The Differential Effects of Malpractice Reform: Defensive Medicine in Obstetrics*

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Abstract

Recent studies have argued that different types of patients are affected differently by changes in malpractice pressure, which could explain conflicting evidence from the literature regarding the impact of tort reform. This paper argues that defensive medicine causes these differential effects. It constructs a model of defensive medicine predicting that reduced malpractice pressure results in decreased health care spending among patients with good access to care, but increased spending among those with poor access. This theory is tested by estimating the effects of various tort reforms on the incidence of birth by cesarean section. The findings support the predictions of the model, uncovering differential effects consistent with the practice of defensive medicine. For example, noneconomic damages decrease C-section rates by 3% for mothers with timely initiation of prenatal care, but increase them by 5% for mothers with late or no prenatal care. Further estimation of the effects on access proxies and prevalence of birth abnormalities suggests that tort reform (*i*) improves access to health care for vulnerable populations, and (*ii*) reduces utilization among well-served populations.

Keywords: Defensive Medicine; Obstetrics; Medical Malpractice.

JEL Codes: I18, H75, K13

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1 Introduction

The existence and importance of defensive medicine practiced by health care providers has been a contentious issue for over forty years. Defensive medicine is the treatment decisions by health care providers made primarily to limit malpractice liability risk, rather than for the medical benefit of patients. Examples include the ordering of unnecessary and costly tests or procedures ("positive" defensive medicine) to forestall any claims of negligence, as well as the avoidance of the patients or procedures ("negative" defensive medicine) likely to result in a malpractice claim. Such behavior, if practiced on a sufficient scale, demonstrates the adverse effects that malpractice liability costs, or "malpractice pressure," could have on patients' access to care and the affordability of health insurance. Concerns about defensive medicine have led to policy discussions on how best to reduce providers' malpractice burden, with the goal of making health insurance more affordable and accessible.

Empirical investigations of defensive medicine have produced findings with inconsistent and often conflicting implications. A number of empirical studies have revealed a clear positive relationship between malpractice pressure and health care spending (Localio et al., 1993; Kessler and McClellan, 1996, 2002; Dubay et al., 1999; Grant and McInnes, 2004; Baicker et al., 2007; Yang et al., 2009; Moriya, 2010; Lakdawalla and Seabury, 2012; Cotet, 2012; Frakes, 2012; Shurtz, 2013; Chen and Yang, 2014; Avraham and Schanzenbach, 2015). The findings of several other studies, however, indicate a that the effect of malpractice pressure on health care spending is negative (Tussing and Wojtowycz, 1992; Currie and MacLeod, 2008; Paik et al., 2012; Shurtz, 2014). Finally, there are other investigations that did not uncover any statistically significant relationship between malpractice pressure and health care spending or insurance premiums (Baldwin et al., 1995; Baicker and Chandra, 2005; Hellinger and Encinosa, 2006; Congressional Budget Office, 2006; Baicker et al., 2007; Kim, 2007; Sloan and Shadle, 2009). Overall this shows the lack of a clear message from the empirical literature, which has left interested parties deadlocked in the discussion of malpractice reform as a viable policy option for improving health care systems.

An explanation for the inconsistent empirical findings has recently emerged. Upon investigating the impact of tort reform on C-section rates, Shurtz (2014) and, to a lesser extent, Avraham and Schanzenbach (2015) find that different groups of patients are affected differently by tort reform. Rather than defensive medicine, they attribute these differential effects to "offensive medicine": providers taking advantage of lenient malpractice environments to increase provision of C-sections in profitable (and potentially unnecessary) cases, and/or decreasing provision among unprofitable (yet potentially needy) patients. If true, this implies that reductions in malpractice pressure have a detrimental impact on patients, meaning policymakers should be wary of pressure-reducing tort reforms.

According to this explanation, the fear of liability constrains an obstetrician from providing a C-section in the marginal profitable case. This is inconsistent, however, with two key institutional details surrounding C-sections and their role in malpractice liability. First, providers' generally have greater financial incentive to perform a C-section rather than vaginal birth (Keeler and Brodie, 1993; Gruber and Owings, 1996; Gruber et al., 1999; Dranove et al., 2011; Huynh et al., 2013). Second, performing a C-section generally carries lower malpractice risk than vaginal birth. Physicians regularly report increasing the provision of C-sections in response to rising malpractice pressure (Klagholz and Strunk, 2006; Carpentieri et al., 2015). During the period studied here, many more malpractice claims (31% vs. 3%) were associated with delayed or nonperformance of C-section rather than unnecessary performance (Kravitz et al., 1991). This pattern still holds in the 21st century (Shwayder, 2007; Jena et al., 2015). Therefore, physicians are not generally sued for performing C-sections, but for *not* performing them. This all suggests that the marginal C-section, even in profitable cases, may be defensive rather than offensive. Therefore, the literature's existing explanation for the differential effects of malpractice reform requires further investigation.

The theoretical analysis in Montanera (2016) offers a different explanation for these differential effects. It predicts that defensive medicine produces a non-monotonic relationship between malpractice pressure and health care spending. Intuitively, as a result of defensive medicine, access to care becomes more expensive as malpractice pressure rises. At least initially, consumers are willing to bear the added expense in order to maintain "full access" to care (for example, without excessive wait times), resulting in increased health care spending. Eventually, however, the additional expense becomes too great a burden. Should malpractice pressure continue to rise, consumers begin to demand cheaper, lower-quality health insurance with "limited access" to care. If these are the differential effects uncovered in the empirical literature, then a more favorable implication emerges for malpractice reform. Indeed, if lower malpractice pressure makes access less expensive for those who have it, and improves access for those who don't, pressure-reducing reforms could generate welfare improvements. Some ambiguity remains in the predictions of Montanera (2016), however, making empirical testing difficult. Given the very different implications for the pursuit of malpractice reform, evaluating these competing explanations for differential effects is vitally important.

In this study, we develop a special case of the model in Montanera (2016) that yields clear, unambiguous, and testable predicted effects of changes in malpractice pressure. The analytical results predict differential effects due to defensive medicine. Specifically, individuals with different levels of access to care (which is determined endogenously) should experience different qualitative effects from an exogenous change in malpractice pressure. It predicts that consumers choosing health plans affording good access to care should experience greater health care spending following an increase in malpractice pressure, while spending would end up lower for those with poor access to care. Informed by the model, this study proceeds with an empirical investigation for evidence of the predicted differential effects. This is done by estimating the effects of various state-level tort reforms on C-section rates in the United States between the years of 1989 and 2001.[1] The empirical strategy, following the predictions of the model, uses an endogenous proxy for access to sort individuals into "full-access" and "limited-access" subgroups and runs separate regressions estimating the impact of malpractice pressure on health care spending.

The empirical results, under multiple specifications, uncover effects consistent with the theory's predictions, indicating that pressure-reducing tort reforms have differential effects resulting from defensive medicine. For example, caps on noneconomic damages result in a contemporaneous 5% increase in the provision of C-sections in limited-access births. Over a two-year period, however, those same caps result in a 3.4% decrease in C-sections among full-access births. According to the theory, these effects are due to improved access among vulnerable populations and reduced provision among well-served populations. To investigate whether limited-access mothers enjoyed improved access and health outcomes following tort reform, we estimate the impact on the incidence of late prenatal care, number of prenatal care visits, and prevalence of access-sensitive birth abnormalities. The results are generally consistent with improved access following reductions in malpractice pressure, supporting the theory's explanation for the aforementioned changes in health care spending.

There are already many studies designed to estimate the effects of various tort reforms on C-section rates. This paper has a different objective. Our primary goal is to determine how the practice of defensive medicine is revealed in the data. Specifically, it investigates for differential effects from changes in malpractice pressure and whether or not the any specific relationships uncovered fit the pattern of defensive medicine predicted by economic theory. This article contributes to the literature in several ways. First, it finds further evidence that different populations are affected differently by changes in malpractice pressure. Second, it offers a new theoretically-grounded explanation for why this is so, one with the

[1] Tort reforms passed during this specific period represent the best source of plausibly exogenous changes in malpractice pressure (Kessler and McClellan, 1996, 2002; Dubay et al., 2001; Currie and MacLeod, 2008).

opposite implication for tort reforms than is currently offered in the literature. Third, it details a novel method for estimating for the presence and effects of defensive medicine using endogenous access proxies. Finally, in estimating the model using a national sample, it uncovers differential effects of tort reform consistent with the widespread practice of defensive medicine. These are important for researchers and policymakers investigating defensive medicine and whether or not to pursue malpractice reform.

2 The Model

This section develops a model in order to derive unambiguous and testable predicted effects of malpractice pressure on health care spending. It is a simplified version of Montanera (2016) designed to investigate how malpractice pressure affects the health plans insurers are able to offer, and how this in turn affects the plans that consumers would want to purchase. The model considers three types of decision maker: (*i*) many discrete, non-strategic, and potentially heterogenous consumers, (*ii*) a continuum of identical physicians, and (*iii*) a continuum of managed care organizations (MCOs). Like other models of defensive medicine, the market for physician services follows a principal-agent framework where the MCO (principal) cannot contract directly on physicians' medical decisions, but can influence them through the parameters of a contract. The health insurance market follows Cutler and Gruber (1996) in that each consumer independently chooses how much to spend on health insurance and receives a level of "coverage" in return. Furthermore, in order to focus on MCO-physician contracting problems, we assume a perfectly competitive health insurance market with symmetric information, thus allowing MCOs to offer each consumer an actuarially fair insurance contract.[2] Each consumer's insurance market decision is therefore independent of the others. While the exact solution to each consumer's problem would depend on individual-level parameter values, the decision rules obtained from solving a given consumer's problem would apply to any other consumer. In order to obtain these decision rules, the model proceeds in solving a given consumer's insurance market problem.

The consumer is endowed with income m and holds preferences over consumption (y) and health status (H) according to the utility function $U(y, H)$, which is subject to the Inada conditions. The utility function is concave in each good, with strictly positive first derivatives and strictly negative second derivatives. A healthy consumer enjoys health status

[2] This framework ensures that all consumers' insurance market decisions respond smoothly to changes in model parameters. In the real world, where the number of offerings is limited, there would be bunching of consumers and only those on the margin would respond.

H_1 while an ill consumer suffers a strictly lower status, H_2. Prior to the determination of health status, the consumer may purchase a health insurance policy. Illness occurs with probability q, but in the case of illness, insurance affords the consumer a chance at recovery to the higher health status. Therefore, in purchasing health insurance, the consumer gives up some consumption in exchange for the chance of recovery in the event of illness.

We assume that the consumer's utility function is additively separable, which means the cross-partial derivative is zero and makes consumers' marginal utility of consumption independent of health status. This assumes away interactions found in the empirical literature, which indicates that health and consumption tend to be compliments (Levy and Nir, 2012; Finkelstein et al., 2013). Where this is true, an individual facing a negative health shock would find consumption less valuable. This effect may be reasonably assumed away in this model specifically because this is a market for health insurance, where real-world insurance policies tend to cover entire households. While one individual may devalue their own consumption upon falling ill, other uses of income (rent, tuition, etc.) would likely remain important for the rest of the household. The impact of this assumption is revisited in the Equilibrium section.

There is a continuum of MCOs, each offering a single insurance policy to the consumer. MCOs and their insurance policies are indexed by price (τ), ranging from 0 to m. There may be policies at prices greater than m, but due to the Inada conditions, these would be irrelevant options to this consumer. In addition to price, a health insurance policy consists of a probability of recovery (Q). Given the assumption that the health insurance market is perfectly competitive, each MCO's problem is to maximize Q given τ, subject to a zero-profit constraint. The probability of recovery depends on the health care services procured by the MCO. The MCO procures these services by setting a contract with the physicians. Under the contract, the MCO provides a physician with a payment (w) for each consumer on the physician's caseload, as well as a stock of resources (s) to divide and allocate across each case. MCOs procure resources at a marginal cost of c, which is constant.

Let $D > 0$ be the be the measure of physicians under contract with each MCO. Each physician is a risk-neutral income maximizer. Taking as given the contract $\{w, s\}$ set by their MCO, each physician chooses the size of his caseload (n) to devote to the MCO's patients as well as the quantity of resources (t_i) to devote as "treatment" to each case i, where the total amount of treatment across the physician's caseload cannot exceed the available stock of resources (s). A filled case receiving treatment t_i receives a favorable outcome (recovering from H_2 to H_1) with probability $1 - \rho(t_i)$ but suffers an adverse outcome (remaining with

H_2) with probability $\rho(t_i)$. The function $\rho(t_i)$ is strictly positive, decreasing, continuous, and strictly convex. Furthermore, assume that the adverse outcome occurs with probability 1 when no treatment is provided (meaning $\rho(0) = 1$), but approaches zero as treatment increases. These all imply that physicians can reduce the probability of an adverse outcome, but cannot eliminate it entirely. Assume that taking on the given consumer as a case (if ill) carries an uninsurable[3] expected malpractice liability cost to the physician of $g(t_i, P)$, where P is a parameter representing malpractice pressure. As a functional form assumption, let $g(t, P) = \rho(t_i)P$, meaning that expected liability cost is proportional to the probability of an adverse outcome. Given that $\rho(t_i)$ is strictly convex, the physician's total liability costs are lowest when resources are evenly distributed, meaning $\left(t_i = \frac{s}{n}\right)$ for all cases.[4] A given physician's income-maximizing caseload $n^\star(w, s, P)$ for a given contract is the solution to:

$$(1) \quad \max_n \quad \left\{ wn - n\rho\left(\frac{s}{n}\right)P \right\}$$

Intuitively, while expanding the caseload allows a physician to increase revenues, it also increases the exposure to malpractice liability costs. This is due to both the number of potential claims increasing with the number of patients and also because the physician's available resources become more thinly spread over the larger caseload.

The solution to the physician's problem ultimately determines the quality and cost of the health insurance policy offered, and so this must be accounted for in the MCO's problem. The total number of cases the MCO procures on behalf of a given consumer is $Dn^\star$ while the consumer's expected demand is q. Since any cases in excess of the demand would go unfilled in expectation, and assuming an even distribution of patients across physicians, the actual number of cases taken on by each physician is:

$$\tilde{n} = \tilde{n}(w, s \mid q, D, P) = \min\left\{ n^\star(w, s, P), \frac{q}{D} \right\}.$$

[3]Examples of uninsurable liability costs include reputational damage, the stress of a malpractice suit, potential disciplinary action from licensing boards, and increases in malpractice premiums following a claim. Malpractice premiums themselves summarize the insurable liability costs, which do not affect this margin of physician behavior and are thus normalized to zero.

[4]Even though consumers are discrete, caseloads are assumed to be continuous for tractability. This ensures smooth comparative statics from the physician's problem that can easily be incorporated into the MCO's problem. An interpretation of this assumption is that a given consumer can be treated by a team of physicians, with each earning a share of the payment, contributing a share of the resources, and bearing a share of the liability cost. A physician would thus expect the entire caseload, even fractions of cases, to eventually be filled.

Given the assumptions of the model, a consumer's successful recovery in the event of illness is the result of two events. First, the consumer must be taken on as a case. This occurs with probability $(D\tilde{n}/q)$, which serves as the level of "access" provided to the ill consumer through the health insurance policy. Second, conditional on gaining access, the patient's treatment is successful with probability $(1 - \rho(s/\tilde{n}))$. Therefore, the unconditional probability that the consumer recovers through their health insurance policy in the event of illness is:

$$\tilde{Q} = \tilde{Q}(w, s \mid q, D, P) = \frac{D\tilde{n}}{q}\Big(1 - \rho\Big(\frac{s}{\tilde{n}}\Big)\Big).$$

In procuring this probability of recovery, the MCO must make total payments of $Dw\tilde{n}$ to physicians and bear the total cost Dcs in procured resources. Therefore, each MCO's problem is:

$$\text{(2)} \quad \max_{w,s} \quad \Big\{\tilde{Q} = \frac{D\tilde{n}}{q}\Big(1 - \rho\Big(\frac{s}{\tilde{n}}\Big)\Big)\Big\}$$

$$s.t. \quad \tau = Dw\tilde{n} + Dcs.$$

The result of each MCO solving this problem is that the probability of recovery $\tilde{Q}(\tau)$ for a given insurance policy is a function of the policy price τ. It is finally up to the consumer to choose the insurance policy that maximizes expected utility, as is laid out in the consumer's problem:

$$\text{(3)} \quad \max_{\tau} \quad \Big\{EU = \Big(1 - q + q\tilde{Q}(\tau)\Big)\, U(m - \tau, H_1) + \Big(q - q\tilde{Q}(\tau)\Big)\, U(m - \tau, H_2)\Big\}$$

Therefore, in considering insurance policies at different prices across the continuum, the consumer faces a tradeoff between consumption and the probability of recovery in the event of illness.

3 Equilibrium

Equilibrium is defined as, for a given set of model parameters, *i*) a decision rule $n^\star(w, s, P)$ solving physician's problem (1), *ii*) a contract $\{w^\star, s^\star\}$ solving MCO's problem (2), *iii*) and a choice of insurance policy $\tau^\star$ solving consumer's problem (3). The choice of caseload size that maximizes a given physician's income is $n^\star(w, s, P)$ such that:

$$(4) \quad \frac{w}{P} = \rho\Big(\frac{s}{n^\star}\Big) - \Big(\frac{s}{n^\star}\Big) \cdot \rho'\Big(\frac{s}{n^\star}\Big)$$

where $\rho'(.)$ is the first derivative of $\rho(t)$. Due to the properties of $\rho(t)$ defined earlier, there exists a unique, finite, and non-negative $n^\star$ for any $s > 0$ and $w \in [0, P)$.[5] An increase in malpractice pressure (P) increases both the total liability exposure as well as the marginal cost of expanding his caseload, inducing the physician to choose a smaller caseload and focus available resources on a smaller group of patients. An increase in either w or s has the opposite effect, meaning the MCO must use the contract $\{w, s\}$ to overcome these liability concerns in order to procure physicians' services.

The MCO's problem incorporates the solution to the physician's problem. In setting the contract with physicians, the MCO would never set w and s such that $n^\star > \frac{q}{D}$ because all procured cases above $\frac{q}{D}$ are costly but expected to go unfilled. As long as $n^\star < \frac{q}{D}$, then the optimal w and s are defined by the following conditions:

$$(5) \quad \frac{\frac{\partial \tilde{Q}}{\partial w}}{D\big[\tilde{n} + w\frac{\partial \tilde{n}}{\partial w}\big]} = \frac{\frac{\partial \tilde{Q}}{\partial s}}{D\big[w\frac{\partial \tilde{n}}{\partial s} + c\big]}$$
$$\tau = Dw\tilde{n} + Dcs$$

Deriving $\frac{\partial n^\star}{\partial w} = \Big(\frac{n^2}{s}\Big)\Big[Pt\frac{\partial^2 \rho}{\partial t^2}\Big]^{-1}$ and $\frac{\partial n^\star}{\partial s} = \frac{n}{s}$ from the physician's problem (4) and rearranging Condition (5) yields the following necessary condition:

$$(6) \quad \frac{1-\rho}{w + ct} = \frac{-\frac{\partial \rho}{\partial t}}{c - Pt\frac{\partial^2 \rho}{\partial t^2}},$$

The left side of Condition (6) shows the MCO's returns from inducing physicians to increase n. The right side shows the MCO's returns from inducing an increase in t. As Proposition 1 from Montanera (2016) shows, if the technical assumptions 1 and 2 in the Appendix hold,[6]

[5] For any $s > 0$, the right side of Condition (4) approaches 0 as n approaches 0, meaning physician income must be strictly positive at $n^\star$.

[6] Assumption 1 implies there is some level of treatment above which which the curvature of $\rho(t)$ begins to flatten out. Assumption 2 implies that physicians are very averse to treating patients in the absence of

then there is a unique level of treatment satisfying Condition (6) and also that this level of treatment ($t^\star(P)$) is independent of the policy price τ.[7] Intuitively, the returns from increasing n are constant for a given t, while those from increasing t are diminishing. It thus follows that the MCO should increase t until the returns equalize, which happens at $t^\star(P)$, and then use any remaining funds to increase n while holding treatment constant.

From the physician's problem (4) define $w = \omega(t; P) = P[\rho(t) - t\rho'(t)]$ as the payment that induces physicians to choose t. As the optimal level of treatment is $t^\star(P)$, defined by Condition (6), the unique optimal payment is $w^\star(P) = \omega(t^\star(P); P)$ for contracts such that $n^\star < \frac{q}{D}$. Given $w^\star(P)$, the zero profit condition in the MCO's problem implies that all remaining funds be allocated to the procurement of resources, which defines the unique optimal level of resources $s^\star = \psi(\tau; P)$ such that:

$$\tau = Dn^\star\left(w^\star(P), \psi(\tau; P), P\right)\left[w^\star(P) + ct^\star(P)\right],$$

Since $\frac{\partial\psi}{\partial\tau} > 0$, it must be that the level of access offered by MCOs increases in τ for all MCOs offering $\tilde{n}^\star < \frac{q}{D}$. There is a price, however, at which $\tilde{n}^\star = \frac{q}{D}$ and access is maximized. This level of spending is defined by Condition (5) and the MCOs' zero profit constraint as $\bar{\tau}(P) = q[w^\star(P) + ct^\star(P)]$. For any MCOs with $\tau > \bar{\tau}(P)$, the additional funds cannot be used to increase n, and so these funds must be used to purchase additional resources and increase t instead. Levels of treatment greater than $t^\star(P)$ cause the left side of Condition (6) to be greater than the right side, meaning it is never optimal to bring $\tilde{n}^\star$ below $\frac{q}{D}$ once τ is greater than $\bar{\tau}(P)$. This means that, for $\tau > \bar{\tau}(P)$, the optimal payment is the one that maintains $n^\star = \frac{q}{D}$ given the available resources, or $w^\star = \omega\left(\frac{Ds}{q}; P\right)$. Again, given $w^\star$, it is optimal to devote any remaining funds to resource procurement, defining $s^\star = \sigma(\tau; P)$ from the MCOs' zero profit condition such that:

resources. In other words, in procuring any given caseload n', it is at least as expensive for the MCO to provide physicians with some strictly positive amount of resources (s') rather than no resources at all (the contract $\{\omega(0; P), 0\}$ is at least as expensive as $\{\omega\left(\frac{s'}{n'}; P\right), s'\}$).

[7] Note that Condition (6) is independent of the number of physicians. According to Condition (4), there is a unique level of treatment maximizing physician income for a given w that is independent of s. To illustrate; at a given w, two physicians with s resources each would choose the same total caseload as a single physician with $2s$ resources. Therefore, the total caseload procured in the MCO's problem depends not on the number of physicians but on the total amount of resources provided. This result implies that the earlier assumption of a fixed ratio of physicians-to-consumers, as well as the lack of participation constraints for physicians in the MCO's problem, do not impact the equilibrium. Montanera (2012) relaxes this assumption by making D endogenous and fixing the amount of resources per physician, finding the same qualitative relationship between malpractice pressure and health care spending as is predicted here.

$$\tau = q\omega\left(\frac{D\sigma(\tau;P)}{q};P\right) + Dc\sigma(\tau;P),$$

which is also unique given that $\tau > \bar{\tau}(P)$. Therefore, an MCO selling an insurance policy at price τ has the following optimal strategy:

$$s^\star(\tau) = \begin{cases} \psi(\tau;P) & \text{if} \quad \tau \le \bar{\tau}(P); \\ \sigma(\tau;P) & \text{if} \quad \tau > \bar{\tau}(P), \end{cases} \qquad w^\star(\tau) = \begin{cases} \omega(t^\star(P);P) & \text{if} \quad \tau \le \bar{\tau}(P); \\ \omega\left(\frac{D\sigma}{q};P\right) & \text{if} \quad \tau > \bar{\tau}(P). \end{cases}$$

Finally, the consumer's problem is to select the insurance policy $\{Q,\tau\}$ that maximizes expected utility. From the MCO's problem, the maximum probability of recovery achievable by the MCO with its insurance policy priced at τ is $\tilde{Q}(\tau) = \tilde{Q}(w^\star(\tau), s^\star(\tau) \mid q, D, P)$. Therefore, the solution to the consumer's problem is the insurance policy that satisfies the following first-order condition:

$$(7) \quad q\Delta U\tilde{Q}'(\tau) = U_y'(m-\tau)$$

where $\tilde{Q}'(.)$ is the first derivative of $\tilde{Q}(\tau)$, $U_y'(.)$ is the consumer's marginal utility of consumption, and $\Delta U = U(m-\tau, H_1) - U(m-\tau, H_2)$ is the utility gained when an ill consumer recovers, or the benefit from recovery.

Proposition 1. ***(Uniqueness of Equilibrium.)*** *Given Assumptions 1 and 2 in Appendix A, there exists a unique equilibrium.*

The proof of Proposition 1, presented in Appendix B, shows that the left side of Condition (7) is weakly decreasing in τ while the right side is strictly increasing, which produces a unique solution. It is possible for the solution to occur at the corner ($\tau^\star = 0$), in which case the consumer would choose to go uninsured. For all interior solutions ($\tau^\star > 0$), by the Implicit Function Theorem, Condition (7) produces the following comparative static regarding a consumer's spending on health insurance as malpractice pressure changes:[8]

[8] In the event of a corner equilibrium, the left side of Condition (7) would still be greater than the right side following an increase in malpractice pressure, and so $\tau^\star$ would remain at zero.

$$(8) \qquad \frac{\partial \tau^\star}{\partial P} = \frac{-q\Delta U \frac{\partial^2 \tilde{Q}}{\partial \tau \partial P}}{q\Delta U \frac{\partial^2 \tilde{Q}}{\partial \tau^2} + U_y''}$$

The denominator on the right side of Equation (8) is always negative, and so the sign of (8) is determined by the numerator. Since both q and ΔU are strictly positive, the sign of $\frac{\partial \tau^\star}{\partial P}$ is completely determined by the sign of $\frac{\partial^2 \tilde{Q}}{\partial \tau \partial P}$.

Proposition 2. ***(Full Access in Equilibrium.)*** *If* $q\Delta U \tilde{Q}'(\bar{\tau}(P)) > U_y'(m - \bar{\tau}(P))$, *then:*

i) $\dfrac{D\tilde{n}^\star}{q} = 1,$

ii) $\dfrac{\partial \tilde{n}^\star}{\partial P} = 0,$ *and*

iii) $\dfrac{\partial \tau^\star}{\partial P} > 0.$

The proof of Proposition 2 is found in Appendix C. The condition $q\Delta U \tilde{Q}'(\bar{\tau}(P)) > U_y'(m - \bar{\tau}(P))$ is the first-order condition from the consumer's problem evaluated at $\bar{\tau}(P)$. Where the left side is greater, the consumer is willing to spend more than $\bar{\tau}(P)$ in the pursuit of greater $\tilde{Q}(\tau)$. From the solution to the MCO's problem, this implies that the solution constitutes a "full-access" insurance policy $\left(\tau > \bar{\tau}(P) \text{ and thus } \frac{D\tilde{n}^\star}{q} = 1\right)$. The intuition behind the comparative statics is that rising malpractice pressure makes each level of access more expensive. Each MCO with $\tau > \bar{\tau}(P)$ would optimally react to rising malpractice pressure by maintaining full access, requiring a redistribution of funds from resources to increased physician payments. This lowers the level of treatment under the policy, and since treatment is subject to diminishing returns, the marginal effectiveness of treatment increases. As resources become more effective while the marginal cost is constant, the rise in malpractice pressure makes an increase in resources more cost-effective. This increased cost-effectiveness makes the consumer willing to increase spending on health insurance in order to secure more treatment, which in turn raises health care spending.

Proposition 3. ***(Limited Access in Equilibrium.)*** *If* $q\Delta U\tilde{Q}'(\bar{\tau}(P)) \leq U_y'(m - \bar{\tau}(P))$,

$$i) \quad \frac{D\tilde{n}^\star}{q} \leq 1,$$

$$ii) \quad \frac{\partial \tilde{n}^\star}{\partial P} < 0, \textit{ and}$$

$$iii) \quad \frac{\partial \tau^\star}{\partial P} < 0.$$

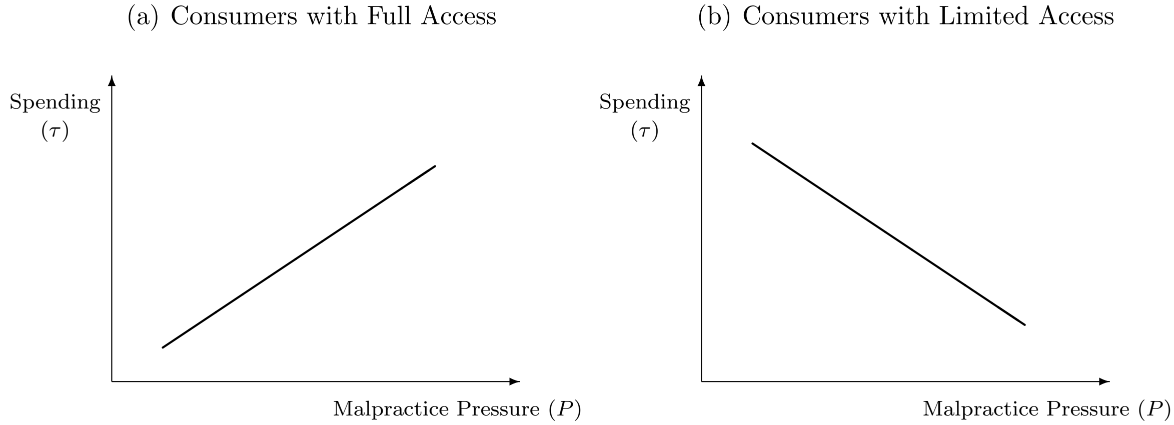
Corollary: $\dfrac{D\tilde{n}^\star}{q} < 1 \quad \Rightarrow \quad \dfrac{\partial \tau^\star}{\partial P} < 0.$

The proof of Proposition 3, found in Appendix D, reveals that the qualitative effect of malpractice pressure on health care spending for consumers choosing to purchase "limited-access" policies ($\tau \leq \bar{\tau}(P)$ and thus $\frac{D\tilde{n}^\star}{q} \leq 1$) is the opposite of those with full access. The reason for this difference is that, as long as access is limited, the MCO's best use of the marginal unit of funding is to increase access. Just as in the other equilibrium, however, a rise in malpractice pressure makes physicians more wary of increasing caseloads, and thus makes access more expensive. This reduces the cost-effectiveness of increased caseloads, thus making the marginal unit of funds less effective at increasing the probability of recovery.[9] Therefore, consumers holding limited-access policies are induced to forego the marginal unit of funding. They instead choose a less expensive insurance policy with poorer access, leading to lower health care spending.

Figure 1 illustrates the analytical results of the model. The figure shows that those consumers choosing insurance policies providing full access (with the exception of those consumers for whom $\tau^\star = \bar{\tau}(P)$) would ultimately spend more following an exogenous increase in malpractice pressure. On the other hand, those consumers choosing to purchase insurance policies affording limited access would ultimately spend less on health insurance following an exogenous increase in malpractice reform. Intuitively, a consumer willing to spend $\tau^\star > \bar{\tau}(P)$ places a relatively high value on access to care. As rising malpractice pressure makes access more expensive, such a consumer is willing to pay a higher insurance premium in order to maintain this high level of access. Conversely, a consumer for whom $\tau^\star < \bar{\tau}(P)$ is either unwilling or unable to pay the high premiums necessary to secure full access. Such a con-

[9] Without the assumption of additive separability in the utility function, a second term would appear in the numerator of Condition 8. This term would be the effect of the increase in malpractice pressure, which lowers expected health status for a given level of health care spending, on $U_y'(.)$. Depending on its sign, this term's presence would reinforce the effect of malpractice pressure for one access type, but confound it in the other.

Figure 1: Effects of Rising Medical Malpractice Pressure



sumer would instead choose a limited-access policy such that the marginal units of access and consumption are equal in value. As increasing malpractice pressure makes access more expensive, however, this consumer would substitute away from health insurance. They resort to cheaper health insurance with poorer access to care, or may simply opt out of the market altogether.

It is important to note that access is endogenous in the model and, for a given consumer, is determined by the condition $q\Delta U\tilde{Q}'(\bar{\tau}(P)) > U'_y(m - \bar{\tau}(P))$. There are multiple reasons why this condition may hold for a given consumer, including a high probability of falling ill (high q) or a high perceived value of health care services (high ΔU). Additionally, the condition may not hold for low-income consumers (high U'_y) or those representing a high malpractice risk or treatment cost (high $\bar{\tau}(P)$). For the purpose of testing the model's predictions, however, the reasons why the condition holds or does not hold are irrelevant. The condition itself fully determines both the consumer's access to care as well as how the consumer is affected by an exogenous change in malpractice pressure. Therefore, the predictions of the model could be tested if an endogenous access proxy is available to use in partitioning a given sample into full- and limited-access subgroups. The effect of an exogenous change in malpractice pressure could then be estimated separately for each subgroup. Finding different qualitative effects fitting the pattern from Figure 1 would suggest that i) differential effects of malpractice reform do exist, and ii) defensive medicine is responsible for these effects. To this end, we proceed with an empirical strategy to test the model's predictions.

4 Data

We draw data from two sources: (i) the Vital Statistics Natality Birth Data, provided by the National Center for Health Statistics (NCHS), and (ii) tort reforms provided by Harvard University's Institute for Quantitative Social Science Dataverse Network (Currie and MacLeod, 2009). The Vital Statistics Natality Birth Data was obtained from the National Bureau of Economic Research (NBER) website and provides demographic and health data from all births occurring during a calendar year in all fifty US states. We use these data for years 1989 through 2001. Demographic data include variables such as age, educational attainment, race, and marital status of the mother as well as date of birth and sex of the child. Health data include method of delivery, prenatal care, plurality (the number of children resulting from a single pregnancy), birth order, and birth weight. The health data also include abnormal conditions of the newborn such as fetal alcohol syndrome and newborn anemia. The geographic data includes state and county where the birth occurred as well as the population size of the county of residence. Given the size of the data set, we obtained a random sample of 15 percent for each year, which amounts to 5,332,192 observations

The data on tort reforms contain information on the enactment or rescindment of tort reforms for each state and the District of Columbia for each month and calendar year from 1987 through 2001. Four noted tort reforms are caps on noneconomic damages, caps on punitive damages, joint-and-several liability reform, and collateral source rule reform.[10] We subscribe to the argument from Currie and MacLeod (2008) regarding the relationships between each reform and malpractice pressure. Punitive or noneconomic damage caps limit the direct liability costs of jury awards and, by lowering the expected payoff of a lawsuit, potentially the indirect costs through reduced frequency of lawsuits. For this reason, the passage of either type of damage cap is considered a reduction in malpractice pressure. Collateral Source Rule (CSR) reform allows courts to consider other sources of income to a plaintiff stemming from a medical injury (insurance payouts, for example) when determining damages. To the extent that these other sources substitute for damages in making the plaintiff whole, CSR reform is also considered a reduction in malpractice pressure. Finally, under the common law of joint-and-several liability (JSL), physicians can be sued for damages even if other providers (nurses, administrators, etc.) are primarily responsible for a plaintiff's injuries. Reforms of JSL allow plaintiffs to sue physicians only if the physician bore some minimum threshold of liability (typically 50%). Such a reform creates a greater dependence

[10] Appendix E provides detailed definitions of these tort laws.

of a physician's claims experience on that physician's own treatment decisions. As this reform increases the relationship between treatment decisions and liability costs, it represents an *increase* in malpractice pressure; the opposite of the other three reforms.

Given the descriptions of the four tort reforms and their impact on malpractice pressure, we define the following four indicator variables for use in our empirical specification:[11]

$$PDC_{st} = \mathbf{1}\{\text{state } s \text{ at time } t \text{ has a cap on punitive damages}\}, \tag{9}$$

$$NEC_{st} = \mathbf{1}\{\text{state } s \text{ at time } t \text{ has a cap on noneconomic damages}\}, \tag{10}$$

$$CSR_{st} = \mathbf{1}\{\text{state } s \text{ at time } t \text{ allows consideration of payments from outside sources}\}, \tag{11}$$

$$NJSL_{st} = \mathbf{1}\{\text{state } s \text{ at time } t \text{ does not require at least 50\% responsibility for the injury}\}. \tag{12}$$

Note that $NJSL_{st}$ turned on implies that the state has *not* reformed joint-and-several liability, and instead follows the common law. This is done so that all indicators have the same qualitative impact (reduction) on malpractice pressure, which makes the tables in Section 6 easier to interpret. Table 1 shows the states that experienced an enactment (law-on) or rescindment (law-off) of each type of tort reform, as well as the month and year when the change took place. Having reforms turning on as well ass off in different states at different times is useful for identification purposes as it disentangles the effects of tort reform from other long-term trends; Medicaid expansions, for example.

The model presented in Section 2 is static and does not contain a time dimension. This means that the effects of malpractice reform on health care spending could be realized either immediately following or years after the passage or rescindment of of the reform, and still be consistent with the model. In fact, Dubay et al. (1999) found that physician behavior in a given year was affected by tort reforms occurring years earlier. Since the responses to changes in tort law may be quick or gradual, The analysis performed in Section 6 estimates a contemporaneous specification as well as those with lagged effects of up to two years. This is why the natality data covers the years 1989-2001 while the tort reform data goes back two years earlier.

The empirical analysis is restricted to births in counties with a population of at least 100,000. The reason is that, in the interest of tractability, the model developed in this study assumes a fixed ratio of physicians to patients, which effectively makes physicians immobile. In the real world, however, both Matsa (2007) and Lieber (2014) found evidence

[11] The first three indicators, PDC_{st}, NEC_{st}, and CSR_{st} are identical to those of Currie and MacLeod (2008) while the definition of $NJSL_{st}$ is the exact opposite of their JSL_{st} variable.

Table 1: Tort Reforms by Date and State

	Non-Economic Damages Cap	Punitive Damages Cap	Joint-and-Several Liability Reform	Collateral-Source Reform
LAW	Alabama (6/1987)	Georgia (7/1987)	South Dakota (4/1987)	Alabama (6/1987)
ON	Utah (7/1987)	Oregon (8/1987)	Idaho (7/1987)	Georgia (7/1987)
	Idaho (7/1987)	Texas (9/1987)	Louisiana (7/1987)	Montana (10/1987)
	Oregon (8/1987)	Alabama (11/1987)	Oregon (8/1987)	New Jersey (1/1988)
	Florida (2/1988)	Nevada (6/1989)	North Dakota (8/1987)	Kentucky (7/1988)
	Kansas (7/1988)	North Dakota (5/1993)	Montana (10/1987)	Kansas (7/1988)
	Illinois (3/1995)	Wisconsin (7/1995)	New Jersey (1/1988)	Idaho (4/1990)
	North Dakota (8/1995)	Indiana (7/1995)	Arizona (1/1988)	Maine (5/1990)
	Montana (10/1995)	New Jersey (11/1995)	Mississippi (7/1989)	Wisconsin (6/1995)
	Ohio (2/1997)	North Carolina (1/1996)	New Hampshire (1/1990)	Alabama (10/2000)
		Ohio (2/1997)	Tennessee (5/1992)	
		Pennsylvania (2/1997)	Illinois (3/1995)	
		Alaska (8/1997)	Wisconsin (6/1995)	
		Alabama (6/1999)	Texas (9/1995)	
			Ohio (2/1997)	
LAW	Florida (5/1987)	Montana (10/1987)	Illinois (1/1998)	Kansas (8/1987)
OFF	Texas (5/1988)	Alabama (7/1993)	Ohio (3/1998)	Georgia (3/1991)
	Kansas (6/1988)	South Dakota (2/1996)		Kansas (5/1993)
	Washington (5/1989)	Ohio (3/1998)		Kentucky (2/1995)
	New Hampshire (3/1991)			Alabama (7/1996)
	Ohio (9/1991)			
	Alabama (10/1991)			
	Illinois (1/1998)			
	Ohio (3/1998)			
	Oregon (7/1999)			

Notes: Data obtained obtained from the website of W. Bentley MacLeod through the Institute for Quantitative Social Science Dataverse Network (IQSS Dataverse Network) of Harvard University. These are the tort reforms from years 1987 to 2001.

that physicians' location decisions are sensitive to malpractice pressure. In less-populated counties, likely without many physicians, the movement of even a small number physicians can cause significant changes to the physician-to-patient ratio. By focussing the analysis on counties with larger populations and presumably greater numbers of physicians, this ratio is likely to be more stable and thus more closely resemble the conditions assumed in the model.[12] In the next section, we present more details of the sample used for empirical analysis.

5 Empirical Methodology

The model developed in Section 2 provide predictions on the relationship between three main variables: (i) health care spending, (ii) medical malpractice pressure, and (iii) access to health care. The incidence of birth by cesarean section is used here as a proxy for health care spending.[13] It is a useful proxy because C-section is an expensive alternative to vaginal birth (Dubay et al., 1999; Chen and Yang, 2014; Shurtz, 2014) in terms of both physician fees and the amount of resources devoted to each treated patient (Keeler and Brodie, 1993; Gruber and Owings, 1996; Huynh et al., 2013), meaning relatively higher average w and t (and thus τ) from the model. Delivery by C-section is associated with defensive behavior since it is an expensive alternative to vaginal birth and is widely believed among physicians to reduce the complications most likely to result in malpractice claims (Yang et al., 2009). As a proxy for malpractice pressure, we use the passage or rescindment of the four tort reforms described in Section 4. It is important to note, however, that the purpose of this study is not to evaluate the merits or effectiveness of tort reforms in achieving policy objectives. Our strategy for identifying defensive medicine requires estimates of the impact of malpractice pressure, not the impact of tort reforms. It is mainly for this reason that we focus on reforms occurring from 1987 up to 2001. These specific reforms were unrelated to medical malpractice issues, and so they are widely treated in the literature as exogenous changes in malpractice pressure (Kessler and McClellan, 1996, 2002; Dubay et al., 2001; Avraham, 2007; Currie and MacLeod, 2008).

Taking both panels of Figure 1 together, the clear prediction is that rising malpractice pressure has a positive effect on the health care spending of those patients enjoying good

[12]Montanera (2012) shows that physician mobility can be a source of bias in the effects of malpractice pressure on health care spending, and so focusing in large counties would help in reducing this bias.

[13]Ideally we would like to work with a measure of spending that includes the amount claimed by providers for each C-section, but these claims data are unavailable to us.

access to care, while a negative effect is experienced by patients with poor access. As long as the observations in the data could be separated into full- and limited-access groups, estimation is straightforward. However, unlike the clear-cut definition in Figure 1, modern health care industries tend to have operational and regulatory characteristics that make access to care a more complex concept. While there are multiple places along the continuum of care where low-income patients face access barriers, there tend to be regulations guaranteeing at least some minimum level of access in certain venues, regardless of ability to pay.[14] Therefore, limited access in the real world is unlikely to be characterized by a complete lack of care. Instead, differences between capacity and need are likely to manifest as congestion, which in turn results in irregular or delayed care.

We use the timeliness of prenatal care initiation to partition the sample into full- and limited-access subgroups.[15] Dubay et al. (2001) use this same variable as a direct measure of access (which is done here in only one specification) and we follow their definition. Prenatal care initiated during the first trimester is considered timely, while initiation in second or third trimesters, or not at all, is considered untimely. There are reasons why timeliness is an appropriate access proxy for this study. First, timeliness is bound to be correlated with unmeasured characteristics of a birth and so is endogenous, satisfying a necessary condition of the empirical strategy for estimating the model. Second, notwithstanding the prior usage by Dubay et al. (2001), access was an important factor in determining timeliness for mothers during the study period. 56% of mothers who initiated prenatal care late had wanted to begin care earlier, and of these, between 41% and 27% cited financial barriers or a lack of available appointments as the primary constraints (Center for Disease Control and Prevention, 2000). As availability of appointments and ability to pay are key determinants of timeliness, it thus closely follows the concept of access depicted in the model. Of course, timeliness does not capture access perfectly, but this is not a requirement for our empirical strategy.[16] The only assumptions we make are *i*) access is a factor in determining timeliness, and *ii*) the other main determinants of timeliness (such as unawareness of pregnancy or disengagement of the mother) are independent of malpractice pressure. Both assumptions are relatively weak.

[14]For example, while low-income pregnant women in the United States may have difficulty obtaining a regular source of prenatal care, regulations like the Emergency Medical Treatment & Labor Act (EMTALA) compel hospitals to provide birthing services, even if the patient cannot pay.

[15]Additional proxies to the one examined here, including the Kessner Index for adequacy as well as others, can be found in Cano-Urbina and Montanera (2015).

[16]To the extent that timeliness may mischaracterize some mothers' level of access, the predicted differential effects imply that our estimates would be biased toward zero. As the signs of the effects are of greater importance than the magnitudes, this is not a major problem.

Table 2 presents summary statistics for the sample drawn from the Vital Statistic Natality Birth Data both for the whole sample and for full- and limited-access subgroups. Note that limited-access births are relatively less likely to be conducted by cesarean section. These births also correspond, on average, to mothers who are younger, less educated, and more likely to be unmarried, black, or Hispanic. A similar pattern is observed when separating the set of limited-access births into those receiving late prenatal care and those receiving no care, shown in the last two columns. The no care group is relatively small, making up 8% of the limited access group and 1.5% of the entire sample. Compared to the late care group, the no care group (i) has an even lower incidence of C-section, (ii) has significantly higher rates of fetal alcohol syndrome and newborn anemia, (iii) has a greater concentration of black mothers, (iv) is less likely to be married, and (v) tends to have a lower level of education. The summary statistics suggest that partitioning the sample by prenatal care initiation is separating observations according to socioeconomic characteristics indicative of access to care (Schlesinger and Kronebusch, 1990). Therefore, this proxy captures the concept of access of the model developed in Section 2. Similarly, Table 3 presents the summary statistics for the tort reforms for the whole sample and by access group. The summary statistics in Table 3 indicate that exposure to each tort reform is approximately equal for full- and limited-access groups, including limited-access subgroups. This does not mean that each group is affected by each tort reform in the same way, but at least rules out any bias in the results due to an imbalance in the shares of treated observations.

There is an additional concern regarding Medicaid expansions and their effects on the composition of the full- and limited-access groups. One of the goals of these expansions was to improve access to care for expectant mothers. If successful, this would cause periodic transfers of some mothers who would otherwise be limited-access into the full-access group. Given the opposite predicted effects of changes in malpractice pressure, this could bias the full-access estimates toward zero. In our sample, we do observe a significant drop over time in the share of limited-access births, from approximately 24% in 1989 to 16.5% in 2001. As shown in Appendix F, Table 10, however, the profile of the typical limited-access mother is relatively steady between 1989 and 2001. The changes observed in the limited-access group are similar to those in the full-access group, which suggests they are mainly the result of demographic changes in the general population. A reasonable explanation for this is that Medicaid expansions, while generally improving access for the newly eligible (Andrulis, 1998), had a muted impact on the timeliness of prenatal care initiation (Schlesinger and Kronebusch, 1990; Braveman et al., 1993). Reasons for this include bureaucratic delays

Table 2: Summary Statistics by Access Group

	Whole Sample	Full Access	Limited Access: All	Limited Access: Late Care	Limited Access: No Care
Outcome Variables:					
C-Section (%)	21.77	22.70	17.94	18.22	14.70
Number of Prenatal Care Visits	11.37	12.27	7.62	8.28	0
Fetal Alcohol Syndrome (%)	0.01	0.01	0.01	0.01	0.05
Newborn Anemia (%)	0.11	0.11	0.13	0.13	0.22
Demographics (%):					
Male Child	51.14	51.09	51.34	51.36	51.02
Multiple Birth	2.75	2.89	2.16	2.12	2.56
Mother Hispanic	21.00	18.41	31.74	31.75	31.58
Mother Black	16.86	14.49	26.73	25.69	38.93
Mother Other Race	5.48	5.43	5.68	5.88	3.34
Mother Married	68.17	73.76	44.93	46.17	30.44
Mother's Age (%):					
$10-18$	7.61	5.72	15.44	15.48	15.05
$19-24$	27.79	25.07	39.09	39.20	37.82
$25-34$	52.20	55.77	37.37	37.30	38.22
35+	12.40	13.44	8.09	8.02	8.92
Mother's Education (%):					
< 12	22.60	17.73	42.81	41.94	53.02
12	32.64	31.97	35.42	35.61	33.29
$13-15$	21.53	23.21	14.56	14.95	9.95
16+	23.23	27.08	7.21	7.51	3.74
Parity (%):					
1 child	40.86	41.78	37.01	37.71	28.81
2 children	32.29	33.33	27.97	28.26	24.49
3 children	16.28	15.94	17.69	17.61	18.65
4 children	6.36	5.71	9.05	8.79	12.09
5+ children	4.22	3.24	8.28	7.63	15.96
No of obs	5,332,192	4,297,293	1,034,899	953,508	81,391

Notes: Data obtained from the Vital Statistics Natality Birth Data, provided by the NBER. This certificate information covers all births occurring between 1989 and 2001 in all U.S. states between the years of 1987 and 2001, from which a 15 percent random sample is drawn. The summary statistics for: Prenatal Care Visits, Apgar Score, Fetal Alcohol Syndrome, and Newborn Anemia are based on a smaller subsample due to missing values on these outcomes.

Table 3: Tort Reforms (Percentages) by Access Group

	Whole Sample	Full Access	Limited Access All	Limited Access Late Care	Limited Access No Care
PDC	45.80	46.04	44.80	44.53	47.96
NEC	47.63	47.74	47.20	47.81	40.04
NJSL	42.93	43.47	40.67	40.28	45.20
CSR	58.86	58.59	59.99	60.51	53.89
No of obs	5,332,192	4,297,293	1,034,899	953,508	81,391

Notes: Data obtained obtained from the website of W. Bentley MacLeod through the Institute for Quantitative Social Science Dataverse Network (IQSS Dataverse Network) of Harvard University. The descriptive statistics are obtained using the tort reforms from years 1987 to 2001 implemented in all 50 US states plus the District of Columbia including states that did not have any tort reform during these years. PDC, NEC, NJSL and CSR are the indicator variables defined in equations (9)-(12).

between the discovery of pregnancy and Medicaid enrollment (Schlesinger and Kronebusch, 1990), low Medicaid reimbursement that made it unappealing to provide regular prenatal care even to enrolled women (Braveman et al., 1993; Dubay et al., 2001), and a tendency for these women to become enrolled only upon presenting in the emergency department in active labor (Aizer and Currie, 2004). Therefore, even with periodic expansions of Medicaid, partitioning the data based on timeliness of prenatal care initiation should leave the access groups relatively intact over the study period.

6 Results

6.1 Effect of Malpractice Pressure on Health Care Spending

This section presents the principal results of our study. Estimation proceeds in two steps. First, each birth is sorted into full- and limited-access groups using the timeliness of prenatal care as explained in the Section 5. Second, we estimate the effect of malpractice pressure on C-section separately for each group. For the second step we follow Currie and MacLeod (2008) and estimate the following specification:

$$(13)\quad C_{it} = \beta_0 + \mathrm{TR}'_{s(t-k)}\beta_1 + x'_{it}\beta_2 + \delta_y + \eta_m + \gamma_c + \theta_s \times\ t + \varepsilon_{it}, \quad k \in \{0, 12, 24\}$$

where the vector TR_{st} includes the four indicator variables defined in (9)-(12) corresponding to each of the four tort reforms considered in this study at state s on time t, where time t is measured in months. The vector x_{it} contains the following control variables: a dummy for child gender, a dummy for multiple birth, dummies for mother Hispanic, African American or other race, dummies for each parity from 1 to 4 and more than 5, dummies for mother's education (less than high school, high school, some college, college or more), dummies for mothers's age (19-24, 25-34, 35 or more). Finally, δ_y are year effects, η_m month effects, γ_c county effects, and $\theta_s \times\ t$ are state-specific linear time trends. These last regressors are meant to account for differences across states over time in terms of health care policies (e.g. managed care penetration, expansions in Medicaid eligibility) that likely affected obstetric practices. Note that (13) implies that we estimate three separate specifications for each access group: (i) the contemporaneous effect of tort reforms of C-section, $k = 0$, (ii) the effect of tort reforms in the previous year, $k = 12$, and (iii) the effect of tort reforms two years before, $k = 24$. The results of an event study presented in Appendix G indicate that the difference-in-differences specification (13) is suitable for our empirical analysis.

As a starting point we estimate specification (13) for the entire sample.[17] The results from this estimation are presented in Table 4. Recall that the way we defined the indicator variables for tort reforms, all of them represent a reduction in malpractice pressure. For the contemporaneous effects of the tort reforms in the first column, only NJSL is significant, so that a decrease in malpractice pressure is associated with a 0.55 percentage point increase in the C-section rate, this represents an increase of C-sections of 2.53% given baseline rates for C-section (see first column of Table 2). The same pattern holds in the one-year lagged effects, shown in the second column of Table 4. NJSL has roughly the same effect, and it is more precisely estimated, while reduced pressure through NE caps is associated with a 0.26 percentage point increase in the C-section-rate, representing a 1.19% increase in C-sections. The pattern in the coefficients from the contemporaneous and one-year lagged specification reveals a negative relationship between malpractice pressure and the C-section rate.

The pattern of the first two columns of Table 4 is reversed in the third column for the

[17] The first column of Table 4 could be compared to the main results of Currie and MacLeod (2008) (see Table IV, first column), except that the sign we obtain for the NJSL indicator is the opposite of the sign obtained by Currie and MacLeod because we defined our dummy exactly opposite to theirs. Although the data sources we use are the same as those used in Currie and MacLeod (2008), the samples are not identical. There are four main differences between our sample and their sample: (i) they use only the 24 US states that experienced tort reforms over the years 1989-2001, we use all the US states; (ii) they take a 10 percent random sample from these 24 states, we take a 15 percent random sample from all states, (iii) they group all counties in a given state with less than 100,000 population as an additional "county", we drop counties with less than 100,000 population, and (iv) they impute observations with unstated method of delivery as a vaginal birth, we drop observations with unstated method of delivery. This last point is more deeply analyzed in Cano-Urbina and Montanera (2017).

Table 4: Effects of Tort Reforms on C-Section without Splitting Sample in Full- and Limited-Access

	No Lag	Lag 1	Lag 2
PDC	0.2257	-0.1011	0.1154
	(0.1902)	(0.3034)	(0.2345)
NEC	0.2188	0.2581**	-0.7533*
	(0.2757)	(0.1174)	(0.4118)
NJSL	0.5478*	0.5449***	-0.2212
	(0.2812)	(0.1903)	(0.2441)
CSR	0.4911	0.1814	-0.4402**
	(0.5891)	(0.3355)	(0.1935)
R^2	0.0474	0.0474	0.0474
No of obs	5,452,605	5,452,605	5,452,605

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to one if the delivery method was a C-section and zero if it was a vaginal birth. All coefficient estimates and standard errors are multiplied by 100. All specifications control for child gender, multiple births, mother race (Hispanic, Black, or other race), parity from 1 to 4 and 5+, mother's education (<12, 12, 13-15, 16+ years), mother's age (19-24, 25-34, 35+ years), state-of-occurrence-specific time trends, as well as year, month, and county of occurrence.
*Significant at 10%, **Significant at 5%, ***Significant at 1%.

two-year lagged effect of the tort reforms. Reductions in malpractice pressure through NE caps or CSR reform cause fewer births to be conducted via C-section two years later by 0.75 and 0.44 percentage points, respectively (corresponding to reductions in C-sections by 3.44% and 2.02%, respectively). This shows that the two-year lagged coefficients imply a positive relationship between malpractice pressure and the C-section rate. Taken together, the three columns of Table 4 reveal an inconsistent relationship, at times positive or negative, between malpractice pressure and health care spending over the entire sample. The differential effects predicted by the model presented in Section 2 could explain these inconsistencies if limited- and full-access groups of patients are affected differently by changes in malpractice pressure. To investigate this possibility, the analysis proceeds by estimating Equation (13) separately for full- and limited-access patients which are the groups suggested by the model.

Table 5 shows the effects of the four tort reforms separately for full- and limited-access births. The signs of the coefficients predicted by the model are indicated in the table. The first two columns present the contemporaneous effects of tort reforms on the likelihood of a C-section. The results indicate that C-section rates for limited-access mothers are affected contemporaneously by changes in malpractice pressure, although only NE caps and NJSL have significant effects. According to the estimates, reducing the level of malpractice pressure by introducing a noneconomic damages cap results in a 1.12 percentage-point increase in the probability of C-section being the method of delivery, that is a 6.2% increase in C-section given baseline rates for limited-access mothers (see Table 2). Similarly, decreasing the level of malpractice pressure by having a JSL closer to the common law is associated with a 0.98 percentage-point increase in the probability of a C-section, representing a 5.5% increase in C-section for limited-access mothers. Together, these net effects represent a negative relationship between malpractice pressure and health care spending for limited-access mothers, which is consistent with the practice of defensive medicine as predicted in the model presented in Section 2.

The results for one-year lags in the middle two columns of Table 5 are similar to the contemporaneous effects, with the exception of a small positive effect (0.36 percentage points) of NJSL for full-access mothers (this represents an increase of 1.6% in C-section given baseline rates for full-access mothers as indicated in Table 2). This negative relationship between malpractice pressure and health care spending for full-access mothers is not consistent with the model of defensive medicine in Section 2. The final two columns contain estimates from two-year lagged reforms. The results indicate that most of the effects borne by full-access mothers are experienced two years after the reform takes place. The significant effects of NE caps (-0.84 percentage points, or -3.7%), NJSL (-0.49 percentage points, or -2.2%), and CSR reform (-0.48 percentage points, or -2.1%) are all smaller in magnitude than the contemporaneous effects on limited-access mothers, but all three point to a positive relationship between malpractice pressure and health care spending among full-access mothers. Overall, Table 5 reveals a relationship between malpractice pressure and health care spending that is positive for full-access mothers and negative for limited access mothers over a two-year period. These findings represent differential effects from changes in malpractice pressure consistent with the practice of defensive medicine as predicted by the model of Section 2.

The magnitudes of the effects of tort reform estimated in Table 5 are similar to those uncovered in the literature, particularly for this time period. Kessler and McClellan (1996) found that "direct" tort reforms like these caused Medicare spending on heart disease and heart attack patients to decrease by between 4% and 9%. Lakdawalla and Seabury (2012) estimated that a 10% increase in malpractice costs would reduce health care spending by 1.2%. Currie and MacLeod (2008), using a differently-specified sample from the same data set, found that the C-section rate changed between 5% and 7% following certain reforms. These similarities to previous literature suggest that the changes in C-section rates derived

Table 5: Effects of Tort Reforms on C-Section by Access Group

	No Lag		Lag 1		Lag 2	
	Full Access	Limited Access	Full Access	Limited Access	Full Access	Limited Access
PDC	0.2200	-0.1432	-0.1839	-0.4580	-0.0815	0.2039
	(0.2007)	(0.4940)	(0.2694)	(0.4395)	(0.2359)	(0.2510)
NEC	-0.0160	1.1249**	0.0112	1.1435***	-0.8431**	-0.5568
	(0.4053)	(0.4780)	(0.1743)	(0.3100)	(0.4104)	(0.4606)
NJSL	0.3526	0.9793**	0.3641*	0.6917	-0.4855**	0.3217
	(0.3635)	(0.3993)	(0.1885)	(0.4498)	(0.2298)	(0.3806)
CSR	0.5660	0.2949	0.1656	0.5069	-0.4777*	-0.0107
	(0.6414)	(0.6929)	(0.4062)	(0.6313)	(0.2521)	(0.4348)
Predicted sign	(−)	(+)	(−)	(+)	(−)	(+)
R^2	0.0470	0.0416	0.0470	0.0416	0.0470	0.0416
No of obs	4,297,293	1,034,899	4,297,293	1,034,899	4,297,293	1,034,899

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to one if the delivery method was a C-section and zero if it was a vaginal birth. All coefficient estimates and standard errors are multiplied by 100. All specifications control for child gender, multiple births, mother race (Hispanic, Black, or other race), parity from 1 to 4 and 5+, mother's education (<12, 12, 13-15, 16+ years), mother's age (19-24, 25-34, 35+ years), state-of-occurrence-specific time trends, as well as year, month, and county of occurrence.
*Significant at 10%, **Significant at 5%, ***Significant at 1%.

from the estimates in Table 5 are indeed plausible effects of tort reforms on the practice of C-section.

The results in Table 5 estimate Equation (13) with all four reforms simultaneously. For robustness, we also estimate separate specifications that include one reform at a time, as well as a specification with a sum-of-reforms variable as in Avraham and Schanzenbach (2010). First, we consider the individual impact of each reform. These individual specifications may yield different findings than the simultaneous because some of these reforms were adopted jointly and as a result they (i) could have offsetting effects and (ii) the estimates could suffer from multicollinearity. The first four rows of Table 6 present the results from estimating Equation (13) when reforms are entered separately. This means that each coefficient in Table 6 represents the result of a separate regression.

The first two columns of Table 6 indicate that none of the reforms have a statistically significant contemporaneous effect on the likelihood of a C-section when considered individually, which is contrary to the results in Table 5. This result is consistent with the findings of Currie and MacLeod (2008).[18] The one-year lagged NE cap specification supports the defensive medicine model in Section 2 with at least the 10% level of significance. One year after passage of an NE cap, C-sections rates rise among limited access mothers (0.65 percentage points, or 3.6%) but fall among full-access mothers (0.26 percentage points, or 1.1%). A comparison of the simultaneous estimates in Table 5 versus individual specifications in Table 6 reveals that some of the estimates are quite robust, including the one-year lagged impact of NJSL on full-access mothers that is not consistent with the model developed in Section 2. The standard errors do not seem to drop dramatically when considering the reforms individually which suggests that multicollinearity is not a severe problem.

The fact that tort reforms tend to have contemporaneous effects on limited-access mothers but lagged effects on full-access mothers is not inconsistent with the model. This paper presents a static model without a time dimension, and so it can be used to predict what happens following tort reform, but not when. Nevertheless, it remains an interesting question why the timing of the effects differs across the access subgroups. Other studies have noted delayed effects, although they have not attributed them to any particular group of patients (Avraham and Schanzenbach, 2015). Possible explanations include most tort reforms studied here not applying to pending lawsuits; only to lawsuits filed or injuries incurred after the effective date (Paik et al., 2013). Additionally, over this time period, malpractice insurers delayed adjusting premiums following tort reform in order to collect post-reform data (Dubay

[18]See panel (b) of Table IV of Currie and MacLeod (2008).

Table 6: Effect of Single Tort Reforms and Sum-of-Reforms on C-Section by Access Group

	No Lag		Lag 1		Lag 2	
	Full Access	Limited Access	Full Access	Limited Access	Full Access	Limited Access
PDC	0.1878	-0.0727	-0.2549	-0.3405	-0.1533	0.1983
	(0.1889)	(0.4485)	(0.2802)	(0.4277)	(0.2533)	(0.3250)
NEC	-0.2123	0.4701	-0.2560*	0.6474***	-0.5892	-0.7062
	(0.1988)	(0.2996)	(0.1348)	(0.1849)	(0.4127)	(0.4361)
NJSL	0.2896	0.3558	0.3807**	0.1054	0.0722	0.6156*
	(0.2242)	(0.3859)	(0.1733)	(0.5526)	(0.1334)	(0.3325)
CSR	0.5521	0.0618	0.0655	0.2462	-0.3121	-0.1098
	(0.5962)	(0.5899)	(0.3813)	(0.4921)	(0.2425)	(0.3783)
Count	0.2241	0.4247	-0.0252	0.2981	-0.4075**	-0.0322
	(0.2228)	(0.2941)	(0.1643)	(0.3467)	(0.1606)	(0.2249)
Predicted sign	(−)	(+)	(−)	(+)	(−)	(+)
No of obs	4,297,293	1,034,899	4,297,293	1,034,899	4,297,293	1,034,899

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. Each estimate in the table comes from a separate regression in which only the reform in question is considered. The dependent variable is a dummy equal to one if the delivery method was a C-section and zero if it was a vaginal birth. The independent variable *Count* is defined in Equation (14). All coefficient estimates and standard errors are multiplied by 100. All specifications control for child gender, multiple births, mother race (Hispanic, Black, or other race), parity from 1 to 4 and 5+, mother's education (<12, 12, 13-15, 16+ years), mother's age (19-24, 25-34, 35+ years), state-of-occurrence-specific time trends, as well as year, month, and county of occurrence.

*Significant at 10%, **Significant at 5%, ***Significant at 1%.

et al., 1999). Together, these may create a lag between the passage and impact of the reform. Discerning among these potential explanations would require a dynamic model, however, and so is beyond the scope of this paper and left for future research. In any case, the finding in Table 6, columns 3 and 4, showing that full- and limited-access mothers experience significant and opposite qualitative effects one year following a change in non-economic damage caps reveals some evidence for concurrent differential effects due to defensive medicine across access groups.

Next, we consider the sum-of-reforms specification. We create the variable *Count* that varies from zero to four indicating how many of the four reforms each state has in place at a given time. It is defined as follows:

$$(14) \quad Count = PDC + NEC + NJSL + CSR$$

This type of independent variable has been used in the literature to capture the level of pressure-reducing reform efforts (Avraham and Schanzenbach, 2010). It assumes that all reforms have the same magnitude and qualitative effect on malpractice pressure. Given the way we defined our indicator variables in (9)-(12) all these variables have the same qualitative effect: a reduction in malpractice pressure. Then, the variable *Count* serves as an index of malpractice pressure with a value of four representing the lowest level of pressure and zero representing the highest.

The results from estimating specification of Equation (13) using *Count* in place of the four tort reforms are presented in the final rows of Table 6. Recall that an increasing value of *Count* corresponds with decreasing malpractice pressure. Notice that only the two-year lagged estimate for the full-access mothers is statistically significant. This estimate reveals that an increase of *Count* by 1 is associated with an decrease of 0.41 percentage points (-1.8%) in the C-section rate. Once again, this indicates a positive relationship between malpractice pressure and health care spending for full-access mothers consistent with our theoretical model of Section 2. In summary, virtually all significant coefficients uncovered in Tables 5 and 6 show consistency with the elaborate pattern of signs predicted by the model, which is evidence of differential effects from changes in malpractice pressure resulting from the widespread practice of defensive medicine.

6.2 Effect of Malpractice Pressure on Access and Abnormalities

According to this model, differential effects uncovered in the previous subsection occur because reduced malpractice pressure makes access to care more affordable. Additional information available in the Vital Statistics Natality Birth Data allows for further investigation into this claim. To determine whether or not malpractice reform improves access to care, particularly for vulnerable populations (the limited-access group), this study proceeds by estimating Equation (13) using two access proxies as the dependent variable. The most obvious proxy is that which was used to separate full- and limited-access subgroups: a dummy variable equal to 1 if prenatal care was timely (initiated in the first trimester) and 0 if initiated afterward or not at all. The first three columns of Table 7 present these results. It is not surprising that the contemporaneous effects are insignificant given that access is, by this definition, unchangeable for mothers in their second or third trimesters, regardless of the impact of tort reform. Consistent with more affordable access to care following reductions in malpractice pressure, PD caps significantly increase the likelihood that a mother's prenatal care was timely by 0.98 percentage points (1.2%) two years later, revealing improved access following reduced malpractice pressure.

The second proxy for access is the number of prenatal care visits, with results shown in the last three columns of Table 7. In order to filter out high-risk births requiring many prenatal visits, the top 5% are dropped from this sample. These estimates reveal a pattern that is similar to the timeliness of prenatal care. NE caps and NJSL had effects achieving at least the 10% level of significance. A reduction in malpractice pressure due to an NE cap increases the number of prenatal care visits by 0.13 (1.14%) one year after the reform. Reduced pressure through NJSL had an effect of approximately equal magnitude but more precisely estiamted. Therefore, to the extent that these two variables directly measure access, reduced malpractice pressure through tort reform has a weakly positive effect on access to care over the entire sample. This finding is consistent with tort reform resulting in reduced negative defensive medicine.

The final specifications estimated here are designed to investigate whether or not access-sensitive health outcomes are affected by changes in malpractice pressure, particularly for limited-access mothers. This is done by estimating Equation (13) using the presence of specific birth abnormalities.[19] Two abnormalities listed in the Natality Birth Data are fetal alcohol syndrome and newborn anemia. Both abnormalities can be caused by clinical, be-

[19]We focus on birth outcomes rather stated risky behavior while pregnant because mothers may not report such behavior accurately.

Table 7: Effects of Tort Reforms on Access Measures

	On-Time Prenatal Care			Number of Prenatal Visits		
	Lag 0	Lag 1	Lag 2	Lag 0	Lag 1	Lag 2
PDC	-0.0928	0.3969	0.9824***	-0.0031	0.0129	0.0638
	(0.3718)	(0.4783)	(0.3392)	(0.0760)	(0.0931)	(0.0723)
NEC	-0.1214	0.3845	0.5548	0.1122	0.1311*	0.0771
	(0.6152)	(0.3692)	(0.3971)	(0.0839)	(0.0753)	(0.0820)
NJSL	-0.1242	0.6884	0.7742	0.0790	0.1292**	0.0793
	(0.4973)	(0.4512)	(0.5725)	(0.0762)	(0.0638)	(0.0747)
CSR	0.1363	-0.3620	-0.2828	-0.0167	0.0040	0.0003
	(0.6040)	(0.7934)	(0.7972)	(0.0743)	(0.0778)	(0.0856)
Predicted sign	(+)	(+)	(+)	(+)	(+)	(+)
R^2	0.1378	0.1378	0.1378	0.1530	0.1530	0.1530
No of obs	5,332,192	5,332,192	5,332,192	4,925,151	4,925,151	4,925,151

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. Coefficient estimates and standard errors for On-Time Prenatal Care are multiplied by 100. We drop the top 5% of the "Number of Prenatal Visits" which corresponds to 17 or more prenatal care visits. All specifications control for child gender, multiple births, mother race (Hispanic, Black, or other race), parity from 1 to 4 and 5+, mother's education (<12, 12, 13-15, 16+ years), mother's age (19-24, 25-34, 35+ years), state-of-occurrence-specific time trends, as well as year, month, and county of occurrence.
*Significant at 10%, **Significant at 5%, ***Significant at 1%.

havioral or environmental risk factors during pregnancy. For example, newborn anemia can be caused by untreated hemolytic disease of the newborn (Dean, 2005). To the extent that regular primary care can mitigate these risk factors, a reduction in the incidence of these abnormalities in limited-access mothers following tort reform may indicate improved access to care. Furthermore, mitigation of these abnormalities is largely achieved by prevention and monitoring.[20] As prevention tends not to be a large source of provider revenue, it is unlikely that any additional preventative services are the result of physicians motivated by revenue maximization.

In an effort to capture the changes in health status that are particularly sensitive to changes in access to care, Table 8 presents estimates of Equation (13) using a dummy variable for the presence of fetal alcohol syndrome in the newborn as the dependent variable. Table 9 does the same for anemia. As shown in Table 8, reduction in malpractice pressure through NE caps or NJSL reduces the incidence of fetal alcohol syndrome in limited-access births over a two-year period by between 0.0134 and 0.0352 percentage points. While these effects are small in absolute terms, they are striking given the low baseline rates[21] of fetal alcohol syndrome among limited-access births (one case per ten thousand births, see Table 2). Even using the relatively high baseline rate among births with no prenatal care, these changes represent an up to 70.4% reduction in fetal alcohol syndrome. For these reforms, and among limited-access mothers, the estimated positive relationship between malpractice pressure and birth outcomes associated with poor access to care is consistent with defensive medicine as outlined in the model in Section 2. Estimates for CSR reform, however, are not consistant. The passage of CSR reform, which represents a reduction in malpractice pressure, yields between a 0.043 and 0.054 percentage point increase in fetal alcohol syndrome rates. Overall, however, most of the reforms are consistent with the theory.

The estimates in Table 9 indicate similar results for anemia. Reductions in malpractice pressure through NE caps reduce the incidence of newborn anemia among limited-access mothers by 0.138 percentage points and NJSL decreases the incidence by 0.17 percentage points. Again, using the high rate of anemia among births with no prenatal care as a baseline, these represent changes of -63% and -77%, respectively. These estimates reveal a positive relationship between malpractice pressure and an access-sensitive birth abnormality in newborn anemia. These effects are consistent with reduced defensive medicine following

[20] An exception to this is severe cases of hemolytic disease where *in utero* blood transfusion may be required (Dean, 2005).

[21] Fetal alcohol syndrome is difficult to diagnose at birth (National Center for Health Statistics, 1992), and so the baseline rates in the data do not capture those diagnosed later in life.

Table 8: Effects of Tort Reforms on Fetal Alcohol Syndrome by Access Group (in Percentage Terms)

	Lag 0		Lag 1		Lag 2	
	Full Access	Limited Access	Full Access	Limited Access	Full Access	Limited Access
PDC	0.0046	0.0058	-0.0038*	-0.0312	-0.0054	-0.0287**
	(0.0046)	(0.0172)	(0.0021)	(0.0224)	(0.0033)	(0.0132)
NEC	-0.0007	-0.0352***	-0.0017	-0.0202***	0.0034	-0.0120**
	(0.0023)	(0.0123)	(0.0031)	(0.0074)	(0.0038)	(0.0057)
NJSL	0.0014	-0.0134*	-0.0028	-0.0221**	-0.0015	-0.0101*
	(0.0021)	(0.0070)	(0.0027)	(0.0089)	(0.0028)	(0.0051)
CSR	0.0029	0.0023	0.0010	0.0431**	0.0029	0.0537***
	(0.0030)	(0.0215)	(0.0013)	(0.0165)	(0.0021)	(0.0107)
Predicted sign	(≈ 0)	($-$)	(≈ 0)	($-$)	(≈ 0)	($-$)
R^2	0.0002	0.0010	0.0002	0.0010	0.0002	0.0010
No of obs	4,116,855	998,788	4,116,855	998,788	4,116,855	998,788

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to one if the newborn manifest the fetal alcohol syndrome and zero if not. All coefficient estimates and standard errors are multiplied by 100. All specifications control for child gender, multiple births, mother race (Hispanic, Black, or other race), parity from 1 to 4 and 5+, mother's education (<12, 12, 13-15, 16+ years), mother's age (19-24, 25-34, 35+ years), state-of-occurrence-specific time trends, as well as year, month, and county of occurrence.
*Significant at 10%, **Significant at 5%, ***Significant at 1%.

Table 9: Effects of Tort Reforms on Newborn Anemia (Hct.$<$ 39/Hgb.$<$13) by Access Group (in Percentage Terms)

	Lag 0		Lag 1		Lag 2	
	Full Access	Limited Access	Full Access	Limited Access	Full Access	Limited Access
PDC	0.0061	-0.0153	-0.0104	-0.0389	-0.0171	-0.0390
	(0.0161)	(0.0511)	(0.0277)	(0.0520)	(0.0151)	(0.0525)
NEC	-0.0452*	-0.1384**	-0.0459	-0.0744	0.0831***	0.2744*
	(0.0255)	(0.0556)	(0.0282)	(0.0706)	(0.0282)	(0.1441)
NJSL	-0.0166	-0.1699**	-0.0456	-0.1845*	0.0019	0.0035
	(0.0255)	(0.0693)	(0.0401)	(0.1057)	(0.0442)	(0.0916)
CSR	0.0155	0.0757	0.0419	0.0801	0.0244	0.0356
	(0.0192)	(0.0489)	(0.0302)	(0.0565)	(0.0259)	(0.0581)
Predicted sign	(≈ 0)	($-$)	(≈ 0)	($-$)	(≈ 0)	($-$)
R^2	0.0023	0.0042	0.0023	0.0042	0.0023	0.0043
No of obs	4,228,008	1,020,307	4,228,008	1,020,307	4,228,008	1,020,307

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dep endent variable is a dummy equal to one if the newborn manifest anemia and zero if not. All coefficient estimates and standard errors are multiplied by 100. All specifications cont rol for child gender, multiple births, mother race (Hispanic, Black, or other race), parity from 1 to 4 and 5+, mother's education ($<$12, 12, 13-15, 16+ years), mother's age (19- 24, 25-34, 35+ years), state-of-occurrence-specific time trends, as well as year, month, and county of occurrence.
*Significant at 10%, **Significa nt at 5%, ***Significant at 1%.

pressure-reducing tort reforms as predicted by the model in Section 2. NE caps have the same qualitative effect on full- and limited-access births, although the magnitude of the effect is smaller (-0.045 percentage points, or -41%). This is most likely because the timeliness of prenatal care initiation is an imperfect proxy for access. Unlike the contemporaneous and one-year lagged effects, the two-year lagged effects of NE caps reveal the opposite relationship. Reduced malpractice pressure through NE caps lead to higher rates of anemia in infants born two years later. Taken together, Tables 7, 8, and 9 reveal estimates that are consistent overall with improved access following reductions in malpractice pressure, though with some exceptions. In combination with the Table 5 and 6, a clear majority of significant coefficients support the model's predictions. This suggests that changes in malpractice pressure through tort reform result in differential effects and that these effects occur because of defensive medicine.

7 Conclusion

Contrary to physicians' assertions that defensive medicine is widely practiced, existing empirical investigations into the subject have uncovered inconsistent and often conflicting findings. Using state-level tort reforms as proxies for changes in malpractice pressure, researchers have found increased health care spending in some cases, decreased in others, and no effect in still others. An emerging literature suggests that these inconsistent findings arise from fundamentally differential effects, where changes in malpractice pressure have different qualitative effects on different groups. Researchers studying the field of obstetrics surmise that these differential effects are due to the practice of "offensive medicine", where physicians shift resources away from unprofitable to profitable patients as the malpractice environment becomes more lenient (Shurtz, 2014; Avraham and Schanzenbach, 2015). This paper offers a different explanation for the differential effects; physicians react defensively to rising malpractice pressure, which makes access to care more costly for insurers to procure. Consumers with a high willingness to pay for access would choose to bear the higher expense in order to maintain good access to care, while those with low willingness to pay would substitute away from health insurance, resulting in poorer access and lower health care spending. Therefore, according to this alternative explanation, defensive medicine is responsible for the differential effects in the literature, not offensive medicine. The two explanations have the opposite implications for the long-standing and nationwide efforts to reduce malpractice pressure, and so it is vital to determine which is best supported by the evidence.

This investigation into differential effects begins with a theoretical model of consumer, physician, and insurer behavior. It characterizes the impact of rising malpractice pressure on physicians incentives, and how this in turn affects the insurance policies that health plans are able to offer and that consumers choose to purchase. A condition is derived from the model that determines whether a given consumer would choose a relatively expensive insurance policy with low barriers to access (full-access) or an inexpensive one with high barriers (limited-access). The analytical results then reveal that the impact of an exogenous change in malpractice pressure is qualitatively different depending on the consumer's chosen access level. Consumers choosing full-access insurance policies spend more on health insurance following a rise in malpractice pressure while those in limited-access policies spend less. This suggests an empirical strategy for estimating differential effects using an endogenous proxy for access to sort individuals into full- and limited-access subgroups and regress separately. Finding qualitatively different effects of malpractice pressure on health care spending in the pattern predicted by the model would indicate that defensive medicine is both widely practiced and responsible for the differential effects of malpractice reform.

The empirical test of the model's general predictions on defensive medicine is set in the field of obstetrics. We utilize birth certificate data from all 50 U.S. states over the years 1989 - 2001. Our endogenous proxy for access is whether prenatal care was initiated in the first trimester (full-access) or not (limited-access). We then estimate the impact of four tort reforms on various dependent variables representing health care spending, access to care, and access-sensitive birth abnormalities. The findings reveal that patients selecting into the different access groups are affected differently by changes in malpractice pressure. On the whole, the specific differential effects uncovered support the predictions of the model, indicating that reduced malpractice pressure leads to reduced defensive medicine. For example, over a two-year period, caps on non-economic damages result in a 3.7% decrease in C-section rates among full-access mothers, but a 6.3% increase among limited-access mothers. According to the model, the reduced malpractice pressure caused access to become less expensive for those who have it and more affordable for those who do not. Other reforms tended to exhibit a similar pattern of differential effects on C-section rates with equal or lesser magnitude. Regarding access, various reforms had weakly positive effects on both the timeliness of prenatal care initiation and the number of prenatal care visits, also consistent with reduced defensive medicine. The estimated effects of the reforms on birth abnormalities presented somewhat mixed evidence but overall were supportive of the theory. In general, there were large declines in fetal alcohol syndrome and newborn anemia rates (as much as 70% and 77%, respectively) following pressure-reducing reforms, but notable instances where the reforms had the opposite effect. In summary, most of the significant coefficients uncovered indicate that reduced malpractice pressure through tort reforms reduces the practice of defensive medicine.

It is unlikely that the differential effects uncovered here represent offensive medicine. Where offensive medicine is practiced, reduced malpractice pressure induces physicians to reduce necessary provision to unprofitable patients and increase unnecessary provision among profitable patients. If the effects estimated here are the result of offensive medicine, it would imply that the limited-access mothers are profitable while the full-access are unprofitable. This is inconsistent with the evidence that many mothers receive care late because they either cannot afford it or cannot secure an appointment (Center for Disease Control and Prevention, 2000). It is further inconsistent with the summary statistics showing a greater concentration of lower socioeconomic groups among those with limited-access. These groups have characteristics correlated with a lack of private insurance and less-generous reimbursement (Schlesinger and Kronebusch, 1990), leading to a general unwillingness of providers to set up practices in these women's neighborhoods or serve as a regular source of care (Braveman et al., 1993; Dubay et al., 2001; Aizer and Currie, 2004). As offensive medicine is probably not responsible for the effects estimated here, defensive medicine is the most plausible explanation for why different individuals are affected differently by changes in malpractice pressure.

This study has notable limitations. First, as we do not observe mothers' insurance status, we are unable to use it as an endogenous access proxy when testing the model's predictions. Shurtz (2014) was able to separate mothers by insurance status and derived very different results, although using only before-and-after analysis for one tort reform in a single state. Second, we have no way of knowing whether a given tort reform has the same impact on malpractice pressure across the two access groups. For example, CSR reform only binds when plaintiffs receive additional compensation from other sources. If full-access mothers are significantly more likely to have these other sources, then CSR reform could represent a large decrease in pressure concerning full-access mothers without much change for limited-access ones. While these differences could affect the magnitude of a given reform's impact, however, they are unlikely to affect the direction of the change in malpractice pressure, which is the more important factor in our empirical strategy. Finally, as in Montanera (2016), the normative implications for tort reform are limited. This is because the model leaves out the physician incentive problems that make malpractice law necessary in the first place, and so it does not shed light on what may be the “optimal” level of malpractice pressure. Such normative issues are left to policymakers and future research.

The findings presented here make several important contributions to the literature. First, the empirical findings contribute to the growing literature on the differential effects of tort reform, which help explain why the empirical literature on defensive medicine has uncovered so many conflicting implications. It is not that changes in malpractice pressure produce no consistent behavioral responses from providers, but that the responses are complex and vary depending on the patient population under investigation. Second, the model produces an alternative, theory-based explanation for differential effects with implications for tort reform that are very different from those found in the existing literature. For these two reasons, the empirical literature can uncover seemingly mixed evidence of defensive medicine, even where it is widely practiced. Third, the results show that the primary estimated benefit of tort reform to consumers is improved access to care among vulnerable populations, along with some spending reductions among those with good access. This is important, not only because access improvements tend to be secondary considerations in policy discussions, but also when interpreting increases in utilization following pressure-reducing tort reforms, which may be mistaken for offensive medicine. Finally, this study makes a methodological contribution through the innovative role that endogenous access proxies can play in uncovering the effects of changing malpractice pressure. This creates opportunities to use these access proxies to reevaluate past empirical investigations of defensive medicine with specifications designed to estimate differential effects. Additionally, the findings suggest that policymakers contemplating changes to the malpractice environment should first evaluate access proxies in order to better predict the qualitative impact on consumers in their jurisdictions.

Appendix

A Technical Assumptions

Consider the following assumptions.

Assumption 1. *The function $\rho(t)$ is such that $\exists!\ \underline{t} > 0$ where:*

$$\frac{\partial^2 \rho}{\partial t^2} + t\left(\frac{\partial^3 \rho}{\partial t^3}\right) \begin{cases} \geq 0 \ \forall \ t \in [0, \underline{t}]\,; \\ < 0 \ \textit{otherwise.} \end{cases}$$

Assumption 2. *The function $\rho(t)$ and parameters $\{c, P\}$ are such that:*

$$\exists \ \bar{t} > 0 \ \textit{where} \ c\bar{t} = P[1 - \rho(\bar{t}) + \bar{t}\rho'(\bar{t})]$$

B Proof of Proposition 1

Condition (7) determines the consumer's optimal choice of τ. For $0 \leq \tau \leq \bar{\tau}(P)$,

$$\tilde{Q}(\tau) = \frac{D\tilde{n}(w^\star(P), \psi(\tau; P), P)}{q}(1 - \rho(t^\star(P))),$$
$$\tilde{Q}'(\tau) = \frac{D}{q}(1 - \rho(t^\star(P)))\frac{\partial \tilde{n}}{\partial s}\frac{\partial \psi}{\partial \tau}.$$

Since $\frac{\partial \tilde{n}}{\partial s} = \frac{1}{t^\star(P)}$ wherever $\tau < \bar{\tau}(P)$, and $\frac{\partial \psi}{\partial \tau} = t^\star(P)[D(w^\star(P) + ct^\star(P))]^{-1}$, therefore,

$$\tilde{Q}'(\tau) = \frac{(1 - \rho(t^\star(P)))}{q(w^\star(P) + ct^\star(P))} > 0.$$

Since both $w^\star(P)$ and $t^\star(P)$ are independent of τ, therefore $\tilde{Q}''(\tau) = 0$. Therefore, for all $0 \leq \tau \leq \bar{\tau}(P)$, the left side of Condition (7) is constant. For $\tau > \bar{\tau}(P)$,

$$\begin{aligned}
\tilde{Q}(\tau) &= \left(1 - \rho\left(\frac{D\sigma(\tau;P)}{q}\right)\right),\\
\tilde{Q}'(\tau) &= -\frac{\partial\rho}{\partial t}\frac{D}{q}\frac{\partial\sigma}{\partial\tau},\\
\frac{\partial\sigma}{\partial\tau} &= D^{-1}\left[c - Pt\left(\frac{\partial^2\rho}{\partial t^2}\right)\right]^{-1} > 0\\
\Rightarrow \tilde{Q}'(\tau) &= \frac{-\frac{\partial\rho}{\partial t}}{q\left(c - Pt\frac{\partial^2\rho}{\partial t^2}\right)} > 0.
\end{aligned}$$

Lemma 1. *If Assumptions 1 and 2 hold, then in any equilibrium, $\tilde{t}^\star$ must be such that:*

$$\frac{\partial^2\rho}{\partial t^2} + t\left(\frac{\partial^3\rho}{\partial t^3}\right) < 0$$

Proof. See Montanera (2016). □

Therefore, by Lemma 1,

$$\frac{\partial^2\sigma}{\partial\tau^2} = P\left(\frac{D^2}{q}\right)\left(\frac{\partial\sigma}{\partial\tau}\right)^3\left[\frac{\partial^2\rho}{\partial t^2} + t\left(\frac{\partial^3\rho}{\partial t^3}\right)\right] < 0,$$

and $\tilde{Q}''(\tau) = -\left(\frac{D}{q}\right)\left[\frac{\partial^2\rho}{\partial t^2}\left(\frac{D}{q}\right)\left(\frac{\partial\sigma}{\partial\tau}\right)^2 + \frac{\partial\rho}{\partial t}\left(\frac{\partial^2\sigma}{\partial\tau^2}\right)\right] < 0$, meaning the left side of Condition (7) is strictly decreasing in τ where $\tau > \bar{\tau}(P)$, and is thus finite and weakly decreasing in τ for all τ. By Condition (6), the limit of $\tilde{Q}'(\tau)$ as τ approaches $\bar{\tau}(P)$ from below is equal to both the limit evaluated at $\bar{\tau}(P)$ and the limit as it approaches $\bar{\tau}(P)$ from above, meaning the left side of Condition (7) is continuous in τ. Due to the concavity of $U(y, H)$ in y, the right side of Condition (7) is increasing in τ. As $U(y, H)$ is assumed to satisfy the Inada conditions, the right side of Condition (7) approaches infinity as τ approaches m. Therefore, if the left side of Condition (7) is greater than the right side at $\tau = 0$, then there is a unique $\tau^\star > 0$ solving the consumer's problem. If the left side of Condition (7) is less than or equal to the right side for all τ, then $\tau^\star = 0$. Due to the unique solutions to each of the physcians', consumer's, and MCOs' problems, there is thus a unique equilibrium.

C Proof of Proposition 2

If $q\Delta U\tilde{Q}'(\bar{\tau}(P)) > U_y'(m-\bar{\tau}(P))$, then $\tau^\star > \bar{\tau}(P)$ by Proposition 1, and therefore $\frac{D\tilde{n}^\star}{q} = 1$. The sign of $\frac{\partial \tau^\star}{\partial P}$ depends on $\frac{\partial^2 \tilde{Q}}{\partial \tau \partial P}$. Since,

$$\tilde{Q}'(\tau) = \frac{-\frac{\partial \rho}{\partial t}}{q\Big(c - Pt\frac{\partial^2 \rho}{\partial t^2}\Big)},$$

$$\frac{\partial^2 Q}{\partial \tau \partial P} = -\left(\frac{D}{q}\right)\left[\frac{\partial^2 \rho}{\partial t^2}\left(\frac{D}{q}\right)\frac{\partial \sigma}{\partial P}\frac{\partial \sigma}{\partial \tau} + \frac{\partial \rho}{\partial t}\left(\frac{\partial^2 \sigma}{\partial \tau \partial P}\right)\right].$$

From the MCO's problem where $\tau^\star > \bar{\tau}(P)$,

$$\frac{\partial \sigma}{\partial P} = \frac{-\left(\frac{q}{D}\right)\frac{\partial \omega}{\partial P}}{\left[c - Pt\left(\frac{\partial^2 \rho}{\partial t^2}\right)\right]} < 0$$

$$\frac{\partial \sigma}{\partial \tau} = D^{-1}\left[c - Pt\left(\frac{\partial^2 \rho}{\partial t^2}\right)\right]^{-1} > 0$$

$$\frac{\partial^2 \sigma}{\partial \tau \partial P} = q^{-1}\left[c - P\sigma\frac{\partial^2 \rho}{\partial t^2}\right]^{-2} \cdot \left[\sigma\frac{\partial^2 \rho}{\partial t^2} + P\frac{\partial \sigma}{\partial P}\left[\frac{\partial^2 \rho}{\partial t^2} + t\frac{\partial^3 \rho}{\partial t^3}\right]\right] > 0 \qquad \text{(By Lemma 1)}$$

Therefore $\frac{\partial^2 Q}{\partial \tau \partial P} > 0$ wherever $\tau^\star > \bar{\tau}(P)$. Since $\frac{\partial^2 \tilde{Q}}{\partial \tau^2} < 0$ and $U_y'' < 0$, therefore:

$$\frac{\partial \tau^\star}{\partial P} = \frac{-q\Delta U\frac{\partial^2 \tilde{Q}}{\partial \tau \partial P}}{q\Delta U\frac{\partial^2 \tilde{Q}}{\partial \tau^2} + U_y''} > 0.$$

As $\tau^\star$ is strictly greater than $\bar{\tau}(P)$ whenever $q\Delta U\tilde{Q}'(\bar{\tau}(P)) > U_y'(m-\bar{\tau}(P))$, therefore $\tau^\star >$ is still greater than $\bar{\tau}(P)$ following a marginal change in P. Since $\frac{D\tilde{n}^\star}{q} = 1$ wherever $\tau^\star > \bar{\tau}(P)$, therefore $\frac{D\tilde{n}^\star}{q}$ still equals 1 following a marginal change in P. Therefore, $\frac{\partial \tilde{n}^\star}{\partial P} = 0$.

D Proof of Proposition 3

If $q\Delta U\tilde{Q}'(\bar{\tau}(P)) \leq U_y'(m-\bar{\tau}(P))$, then $\tau^\star \leq \bar{\tau}(P)$ by Proposition 1, and therefore $\frac{D\tilde{n}^\star}{q} \leq 1$. The sign of $\frac{\partial \tau^\star}{\partial P}$ depends on $\frac{\partial^2 \tilde{Q}}{\partial \tau \partial P}$. Since, where $\tau^\star \leq \bar{\tau}(P)$,

$$\tilde{Q}'(\tau) = \frac{(1-\rho(t^\star(P)))}{q(w^\star(P)+ct^\star(P))},$$

$$(15) \quad \frac{\partial^2 Q}{\partial\tau\partial P} = \left[\left(-\frac{\partial\rho}{\partial t}\right)\frac{\partial t^\star}{\partial P}\right]\left(\frac{1}{q[w^\star(P)+ct^\star(P)]}\right) - \left(\frac{1-\rho}{q[w^\star(P)+ct^\star(P)]^2}\right)\left[\frac{\partial w^\star}{\partial P}+c\frac{\partial t^\star}{\partial P}\right].$$

Since $\frac{\partial w^\star}{\partial P} = \frac{\partial \omega}{\partial P}\Big|_t - Pt\frac{\partial^2\rho}{\partial t^2}\frac{\partial t^\star}{\partial P}$ and $\frac{\partial\omega}{\partial P}\Big|_t = \frac{w}{P}$, Condition (6) can be combined with Condition (15) to reduce $\frac{\partial^2 Q}{\partial\tau\partial P}$ to:

$$\frac{\partial^2 \hat{Q}}{\partial\tau\partial P} = -\left(\frac{1}{q}\right)\left[\frac{(1-\rho)\frac{w^\star(P)}{P}}{[w^\star(P)+ct^\star(P)]^2}\right] < 0$$

Therefore $\frac{\partial^2 Q}{\partial\tau\partial P} < 0$ wherever $\tau^\star \leq \bar{\tau}(P)$. Since $\frac{\partial^2\tilde{Q}}{\partial\tau^2} = 0$ and $U''_y < 0$, therefore:

$$\frac{\partial\tau^\star}{\partial P} = \frac{-q\Delta U\frac{\partial^2\tilde{Q}}{\partial\tau\partial P}}{U''_y} < 0.$$

By Corollary 5a from Montanera (2016), $\frac{\partial\tau^\star}{\partial P} < 0$ implies that $\frac{\partial\tilde{n}^\star}{\partial P} < 0$.

E Tort Law Definitions

The Congressional Budget Office report, "The Effects of Tort Reform: Evidence from the States" provides the following descriptions of the tort laws used in this analysis (see Congressional Budget Office, 2004). These are:

- **Punitive damages**: Damages awarded in addition to compensatory (economic and noneconomic) damages to punish a defendant for willful and wanton conduct.
- **Noneconomic damages**: Damages payable for items other than monetary losses, such as pain and suffering. The term technically includes punitive damages, but those are typically discussed separately.
- **Collateral-source payments**: Amounts that a plaintiff recovers from sources other than the defendant, such as the plaintiff's own insurance. Under the collateral-source rule, that compensation from other sources may not be admitted as evidence at trial.

- **Joint-and-several liability**: Liability in which each liable party is individually responsible for the entire obligation. Under joint-and-several liability, a plaintiff may choose to seek full damages from all, some, or any one of the parties alleged to have committed the injury. In most cases, a defendant who pays damages may seek reimbursement from nonpaying parties.

F Summary Statistics by Access Group in First and Last Year of Data

Table 10: Summary Statistics by Access Group in First and Last Year of Data

	All		Full Access		Limited Access	
	1989	2001	1989	2001	1989	2001
Dependent Variables:						
C-Section Rate	22.76	24.32	24.16	25.06	18.41	20.52
Prenatal Care Visits	10.89	11.56	12.07	12.29	7.19	7.82
Apgar Score	8.95	8.90	8.96	8.90	8.90	8.88
Fetal Alcohol Syndrome Rate	0.01	0.00	0.01	0.00	0.02	0.01
Newborn Anemia Rate	0.18	0.09	0.17	0.09	0.23	0.10
Demographics (Rates):						
Male Child	51.10	51.04	50.92	51.01	51.64	51.21
Multiple Birth	2.32	3.28	2.40	3.45	2.07	2.37
Mother Hispanic	17.09	24.89	13.69	22.88	27.65	35.20
Mother Black	17.69	16.01	14.27	14.32	28.33	24.67
Mother Other Race	4.58	6.58	4.51	6.58	4.82	6.59
Mother Married	71.57	66.80	79.04	71.21	48.37	44.26
Mother's Age (Rates)						
$10-18$	7.83	6.40	5.29	5.01	15.72	13.50
$19-24$	29.49	27.44	25.96	25.25	40.47	38.61
$25-34$	53.52	51.10	58.62	53.72	37.67	37.69
35+	9.16	15.06	10.13	16.01	6.14	10.20
Mother's Education (Rates)						
< 12	23.07	21.64	16.63	17.93	43.06	40.59
12	36.95	29.55	36.69	28.70	37.73	33.89
$13-15$	20.96	21.25	23.40	22.37	13.38	15.57
16+	19.02	27.56	23.28	31.01	5.82	9.96
Parity (Rates)						
1	41.65	40.16	42.78	40.80	38.13	36.87
2	31.96	32.55	33.20	33.43	28.14	28.08
3	16.14	16.51	15.63	16.25	17.71	17.83
4	6.24	6.57	5.42	6.09	8.80	9.02
5+	4.01	4.21	2.98	3.43	7.22	8.20
No of obs	356,542	429,625	269,671	359,276	86,871	70,349

Notes: Data obtained from the Vital Statistics Natality Birth Data, provided by the NBER. This certificate information covers all births occurring in the years 1989 and 2001 in all U.S. states, from which a 15 percent random sample is drawn. The summary statistics for: Prenatal Care Visits, Apgar Score, Fetal Alcohol Syndrome, and Newborn Anemia are based on a smaller sample due to missing values on these outcomes. Tables 7, 8, and 9 provide the sample size used for these summary statistics.

G Event Study Specifications

The estimation of the net effects of malpractice pressure on the probability of C-section presented in Section 6.1 is a difference-in-difference estimation, and so it seems pertinent to investigate the existence of pre-trends that could violate the assumptions underlying the difference-in-differences methodology. We do this with an event study breaking up the difference-in-difference estimation as described in Angrist and Pischke (2008) and Malani and Reif (2015). We estimate the following specification separately for each tort reform:

$$(16) \quad C_{it} = \beta_0^d + \sum_{\tau=-p}^{q} \beta_{1,\tau}^d D_{s,t+\tau} + x_{it}'\beta_2^d + \delta_y^d + \eta_m^d + \gamma_c^d + \theta_s^d \times t + \varepsilon_{it}^d$$

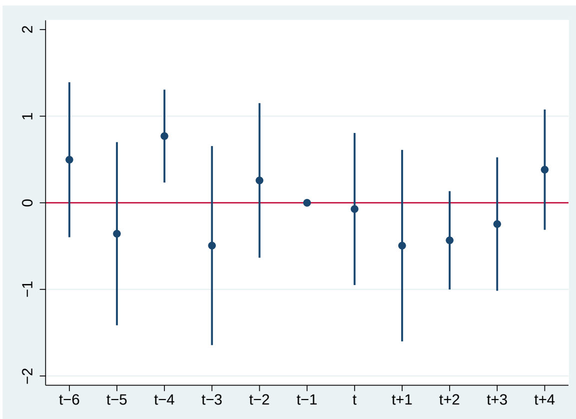
where C_{it} is an indicator variable for the method of delivery used in birth i at time t. In particular, we define $C_{it} = 1$ if cesarean section was the method of delivery, and $C_{it} = 0$ if it was a vaginal birth. The variable $D_{s,t+\tau}$ is an indicator equal to one if a there was a tort reform in period $t + \tau$ in state s.[22] We consider leads and lags at year intervals, so that $\tau = -1$ corresponds to 12 months before the reform took place, $\tau = -2$ corresponds to 24 months before and so on. The omitted category is the year before the reform took place, that is $t - 1$. We consider up to six years before the reform and up to four years after the reform took place. The vector x_{it} contains the same control variables as those used to estimate Equation (13) and described in Section 6.1. Finally, δ_y^d are year effects, η_m^d month effects, γ_c^d county effects, and $\theta_s^d \times t$ are state-specific linear time trends just as in Equation (13).

The results for estimating specification (16) are presented in Figure 2. The graph presents the estimate of $\beta_{1,t+\tau}$ and its corresponding 95 percent confidence interval. The estimate for $\beta_{1,t-1}$ does not have confidence interval because $D_{s,t-1}$ is the omitted category. As the graph indicates, even when there are some significant effects before a tort reform for noneconomic damages cap and for CSR reform, there seems to be no clear pre-trend in any of the reforms. Our main specification includes all four reforms at the same time, and so we estimated a similar specification in which we include all four reforms at the same time, but the results are nearly identical as those presented in Figure 2.

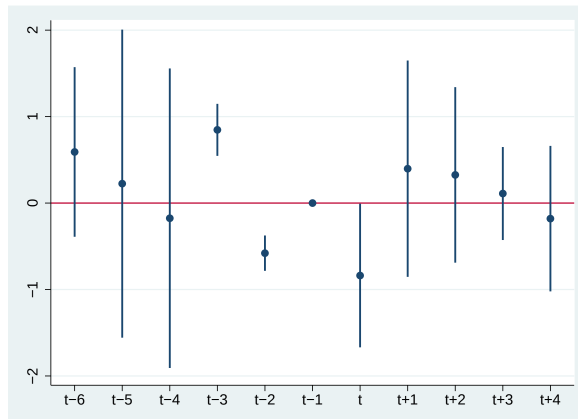
[22] As described by Table 1 some states have laws turning on and sometimes these laws turn off. This reversal of laws being enacted is hard to implement in specification (16) and so this specification only considers laws that were turned on during the period of study and ignores laws that were turned off. To account for this we build an indicator variable for states that have their tort law turned off and include it in the controls.

Figure 2: Effect of Individual Tort Reforms on the Probability of C-Section Before and After Tort Reform (in Percentage Terms)

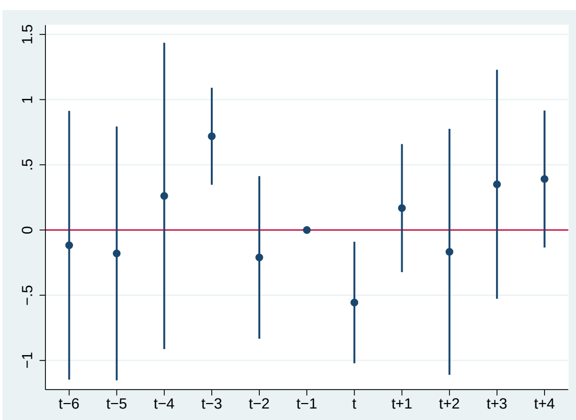
(a) PDC



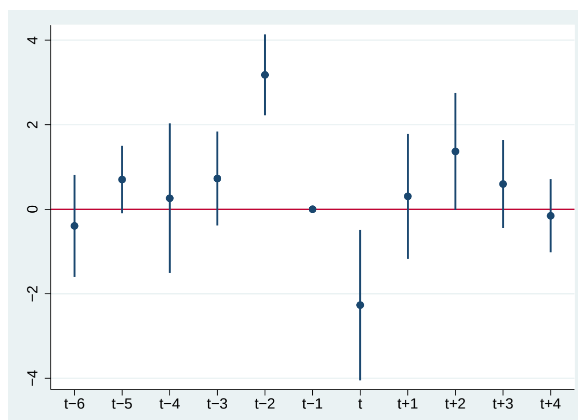
(b) NEC



(c) NJSL



(d) CSR



Notes: The period when the reform took place is t. The $t-k$ corresponds $(12 \times k)$ months before the reform took place. The $t+k$ corresponds $(12 \times k)$ months after the reform took place. The horizontal lines correspond to the 95 percent confidence interval for each estimate. The omitted category is period $t-1$.

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