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# Medical Malpractice Liability and Hospital Competition in Obstetrics

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# Medical Malpractice Liability and Hospital Competition in Obstetric Service

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# 1 Abstract

Since 1980s, debates over efficiency of current tort system have encouraged various researches on healthcare cost and quality pertaining to the changes in tort pressure, and tort reforms are frequently used as exogenous changes to tort liability to study healthcare provider behaviors.

In the first chapter, I examine the effect of medical malpractice liability on obstetric practice pattern, in particular, whether the effect varies by patient health condition. I extend Janet Currie and Bentley MacLeod (2008)'s model that allows for variation of patient's health conditions by relaxing the assumption of purely altruistic physicians. The model predicts that the effects of tort reforms will be mostly concentrated on patients with better health conditions. I use two types of tort reform, specifically Caps on Punitive Damages (CPD) and modification of Joint and Several Liability (JSL), in New Jersey to test our theoretical predictions and find consistent empirical evidence.

The second chapter investigates the relationship between medical malpractice liability and the effect of hospital competition on quality of services provided to patients who are covered by private insurance in one of the more frequently sued practices, obstetrics. Medical malpractice lawsuit may send negative quality signals to the consumers, and reduce hospital's market power by increasing quality elasticity of demand among consumers. Therefore, hospitals in a market where consumers are more sensitive to quality may compete over quality more than price. Consistent with theoretical prediction, the findings suggests that hospitals in markets where malpractice lawsuits are frequently

filed and jury verdicts are frequently awarded use resources more efficiently, and provide better care.

# 2 Tort Reform and Obstetric Practice: The Role of Heterogeneity in Patient Health in Physician Effort and Altruism

## 2.1 Introduction

Amid various concerns related to the reform of healthcare financing and delivery in the United States is an ongoing discussion over the role of tort reform. The call for or against tort reform has become increasingly contentious. Those in favor of tort reform claim that the incentives for excessive numbers of lawsuits that arise from the fractured medical liability system in combination with the risk aversion of physicians lead to excessive medical testing and procedures, so called defensive medicine,[1] which raises costs and unnecessarily consumes scarce resources. The opponents of tort reform rebut the claim that reducing tort liability would curb cost, suggesting this argument is a "red-herring" that has been repeated often enough that it is taken as truth rather than properly scrutinized (Underwood, 2009).

Opponents of tort reform claim that current tort liability is not an actual driver of the increasing medical costs as it is often blamed to be. Rather, they argue that current system provides appropriate recourse for those who have suffered losses to seek adequate compensation for those losses. Furthermore, inefficiencies introduced by changing the current system may be further exacerbated if physicians do respond to reduced liability pressure by taking less care, because more individuals will wind up with worse than

[1] This specifically refers to positive defensive medicine, which is physician's assurance behavior to reduce medical malpractice risk, such as ordering unnecessary tests, referring to consultants, or performing unneeded procedures.

expected health outcomes and may be unable to seek what would be considered proper recompense. Apparently, these arguments hinge on a very fundamental question: "How would the doctors alter their practice patterns in response to changes in tort liability?"

The complex incentives created by the tort reforms have led to mixed conclusions among previous studies that assess the effect of tort reform on physicians' treatment decisions. For example, in a seminal work, Kessler and McClellan (1996) empirically demonstrate that elderly Medicare beneficiaries with cardiac diseases underwent fewer procedures without a significant effect on their health outcomes in lower liability environments. They categorize the reforms into the ones that legislate reduced malpractice awards (direct reforms) and ones that redistribute financial liability exposure during a malpractice lawsuit (indirect reforms). Using similar categorization of tort reforms, however, Sloan and Shadle (2009) find that tort reforms have no significant effect on either medical decisions or patient health outcomes. While it is important to investigate the overall effect of tort reform, these mixed findings really point to the need to examine the effects of specific types of reform on specific fields of medicine. It is possible that different types of reform have conflicting effects on physician behaviors that are concealed from overall effects. In a recent study by Currie and MacLeod (2008), they show that in obstetrics, the Joint and Several Liability reform reduces complications of labor and C-section use, whereas caps on noneconomic damages increase them. Their findings suggest the importance to evaluate the effects of specific tort reforms independently, as those effects may work against each other.

In this chapter, we follow Currie and MacLeod (2008) to exploit two specific types of tort reform that occurred in New Jersey since 1995: Caps on Punitive Damages (CPD) and modification of Joint and Several Liability (JSL) rule on the physician's practice pattern (C-section rates). Obstetrics is a medical specialty with high professional liability exposure. In the ACOG's 2009 survey, nearly 91% of ob-gyns had experienced at least one liability claim filed against them during their professional careers (American College of Obstetricians and Gynecologists 2009). Thus, it is not surprising that many researchers have used obstetrics to study the impact of medical malpractice on physicians' behaviors.

Previous studies on the impact of malpractice pressure on C-section rates have yielded mixed results. One possible explanation for the mixed results is that most of these studies ignore the heterogeneous impacts of malpractice pressure along the patient severity distribution.[2] Intuitively, at least for a small proportion of deliveries that have a clear medical indication for cesarean, malpractice pressure should have no impact on obstetricians' choice. For the rest that are open to discretion, malpractice pressure may or may not have an impact. Thus, it is reasonable to suspect that the impacts of malpractice pressure on physicians' behaviors vary by patient severity.

[2] Two previous studies provide some insight on the heterogeneous impacts of tort reform among patients of differing health status. Dubay, Kaestner and Waidmann (1999) find that the effect of malpractice pressure varies with mother's socioeconomic status. A closer look at the descriptive statistics shows that mothers in different socioeconomic groups are quite different in terms of their health status, which suggests that the effect of malpractice pressure might also vary with mothers' health status. Although higher malpractice pressure generally results in more c-sections, a negative but insignificant coefficient is reported among the less healthy group (married with a college degree) indicating that c-section is not always the safe choice for women who exhibit certain birth risks. More specifically, Currie and MacLeod (2008) find that the effects of tort reforms on both c-section and preventable birth complications are slightly larger and more significant among mothers without birth risk in their specification checks, although they fail to reject the equality among the coefficients.

We make contributions to the literature by examining whether the impacts of malpractice pressure on physicians' practice patterns vary by patient health condition. First, we extend Currie and MacLeod (2008)'s model that allows for variation of patient's conditions by relaxing the assumption of purely altruistic physicians. We allow for the variations of physician's response to patient's health status upon admission through disentangling physician's incentives to take more care (altruistic character), incentives to perform lucrative, quick or convenient procedures (non-altruistic character) and incentives to avoid lawsuit (pertaining to the risk associated with procedure choice). Our model predicts that the effects of tort reforms will be mostly concentrated on healthier patients. Second, we use hospital claims data provided by the Pennsylvania Healthcare Cost Containment Council (PHC4) and Health Care Utilization Project, New Jersey (HCUP-NJ) from 1994 to 2005 to empirically test our theoretical predictions. Our results suggest a statistically significant change in physician's practice pattern after reforms in tort status. Moreover, we find that most of these effects are concentrated in relatively healthy patients.

While comprehensive national examinations of tort reform are insightful, there are several strengths to focus on one state's tort reforms. First, several longitudinal studies (Kessler and McClellan 1996; Currie and MacLeod 2008; Sloan and Shadle 2009) use national data and state fixed effects to identify the impact of medical malpractice liability on physicians' practice patterns. However, in spite of the discussions around tort reform and its potential effects on medical costs, many modern tort reforms were not enacted in response to the specific concern of rising medical liability. Rather, many reforms have

been lobbied for and enacted for general personal injury, property or other interests' damages.[3] Thus, existing state-level tort laws are often heterogeneous in their focus on medical malpractice as well as in the degree of liability they expose a physician to, despite being similar in name and legal language. By focusing on one state, we can measure changes in tort liability using active/non-active status of specific tort reforms to avoid heterogeneity issues in tort legal status. A directly related advantage by doing so is that we estimate the effect of changes in *potential* tort liability. Past studies are focused on the impacts of observed tort actions to the physician (medical malpractice claim payouts or history) or in the physician's area of practice (medical malpractice insurance premium). However, if one reads trade journals, it is evident that in medicine any law changes effecting malpractice or tort law and the *potential* consequences of these changes on the physician are often highlighted. Thus, changes in the physician's behavior may happen absent being slapped with a medical malpractice suit or having insurance premiums increase due to public information on the potential effects of the change.

Second, New Jersey enacted JSL reform in the third quarter of 1995 and CPD in the last quarter of 1995, while the adjacent state Pennsylvania enacted similar JSL reform in the second quarter of 2002, and CPD for medical malpractice in the last quarter of 1996. This series of reforms allows us to use difference-in-differences (DD) specifications to estimate the causal effects of tort reform. We first by examining changes in delivery methods between 1994 and 1996 for pregnant women in New Jersey that had tort reforms

[3]For example Pennsylvania's 1997 caps on punitive damages were specifically enacted to reduce the medical liability, while the caps in New Jersey apply to all torts. Pennsylvania's 2002 joint and several liability law change was in response to alcohol serving establishment owner's concerns over being liable for bartenders serving overly intoxicated patrons.

in 1995 relative to pregnant women in Pennsylvania that did not have any tort reform during that period. Then, we note that with the enactment of tort reforms in Pennsylvania in 2002, New Jersey became a natural control state; we exploit this "reverse experiment" to confirm our earlier findings.

Third, because the tort law environment was dynamic in the two states during the period we examined, we are also able to assess the degree to which specific reforms can counteract one another when enacted within a short time interval of one another, a consideration we have not seen addressed in the literature.[4] Indeed we find the effects of these two reforms (JSL reform and CPD) countervail each other if both reforms were enacted in the adjacent quarters, which provides insights on previous insignificant findings on tort reforms especially when states enact countervailing tort reforms simultaneously.

The rest of the chapter is organized as follows. Section II reviews current tort reform literature and obstetrics practice pattern. Section III presents the theoretical model. Section IV describes the data, and empirical specifications are specified in Section V. Section VI discusses the empirical results and robustness checks. Section VII extends the discussions on the patient autonomy. Conclusions follow in Section VIII.

[4]Currie and MacLeod (2008) mentioned the potential counteractive effects of tort reforms by estimating each tort reform in separate regressions, however they did not further address the combined effects of those counteracting reforms in a short time interval.

## 2.2 Background and Literature Review

### 2.2.1 CPD and JSL Reforms in New Jersey and Pennsylvania

New Jersey and Pennsylvania were both identified as the states facing medical malpractice crises in the 1990s (Mello, Studdert and Brennan 2003). Both states also experienced tort reforms, particularly the CPD and JSL reforms, during our study period (1994-2005).[5]

Punitive damages are awarded in addition to economic and noneconomic damages in order to punish "willful or wanton misconduct or reckless indifference to the rights of others." Policymaker's interest in this type of reform is ostensibly due to the potential domino effect capping these damages would have on reigning in the increasing medical costs in the United States. First, these caps would lower the expected payout conditional upon winning a suit by taking the decision of non-economic and punitive damage awards out of the hands of juries who are thought to be more sympathetic to the plaintiffs in these cases. The secondary effect of limited caps would be that the incentive for a lawyer to advise a client to file suit would be lower if the expected payout were lower *ceteris paribus*. The tertiary effect of such a change in incentives would be that both the probability of being sued and expected limit on the payout conditional upon being sued would be lower and therefore lower malpractice premiums. Taken together, these three effects of punitive damage caps could reduce the level of liability facing by physicians.

[5] There were two other tort reforms that occurred in New Jersey well before the period for which we have data. These were contingency fees (1972) and collateral source rules (1987).

JSL rules determine the distribution of financial liability arising from tort actions in relation to culpability in the context of multiple tortfeasors. If there are multiple defendants involved in a lawsuit, the conventional JSL rule allows a plaintiff to recover full damages from any of the defendants found to have a non-zero amount of culpability, with many specifying a minimum amount of culpability to qualify under the JSL rule. For example some states will only allow a “deep pockets” approach to seeking recompense if the defendant with the “deep pockets” is found to be at least 20% culpable for the error. Prior to the modification of the JSL rule in each of the states, the so-called “deep pockets” rules were in effect. This allowed plaintiffs to collect the damages in the full amount awarded in a malpractice case from the defendant with the highest ability to pay. In the case of malpractice lawsuit faced by any physician, if there is any culpability of physician's nurse, then employer of the nurse, usually the hospital will be named in the lawsuit as one of the defendants as well. Under such a regime, physicians face lower malpractice risk because hospitals are usually the ones with deeper pockets.

The New Jersey legislature enacted JSL reform in June 1995 (the third quarter of 1995). Under the preceding JSL regime in New Jersey, the plaintiff could recover the full amount of all damages from any party that was found to be 20% or more responsible, or over 60% for non-economic damages. The 1995 reform raised the fault cutoff to 60% and over for all damages. In the case of each party's negligence being less than that amount, the respective proportion of damages would be recovered from the respective parties.

In October 1995, the New Jersey legislature enacted CPD. The specific cap was set at the greater of five times the amount of compensatory (economic and non-economic) damages or $350,000 (Public Law 1995, Ch. 142, N.J.S.A 2A: 15-5.9 *et seq*.). Besides directly capping the awards, the legislation also requires a bifurcated trial[6] when suing for punitive damages as well as convincing evidence[7] of malicious conduct.

Although the Pennsylvania legislature moved to reform their tort law later than New Jersey, some of the reforms specifically targeted medical liability. In January 1997, punitive damage awards were capped at the greater of two times the compensatory damages awarded or $100,000. Physicians and other medical providers became the only group with such protection. This legislation was repealed (Avraham 2010) and was replaced by a sweeping set of reforms in March 2002 (Kersh 2005). Confronted with ongoing debates on the issue and concerns over the perception that physicians would leave the state, the Pennsylvania legislature initiated the Medical Care Availability and Reduction of Error Act (MCARE) in March 2002 (Kersh 2005). MCARE addresses issues in patient safety, legal reform and provider malpractice insurance reconstruction with the goal of ending the malpractice crisis. For example, it claims that "if punitive damages are awarded in a medical malpractice case arising on or after March 20th, 2002, 25 percent of the awards must be paid into the MCARE Fund rather than the prevailing party." The effect of such a change reduces the payout conditional upon winning, and this

[6] "It is a separated trial that shall be conducted to determine punitive damages." (Avraham 2010)
[7] "It requires a plaintiff to show clear and convincing evidence that the defendant acted with actual malice or a wanton and willful disregard; no proof of negligence, including gross negligence will satisfy this burden of proof." (Avraham 2010)

may deter patients and their lawyers from filing for medical malpractice against physicians. Thus we consider it as a new cap on the damage awarded.

In a subsequent legislative action, the Pennsylvania legislature also modified the JSL rule in June 2002,[8] enacting the same criterion that had been put in place in New Jersey in 1995. Interestingly, the call for changes to the JSL rules enacted in Pennsylvania was not driven by medical malpractice concerns. Instead they were driven by the proprietors of bars and restaurants who were concerned about their own liability resulting from bartenders who were found to be responsible for serving additional drinks to patrons that were already visibly intoxicated. Nonetheless, the JSL modifications applied to all cases with multiple tortfeasors, including medical torts.

The CPD and JSL reforms in New Jersey and Pennsylvania are summarized in Figure 2.1. These tort reforms allow us to construct a series of "natural experiments" to examine the impacts on physicians' treatment decisions. Specifically, we will examine the New Jersey tort reforms in 1995 by comparing the outcome changes of pregnant women in New Jersey relative to the outcome changes of pregnant women in Pennsylvania that had no tort reforms between 1994 and 1996. Then we conduct a "reverse experiment" to identify the effects of JSL and CPD in Pennsylvania using pregnant women in New

[8] JSL reform was ruled unconstitutional by DeWeese v. Weaver, 880 A.2d 54, (Pa. Commonwealth. July 26, 2005) (No. 567 M.D. 2002), because it was improperly appended to another law requiring DNA samples from incarcerated felony sex offenders. In Pennsylvania, legislative riders have to be related to the purpose of the parent bill, otherwise they are considered unconstitutional. Anecdotal evidence from industry publications suggests there was substantial uncertainty as to enforceability surrounding this reform.

Jersey as a comparison group between 1996 and 1998 for the CPD reform and between 2001 and 2003 for the JSL reform.

However, there are several caveats when using Pennsylvania as a "reverse experiment" to identify the effect of CPD. First, if a specific tort reform was passed for the purpose of reducing healthcare provider's medical liability or the number of medical malpractice lawsuits, healthcare providers such as physicians and hospital administrators may change their behaviors prior to the official enactment date of such reforms. CPD reforms in 1997 and in 2002 under MCARE in Pennsylvania are potentially problematic in this regard, because they were intended to reduce medical liability. Second, the constitutionality of the CPD reform in 1997 in Pennsylvania was not as certain as those implemented in New Jersey. It was not initially clear that the caps would hold because of provisions in the Pennsylvania constitution, which limit legislative efforts to put caps on damages in tort awards. Challenges to the cap on punitive damages were successful in weakening the imposition of caps on punitive damages (Kersh 2005). In addition, these caps may be ineffective because there is little direction given to juries other than telling them that punitive damages may be awarded if the defendant's conduct was outrageous. Again, in Pennsylvania the caps on punitive damages would not hold in cases where there was willful misconduct.

### 2.2.2 Cesarean Section and Medical Malpractice

Obstetric care has a few features that make it an interesting, as well as complex, area of medical practice to study the impacts of tort reform on the provider-patient interaction as

it relates to treatment choice. First is that the initial patient-physician interaction occurs well in advance of the administration of the choice of the progression of treatment[9], thus search costs are lower than in a critical acute care situation. A correlate of this feature is that there is also an opportunity for independent information gathering as it pertains to the main treatment decision, that is, what set of conditions need to be met for the patient to attempt or continue with trial-of-labor (TOL) rather than opting for a cesarean section (C-section). A second interesting aspect to obstetric care is that there are substantial cost differences in the two treatment opinions, with C-section costing more than vaginal birth on average.[10] As Gruber and Owings (1996) indicates that physicians do responds to such financial incentives (as well as non-financial incentives such as time convenience) associated with performing a C-section.

The high C-section rates in the U.S. have also drawn a lot of attentions from researchers and policy makers. The percentage of births delivered by cesarean in the U.S. has been rising steadily in the past 15 years, from 20.7% in 1996 to a record-high of 32.9% in 2009, showing no signs of slowing (Hamilton, Martin and Ventura 2010). The cesarean section rates are much higher than the earlier recommended maximum rates of 10%-15% by World Health Organization (1985). The four leading indicators responsible for most of the rise in cesarean rates — previous cesarean, dystocia, breech presentation, and fetal

[9] We say choice of treatment progression because women generally layout a birthing plan, formally or informally, with their obstetrician, which specifies the patient's desire for pain medication and includes a discussion at what point a c-section might be considered in the event that trial of labor does not progress as planned. Of course the obstetrician has persuasive power in this plan, and even more so in its execution, particularly for women with little first or second hand experience in labor and delivery.

[10] According to a recent estimate by Thompson (2007), the expenditures for maternity care averaged $7,737 for a delivery in 2004, and $10,958 for cesarean section. The higher cost of cesarean section included $2,090 additional expenditures for the hospital stay and $723 additional payments for professional fees.

distress — are clinical grey areas (Shearer 1993) conferring the least clear-cut benefits and leaving great rooms for intrusion of non-medical considerations.[11] Recent studies suggest that "changing primary cesarean rates were not related to general shifts in mothers' medical risk profiles or patient-related reasons such as pre-pregnancy obesity, macrosomia etc. (Rhodes, Schoendorf and Parker 2003; Lu, Rouse, DuBard, Cliver, Kimberlin and Hauth 2001; Kaiser and Kirby 2001); rather, changes in obstetric practices were the major influence on the shifting pattern of primary cesarean rates" (Eugene Declercq and MacDorman 2005; Declercq, Menacker and MacDorman 2006; MacDorman, Menacker and Declercq 2011). Indeed, in economics literature, researchers have associated the cesarean section rates with physicians' greater financial incentives to perform the procedure (Gruber and Owings 1996; Gruber 1999), physicians' greater demand for leisure (Brown III 1996) and physicians' fear of being named in a medical malpractice suit.

Past literature examining the impacts of tort liability on physicians' behaviors generally regards cesarean delivery as defensive medicine. The reasoning is that most of prime areas for obstetrical litigation are associated with a failure or delayed cesarean section (Shwayder 2007). Thus, most studies examine whether the positive association between risk of liability and cesarean delivery exists. A number of previous studies have found a positive association between malpractice claims experience or malpractice insurance premiums and cesarean section rates (Tussing and Wojtowycz 1992; Localio, Lawthers,

[11] It is interesting to note that in discussing the ethics of medically elective cesareans, the American College of Obstetricians and Gynecologists (2004) states, "In the absence of significant data on the risks and benefits of cesarean delivery ... if the physician believes that cesarean delivery promotes the overall health and welfare of the woman and her fetus more than vaginal birth, he or she is ethically justified in performing a cesarean delivery.)

Bengtson, Hebert, Weaver, Brennan and Landis 1993; Dubay et al. 1999; Murthy, Grobman, Lee and Holl 2007; Yang, Mello, Subramanian and Studdert 2009; Grant and McInnes 2004), while others have found no such relationship (Baldwin, Hart, Lloyd, Fordyce and Rosenblatt 1995; Sloan, Entman, Reilly, Glass, Hickson and Zhang 1997; Baicker and Chandra 2005; Beomsoo 2007; Gimm 2010). In this chapter, we do not directly impose the assumption that C-section is defensive medicine. Instead, we make two assumptions based on medical literature in our theoretical framework described in the next section.

First, we assume the medical error rate associated with C-section is always higher than the medical error rate associated with vaginal delivery. This assumption is legitimate given that cesarean deliveries are generally associated with higher infant mortality rates (NCHS) and higher risks of maternal death (Harper, Byington, Espeland, Naughton, Meyer and Lane 2003). This positive association, to a large extent, could reflect a higher risk profile of those who experience a cesarean delivery. Nevertheless, our assumption does not distinguish whether the C-section is medically necessary. A higher medical error rate of C-section could be due to existing medical conditions that lead to both a cesarean delivery and worse outcomes. It could also be due to the risks of cesarean delivery itself. Second, we assume that the medical error rate associated with C-section relative to the medical error rate associated with vaginal delivery is larger when the patient is relatively healthier. That is, the C-section is relatively riskier for healthy patients. According to the literature, cesarean delivery on maternal request was moderately associated with: (1) an increased risk of maternal hemorrhage; (2) longer maternal length of stay; and (3) an

increased risk of neonatal respiratory morbidity (National Institute of Health 2006). Several studies published after the 2006 NIH conference provided stronger evidence showing the harms of unnecessary cesarean delivery. For example, a planned cesarean delivery is associated with a higher rate of transfer to the NICU and a higher risk for pulmonary disorders (Kolas, Saugstad, Daltveit, Nilsen and Øian 2006); higher risks of severe maternal morbidity (Liu, Liston, Joseph, Heaman, Sauve and Kramer 2007) and higher neonatal mortality rates (MacDorman, Declercq, Menacker and Malloy 2008).

## 2.3 Conceptual Framework

### 2.3.1 Basic Setup

In this study, we investigate the effects of tort reforms on C-section rate in obstetrics. Disentangling various incentives facing the physicians, we extend Currie and MacLeod (2008)'s work and construct a theoretical model that allows for the variations of the physician's behaviors that result from her patients' health conditions upon admission. The physician's reduced form utility function is defined as

$$U(s,\tau,law,p) = B(s,\tau(s,law),p) - H(s,law,p) \times e(\tau(s,law),s,p)$$

The benefit of treating a patient ($B$) depends on the patient's severity upon admission ($s$), the physician's effort in treating his/her patient ($\tau$) and procedure choice ($p$). Physician's effort ($\tau$) is a function of patient's severity ($s$) and the tort law when the patient is treated ($law$). Procedure choice $p=C$ indicates that cesarean section is performed and $p=V$ indicates that vaginal delivery is performed. A higher $s$ indicates that the patient has more medical indications that increase the risk of adverse outcomes during the delivery

process. One major difference of our model is that we introduce physician's effort into the benefit function.[12] The purpose is to incorporate physician's multifaceted, yet potentially conflicting, incentives to the process of his/her treatment decision. We assume that the benefit function has a quadratic form in patient severity. Firstly, a physician has incentives to treat healthier patients to save time and effort (non-altruistic motivation). Because $\tau_s > 0$ and $B_\tau < 0$, it implies that $B_\tau \tau_s < 0$. Secondly, a physician gains more intrinsic rewards by treating more severe patients or a physician takes patients' benefits into consideration and patients' benefit of treatment is an increasing function of patient's severity (altruistic motivation), $B_s > 0$.[13] Thirdly, physicians are more likely to comply with patient autonomy in terms of treatment choice when the patient is healthier.[14] That is, physician's altruistic benefits accruing from yielding patients' wishes decrease with patient severity, $B_s < 0$.

The physician's perceived tort liability is denoted by the product of the expected payout, given the physician is being sued ($H$) and the probability a medical error occurs (e). The expected payout is a function of the patient's health status ($s$), tort law at the time of treatment and physician's procedure choice. Independent from the tort environment, we assume that the medical error rate ($e$) is a function of physician's effort, patient's severity

[12] Similar to the theoretical model in Arlen and MacLeod (2005), the physician's effort could be viewed as a cost function for the physicians to gather information on patient health conditions and overall medical malpractice atmosphere

[13] In Currie and Macleod (2008), they simply assumed that the physician's benefit is increasing with patient severity.

[14] Patient autonomy is the right of patients to make decisions about their care absent provider influence on the decision beyond the provider's responsibility to educate patients on the different courses of treatment. There is recent intense interest in patient autonomy, particularly within obstetrics and choice of mode of delivery, e.g. Price and Simon (2009) find that response to highly publicized new medical research on VBACs is concentrated in women of higher socioeconomic status. While we do not directly address patient autonomy in this chapter, our model and empirical results have potential implications for the question of the tort environment impact on patient autonomy.

and procedure choice. Patient severity ($s$) affects the medical error rate through two potential channels: the abatement effect of physician effort ($e_\tau \cdot \tau_s < 0$)[15] and the natural error borne with certain procedure that depends on patient's severity ($e_s$). Given the physician goes forward with vaginal delivery, the medical error rate would increase with patient severity ($e_s^V > 0$), because the surgical procedure would be more medically appropriate for patients with certain birth complications. On the contrary, given the physician has chosen to perform a C-section, the medical error rate would decrease with patient severity ($e_s^C < 0$). We also assume the strength of abatement effect (effort) is always smaller than the natural error associated with each procedure ($\left|e_s^p\right| \geq |e_\tau \cdot \tau_s|$) because full elimination of medical error through physician effort would be too restrictive an assumption. Thus, the perceived tort liability is an increasing function of patient severity (i.e. $H_s + He_\tau\, \tau_s + H\, e_s > 0$) if vaginal delivery is performed. If C-section is performed, the perceived tort liability could be an increasing or decreasing function of patient severity depending on the relative magnitude of $H_s$ and $e_\tau\, \tau_s\, + H\, e_s$.

The physician will determine an optimal level of effort ($\tau^*$) in treating his/her patient by maximizing his utility, where $\tau^*$ is characterized by

$$B_\tau(s, \tau^*(s, law), p) - \, H(s, law, p) \times \, e_\tau(\tau^*(s, law), s, p) = 0.$$

Given $\tau^*$, a physician's indirect utility function of performing a C-section will be

15 Physician perceives subjectively that the probability of committing an medical error would be lower given she/her provides more effort in treating patients.

$$U^*(s, law, C) = B(s, \tau^*(s, law), C) - H(s, law, C) \times e(\tau^*(s, law), s, C).$$

The indirect utility of a vaginal delivery will be

$$U^*(s, law, V) = B(s, \tau^*(s, law), V) - H(s, law, V) \times e(\tau^*(s, law), s, V).$$

The physician chooses to perform a C-section if $U^*(s, law, C) > U^*(s, law, V)$. Otherwise, vaginal delivery occurs. Given that the benefit function is a quadratic form and the tort liability would be an increasing or decreasing function in patient severity, we assume $U^*(s, law, C)$ and $U^*(s, law, V)$, illustrated in Figure 2.2, are also quadratic in form.[16]

We make two further assumptions. First, performing C-section yields higher financial and non-financial (time convenience and less effort) returns for physicians especially when patients are relatively healthier, so we assume $U^*(0, law, C) > U^*(0, law, V)$ when $s = 0$.

Relatedly, C-section is more medically appropriate for patients with certain medical complications and treating more severe patients provides physician higher intrinsic rewards, so we assume $U^*(max, law, C) > U^*(max, law, V)$ when $s = max$. Second, we assume that $U^*(s, law, C)$ decreases at a faster rate than does $U^*(s, law, V)$ when *s* is

[16] That is, $U_s^* < 0$, when $s < \underline{s}$, where $\underline{s}$ is the severity level that physician's utility is at the minimum, and $U_s^* > 0$, when $s > \underline{s}$.

low and $U^*(s, law, C)$ increases at a faster rate than does $U^*(s, law, V)$ when *s* is high.[17] Given these assumptions and the curvature of the utility function, there exists $\overline{s}(law)_L$ in the low severity spectrum ($s < \underline{s}$) and $\overline{s}(law)_H$ in the high severity spectrum ($s > \underline{s}$) for which

$$U^*(\overline{s}(law)_L, law, C) = U^*(\overline{s}(law)_L, law, V)$$
$$U^*(\overline{s}(law)_H, law, C) = U^*(\overline{s}(law)_H, law, V)$$

Thus, in Figure 2.2, when the patient is healthy (i.e. $s < \overline{s}(law)_L$), the physician will choose to perform C-section due to higher financial returns, time convenience and less efforts. When the patient has more severe conditions (i.e. $s > \overline{s}(law)_H$), the physician will also choose to perform C-section because the procedure is more medically appropriate and the physician's intrinsic rewards is aligned with the financial incentives in this case.

### 2.3.2 Physician Effort and Tort Reforms

Given this model, we have the following propositions. Proofs are in Appendix I.

> *Proposition 1*: **The liability-increasing (liability-decreasing) tort reform will increase (decrease) a physician's effort level and reduce his/her medical error rate.**

[17] That is, $U_s^*(s, law, C) < U_s^*(s, law, V)$, when $s < \underline{s}$ and $U_s^*(s, law, C) > U_s^*(s, law, V)$, when $s > \underline{s}$.

The effect of liability increasing tort reform will increase physician's effort level regardless of physician's procedure choice. Nevertheless, the liability increasing tort reform will lead to fewer C-section performances as stated in the next proposition. To prove the second proposition, two assumptions are made. First, similar to Currie and Macleod (2008), we assume that the effect of tort law on tort liability is independent of procedure choice, which implies that the tort liability given a medical error has occurred if the physician performs a C-section is the same as when the physician performs a vaginal delivery, $H_{law}(s, law, C) = H_{law}(s, law, V)$. Second, given $\tau^*$, the medical error rate associated with C-section is always higher than the medical error rate associated with vaginal delivery, $e(\tau^*, s, C) - e(\tau^*, s, V) > 0$. We then have

*Proposition 2*: **The liability-increasing (liability-decreasing) tort reform will decrease (increase) physician's C-section performances.**

As discussed in Section 2.1, CPD reform reduces the level of liability facing by physicians and JSL reform does the opposite. Thus, we expect the CPD reform will increase physicians' C-section rates and the JSL reform will decrease physicians' C-section rates.

As mentioned above, C-section is more medically appropriate for patients with certain medical complications, and unnecessary C-section entails higher risks to mothers without such medical conditions.[18] Therefore, we assume that the difference in medical error rates

18 The criteria for low -risk childbearing established by Healthy People 2020 were: giving birth at greater than or equal to 37 weeks completed gestation (full-term) with a single baby (singleton) in a

associated with C-section and vaginal delivery is larger (smaller) when the patient is relatively healthier (sicker). That is, $e(\tau^*, \overline{s}(law)_L, C) - e(\tau^*, \overline{s}(law)_L, V) > e(\tau^*, \overline{s}(law)_H, C) - e(\tau^*, \overline{s}(law)_H, V)$. Finally we have

> *Proposition 3:* **The liability-increasing (liability-decreasing) tort reform will decrease (increase) physician's C-section performances on healthy patients more than on sicker patients.**

For some intuition on what this model adds to the literature, consider that the innovation brought about by the quadratic utility function is what it reveals about performing C-section on healthy patients (*s* is less than the cutoff value $s_L$). On this end of the spectrum altruism effects are unambiguous. Lack of physician altruism would result in more C-sections under lower liability pressure because of the financial/non-financial benefits. Alternatively altruistic physicians treating a healthy patient with a preference for C-section would likely yield to patient wishes with regard to delivery type[19].

In a high liability tort environment this altruism (in this case deferring to patient preference) would be offset by the increased risk, even if slight, of C-section over vaginal delivery. If tort liability is lowered by reform, then a model using quadratic utility would

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head down position (vertex presentation). In 2007, 26.5% of low-risk females giving birth for the first time had a cesarean delivery. Several studies (e.g., MacDorman et al. (2008), Declercq et al. (2006), MacDorman et al. (2011)) further examine cesarean rates for mothers who have "no indicated risk" for cesarean delivery by adding to more selection criteria: having none of the 16 medical risk factors (e.g., diabetes, hypertension) or 15 labor and delivery complications (e.g., fetal distress, prolonged labor) and no prior cesarean.

[19] It is documented that some women prefer c-section for medical reasons, for example maintaining the integrity of their pelvic floor, avoiding future incontinence issues, etc, as well as non-medical reasons, i.e. timing of the birth. The American College of Obstetricians and Gynecologists has published numerous guidelines and statements related to patient (i.e. mothers') choice in this matter.

predict an increase in C-section rates even in the altruistic case, because physicians would be willing to perform more C-sections. Thus, regardless of physician altruism, lower tort liability leads to more C-sections in otherwise healthy patients[20].

On the high end of the severity spectrum, a patient in distress, that is with higher $s$, provides an altruistic benefit to a physician with altruistic motives, while at the same time reducing a physician's welfare level because more effort is required to go forward with vaginal delivery in a clinically complex patient and to reduce the likelihood of medical error in such cases. However, at some level of severity, a C-section is unequivocally indicated, regardless of the level of altruism. Thus, for patients with $s > s_H$, the physician will also choose to perform a C-section because her utility rises with patient severity and is only reinforced if the physician derives an altruistic benefit from treating such patients.

On the other hand, the abatement effect of effort is smaller if the patient is relatively healthy. The probability to err on healthy patients with a medically inappropriate procedure is larger than on sick patients given the natural error rate is less reduced by the smaller effect of patient severity on physician effort level. Assuming uniformly distributed liability increase across patient severity, the liability increasing tort reform

[20] The key assumption here is that the high liability tort environment is constraining the rate of elective cesarean section below what it would otherwise be. The assumption is not crucial to the result, it simply modifies the interpretation if one is unwilling to assume this constraint. Specifically, if this assumption is not valid, it would simply indicate that the sign of the impact of reform was informative of the net effect of the tort law change between altruistic and non-altruistic motives, rather than an additive effect of the two phenomena.

will largely reduce those medically inappropriate and unnecessary invasive procedures (C-sections) on the healthy patients.

## 2.4 Data and Sample

Our main source of Pennsylvania and New Jersey tort law information is the American Tort Reform Association (ATRA). ATRA does not provide exact tort reform enactment dates, so we cross reference to Westlaw, the Summary of US Medical Malpractice Law provided on McCullough, Campbell and Lane LLP's website and Database of State Tort Law Reforms summarized by Avraham (2010) for detailed information on the tort reforms' status in both states.

Our patient level data include hospital inpatient claims records collected by the Pennsylvania Health Care Cost Containment Council (PHC4) and New Jersey Healthcare Cost and Utilization Project (HCUP) from 1994 to the second quarter of 2006. Both datasets include a comprehensive set of hospitalization records, diagnosis and procedure codes, and basic patient socio-demographic characteristics. Specifically these patient characteristics include patient age, race and ethnicity (Black, White, Hispanic, and other), patient residential zipcode, and insurance type (Medicaid, private insurance, out-of-pocket payer or other insurance). The data also include unique hospital identifiers, admission type indicator (i.e. urgent, emergent), quarter of admission, and whether the admission occurred on a weekend.

From the inpatient claim data we select pregnant women aged from 15-45 years, as this is widely considered the standard age range for fertility. We exclude patient claims with procedure codes for complications that are not intended to result in live birth such as removal of extratubal ectopic pregnancy, hysterectomy to terminate pregnancy and intra-amniotic injection for abortion, as well as patients diagnosed with one of the following cases: ectopic and molar pregnancy, pregnancy with abortive outcomes and intrauterine death. We also exclude non-singleton birth claims because C-section incidence and birth risk are generally higher for multiple births. We also exclude patients residing outside NJ and PA. Later in our robustness check, we confirm that these sample selections do not affect our results. Our final sample includes 1,400,612 singleton births that occurred in Pennsylvania and 1,199,658 singleton births that occurred in New Jersey between 1994 and the second quarter of 2006.

Table 2.1 presents means of our outcome variables and explanatory variables by the states. The cesarean section rate is higher in NJ (27.6%) than in PA (22.1%). Since our theory predicts that tort reform will have a larger impact on physician's C-section performances on healthy patients, we also run regressions by birth risks measured in terms of patients' pre-existing medical conditions and non-preventable birth, patients' age and patients' income at their county of residence. Table 2.1 shows that C-section rate is higher for mothers with pre-existing medical condition or non-preventable birth complications (46.5%), older mothers (29.8%), and mothers residing in wealthier areas (25%). With regard to explanatory variables, differences between PA and NJ are limited,

but include the proportion of Medicaid versus self-pay (in part due to different Medicaid qualification thresholds in each state).

## 2.5 Empirical Specification

We employ difference-in-differences method to estimate the effect of a specific tort reform on changes in delivery type. We first estimate the effect of CPD and JSL separately using the following equation.

$$P_{ist} = \beta_1 TORT_t + \beta_2 TORT_t \times NJ_{is} + \beta_3 X_{ist} + \eta_s + \epsilon_{ist} \quad (5)$$

The dependent variable $P_{ist}$ is the indicator for C-section for individual *i* treated by physician *s* in quarter *t*. $TORT_t$ is equal to one for the periods after CPD (3rd quarter of 1995) or JSL reform (4th quarter of 1995) in NJ. $NJ = 1$ indicates the pregnant women in New Jersey. $X_{is}$ is a vector that include patient's age, a dummy variable for black, dummy variables for admission during weekends and emergency admission, dummy variables for insurance status (private insurance and self-pay), and dummies indicating any pre-existing medical conditions and non-preventable birth complications. Finally, we include physician fixed effects $\eta_s$ to control time-invariant unobserved characteristics of physicians. All standard errors are adjusted for clustering by physician. We run the regressions using three different samples: pregnant women who were in labor and delivery within a quarter, within two quarters and within one year before and after the tort reform.

Our parameter of interest is $\beta_2$. For the JSL reform, we expect $\beta_2$ to be negative. On the contrary, we expect $\beta_2$ to be positive for the CPD reform. Since the CPD and JSL reforms are expected to have opposite effects, we jointly estimate the impacts of these reforms based on the following equation.

$$P_{ist} = \alpha_1 JSL_t + \alpha_2 CPD_t + \alpha_3 JSL_t \times NJ_{is} + \alpha_4 CPD_t \times NJ_{is} + \alpha_5 X_{ist} + \eta_s + \epsilon_{ist} \quad (6)$$

Since CPD and JSL were enacted in adjacent quarters, our samples include pregnant women who were in labor and delivery within a quarter, two quarters and one year before the CPD and after the JSL. We expect $\alpha_3$ to be negative and $\alpha_4$ to be positive.

We use the subsequent tort reforms in Pennsylvania for a "reverse experiment". Since JSL and CPD remained active in NJ when PA modified its CPD (January 1997) and JSL (June 2002), the DD estimates allow us to identify the effect of "removal of tort reforms". Specifically, we estimate the following equation using NJ as the comparison group.

$$P_{ist} = \beta_1 NOTORT_t + \beta_2 NOTORT_t \times PA_{is} + \beta_3 X_{ist} + \eta_s + \epsilon_{ist} \quad (7)$$

$NOTORT_t$ is equal to 1 for the periods before the reform in Pennsylvania. *PA* is equal to 1 for pregnant women in Pennsylvania. Because the DD estimate captures the effect of having no reform in PA, we expect $\beta_2$ to be positive for having no JSL reform, and $\beta_2$ to be negative for having no CPD reform.

There are two advantages of estimating equation (7). First, technically we can estimate equation (5) by replacing NJ dummy with PA dummy. However, it makes a stronger assumption that PA experienced the same common trend as NJ, the state that already passed the CPD and JSL. It is more legitimate to assume that PA and NJ experienced the same common trend if they have the same tort status before any law change. Second, it also avoids the endogeneity of "turning off" tort reforms. Physicians will have an incentive to change their behaviors before the "removal" because they will be subject to the new law even if the tort occurred under the old regime. Thus, Currie and MacLeod (2008) find insignificant effects if tort reforms are removed. As a reversed experiment, our estimates serve as a robustness check on the effect of enacting tort reforms.

## 2.6 Empirical Results

### 2.6.1 Basic DD Results

Table 2.2 shows the individual effects of CPD and JSL reforms in New Jersey. We test the effects of reforms within different lengths of time around the quarter in which the reform is enacted: +/- one quarter, half year and one year.

As reported in Panel A, enacting CPD in New Jersey increases C-section incidence by 0.011 percentage point in the shortest interval. This is similar to the results found in Currie and MacLeod (2008). Looking at longer time periods around the addition of CPD leads to smaller and less precisely estimated effects on C-section. While this might draw into question the initial empirical result, keep in mind that JSL reform in New Jersey occurs within 2 quarters of CPD reform, and is predicted to have a countervailing effect.

We will discuss this more in our joint estimation in Panel C. Results in Panel B reveal consistent story with our expectation of JSL reform, which increases the liability of the physician in the event of a suit. Enacted two quarters prior to CPD reform in New Jersey, JSL reform lead to a 0.0126 percentage point decline in C-section. Again, the diminishing effect of JSL could be due to the conflicting effect of CPD.

In Panel C, we show the joint effects of CPD and JSL reforms enacted in NJ in 1995. The effects of CPD and JSL on C-section rate are opposite as predicted by our theory. Moreover, it is interesting to note that the effects of both CPD and JSL persist over a long period of time on C-section choice. In a year after the reforms were enacted, the JSL reform led to a 0.012 percentage point decrease and the CPD reform led to a 0.011 percentage point increase in the C-section rate. The effects of CPD and JSL nearly cancelled out one another. These results suggest the importance to separate the effect of each individual tort reform. The overall effect of tort reforms is masked by heterogeneous effects of different reforms.

We investigate the robustness of the preceding results in Panel C to a number of alternative specifications as reported in Table 2.3. Overall the results were very robust. To conserve space, we only report the estimates +/- one quarter. The first set of sensitivity analyses uses alternative sources of within variation to identify the effect of tort reform on C-section incidence. Hospital fixed-effect models in which the standard errors are clustered by hospital (column 2) and county fixed-effect models in which the standard errors are clustered by county (column 3) yield very similar results as our

previous physician fixed-effect models. The second set of sensitivity analyses (columns 4 and 5) use different sample selection criteria. Our results do not appear to be driven by the sample inclusion criteria.

### 2.6.2 Results from Reverse Experiments

Using New Jersey as a natural control state, the reverse experiment in Pennsylvania leads to a different conclusion in the case of CPD. The coefficients in Panel A of Table 2.4 are insignificant and mostly positive. It implies that the C-section rate was higher before CPD reform in PA and CPD reform literally reduced the C-section rate, a finding that is inconsistent with our theory. As discussed in Section 2.1, the results on CPD in PA need to be interpreted with caution, because the CPD reform in PA lacked in its strength of constitutionality.

Driven by bar owners and restaurants entrepreneurs trying to reduce the number of drunk driving torts they faced, PA JSL reform is also applicable to medical malpractice, which holds the physicians more liable to the medical torts. The positive coefficient in Panel B represents that the absence of JSL reform results in a higher C-section rate in PA, which is equivalent to the statement that enacting JSL reform in Pennsylvania decreases C-section by 0.0081 percentage point. However the effect of JSL reform on C-section vanished over longer periods of time. As been discussed previously, the ongoing medical malpractice crisis in Pennsylvania during late 90s contaminated the effect of JSL reform with the passage of MCARE act in early 2002. The MCARE act seeks to lower medical malpractice risk experienced by physicians, an opposite effect to the JSL reform. In Panel

C, controlling the effects of MCARE, the effects of no JSL reform are all positive and statistically significant, suggesting that the JSL reform in PA reduced the C-section rates.

Overall, the results in NJ and PA are consistent with our theoretical prediction that the JSL reform (liability-increasing reform) reduces the C-section rates, while the CPD reform (liability-decreasing reform) increases the C-section rates. Nevertheless, the effects are relatively small. Tort reform changed, either increase or decrease, C-section rates by 2%-4% in a year after the reform. Putting JSL and CPD reforms together, the effects are almost cancelled out each other, suggesting no effect of tort reform overall.

### 2.6.3 Effects by Patients' Health

Our theoretical model predicts that the effects of tort reforms will be concentrated among the relatively healthy patients because the medical error rate on C-section without medical indication in healthy patients is higher than it would be in having them undergo vaginal delivery. Table 2.5 summarizes the effects of tort reforms in NJ on C-section use among different patient groups.

We use three characteristics to proxy patient's relative health status: (1) whether the patient has any pre-existing medical condition (risky vs. safe pregnancy); (2) young patients between 15-30 years old (young vs. old); (3) whether the patient lives in high-income area.

In columns (1) and (2), we estimate the effects of tort reforms specifically on patients with and without any pre-existing medical conditions and any non-preventable complication upon admission.[21] Consistent with our theoretical model, the effects of tort reform are concentrated among patients without any reported pre-existing medical conditions or any non-preventable complication. The physician is more likely to change his/her behavior on the margin given changes in the tort liability.

The estimates in columns (3) and (4) suggest that younger patients (aged group 15-30) are more affected by the tort reform than older mothers (30+). It has been universally recognized that age plays an important factor in evaluating the birth risk. An older mother has a higher chance to suffer from age or other factors related to age, whether she is an 'elderly primagravida' or who is giving birth to the fifth or sixth child and thus likely older in age.[22] The change of liability risk affects physicians to change the practice patterns on young patients only.

Last, we separate the patients by their residence zipcode income level in each state.[23] Patients residing in higher or equal to state median income are usually wealthier and have

[21] The pre-existing medical conditions are medically reported to present challenges and difficulties in the birth delivery practice, which are obtained from the diagnosis codes on the inpatient claim, are: malpresentation, genital herpes simplex virus, diabetes mellitus, abnormal glucose tolerance, hypertensive disorder, oligohydramnios, congenital or acquired abnormality of vagina, other congenital or acquired anomaly, phesus (anti-D) isoimmunization. Non-preventable birth complications include breech, cephalopelvic disproportion, cord prolapse, placental abruption, placenta previa and premature rupture of membrances.

[22] Medical literature provides evidence that an older woman has an increased risk of developing medical disorders such as diabetes, hypertensive disorders or fibroids. The incidence of pre-existing medical conditions rises from 5.5 % in the age group of under 29, to 11.8 % in the age group of 35+.

[23] Using zipcode level median income information from census data 2000, we divide the patients into rich and poor categories, where patients are categorized as rich if her resident zipcode median income is above her resident state median income, and vice versa.

higher education level, and thus more likely to have better prenatal care as well as more responsive to information regarding medical treatment and tort law change. These women may also be more likely to have developed preferences for the mode of delivery (Price and Simon 2009). The physicians are more likely to change their behavior in the area where the median income is higher, as suggested in columns (7) and (8). This suggests some of the effect of lowering tort pressure is potentially operating through physician altruism via being willing to yield to patient autonomy in lower tort environments.

In a lower tort liability environment, the physicians are more likely to give patient more autonomy before their due date to select a C-section.

## 2.7 Conclusion

Our theoretical model indicates that a physician adjusts her procedure use according to change in her tort liability that is created by various exogenous tort reforms. This model disentangles the various incentives facing physicians during her medical decision making process. Aside from the malpractice liability pressures, we model the physician's choice is also affected by her altruistic characteristics to treat severe patients and non-altruistic characteristics to treat healthier patients. Allowing for the variations in patient conditions and physician effort level, we predict the tort reforms may affect the procedure choice differently, and the effects are concentrated in relatively healthy patients.

We examine the effect of specific tort reform (CPD and JSL reform) on the procedure choice in the area of obstetrics using state level inpatient claim datasets, which cover

almost all the birth cases in both states. Consistent with our theoretical model, we find evidence that JSL reform reduces invasive and risky procedure by increasing physician's liability. We observe a significant reduction in C-sections. Conversely, CPD reduces both hospital and physician's malpractice liability by directly limiting patient's incentives to sue. Therefore the joint decision to have a C-section would be favored by physicians and hospitals due to financial and non-financial incentives (time convenience). Overall enacting CPD results in more C-sections.

The overall effects of tort reform on procedure choice are rather small considering the mean rates of C-section over the period are in excess of 20%. Our model is more flexible in that it allows us to examine effects along the spectrum of patient health. In this model the expansion of C-section utilization in lower tort liability environments is predicted to occur in healthy women. This is because obstetricians respond to either or both patient autonomy and their own financial and convenience incentives and perform more C-sections on healthy patients in response to lower liability exposure.

Previous models examining obstetrics practice have largely considered the financial incentives physicians have to do C-sections (Gruber 1999). Our model and empirical results are also potentially consistent with a story of patient autonomy, wherein low liability exposure legal environments obstetricians are more willing to defer to a patient's desire to undergo planned C-section for reasons other than medical need. Under the assumption that there are more women who would prefer elective C-section than are getting it due to tort concerns, autonomy and financial incentives are both working to

move use rates in the same direction in the event of liability decreasing reform. This is also consistent with Blomqvist (1991) physician agent model, where the legal environment serves to affect who the physician acts as an agent for (insurer or patient) and would predict the changes we observe. While our empirical investigation of this point is limited by the data, this point is salient to discussions surrounding the tension around patient choice and costs of care and should be investigated further. Our results suggest the incidence of C-section among the less healthy patients are unaffected by tort reform, indicating C-sections in this group may be driven entirely by medical need.

There are also limitations in our study. First, we do not fully observe patient's heterogeneity in terms of their education or health behaviors such as smoking and drinking during pregnancy. Second, because HCUP-NJ data do not assign personal identifier for each individual's hospitalization records; we are not able to track patients over time to fully identify the changes in patients' utilization of preventative treatment prior to delivery. Third, the data do not provide information with respect to physician's education, experience and malpractice claims, which might impact their personal practice pattern. Also we do not address existence of negative defensive medicine.[24] Tort reform could influence the labor supply decision of physicians in a heterogeneous manner, as well as the potential to select patients. However, we are examining a relatively short period around each reform, and the labor supply is likely slower to respond.

[24] Also known as "avoidance behavior". Physicians may refuse to treat patients or perform procedures that carry a high risk of malpractice liability, or select healthier patients in general.

Further study of the impacts of tort reform on medical practice needs to focus on the intersection of physician's behavior and patient autonomy. In addition, our research points out the need for understanding the dynamics of the tort environment. As Currie and Macleod (2008) touch on in their work, the tort reform database has many errors regarding the status of the reforms, and sometimes practices could already be covered under common law.

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Table 2.1 Means of Variables by State and Birth Risk Indicators

| | Pennsylvania | New Jersey | Patients with Any Pre-existing Medical Conditions or Non-preventable Complications | Patients without Any Pre-existing Medical Conditions or Non-preventable Complications | Patients Aged 31-45 | Patients Aged 15-30 | Patients Living in Below Median Income Areas | Patients Living in Equal to or Above Median Income Areas |
|---|---|---|---|---|---|---|---|---|
| Outcome Variables | | | | | | | | |
| C-section Incidence | 21.5% | 26.9% | 42.3% | 15.1% | 29.0% | 20.8% | 23.2% | 24.3% |
| Explanatory Variables | | | | | | | | |
| Age in Years | 27.8 | 29.0 | 28.5 | 28.3 | 34.4 | 24.5 | 26.0 | 29.4 |
| Patient Race: Black | 12.7% | 14.5% | 16.2% | 12.3% | 8.3% | 16.8% | 29.3% | 6.9% |
| Admission During Weekends | 20.8% | 20.9% | 18.9% | 21.8% | 19.7% | 21.6% | 21.6% | 20.6% |
| Emergency Admissions | 9.1% | 7.9% | 9.3% | 8.1% | 6.7% | 9.6% | 13.6% | 6.4% |
| Self Pay | 1.4% | 7.2% | 4.2% | 4.0% | 2.8% | 4.8% | 7.1% | 2.8% |
| Medicaid | 25.8% | 12.7% | 20.6% | 19.3% | 7.4% | 27.5% | 34.9% | 13.4% |
| Recorded Previous C-section | 12.0% | 13.9% | 13.2% | 12.7% | 18.6% | 9.3% | 12.4% | 13.1% |
| Pre-existing Medical Conditions | 23.0% | 25.5% | 73.9% | - | 24.4% | 24.0% | 27.3% | 22.9% |
| Non-Preventable Birth Complications | 11.7% | 12.3% | 36.6% | - | 13.0% | 11.3% | 10.9% | 12.4% |
| Observations | 1,275,630 | 1,097,039 | 776,679 | 1,595,990 | 916,227 | 1,456,442 | 702,529 | 1,670,140 |

Notes: the sample is drawn from the Pennsylvania Health Care Cost Containment Inpatient Claim Data and HCUP NJ State Inpatient Data for 1994-2004. Pre-existing medical conditions include malpresentation, herpes, diabetets mellitus/abnormal glucose tolerance, hypertensive disorder/eclampsia, oligohydramnios, incompetent cervix and other congenital /acquired, congenital/acquired abnormality of vagina, rhesus (anti-D) isoimmunization, anemia; non-preventable birth complications include breech, cephalopelvic disproportion, cord prolapse, placental abruption, placenta previa, premature rupture of membranes.

Table 2.2 Effects of Tort Reforms on C-section Utilization in New Jersey

| Variables | +/-1 Quarter | +/-2 Quarter | +/-1 Year |
|---|---|---|---|
| | Panel A: Effect of CPD in NJ (enacted in Oct. 1995) | | |
| CPD ON | 0.0110** | 0.0049 | 0.0024 |
| | [0.004] | [0.004] | [0.003] |
| R-squared | 0.441 | 0.437 | 0.432 |
| Observations | 100,658 | 204,660 | 412,954 |
| | Panel B: Effect of JSL reform in NJ (enacted in Jun. 1995) | | |
| JSL ON | -0.0126*** | -0.0064** | -0.0051* |
| | [0.004] | [0.003] | [0.003] |
| R-squared | 0.444 | 0.440 | 0.436 |
| Observations | 103,579 | 198,858 | 406,262 |
| | Panel C: Joint Estimation of the Effect on C-sections | | |
| JSL ON | -0.0125*** | -0.0117*** | -0.0122*** |
| | [0.004] | [0.004] | [0.003] |
| CPD ON | 0.0116*** | 0.0106*** | 0.0113*** |
| | [0.004] | [0.004] | [0.004] |
| R-squared | 0.442 | 0.437 | 0.434 |
| Observations | 151,049 | 252,469 | 464,719 |

All columns control for physician fixed effect. Standard errors, reported in brackets, are clustered by physician. Other control variables in all regressions include age, black, self pay, medicaid, previous c-section, emergency admission, admission at weekend, non-preventable birth complications and pre-existing medical conditions. *** p<0.01, ** p<0.05, * p<0.1

Table 2.3 Robustness Check

| | Physician FE & Cluster by Physician | Hospital FE & Clustered by Hospital | County FE & Cluster by County | Include Patients Reside outside NJ & PA | Include Multiple Births but Exclude Out-of-State Patients |
|---|---|---|---|---|---|
| JSL ON | -0.0125*** | -0.0127*** | -0.0120*** | -0.0115*** | -0.0128*** |
| | [0.004] | [0.004] | [0.003] | [0.004] | [0.004] |
| CPD ON | 0.0116*** | 0.0109** | 0.0096** | 0.0074* | 0.0113** |
| | [0.004] | [0.005] | [0.005] | [0.004] | [0.005] |
| R-squared | 0.442 | 0.444 | 0.441 | 0.438 | 0.443 |
| Observations | 151,049 | 151,094 | 151,094 | 177,716 | 151,858 |

Columns 1, 4 and 5 control for physician fixed effect, column 2 controls for hospital fixed effect and column 3 controls for county fixed effect. Standard errors, reported in brackets, are clustered by physician in columns 1, 4, and 5, clustered by hospital in column 2 and clustered by county in column 3. Other control variables in all regressions include age, black, self pay, medicaid, previous c-section, emergency admission, admission at weekend, non-preventable birth complications and pre-existing medical conditions. *** p<0.01, ** p<0.05, * p<0.1

Table 2.4 Effects of Tort Reforms on C-section Utilization in Pennsylvania – "Reverse Experiment"

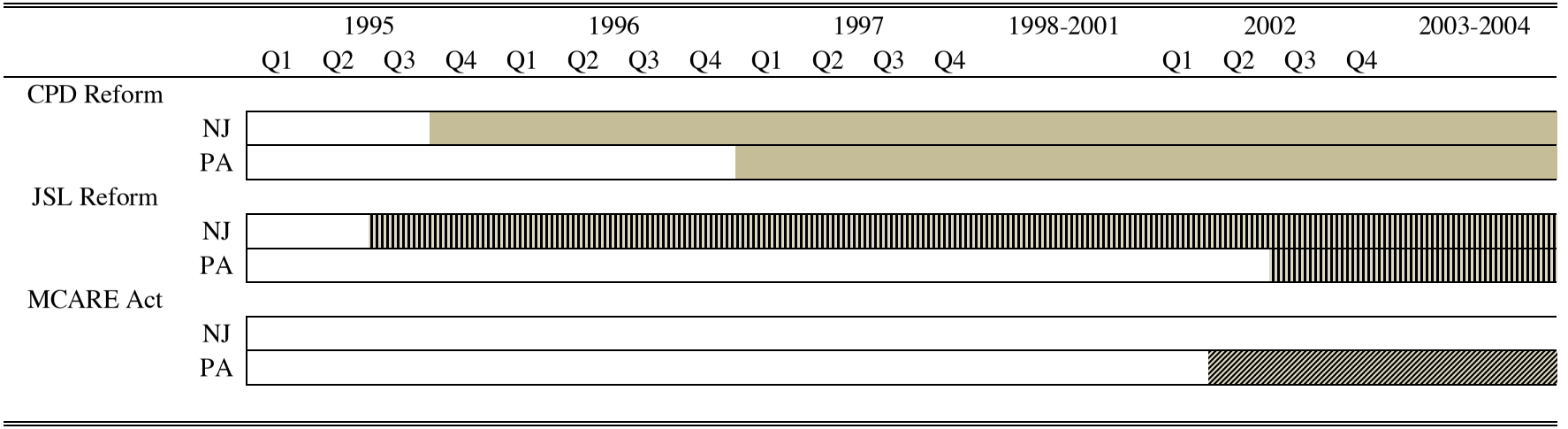
| Variables | +/-1 Quarter | +/-2 Quarter | +/-1 Year |
|---|---|---|---|
| | Panel A: Effect of CPD in PA (enacted in Jan. 1997) | | |
| CPD OFF | 0.0063 | 0.0040 | 0.0037* |
| | [0.004] | [0.003] | [0.002] |
| R-squared | 0.422 | 0.420 | 0.420 |
| Observations | 106,542 | 217,465 | 434,725 |
| | Panel B: Effect of JSL reform in PA (enacted in Mar. 2002) | | |
| JSL OFF | 0.0081* | 0.0034 | 0.0017 |
| | [0.004] | [0.003] | [0.002] |
| Observations | 0.441 | 0.442 | 0.439 |
| R-squared | 106,437 | 217,183 | 437,152 |
| | Panel C: Joint Estimation of the Effect on C-sections | | |
| JSL OFF | 0.0084** | 0.0083** | 0.0067** |
| | [0.004] | [0.004] | [0.003] |
| MCARE | 0.0095** | 0.0085** | 0.0056* |
| | [0.004] | [0.004] | [0.003] |
| R-squared | 0.443 | 0.441 | 0.436 |
| Observations | 159,329 | 274,905 | 490,894 |

All columns control for physician fixed effect. Standard errors, reported in brackets, are clustered by physician. Other control variables in all regressions include age, black, self pay, medicaid, previous c-section, emergency admission, admission at weekend, non-preventable birth complications and pre-existing medical conditions. *** p<0.01, ** p<0.05, * p<0.1

Table 2.5 Effects of Tort Reforms on C-section Utilization among Subgroups of Differing Health Status

| | Patients with Any Pre-existing Medical Conditions or Non-preventable Complications | Patients without Any Pre-existing Medical Conditions or Non-preventable Complications | Patients Aged 31-45 | Patients Aged 15-30 | Patients Living in Below Median Income Areas | Patients Living in Equal to or Above Median Income Areas |
|---|---|---|---|---|---|---|
| | | | Physician Fixed Effect | | | |
| JSL ON | -0.0075 | -0.0122*** | -0.0088 | -0.0140*** | -0.0082 | -0.0151*** |
| | [0.011] | [0.004] | [0.007] | [0.005] | [0.008] | [0.005] |
| CPD ON | 0.0029 | 0.0115*** | 0.0111 | 0.0133** | 0.0072 | 0.0142*** |
| | [0.011] | [0.004] | [0.007] | [0.005] | [0.008] | [0.005] |
| R-squared | 0.082 | 0.296 | 0.445 | 0.437 | 0.413 | 0.454 |
| Observations | 48,679 | 102,370 | 56,418 | 94,631 | 44,573 | 106,476 |
| | | | Hospital Fixed Effect | | | |
| JSL ON | -0.0061 | -0.0125*** | -0.0106 | -0.0136*** | -0.0081 | -0.0147*** |
| | [0.012] | [0.004] | [0.007] | [0.004] | [0.006] | [0.005] |
| CPD ON | 0.0016 | 0.0108** | 0.0110 | 0.0112** | 0.0025 | 0.0146*** |
| | [0.012] | [0.005] | [0.007] | [0.006] | [0.009] | [0.005] |
| R-squared | 0.086 | 0.299 | 0.446 | 94,671 | 0.418 | 0.454 |
| Observations | 48,691 | 102,403 | 56,423 | 0.438 | 44,586 | 106,508 |
| | | | County Fixed Effect | | | |
| JSL ON | -0.0064 | -0.0123*** | -0.0108** | -0.0125*** | -0.0087* | -0.0140*** |
| | [0.009] | [0.003] | [0.005] | [0.003] | [0.005] | [0.004] |
| CPD ON | 0.0049 | 0.0092** | 0.0098 | 0.0100** | 0.0017 | 0.0131** |
| | [0.010] | [0.004] | [0.007] | [0.005] | [0.008] | [0.005] |
| R-squared | 0.086 | 0.299 | 0.444 | 0.436 | 0.416 | 0.452 |
| Observations | 48,691 | 102,403 | 56,423 | 94,671 | 44,586 | 106,508 |

All columns control for physician fixed effect. Standard errors, reported in brackets, are clustered by physician. Other control variables in all regressions include age, black, self pay, medicaid, previous c-section, emergency admission, admission at weekend. Non-preventable birth complications and pre-existing medical conditions are included in columns 3 to 6. *** p<0.01, ** p<0.05, * p<0.1




*The shaded bars do not reflect the exact dat of enacting or banning the tort reforms. First quarter includes January, Feburary and MArch, and each quarter contains three sequential months.

Figure 2.1 Summary of CPD and JSL Reforms in New Jersey and Pennsylvania 1994 - 2004

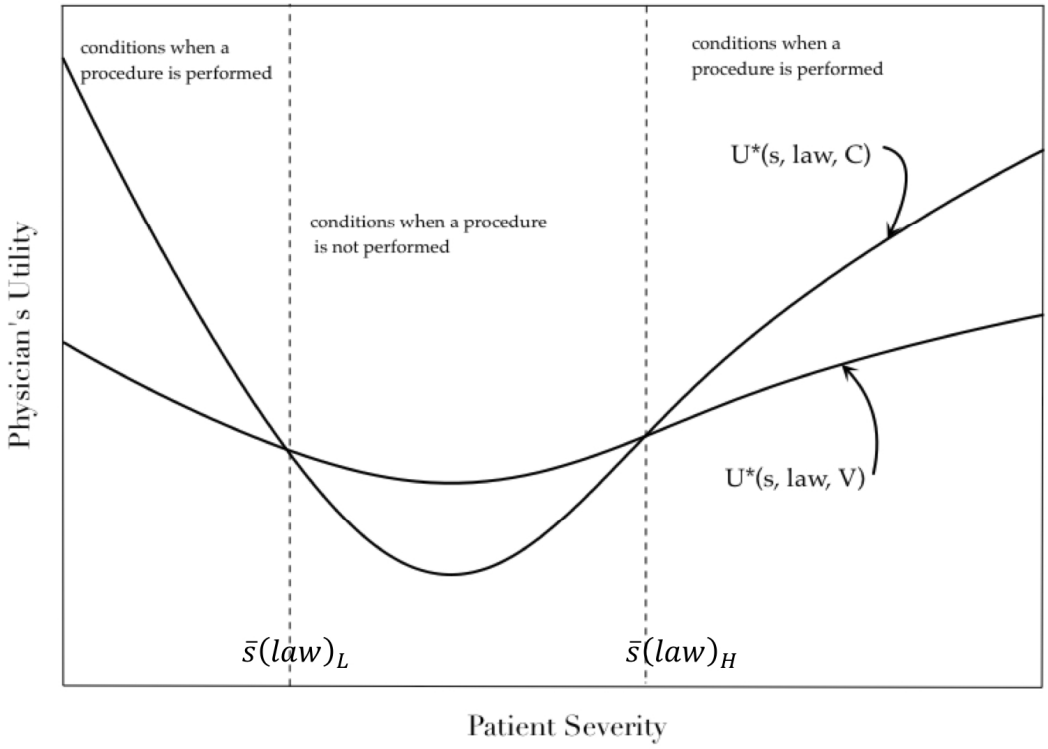



Figure 2.2 – Physician Utility Level with respect to Patient Severity upon Admission

## 2.9 APPENDIX. Mathematical Proof of Proposition

### 2.9.1 Proposition 1.

Differentiating equation (2) with respect to law,

$$B_{\tau\tau}\,\tau^*_{law} - H_{law}e_\tau - He_{\tau\tau}\,\tau^*_{law} = 0$$

$$\tau^*_{law} = \frac{H_{law}e_\tau}{B_{\tau\tau} - e_{\tau\tau}H} = \frac{H_{law}e_\tau}{U_{\tau\tau}}$$

From the second-order condition, $U_{\tau\tau} < 0$. Together with $e_\tau < 0$,

$$sign\{\tau^*_{law}\} = sign\{H_{law}\}.$$

### 2.9.2 Proposition 2.

Differentiating equations (3) and (4) with respect to law,

$$U^*_s(\overline{s}(law)_k, C, law)\frac{d\overline{s}(law)_k}{dlaw} + U^*_{law}(\overline{s}(law)_k, C, law)$$

$$= U^*_s(\overline{s}(law)_k, V, law)\frac{d\overline{s}(law)_k}{dlaw} + U^*_{law}(\overline{s}(law)_k, V, law)$$

where $k = L, H$.

$$U^*_{law}(\overline{s}(law)_k, p, law) = B_\tau\tau^*_{law} - H_{law}\,e(\tau^*, s, p) - He_\tau\tau^*_{law}$$

$$= (B_\tau - He_\tau)\tau^*_{law} - H_{law}e(\tau^*, s, p)$$

Given equation (2), $B_\tau - He_\tau = 0$,we can write

$$U^*_{law}(\overline{s}(law)_k, p, law) = -H_{law}(s, law, p)e(\tau^*, s, p).$$

$$\{U_s^*(\overline{s}(law)_k, C, law) - U_s^*(\overline{s}(law)_k, V, law)\}\frac{ds(law)_k}{dlaw}$$

$$= U_{law}^*(\overline{s}(law)_k, V, law) - U_{law}^*(\overline{s}(law)_k, C, law)$$

$$= H_{law}(s, C, law)e(\tau^*, s, C) - H_{law}(s, V, law)e(\tau^*, s, V)$$

Suppose $H_{law}(s, C, law) = H_{law}(s, V, law) = H_{law}$,

$$\frac{d\overline{s}(law)_k}{dlaw} = \frac{e(\tau^*, s, C) - e(\tau^*, s, V)}{\mathrm{U_s^*(\overline{s}(law)_k, C, law) - U_s^*(\overline{s}(law)_k, V, law)}} Hlaw$$

Suppose $e(\tau^*, s, C) - e(\tau^*, s, V) > 0$. When $s = \overline{s}(law)_L$,

$$U_s^*(\overline{s}(law)_L, C, law) - U_s^*(\overline{s}(law)_L, V, law) < 0.$$

$$sign\{\frac{ds(law)_L}{dlaw}\} = -sign\{H_{law}\}$$

When $s = \overline{s}(law)_H, U_s^*(\overline{s}(law)_H, C, law) - U_s^*(\overline{s}(law)_H, V, law) > 0.$

$$sign\{\frac{d\overline{s}(law)_H}{dlaw}\} = sign\{H_{law}\}$$

2.10 Proposition 3.

Suppose

$$|U_s^*(\overline{s}(law)_L, C, law) - U_s^*(\overline{s}(law)_L, V, law)|$$

$$\approx |U_s^*(\overline{s}(law)_H, C, law) - U_s^*(\overline{s}(law)_H, V, law),$$

Because

$$\{e(\tau^*, \overline{s}(law)_L, C) - e(\tau^*, \overline{s}(law)_L, V)\} > \{e(\tau^*, \overline{s}(law)_H, C) - e(\tau^*, \overline{s}(law)_H, V)\},$$

$$|\frac{d\overline{s}(law)_L}{dlaw}| > |\frac{d\overline{s}(law)_H}{dlaw}|$$

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# 3 Medical Malpractice Lawsuits as Bad Signals: Does the Fear of being Sued Encourage Better Quality of Care?

## 3.1 Introduction

Since the late 1990s, a nationwide crisis of "availability and affordability" of malpractice insurance has generated great research interest in whether and how suing healthcare providers for negligence or wrongdoings alters treatment decisions and intensity, which indirectly increase the cost of healthcare. Less attention, however, has been paid to the potential quality signals that medical malpractice lawsuits and jury verdicts provide about hospitals that are sued together with physicians (Morlock and Malitz, 1991). Given the information asymmetry in healthcare markets, consumers (patients) could potentially view medical malpractice and jury verdicts (on proven guilty) as a signal of bad quality of overall hospital services, and these patients might avoid hospitals that are frequently involved in medical malpractice lawsuits. If medical malpractice lawsuits increase market quality elasticity, and therefore reduce the monopoly power of hospitals in a local market, the question is whether the fear of being sued and losing in medical malpractice lawsuits drives hospitals to compete over quality.

This chapter investigates how the likelihood of being labeled with bad quality by medical malpractice lawsuits changes the nature of hospital competition in Pennsylvania and whether hospital competition in markets where likelihood to be named in malpractice lawsuits will have impact on the quality of services provided to patients who are covered by private insurance in one of the more frequently sued practices, obstetrics.

The effect of hospital competition on quality provided to privately insured patients remains an open empirical question. In theory, hospitals can both compete over quality and price among patients with private insurance; therefore whether hospital competition improves quality depends on the relative magnitude of hospital competition over quality and price. The empirical findings on the effect of hospital competition on quality also vary greatly. Many current studies focus on more severe patient conditions, such as Ischemic Heart Diseases, AMI, and pneumonia, and often draw different conclusions and implications of hospital competition (Kessler and McClellan 2000; Ho and Hamilton 2000; Gowrisankaran and Town 2003; Mukamel, Zwanziger and Bamezai 2002; Shen 2003; Sohn and Rathouz 2003; Tay 2003; Propper, Burgess and Green 2004; Kessler and Geppert 2005).

While the economic theory is clear when it comes to patients who are publicly insured (such as participants of Medicaid and Medicare), the effect of hospital competition on quality provision can be ambiguous when the firms (hospitals) set the price and quality simultaneously[25] as is the case with private insurance. Economic theory points out that the effect of competition on quality depends on the changes in the price and quality elasticities of the market for privately insured patients. On the one hand, it predicts that hospital competition may reduce medical treatment if hospitals compete heavily on price and therefore decreasing profit margins may adversely affect health outcomes (Encinosa and Bernard, 2005). On the other hand, hospital competition may also improve the

[25] The effect of hospital competition among Medicaid patients (fixed price) on quality is unambiguous: quality improves as long as the price margin (decreasing with increasing competition) is non-negative (Gaynor 2005).

quality of care if public information about quality serves as an incentive for hospitals to compete along the quality dimension (Dranove and Satterthwaite 1992).

This paper makes three contributions to the literature. First, unlike others, this study focuses on one of the largest hospital practices, obstetrics, which is also highly influenced by the nationwide medical malpractice crisis (2001-present) in the United States between 1995 and 2005. Second, to measure market competition, this paper uses the Herfindahl-Hirschman Index (or HHI), which is predicted by a discrete choice model, separately for each insurance type, using information about distance, hospital characteristics, patient characteristics, particularly patient medical conditions and childbirth characteristics (such as having previous C-sections or not) that are observable prior to delivery, and factors that determine patient hospital choice. Third, this paper is the first in the literature to study the impact of quality information revealed by lawsuits for medical malpractice on the effect of hospital competition for privately insured patients.

Overall, I find that hospital competition improves quality. Hospitals in more competitive markets use resources more efficiently and provide better care. They also have greater incentives to encourage physicians to perform more C-sections, but the empirical evidence suggests that hospital competition increases C-sections only among patients who exhibit certain medical conditions that may complicate birth delivery. Because medical malpractice lawsuits could potentially indicate that the hospital (or its associated physicians) being sued was of poor quality, and the number and size of jury verdicts suggest the likelihood of being sued, hospitals located in markets where negative jury

verdicts are both larger and more frequent may have a stronger incentive to improve their quality (compared to hospitals in markets where negative jury verdicts are less likely). If hospitals compete with each other, such stronger incentive may also encourage hospitals to compete more heavily by providing better care.

Specifically, I examine the effect of hospital competition on procedure choice, health outcomes and hospital resource use both before and after the enactment of Medical Care Affordability and Reduction of Error (MCARE) Act in 2002. I find that the likelihood of being involved in malpractice lawsuits affects hospital competition, plausibly because information about bad quality could be conveyed to the market by the lawsuits. This finding is particularly interesting because it provides insight into the potential directions for current tort reform debates on the reduction of medical malpractice cost.

MCARE Act included a comprehensive set of medical malpractice liability reforms and was enacted in 2002 to deal with the ongoing medical malpractice crisis in Pennsylvania. Several steps were taken to reduce healthcare providers' medical malpractice liability by making filing a lawsuit more difficult and by providing public medical malpractice insurance against unusually large damage awards. MCARE also aims to improve patient safety and to reduce medical errors by using stricter guidelines for reporting medical errors and by creating a state agent, Patient Safety Authority[26], to collect information on existing medical errors.

[26] For details on the Patient Safety Authority, please refer to its website: http://patientsafetyauthority.org/Pages/Default.aspx

The rest of the chapter is organized as follows. Section II reviews institutional background including the literature on the effects of hospital competition on obstetrics, and the effect of medical malpractice liability on hospital competition. Section III presents a conceptual framework. Section IV discusses the calculation of HHI. Section V explains the sample selection process. Section VI presents the empirical model and Section VII discusses the results. Section VIII concludes.

## 3.2 Institutional Background

### 3.2.1 Literature on hospital competition

Although the "Structure-Conduct-Performance" approach to studying the effect of competition on quality has been popular, it suffers from the endogeneity of the measures of market competitiveness[27] (Kessler and McClellan 2000; Gowrisankaran and Town 2003; Tay 2003; Gaynor 2005). One example of the endogeneity is that hospitals in a more competitive market tend to attract sicker patients, which may negatively impact the overall quality of health care provided by the hospitals in that area when patient severity is not adjusted for.

When a firm sets its own price (in the absence of *perfect* competition), theory indicates that the effect of competition depends on the relative change of the elasticity of quality and the elasticity of price, with the cost of quality held constant. A number of studies that find a positive impact from competition have argued that more competitive markets

[27] Another important issue is whether the competition across different payers (main government payers and private insurers) are separable. Most studies focusing on Medicaid and Medicare implicitly assume the demand and cost of those two types of markets are separable.

usually have higher quality elasticity (Sari 2002). Using Los Angeles county secondary discharge data, Gowrisankaran and Town (2003) find that risk-adjusted mortality for HMO acute myocardial infarction and pneumonia patients is significantly lower in more competitive markets, which implies that competition could be quality increasing. Sohn and Rathouz (2003) also study patients receiving percutaneous transluminal coronary angioplasty (PTCA) surgery in California and find that mortality is lower for patients in hospitals facing more competition.

One counterargument to the quality enhancing effect of competition is that competition may reduce quality because it may reduce hospital profit margin. This profit trimming effect of competition is especially of concern when it comes to the current payer-driven competition. Encinosa and Bernard (2005) examine the impact of hospital financial pressure on patient safety. They find higher incidence of adverse safety events among financially stressed hospitals, which implies that competition that reduces hospital profit margin could have negative impact on patient health outcomes. Mukamel, Zwanziger and Bamezai (2002) find that the introduction of selective contracting leads to more price competition, lower clinical expenditures and higher mortality. Consistent with Dorfman and Steiner's model (1954), they suggest that selective contracting has increased the price elasticity of demand face by hospitals more than the quality elasticity that leads to a decline in quality. Outside the U.S. setting, Propper, Burgess and Green (2004) find that mortality increases with the number of competitors in the United Kingdom.

### 3.2.2 Hospital Competition in Obstetrics

C-sections have both greater financial returns and more non-financial conveniences for physicians and patients than vaginal delivery. There are several reasons why opting for a C-section, especially a planned C-section, is preferred by hospitals. First, the prevalent C-section rate (30% in 2007) nationwide in the modern health care reveals that the public is more tolerant than ever to such a major surgical procedure. This is partially because the public is unaware of the potential harms of C-sections[28]. Second, vaginal delivery takes much more time for caregivers and requires using the birth room longer. Third, equipped with the advanced modern technology in birth delivery (such as labor induction, continuous electronic fetal monitoring), physicians and hospitals often prefer not to offer patients informed choice of vaginal birth especially for mothers with certain medical conditions because they fear medical malpractice lawsuits. Finally, aside for the greater reimbursements to physicians and hospitals that accompanies C-sections, organizing and utilizing hospital resources (such as birth rooms, device use, physician and staff work schedule) is easier in C-sections than when women undergo trial-of-labor (TOL), and this is especially true for planned C-sections.

### 3.2.3 Hospital Medical Malpractice Liability in Pennsylvania

As long as negligence occurs within a hospital, the victim may be able to sue the hospital and the physician jointly. In some cases, a hospital can be charged when any physician or any nurse who is an employee of the hospital commits negligence. In general medical

[28] In the previous chapter, I discussed a list of potential harms that could occur with C-section. For more detailed information, please refer to the article on Childbirth Connection's Website: http://www.childbirthconnection.org/article.asp?ck=10456.

malpractice lawsuits (in obstetrics) against hospitals are often brought up for their employees' failure to monitor fetal heart rates, to provide standard medical assistance,[29] or to advise obstetricians of medical status, which may result in a delay in performing an emergency C-section. Historically, hospitals in Pennsylvania were also sued for mismanagement of labor and improper discharge from the hospital. When the physicians are employed by a hospital, the hospital is often involved in the medical malpractice lawsuits when the physicians deviate from the standard of care and harm the patients and their infants.

The MCARE of 2002 in Pennsylvania also officially adds ostensible liability as a grounds for medical malpractice lawsuits, so that the hospital can be charged with ostensible liability if a reasonable person would believe that the physician was an agent of the hospital and if the care the victim received was represented as being provided by the hospital or an agent of the hospital.[30] Further, conventional corporate liability sometimes also applies to medical malpractice. In one case involving birth delivery in a hospital by a midwife who was not an employee of the hospital but was retained by the patient's HMO, the plaintiff sued the hospital for "failure to have a protocol in place requiring the midwife to obtain an obstetrician when labor complications were encountered and that the hospital failed to enforce applicable standards or to oversee the care of the patients" on the grounds of conventional corporate liability theory that the defendant hospital was responsible for the care rendered to its patients whether or not such care was rendered by a hospital employee.

[29] Webster vs. Lower Bucks Hospital, et al. Case no. 0503038-12-2; Judge Clyde W. Waite, 07-19-11.
[30] Statutes before MCARE are similar.

Hospitals are frequently sued. One study on Maryland hospital medical malpractice claim experience by Morlock and Malitz (1991) shows that hospitals are sued in 72% of the claims (10% as the only defendant and 62% as one of multiple defendants) for events that occurred within the hospital.[31]

Hospitals are frequently involved in medical malpractice lawsuits probably because of the "deep pocket rule", or the joint and several liability (JSL) rule, both of which expose hospitals to greater medical malpractice liability because hospitals usually are financially more capable (or even lucrative from the perspective of plaintiff lawyers) of paying for medical malpractice damages, compared to other tortfeasors (physicians and nurses). Under the conventional JSL rule, once a verdict is ordered, the named hospital has to cover the whole award if the hospital is proven to be more capable of paying even if it is only 10% liable for the adverse event, at a cost of dramatic increases in its medical malpractice insurance premiums and thinning profit margin. This practice is known as the "deep pocket rule".

JSL reform bans the application of the "deep pocket rule" unless the tortfeasor is 60% liable for the medical malpractice. While JSL reform has proven to significantly affect physician behavior (Currie and MacLeod 2008), it actually also incentivizes hospitals to provide a higher level of care. If the adverse incidences are highly correlated with lower quality of care, improving care standards within the hospital may reduce its medical

[31] Particularly in labor-delivery lawsuits, hospitals are the only defendant in 4% of the claims and one of the multiple defendants in 69% of the claims.

malpractice liability, because the threshold to be fully responsible for the damages award is raised to 60%. That being said, the JSL reform introduces greater potential opportunities for hospitals to use the increase in quality of care as evidence against negligence and avoid liability.

Overall, losing a medical malpractice lawsuit may affect hospital behavior in two ways. First, the direct effect is the costs to realize court ordered payout and associated administrative expenses, both of which affect hospital profit margins. However, the direct impact of medical malpractice liability costs is small[32] because almost all hospitals are covered by state and commercial insurance, which covers the majority of the payouts. Although this leaves defendant hospitals with higher medical malpractice insurance premiums in the future,[33] much of the increase in medical malpractice insurance premium rates is determined by the overall market and the clinical services offered such as community-specialty based rating (Mello, 2006).

Second, being sued or losing a medical malpractice lawsuit could damage the defendant hospital's reputation and thus could affect the defendant hospital's future demand. Similar to the impact of bad report card ratings for hospitals, medical malpractice lawsuits, especially those with large size verdicts, are usually widely broadcast in the news, on the Internet, and via other media. More interestingly, medical malpractice claims against defendant hospitals may signal poor quality of overall hospital services,

[32] Medical malpractice liability counts for 2.67% of hospital's medical service revenue (http://www.phc4.org/reports/researchbriefs/050205/nr050205.htm).
[33] Until 2006 there is only about 25% of hospital medical malpractice insurance that is experience rated in Pennsylvania.

where negligence could be interpreted as lack of care to the patients or inadequate management of safety protocols. In markets where hospitals are more likely to suffer from reputation damages (frequently sued and higher medical malpractice verdicts are ordered), it may be reasonable to assume that hospitals care about quality, balancing between potential loss of consumers and higher costs of providing appropriate level of care (as well as risk management).

One concern for defendants in medical malpractice lawsuits is that plaintiff lawyers are likely to venue shop. The plaintiff lawyers could file their medical malpractice claims in any county where any of the defendants is conducting business in an attempt to shop for friendlier courts, where they may have better chance to win the lawsuits and extract higher compensation. Prior to March 2002, the plaintiffs were able to choose where to file suit, especially when multiple defendants were involved.[34] However, venue shopping is a smaller concern in this study because of the nature of obstetrics. Most of the patients received obstetric services near their home residence (prenatal care, physician visits, and antenatal care) and do not travel long distances to deliver because of the uncertainty between the time of contraction and delivery. Therefore the full advantage of venue shopping is limited because of the geographical limits of obstetric services. Although this does not completely rule out the possibility of cross-county deliveries (where patients may be living on the border of a jury-friendly county and received delivery-related care in that county, which significantly reduces the transaction costs of venue shopping), I will include those border counties as jury-friendly counties to conduct a robustness check.

[34] This also explains the small proportion of medical malpractice claims filed against hospitals only in Morlock and Malitz (1991).

## 3.3 Conceptual Framework

Theory used previously on airline companies shows that price and quality are determined simultaneously when firms set prices; however, in the theory of the effect of hospital competition on the quality of services provided to patients covered by private insurance, models relying on different assumptions give different predictions (Spence 1975; Shaked and Sutton 1983; Motta 1993). Whether hospital competition among privately insured patients will improve quality or not is an empirical question.

Among economic models on the quality effect of hospital competition, Dorfman and Steiner's (1954) model on a monopolist's choice of price and advertising provides some insight into the effect of competition in the monopolistically competitive hospital markets. Considering a monopolist's demand could be approximated as a residual demand facing a monopolistically competitive firm (Dranove and Satterthwaite 2000), the Dorfman and Steiner (DS) condition indicates that the optimal quality when the firm sets its prices is a function of price ($p$), cost of quality ($d$), and the ratio of quality elasticity ($\epsilon_z$) ($z$ indicates quality) and price elasticity of demand ($\epsilon_p$):

$$z = \frac{p}{d} \times \frac{\epsilon_z}{\epsilon_p}.$$

Its implication on whether competition will increase or decrease the hospital quality, where quality depends on the relative changes in both quality and price elasticity of demand, is unclear. Having more competitors in a hospital market means a patient has more options from which to choose her caregivers based on her preferences for the price

and quality a hospital offers. In other words, by giving the patients more options, competition may increase both quality elasticity and price elasticity of demand in hospital markets. As discussed in the previous section, medical malpractice lawsuits may reduce hospital profit margins, which may encourage hospital price competition and may also send signals of bad quality to the market, where hospitals could gain more customers by offering higher quality of care and steer away from being frequently involved in malpractice lawsuits.

## 3.4 HHI Calculation

To deal with the endogeneity of the market competitiveness measures in the conventional regression analysis of the quality "Structure-Conduct-Performance," this paper adopts a similar strategy as that used by Kessler and McClellan (2000), calculating the Herfindahl-Hirschman Index (HHI) using weighted hospital shares predicted by a discrete choice model of individual patients. In this discrete choice model, the distance to each hospital that is in a patient's choice set is a key variable. As an extension to Kessler and McClellan's model, I estimate patient's preference with respect to distance first among Fee-for-Service patients, and then apply the estimates coefficients to all the private insured patients to calculate predicted probabilities for each individual patient to choose a hospital within her choice set. Assuming patients covered by private insurance behave similarly in choosing her hospital, this HHI is not subject to provider network constraints in some private insurance.

This method uses two steps to construct HHIs at the zipcode level. In the first step, an individual-hospital-insurance specific probability is estimated using a conditional logit model in which a patient having a certain Fee-for-Service insurance (private insurance including Blue Cross and other commercial insurance) is assumed to choose any hospital within 25-miles[35]. The neighborhood is constructed based on the distance between two zip codes – one for the patient's home residence and the other for the hospital. In the second step, I sum up the predicted probabilities by hospital and by zipcode to get HHIs at zipcode level.

The reason to use only Fee-for-Service (FFS or indemnity plan) patients in the conditional logit estimation for each insurance type is that those patients are least limited to the insurance networks that are popularly used in HMO, PPO, or others, which validates the method's assumption that distance to hospital is essential in a patient's choice for his or her hospital. Assuming the patients with the same type of insurance will have similar preferences in choosing her hospitals, I then use all the coefficient estimates in the conditional logit model of each insurance FFS type to predict each hospital's share of all the patients living in a patient's zip code for each insurance separately, and the overall individual-hospital specific probabilities are summed across the entire market.

There are three steps to compute the market level HHIs for each insurance type. First, I aggregate the predicted demand for each hospital by the zip code of each patient's home residence; second, the zip code-level predicted HHI is aggregated by hospital; finally, the

[35] The 25-mile radius includes at least 90% patients for any hospital, and in the sample the patients on average travels less than 10 miles to the admitting hospital.

hospital specific HHI is aggregated and weighted to the zipcode using the estimated probability of a hospital being chosen by those living in the patient's residential zip code.

Therefore, the predicted HHIs will capture three types of variations. First, there are variations in the size of hospital markets through hospital openings, closures and mergers; second, variations in HHIs could also result from changes in a potential patient's decision to attend a hospital based on her distance to the hospital;[36] third, changes in the population distribution may also change the predicted HHIs.

## 3.5 Empirical Specifications

### 3.5.1 Empirical Model

The hypotheses that I will test are whether hospital competition affects: (1) procedure choice; (2) patient health outcomes; and (3) hospital resource use. The regression model is the following:

$$D_{ijkt} = \beta_1 C_{kt} + \beta_2 M_{kt} + \beta_3 P_{ijkt} + \lambda_j + \gamma_c + \tau_t + \epsilon_{ijkt}$$

where $D_{ijkt}$ represents three types of outcomes: (1) procedure choice (a binary variable indicating C-section or vaginal delivery), (2) patient health outcomes, and (3) hospital resource utilization (logarithm of CPI-deflated hospital expenditures) for individual patient *i* attended by physician *j* at quarter *t* in market *k*. $C_{kt}$ is a vector of hospital market competition measures, which is calculated using the probabilities predicted by the

[36] In each insurance category for each quarter, patient's preference parameters for choosing a hospital also vary by patient's pre-existing medical conditions and whether she is a case of previous c-section or multiple pregnancies.

conditional logit model. $M_{kt}$ is a vector of weighted market characteristics variables, $P_{ijkt}$ is a vector of patient characteristics, $\gamma_c$ is a set of the county dummies, $\lambda_j$ is a set of physician dummies, and $\tau_t$ is a set of quarter dummies.

I use five different measures for the quality of hospital service at the market level. Patient's procedure choice at the time of delivery: $D_{ijkt}$ equals one if the patient had a C-section and zero if the patient had a vaginal delivery. Preventable birth complications are major adverse events in the area of obstetrics, because most of the preventable birth complications could be avoided if the physicians or hospitals provide more effort. The health outcome dummy $D_{ijkt}$ equals one if the patient exhibits any of the following ten preventable complications: maternal fever, excessive bleeding, maternal seizure, precipitous labor, prolonged labor, dysfunction labor, anesthetic complications, fetal distress, uterine rupture during labor, and choriamnionitis.

Considering medical malpractice liability and incentives (financial and non-financial) associated with particular procedure choice, I also interact the procedure choice with a health outcome dummy to define a more medically appropriate and less risky procedure if the patient receiving a C-section exhibits none of preventable birth complications listed above, and a medically less appropriate and more risky procedure when the patient delivering vaginally exhibits any of these preventable birth complications. The last measure is hospital resource use represented by the patient's total hospital expenditure, which is the logarithm of the CPI-adjusted (based on 1994 Medical CPI) individual level total hospital charges.

Hospital market competition is measured by the Herfindahl-Hirschman Index, which measures market concentration level using the sum of squares of each firm's market share within a geographical area. As noted in the previous section, the HHIs in this study are calculated using the predicted market share for each hospital for each individual patient residing within 25 miles radius (distance between zip code centroids) of the hospital in each quarter, assuming the importance of travel distance for birth deliveries, in addition to the hospital quality and patient preferences. The predicted probabilities are then aggregated from the entire market and weighted to the zipcode level. Thus, the predicted market shares are exogenous. Further, because of the potential non-linear effects of market competition, I divide HHIs across the whole sample period (1995-2005) into four quartiles to measure the competition of the market at the zipcode level. HHI quartiles also vary by quarter $t$ and zipcode $k$.

Patient characteristics included in the regression model are: age, race/ethnicity, referral source (physician referral, transferred from another hospital), admission information (day of week), admission source (normal admission or admitted from emergency department), admission type (normal admission or emergency admission), and insurance type (Blue Cross and other commercial insurance). PHC4 claims data also provides information on patient diagnosis and procedures received during the hospital visit. One of the challenges in an obstetrics study using hospital claim data is that it is difficult to observe any preventive treatments that a pregnant woman received prior to her delivery admission. Therefore, to capture the variation in terms of patient pre-admissions health status, I

identify ten pre-existing medical conditions[37] that may complicate the delivery process from individual patient's ICD9 diagnosis codes, as well as six non-preventable birth complications[38] that could not be successfully avoided by more effort the physicians or hospitals provide, as a set of proxy variables for patient health conditions prior to delivery.

Other market characteristics included in the regression model are weighted with predicted patient flow to control for impacts other than competition and avoid the endogeneity problems using admitting hospital characteristics (patient self-selection). Other market characteristics (at the zip code level) included in the regression model are weighted percentage of teaching hospitals, weighted percentage of hospitals contracted with HMOs, weighted percentage of mid-sized hospitals (hospital bed size ranges from 200 to 400) and large-sized hospitals (bed size over 400), and percentage of hospitals having established women health centers. To control for variations that might result from the entry and exit of hospitals in some markets, I also include the predicted market shares for hospital markets with any new entrances and exits for each quarter.

Several studies use HMO enrollment as a measure of price competition in the market, where the managed care organizations selectively contract with healthcare providers to pay lower prices. Hospitals are more likely to trade price margin for the additional market

[37] Pre-existing medical conditions include malpresentation, herpes, diabetets mellitus/abnormal glucose tolerance, hypertensive disorder/eclampsia, oligohydramnios, incompetent cervix and other congenital/acquired anomaly, congenital/acquired abnormality of vagina, rhesus (anti-D) isoimmunization, anemia, and habitual aborter.
[38] Non-preventable birth complications include breech delivery, cephalopelvic disproportion, cord prolapsed previa, abruptio placenta and premature rupture of membranes.

share that could be brought by contracting with a large payer. Therefore markets with lower HMO enrollment rates are more likely to engage in quality competition (Kessler and McClellan 2000). The effect of competition on cost containment will likely be higher in more competitive markets. To control for the managed care influence, I include county level HMO penetration rates in the regression model.

To deal with the effects of unobservables on individual physician quality and practice patterns, county-level time-invariant characteristics and time trend, I use the individual physician fixed effects, county fixed effects and quarter fixed effects in the regression model.

To test whether medical malpractice liability will encourage hospitals to engage in quality competition, I interact the competition dummies with a dummy indicating the level of jury friendliness at the county level. $J_{HL}$ equals one if juries in medical malpractice law courts in hospital market *k* are usually more sympathetic towards victims (patients) and often decide verdicts in favor of the victims, and zero otherwise. $J_{LL}$ equals one if juries in the hospital market *k* are less in favor of the victims. The revised regression model is the following:

$$D_{ijkt} = \beta_1 C_{kt} * J_{HL} + \beta_2 C_{kt} * J_{LL} + \beta_3 M_{kt} + \beta_4 P_{ijkt} + \lambda_j + \gamma_k + \tau_t + \epsilon_{ijkt}.$$

County-level jury verdict records reflect the medical malpractice liability for obstetricians and hospitals. The frequency and size of medical malpractice verdicts reflect how

sympathetic juries are towards plaintiffs. Hospitals in a county where juries are more sympathetic to plaintiffs, in most cases patients, are more likely to require the defendants to pay larger awards. Even though defendant hospitals are most likely to be covered by their insurance, quality information conveyed by the large verdicts are inevitably and often widely broadcast to the public, which can harm the reputations of defendant hospitals. Because consumers are better informed of adverse events that occurred in hospitals, hospitals in jury friendlier markets are more likely to compete in quality, especially those who have been sued and lost the lawsuits. To retain the loss in market share, defendant hospitals could either provide higher quality of care or cut their prices for their services.

The larger the size of the jury verdict, the greater the impact the medical malpractice lawsuit could have on the market quality elasticity. In this case, I measure the market jury friendliness by the size of verdicts at the county level (and counties in the upper 50 percentile of total jury verdict number during 2000-2003). As a robustness check, I also use two alternative measures for the medical malpractice liability: (1) any county with one verdict that is more than 1 million US dollars during 2000-2003; (2) any county with ten or more verdicts during 2000-2003.

The first alternative is a stronger measure for the impact of information about bad quality conveyed by large size verdicts (over one million dollars), cases in which many victims suffer from disability (employment unsuitability for women, or cerebral palsy for infants). Therefore a larger damage is assumed to affect quality elasticity more

significantly. The second alternative selects those counties where there were more than ten jury verdicts during 2000-2003, and measures the effect of quality information if hospitals in those markets frequently lose a medical malpractice case.

Figure 3.1 lists detailed county level jury verdicts in Pennsylvania between 2000 and 2003.[39] Overall the number of jury verdicts is divided into four quartiles, with the level of dark shades indicating the level of jury friendliness. The darkest gray shades represent the counties with the friendliest juries (more than ten jury verdicts) and counties with white shades have one or no jury verdicts.

As the average lawsuit process may take a long time[40] from filing to the point at which the jury reaches a verdict, it is appropriate to use the 2000-2003 verdict information for this study period (1995-2005).

## 3.6 Data and Descriptive Statistics

Hospital characteristics are obtained through the American Hospital Association Survey of hospitals from 1995 to 2005. The dataset identifies hospital teaching status, ownership, hospital beds, ultrasound services, service specialties (general/medical/surgical and ob-gyn services), women health center services, and if the hospital has formal contracts with any HMO. In the hospital sample, I exclude hospitals with fewer than five birth claims per quarter.

[39] 2000-2003 is the earliest jury verdict data provided on Pennsylvania's Unified Judicial System's webpage (http://) on the medical malpractice lawsuits.
[40] On average, it takes about four to five years to resolve a claim from the date of an adverse incident.

Patient-level information is derived from Pennsylvania in-hospital claim data provided by Pennsylvania Healthcare Cost Containment Counsel (PHC4) from the corresponding period (1995-2005). The claims are collected through standard medical billing information, which consists of patient's personal information (personal ID, age, race/ethnicity, and home zip code), admission information (admitted hospital, admission date, admission source/type), insurance type, and the full set of diagnosis and procedure codes. The study sample includes Pennsylvania[41] women with a valid personal ID and aged between 15 and 45 who were covered by Blue Cross and other commercial insurance and gave birth to a single child[42] during the first quarter of 1995 and the last quarter of 2005. The entire sample includes 875,969 privately insured patients.

HMO market penetration information is obtained from the Pennsylvania Department of Health. It summarizes the total number of HMO enrollments in each county each year, as well as the market penetration rates (using total population in the county as denominator).

Pennsylvania medical malpractice jury verdict data is from the website of the unified judicial system of Pennsylvania for the period of 2000-2003. The data contain information on the numbers and categorical amounts of defense verdicts, and jury and non-jury medical malpractice verdicts.[43]

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41 Patients whose home residence is outside Pennsylvania are excluded from the sample.
42 Because abortion is legal in Pennsylvania, I also exclude patients with abortive outcomes from the sample because it is difficult to identify if the patient self intended for the abortive procedure.
43 The verdicts do not reflect post-trial settlements or actions of an appellate court. They are not actual payouts. Detailed information could be found at: http://www.aopc.org/Links/Media/MedicalMalpractice/default.htm.

Table 3.1 presents summary statistics for patients and hospital markets characteristics by market competitiveness. Panel A of Table 3.1 reports patient sample characteristics. The most competitive markets account for almost half of the patient sample (48.9%). While statistics on patient procedure choice and health outcomes across all the markets are similar, average hospital expenditure in the most competitive markets is almost twice as large as that in less competitive markets. This suggests that hospitals in more competitive markets may use more resources to treat their patients. Patients in more competitive markets are older, and there are also more black and/or Hispanic patients in more competitive markets. Admission characteristics across the markets are also similar, except that more patients have emergency admissions or are admitted through the emergency department in more competitive markets.

The average distance to the closest hospitals or average distance to the admission hospitals reflects the level of competitiveness in the market. The difference between the two indicates that patients are likely to choose a hospital other than the closest hospital to her home residence for birth delivery. Although distance is important in time of delivery, patients do select hospitals based on their preference for other characteristics.

Panel B of Table 3.1 summarizes Pennsylvania hospital market characteristics by market competitiveness. Entrant and exit market shares are relatively smaller in more competitive markets. Small size hospitals (<200 beds) are prevalent across all the markets, and large hospitals are more likely to exist in more competitive markets.

Competitive markets also have more teaching hospitals. Hospitals in more competitive markets are more likely to contract with HMOs.

## 3.7 Empirical Results

### 3.7.1 Overall effects of hospital competition

Table 3.2 reports the effects of hospital market competition on procedure choice, health outcomes, and hospital resource use among privately insured patients during the sample period (1995-2005). The most concentrated or the least competitive markets is a base group (omitted group). All regressions control for individual physician fixed effects, county fixed effects and quarter fixed effects.

Column 1 reports that more C-sections are performed in more competitive markets, and many C-sections occurred without any incidence of preventable birth complications, as indicated in column 2. Also hospitals in more competitive markets have fewer vaginal deliveries that accompanied one or more preventable birth complications. Overall, hospital competition is quality improving. Hospitals in more competitive markets on average have about 1% fewer preventable birth complications incidence, which does not come at a price of significantly more hospital resources being used in the treatment of patients[44]. As noted in the theory, competition may both increase quality and price elasticity. The estimates imply the overall effect of hospital competition increases the quality elasticity more than the price elasticity. The significant estimates among the very

[44] Estimates are adjusted with different procedure choice for the large differential in reimbursement rates between C-section and vaginal delivery.

competitive and competitive markets confirm that price is less of an issue among privately insured patients (only to their insurance providers), to whom a good C-section (without any adverse events on health outcomes) would be more preferred since utilization reviews are not common in birth delivery choice.

Table 3.2 also reports the effects of other market characteristics on the variables of interest. Overall markets with higher percentage of teaching hospitals have lower C-section rates, higher rates of preventable birth complications, and use less hospital resources. Plausibly patients are more likely to be diagnosed with some level of preventable birth complications because teaching hospitals are more equipped with advanced technology and high quality physicians. Markets with more large-size hospitals (more than 200 beds) are more likely to perform C-sections, especially good ones, suggesting that larger hospitals tend to use their capacities efficiently to perform more good C-sections when confronted with thinning profit margins at a time of a medical malpractice crisis and managed care cost containment pressure. Also markets with more large hospitals have lower level of preventable birth complications and use significantly more hospital resources on patients.

Hospital market competition due to hospital entry reduces C-section incidence and preventable birth complications without employing significantly more hospital resources, which reveals the quality improving effect of hospital competition through another perspective. Equally interesting, estimates on hospital markets with more exiting competitors suggests slightly negative impact on patient health outcomes.

### 3.7.2 Effect of hospital competition in markets with differing medical malpractice liability pressure

One major research question of this study is to address the effect of competition when the medical malpractice liability is prevalent in the marketplace. Table 3.3 reports separate estimates on the effects of hospital market competition interacting with the county level of jury friendliness in medical malpractice lawsuits. Specifically, I measure the county level medical malpractice pressure using as a dummy whether the county is in the upper 50 percentile of total jury verdict number across all the counties.

Although medical malpractice litigation may only impose a small financial burden to the hospitals, such as administrative expenses, damage payouts[45] if awarded, and potential increase in hospital medical malpractice premiums, it sends out disastrous quality indications to the market which possibly damage the defendant hospital's reputation severely. The size of awards is likely to be positively correlated with the magnitude of such damage. Counties with friendlier juries are more likely to award verdicts to the victim[46], especially those large size verdicts that usually enjoy greater publicity in the media. Therefore I assume that hospitals competing in the markets with friendly juries are more concerned with the quality of their health service, in fear of more and larger awards and greater damage to their reputations. If markets with friendlier juries are more

[45] The size of payout is a complex matter, which depends on the defendant hospital's insurance policy. The defendant hospital may up to its deductible.
[46] During the period 2000-2003 in Pennsylvania, the average number of verdicts ordered among the counties with friendlier juries is about 37.47 cases per county compared with 1.34 cases per county among less friendly counties.

concerned with quality, which is more likely to have higher quality elasticity of demand, hospitals will engage in more quality competition where the effect of competition will increase quality. Estimates in Table 3.3 provide consistent evidence on this hypothesis. Facing higher medical malpractice liability, hospitals in more competitive markets perform more good C-sections and the preventable birth complications are 1% lower than in those most concentrated markets. Competition also drives hospitals to employ more hospital resources in treating their patients when their medical malpractice liability is higher. By contrast, the effects of hospital market competition are less significant in the markets where juries had never ordered a verdict that is larger than one million dollars.

One very important point that I make here is that the results in Table 3.3 are not a recommendation to create more medically liable hospital markets and thus are not in favor of high and frequent lawsuits involving medical malpractice, but rather they are an emphasis on the increased quality elasticity due to competition, given the argument that medical malpractice lawsuits serve as indicators of poor quality that influence the public when choosing healthcare providers. The unintended consequence for a hospital to be in a market where medical malpractice lawsuits are frequent and juries are much friendlier to the plaintiffs is that that hospital is more motivated to compete over quality because the net benefit of improving quality outweighs the net benefit of reducing price[47].

[47] If thinning profit margin leads to lower quality of care provided (Encinosa and Bernard, 2005), hospitals in more medical liable market may also be more subject to the additional medical malpractice costs (reputation damages) due to the lower quality of care.

### 3.7.3 Would hospital competition drive the hospitals to treat patients of differing health conditions accordingly?

Patient's specific medical conditions are often factored into the joint decision of procedure choice in delivery. As many malpractice lawsuits use failure to perform an in-time C-section as grounds for lawsuits and evidence against the defendants[48], C-sections are medically appropriate for patients who exhibit certain medical conditions prior to delivery. Table 3.4 provides evidence that the effects of hospital market competition on procedure choice mostly affect patients who have certain medical conditions where medical malpractice pressure is higher in the market. Facing higher medical malpractice pressure, hospitals in more competitive markets perform more C-sections to patients who have any of the previously discussed medical conditions or non-preventable birth complications. However, hospitals do not seem to treat their patients differently. Both patient groups (healthy and sick) in more competitive markets where medical malpractice liability is higher experienced lower preventable birth complications, and hospitals in those markets used more resources, compared to the effects of competition in the markets where medical malpractice liability is lower.

Hospital competition also does not differ much among patients with a previous C-section and those have never had a C-section. Table 3.5 reports the estimates on these two subsamples. Consistent with previous findings, hospitals engage in quality competition in markets where medical malpractice liability is higher. However, there is no significant practice pattern across markets with different levels of competition suggested by the

[48] As listed by many medical malpractice law firms, failure to perform an in-time C-section as one of the common delivery errors that could be used as grounds of a lawsuit.

procedure choice and hospital expenditures. Overall hospitals do not differentiate patients by whether the patient has a previous C-section as hospital competition improves quality in both groups.

### 3.7.4 What Happened to Hospital Competition if Liability is Lower and Reporting Quality Information is Easier? Effect of MCARE in Pennsylvania

MCARE in 2002 took significant steps to improve patient safety and reduce medical errors. The majority of measures taken have focused on the collection and availability of quality information from the healthcare providers within the state. For example, under MCARE, a new Safety Authority is created collect information on medical errors, which is also being collected by the state health department. Medical facilities are required to notify patients affected by a serious event in writing within seven days and the state Medical Board is granted with more authority to investigate reports of serious provider error. Physicians are required to report various offences, including liability complaints, to the Medical Board. It also prohibits retaliation against health care workers reporting serious events. Such enforcement has significantly reduced the transaction costs of reporting adverse events, which plausibly would make healthcare providers in the market more aware of the quality of care they provide due to the fact that MCARE has made the adverse event reporting mechanism much clearer and quality information is potentially more widely available to the public.

I investigate the effects of hospital competition before and after the enactment of MCARE in 2002, where the results are reported in Table 3.6. Prior to 2002, hospitals

engaged in quality competition in the counties where the probability to be sued for an adverse event was higher. Competition overall slightly reduced the incidence of C-sections, as C-sections are relatively risky for both mothers and infants. Also prior to 2002, health outcomes (vaginal birth with complications and preventable birth complications) were better in more competitive markets. With clear guidelines on adverse event reporting after 2002, competition continues to improve quality more significantly, especially in the markets where the threat of a medical malpractice lawsuit is higher. Together with findings in Table 3.4, hospitals in more competitive markets start to perform more C-sections on less healthy patients who exhibit one of the listed medical conditions or non-preventable birth complications after MCARE reduces the healthcare providers' medical malpractice liability. According to the Institute of Medicine's report on medical errors (To Err is Human 1999), both physicians and hospitals have more incentives to avoid the potential adverse event that had been made more easily reportable. Besides the high frequency of failing to perform a C-section cited in medical malpractice lawsuits, performing a C-section on patients with certain medical conditions reduces the probability of more birth complications later on if vaginal delivery is chosen. One thing to notice is that, although mothers in more competitive markets may be more likely to request a C-section due to work and other reasons[49], their healthcare providers (mainly physicians) still serve as a joint decision maker, who will be likely to turn down the request if the stakes of performing a maternally requested C-section is too high, especially when the patient is healthy (Currie and MacLeod 2008). Consistent with Table 3.6, estimates on the procedure choice before 2002 do not show a significant pattern that

[49] Also currently there's no empirical evidence on the rising trend of maternal requested C-section (Declerq 2006).

mothers in more competitive markets have more C-sections and the surge of C-section rates occurred right after the MCARE enactment, which provides evidence on the formal case that MCARE increases hospital incentives to perform more C-sections to reduce the potential birth complications among the less healthy patients.

### 3.7.5 Robustness Check

To provide evidence that the paper's findings do not vary with the definition of jury friendliness, I also use two alternative measures of jury friendliness to investigate the effect of hospital competition with the specification (2). The findings are consistent with the main jury friendliness definition as suggested by Table 3.7. Using different geographical definitions for jury friendliness also suggests that venue shopping does not pose a significant threat to this study due to the nature of regionalized birth markets. Patients are less likely to travel long distance to receive birth care for the purposes of shopping for a potential jury venue that is friendlier to the plaintiffs.

As another robustness check, I also use various fixed effects to check if the results are affected by other unobservables. Table 3.8 reports consistent estimates on the major quality variable (preventable birth complications).

## 3.8 Conclusion and Discussion

This study examines the impact of medical malpractice lawsuits on the effect of hospital competition in one of the most common but understudied hospital services: obstetrics. During the period 1995-2005, hospital competition among hospitals in Pennsylvania is

overall quality improving, as suggested by lower preventable birth complications, lower adverse vaginal births, and complication-free C-sections. Medical malpractice lawsuits serve as a hazardous quality indicator of overall hospital services, which affects potential hospital market share. In the markets where hospitals are more likely to be involved in medical malpractice lawsuits, especially those with large verdicts, hospitals compete more on the quality, as patients in those markets are more likely to be aware of the quality of care being offered. The paper also finds that hospitals do not compete based on the severity of patients and quality improvement due to competition appears to be the same for both the healthy and less healthy patients. The paper does not find any difference between patients who had a previous C-section and those who had not.

Another interesting finding is the effect of hospital competition on procedure choice in obstetrics. Overall more C-sections are performed in more competitive markets. Providing evidence against the hypothesis that maternally requested C-sections are more likely to occur in cities where competition is stronger, this paper finds that competition significantly increases the incidence of C-section among less healthy patients, and argues that the increase in C-section rates due to healthcare providers' adaptation to the quality-driven competition atmosphere after MCARE lowered the transaction cost of reporting adverse events. Easier access to quality information (mostly from adverse events) has encouraged healthcare providers to deviate from the standard practice and to become more risk averse, and therefore perform more C-sections among less healthy patients to reduce the chance of potential birth complications.

The case of MCARE proposes a very interesting direction for current medical malpractice liability reform debates. A medically more liable hospital market has showed its potentials to excel in quality if competition is prevalent in this market. Hospitals compete for higher quality in the fear of being involved in a medical malpractice lawsuit that could potentially send information about bad quality to the market. Considering that MCARE imposes guidelines to report quality information while reducing all healthcare providers' medical malpractice liability, the similar effects of competition on incidence of preventable birth complications before and after 2002 suggest that availability of quality information and medical malpractice liability might be substitutes. However, the latter one is frequently cited as one of the main drivers for the current drastically increasing healthcare costs.

## 3.9 Limitations and Discussion

One major limitation in this study is that the conditional logit model requires the Independence of Irrelevant Alternative (IIR) assumption — it assumes that the patient makes choices by comparing only two hospitals at a time. The method could be improved by using mixed logit or nested logit models.

Different quality and resource use enters patient's utility function differently especially in this study. I use medical malpractice lawsuit as one of the quality information indicator. However, the jury verdicts reports are collected at the county level during 2000-2005, and they do not indicate a specific hospital name, physician name/license, or zip code.

More variation may be available if I have detailed medical malpractice lawsuits/jury verdict information to calculate the market competitiveness measure.

Although I have used various quality indicators such as stillborn incidence, maternal death, readmission within one year, unnecessary C-section and vaginal birth with medical conditions, I have only been able to find significant changes on the preventable birth complications. The patient level quality indicator lacks variation probably because of the less severe nature of obstetric practice.

Personal practice patterns of physicians differ, which may influence patient treatment decisions greatly. The hospital market measure perhaps may also account for the physician influence by including the physician characteristics.

## 3.10 Appendix: HHI calculation

### 3.10.1 Predict Individual Probability of Hospital Choice

Each individual patient *i* covered by insurance *o* (Blue Cross or other commercial insurance) has a chance to choose hospital *j* from *j* hospitals within 25 miles of her residence (center of her home zipcode) by maximizing an indirect utility function of the form

$$U_{ij}^{o} = V_{ij}^{o} + W_{ij}^{o} + \varepsilon_{ij}^{o}$$

where $V_{ij}^{o}$ and $W_{ij}^{o}$, the deterministic components of the utility function for insurance type *o*, are variables representing hospital and patient's characteristics. Let $\varepsilon_{ij}^{o}$ denote patient *i*'s (with insurance *o*) unobserved preference for hospital *j*. We assume $\varepsilon_{ij}^{o}$ follows the generalized extreme value distribution.

$V_{ij}^{o}$ is a vector of variables included to measure differences among the hospitals in a patient's choice set with respect to travel distance and three other hospital characteristics: number of beds, whether it has women health center, and whether it is a teaching hospital. I first identify the closest hospital *j*' with any characteristics *h* to each patient's zip code: this is the reference hospital with characteristic *j*. Then each hospital *j* that exist the patient's choice set is compared to the reference hospital in the dimension of characteristics *h*. First, I calculate how much further a patient must travel to each hospital *j* beyond the reference hospital in order to enjoy the specific hospital characteristics *h*, as well as their difference in distance to patient i's home zipcode, or

relative distance with respect to characteristics *h*. Second, I separate the relative distances when the characteristics *h* of choice hospital is the same as the reference hospital, from the relative distances when they are different in terms of characteristics *h*, since the former one indicates the cost for the patient to obtain the same characteristics *h* from a hospital that is further away from her residence and the latter is a trade-off for her to enjoy some characteristics that the nearest hospital does not provide.

I then group the relative distance variables, drawing boundaries at the twenty-fifth, fiftieth and seventy-fifth percentile of the distribution of the respective relative distances to create same/different-type quartile dummies, and interact the same/different-type categories with same/different-type relative distance quartiles. Assuming a linear and additively separable function of such interactions between hospital characteristics and relative distance, we have

$$V_{ij}^{o} = \sum_{h=1}^{H} DD_{ij}^{h+}\left[\theta_1^h Z_{ij}^h + \theta_2^h\left(1 - Z_{ij}^h\right)\right] + DD_{ij}^{h-}\left[\theta_3^h Z_{ij}^h + \theta_4^h\left(1 - Z_{ij}^h\right)\right];$$

where $DD_{ij}^{h+}$ and $DD_{ij}^{h-}$ are same/different-type relative distance quartiles, respectively, and $Z_{ij}^h$ is a vector of dichotomized hospital characteristics including bed sizes (<200 beds, 200 beds to 400 beds, >400 beds), teaching status, whether the hospital have formal contract with a HMO and woman health center. The vector $[\theta_1^h, \theta_2^h, \theta_3^h, \theta_4^h]$ is the parameter of interest. A graphic description of the comparison scheme could be illustrated as follows:

| Choice Hospital | j has same characteristic | j has different characteristic |
|---|---|---|

| Reference Hospital | | |
|---|---|---|
| Given j' has character $Z_{j'}^{h} = 1$ | $\theta_1^h$ | $\theta_4^h$ |
| Given j' has character $Z_{j'}^{h} = 0$ | $\theta_2^h$ | $\theta_3^h$ |

In a conditional logit, I observe a single patient making a choice among hospitals with different characteristics: the individual patient's characteristics are obviously the same as they consider the different hospitals and cannot be entered as separate variables. However, we can include the possible effect of patients' characteristics on their choice of hospital by interacting them with different hospital characteristics. Thus, I also consider patient's average preferences on different hospital characteristics by interacting each patient's characteristics with hospital j's characteristics:

$$W_{ij} = \sum_{h=1}^{H} X_i \, Z_j^h \beta_h; \qquad (3)$$

$X_i$ is a vector of patient i's characteristics (gender, ethnicity/race, admission type, pre-existing medical condition, multiple pregnancy, previous c-section, etc). Therefore, $\beta_h$ controls for patients' average response or preferences to hospital j's characteristic h.

From McFadden (1978, 1981), assuming the generalized extreme value distribution implies that the conditional choice probability is given by:

$$\hat{\pi}_{ij} = \Pr(Y_{ij} = 1) = \frac{e^{\hat{V}_{ij} + \hat{W}_{ij}}}{\sum_{j \in J} e^{\hat{V}_{ij} + \hat{W}_{ij}}};$$

Then, we can estimate the vector $\theta$ and $\beta$ by maximizing the log-likelihood function:

$$\log l = \sum_{i=1}^{N} \sum_{j=1}^{J} \log \hat{\pi}_{ij} \ ;$$

The patient samples are estimated year by year from 1995 to 2005 where we allow different effects of different years.

### 3.10.2 Constructing HHIs

Given patients' indirect utility function maximized through the conditional logit model, we predict a patient's probability ( $\hat{\pi}_{ij}$) of attending the hospitals. We construct the Herfindahl-Hirschman Index based on observable, exogenous characteristics of patients and hospitals as in Kessler and McClellan (2000). First, we calculate the market share of each hospital j in each zip code k area by summing the predicted patient flow for hospital j over all the market shares of hospitals in area k.

$$\alpha_{jk} = \frac{\sum_{i \epsilon k} \hat{\pi}_{ij}}{\sum_{j=1}^{J} \sum_{i \epsilon k} \hat{\pi}_{ij}};$$

Thus, if we assume that hospitals "are able to differentiate among patients based on their zip code of residence," then the predicted HHI for patients residing in zip code k is

$$HHI_k^{pat} = \sum_{j=1}^{J} \hat{\alpha}_{jk}^2 ;$$

However, it is more realistic to presume that hospitals compete over "the total demand for hospital services from all nearby areas." So we must measure the share of a hospital's predicted demand coming from a given zip code

$$HHI_j^{hosp} = \sum_{k=1}^{K} \hat{\beta}_{kj} * HHI_k^{pat};$$

where

$$\hat{\beta}_{kj} = \frac{\sum_{i \in k} \hat{\pi}_{ij}}{\sum_{i=1}^{N} \hat{\pi}_{ij}};$$

represents the share of hospital j's predicted demand coming from zip code k.

But ultimately, we use another measure as our HHI; one which is "based on the vector of average expected probabilities of hospital choice in the patient's zip of residence." We define it as follows

$$HHI_k^{pat^*} = \sum_{j=1}^{J} \hat{\alpha}_{jk} * HHI_j^{hosp};$$

Following this transformation of $\hat{\pi}_{ij}$, we obtain a competition metric that functions just like the more traditional HHI. $HHI_k^{pat^*}$ is bounded below by zero and above by one; additionally, $HHI_k^{pat^*}$ is decreasing in competition. Although this measure is significantly more empirically intensive than the standard fixed or variable radius indices, $HHI_k^{pat^*}$ is formulated through exogenous determinants of hospital demand, and thus not subject to the endogeneity with respect to hospital outcomes. In other words, changes in $HHI_k^{pat^*}$ originate from three sources: variations in the sizes of hospital markets – through openings, closures and mergers, changes in a potential patient's decision to attend a hospital based off of distance, and changes in the distribution of patient population.

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Table 3.1a Descriptive Statistics of Patient Characteristics, Hospital Characteristics and Market Structure over 1995 - 2005

| | Most Competitive | Very Competitive | Competitive | Less Competitive |
|---|---|---|---|---|
| ***Panel A: Patient Characteristics*** | | | | |
| *Resource use & health outcomes* | | | | |
| C-section Incidence | 23.67% | 22.84% | 23.17% | 23.79% |
| C-section w/o Preventable Birth Complications | 19.21% | 18.58% | 18.43% | 19.06% |
| Vaginal Birth w/ Preventable Birth Complications | 7.81% | 7.09% | 9.43% | 7.83% |
| Any preventable birth complications | 12.27% | 11.36% | 14.18% | 12.56% |
| Total Hospital expenditure* | $ 9,993.01 | $ 5,281.06 | $ 4,780.62 | $ 4,163.49 |
| *Admission characteristics* | | | | |
| Age group 1: 15-25 | 18.64% | 24.70% | 26.85% | 29.59% |
| Age group 2: 26-35 | 65.13% | 63.07% | 62.04% | 60.52% |
| Age group 3: 35 and above | 16.23% | 12.23% | 11.11% | 9.90% |
| Patient race: Black | 12.32% | 2.50% | 2.70% | 1.20% |
| Patient ethnicity: Hispanic | 3.52% | 2.31% | 2.24% | 0.94% |
| Patient is referred by physicians, clinic or HMO | 97.52% | 98.08% | 98.67% | 98.38% |
| Admission on fridays | 15.20% | 15.36% | 15.69% | 15.98% |
| Admission on weekends (Saturday/Sunday) | 20.49% | 19.48% | 20.05% | 20.12% |
| Emergency admissions | 7.24% | 10.17% | 6.51% | 3.47% |
| Admission via emergency department | 2.19% | 1.33% | 0.86% | 0.70% |
| Blue cross | 53.73% | 60.11% | 56.76% | 59.04% |
| Commercial Insurance | 46.27% | 39.89% | 43.24% | 40.96% |
| *Distance variables* | | | | |
| Distance to the closest hospital (miles) | 2.91 | 4.88 | 5.56 | 6.08 |
| Mean distance to admission hospital (miles) | 6.41 | 9.46 | 10.78 | 14.34 |
| Number of Patients | 428467 | 168635 | 168354 | 110513 |

Preventable birth complications includes one or more of the following: maternal fever, excessive bleeding, maternal seizure, precipitous labor, prolonged labor, dysfunction labor, anesthetic complications, fetal distress, uterine rupture during labor and choriamnionitis. The whole sample includes patient aged 15-45 covered by blue cross or commercial insurance who gave birth in a hospital that have at least five birth deliveries per quarter during 1995 and 2005, and all the patients selected are singleton births.

Table 3.1b Descriptive Statistics of Patient Characteristics, Hospital Characteristics and Market Structure over 1995 - 2005

| | Most Competitive | Very Competitive | Competitive | Less Competitive |
|---|---|---|---|---|
| ***Panel B: Market Competitiveness Measure (HHI) & Weighted Other Hospital Market Characteristics*** | | | | |
| Average Market HHI | 0.195 | 0.386 | 0.494 | 0.670 |
| Entrant Market Share | 0.043 | 0.092 | 0.123 | 0.165 |
| Exiter Market Share | 0.047 | 0.064 | 0.084 | 0.075 |
| Teaching status | 0.311 | 0.177 | 0.121 | 0.060 |
| Formal contract with an HMO | 0.637 | 0.597 | 0.453 | 0.373 |
| Hospital size (<200 beds) | 0.490 | 0.602 | 0.735 | 0.830 |
| Hospital size (>=200 and <400 beds) | 0.299 | 0.286 | 0.181 | 0.139 |
| Hospital size (>= 600 beds) | 0.212 | 0.112 | 0.084 | 0.032 |
| Contain woman health center | 0.535 | 0.456 | 0.307 | 0.207 |

Preventable birth complications includes one or more of the following: maternal fever, excessive bleeding, maternal seizure, precipitous labor, prolonged labor, dysfunction labor, anesthetic complications, fetal distress, uterine rupture during labor and choriamnionitis. The whole sample includes patient aged 15-45 covered by blue cross or commercial insurance who gave birth in a hospital that have at least five birth deliveries per quarter during 1995 and 2005, and all the patients selected are singleton births.

Table 3.2 Effects of Hospital Competition on Procedure Choice, Health Outcome and Hospital Resource Use among Privately Insured Patients

| | C-section | C-section without Any Preventable Birth Complications | Vaginal Birth with One or More Preventable Birth Complications | Preventable Birth Complications | Total Hospital Expenditure |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Most Competitive | 0.0096*** | 0.0086*** | -0.0080** | -0.0081** | 0.0079 |
| | [0.003] | [0.003] | [0.003] | [0.004] | [0.012] |
| Very Competitive | 0.0048** | 0.0060*** | -0.0098*** | -0.0115*** | 0.0137 |
| | [0.002] | [0.002] | [0.003] | [0.003] | [0.009] |
| Competitive | 0.0032 | 0.0025 | -0.0004 | 0.0000 | -0.0002 |
| | [0.002] | [0.002] | [0.002] | [0.002] | [0.006] |
| Teaching status | -0.0463*** | -0.0578*** | 0.0681*** | 0.0850*** | -0.3945*** |
| | [0.015] | [0.016] | [0.017] | [0.020] | [0.057] |
| Formal contract with an HMO | -0.0105 | -0.0067 | 0.0004 | -0.0022 | -0.1564*** |
| | [0.008] | [0.008] | [0.009] | [0.011] | [0.034] |
| Hospital size (>=200 and <400 beds) | 0.0377*** | 0.0445*** | -0.0534*** | -0.0646*** | 0.4640*** |
| | [0.011] | [0.012] | [0.012] | [0.014] | [0.050] |
| Hospital size (>=600 beds) | 0.0363* | 0.0602*** | -0.1053*** | -0.1334*** | 1.1276*** |
| | [0.021] | [0.021] | [0.023] | [0.028] | [0.095] |
| Contain woman health center | -0.0046 | -0.0175* | 0.0340*** | 0.0474*** | -0.1295*** |
| | [0.010] | [0.009] | [0.011] | [0.013] | [0.043] |
| Entrant Share | -0.0097** | -0.0045 | -0.0096** | -0.0136** | 0.0110 |
| | [0.005] | [0.004] | [0.005] | [0.005] | [0.014] |
| Exit Share | -0.0036 | -0.0102** | 0.0000 | 0.0070 | -0.0440** |
| | [0.005] | [0.005] | [0.005] | [0.006] | [0.017] |
| HMO Penetration Rate | -0.0006*** | -0.0009*** | 0.0004*** | 0.0007*** | -0.0010* |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.001] |
| C-section Choice | | | | 0.1160*** | 0.5500*** |
| | | | | [0.003] | [0.005] |
| Blue Cross | 0.0032*** | 0.0029*** | -0.0002 | -0.0003 | 0.0286*** |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.002] |
| Observations | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 |
| R-squared | 0.441 | 0.381 | 0.018 | 0.055 | 0.438 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on Fridays, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). All regressions also control non-preventable birth complications and pre-existing medical conditions, and include quarter fixed effects, county fixed effects and physician fixed effect. Column 4 and 5 also control for the procedure choice of current delivery. The robustness standard errors are clustered at the individual physician level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. *** p<0.01, ** p<0.05, * p<0.1

Table 3.3 Market Concentration, Jury Friendliness and Health Outcomes

| | C-section | C-section without Any Preventable Birth Complications | Vaginal Birth with One or More Preventable Birth Complications | Preventable Birth Complications | Log(Total Hospital Expenditures) |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| **D1=(Friendly Juries): Higher Medical Malpractice Liability** | | | | | |
| Most Competitive*D1 | 0.0108*** | 0.0119*** | -0.0106*** | -0.0130*** | 0.0131 |
| | [0.003] | [0.003] | [0.004] | [0.005] | [0.014] |
| Very Competitive*D1 | 0.0061** | 0.0094*** | -0.0127*** | -0.0167*** | 0.0194* |
| | [0.003] | [0.003] | [0.004] | [0.004] | [0.012] |
| Competitive*D1 | 0.0041* | 0.0050** | -0.0025 | -0.0038 | 0.0033 |
| | [0.002] | [0.002] | [0.002] | [0.003] | [0.008] |
| **D2=(Unfriendly Juries): Lower Medical Malpractice Liability** | | | | | |
| Most Competitive*D2 | 0.0028 | -0.0019 | -0.0041 | 0.0002 | 0.0001 |
| | [0.011] | [0.011] | [0.009] | [0.011] | [0.018] |
| Very Competitive*D2 | 0.0023 | -0.0014 | -0.0034 | 0.0000 | -0.0003 |
| | [0.004] | [0.004] | [0.003] | [0.004] | [0.012] |
| Competitive*D2 | 0.0020 | -0.0008 | 0.0024 | 0.0049 | -0.0044 |
| | [0.003] | [0.003] | [0.003] | [0.003] | [0.008] |
| Observations | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 |
| R-square | 0.441 | 0.381 | 0.018 | 0.055 | 0.438 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on Fridays, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). All regressions also control non-preventable birth complications and pre-existing medical conditions, and include quarter fixed effects and physician fixed effect. Column 4 and 5 also control for the procedure choice of current delivery. The robustness standard errors are clustered at the individual physician level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. D1 (higher medical malpractice liability) is one if the county has one jury verdict higher than one million dollars during 2000-2003. *** p<0.01, ** p<0.05, * p<0.1

Table 3.4 Market Concentration, Jury Friendliness and Health Outcomes among Patients of Differing Health Conditions

| | C-section | | Preventable Birth Complications | | Log(Total Hospital Expenditures) | |
|---|---|---|---|---|---|---|
| | Healthy | Sick | Healthy | Sick | Healthy | Sick |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **D1=(Friendly Juries): Higher Medical Malpractice Liability** | | | | | | |
| Most Competitive*D1 | 0.0041 | 0.0242*** | -0.0149*** | -0.0093 | 0.0108 | 0.0155 |
| | [0.004] | [0.006] | [0.005] | [0.007] | [0.014] | [0.015] |
| Very Competitive*D1 | 0.0014 | 0.0158*** | -0.0166*** | -0.0173*** | 0.0199 | 0.0172 |
| | [0.003] | [0.005] | [0.004] | [0.006] | [0.012] | [0.012] |
| Competitive*D1 | 0.0005 | 0.0124*** | -0.0070** | 0.0016 | 0.0048 | 0.0020 |
| | [0.003] | [0.005] | [0.003] | [0.005] | [0.009] | [0.008] |
| **D2=(Unfriendly Juries): Lower Medical Malpractice Liability** | | | | | | |
| Most Competitive*D2 | 0.0046 | -0.0072 | -0.0040 | 0.0066 | -0.0026 | 0.0012 |
| | [0.013] | [0.022] | [0.013] | [0.021] | [0.020] | [0.026] |
| Very Competitive*D2 | 0.0036 | 0.0019 | -0.0023 | 0.0073 | 0.0033 | -0.0064 |
| | [0.004] | [0.007] | [0.004] | [0.008] | [0.012] | [0.012] |
| Competitive*D2 | 0.0012 | 0.0052 | 0.0014 | 0.0116* | -0.0053 | -0.0015 |
| | [0.003] | [0.006] | [0.003] | [0.007] | [0.009] | [0.009] |
| Observations | 597,449 | 278,520 | 597,449 | 278,520 | 597,449 | 278,520 |
| R-square | 0.354 | 0.421 | 0.024 | 0.093 | 0.369 | 0.416 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on Friday, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). Healthy patients are selected if the patient has no recorded pre-existing medical conditions or non-preventable birth complications. All regressions on sick patients also control for specific non-preventable birth complications and pre-existing medical conditions. In all regressions, I control quarter fixed effects and physician fixed effects. Column 3-6 also control for the procedure choice of current delivery. The robustness standard errors are clustered at the individual physician level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. D1 (higher medical malpractice liability) is one if the county has one jury verdict higher than one million dollars during 2000-2003. *** p<0.01, ** p<0.05, * p<0.1

Table 3.5 Market Competition, Jury Friendliness and Preventable Birth Complications among Patients with and without a Previous C-section

| | C-section | | Preventable Birth Complication | | Hospital Charges | |
|---|---|---|---|---|---|---|
| | Patients with Previous C-sections | Patients without Previous C-sections | Patients with Previous C-sections | Patients without Previous C-sections | Patients with Previous C-sections | Patients without Previous C-sections |
| **D1=(Friendly Juries): Higher Medical Malpractice Liability** | | | | | | |
| Most Competitive*D1 | 0.0162 | 0.0087*** | -0.0156** | -0.0126*** | -0.0046 | 0.0152 |
| | [0.012] | [0.003] | [0.008] | [0.005] | [0.016] | [0.014] |
| Very Competitive*D1 | 0.0169* | 0.0038 | -0.0161** | -0.0166*** | 0.0081 | 0.0208* |
| | [0.010] | [0.003] | [0.007] | [0.004] | [0.014] | [0.012] |
| Competitive*D1 | 0.0127 | 0.0022 | -0.0096* | -0.0028 | -0.0159 | 0.0060 |
| | [0.008] | [0.002] | [0.005] | [0.003] | [0.010] | [0.008] |
| **D2=(Unfriendly Juries): Lower Medical Malpractice Liability** | | | | | | |
| Most Competitive*D2 | -0.0395 | 0.0075 | 0.0450* | -0.0077 | -0.0515 | 0.0073 |
| | [0.043] | [0.012] | [0.027] | [0.013] | [0.031] | [0.019] |
| Very Competitive*D2 | -0.0125 | 0.0043 | 0.0078 | -0.0009 | -0.0066 | -0.0009 |
| | [0.013] | [0.004] | [0.009] | [0.004] | [0.013] | [0.012] |
| Competitive*D2 | 0.0026 | 0.0009 | 0.0081 | 0.0049 | -0.0095 | -0.0046 |
| | [0.010] | [0.003] | [0.007] | [0.003] | [0.010] | [0.009] |
| Observations | 110,038 | 765,931 | 110,038 | 765,931 | 110,038 | 765,931 |
| R-square | 0.120 | 0.378 | 0.055 | 0.061 | 0.401 | 0.424 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on Fridays, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). Healthy patients are selected if the patient has no recorded pre-existing medical conditions or non-preventable birth complications. All regressions on sick patients also control for specific non-preventable birth complications and pre-existing medical conditions. In all regressions, I control quarter fixed effects and physician fixed effects. Column 3-6 also control for the procedure choice of current delivery. The robustness standard errors are clustered at the individual physician level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. D1 (higher medical malpractice liability) is one if the county has one jury verdict higher than one million dollars during 2000-2003. *** p<0.01, ** p<0.05, * p<0.1

Table 3.6 Market Concentration, Jury Friendliness and Health Outcomes Before and After MCARE Enactment

| | C-section | C-section without Any Preventable Birth Complications | Vaginal Birth with One or More Preventable Birth Complications | Preventable Birth Complications | Log(Total Hospital Expenditures) |
|---|---|---|---|---|---|
| ***Post 2002 (D1: Higher Medical Malpractice Liability; D2: Lower Medical Malpractice Liability)*** | | | | | |
| Most Competitive*D1 | 0.0249*** | 0.0217*** | -0.0128*** | -0.0125*** | 0.0772*** |
| | [0.004] | [0.004] | [0.004] | [0.005] | [0.018] |
| Very Competitive*D1 | 0.0128*** | 0.0149*** | -0.0177*** | -0.0212*** | 0.0404** |
| | [0.004] | [0.004] | [0.005] | [0.006] | [0.016] |
| Competitive*D1 | 0.0109*** | 0.0085*** | -0.0106*** | -0.0095*** | 0.0387*** |
| | [0.003] | [0.003] | [0.003] | [0.003] | [0.009] |
| Most Competitive*D2 | 0.0162 | 0.0150 | -0.0043 | -0.0050 | -0.0673** |
| | [0.018] | [0.019] | [0.013] | [0.016] | [0.028] |
| Very Competitive*D2 | 0.0109** | 0.0042 | -0.0052 | 0.0003 | 0.0254 |
| | [0.005] | [0.005] | [0.004] | [0.005] | [0.019] |
| Competitive*D2 | 0.0111** | 0.0028 | -0.0069* | 0.0002 | 0.0372*** |
| | [0.005] | [0.005] | [0.004] | [0.005] | [0.012] |
| ***Prior 2002 (D1: Higher Medical Malpractice Liability; D2: Lower Medical Malpractice Liability)*** | | | | | |
| Most Competitive*D1 | -0.0045 | 0.0014 | -0.0072 | -0.0126** | -0.0577*** |
| | [0.004] | [0.004] | [0.005] | [0.005] | [0.015] |
| Very Competitive*D1 | -0.0042 | 0.0021 | -0.0075** | -0.0133*** | -0.0228** |
| | [0.003] | [0.003] | [0.004] | [0.004] | [0.011] |
| Competitive*D1 | -0.0058* | -0.0011 | 0.0043 | 0.0003 | -0.0442*** |
| | [0.003] | [0.003] | [0.003] | [0.004] | [0.009] |
| Most Competitive*D2 | -0.0034 | -0.0081 | -0.0035 | 0.0017 | 0.0098 |
| | [0.013] | [0.013] | [0.011] | [0.013] | [0.021] |
| Very Competitive*D2 | -0.0005 | -0.0032 | -0.0046 | -0.0018 | -0.0013 |
| | [0.005] | [0.005] | [0.004] | [0.004] | [0.012] |
| Competitive*D2 | -0.0007 | -0.0010 | 0.0067** | 0.0072* | -0.0170** |
| | [0.003] | [0.003] | [0.003] | [0.004] | [0.009] |
| Observations | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 |
| R-square | 0.442 | 0.381 | 0.018 | 0.055 | 0.440 |
| Number of markets | 3,577 | 3,577 | 3,577 | 3,577 | 3,577 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on Friday, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). Healthy patients are selected if the patient has no recorded pre-existing medical conditions or non-preventable birth complications. All regressions on sick patients also control for specific non-preventable birth complications and pre-existing medical conditions. In all regressions, I control quarter fixed effects and physician fixed effects. Column 3-6 also control for the procedure choice of current delivery. The robustness standard errors are clustered at the individual physician level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. D1 (higher medical malpractice liability) is one if the county has one jury verdict higher than one million dollars during 2000-2003. Years from 1995 to 2002 are defined as "Prior to 2002", and years 2002-2005 are defined as "After". *** p<0.01, ** p<0.05, * p<0.1

Table 3.7 Robustness Check: Effect of Market Competitions on Health Outcome using Different Measures of Jury Friendliness

| | Alternative Medical Malpractice Liability Definition I | | | | | Alternative Medical Malpractice Liability Definition II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C-section | C-section w/o Comp | Vag w/ Comp | Preventable Birth Complication | Hospital Charges | C-section | C-section w/o Comp | Vag w/ Comp | Preventable Birth Complication | Hospital Charges |
| **D1=(Friendly Juries): Higher Medical Malpractice Liability** | | | | | | | | | | |
| Most Competitive*D1 | 0.0074 | 0.0093** | -0.0288*** | -0.0315*** | 0.0422* | 0.0174*** | 0.0201*** | -0.0191*** | -0.0238*** | -0.0277* |
| | [0.005] | [0.004] | [0.006] | [0.007] | [0.022] | [0.005] | [0.005] | [0.006] | [0.007] | [0.014] |
| Very Competitive*D1 | -0.0008 | 0.0063* | -0.0279*** | -0.0349*** | 0.0505*** | 0.0089* | 0.0141*** | -0.0205*** | -0.0268*** | -0.0206* |
| | [0.004] | [0.004] | [0.006] | [0.007] | [0.018] | [0.005] | [0.004] | [0.006] | [0.007] | [0.012] |
| Competitive*D1 | -0.0026 | -0.0006 | -0.0168*** | -0.0186*** | 0.0105 | 0.0051 | 0.0075** | -0.0093** | -0.0122** | -0.0370*** |
| | [0.004] | [0.003] | [0.004] | [0.005] | [0.015] | [0.004] | [0.004] | [0.005] | [0.005] | [0.008] |
| **D2=(Unfriendly Juries): Lower Medical Malpractice Liability** | | | | | | | | | | |
| Most Competitive*D2 | 0.0112*** | 0.0077** | 0.0027 | 0.0048 | -0.0398*** | -0.0020 | -0.0042 | -0.0035 | -0.0011 | 0.0007 |
| | [0.004] | [0.004] | [0.003] | [0.004] | [0.010] | [0.004] | [0.004] | [0.004] | [0.005] | [0.013] |
| Very Competitive*D2 | 0.0098*** | 0.0044 | -0.0017 | 0.0025 | -0.0225*** | 0.0039 | 0.0013 | -0.0049** | -0.0027 | 0.0315** |
| | [0.003] | [0.003] | [0.002] | [0.003] | [0.008] | [0.003] | [0.003] | [0.002] | [0.003] | [0.013] |
| Competitive*D2 | 0.0054** | 0.0038 | 0.0050*** | 0.0059*** | 0.0030 | 0.0029 | 0.0012 | 0.0025 | 0.0038 | 0.0161** |
| | [0.002] | [0.002] | [0.002] | [0.002] | [0.005] | [0.002] | [0.002] | [0.002] | [0.002] | [0.006] |
| Observations | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 | 875,969 |
| R-square | 0.441 | 0.380 | 0.018 | 0.055 | 0.439 | 0.441 | 0.380 | 0.018 | 0.055 | 0.438 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on Fridays, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). All regressions also control non-preventable birth complications and pre-existing medical conditions, and include quarter fixed effects and physician fixed effect. Column 4 and 5 also control for the procedure choice of current delivery. The robustness standard errors are clustered at the individual physician level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. Alternative medical malpractice liability definition I is one if the county has more than ten jury verdict during 2000-2003. Alternative medical malpractice liability definition II is one if the county is in the upper 50% of jury verdict number over 2000-2003. *** p<0.01, ** p<0.05, * p<0.1

Table 3.8 Robustness Check: Market Competition, Jury Friendliness and Preventable Birth Complications

| | Preventable Birth Complications | | | | | | |
|---|---|---|---|---|---|---|---|
| **D1=(Friendly Juries): Higher Medical Malpractice Liability** | | | | | | | |
| Most Competitive*D1 | -0.0139 | -0.0144** | -0.0181 | -0.0105*** | -0.0140*** | -0.0179*** | -0.0122*** |
| | [0.012] | [0.006] | [0.013] | [0.004] | [0.005] | [0.006] | [0.004] |
| Very Competitive*D1 | -0.0191 | -0.0200*** | -0.0228* | -0.0135*** | -0.0171*** | -0.0246*** | -0.0177*** |
| | [0.013] | [0.007] | [0.013] | [0.003] | [0.004] | [0.006] | [0.003] |
| Competitive*D1 | -0.0010 | -0.0034 | -0.0059 | -0.0005 | -0.0034 | -0.0062 | -0.0032 |
| | [0.004] | [0.005] | [0.006] | [0.002] | [0.003] | [0.004] | [0.003] |
| **D2=(Unfriendly Juries): Lower Medical Malpractice Liability** | | | | | | | |
| Most Competitive*D2 | -0.0117 | -0.0152 | 0.0036 | -0.0081 | 0.0015 | -0.0091 | -0.0076 |
| | [0.014] | [0.020] | [0.013] | [0.010] | [0.014] | [0.016] | [0.015] |
| Very Competitive*D2 | -0.0036 | 0.0043 | 0.0043 | -0.0049 | 0.0003 | 0.0051 | -0.0006 |
| | [0.006] | [0.007] | [0.006] | [0.003] | [0.004] | [0.006] | [0.005] |
| Competitive*D2 | 0.0036 | 0.0121*** | 0.0079* | 0.0020 | 0.0050 | 0.0130*** | 0.0102*** |
| | [0.004] | [0.004] | [0.005] | [0.003] | [0.003] | [0.004] | [0.004] |
| *Quarter FE* | Y | Y | Y | Y | Y | Y | Y |
| *County FE* | | | Y | | Y | | |
| *Zipcode FE* | | Y | | | | Y | Y |
| *Hospital FE* | Y | | Y | Y | | Y | |
| *Physician FE* | | | | Y | Y | | Y |
| Observations | 877,024 | 877,024 | 877,024 | 875,969 | 875,969 | 877,024 | 875,969 |
| R-square | 0.059 | 0.058 | 0.059 | 0.054 | 0.055 | 0.058 | 0.056 |

Market competition index HHI is calculated based on privately insured patients. Regressions also control for patient characteristics (Age group 15-25, 26-35, 35 and above, Black, Hispanic, whether the patient is referred by physicians, clinic or HMO, admission on friday, admission on weekends (Saturday/Sunday), emergency admissions, admission via emergency department, whether the patient have a previous c-section and private insurance type (commercial and blue cross). All regressions also control non-preventable birth complications and pre-existing medical conditions, and include quarter fixed effects and physician fixed effect. All columns also control for the procedure choice of current delivery. The robustness standard errors are clustered at each FE level. Hospital Expenditures are deflated using 1994 Medical CPI provided by the Bureau of Labor Statistics and logged. D1 (higher medical malpractice liability) is one if the county has one jury verdict higher than one million dollars during 2000-2003. *** p<0.01, ** p<0.05, * p<0.1

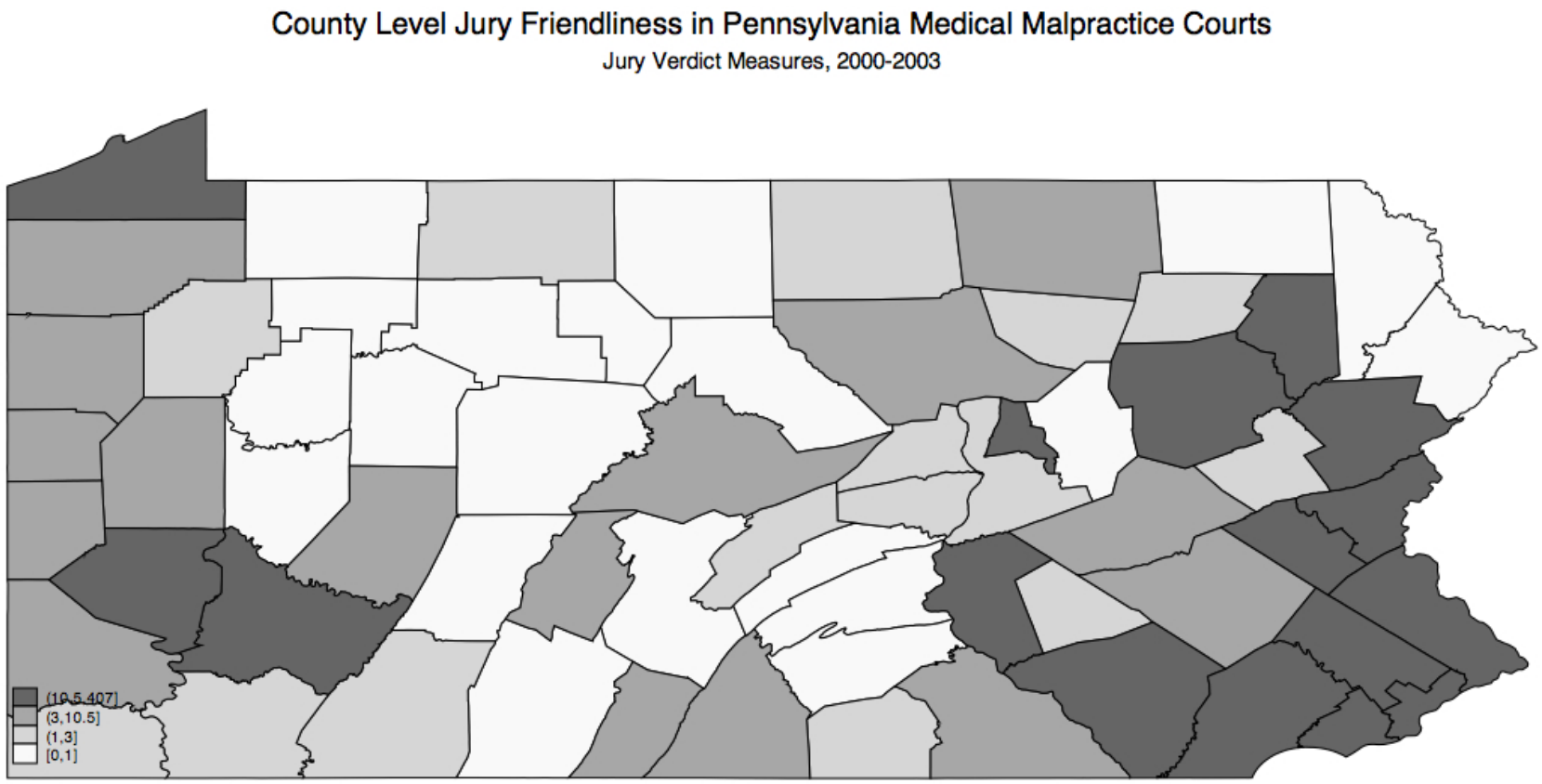


Figure 3.1 – County Level Pennsylvania Medical Malpractice Jury Verdict Cases

Biography

Yi Lu was born June 30, 1983 in Jiaxing, Zhejiang Province, P.R. China to Jiaming Lu and Liping Yang. He attended Beijing University of Chemical Technology from 2002 to 2006 and received a Bachelor's of Arts in International Economics and Trade. Yi Lu attended graduate school at Lehigh University and received a Doctor of Philosophy in Economics in 2012. While at Lehigh, Yi Lu was a Teaching Assistant for three undergraduate Economics courses including Principles of Economics, Money, Banking and Financial Markets, and Business Statistics. In the summer of 2009, 2010 and 2011, he was an Adjunct Professor at Lehigh University teaching Principles of Economics. During academic year 2010-2011, he serves as an Adjunct Professor at Lehigh University teaching Applied Microeconomics Analysis and Business Statistics. He also taught Applied Microeconomic Analysis as a Visiting professor at Lehigh University in the fall semester of 2011. After completing graduate studies, Yi Lu moved to work as an Assistant Professor in the College of Health Sciences at Barry University, Miami Shores, Florida.

# Curriculum Vitae


## Yi Lu

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**Education:**

Aug 2006—Jan 2012 Ph.D., Economics, Lehigh University

Thesis: Medical Liability and Hospital Competition in Obstetrics Service

Advisor: Shin-Yi Chou

Dissertation Committee: Mary E. Deily, Muzhe Yang, Jason Hockenberry

Sep 2002—Jul 2006 B.A., Beijing University of Chemical Technology, P.R.China

Major: International Economics and Trade

**Skills and Languages**

Computer Skills: Stata, SAS, LaTeX, Maple, Matlab, TreeAge Pro, Microsoft Office

Languages: English and Chinese

National Accreditation Examinations for Translators and Interpreters: Certificate in English Translation, Beijing Foreign Studies University

**Research Fields**

Fields: Health Economics, Applied Microeconometrics, Industrial Organization

Research Interests: Medical Malpractice Liability, Treatment Effect, Investment and Derivatives

**Teaching Experience**

Instructor:

Business Statistics: Spring 2011

Applied Microeconomic Analysis: Fall 2010

Principle of Economics (Online Course): Summer 2009, Summer 2010

Other Teaching Experience:

Cost Benefit Analysis (Spring 2011): TreeAge Pro Instructor

BioPharmaceutical Economics (Spring 2010, Fall 2010): Guest Speaker

Money, Banking and Financial Markets (Fall 2008, Spring 2010): Guest Speaker

**Research**

Research Papers

1. Yi Lu, Jason Hockenberry, Shin-Yi Chou and Muzhe Yang, "Tort Reform and Obstetric Practice: The Role of Heterogeneity in Patient Health in Physician Effort and Altruism" (Job Market Paper)
2. Yi Lu, "Medical Malpractice Lawsuits as Bad Signals: Does the Fear to be Sued Encourage Better Quality of Care?"
3. Shin-Yi Chou, Mary E. Deily, Suhui Li and Yi Lu, "Quality Information and Quality Competition: Evidence from the Pennsylvania CABG Market"

**Professional Presentations**

*Conference Presentations*

1. Southern Economics Association Annual Conference: "Tort Reform in Obstetrics: Examining the Casual Effects of Tort Law Changes on Practice Patterns in Pennsylvania and New Jersey", Atlanta, GA, November 2010.
2. Third American Society of Health Economists Conference: "Would Tort Reform Curb Defensive Medicine or Could It Induce Demand for Riskier Procedures? Examining the Causal Effects of Tort Law Changes on Practice Patterns in Pennsylvania and New Jersey", Ithaca, NY, June 2010.

3. Eastern Economic Association Annual Meeting, "Competition, Health Outcomes, and Resource Use in Pennsylvania Hospitals", Philadelphia, PA, February 2010.
4. American Public Health Association Annual Conference: "Tort Reform, Physician Behavior, and Health Outcomes: Evidence of Caps on Punitive Damage Reform in Pennsylvania and New Jersey", Philadelphia, PA, November 2009.
5. Seventh International Health Economics Association Conference: "Tort Reform, Physician behavior and Health outcomes: Experiences of Joint and Several Liability in Pennsylvania and New Jersey", Beijing, P.R. China, July 2009.
6. Eastern Economic Association Annual Meeting, "The Effect of Joint and Several Liability on the Cesarean Section Rates", New York, NY, February 2009.

**Professional Activities**

1. Third American Society of Health Economists Conference, Chair & Discussant, Ithaca, New York, NY, June 2010.
2. Eastern Economic Association Annual Meeting, Discussant, Philadelphia, PA, February 2010.
3. Twenty First Annual Health Economics Conference, Correspondent, Bethlehem, PA, October 2010.
4. National Bureau of Economic Research Summer Institute, Attendee (Invited), Cambridge, MA, July 2009, July 2010.
5. Lehigh University Academic Symposium, Presenter, Bethlehem, PA, April 2009.
6. Department Seminars, Department of Economics, Lehigh University, Presenter, Bethlehem, PA, March 2009, September 2010, November 2010.

**Professional Membership**

American Economic Association, International Health Economics Association, American Society of Health Economists, Eastern Economics Association, American Public Health Association, Southern Economics Association

**Peer Review Activities**

Journal of Medical Economics, American Public Health Association Annual Conference (Abstract Reviewer) 2009, 2010

**Honors and Awards**

Warren York Dissertation Fellowship, Lehigh University, Spring 2009

Teaching Assistantship, Lehigh University, 2006-2010

Renmin Scholarship, BUCT, 2002-2004

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