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CHESG Special Edition
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Working Paper No: 150012

www.canadiancentreforhealtheconomics.ca

August 5, 2015

Canadian Centre for Health Economics
Centre canadien en économie de la santé
155 College Street
Toronto, Ontario

CCHE/CCES Working Paper No. 150012
August 5, 2015

Investigating Defensive Medicine: The Role of Access

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Abstract

Defensive medicine is the treatment decisions by physicians made primarily to limit malpractice liability risk, rather than for the medical benefit of patients. Despite widespread reports of defensive medicine in surveys of physicians, empirical investigations have produced conflicting evidence. This paper develops a model of the interactions in the health care market that shows that rises in medical malpractice pressure have non-monotonic effects on health care spending. The key element in the model is the endogenous determination of access to health care, which reacts to changes in medical malpractice pressure. This implication is tested using the Vital Statistics Natality Birth Data and data on tort reforms by state-month-year, and it is found that, in general, the non-monotonic relationship predicted by the model is supported.

JEL Classification: I18; H75; K13

Keywords: defensive medicine; obstetrics; healthcare spending

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1 Introduction

Medical malpractice liability reform has been a contentious policy issue at the state and federal levels for over forty years. One of the greatest points of disagreement concerns the existence and extent of the practice of defensive medicine. 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 of defensive medicine include the unnecessary ordering of costly tests, the avoidance of the types of patients or procedures likely to result in claims, and the departure of physicians from jurisdictions with severe malpractice environments. Such behavior, if practiced on a sufficient scale, demonstrates the adverse effects that malpractice liability costs, or "malpractice pressure," could have on the cost and quality of health care.

Widespread reports of defensive medicine in surveys of physicians have led to calls for liability-reducing reforms. The goal of such policies is the reduction of wasteful medical spending, making health insurance more affordable and thus improving consumers' access to care. Researchers have investigated the benefits of malpractice reform for two decades using utilization, spending, and quality data. Unlike the physician surveys, however, these studies have produced inconsistent and often conflicting findings. The lack of a clear empirical message has left interested parties without a common basis for their arguments, creating a deadlock in the discussion of malpractice reform as a viable policy option for improving the US health care system.

Several studies have noted the inconsistent results in the empirical defensive medicine literature (Helland and Showalter, 2009; Lakdawalla and Seabury, 2012; Sloan and Shadle, 2009; Avraham and Schanzenbach, 2010; Reyes, 2010; Cotet, 2012), but an explanation for these conflicts has been lacking. It could be that some studies uncover positive defensive medicine (increased provision out of fear of a lawsuit) where others find negative defensive medicine (reduced provision due to avoidance of risky patients or procedures). While plausible, this does not explain why defensive medicine would be positive in one case and negative in another, nor does it help researchers and policymakers form expectations of potential future changes in the malpractice environment. Currie and MacLeod (2008), studying the field of obstetrics, propose that reductions in the fear of liability induce physicians to perform more expensive cesarean sections in order to pull in higher fees. While this incentive to gain revenue surely exists, it is unlikely to be held in check by the fear of liability. Many more obstetrical claims (31% vs 3%) are associated with nonperformance or delay in performing a cesarean section than the unnecessary performance of one (Kravitz et al., 1991) and there is

some evidence that cesarean section is not susceptible to supplier-induced demand (Tussing and Wojtowycz, 1992).

The model developed in this paper is an special case of the model in Montanera (2013). It provides an alternative explanation and shows that rising malpractice pressure has non-monotonic effects on health care spending and quality. Specifically, health care spending rises initially with malpractice pressure. These effects are positive up to a threshold, after which any further increases in pressure produce negative effects. Intuitively, at low levels of malpractice pressure, access to care is relatively inexpensive. Physicians are not overly concerned with the prospect of a malpractice lawsuit, and so are willing to provide care to many patients at low levels of reimbursement. When access is so inexpensive, patients are willing to pay for health insurance policies that provide excellent access to care; for example, without excessive wait times or travel distances to willing providers. We define this type of outcome as a "full-access equilibrium." As malpractice pressure rises, however, physicians become more wary of lawsuits, and require greater financial reimbursement in order to provide the same level of access. At least initially, consumers are willing to bear the added expense, resulting in increased health care spending, in order to maintain the high quality of their health insurance. If malpractice pressure continues to rise, however, this willingness to pay becomes exhausted. Consumers instead demand cheaper, lower-quality health insurance with poorer access to care, or may simply opt out of the market altogether. We define this outcome as a "limited-access equilibrium." In this way, for a given individual or homogenous group, the theory predicts that defensive medicine creates non-monotonic effects of malpractice pressure on health care spending and quality: initially positive before becoming negative.

If the underlying effects of changes in malpractice pressure are non-monotonic, then the weakly monotonic relationship that best fits a data set would qualitatively depend on the prevailing level of malpractice pressure. Studies focusing on specialties facing relatively low malpractice pressure should tend to report positive relationships, while negative relationships should be expected in cases of high malpractice pressure. Studies utilizing broad data sets incorporating multiple specialties, demographics, and geographic regions tend to report weak or no relationships.

This article's primary objective is to test empirically for non-monotonic effects of changes in medical malpractice liability costs on health care spending. Second, should the evidence support the non-monotonicity theory, estimate separate marginal effects of changes in malpractice pressure; for both those on the upward-sloping segment, as well as on the

downward-sloping segment. The model is tested by estimating the effects of various state-level tort reforms on the incidence of cesarean section in births occurring in the United States between the years of 1989 and 2001. Data was drawn from two sources: the Vital Statistics Natality Birth Data, provided by the National Center for Health Statistics (NCHS)[1], and tort reforms by state-month-year provided by W. Bentley MacLeod through the Institute for Quantitative Social Science Dataverse Network (IQSS Dataverse Network) of Harvard University.

The empirical strategy builds on the well-known investigation by Currie and MacLeod (2008) into defensive medicine. Whereas Currie and MacLeod investigate only for monotonic effects, however, this article adapts the estimation strategy to allow for a non-monotonic relationship between malpractice liability pressure and the practice of defensive medicine. The basis for this estimation strategy is a prediction from the model developed in this paper. The positive effect of malpractice pressure on health care spending is born by those consumers willing to pay higher insurance prices in order to maintain high access to care, i.e. those in full-access equilibrium. The negative effect is born by those consumers who are either unwilling or unable to pay for high access, and instead accept cheaper insurance with lower access to care, i.e. those in limited-access equilibrium. Therefore, the positive and negative effects can each be identified by sorting consumers into "full-access" and "limited-access" groups and running separate regressions of health care spending on tort reforms.

This specification requires identifying discrete proxies for access to care, of which several are tested. The first, from Dubay et al. (2001), labels full-access any birth for which prenatal care began during the first trimester, and limited-access any where prenatal care was initiated after the first trimester or not at all. A second proxy for access is whether or not an expectant mother had to leave her county of residence in order to give birth. The final proxy is the Kessner index for adequacy of care found on each birth certificate. As these are only proxies for access to care, none of these partitions are likely to perfectly separate the abstract full-access and limited-access groups of the non-monotonicity theory. For this reason, the union of double intersections of these measures is investigated as a fourth access measure in an attempt to improve separation. Results, in general, support the non-monotonicity theory. Rates of cesarian section strongly and significantly increase, as much as 9.5%, among those with limited access to care when caps on noneconomic damages are put in place. These caps do not significantly affect cesarean section rates for those with full access to care.

The paper is organized as follows. In Section 2, the model is developed and implications of

[1]Available through the National Bureau of Economic Research (NBER) website.

the model are presented. Then section 3 presents the data and the empirical strategy followed by the results in section 4. Section 5 concludes and provides lines for future research.

2 The Model

Consider an economy with three agents or decision makers: (i) a continuum of identical consumers of measure 1, (ii) a continuum of identical physicians of measure D, and (iii) one managed care organization that operates in fully contested health insurance market (as in Arlen and MacLeod, 2005).

Each consumer is endowed with income m and derives utility from consumption and the health status. Consumer preferences are represented by the utility function $U(H, y)$ where H is the health status and y is consumption. The utility function $U(\cdot, \cdot)$ is strictly increasing and strictly concave in both its arguments, and has positive cross-partial derivatives. There are two levels of health status: healthy consumers enjoy health status H_1, while ill consumers enjoy health status H_2, where $H_1 > H_2$. Each consumer becomes ill with probability q and stays healthy with probability $(1 - q)$. Ill consumers who buy health insurance are able to obtain treatment from a physician. An insured consumer who falls ill and receives treatment t becomes healthy with probability $(1-\rho(t))$, but remains ill with probability $\rho(t)$, where the function $\rho(t)$ is decreasing and convex and is such that $\rho(0) = 1$ so that ill consumers who receive no treatment remain ill with probability 1. Since all consumers are identical, strict preference toward health insurance for a single consumer implies that all consumers purchase health insurance, and can be expected that q of them become ill and seek treatment.

Physicians are risk-neutral income maximizers.[2] Each physician is endowed with resources s for treatment of all patients and receives a payment w for each patient treated. Physicians treat both s and w as given. For each patient treated, the physician faces an uninsurable malpractice liability cost. The monetary equivalent of this cost is given by the function $g(t, P)$ where P is the level of medical malpractice pressure and we assume that this function is given by:

$$(1) \quad g(t, P) = \rho(t) \cdot P$$

so that the liability cost of treating a patient is proportional to the risk of that patient

[2]The number of physicians is determined exogenously rather than by a clearing condition in the physician labor market. This is a simplifying assumption. Simulations in Montanera (2013) indicated that the predictions of the model are robust to this assumption.

remaining ill and this proportion is fixed at the level of malpractice pressure. This functional form also implies that patients receiving a large amount of treatment, t, are less likely to have grounds to claim to be victim of physician's negligence.[3] To maximize profits, physicians choose the number of patients to treat, n, and the treatment to each patient t_i. Due to convexity of $\rho(t)$ and for a given number of patients, liability costs are at their lowest when all patients receive equal treatment, resulting in $t_i = (s/n)$ for all $i = 1, 2, \ldots, n$. Hence, the physician's problem reduces to choosing the caseload n to maximize profits taking as given $\{w, s\}$, that is:

$$(2) \quad \max_{n \geq 0} \Big\{ wn - n \cdot g(t, P) \Big\}, \quad \text{where } t = \frac{s}{n}.$$

The managed care organization (MCO) writes contracts with the two other agents in the model. On the one hand, the MCO writes a contract with the physicians consisting of a payment per patient treated (w) and resources to treat patients (s). The MCO acquires resources at a marginal cost of c, which is assumed to be constant. On the other hand, the MCO offers consumers a health insurance policy at a price τ that promises a probability of recovery equal to Q, which measures the "quality" of the health insurance policy, and is given by:

$$(3) \quad Q(n, t) = \left(\frac{Dn}{q} \right) \Big[1 - \rho(t) \Big]$$

where the fraction (Dn/q) serves as a measure of "access" to health care. The MCO chooses $\{w, s\}$ considering the physician's behavior to offer a credible level Q.

Since the MCO operates in a perfectly contestable market, it chooses $\{\tau, w, s\}$ to maximize consumers's expected utility subject to a zero profit constraint, that is:

$$(4) \quad \max_{\tau, ws} \Big\{ \Pr(H_1) U(H_1, m - \tau) + \Pr(H_2) U(H_2, m - \tau) \Big\}$$
$$\text{subject to} \quad \tau - Dwn - Dcs = 0$$

where $\Pr(H_1) = (1 - q) + qQ$ and $\Pr(H_2) = q(1 - Q)$.

[3] Given the first requirement under English common law for a finding of negligence, liability costs are conditional on treatment being unsuccessful, which occurs with probability $\rho(t)$.

2.1 Physicians Behavior

The solution of the physician's problem is the n^* that satisfies the first order condition:

$$(5) \quad \frac{w}{P} = \rho(t) - t\rho'(t), \quad \text{where } t = \frac{s}{n}$$

which defines two implicit functions $n^*(P)$ and $t^*(P)$. It is straightforward to show that these functions have the following properties:

$$(6) \quad \frac{\partial n^*}{\partial P} = -\frac{w}{P}\left(\frac{n^3}{s^2}\right)\left[P \cdot \rho''(t)\right]^{-1} < 0,$$

$$(7) \quad \frac{\partial t^*}{\partial P} = \frac{w}{P}\left(\frac{n}{s}\right)\left[P \cdot \rho''(t)\right]^{-1} > 0.$$

Equations (6) and (7) imply that given a contract with the MCO $\{w, s\}$, physicians in this model practice both positive and negative defensive medicine as malpractice pressure rises. One the one hand, increases in P make the marginal patient too risky to treat, inducing physicians to reduce their caseload, practicing negative defensive medicine (Equation (6)). On the other hand, the physician redistributes the available resources s among the remaining patients, so each patient receives a higher amount of treatment, practicing positive defensive medicine (Equation (7)).

2.2 Equilibrium: MCO's Problem

The MCO's problem is solved in two stages. First, given revenues from charging consumers a policy rate τ, the MCO must determine a contract $\{w, s\}$ with the physicians that induce them to choose n and t that maximize the quality of the insurance policy Q. Second, it must determine the τ that maximizes the consumer's expected utility.

The first stage of the MCO's problem becomes more complicated by the fact that given the level of medical malpractice, P, and the contract with physicians, $\{w, s\}$, it is possible that physicians choose to treat an infeasible number of patients. That is, since there are q ill patients and D physicians, the maximum number of patients that one physician can treat is q/D, then if $n^*(w, s, P)$ is the optimal physician's choice, it is possible that $n^*(w, s, P) > q/D$.[4] If $n^*(w, s, P) > q/D$, the MCO adjust its contract with the physicians to induce them to treat exactly $n^*(w, s, P) = q/D$.

[4]It is assumed that the MCO cannot write a contract with physicians to fix the number of patients they treat. This assumption implies that the number of patients treated by each physician is incentive-compatible.

Let $\bar{\tau}(P)$ be the lowest policy rate that would be sufficient to provide access to the expected number of ill policy holders. That is, $\bar{\tau}(P)$ is such that, along with the optimal contract $\{w, s\}$, it induces all physicians to treat $Dn = q$ ill policyholders. Then, the solution to the MCO's problem implies that is possible to have two different types of equilibria which are defined next.

Definition 1. A *full-access equilibrium* is any equilibrium $\{\tau^*, w^*, s^*, n^*(w, s, P)\}$ such that $n^* = q/D$ and $\tau^* > \bar{\tau}(P)$, and a *limited-access equilibrium* is any equilibrium such that $n^* < q/D$ and $\tau^* \leq \bar{\tau}(P)$.

Hence, capacity is sufficient to accommodate the expected number of ill policyholders in a full-access equilibrium, whereas in a limited-access equilibrium it is not. Proposition 1 summarizes the solution to the MCO's problem.

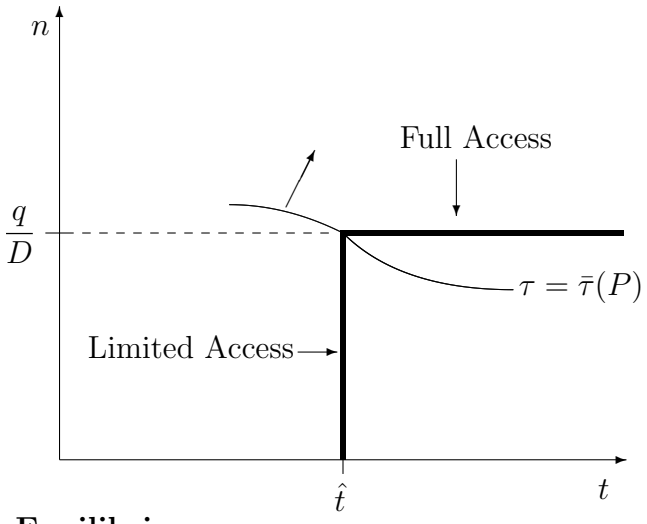
Proposition 1. *There exists a unique solution to the MCO's problem that is either a full-access or a limited-access equilibrium.*

Proof. See Montanera (2013). □

Figure 1 describes the first stage of the MCO's problem, showing an expansion path representing the n and t induced by the optimal contract $\{w, s\}$ as the policy price increases. In the picture, the policy price is represented by the isocost line τ which increases to the north-east of the diagram. Intuitively, the proof of Proposition 1 reveals that the optimal contract $\{w, s\}$ initially induces physicians to choose a unique level of treatment $\hat{t}$ that is independent of the amount of resources that the MCO provides to physicians. As a result, if the MCO increases the price of the policy, the optimal use of the extra revenues would be to hold the level of treatment constant at $\hat{t}$ and induce physicians to increase n. This is represented by the vertical segment in the picture and it corresponds to a limited-access equilibrium.

Once the policy price reaches $\bar{\tau}(P)$, the expansion path cannot continue along the vertical line since there are no more ill policyholders to treat. At this point the MCO must choose a contract that induces physicians to treat a feasible number of patients. Then, if τ increases beyond $\bar{\tau}(P)$, the contract is structured so that $n = q/D$ and increases the treatment to each patient t. This is represented by the horizontal segment in the picture and it corresponds to a full-access equilibrium. Then, any value of τ results in an allocation along this expansion path, and so there exist a unique equilibrium and this equilibrium is either full-access or limited-access equilibrium.

Figure 1: Expansion Path of the Solution to MCO's Problem



2.2.1 Full-Access Equilibrium

Since $n^* > q/D$ would imply payments to physicians that are inefficiently high, the MCO must choose contracts that induce $n^* = q/D$. From the solution to the physician's problem represented in Equation (5) we have that $w = \omega(t, P) = P \times \left[\rho(t) - t\rho'(t)\right]$ is the unique w inducing any choice of t. Therefore, the MCO sets s so that $t = (Ds/q)$ to induce the physicians to choose $n^* = q/D$ for any value of s. Then, to solve the MCO's problem in (4), the MCO sets $w = w(Ds/q, p)$, $n = q/D$, and $t = Ds/q$ and maximizes with respect to s. From the first order conditions it is possible to define two implicit functions $\tau^*(P)$ and $n^*(P)$. Define $\tilde{n}^* = \min\{n^*(w, s, P), \frac{q}{D}\}$, then Proposition 2 characterizes these functions.

Proposition 2. *In any full-access equilibrium,* $\frac{\partial \tau^*}{\partial P} > 0$ *and* $\frac{\partial \tilde{n}^*}{\partial P} = 0$.

Proof. See Montanera (2013). □

Intuitively, Proposition 2 states that, starting in any full-access equilibrium, the MCO would optimally respond to rising medical malpractice pressure by increasing prices, and thus health care spending, while maintaining the level of access to physicians enjoyed by policyholders. Intuitively, rising malpractice pressure requires greater physician payments in order to maintain $n^* = q/D$.

Next, define J as the consumer's marginal rate of substitution between consumption and health care quality and consider the elasticity of J with respect to resources s, $\epsilon_{J,s}$. Similarly consider the elasticity of physician's pay w with respect to resources s, $\epsilon_{w,s}$. Define $\tilde{t}^* = \frac{s}{\tilde{n}^*}$, then Proposition 3 describes the effects of medical malpractice on treatment in the full-access equilibrium.

Proposition 3. *In a full-access equilibrium,* $\frac{\partial \tilde{t}^*}{\partial P} > 0$ *if and only if* $\mid \epsilon_{J,s} \mid < \mid \epsilon_{w,s} \mid$.

Proof. See Montanera (2013). □

In Proposition 3, a high $\mid \epsilon_{w,s} \mid$ indicates that physicians are willing to accept a significant reduction in payments, while still maintaining the same number of patients, if the MCO provides them with more resources. A low $\mid \epsilon_{J,s} \mid$ would occur if a small increase in the price of health insurance (in order to finance additional resources) does not significantly affect the relative marginal values a consumer places on health care quality relative to consumption. The condition $\mid \epsilon_{J,s} \mid < \mid \epsilon_{w,s} \mid$ holds in environments where consumers willingness to pay for recovery (and thus insurance) remains strong, and where increasing resources is an effective method for maintaining access. Cases where willingness to pay is not strong enough are likely to result in limited-access equilibria rather than full-access.

2.2.2 Limited-Access Equilibrium

From the first order conditions of the MCO's problem it can be seen that limited-access equilibria are interior solutions to this problem. Also, the first order conditions indicate that for a given τ, $\{w, s\}$ are chosen such that the marginal increase in access (n) and treatment (t) would be equally cost-effective in producing quality (Q). This results in the optimal level of treatment $\hat{t}$ in Figure 1. An increase in pressure does not affect the marginal quality produced by access nor treatment but, from the physicians problem, does make access more costly relative to treatment. The expected result is substitution in the production of quality away from access toward treatment. This is summarized in Proposition 4.

Proposition 4. *In any limited-access equilibrium,* $\frac{\partial \tilde{t}^*}{\partial P} > 0$.

Proof. See Montanera (2013). □

The effect of rising medical malpractice pressure on health care spending is ambiguous in the limited-access equilibrium. A rise in malpractice pressure decreases the quality of health insurance, which makes consumers more likely to realize the lower health status (increases $\Pr(H_2)$ in (4)). This in turn lowers the expected marginal utility of consumption and thus increases consumers' willingness to spend on health insurance. However, an increase in malpractice pressure unambiguously lowers the "bang for the buck" from spending in health insurance. This is because, where access is limited, additional spending is optimally used to increase access (n), which is made more expensive by higher malpractice pressure.

Hence we make an assumption on the consumers' sensitivity to policy price increases. In particular, we assume that the elasticity of the benefit from recovery, given by $\Delta U = U(H_1, y) - U(H_2, y)$, with respect to changes in the price of health insurance, τ, is less than one, i.e. $\mid \epsilon_{\Delta U,\tau} \mid < 1$. Given the assumptions on $U(H, y)$, this condition would hold even if 50% of income were spent on health insurance, hence it is fairly weak.

Proposition 5. *In any limited-access equilibrium,* $\frac{\partial \tau^*}{\partial P} < 0$ *if and only if* $\mid \epsilon_{\Delta U,\tau} \mid < 1$.

Proof. See Montanera (2013). □

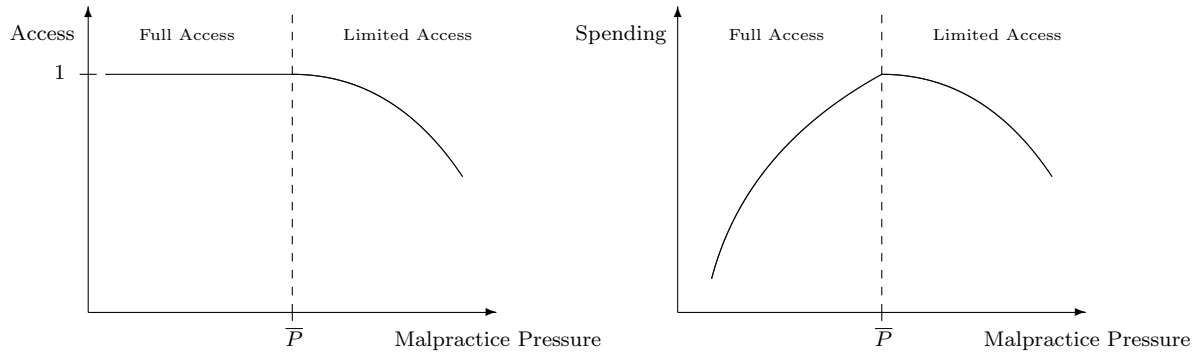
Proposition 5 states that as long as spending on health insurance is low enough for the benefit of recovery to be relatively insensitive to changes in the price of health insurance, then equilibrium health care spending declines with medical malpractice pressure. The following corollary proves useful for the empirical implementation presented below.

Corollary 6. *In any limited-access equilibrium, if* $\frac{\partial \tau^*}{\partial P} < 0$ *at* P'*, then* $\frac{\partial \tau^*}{\partial P} < 0$ *for all* $P > P'$.

Figure 2: Effects of Rising Medical Malpractice Pressure

(a) Effects on Access to Health Care

(b) Effects on Health Care Spending



Greater malpractice pressure makes health insurance of a given quality more expensive to provide, hence if consumers spend less on health insurance, as predicted by Proposition 5, the quality of health insurance must decline as a result. Then, from Proposition 4, these quality reductions must be the result of reduced access. If rising malpractice pressure is met with only further access reductions in limited access equilibria, then there can be no return to full-access equilibrium. This means that the lowest level of malpractice pressure producing a limited-access equilibrium ($\bar{P}$) is a threshold; all levels of malpractice pressure above this threshold must also produce limited-access equilibria, and any full-access equilibria must occur below. This is more easily appreciated referring to Figure 2.

3 Data and Methods

The passage or withdrawl of state-level tort reforms is the most accepted exogenous measure of malpractice pressure in the literature (Kessler and McClellan, 1996; Dubay et al., 2001). In this article, we follow Currie and MacLeod (2008) and consider the effects of four tort reforms: caps on punitive damages, caps on noneconomic damages, collateral source rule reform, and joint-and-several liability rule reform. Data on tort reforms by state-month-year is provided by W. Bentley MacLeod through the Institute for Quantitative Social Science Dataverse Network (IQSS Dataverse Network) of Harvard University, and coded the same as Currie and MacLeod (2008). The CBO report "The Effects of Tort Reform: Evidence from the States" provides a good description of each of these torts. 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.

Delivery by cesarean 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). For this reason, the incidence of birth by cesarean section is used here as a proxy for health care spending. Data on the use of cesarean section came from the Vital Statistics Natality Birth Data, provided by the NBER. Certificate information was drawn from all births occurring between 1989 and 2001 in 22 U.S. states that passed or rescinded any of four tort reforms. The states used in the analysis are presented in Table 1.

Table 1: US States used in the Analysis

Alabama	Maine	Oregon
Alaska	Mississippi	Pennsylvania
Georgia	Montana	South Dakota
Idaho	New Hampshire	Tennessee
Illinois	New Jersey	Texas
Indiana	North Carolina	Wisconsin
Kansas	North Dakota	
Kentucky	Ohio	

Whereas the existing empirical literature on defensive medicine estimate linear models, this article seeks to estimate a nonlinear model of the relationship between malpractice pressure and health care spending. Nonlinear estimation is complicated in this case because the observed changes in malpractice pressure are discrete rather than continuous. It can therefore be used to estimate the effect of a change in malpractice pressure, but not at different levels of malpractice pressure.

We circumvent this problem using the results from Propositions 1 through 5 and Corollary 6 presented in Section 2. Proposition 1 states that for a given set of model parameters and functional forms, there is a unique equilibrium that is one of two types. The first is a "full-access" equilibrium, where consumer willingness to pay in the health insurance market is high enough to support policies offering few restrictions on access to care. In the theoretical model, this means that sufficient capacity is procured from providers to satisfy the expected demand from ill policyholders. The second type of equilibrium is "limited-access," where consumer willingness or ability to pay cannot support full-access insurance policies. Instead, capacity is insufficient, and policyholders are likely to face waiting times, delays in diagnosis, or extended travel to locate willing providers. Rising malpractice pressure makes full-access insurance policies more expensive to provide. Those with high-enough willingness to pay end up spending more on full-access insurance policies, while the rest substitute away from access, ultimately spending less on health insurance. Since the qualitative effect of a change in malpractice pressure on health care spending is dependant on access to care, the non-linear relationship can be estimated, even with a discrete measure of malpractice pressure, by first sorting observations into full- and limited-access groups, and then estimating separately.

The empirical specification we use is the same as the one used by Currie and MacLeod (2008) but estimated separately by access group. Let C_{imy} be an indicator variable for whether or not cesarean section was the method of delivery use with mother i at month

m during year y. In particular, we define $C_{imy} = 1$ if cesarean section was the method of delivery, and $C_{imy} = 0$ if it was a vaginal birth. Then our empirical specification is:

$$(8) \quad C_{imy} = \beta_0 + \mathrm{TR}'_{smy}\beta_1 + x'_{imy}\beta_2 + \delta_y + \eta_m + \gamma_c + \theta_s \times t + \varepsilon_{imy}$$

where TR_{smy} is a vector of four dummy variables each corresponding to the four tort reforms considered in this study at state s on month m during year y. As mentioned before, these reforms are: caps on punitive damages, PDC; caps on noneconomic damages, NEC; collateral source rule reform , CSR; and joint-and-several liability rule reform, JSL. We use the same definitions as Currie and MacLeod (2008) for these dummy variables. In particular we define these dummy variables as follows:

$$PDC_{smy} = \mathbf{1}\{\text{state } s \text{ at time } (m, y) \text{ has a cap on punitive damages}\}$$
$$NEC_{smy} = \mathbf{1}\{\text{state } s \text{ at time } (m, y) \text{ has a cap on noneconomic damages}\}$$
$$CSR_{smy} = \mathbf{1}\{\text{state } s \text{ at time } (m, y) \text{ allows payments from private sources as evidence in trials}\}$$
$$JSL_{smy} = \mathbf{1}\{\text{state } s \text{ at time } (m, y) \text{ requires parties to be responsible for at least 50\% of the harm}\}$$

The vector x_{imy} contains the same control variables used by Currie and MacLeod (2008), these are: 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 $\theta_s \times t$ is a state-specific linear time trend.

As "access" is an abstract concept in the non-monotonicity theory, estimation of the non-linear model requires designation of proxies. The Vital Statistics Natality Birth Data contain three alternative proxies used here. The first is based on the trimester in which prenatal care was initiated. Borrowing from (Dubay et al., 2001), prenatal care initiated during the first trimester is considered timely, while that initiation in second or third trimesters, or not at all, is considered untimely. Assuming that timely prenatal care is in the best interests of the mother and infant, untimely initiation is taken as an indicator of the mother's poor access to prenatal care. Therefore, those mothers with timely initiation of prenatal care are sorted into the full-access group, and those with untimely care into the limited-access group. The second proxy of access is whether or not the mother had to leave her county of residence in order to give birth. Receiving care out-of-county indicates a restriction from seeking care closer to home, or an unwillingness or inability to pay for it. Therefore, under this proxy, those births occurring in the same county as the mother's residence are considered

full-access, while those travelling out-of-county to give birth are limited-access. The final proxy of access is the Kessner Index for adequacy of care. This index sorts births into "adequate", "intermediate", or "inadequate" depending on trimester of initiation, gestation, and number of prenatal care visits, as described in Kotelchuck (1994). By this proxy, births where prenatal care is adequate are considered full-access while intermediate and inadequate are limited-access. Also considered are a union of intersections, where births must satisfy any two of the criteria above to be full- or limited-access.

Table 2 shows the summary statistics broken down by each of the three access proxies. Note that, with the trimester and adequacy proxies, limited-access births are less likely to be conducted by cesarean section relative to full-access ones. They are also, on average, younger, less educated, and more likely to be black or Hispanic. This indicates that inability to pay is a likely a significant barrier to access for these proxies. These tendencies are reversed where access is determined by county of birth. This shows that other considerations, besides willingness to pay, drive mothers to seek care out-of-county. Also notable, by this proxy, the full-access group is likely to contain births by inner-city mothers, and the limited-access group those by rural mothers. The relative mobility of inner-city and rural mothers may misrepresent the actual choices for prenatal care available to them, and thus result in misclassification.

Similarly, in Table 3, note that by any access proxy, full- and limited-access groups' exposure to each tort reform is relatively equal. 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.

4 Results

Caps on either punitive or noneconomic damages, which would limit both 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 discrete reduction in malpractice pressure. CSR reforms allow courts to consider other sources of income to a plaintiff stemming from a medical injury when determining damages. As far as these other sources would lessen the need for damages to make the plaintiff whole, CSR reforms are also considered a reduction in malpractice pressure. The final tort reform examined here, JSL reforms, are considered increases in malpractice pressure. This is because these reforms involve changes to the threshold level

Table 2: Summary Statistics: Mean (Std. Dev.)

	By Trimester		By Residency		By Adequacy	
	Full Access	Limited Access	Full Access	Limited Access	Full Access	Limited Access
C-Section	0.23	0.19	0.22	0.24	0.23	0.19
	(0.42)	(0.39)	(0.41)	(0.43)	(0.42)	(0.39)
Male Child	0.51	0.51	0.51	0.51	0.51	0.51
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Multiple Birth	0.03	0.02	0.02	0.03	0.03	0.02
	(0.17)	(0.14)	(0.15)	(0.18)	(0.17)	(0.14)
Mother's Race						
Hispanic	0.11	0.21	0.16	0.07	0.10	0.20
	(0.31)	(0.41)	(0.36)	(0.25)	(0.30)	(0.40)
Black	0.15	0.28	0.20	0.11	0.14	0.26
	(0.35)	(0.45)	(0.40)	(0.31)	(0.34)	(0.44)
Mother's Education						
< 12	0.18	0.43	0.25	0.17	0.16	0.39
	(0.38)	(0.49)	(0.43)	(0.37)	(0.37)	(0.49)
12	0.35	0.37	0.35	0.37	0.35	0.37
	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)
13-15	0.23	0.14	0.20	0.23	0.23	0.15
	(0.42)	(0.35)	(0.40)	(0.42)	(0.42)	(0.36)
16+	0.24	0.06	0.20	0.24	0.25	0.09
	(0.43)	(0.24)	(0.40)	(0.42)	(0.44)	(0.28)
Mother's Age						
19-24	0.29	0.42	0.32	0.29	0.28	0.40
	(0.45)	(0.49)	(0.47)	(0.45)	(0.45)	(0.49)
25-34	0.54	0.34	0.49	0.53	0.55	0.37
	(0.50)	(0.47)	(0.50)	(0.50)	(0.50)	(0.48)
35+	0.11	0.07	0.10	0.11	0.11	0.07
	(0.31)	(0.25)	(0.30)	(0.31)	(0.31)	(0.26)
Number of obs	1,726,821	416,854	1,581,626	592,343	1,547,244	564,715

of responsibility for injury a party must hold before being potentially liable for damages. Without a threshold, a physician could face a lawsuit over negligence that was primarily another party's doing. Installing a threshold of 50% or higher would result in a greater dependence of a physician's total malpractice liability on that physician's own decisions. As this could increase the incentive for defensive behavior, and following Currie and MacLeod (2008) we consider the setting of such a high threshold as an increase in malpractice pressure. The withdrawl of any of these reforms is assumed to have the opposite effect.

Table 4 shows the effects of the four tort reforms when access is defined by the trimester in which prenatal care was initiated. Births for which prenatal care began during the first trimester are labelled the full-access sub-sample, and those for which prenatal care began after the first trimester, or not at all, are the limited-access. In the first two columns, these

Table 3: Tort Reforms: Mean (Std. Dev.)

	By Trimester		By Residency		By Adequacy	
	Full Access	Limited Access	Full Access	Limited Access	Full Access	Limited Access
Any NE cap	0.22	0.21	0.22	0.21	0.23	0.21
	(0.42)	(0.41)	(0.42)	(0.41)	(0.42)	(0.41)
Any PD cap	0.61	0.64	0.63	0.58	0.60	0.64
	(0.49)	(0.48)	(0.48)	(0.49)	(0.49)	(0.48)
JSL Reform	0.39	0.38	0.39	0.40	0.39	0.38
	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)
CSR Reform	0.28	0.28	0.29	0.25	0.28	0.28
	(0.45)	(0.45)	(0.45)	(0.43)	(0.45)	(0.45)
Number of obs	1,726,821	416,854	1,581,626	592,343	1,547,244	564,715

labels are applied to the entire 10% sample of the population, and the two sub-samples are regressed separately. As JSL reform is considered an increase in malpractice pressure, while the other three are reductions, the signs of the estimated coefficients in the first two columns are consistent with a negative effect of malpractice pressure on the incidence of cesarean section. Only JSL reform is significant at the 5% level of confidence for the full-access sub-sample. Despite a much lower number of observations, the effects of tort reform are larger in magnitude and of greater significance among those with limited-access. By this first measure of access, therefore, the evidence is consistent with the non-monotonicity theory's predictions for those with poor access to care. Non-monotonicity would imply that the coefficients in the full-access sample and the limited-access sample would flip signs, and even though we do not observe that in the results, we observe that the effects of tort reforms are relatively weak in the full-access sample and very strong in the limited-access sample, which is also consistent with non-monotonicity, specially for caps on noneconomic damages which is one of the most important tort reforms.

The third and fourth columns of Table 4 repeat the process of the first two columns, with the exception that the sub-samples are limited to cases in which the mothers were white, married, and had at least twelve years of schooling. This is done in an effort to reduce the share of births in the sub-samples that were reimbursed through Medicaid. This is important because the model developed in section 2 assumes a competitive health insurance market where payments to physicians are responsive to changes in the malpractice environment. As Medicaid rates are not set in a market, a large share of Medicaid births in the sub-samples could obscure the effects predicted by the non-monotonicity theory. As shown in the third and fourth columns, the estimated effects of tort reform are greater among limited-access

Table 4: Effects of Tort Reforms by Access. Full Access determined by Trimester Prenatal Care Began. First Trimester = Full Access.

	Full Sample		White, Married, Educated	
	Full Access	Limited Access	Full Access	Limited Access
Any PD cap	0.2828	0.1032	0.5270	-0.5283
	(0.2230)	(0.2627)	(0.2620)	(0.8964)
Any NE cap	0.1416	0.7331**	-0.0585	1.7611**
	(0.4348)	(0.2573)	(0.5865)	(0.4711)
JSL reform	-0.7683*	-1.1078**	-1.2141*	-1.6033**
	(0.3369)	(0.2688)	(0.4761)	(0.5298)
CSR reform	0.5487	0.8602*	0.6805*	1.5049
	(0.2713)	(0.3333)	(0.3181)	(0.9988)
Number of obs.	1,726,821	416,854	1,033,878	103,536
R^2	0.0428	0.0387	0.0425	0.0439

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to 1 if the delivery method was a C-section. 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. Regressions in columns 3 and 4 only include white women who are married and that are high-school graduates. Significance at the 1% level is indicated by ** and at the 5% level is indicated by *.

mothers who are less likely to be on Medicaid, compared to the general population. This is particularly true of non-economic damage caps. Based on the estimated coefficient, the passage of a cap on non-economic damages results in a 3.9% increase in the incidence of cesarean section among all mothers with poor access to care, rising to 8.5% among those mothers not on Medicaid, and no change among those with good access. Given the socioeconomic status of the limited-access mothers, it is unlikely that the additional cesarean sections are the result of providers taking advantage of generous insurance policies by inducing demand in a lenient malpractice environment. On the contrary, these findings indicate that the primary effect of tort reform is to increase access to care among poorer socioeconomic groups.

Measuring access according to the Kessner Index of adequacy of care, as shown in Table 5, reveals the same pattern. By this measure, a birth is labelled full-access if care was "adequate" under the Kessner Index, and limited-access if "intermediate" or "inadequate". Estimated coefficients for the limited-access sub-sample are greater in magnitude and significance relative to full-access, and with signs consistent with the non-monotonicity theory. Additionally, by this access measure, there is some switching of signs between full- and limited-access coefficients, although not significant in the full-access columns. Mothers with poor access, as measured by adequacy of care, are 4.7% (8.5% among white, married, and educated mothers) more likely to give birth by cesarean section following the passage of a cap on noneconomic damages, with no significant effect on full-access mothers. JSL reform has the opposite effect in roughly equal magnitude, as it did in Table 4, since it increases

Table 5: Effects of Tort Reforms by Access. Full Access determined by Adequacy of Care (Kessner Index). Adequate = Full Access.

	Full Sample		White, Married, Educated	
	Full Access	Limited Access	Full Access	Limited Access
Any PD cap	0.4833	-0.3801	0.6061	-0.5345
	(0.2475)	(0.2689)	(0.3113)	(0.7155)
Any NE cap	0.0415	0.8965**	-0.1762	1.8087**
	(0.4431)	(0.2956)	(0.6186)	(0.4087)
JSL reform	-0.8544*	-0.9080*	-1.2197*	-1.4630**
	(0.3449)	(0.3337)	(0.5095)	(0.3516)
CSR reform	0.5678	0.6229*	0.7396	0.8576
	(0.2934)	(0.2595)	(0.3625)	(0.7063)
Number of obs.	1,547,244	564,715	956,377	168,741
R^2	0.0435	0.0376	0.0432	0.0389

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to 1 if the delivery method was a C-section. 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. Regressions in columns 3 and 4 only include white women who are married and that are high-school graduates. Significance at the 1% level is indicated by ** and at the 5% level is indicated by *.

Table 6: Effects of Tort Reforms by Access. Full Access determined by Resident Status of the Mother. Resident = Full Access.

	Full Sample		White, Married, Educated	
	Full Access	Limited Access	Full Access	Limited Access
Any PD cap	0.2361	0.3502	0.5162	0.4010
	(0.2154)	(0.2970)	(0.2897)	(0.3666)
Any NE cap	0.2184	0.3734	0.0145	0.4364
	(0.2762)	(0.5638)	(0.5109)	(0.7327)
JSL reform	-0.7149**	-1.2854*	-1.2891**	-1.2556
	(0.2223)	(0.4952)	(0.3669)	(0.6980)
CSR reform	0.4591	0.8984	0.6789	0.9109
	(0.3159)	(0.4689)	(0.4938)	(0.4826)
Number of obs.	1,581,626	592,343	770,961	377,276
R^2	0.0431	0.0443	0.0425	0.0451

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to 1 if the delivery method was a C-section. 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. Regressions in columns 3 and 4 only include white women who are married and that are high-school graduates. Significance at the 1% level is indicated by ** and at the 5% level is indicated by *.

Table 7: Effects of Tort Reforms by Access. Full Access determined by the Union of Double Intersections.

	Full Sample		White, Married, Educated	
	Full Access	Limited Access	Full Access	Limited Access
Any PD cap	0.3225	-0.0103	0.5191	-0.2483
	(0.2514)	(0.2729)	(0.2913)	(0.9070)
Any NE cap	0.0956	0.8666**	-0.1312	2.0155**
	(0.4667)	(0.2778)	(0.6290)	(0.3085)
JSL reform	-0.7309	-1.2199**	-1.1688*	-1.7971**
	(0.3577)	(0.2916)	(0.5101)	(0.4699)
CSR reform	0.5178	0.9502*	0.7003*	1.3561
	(0.2719)	(0.3587)	(0.3146)	(0.9579)
Number of obs.	1,681,588	449,334	1,008,421	123,963
R^2	0.0431	0.0386	0.0427	0.0419

Notes: Standard errors corrected for state-of-occurrence clustering are in parenthesis. The dependent variable is a dummy equal to 1 if the delivery method was a C-section. 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. Regressions in columns 3 and 4 only include white women who are married and that are high-school graduates. Significance at the 1% level is indicated by ** and at the 5% level is indicated by *.

malpractice pressure while noneconomic damage caps decrease it.

Table 6 repeats the same exercise as Tables 4 and 5, although based on a different measure of access. The full-access sub-sample in Table 6 are those births occurring in the same county as the mother's residence, while the limited-access mothers gave birth outside of their county of residence. Based on all four columns, this measure of access is not supportive of the non-monotonicity theory. This is not entirely unexpected, as the summary statistics showed the opposite sorting of socioeconomic groups by this access measure, compared to the other two. This could mean that mothers seek care elsewhere because they have less restrictive insurance policies or greater mobility, rather than barriers to access in their county of residence. The converse may also be true in that some mothers may wish for a choice set of providers broader than those available locally, but face financial barriers or network restrictions. Since leaving the county of residence to give birth may indicate an opportunity as well as a barrier, it may not be well-suited as a measure of access on its own.

Given that the initiation of prenatal care, Kessner Index, and distance travelled are all proxies for access, it is unlikely that any alone could perfectly partition the the full- and limited-access sub-samples. For this reason, the last access measure examined utilizes the union of intersections of the previous three measures.[5] In Table 7, the full-access sub-sample is the set of births satisfying any two of the full-access criteria from Tables 4, 5,

[5]The triple intersection was also examined, but the restrictive criteria resulted in few observations and no significant coefficients in limited-access sub-samples.

and 6. Similarly, the limited-access births are those satisfying any two of the limited-access criteria. While this decreases the number of observations, the intention is to examine more concentrated sub-samples by their respective access type. Also, adding the criteria of late prenatal care or inadequate care to those birth occurring outside the mother's county of residence may separate those who do so out of restriction rather than by choice. As shown in Table 7, the more concentrated sub-samples support the non-monotonicity theory. JSL reform decreases limited-access cesarean sections by 6.4% over the whole sub-sample and 8.5% for white, married, and educated mothers. Noneconomic damage caps have the opposite effect; increases of 4.6% and 9.5%, respectively.

5 Conclusion

Contrary to physicians' assertions that defensive medicine is widely practiced, existing empirical investigations into the subject have uncovered inconsistent and often conflicting findings. Why the same tort reforms increase health care spending in some cases, decrease it in others, and have no effect in still others has been difficult to explain. In this article, we developed a model providing such an explanation; that the practice of defensive medicine results in non-monotonic effects of malpractice reforms on health care spending. Rising malpractice pressure makes access to care more expensive. Health care spending rises among those willing to pay to maintain good access to care, but falls for those whose willingness is exhausted. The expected qualitative effect of tort reform on a consumer would therefore depend on that consumer's level of access to care.

This article tests the non-monotonicity theory using data on all births occurring in 22 states experiencing a change in malpractice pressure due to the status of four tort reforms between the years of 1989 and 2001. Births are sorted into full-access and limited-access groups according to three alternative measures: The timeliness of prenatal care initiation, the adequacy of prenatal care under the Kessner Index, and whether or not the birth occurred in a county different from the mother's county of residence. The findings are consistent with the predictions of the non-monotonicity theory. Reductions in malpractice pressure, due to noneconomic damage caps and JSL reform in particular, increase the incidence of birth by cesarean section in mothers with poor access to care between 3.9% and 9.5%, depending on the access measure. While the full-access results do not directly support the upward-sloping half of the non-monotonicity theory, they could indicate that any spending increases due to revenue maximization among providers are balanced by spending reductions through

decreased defensive medicine.

The findings presented here make several important contributions to the literature. First, they show that the primary estimated benefit of noneconomic damage caps and JSL reform to consumers is not spending reductions, but improved access to care among vulnerable populations. This is notable as policy discussions often consider access improvements as secondary to spending considerations. Second, they help to explain the history of inconsistent and conflicting findings in the empirical literature on the existence and importance of defensive medicine. This explanation may help to remove confusion and facilitate policy discussions on the merits of tort reform. It suggests that tort reform is not a "silver bullet" policy capable of expanding access to care while also lowering health care spending for a given homogenous population. While spending may fall for those who have good access to care, it would rise among those newly able to afford good access. Third, the findings show the usefulness of access measures in estimating the effects of past tort reforms in a novel way. This creates opportunities to reevaluate the data used in past empirical investigations of defensive medicine using non-monotonic specifications where access measures are available. They further show that evaluating access measures prior to changing the malpractice environment could aid policymakers contemplating tort reform in predicting the qualitative effects on consumers in their jurisdictions.

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