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First Do No Harm?

Tort Reform and Birth Outcomes*

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Abstract

We examine the impact of several specific tort reforms using U.S. vital statistics natality records from 1989 to 2001. We make many contributions to the existing literature on tort reform and medical malpractice. First, we develop a model that analyzes the incentives created by specific tort reforms. Second, we have assembled very detailed data on tort reform in an effort to accurately identify changes in the laws. Third, we examine a range of outcomes representing procedure use, care taken by physicians, and infant health. Finally, we examine the effect of tort reform on demographic/risk groups who ought to be differentially affected.

Our strongest and most robust findings are that reforms to the doctrine of joint and several liability (the deep pockets rule) reduce complications of labor and delivery and reduce the use of C-sections. Our theory suggests that by aligning malpractice risk more closely with the physician's own actions, JSL causes physicians to take more care and avoid unnecessary and potentially harmful procedures. In contrast, caps on damages reduce liability pressure and this increases the use of C-sections. Hence, in one important example, tort reform that reduces the malpractice risk facing doctors appears to increase rather than decrease unnecessary procedure use. Our results demonstrate that the incentives created by the tort system are complex, and interact in important ways with other incentives facing physicians.

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1 Introduction

A tort is an action that injures someone, and for which the injured person may sue for civil damages. If the tort results from medical procedures, then it may result in malpractice litigation. A movement to reform common law tort rules gained steam in recent years leading the majority of states to enact tort reforms. The fact that many of these statutes were latter overturned has been less appreciated in the literature, and illustrates the controversy that continues to swirl around the subject of tort reform. Discussion of tort reform at the federal level also figured prominently in the 2004 U.S. Presidential campaign.

The tort system exists to encourage people, including doctors, to take care to avoid injuring others.[1] However, advocates of tort reform argue that large settlements have led doctors to practice "defensive medicine". That is, doctors are thought to choose procedures in order to avoid liability, rather than procedures that are in the best interests of their patients. In some of the most widely cited work on the subject, Kessler and McClellan (1996) use Medicare claims data on elderly heart attack patients. They find that a composite measure of tort reform reduced the number of procedures performed on these patients without affecting their health outcomes. They interpret this as evidence that tort reform reduced the practice of defensive medicine.

This study examines the impact of tort reform on births in the U.S. Using data on millions of individual births from 1989 to 2001 from national vital statistics natality files, we ask whether tort reform affects the types of procedures that are performed, and the health outcomes of mothers and their infants. Our work makes several contributions. First, we develop and test a theoretical model of the changes in incentives created by several specific prominent tort reforms. Strong assumptions are often made about the way that medical practice is affected by the litigation environment and by tort reforms. For example, Bakalar (2005) argues that the recent run up in the rate of Caesarean sections in the U.S. (which reached 30 percent in 2004, up from approximately 20 percent in the 1980s) is driven by fear of litigation. We show that two common tort reforms, the introduction of caps on damages and the abolition of the rule of joint and several liability (the so-called "deep pockets" rule) may have opposite effects on physician effort levels and on physician choice of procedure in plausible scenarios. A key insight is that if doctors have incentives to perform unnecessary procedures even in the absence of the tort system, then damage caps will tend to result in more unnecessary procedures while reforms to joint and several liability will have the opposite effect.[2] Second, we

[1] Some legal scholars argue that the tort system also exists to provide insurance. The idea is that it is easier for providers than patients to purchase insurance, especially since providers can pass the costs of premiums on by setting higher fees. Priest (1987) points out that higher prices will disproportionately impact the poor, and that higher premiums may cause insurance markets to fail as lower risk providers pull out (self insure) causing premiums to go still higher.

[2] Joint and several liability (sometimes known as the "deep pockets rule") allow plaintiffs to recover *full* damages for any of

have assembled a very detailed data set on the tort reforms we consider, in an effort to accurately identify changes in the laws.

Third, we examine the effects of tort reform on infants, a very large and important group of patients, given that there are approximately 3.5 million births per year. Moreover, obstetrics is thought to have been particularly hard hit by the liability "crisis", and so ob-gyns may be particularly sensitive to tort reform. We examine indicators of the effects of tort reform on payments for malpractice, procedures, complications of labor and delivery, and infant health outcomes, all in a unified framework. We show that caps on damages (which also has the effect of limiting the size of the payment a plaintiff could expect to receive) increase the use of unnecessary procedures, and increase complications of labor and delivery (suggesting that physicians are taking less care). Reforms of joint and several liability reduce unnecessary procedure use and reduce complications of labor and delivery. We find little consistent evidence of effects on infant health outcomes, however, which supports our contention that the marginal procedures induced or discouraged by tort reforms are unnecessary for infant health.

Our theory suggests an intuitive explanation of these results: Many doctors perform unnecessary procedures not primarily because of fear of liability but because such procedures are more profitable and less time consuming than the alternatives.[3] These doctors are more likely to perform unnecessary procedures when they are less fearful of liability. Unnecessary surgical procedures in turn may lead to maternal complications. On the other hand, JSL reforms mean that doctors are held more strictly accountable for their own actions (and that they are less likely to be held liable for the torts committed by others). This results in more care being taken, fewer inappropriate C-sections being performed, and fewer preventable complications of labor and delivery.

Fourth, we examine the effects of tort reform on identifiable subgroups of the population who ought to be differentially affected. Our theory implies that doctors have less discretion over high risk births, so that tort reform should have the smallest effect on mothers who can be identified as high risk in advance of labor and delivery. Moreover, less educated black women are much more likely to have negative birth outcomes than other women, which may mean that they are more likely to sue. Many doctors claim that they avoid Medicaid patients because these patients (who are disproportionately less educated and minority) are more likely to sue (American College of Obstetricians and Gynecologists, 1988).[4] The effects on procedure use that we find are more pronounced for black mothers and least pronounced for children delivered after high

the defendants, even if the defendant is only slightly responsible for the harm. Reform of the rule entails increasing the level of responsibility for damages (typically, though not always, 50 percent responsible) before they can be held liable for 100 percent of the harm.

[3] See Dranove (1988) and Pauly (1980) for a discussion of physician induced demand.

[4] There is little evidence on this point. Burstin et al. (1993) find that other things being equal, richer and better educated people are actually more likely to sue. However, given the high probability of negative outcomes, less educated black women may still be more likely to sue over all.

risk pregnancies, as predicted.

Our work shows that the incentives created by the tort system are complex and interact in complicated way with other incentives faced by physicians. It cannot be assumed that tort reform will generally either reduce unnecessary procedure use or improve/harm health. It is important to consider the specific reform and the other incentives faced by physicians, and to examine the empirical evidence regarding the effects of specific tort reforms.

The rest of the paper is laid out as follows. Section 2 provides some necessary background regarding tort reform and infant health. A theoretical analysis of tort reform appears in Section 3. Section 4 describes the data, our empirical methods are described in Section 5, results are presented in Section 6, and conclusions follow in Section 7.

2 Background

Most studies of tort reform focus on the effects on claims. In his survey of the literature, Holtz-Eakin (2004) concludes that the most consistent finding is that caps on damages reduce the number of lawsuits, the value of awards made as a result of lawsuits, and the number of payouts made by insurers relative to premiums.[5] He cautions however, that this conclusion is tentative given the limitations of most existing studies. Mello (2006) draws similar conclusions. Ronen (2006) a national data base of medical malpractice payments (which we also explore below) and concludes that only caps on non-economic damages affect size of payments.

High claims in turn are thought to lead to excessively high malpractice insurance premiums.[6] However, it is not clear why a doctors' effort level or choice of procedure would be strongly affected by their malpractice insurance premiums. Doctor's premiums are not experience rated, but are set at the specialty-area level. Hence, short of moving from a high premium area to another area, or leaving their specialty entirely, there is little a doctor can do to affect her premiums. [7] Claims against doctors seldom exceed the amount

[5] Even more recently, Viscusi and Born (2005) examine data at the insurance company and state-level from 1984 to 1991 and find that limits on non-economic damages and punitive damages reduced insurance payouts and premiums, and increased the profits of insurance companies

[6] However, increases in payouts are not necessarily the driving force behind increases in premiums. On average claims are settled about 4 to 5 years after the premiums used to pay for them were collected. Insurers typically invest the premiums during that interval, and their profits are sensitive to the returns on these investments. A reduction in returns can drive up premiums sharply, as apparently occurred in the early 2000s (Baicker and Chandra, 2005; General Accounting Office, 2003; Congressional Budget Office, 2004).

[7] There have been repeated claims that malpractice premiums are driving ob-gyns out of high premium states, or out of practice (Elias, 2002). However, Mello (2006, page 4) concludes that the best studies show "only small or no effects" of the malpractice environment on physician supply (See Baicker and Chandra, 2005, Kessler et al. 2005, and Matsa 2005). In one of the few papers to look at several tort reforms in the same framework, Klick and Stratmann (2005) argue that caps increase physician supply while the abolition of joint and several liability reduces it. Their OLS estimates are small (in line with other

that they are insured for (Lawthers et al., 1992; Silver et al. 2006). Moreover, doctors can pass on the cost of malpractice insurance premiums in the form of higher prices (Danzon, Pauly, and Kington, 1990). Thus doctors generally face little financial risk from malpractice claims. One might wonder then, why they seem to care so deeply about the problem of legal liability? The answer may be that there are many non-insurable costs involved in malpractice litigation. In addition to the psychic and time costs of a potential legal proceeding, there is a very real threat of harm to the doctor's reputation. Any payment made on behalf of a physician to settle a claim of malpractice must be registered in the federally-maintained National Practitioner's Data Base (NPDB). This data bank can be searched by hospitals, other health care professionals, and in some cases, by plaintiff's lawyers.

These facts about the malpractice insurance market suggest that doctors should care deeply about their probability of being sued. Hence, tort reforms are likely to affect doctor behavior primarily by affecting the probability of a suit.[8] Reforms that reduce payments in the event of a suit will tend to reduce the probability that suits are brought. An important implication for empirical work on this subject is that the probability of a suit can respond quickly to tort reform, while premiums will be affected by tort reforms only with a relatively long and uncertain lag.

Holtz-Eakin offers a useful summary of the most common state-level tort reforms. The four we focus on here are the most common and can be defined as follows (see Bryan Garner, 1999):

1. Caps on Non-economic Damages. Non-economic damages cover items other than monetary losses, such as pain and suffering.

2. Caps on Punitive Damages. Punitive damages are awarded in addition to compensatory (economic and non-economic) damages in order to punish defendants for willful and wanton conduct.

3. Modifications of the Collateral-Source Rule. Under the common law collateral-source rule (CSR), amounts that a plaintiff receives from sources other than the defendant (e.g. from their own insurance) may not be admitted as evidence in a trial.

4. Modifications of the Joint-and-Several Liability Rule. In a trial with more than one defendant, the first step is to apportion blame for the harm. Under joint-and-several liability (JSL), the plaintiff can then ask the "deep pockets" defendant to pay all of the damages, even if that defendant was responsible for only a small fraction of the harm. This defendant can in turn initiate separate legal proceedings in order to get "contribution" from the other defendants. Thus, the onus is on the deep pockets defendant

studies surved by Mello) while their instrumental variables estimates are very large.

[8] The relationship between the law and the incentive to litigate and settle is a very complex process (See Spier (2006) for an up to date review). We are simply concerned with the reduced form consequences of the law for expected liability and simply need to suppose that laws reducing liability reduced both expected liability and probability of a suit.

rather than the plaintiff to collect from the other defendants. It this paper we focus on modifications such that a defendant had to be liable for at least 50 percent of the tort before they could be held responsible for 100 percent of the damages.

Table 1 shows the number of states with changes in these tort laws between 1989 and 2001. We are particularly interested in changes given that we will include state fixed effects in our data—hence, only changes in the laws are used to identify their effects. Given the controversy surrounding tort reform, and the flurry of tort reform activity that occurred in the 1980s, it is striking that changes to the tort system during the 1990s often involved turning tort reforms "off" rather than "on". Two states (Illinois and Ohio) passed packages of tort reforms only to find that the laws violated the state constitution and had to be removed two years later. The fact that laws turn on and off is useful for identification, and helps to ensure that we will not mistake general time trends in outcomes such as C-sections for effects of tort reform.[9]

Table 1 also indicates that most of the law changes were changes to general tort statutes and were not aimed specifically at medical malpractice. This point is important because it suggests that most of these law changes were not motivated by things like pre-existing trends in C-section rates or complications of labor and delivery. For example, if caps were passed in an effort to reduce C-section rates, then caps might be viewed as a result of high C-section rates rather than as a potential cause of high (or low) C-section rates. However, there is little evidence that most tort laws were passed in response to specific development in obstetrical practice. The many laws that were turned "off" by state courts also help in this regard, since these cases tended to revolve around the constitutionality of state statutes rather than any desire on the part of courts to influence obstetrical practice.

2.1 C-section rates and physician incentives

There is a good deal of research showing that C-section rates are responsive to physician incentives, as well as a general sense in the medical literature that American C-section rates are "too high". A Healthy People 2010 goal is to reduce the rate of C-sections to 15 percent. This figure suggests that unnecessary C-sections contribute as much as four billion dollars a year in excessive health care costs, as well as inflicting unnecessary surgery on million of mothers.[10] Baicker, Buckles, and Chandra (2005) find that 75 percent of the geographical variation in C-section rates over the 1995 to 1998 period is not explained by differences in risk factors, and that the marginal C-section was performed on a medically less appropriate patient. They also find that higher C-section rates are not associated with improvements in infant health, a finding that is

[9] In Alabama, a cap implemented before the beginning of our sample period was declared unconstitutional and removed in 1991. Yoon (2001) exploits this feature of the data in his study of the effects of caps on malpractice awards in Alabama.

[10] The estimate of four billion is based on the assumption that 15 percent of current C-sections are unnecessary and that the difference in cost between a C-section and a normal delivery is about $6,000.

common in this literature.

One reason for high rates of C-sections is that fees for C-sections are roughly double fees for normal deliveries. Keeler and Brodie (1993), and Currie and Gruber (2001) show that women with more generous insurance coverage are more likely to have C-sections even though they are less likely to have high risk pregnancies. Currie, Gruber and Fischer (1995) and Gruber, Kim, and Mayzlin (1998) show that physicians respond to the differential between fees for vaginal births and Caesarean births under the Medicaid program—places with relatively higher fee differentials have more Medicaid covered C-sections.

And while one might think that a C-section involves more effort for the physician (and thus merits the higher fee), this may be counter-balanced by the fact that many C-sections are scheduled and occur at times that are convenient for physicians (unlike normal deliveries). Burns, Geller, and Wholey (1995) find that the log odds of a C-section rise with the physician's rate of C-sections in the previous year, with delivery on a Friday, and with delivery between 6 am and 6 pm.

Thus, the evidence suggests that C-sections are highly responsive to physician incentives and are a good procedure to examine for evidence regarding the effects of tort reform. Dubay, Kaestner, and Waidmann (1999) and Kim (2005) use panels of national vital statistics data and look at the effects of malpractice premiums on C-sections, finding little effect.[11] As we have argued above, this is a relatively indirect way to get at the effect of tort reforms, which are likely to have their primary impact via effects on the doctor's immediate probability of being sued rather than through their delayed effects on malpractice premiums.

There has been little attempt to look at other obstetrical procedures or outcomes in the previous literature. In addition to C-sections, we will examine the induction and stimulation of labor, and the incidence of complications of labor and delivery. We think complications are a particularly interesting outcome because they may reflect sub-optimal physician effort (many complications are avoidable) and because they represent real health costs.

3 Tort Law, Physician Effort, and Procedure Choice - Theory

This section introduces a model of physician decision making that demonstrates how changes in tort liability affect the physician's effort level, and their preferred procedure.[12] The theory illustrates that the impact of tort reform on procedure choice depends on whether or not there is induced demand for services. For

[11] Several previous studies use cross sections of data from single states to examine the effect of malpractice premiums on obstetrical procedures and infant health outcomes, with mixed results. These include: Baldwin et al. 1995, Localio et al. 1993, Sloan et al. 1997, and Sloan et al. 1995. Baicker and Chandra (2005) look at the effect of malpractice premiums on the use of C-sections and several procedures for Medicare patients using state-level data. They find no effect.

[12] There has been a good deal of discussion recently about patient preferences for C-section delivery in the popular press, but no data is available regarding how commonly the choice is dictated by the patient rather than by the physician. In what follows, we will assume that the physician is the prime mover in this decision.

concreteness, we focus on the choice of whether or not to do a C-section, but similar arguments apply to other procedures which may, in the marginal case, be unnecessary.

The physician's choice of effort level and procedure depends on the benefits and costs of the various options available, as well as on the condition of the patient. Let $s \geq 0$ denote the patient's condition, where $s = 0$ denotes a completely straightforward case where a natural delivery is clearly the preferred choice. Higher values of s correspond to conditions that monotonically increase the likelihood that a Caesarean section is the optimal choice. Procedure choice is denoted by $p \in \{C, N\}$, where $p = C$ denotes a C-section and $p = N$ a natural delivery, while the level of effort provided by the physician is denoted by $e \geq 0$.

The net benefit to the physician of choosing procedure p, and effort level e is $B(e, p, s)$. This captures the fact that pecuniary benefits are likely to rise with s, and if the physician selects a C-section. In addition, the physician is assumed to internalize the some of the benefits to the patient from treatment. This implies that $B_s > 0$, so that other things being equal, the benefit of physician intervention is assumed to rise with the complexity of the case. More effort from the physician is always beneficial, and hence $B_e > 0$. We also suppose that $B_{ee} < 0$ to ensure the existence of a unique optimal choice. Finally, when $s = 0$ a natural delivery is preferred and hence $B(e, N, 0) > B(e, C, 0)$. When the case is very complex, a C-section is always preferred, and hence for some $\bar{s}$, $B(e, C, s) > B(e, N, s)$ for $s > \bar{s}$. In practice there is a certain amount of randomness in these decisions, and hence s could be interpreted as the condition that the physician observes when, for example, they are deciding whether to schedule a C-section. In addition, the function $B(\cdot)$ will vary with the practice style of the physician, as well as with reimbursement rates.

The provision of effort is assumed to be expensive. This cost is denoted by $V(e)$, where $V' > 0$ and $V'' > 0$. Finally, the patient may choose to sue the physician if there is a bad outcome. The expected cost of lawsuits to the physician is denoted $L(e, p, Law, s)$, where Law denotes the current tort law regime. In summary, given the patient's condition s and the law, the physician chooses effort and procedure to maximize utility:

$$U(e, p, Law, s) = B(e, p, s) - V(e) - L(e, p, Law, s).$$

We also assume that the law is sufficiently rational that a natural delivery is preferred for low s, and a C-section for large s. Let us further suppose that the benefit of a C-section increases more quickly as s increases than the benefit of a normal delivery:

$$\partial U(e, C, s, Law)/\partial s > \partial U(e, N, s, Law)/\partial s \tag{1}$$

One can always re-parameterize s so that this is the case. Hence what we are assuming here is that this condition is always satisfied for the law changes that we consider. Let $e^*(p, Law, s)$ be the optimal amount of effort given the procedure, the Law, and the patient's condition. It satisfies:

$$B_e(e^*(p, Law, s), p, s) - L_e(e^*(p, Law, s), p, Law, s) = V'(e^*(p, Law, s)). \tag{2}$$

Let $U(p, Law, s)$ denote the physician's payoff given that effort is optimally chosen. The first and second order conditions, along with property 1 imply that there is a unique $\bar{s}(Law)$ with the property:

$$U(C, \bar{s}(Law), Law) = U(N, \bar{s}(Law), Law). \tag{3}$$

The cutoff condition $\bar{s}(Law)$ is illustrated in Figure 1. Below the cutoff natural deliveries are preferred, whereas above the cutoff, C-sections are preferred.

— Figure 1 Here —

Figure 1 also illustrates the effect of socially excessive payments for C-sections. The dashed line shows the net physician benefit from treatment as a function of the patient's condition. An increase in the payment for C-sections causes the dashed line to shift out which moves the cutoff from $\bar{s}^*$ to $\bar{s}$. In other words, if physicians are over compensated for performing C-sections, then C-sections will be performed on patients with less serious conditions, resulting in an overall increase in the fraction of patients with C-section deliveries. A goal of tort law is to tighten the relationship between the private and social returns to a procedure. We now turn to exploring the effect of tort reform.

3.1 The General Effect of Tort Reform

We explore the effect of tort reform by examining the impact of law changes on effort and procedure choice. Let $e^*(p, s, Law)$ be the optimal effort given the procedure, the condition of the patient, and the legal system . It satisfies the first order condition:

$$\frac{\partial U(e^*(p, Law, s), p, s, Law)}{\partial e} = 0.$$

The effect of a law change is given by the sign of $de^*(p, Law, s)/dLaw$. From the first and second order conditions we get:

$$\begin{aligned} sign\left\{\frac{de^*(Law)}{dLaw}\right\} &= sign\left\{-\frac{U_{eLaw}}{U_{ee}}\right\}, \\ &= sign\{U_{eLaw}\}, \\ &= -sign\{L_{eLaw}\}. \end{aligned} \tag{4}$$

Hence the effect of tort reform on effort depends on the effect of tort reform on the *marginal* effect of effort on legal liability. If tort reform merely affects the total transfer without affecting the marginal impact of effort, then it will have no effect on behavior. However, if tort reform reduces the sensitivity of malpractice payments to effort, then effort will fall as a consequence of the reform.

The choice of procedure depends on the patient's condition. For conditions $s > \bar{s}(Law)$ the physician will choose to perform a Caesarean section. Hence, a tort reform corresponding to an increase in the variable

Law will result in a decrease in the rate of C-sections if and only if $\frac{d\bar{s}(LAW)}{dLaw} > 0$. From the definition of $\bar{s}$ in expression 3 we get:

$$\begin{aligned} & \left\{ \frac{\partial U\left(e^*, C, \bar{s}\left(Law\right), Law\right)}{\partial s} - \frac{\partial U\left(e^*, N, \bar{s}\left(Law\right), Law\right)}{\partial s} \right\} \frac{\partial \bar{s}}{\partial Law} \\ = \quad & L_{Law}\left(e^*, C, \bar{s}\left(Law\right), Law\right) - L_{Law}\left(e^*, N, \bar{s}\left(Law\right), Law\right). \end{aligned}$$

The expression in braces is positive by the single crossing condition 1. Thus

$$sign\left\{ \frac{\partial \bar{s}}{\partial Law} \right\} = sign\left\{ L_{Law}\left(e^*, C, \bar{s}, Law\right) - L_{Law}\left(e^*, N, \bar{s}, Law\right) \right\}. \tag{5}$$

Therefore the effect of tort reform on the number of procedures depends on its differential impact on the procedures themselves. The effects are discussed in further detail below when we look at specific reforms.

3.2 The Effect of Damage Caps

Suppose that conditional on effort, there is always some chance of an injury that results in a harm l to the patient. Let $f\left(\cdot|e\right), F\left(\cdot|e\right)$ be the density and distribution respectively of these losses given physician effort e. The effect of effort is captured by the assumption that an increase in effort shifts the distribution of losses to the left. That is, $F_e > 0$ (i.e. if $e > e'$, then $F\left(\cdot|e'\right)$ first order stochastically dominates $F\left(\cdot|e\right)$). Let $\bar{L}$ be a cap on damages. Then expected liability is given by:

$$L\left(e, p, s, \bar{L}\right) = \int_0^{\bar{L}} l \cdot f\left(l|e, p, s\right) dl + \left(1 - F\left(\bar{L}|e, p, s\right)\right) \bar{L}.$$

This is the expected payment for losses less than $\bar{L}$, plus the payment $\bar{L}$ times the probability that the cap is reached. We can work out the effect on effort by computing the effect of an increase in the cap on the marginal return to effort:

$$L_{e\bar{L}} = -F_e\left(\bar{L}|e, p, s\right) > 0. \tag{6}$$

This is positive, and therefore from 4 it follows that reforms that cap liability should result in a *decrease* in effort. Observe that if caps also decrease the propensity to sue, then they will have exactly the same effect: Reducing total liability faced by the physician will reduce physician effort.

The effect on procedure choice is more complex. Increases in the cap increase liability:

$$L_{\bar{L}} = \left(1 - F\left(\bar{L}|e, p, s\right)\right) > 0. \tag{7}$$

Hence, from 5 the effect of an increase in the cap on C-section rates is given by:

$$sign\left\{ \frac{\partial \bar{s}}{\partial \bar{L}} \right\} = sign\left\{ F\left(\bar{L}|e^*, C, \bar{s}\right) - F\left(\bar{L}|e^*, N, \bar{s}\right) \right\}.$$

Thus increasing the cap decreases the C-section rate if and only if the probability that a payment (in the event that a payment is made) is more likely to exceed the cap with a C-section than with a natural delivery. Note that if expected payments in the event of a suit are higher when the cap is higher, then doctors will also be more likely to be sued when they perform a C-section under the higher caps.

One way to think about what constitutes a socially efficient C-section is in terms of the liability. A C-section is unnecessary if the expected harm to the patient is greater than the benefit. If many unnecessary C-sections are being performed, then C-sections performed at the cutoff $\bar{s}(Law)$ are those in which the health risks are greater than the benefits. Given that surgery always has risks associated with it, we would expect that lowering the cap would *increase the* C-section rate still further, as illustrated in Figure 2. Conversely, suppose that one is at a facility which is very adverse to C-sections, and hence there are situations in which a C-section would be in the best interests of the patient and the baby but is not performed. At such an institution, a decrease in liability would result in even fewer C-sections being performed. Hence, a key insight of our model is that the effect of changing the cap depends on the equilibrium in place before the law change.

——- Figure 2 Here ———

3.3 The Effect of Joint and Several Liability

Under Joint and Several Liability the plaintiff can recover from any individual who shares in the blame for the accident. In the context of medical malpractice, physicians are typically independent contractors, and hence liable for their own torts.[13]. In hospital deliveries nurses are often named in suits, and since they are hospital employees, the rule of vicarious liability implies that the hospital is responsible for any damages awarded against a nurse. Thus the rule of joint and several liability creates a spillover between doctor and hospital liability (via nurses and other hospital staff). Hence, if they are not mainly at fault, a physician may still be named in a suit. Similarly, even if the attending nurse has only a small amount of liability and the physician was negligent, the patient has an incentive to sue both the physician and the hospital (the deep pocket) under the rule of JSL.

The reform of JSL essentially makes each party more responsible for their own torts. This is modelled in a way that allows us to incorporate the damage cap:

$$
\begin{aligned}
L^{JSL}_{Doctor}\left(e^H, e^D, s, p, \bar{L}\right) &= \alpha L\left(e^D, s, p, \bar{L}\right) + (1-\alpha) L\left(e^H, s, p, \bar{L}\right), \\
L^{JSL}_{Hospital}\left(e^H, e^D, s, p, \bar{L}\right) &= (1-\alpha) L\left(e^D, s, p, \bar{L}\right) + \alpha L\left(e^H, s, p, \bar{L}\right),
\end{aligned} \tag{8}
$$

where e^H is the care taken by hospital, and e^D is the physician's effort. In this framework JSL reform

[13] See Arlen and MacLeod (2005) for a discussion of the rule of vicarious liability, and the literature that explores the conditions under which others, such as managed care organizations, might be liable for physician torts.

corresponds to an *increase* in α, while total harm conditional upon effort does not change.

Consider first the effect of JSL reform upon physician effort. From 8 we can compute the effect of JSL reform upon the marginal impact of effort:

$$L^{JSL}_{\alpha e^D} = L^D_e\left(e^D, \bar{s}, p, \bar{L}\right) < 0. \tag{9}$$

From expression 4 it is clear that JSL reform leads to an *increase* in effort levels.

As was the case with damage caps, the effect of JSL reform on doctor liability is ambiguous:

$$L^{JSL}_{\alpha} = L\left(e^D, \bar{s}, p, \bar{L}\right) - L\left(e^H, \bar{s}, p, \bar{L}\right) \equiv \Delta_{DH} L\left(\bar{s}, p\right) \gtrless 0. \tag{10}$$

From 5 and 10 the effect of JSL reform on C-section rates is given by:

$$sign\left\{\frac{\partial \bar{s}}{\partial \alpha}\right\} = sign\left\{\Delta_{DH} L\left(\bar{s}, C\right) - \Delta_{DH} L\left(\bar{s}, N\right)\right\}.$$

Thus, the effect depends on the relative difference between the doctor's and hospital's liability conditional on the patient's condition. As in the case of damage caps, progress can be made in determining the effect by considering whether or not there are an excessive number of C-section procedures before the tort reform. If there are many unnecessary C-sections, a natural birth is unlikely to have much liability (since only the safest deliveries are allowed to proceed naturally), and hence the absolute value of $\Delta_{DH} L\left(\bar{s}, N\right)$ is likely small. However, surgery is always a risky activity, and since it is the doctor's decision that leads to a C-section, then it is reasonable to suppose that $\Delta_{DH} L\left(\bar{s}, C\right) > \Delta_{DH} L\left(\bar{s}, N\right)$, and therefore $sign\left\{\frac{\partial \bar{s}}{\partial \alpha}\right\} > 0$. In this case we expect that JSL reform would lead to decrease in C-section rates, as illustrated in Figure 3:

——- Figure 3 Here —-

Conversely, if there are too few C-sections from a social point of view, then the effect of JSL reform on C-section rates would be positive. That is JSL reform would lead to more C-sections. The theory also predicts that the effect may be zero or very small when the number of C-sections is between the extreme values.

3.4 Summary

Consistent with the standard economic theory of tort law, the theory we outline here predicts that with less liability physicians will exert less effort (see Landes and Posner, 1987; Shavell, 1987; Danzon 2000 for exhaustive reviews). What has received little attention however, is how specific tort reforms are likely to affect the choice of specific procedures, such as C-sections. We find that studying the impact of tort reform on depends on whether there is already excessive use of a procedure so that conversely, physician responses to tort reform may provide some evidence about whether there is socially excessive use of procedures.

Reforms reducing liability have the tendency to exacerbate the problem of excessive procedure use if providers already have a preference for one procedure over another in cases where the health benefit of each procedure is the same. These results are summarized in the following table:

		Caesarean Section Rate	
Tort Reform	Complications	If excessive	If not excessive
Decreasing the Cap on Liability	Increases	Increases	Decreases
Reforming the JSL Rule	Decreases	Decreases	Increases

Table 1: The Effect of Tort Reform on Care and Cesarean Section Rates

Observe that, relative to the prior literature, the theory provides some addition falsifiable predictions. Namely, the effect of caps on liability should have the opposite effect as JSL reform. Also reforms like modifying the collateral source rule which that act like damage caps, will have effects similar to caps.

Note that while we have emphasized the incentives faced by physicians in the preceding discussion, many of our arguments will also apply to hospitals. In particular, with JSL reform, hospitals may have particularly strong incentives to modify their procedures so as to make it less likely that they will be judged responsible for over 50 percent of the damages (and therefore potentially held liable for paying for 100 percent of the damages).

4 Data

Several previous studies of tort reform rely on data from the American Tort Reform Association (ATRA), which has kept track of reforms enacted after 1986, when it was founded. Using the ATRA file as a starting point, we employed several law students to independently look up and record the all state statutes that implemented tort reforms, and any decisions that subsequently affected the status of these statutes (e.g. if the statute was subsequently ruled unconstitutional). A major issue here is to determine the pre-1986 status quo. That is, the ATRA might note that a state passed a tort reform in 1991, but not that it had passed earlier tort reform legislation in 1984. Moreover, sometimes state legislatures codified practices that were already established under common law, so that what appears to be a law change is not. We have also compared our data with tort reform data independently collected by Ronen Avraham (2006), using Westlaw to clarify any discrepancies. One reason for the disparate findings in the literature may be that there are many errors in existing data sets regarding tort law. We have made every effort to correct these errors in

our data though occasionally there are some difficult issues of legal interpretation involved.[14]

Our primary data on outcomes comes from the Vital Statistics natality data. These data come from birth certificates collected by each state and filed with the National Center for Health Statistics. Since the last revision of the standard birth certificate in 1989, Vital Statistics data has formed a very rich repository of information about pregnancy risk factors, procedures performed at the time of birth, and birth outcomes. In addition to information about whether a Caesarean section was performed, we know whether labor was induced or stimulated, whether there were any complications of labor and delivery (and if so, what they were), and risk factors for the pregnancy. We define high risk using 17 different variables that indicate whether the mother suffers from conditions such as anemia, cardiac, or lung conditions; diabetes, herpes, eclampsia, or incompetent cervix; previous large or preterm deliveries; renal failure; rh problems; uterine bleeding or other medical risk factors. Generally, these risk factors would be known to medical staff before the delivery and would affect decisions about appropriate procedure use.

In terms of outcomes, we know the infant's birth weight, which has long been considered a key indicator of infant health, but is not likely to be much affected by the doctor's behavior at the time of the delivery. Almond, Chay and Greenstone (2005) argue that APGAR scores are a better measure of infant health than birth weight, and we also examine this outcome.[15] In contrast to birth weight, APGAR scores could be affected by a doctor's decisions during the delivery. For example, the administration of antenatal steroids can improve a child's lung functioning, while fetal distress may reduce APGAR if, for example, the baby turns blue.

We also know an important outcome for the mother, which is whether there were complications of labor and delivery. Certain types of complications including breech delivery, cephalopelvic disproportion (baby's head too big for mother's pelvis), and cord prolapse (umbilical cord around the neck) are unlikely to be caused by the doctor's behavior at the time of delivery, while others such as excessive bleeding or meconium (a sign of fetal distress) may be preventable in many cases. Hence, we separately examine these two types of complications. If our model is correct, then tort reform should affect "preventable complications" while having little or no effect on other complications. An additional problem is that complications could be mechanically related to C-sections, since complications might be considered indications for C-section. That is, a doctor may be unlikely to perform a C-section without indicating on the birth certificate that there was some complication that warranted such intervention. To address this concern, we examine complications for

[14] For example, in a few states, cap apply only to settlements for wrongful deaths, and not to medical malpractice more generally. We have treated these states as if caps did not apply. A second issue is that some states have caps on total damages (although in some cases these are only for wrongful death). We have coded states with total caps as having caps on both non-economic damages and punitive damages (unless punitives are specifically excluded).

[15] The APGAR score measures Activity, Pulse, Grimace, Appearance, and Respiration. A child can score a maximum of 2 for each category for a maximum of 10 points. Since most children have APGAR scores of 9 or 10, we will use an indicator for whether the score is less than 8.

non-C-section deliveries separately.

We have also used linked birth and infant death files and fetal death files to examine the effect of the tort reforms. We examined fetal deaths after 26 weeks of gestation, neonatal deaths (deaths in the first month) and infant deaths (deaths in the first year of life). In contrast to Klick and Stratmann (2005) who used state-level data to examine the effects of specific tort reforms on infant mortality, we found no statistically significant effect on any of these outcomes and have not reported these regressions below. One reason for the difference may be that using individual-level data allows us to control for many predictors of mortality (such as whether it is a multiple birth) which have not been controlled in analyses using state-level data.[16]

The Vital Statistics data has a great deal of information about factors that might be expected to influence infant health. We know the infant's parity (birth order) and gender as well as the mother's education, race, age, marital status, and county of residence (which proxies for the geographical differences in procedure use noted above).

The Vital Statistics data is linked to the tort data using the state, month, and year of birth (the exact date of birth is not given in the public use Vital Statistics data). Table 2 presents means of key outcome variables, tort variables, and control variables for the years 1989 to 2001. Because the data set is very large, we use a 10 percent random sample and include only states that experienced a law change over the sample period. The states without law changes would not contribute to the identification of the law changes in any case.

The first panel indicates that C-section rates and the incidence of complications are slightly lower for births that took place in jurisdictions with a cap on non-economic damages. However, the third panel of Table 2 suggests that the characteristics of mothers also vary across these jurisdictions. For example, births subject to caps were less likely to be to black or Hispanic women but more likely to be to women deemed to be high risk in advance of the delivery. Hence, differences in the incidence of outcomes might reflect this differences in demographic characteristics. This simple comparison of means highlights the importance of adequately controlling for other determinants of procedure use when examining the impact of tort reform.

The middle panel of Table 2 shows the correlations between the different types of reforms that we consider. It is clear that the reforms tend to move together, but it is equally clear that there are no one-to-one relationships. For example, roughly 60 percent of places with a cap on non-economic damages had also undertaken a significant reform of joint and several liability laws. (Recall, a JSL reform is coded as significant if the threshold for a defendant to be held liable for 100 percent of the damages is at least 50 percent). But only 30 percent of places with such JSL reforms had also implemented a non-economic damages cap. Whether the degree of correlation between the laws is too high to tease out their separate

[16] Alternatively, Klick and Stratmann use data from 1980 to 1998, while our data cover 1989 to 2001. It is possible that tort reforms had larger effects on health in the earlier period.

effects is an empirical matter that we will return to below.

Table 2b shows means of our outcome and control variables by demographic/high risk group. This table indicates that while black women are much more likely to have negative birth outcomes than white women, they are also less likely to have either C-sections or induction/stimulation of labor. Given that black women are likely to have less generous insurance coverage on average, this observation is consistent with the idea that much of the variation in C-section rates may be driven by differences in the profitability of C-section rather than by medical necessity. Black women are also more likely to have preventable complications of labor and delivery.

4.1 Payments data

As discussed above, we believe that tort reforms are likely to influence physician behavior primarily through their effects on the probability that a complaint is brought against the doctor. It is however, remarkable difficult to provide evidence on this point. For example, if ceteris paribus, the probability of being sued rises and physicians respond by taking more care, there may not be any effect on the probability that a complaint against a physician observed. Still, we use data from the National Practitioner Data Bank (NPDB) to examine the effect of tort reforms on the number of payments for malpractice made on behalf of physicians, and on the amounts of these payments.

The NPDB is a data bank maintained by the Health Resources and Services Administration (HRSA) under the U.S. Department of Health and Human Services. Reporting is required by federal law, so in principal, we should have every malpractice payment made since 1990 (in some cases, however, the federal government or an HMO may be sued rather than the individual physician and only payments made on behalf of individual physicians are recorded in the NPDB).

We kept only malpractice claims paid to doctors, and excluded malpractice claims against pharmacists, dentists, and other types of medical personnel. Any observations in which both work state and home state were missing were also dropped, since without these fields, we have no way of tying the records to a specific state. Any records in which the state was a U.S. territory or military base, were also excluded. Finally, we include payments for incidents that took place between 1990-2001 for all 50 states plus the District of Columbia, although payments for some incidents that occurred in the later years of our data may not have been made by 2005, our last year of payment data. In our regressions, the year is the year that the incident took place rather than the year of the payment. In nine states, individuals receive payments for the same injury from both private insurers representing doctors and from state funds. In order to avoid double counting injuries and come up with accurate totals for payments, we consolidate payments on the basis of the practitioner number, injury year, payment year, and state.[17]

[17] Ronen (2006) discusses different ways of dealing with the duplicate payments caused by state funds, and with the fact

One limitation of these data for our purposes are that only the total payment is given—it is not broken into economic, non-economic, and punitive damages. Another problem (common to all investigations of this type) is that we see only cases that actually result in a payment and changes in the law are likely to affect the payments the probability that payments are observed. For example, under conventional JSL rules, a doctor might not pay anything even if he was at fault, because the hospital might be held liable for 100 percent of the damages. In this example, reforms to JSL might result in more physicians being held liable, but for smaller average amounts than were observed prior to the reform.

All information that might identify a physician (such as specialty) has been surpressed in the public use NPDB files. We can however separately examine payments that are flagged as "obstetrics related" though there is some question about how accurately this distinction is made (payments may also be "surgery related" or "anesthesia related" for example). An advantage of the NPDB is that many cases settle without ever going to trial, or before any legal award is made, so it is preferable to look at payments rather than awards, though of course this is still a selected sample–only a small fraction of those who are harmed ever receive any payment (Harvard Medical Practice Study, 1990).

Finally, the fact that so many laws were ruled unconstitutional over our sample period raises additional difficulties given that there is usually a substantial lag between the time an injury occurs and the time a payment is made. If the legislature changes the law between the two dates, then usually the law in effect at the time of the injury is the one that applies. But if the law in effect at the time of the injury has been ruled unconstitutional by the time of the payment, then the law in effect at the time of the payment applies. Avraham (2006) argues that this distinction is empirically important. However, the gap between the two dates is not exogenous and may be affected by pending changes in the legislation. That is, if lawyers know that a challenge to the constitutionality of a statute such as a damage cap has been filed, then they may attempt to either speed up or delay agreements about payments so as to take advantage of the pending law change. We will attempt to take this problem into account in our analysis of payments for malpractice. Note that this is much less of an issue for medical practice decisions where the law in effect at the time of the injury is presumably what is relevant to the behavior at the time of the injury.

payments are less likely to be observed for injuries in the last years of our sample. He also discusses inconsistent reporting of periodic payments. He argues that none of these things affect his estimates. Some things that may cause our estimates to differ from his is that he uses all of the medical malpractice claims rather than those for doctors only. He also controls for several variables (such as the time between the injury date and the payment date and the number of defendants in the suit) in his individual-level regressions which we believe to be endogenous. We have not included these variables.

5 Methods

We explore the relationship between tort reform and outcomes using standard panel data methods. Since our outcomes are relatively common and we include a large number of county fixed effects in our models, we rely on linear probability models. Our base model is specified as follows:

$$(11)\ OUTCOME_{it} = a + b_1 TORT_{st} + b_2 XVAR_{it} + b_3 YEAR + b_4 STATE * TIME + b_5 COUNTY + e_{it},$$

where OUTCOME represents a procedure or health outcome; TORT is a vector of indicators for the tort reforms; XVAR is a vector of personal characteristics (see Table 2); YEAR is a vector of YEAR indicators; STATE*TIME is a vector of state specific linear time trends; and COUNTY is a vector of indicators for all of the counties that are identified in the Vital Statistics data (generally counties with over 100,000 population, with balance of each state is treated as an additional "county"); and e is a random error term. The subscript i indicates that the variable is defined at the individual level, while the subscript s indicates that it is defined at the state level, and t indicates that the variable is time varying.

As discussed above, there are large differences in outcomes between demographic groups. Variables such as race may also interact with tort reform, if for example, blacks and whites have different propensities to sue. Hence, it is important to control for the variables in XVAR. The year indicators allow there to be systematic differences over time, while the state-specific time trends allow different states to be on different trajectories with respect to outcomes such as C-section rates. Finally, the county indicators help to account for well-known geographic differences in factors such as access to medical care and physician practice patterns. We estimate our models clustering the standard errors by state and year, in order to allow for correlations within state-year cells.

While (11) is a simple model, there are many possible permutations of the vector TORT. We estimate the model including each tort reform separately (as some previous work has done) as well as estimating the base model that includes all four tort reforms together. We estimate the model separately for different demographic/risk groups as discussed above.

Finally, we have conducted a number of additional specification checks. These include estimating models that systematically exclude data from each of the largest states in order to see if our results are driven by a few large states, and estimating models that exclude data from states that passed reforms that deal only with medical malpractice. The latter models are identified using only data from states that passed general tort reforms that also happen to apply to malpractice cases. The idea is that these law changes are likely to be exogenous to medical practice.

6 Results

6.1 Effects on Procedures and Health Outcomes

Our main estimation results are shown in the first panel of Table 3. Caps on damages increase the incidence of C-sections, while JSL reform reduces C-sections. The coefficients and standard errors are multiplied by 100, and represent roughly 5 and 7% increases/decreases in the probability of C-section, respectively. In addition to its effects on C-sections, JSL reform reduces the incidence of preventable complications of labor and delivery, even in non-C-section births. However, it has no effect on the incidence of non-preventable complications such as breech birth, as predicted. We find no effects on the probability of low APGAR scores or low birth weight, and these outcomes are not reported in the tables that follow.

The second panel of Table 3 shows estimates from models that include each tort reform separately. The estimated effects of JSL reform on complications are quite robust, as are the estimated effects of caps on punitive damages on C-sections. However, the estimates for caps on non-economic damages suggest that it can be quite misleading to consider these caps separately, perhaps because JSL and NE caps are often implemented at the same time and tend to have off-setting effects.[18]

6.2 Effects on Subgroups

Table 4 shows the results for different demographic/risk groups. Our model implies that doctors have little discretion in high-risk cases, so that we expect to see smaller effects of tort law changes on procedure use in this group. At the other end of the spectrum, doctors may perceive that they face the highest risk of being sued from minority mothers, so we might expect to see the largest effects in this group. Table 4 confirms these predictions for procedure use: For C-sections, the effects of tort reform are systematically larger for black women and smaller for high risk women. The figures suggest that a cap on non-economic damages increases C-section rates by 2.6 percent, while JSL reform reduces it by 3.7 percent relative to the baseline figures in Table 2b. Among black women, the corresponding percentages are 14.2 and 14.9 percent, respectively.

Interestingly, the effects of tort reform are not statistically significant among white, college-educated women, suggesting that doctors may also have less discretion in these cases–perhaps these women are better able to make their own decisions regarding the use of C-section. For induction/stimulation of labor, JSL has effects only on minority women. Table 3 showed that there was no overall effect of JSL on induction/stimulation of labor so again this result is consistent with the idea that JSL has the largest effect on

[18] Given the strong correlations between some of the tort reforms (as shown in Table 2) an alternative interpretation is that the estimates in the first panel are afflicted by multicollinearity. However, if this were the case, we would see a large drop in standard errors between panel 1 and panel 2, which we do not see.

procedure use among minority women.

The effect of JSL reform on preventable complications is remarkably similar across groups, however. Doctors presumably make most of the decisions about procedure use, while the incidence of complications may depend on the medical staff more broadly. It is possible that although our theory emphasizes the incentives of doctors, hospitals also respond to JSL reform by taking steps that make it less likely that hospital staff will be responsible for a large share of damages in any tort. In this case, one might see the type of across-the-board reduction in the incidence of preventable complications that we find.

Table 5 explores the issue of caps on non-economic damages further. For non-economics damages, we were able to collect data on the amount of the caps in effect. For punitive damages, the task is complicated by the fact that some states specify dollar amounts while others specify multiples of economic damages. Hence, in Table 5 we focus on non-economic damages and include interactions of the dummies for the existence of caps with their amounts. The idea is that if a cap has an effect, then a lower cap should be associated with a stronger effect, while a higher cap should have a weaker effect. Table 5 shows that the interaction term does tend to have a sign opposite to the sign of the cap dummy. The interaction is marginally significant (at the 10 percent level) in the model of preventable complications, suggesting that higher caps produce fewer complications. The estimates suggest that a cap of $720,000 or more (which can be compared to the mean cap of $473,803 in our data) would have a negligible effect on complications.

6.3 Specification Checks

The appendix offers two specification checks on our main results concerning outcomes. In Appendix Table 1, we re-estimate the models in the first panel of Table 3 after systematically excluding each large state with a law change. This is a demanding specification check since there are relatively few states with law changes over our sample period, and large states account for the majority of births. These estimates show the extent to which our estimates are sensitive to the inclusion or exclusion of single large states.

Our results regarding the effects of JSL on C-sections and preventable complications are remarkably robust and hold in all five panels of Appendix Table 1. Results regarding the effects of caps on C-sections are also robust, though when we exclude Illinois, the estimated effect of the cap on non-economic damages is only statistically significant at the 10 percent level of confidence.

In some specifications, caps on non-economic damages increase preventable complications, but this result is not robust to changes in the sample. Similarly, JSL reform reduces induction/stimulation in three out of five cases.

Appendix Table 2 shows the effect of excluding states that passed laws which pertained only to medical malpractice, rather than to torts more generally. As discussed above, laws that were passed to deal with malpractice might have been passed in response to specific incidents of malpractice, and thus might be

regarded as effects rather than causes of changes in physician behavior. Excluding states that passed such laws has no effect on our estimates of the effects of changes to JSL. The estimated effects of changes in non-economic damage caps become stronger than before and are statistically significant in both models of C-sections and in models of complications. CSR reform also becomes statistically significant for the first time, with positive effects on both the probability of C-section and the probability of preventable complications. If anything then, this exercise strengthens our conclusion that some kinds of tort reform can increase the use of unnecessary procedures and worsen health.

6.4 Effects on Payments

Table 6 shows estimates of the effects of tort reforms on payments made on behalf of physicians using the NPDB data. The first three columns show estimates aggregated to the state-year level so that we can examine the number of payments in each state-year, and the median payment. In these aggregated models, the data are weighted using the number of births in each state and year, calculated from the Vital Statistics natality data. The first column shows estimates using the laws in effect at the time of the injury, and suggests that tort reforms have no effect on the probability that a payment is made. Of course, if tort reforms increase the risk of a suit and doctors take more care, then there may be no effect on the observed number of payments. But another potential problem with these estimates is that they do not take account of relevant law changes between the time of the injury and the time of the payment due to laws that are ruled unconstitutional.

The second, third, fourth, and sixth columns shows estimates of the following form:

(12)

$$PAYMENT_{sp} = a + b_1 TORT_{st} + b_2 UNCONST_{sp} * (TORT_{sp} - TORT_{st}) + b_3 YEAR + b_4 STATE * TIME + e_{sp},$$

where the subscript p indicates the time of the payment, and the subscript t indicates the time of the injury. $UNCONST$is a dummy variable equal to one if the law in effect at time t was ruled unconstitutional as of time p. If the law was not ruled unconstitutional, then $UNCONST$=0 and the second term drops out: The relevant law is the law in effect at the time of the injury. If $UNCONST$=1 and $b_1 = b_2$, then only the law in effect at the time of the payment is relevant. If turning a law "on" has the same effect as turning the law "off", then one would expect $b_1 = b_2$. One reason why this might not be the case is that whether or not a payment occurs depends on the probability of an injury being sustained, AND on the probability that an injured person is able to receive a payment. Turning a law "on" is likely to affect both probabilities, while in the case of an injury that has already occurred, turning the law off after the fact can

only affect the probability that payment is received conditional on an injury already having occurred. A pending challenge to the constitutionality of a tort reform may significantly reduce the probability that a payment is made prior to the resolution of the challenge.

Column 2 shows that the law appears to have little effect on the number of payments in a state and year. Column 3 suggests, consistent with other literature, that caps on non-economic damages reduce the median payment in a state and year. The interaction terms suggest that caps on punitive damages and reforms to JSL may also reduce median payments.

Column 4 shows estimates of the amount of payments conditional on any payment being made using individual-level data. In these regressions we control for the age and experience levels of the physicians (in 10 year categories). These estimates suggest that all of the tort reforms we consider reduce average payments However, the restriction that $b_1 = b_2$ does not appear to hold, suggesting that lawyers may be actively manipulating the time between injuries and payments in response to pending challenges to state tort statutes. In fact, the size and significance of b_2 tends to greatly exceed that of b_1 suggesting that having a tort law reversed has a large impact on payments conditional on an injury having taken place. Column 5 shows that if we restrict $b_1 = b_2$ only the effect of CSR remains statistically significant indicating that erroneously imposing this restriction masks much of the true effect of tort reform. Finally, Column 6 shows estimates that include only payments made for obstetrical malpractice. We estimate negative interaction terms for punitive damage caps, JSL reform, and CSR reform. However, the negative effect of non-economic damage caps is no longer statistically significant.

Table 6 suggests then, that many tort reforms may in fact have negative effects on the size the expected payments for malpractice, conditional on a payment having being made. But the estimates provide little insight into the key question of how tort reform affects the probability that a claim is filed conditional on a given level of effort on the part of the physician. They also suggest that while it is important to take account of the fact that the law applicable to the payment may not be the law that was in effect at the time of the injury, the interval between the two dates is endogenous and subject to gaming by lawyers. There remain then, many questions for future research on this aspect of tort reform.

7 Conclusions

We offer many contributions to the existing literature on tort reform and medical malpractice. First, we develop a model that analyzes the incentives created by specific tort reforms. Our model shows that contrary to popular belief, reducing a doctor's threat of malpractice can increase the use of unnecessary procedures and may reduce the effort made by doctors in realistic scenarios. Second, we have assembled very detailed data on tort reform in an effort to accurately identify changes in the laws. We apply this data to a large

national panel data set covering an important population, newborns, and examine a range of outcomes representing procedure use, care taken by physicians, and infant health. Finally, we examine the effect of tort reform on groups who ought to be differentially affected, and conduct several specification checks.

Our strongest and most robust findings are that JSL reform reduces C-sections, and complications of labor and delivery. We argue that by aligning malpractice risk more closely with the physician's own actions, JSL causes physicians to take more care and avoid unnecessary and potentially harmful procedures. In addition, JSL reform may cause hospitals to undertake systematic reforms that are beneficial to patients generally in order to avoid being held responsible for a large share of the damages in medical malpractice cases. In contrast, caps on damages are found to increase unnecessary procedure use. They also increase complications of labor and delivery in some specifications, particularly those that exclude states with potentially exogenous tort reforms that apply to malpractice only. Hence, in one important example, tort reform that reduces the malpractice risk facing doctors appears to increase rather than decrease unnecessary procedure use, with harmful effects on patients.

Much of the public and academic discussion of tort reform in medical malpractice is premised on the idea that reforms must either reduce unnecessary procedure use or have no effect. Our results demonstrate that the incentives created by the tort system are complex, and interact in important ways with other incentives facing physicians. Without knowing more about the specific incentives faced by physicians it is hazardous to predict that a specific tort reform will either reduce unnecessary procedure use or have beneficial impacts on health.

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Table 1: Summary of Changes in State Tort Laws, 1989-2001			
			Law both
	Law "on"	**Law "off"**	**on & "off"**
Cap Punitive Damages	,IN,NJ,NC,ND,NV,PA,W	SD	AL*,OH*
Cap Non-Economic	**MT,ND**	AL*, OR*,WA*, NH*	IL*,OH*
Damages			
Limit Joint and Several	MS,NH,TX,WI, TN*		IL*,OH*
Liability			
Modify the Collateral	ID,ME,WI	GA*,KS*,KY*,RI*	OH, AL*
Source Rule			
* indictes that the law was found unconsitutional and reversed, or created through a			
court's decision.			
Bold indicates that the law applied only to malpractice rather than all torts.			

Table 2a: Means of Key Variables by Law or Demographic Group

OUTCOMES	*ALL*	*anyNEcap*	*JSL*	*CSR*	*anyPDcap*
C-section	0.217	0.192	0.222	0.214	0.216
Induction/Stim.	0.309	0.338	0.345	0.312	0.317
Complications	0.334	0.328	0.332	0.357	0.324
Preventable Compl.	0.287	0.281	0.283	0.304	0.281
5-minute APGAR < 8	0.031	0.035	0.030	0.030	0.031
Low Birth Weight	0.077	0.069	0.076	0.076	0.076
TORT REFORM MEASURES					
Any NE Cap	0.188	1	0.301	0.172	0.203
Amount if Cap	473803	473803	374954	352677	375707
Modified JSL	0.377	0.607	1	0.412	0.379
Modified CSR	0.427	0.391	0.466	1	0.385
Any Dollar PD Cap	0.596	0.676	0.628	0.563	0.953
Amount if Cap	290326	256482	449621	351728	290326
Any Multiple PD Cap	0.511	0.429	0.524	0.450	0.817
Amount if Cap	3.071	2.939	2.746	4.230	3.071
DEMOGRAPHIC VARIABLES					
Male	0.512	0.512	0.512	0.512	0.512
Multiple Birth	0.027	0.027	0.028	0.028	0.028
High Risk	0.280	0.303	0.294	0.283	0.284
Mother Hispanic	0.133	0.067	0.168	0.095	0.191
Mother African-American	0.167	0.101	0.143	0.164	0.161
Mother Other Race	0.033	0.043	0.041	0.041	0.037
First Birth	0.406	0.394	0.405	0.407	0.401
Mother HS Dropout	0.218	0.189	0.221	0.191	0.233
Mother College or More	0.204	0.211	0.216	0.213	0.208
Teen Mother	0.135	0.125	0.134	0.126	0.134
Mother Married	0.697	0.712	0.698	0.696	0.700
Observations	2,410,316	451,994	909,778	1,029,714	1,507,251

Table 2b: Means of Key Variables by Demographic Group

OUTCOMES	*All*	*High Risk*	*All White*	*White College*	*Black*	*Black Dropout*
C-section	0.217	0.297	0.218	0.226	0.219	0.175
Induction/Stim.	0.309	0.383	0.334	0.351	0.244	0.220
Complications	0.334	0.450	0.341	0.344	0.346	0.336
Preventable Compl.	0.287	0.390	0.287	0.289	0.309	0.305
5-minute APGAR < 8	0.031	0.052	0.028	0.024	0.047	0.047
Low Birth Weight	0.077	0.157	0.064	0.052	0.138	0.153
DEMOGRAPHIC VARIABLES						
Male	0.512	0.514	0.513	0.513	0.509	0.509
Multiple Birth	0.027	0.097	0.029	0.038	0.030	0.026
High Risk	0.280	1	0.278	0.270	0.317	0.332
Mother Hispanic	0.133	0.117	0	0	0	0
Mother Black	0.167	0.189	0	0	1	1
Mother Other Race	0.033	0.032	0	0	0	0
First Birth	0.406	0.387	0.417	0.439	0.379	0.429
Mother HS Dropout	0.218	0.221	0.145	0	0.285	1
Mother College +	0.204	0.198	0.256	1	0.088	0
Teen Mother	0.135	0.134	0.102	0	0.239	0.540
Mother Married	0.697	0.665	0.799	0.971	0.304	0.102
Observations	2410316	674610	1608603	411540	402094	114441

Table 3: Effects of Tort Reforms

a) Overall Effects, Four Laws Entered

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations	Other Compli-cations	No-C sect. Compli-cations	Low Apgar	LBW
Any PD Cap	0.95**	0.85	1.41	0.09	0.99	0.04	0.11
	[0.30]	[0.63]	[0.77]	[0.16]	[0.79]	[0.06]	[0.09]
Any NE Cap	1.10**	0.72	1.09	-0.24	0.36	0.13	0.1
	[0.41]	[0.73]	[0.60]	[0.23]	[0.56]	[0.08]	[0.10]
JSL Reform	-1.57**	-1.28	-3.02**	0.42	-1.89**	-0.12	-0.17
	[0.50]	[0.71]	[0.66]	[0.27]	[0.60]	[0.08]	[0.09]
CSR Reform	0.17	-0.53	0.39	0.19	0.35	0.06	0.13
	[0.26]	[0.49]	[0.49]	[0.15]	[0.52]	[0.07]	[0.12]
Observations	2,410,316	2,410,316	2,410,316	2,410,316	1,865,956	1,959,586	2,410,316
R-squared	0.04	0.06	0.04	0.03	0.04	0.01	0.11

b) Effects with Tort Laws Entered Separately

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations	Other Compli-cations	No-C sect. Compli-cations	Low Apgar	LBW
Any PD Cap	0.67*	0.62	0.71	0.16	0.48	0.00	0.11
	[0.28]	[0.57]	[0.76]	[0.13]	[0.76]	[0.06]	[0.10]
Any NE Cap	0.28	0.13	-0.57	0.01	-0.68	-0.01	0.00
	[0.20]	[0.67]	[0.50]	[0.13]	[0.55]	[0.05]	[0.08]
JSL Reform	-0.87*	-0.73	-2.23**	0.32	-1.51**	-0.08	-0.10
	[0.35]	[0.56]	[0.54]	[0.19]	[0.51]	[0.05]	[0.07]
CSR Reform	0.16	-0.52	0.51	0.17	0.45	-0.04	0.00
	[0.23]	[0.49]	[0.45]	[0.14]	[0.51]	[0.07]	[0.14]

Notes: Coefficients and standard errors multiplied by 100. Linear probability models include dummy variables for county, state-specific time trends, month, and year dummies, in addition to controls for child gender, multiple births, indicators for mother Hispanic, African American or other race, dummies for each parity from 1 to 4 and for parity 5+, dummies for mother's education (<12, 12, 13-15, 16+ years), mother's age (19-24, 25-34, 35+) and marital status. Complications that are not considered preventable are breech position, cephalopelvic disproportion, and cord prolapse. Other complications are considered to be preventable.
Standard errors are clustered at the state-year level. A ** or * indicates statistical significance at 99 or 95%, respectively.

Table 4: Effects of Tort Reform on Subgroups

	High Risk	*All White*	*White College*	*Black*	*Black Dropout*
C-section					
Any PD Cap	0.37	0.88**	0.84*	0.34	0.01
	[0.36]	[0.30]	[0.35]	[0.39]	[0.61]
Any NE Cap	0.78*	0.95*	0.11	1.76**	2.49**
	[0.39]	[0.38]	[0.43]	[0.49]	[0.57]
JSL Reform	-1.11**	-1.28**	-0.24	-1.45*	-2.62**
	[0.39]	[0.48]	[0.40]	[0.59]	[0.61]
CSR Reform	-0.24	0.22	0.64	0.00	-0.16
	[0.39]	[0.26]	[0.36]	[0.32]	[0.52]
Induction or Stimulation of Labor					
Any PD Cap	-0.15	0.80	0.89	0.17	-0.95
	[0.60]	[0.63]	[0.91]	[0.78]	[1.15]
Any NE Cap	0.94	1.25	1.50	1.34	1.63
	[0.78]	[0.71]	[0.91]	[1.15]	[1.33]
JSL Reform	-0.59	-0.91	-1.57	-2.37*	-2.37
	[0.64]	[0.78]	[0.92]	[1.00]	[1.26]
CSR Reform	-1.42*	-0.19	0.25	-1.47	-2.38
	[0.63]	[0.48]	[0.73]	[0.84]	[1.28]
Preventable Complications of Labor and Delivery					
Any PD Cap	1.46*	1.08	1.71	0.86	1.23
	[0.73]	[0.77]	[1.12]	[0.85]	[1.11]
Any NE Cap	0.03	1.11	0.57	0.38	0.81
	[0.57]	[0.58]	[0.76]	[1.22]	[1.55]
JSL Reform	-2.74**	-2.81**	-2.54**	-2.83**	-2.21
	[0.68]	[0.72]	[0.94]	[1.07]	[1.40]
CSR Reform	0.75	0.24	0.14	1.16	0.03
	[0.54]	[0.52]	[0.74]	[0.67]	[1.15]

Notes: See Table 3.

Table 5: Effect of the Size of the Cap on Outcomes

	(1)	*(2)*	*(3)*	*(4)*
	C-section	**Stim./ Induct.**	**Preventable Compli-cations**	**Low Apgar**
Any PD Cap	0.94**	0.85	1.40	0.02
	[0.30]	[0.63]	[0.76]	[0.05]
Any NE Cap	1.62*	-0.48	2.45*	-0.53**
	[0.79]	[1.32]	[0.96]	[0.14]
Any NE Cap * NE Cap	-0.13	0.29	-0.34	0.15**
	[0.13]	[0.23]	[0.17]	[0.02]
JSL Reform	-1.63**	-1.13	-3.20**	0.02
	[0.53]	[0.74]	[0.67]	[0.08]
CSR Reform	0.05	-0.26	0.09	0.20**
	[0.29]	[0.52]	[0.52]	[0.07]
Observations	2,410,316	2,410,316	2,410,316	1,959,586
R-squared	0.04	0.06	0.04	0.01

Notes: See Table 3. Caps are in units of $100,000 (1989).

Table 6: Effects of Laws on Doctor Payments for Medical Malpractice (Data = NPDB)

	-1 All # payments in state year	-2 All # payments in state year	-3 All Median pay-ment in state/yea	-4 All Log(real payment)	-5 All Log(real payment)	-6 Ob-gyn only Log (real payment)
Cap on punitives (t=i)	-27.46	-46.52	5,668.97	0		-0.04
	[32.32]	[38.35]	[5,251.24]	[0.04]		[0.08]
Cap on non-economic damages (t=i)	-18.74	-19.02	-14,440.62*	-0.31**		-0.15
	[30.45]	[30.75]	[5,871.58]	[0.11]		[0.19]
Reform of JSL (t=i)	38.91	63.37	-6,382.01	-0.02		-0.16
	[35.92]	[44.76]	[7,131.13]	[0.06]		[0.11]
Reform of CSR (t=i)	48.01	65.11	-7,036.78	-0.22**		-0.17
	[26.80]	[37.90]	[8,295.09]	[0.07]		[0.16]
Unconst*(diff cap on punitive damages)		-63.43	-39,269.97**	-0.75**		-0.72**
		[67.26]	[13,975.73]	[0.14]		[0.25]
Unconst*(diff cap on noneconomic damages)		-125.59	-19,930.60	-0.26*		0.4
		[106.75]	[44,666.75]	[0.12]		[0.38]
Unconst*(diff JSL)		44.87	-33,200.76**	-0.50**		-0.63**
		[47.17]	[8,480.30]	[0.14]		[0.19]
Unconst*(diff CSR)		41.37	-18,790.81	-0.46**		-0.37*
		[47.24]	[10,416.70]	[0.09]		[0.17]
Cap on punitives (t=i|t=p)					-0.02	
					[0.04]	
Cap on noneconomic damages (t=i|t=p)					-0.07	
					[0.07]	
JSL reform (t=i|t=p)					-0.1	
					[0.07]	
CSR reform (t=i|t=p)					-0.28**	
					[0.08]	
Observations	663	663	663	153937	153937	11572
R-squared	0.98	0.98	0.89	0.06	0.06	0.08

Notes: All regressions include state effects and state-year trends, and standard errors are clustered at the state-year level.
The first four variables are laws in effect at the time of injury. The next four variables are interactions between unconst (a dummy variable equal to one if the law in effect at the time of injury has been ruled unconstitutional by the time of the payment) interacted with the difference between the law at the time of payment and the law at the time of injury. The last four rows show the law that applies to a particular payment. This may be either the law in effect at the time of the injury, or the law in effect at the time of the payment if the later is the result of overturning the former.

* significant at 5%; ** significant at 1%

Appendix Table 1: Effect of Excluding Large States with Changes, One State at a Time

a) Exclude IL

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations
Any PD Cap	1.06**	0.75	1.86*
	[0.35]	[0.69]	[0.83]
Any NE Cap	0.68	1.99*	0.18
	[0.36]	[0.93]	[0.68]
JSL Reform	-1.76**	-0.69	-3.34**
	[0.58]	[0.80]	[0.74]
CSR Reform	0.1	-0.36	0.20
	[0.27]	[0.52]	[0.49]
Observations	2,164,167	2,164,167	2,164,167
R-squared	0.04	0.06	0.04

b) Exclude OH

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations
Any PD Cap	0.93**	0.58	1.34
	[0.33]	[0.74]	[0.90]
Any NE Cap	1.34**	1.20	1.77**
	[0.50]	[0.85]	[0.63]
JSL Reform	-1.76**	-1.85*	-3.57**
	[0.60]	[0.77]	[0.71]
CSR Reform	0.41	-0.15	1.11*
	[0.31]	[0.56]	[0.56]
Observations	2,206,605	2,206,605	2,206,605
R-squared	0.04	0.06	0.04

c) Exclude TX

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations
Any PD Cap	0.51*	0.88	0.75
	[0.25]	[0.62]	[0.76]
Any NE Cap	0.64**	1.30	0.01
	[0.22]	[0.68]	[0.50]
JSL Reform	-0.68**	-1.61*	-1.49*
	[0.24]	[0.68]	[0.61]
CSR Reform	0.16	-0.65	0.47
	[0.19]	[0.42]	[0.47]
Observations	1,974,702	1,974,702	1,974,702
R-squared	0.04	0.06	0.04

d) Exclude NJ

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations
Any PD Cap	0.87**	-0.29	-0.40
	[0.30]	[0.55]	[0.46]
Any NE Cap	1.11**	0.76	1.18*
	[0.40]	[0.79]	[0.56]
JSL Reform	-1.54**	-0.71	-2.13**
	[0.48]	[0.73]	[0.60]
CSR Reform	0.15	-0.64	0.26
	[0.27]	[0.50]	[0.45]
Observations	2,257,735	2,257,735	2,257,735
R-squared	0.04	0.06	0.04

d) Exclude PA

Procedures:	C-sections	Induction/ Stimulation	Preventable Compli-cations
Any PD Cap	1.00**	1.56*	2.19**
	[0.31]	[0.65]	[0.84]
Any NE Cap	1.09**	0.72	1.15
	[0.41]	[0.71]	[0.62]
JSL Reform	-1.61**	-1.48*	-3.19**
	[0.49]	[0.71]	[0.67]
CSR Reform	0.19	-0.47	0.47
	[0.26]	[0.49]	[0.50]
Observations	2,211,258	2,211,258	2,211,258
R-squared	0.04	0.06	0.04

Appendix Table 2: Effect of Excluding Law Changes Pertaining Only to Malpractice

	(1)	*(2)*	*(3)*
	C-section	**Stim./ Induct.**	**Preventable Compli-cations**
Any PD Cap	0.94	2.31	5.60**
	[0.69]	[1.44]	[2.00]
Any NE Cap	1.41*	-0.52	1.82*
	[0.64]	[0.95]	[0.75]
JSL Reform	-1.93**	-0.7	-2.92**
	[0.66]	[0.85]	[0.76]
CSR Reform	1.16**	1.29*	1.26
	[0.42]	[0.61]	[0.70]
Observations	1760142	1760142	1760142
R-squared	0.04	0.06	0.04

Notes: Deleted States include AL, ME, MT, OH, ND, PA, RI, SD and WI.