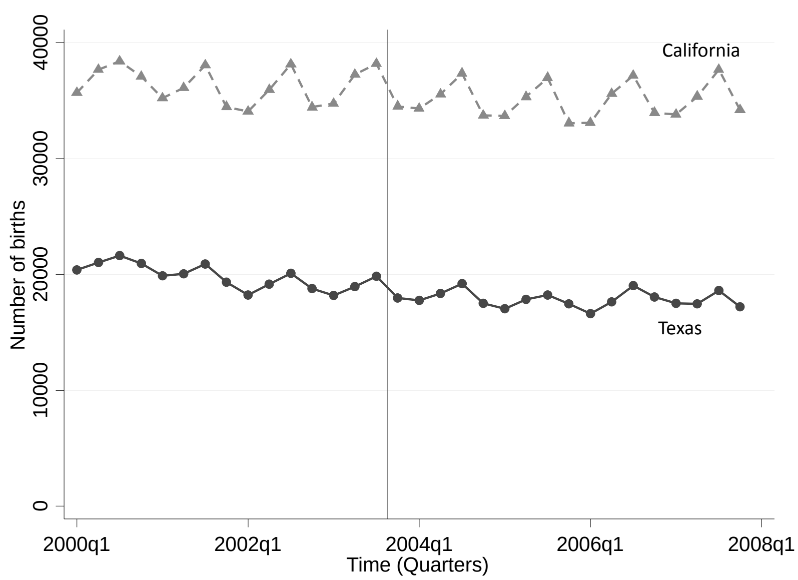
NOTE: This figure plots quarterly C-section rates in California for mothers aged 25-34 insured by a commercial carrier and by Medicaid. The solid vertical line (separating quarters 2003-Q3 and 2003-Q4) denotes the time at which the Texas reform was enacted. The figure was constructed using California Inpatient Data.

Figure 5: Number of Births by Insurance Type: Ca and Tx

(a) Number of births under Medicaid Tx & Ca



(b) Number of births under commercial insurance Tx & Ca



NOTE: Panels (a) and (b) of this figure depict the number of births under Medicaid and commercial insurance in Texas and California in 2000-Q1–2007-Q4. The solid vertical line (separating quarters 2003-Q3 and 2003-Q4) denotes the time at which the Texas reform was enacted. The figure was constructed using inpatient data from these two states.

A Appendix A

Proof of Proposition 1. To see the proof of the proposition, one can find the sign of the effect of an increase in H on s^c under negative and positive profit incentives by noticing that $sign\{\Delta\pi\} = -sign\{\Delta b(s^c)\}$, and we may rewrite equation (7) as

$$sign\{\frac{\partial s^c}{\partial H}\} \quad = \quad sign\{\Delta\pi\} \tag{A1}$$

QED.

B Appendix B

Leads and lags. To explore the causal role of the reform and endogeneity and anticipation issues (Malani and Reif, 2010), Table B.1 displays estimates of the base specification augmented by leads and lags. Consistent with the visual impression of Figure 3, the coefficients of the leads of the reform are not significantly different from zero. In the year of the reform the effect is small, about 1.5 percentage point, and significant only with hospital fixed effects (Column (2)). In subsequent years the effect is much larger, about 3 percentage points, and statistically significant with p-values smaller than 1%.

Nationwide Inpatient Sample (NIS) analysis. To create an additional control group, I repeat the analysis using the NIS data for 2000-2005, omitting the observations from Texas and California, as the control group. The NIS data is gathered by the Agency for Healthcare Research and Quality (AHRQ) and it approximates a 20 percent stratified sample of U.S. community hospitals. Table B.2 provides descriptive statistics of these data. Figure B.1 displays quarterly C-section rates for commercially insured and Medicaid insured mothers in the NIS sample. Table B.3 repeats the baseline analysis in Table 2. As the Table shows, the results strongly resemble the results in Table 2, providing additional support for the results in the main text.

Table B.1: Effect of a Liability Decreasing Reform, Yearly Leads and Lags

	(1)	(2)	(3)
-3 years relative to reform	-0.002	-0.003	-0.000
	(0.007)	(0.005)	(0.005)
-2 years relative to reform	0.005	-0.000	-0.001
	(0.010)	(0.006)	(0.005)
-1 years relative to reform	0.015	0.011	0.013*
	(0.011)	(0.006)	(0.006)
0 years relative to reform	0.017	0.017**	0.016**
	(0.011)	(0.006)	(0.006)
+1 years relative to reform	0.029*	0.023**	0.021**
	(0.013)	(0.008)	(0.007)
+2 years relative to reform	0.032**	0.026**	0.024**
	(0.012)	(0.008)	(0.008)
$\geq$ +3 years relative to reform	0.028*	0.023**	0.023**
	(0.012)	(0.008)	(0.007)
Age, race, risk	No	No	Yes
Hospital FE	No	Yes	Yes
Observations	1,066,020	1,066,020	1,064,995

NOTE: The results in this table show the estimates of (akin to) Equation 11. Each regression includes a constant. The dependent variable in all models is the indicator for C-section. Standard errors clustered at the hospital level are reported in parentheses.

* Significant at 5%.

** Significant at 1%.

Table B.2: Childbirth Sample NIS Data Summary Statistics

	Texas		NIS	
	Medicaid	Commercial	Medicaid	Commercial
Age (median)	25-29	25-29	25-29	30-34
Mother Hispanic	0.69	0.33	0.25	0.07
Mother African American	0.10	0.08	0.12	0.05
Mother other race	0.20	0.60	0.32	0.55
Previous C-section	0.22	0.16	0.18	0.13
Breech	0.03	0.03	0.03	0.04
Early onset	0.07	0.07	0.07	0.06
Hemorrhage	0.02	0.02	0.02	0.02
Distress	0.04	0.05	0.07	0.08
Diabetes	0.01	0.01	0.01	0.01
Obesity	0.00	0.00	0.00	0.00
Oligohydramnios	0.03	0.02	0.03	0.02
Polyhydramnios	0.01	0.01	0.01	0.01
Observations	332,959	458,649	452,379	1,173,639

NOTE: The sample includes mothers aged 25-34 insured by a commercial carrier or by Medicaid in the 2000-Q1–2005-Q4 period using Texas and NIS inpatient data, respectively.

Table B.3: Effect of a Liability Decreasing Reform, Diff in Diff Estimates: Tx and NIS

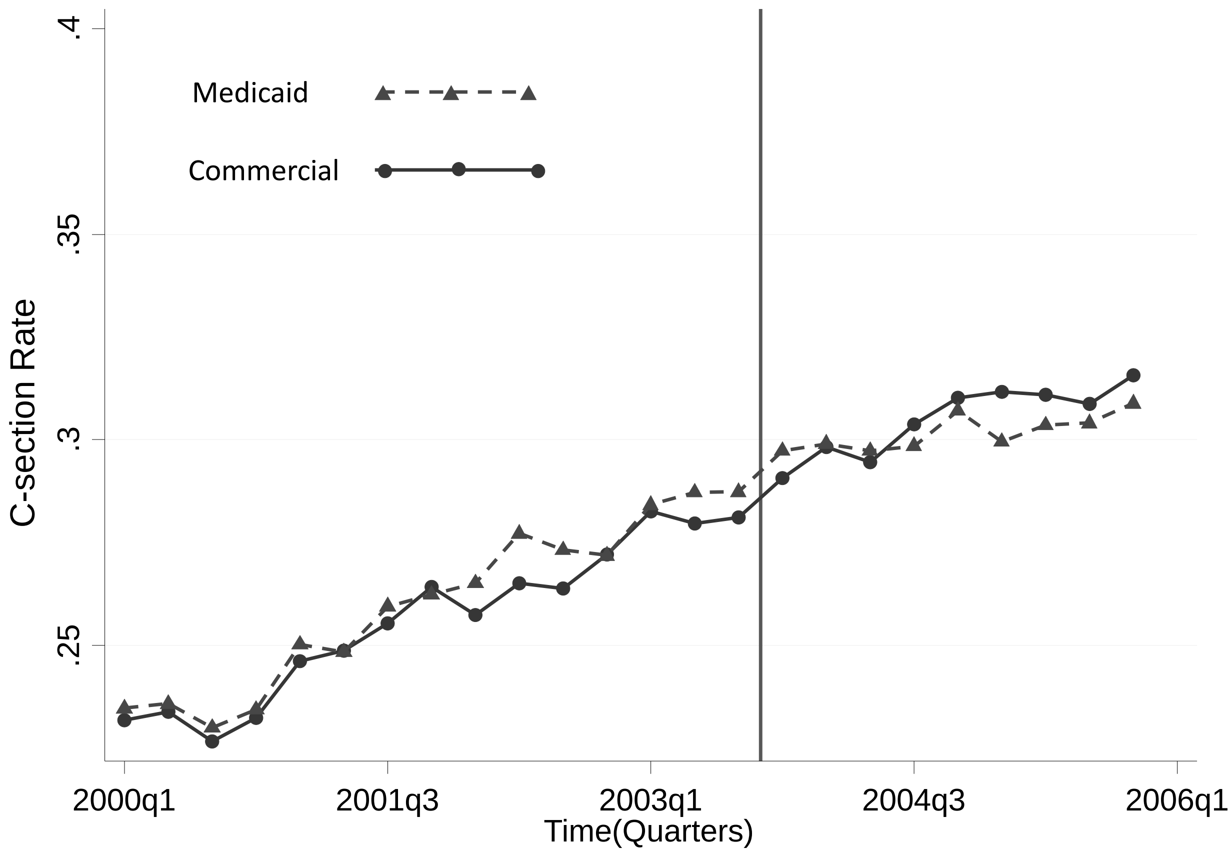
	DD Tx		DD NIS		DDD Tx & NIS	
	(1)	(2)	(3)	(4)	(5)	(6)
$Ref * Comm$	0.019**	0.017**	0.005	0.002	0.014*	0.016*
	(0.006)	(0.005)	(0.003)	(0.003)	(0.006)	(0.006)
Age, race, risk	No	Yes	No	Yes	No	Yes
Observations	791,608	790,776	1,626,018	1,098,638	2,417,626	1,889,414

NOTE: The results in columns (1)-(6) and (7)-(9) of this table show the estimates of Equations 11 and 12, respectively. Each regression includes an indicator for each state interacted with indicators for quarters and for insurance type. Each regression includes a constant. The dependent variable in all models is the indicator for C-section. Standard errors clustered at the hospital level are reported in parentheses.

* Significant at 5%.

** Significant at 1%.

Figure B.1: C-section Rate, Medicaid vs. Commercial, NIS



NOTE: This figure plots quarterly C-section rates in Texas for mothers aged 25-34 insured by a commercial carrier and by Medicaid. The solid vertical line (separating quarters 2003-Q3 and 2003-Q4) denotes the time at which the Texas reform was enacted. The figure was constructed using NIS data.