The Effects of Malpractice Tort Reform on Defensive Medicine

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As the rising cost of malpractice threatens to reduce the number of hospitals and physicians in various states across the nation, policy-makers must examine the factors contributing to these crises. Beyond studying the symptoms of malpractice crises, such as increasing claims frequency and severity manifested through increasing malpractice premia, policy-makers must consider flaws within the malpractice litigation system itself. In addition to structural and administrative issues, policy-makers must also consider physicians' responses to changing malpractice environments; they must consider how malpractice tort laws influence the practice of defensive medicine.

Since the early 1970's economists, lawyers, and those within the medical community have debated the existence of defensive medicine. As defined by the U. S. Congress Office of Technology Assessment (OTA) in its 1994 report on defensive medicine, positive defensive medicine occurs when physicians order additional tests or procedures primarily to avoid malpractice liability; the term "positive " refers to additional health care utilization. Negative defensive medicine occurs when doctors avoid certain patients or treatments chiefly out of concern for malpractice liability; here "negative" refers to a reduction in health care utilization (U. S. Congress 1994). While recent economic analyses support the idea that physicians practice defensive medicine, complexities surrounding the topic have prevented economists from discerning its pervasiveness and direct contribution to healthcare costs. Given the role defensive medicine plays in healthcare and the scarcity of studies that link it to the malpractice environment, this study seeks to provide direct evidence of defensive medicine by comparing health care expenditures between states with different malpractice environments. The scope of this healthcare utilization study has been limited to positive defensive medicine, which if it exists, directly increases total healthcare expenditures.

I.   Literature Review

A.   MEDICAL MALPRACTICE LITIGATION THEORY

Before commencing a discussion on defensive medicine, it is helpful to have an understanding of the medical malpractice system from which this practice has emerged. According to economic theory, professional liability systems are necessary in situations where asymmetric information exists (Danzon 1994). Physician's extensive use of medical jargon and patients' inabilities to understand such terminology is just one example of the information gap that exists in medicine. Thus, the purpose of a liability system like the medical malpractice system is twofold; it is meant to both to deter negligence and compensate patients injured as a result of negligent care (Danzon 1994). In order for negligence systems to function perfectly several conditions must be met. Claims should only be filed and compensation awarded when negligence has occurred. If a provider is found negligent he or she should be liable for an amount equal to the plaintiff's damages (Danzon 1983).

In practice the malpractice liability system does not function perfectly. For instance, there are a high number of claims filed but later dropped before trial. In their study, Farber and White (1991) examined why the frequency of medical malpractice suits is so high. They also sought to find out if certain case characteristics predicted filing and compensation awards for malpractice claims. Study results suggest that claims that are filed, but later dropped, are not random or frivolous. These claims are initially filed in order to obtain more information about what actions occurred to determine if negligence has occurred; the claims are necessary due to the asymmetrical distribution of information in medicine. Some of these claims are later dropped because the expected value of award is less than the costs of pursuing more information and litigation. High settlement and drop rates suggest that plaintiffs are actually risk averse and file in order to gain more information, thus explaining the "random" nature of claims (Farber and White 1991).

Danzon's (1983) research on malpractice tort indicates that the system is far from efficient[1]. For malpractice tort to be efficient, the amount of money invested in the prevention of injury must minimize the total cost to society. At a minimum, efficiency requires that a dollar spent on prevention saves a dollar spent on costs associated with expected injuries. Danzon's study concludes that compensation for negligence can be provided at lower costs and more equitably though first party insurance. Under the current malpractice system in the United States, only forty cents of malpractice premiums reach patients as compensation in malpractice cases. In contrast, ninety cents of insurance premiums for large first-party providers reaches patients as compensation, demonstrating the higher efficiency of first party insurance systems (Danzon 1983).

With regard to liability insurance, economic theory states that premiums should reflect the expected cost of claims based on individual physician's standards of care (Danzon 1983).   Theory predicts that experience rating malpractice premia will ensure that the physicians sued most often pay the highest malpractice premia. However, this theory is not the standard practice.   Malpractice premia are not individually experienced rated because such a system could actually punish good physicians.   For instance, a higher-risk specialty physician might have more claims filed against him than a lower-risk specialty physician simply because he performed riskier procedures due to the nature of his specialty. In this case, experience rating would effectively punish the good doctor and provide incentives to shy away from newly emerging procedures. Instead, malpractice premiums are community rated.

Studies examining the predictive power of past claims on future claims experience justify the current pricing system; these studies have found that other factors, such as physician specialty and locality, have greater explanatory power of future claims risk. Since physicians in the same specialty see patients with similar clinical symptoms and have similar clinical alternatives available from which to choose, they have a similar risk of being sued. In determining premia, insurers consider both the frequency of claims made against physicians in a given specialty as well as the severity of awards from malpractice suits.

In addition to specialty rating, malpractice premia are also rated by locality. State variations in premia are the result of the malpractice tort law itself, since these laws are created by state legislatures. Variations in tort laws, such as the existence and amount of plaintiff award caps or the length of the statute of limitations (discussed later in this paper), influence state claims frequency and severity. Physicians practicing in states that have a high frequency of claims have a higher risk of claims being filed against them and are charged more for insurance; physicians within states that have severe suit awards will have higher premia due to higher insurer payouts and lower profits. Frequency and severity variations within a state also result in regional specialty specific premia variations.

B.   Previous Studies Of Defensive Medicine

There are three major methods to assess the existence of defensive medicine: direct physician surveys, clinical physician surveys, and health care utilization studies.   The direct physician survey method asks physicians to estimate how often they order additional tests or procedures or avoid certain patients or procedures out of concern for medical liability. Alternatively, these surveys may ask physicians to list how and why they have changed their practice behaviors over recent years. An OTA examination of 16 direct physician surveys completed from 1983-1993 found that anywhere from 21 to 81 percent of the physicians surveyed practiced defensive medicine (U. S. Congress 1994). A more recent study by Hickson et al. (1994) supports the practice of positive defensive medicine among pediatricians. In this study, 80% of the physicians responding to the survey ordered more tests than they believe were necessary out of fear of litigation (Hickson et al. 1994).

The second study method, clinical physician surveys, elicits physicians' responses to specific hypothetical situations. These types of surveys can isolate physician specialties and clinical scenarios in which defensive medicine is a concern. Glassman et al. (1993) conducted a study examining the use of defensive medicine among New Jersey physicians insured through the Medical Insurance Exchange of New Jersey. The authors gave 835 physicians specific scenarios, asked what clinical actions they would take, and asked them to

estimate on a five-point scale how strongly certain factors influenced their decision. Between 2.3 to 6.4 percent of respondents cited the "desire to minimize the possibility of malpractice litigation" in various scenarios as extremely or very influential in their decision and did not cite any other reasons as highly. For respondents who cited another reason equally important in their decision, the response ranged from 24 to 42 percent (Glassman et al. 1993).

In 1993, the OTA conducted clinical surveys of members of the American College of Obstetricians and Gynecologists (ACOG), the American College of Cardiologists (ACC), and the American College of Surgeons (ACS) in order to provide additional information about the extent of defensive medicine (1994). The percentage of respondents who chose "malpractice concerns" as the primary reason for implementing a clinical action ranged from 4.9 (back pain scenario) to 29.0 percent (head trauma scenario). Comparison across the studies showed that "malpractice concerns" varied across physician specialties and specific scenarios. The OTA concluded that conscious defensive medicine accounted for a little less than 8 percent of the clinical actions chosen. Based on these survey results, the OTA estimated that the aggregate cost of defensive Cesarean deliveries were $8.7 million in 1991. It estimated that the aggregate cost of defensive diagnostic radiology of the head for American ages 5 to 24 was $45 million (U. S. Congress 1994).

A third method of defensive medicine assessment, healthcare utilization studies, statistically analyzes the impact of liability risk on health care utilization. Utilization data is usually collected for other purposes by other organizations. For instance, hospitals maintain records on individual patients and will compile utilization records for annual reports. These reports may include information listing major diagnostic related group procedures or expenditures, major drugs administered, diagnoses by patients, tests and procedures by patient diagnosis related group, (i.e., acute myocardial infarction), etc. Other organizations, such as the federal and state governments or private insurance carriers, also maintain claims records in order to monitor procedure or test utilization and make strategic insurance coverage decisions.

There are several advantages to using healthcare utilization data rather than physicians surveys to assess defensive medicine. First, in contrast to physician surveys, the data in these studies is real rather than hypothetical. Secondly, while physician surveys are potentially biased by response rates, healthcare utilization data is widely available. Since information is kept on each patient, the sample size of utilization data is extensive. Utilization data is also robust since patient records are often linked to patient demographics and hospital demographics. Thus, econometric healthcare utilization studies can examine defensive medicine on a variety of levels and can control for these factors' influences when examining defensive medicine.

Localio et al. (1993) examined the relationship between malpractice liability risk and the rates of Cesarean deliveries in a sample of New York state hospitals in 1984. When factors known to be associated with Cesarean deliveries (a defensive procedure) were controlled for, higher Cesarean rates were associated with higher malpractice risk within the region and also with hospital claims risk. The authors found that a patient in a hospital with a high frequency obstetric malpractice claims was 32 percent more likely to undergo a Cesarean delivery than a patient in a hospital with low claim frequency (Localio 1993). Thus, this study suggests that elevated malpractice risk increases physician practice of defensive medicine.

Baldwin et al. (1995) examined defensive medical practices among low-risk prenatal cases in the state of Washington. The authors specifically examined the association between physicians' use of technology for low-risk obstetric patients and their malpractice claims experience by linking physicians personal and area-level malpractice claims exposure data for these patients. In this study, they found that there wasn't a significant relationship between physicians' claims experience and prenatal resource use or Cesarean delivery rates, nor between the county defendant rate and resource use (Baldwin et al. 1995).

Grumbach et al. (1993) examined New York physicians' decisions to withdraw from obstetrics from 1980-1989. The authors specifically examined whether physicians (including OB/GYNs and family practitioners) who experienced high insurance premium increases were more likely to withdraw from obstetrics than physicians who experienced lower premium increases. Both complete withdrawal from medical practice and withdrawal only from obstetrics were considered. After controlling for other factors associated with withdrawal, the authors found that malpractice premium increases were not associated with withdrawal from

obstetrics. However, the number of years since licensing and the volume of deliveries in 1980 were positively and negatively significantly associated with withdrawal, respectively (Grumbach et al. 1993).

Since malpractice premiums were not associated with practice withdrawal, this study raises questions as to what other factors actually drive withdrawal. If all OB/GYNs experience the same relative increase in their malpractice premia, then perhaps practice setting (solo vs. multi-physician practice) influences the impact of premium increases. For instance, if solo practitioners are responsible for paying for their own malpractice insurance while group practices pick up this cost for their physicians, then practice setting would change the relative impact of the same premium increase. More study in this area is needed explore such a hypothesis.

Kington (1994) examined the relationship between liability risk and OB/GYNs' volume of obstetrics practice at the individual and state and physician level. The author used self-reported data on obstetric volume, malpractice claims history, and physician characteristics from 1987 national survey of members of ACOG. He also included state-level data on community socioeconomic characteristics and liability insurance premiums. Results from this study show that OB/GYN physicians practicing in states with higher claims frequency had higher volumes of obstetrics care and were more likely to practice than those with states in which liability frequency was less (Kington 1994). Thus, this study supports the idea that physicians are leaving obstetrics practice and that these services are becoming more concentrated in states where the intensity of the malpractice environment is increasing. The study provides further evidence that higher claims frequency might be the result of physician withdrawal from practice, and not the other way around.

Overall, these studies show that defensive medicine is a reality for physicians today. Although certain characteristics make some physicians more likely to have claims filed against them, the threat of a malpractice suit affects physicians in all specialties throughout the nation.

C.   Past National Medical Malpractice Crises And Tort Reform

Literature on malpractice has identified two periods of time during which the system was in crisis: one in the 1970's and one in the 1980's. Economists cite stock market volatility and long claims tails as major contributors to depletion in insurance capital in the 1970s (Danzon 1984). Claims may have a long period of time between when they are filed and when they are closed for two major reasons. Long claim tails may be due to long state statutes of limitations which permit claims to be filed many years after has injury occurred. They can also result due to the length of time it takes for a claim to be decided in court after being initially filed. As a result of the long claims tails, insurers sought huge premium increases between 1974-75 in order to make up for the lag of increasing claims costs due to long tail claims and due to their risk aversion in the face of decreasing insurer capital reserve. These premium increases led to crises in which physicians had difficulty paying for malpractice premiums (Danzon 1984).

Industry analysts believed that the 1980s crisis was the result of price undercutting and inadequate risk information. They believe the largest insurers deliberately underreported claims and used reinsurance to hide losses. Harrington and Danzon's (1984) article examining the general liability insurance industry's behavior and tendencies prior to mid-1980s crisis found that moral hazard was a contributing factor. According to the moral hazard hypothesis, firms with weak safety incentives charge low prices and grow more rapidly than firms with higher safety levels. Premium growth rates should be positively related to loss revisions and negatively related to moral hazard. Results support the idea that reinsurance was used to hide low prices and excessive growth[2]. When abused, this practice makes it easier for companies to expand in the marketplace by charging lower premium prices than competitors with appropriate amounts of capital. The study also suggests industry-wide forecast errors on long-tailed businesses were characterized by significant gaps between time of investment and time of payment/profit recognition. Thus, one can infer that the crisis in medical malpractice insurance was partially due to moral hazard with the excessive nature of the malpractice crisis due to complicating factors like long statute of limitations and the nature of medicine itself (Harrington and Danzon 1984).

Additional literature investigates other reasons cited as contributing to the malpractice crisis of the 1970's and 1980's. These reasons are examined within the context of proposed tort[3] reforms made in response

to these crises. One major concern was the rising cost of malpractice claims. Between the early 1970's and mid-1980's the frequency of malpractice claims grew at over 10% per year while severity of claims grew at twice the national inflation rate (Danzon 1994). Distribution of compensation was also a concern. With mean settlements significantly higher than median payments, people were concerned that compensation was not apportioned appropriately with respect to injury level. For instance, there was concern that payments for pain and suffering were growing at a disproportionally faster rate relative to negligence compensation awards (Danzon 1994). In addition, there were concerns over the inefficiency of the negligence rule and high administrative costs associated with the litigation process. Danzon (1983) also cites pro-plaintiff trends in laws, erosion of traditional malpractice defenses (like the locality rule and charitable immunity), growth in the number and complexity of medical treatments, an increase in the number of lawyers per capita, and erosion of the patient-physician relationship as contributing factors.

In response to the malpractice crises that occurred during the 1970's and 1980's, states enacted various tort reforms. Although many types of reforms were enacted, Barker's (1992) study summarizes the major reforms enacted following the 1970's crisis. Several indirect reforms, those that indirectly affected monetary awards, were enacted. For instance, before the 1970's malpractice crisis most states had statute of limitations with discovery rules, which stated that statutes did not begin until after the injury was discovered.[4] Because this policy allowed claims to be filed years after the date of injury, it contributed greater uncertainty to malpractice insurance pricing. In order to reduce uncertainty, 34 states shortened their statute of limitations. Most statute reforms reduced the total limitations period to 2-3 years and decreased the length of time permitted for injury discovery. Many states also began to define the standard of care that physicians were expected to provide. By defining acceptable standards of care, legislators essentially codified professional standards into a legally binding form rather than an honor code (Barker 1992).

There were several reforms enacted following the 1970's malpractice crisis that directly limited malpractice awards (Barker 1992). After 1975, nine states enacted reforms capping malpractice awards values, seven states capped total damage awards, and two states capped noneconomic damages (pain and suffering) only. Along with these reforms several states created Patient Compensation Funds (PCF). Physicians in these states were responsible for awards up to a certain dollar amount, after which, the PCF kicked in the rest of the money due. Modification of the collateral source rule was another direct reform enacted. Originally, this rule prohibited evidence of collateral award sources to be introduced to the jury. Reform allowed juries to consider and sometimes mandated that they lower awards when plaintiffs had collateral award sources. These collateral sources could include other physicians, hospitals, or insurance companies. By enacting this reform, plaintiffs could no longer receive duplicate malpractice awards from multiple sources (Barker 1992).

In order to reduce costs associated with litigation, three major reforms were enacted (Barker 1992). First, some states mandated pretrial screening. This reform requires that potential cases are screened by a panel before proceeding to trial; cases deemed unworthy do not
reach trial, thus eliminating unnecessary trial expenses. Thirteen states created provisions for arbitration, either voluntary or mandatory, between the pretrial discovery step of litigation and trial, in order to eliminate expenses associated with trial. Under the process of arbitration, plaintiffs and defendants submit their claim to a third party that makes a decision regarding case outcome. Under mandatory arbitration third party decisions are binding and cannot be appealed. A third reform capped contingency fees for attorney representation, limiting the percentage of award collected by lawyers following successful trials (Barker 1992). Table 1 defines the malpractice tort reforms discussed above and included in this analysis.

In her 1984 study, Danzon examines determinants of post-1975 tort reforms and develops a model to measure the effect of medical and demographic characteristics, changes in litigation law, and changes in common and statutory law on claims closed before 1970 and 1975-78. Models estimating the effects of post-1975 reforms showed that states capping awards by January 1975 experienced a 19% decrease in awards, on average, by January 1977.

Table 1. Malpractice tort laws considered in analysis.[5]

Reform	Description of reform
Arbitration (Permitted)	Arbitration is permitted, but not mandated.
Arbitration (Mandatory)	Arbitration is mandated.
Pre-judgment	Claimants need to obtain a certificate of affidavit of merit within a certain amount of time in order to pursue medical liability action.
Contingency Fee Cap	The proportion of an award that an attorney can contractually charge is statutorily capped at a specific level.
Statute of Limitations	The maximum number of years (from incident occurrence, discovery, or the maximum time limit) during which a claimant can commence an action for medical liability
Collateral Source Rule Reform	Damages payable in a malpractice suit are statutorily reduced by all or part of the dollar value of collateral-source payments to the plaintiff.
Damage Caps (noneconomic or total damages)	Either noneconomic, total damages, or both types of damages are capped at a statutorily established dollar amount.
Damage Caps (punitive damages)	Punitive damages are capped at a statutorily established dollar amount.
Joint and Several Liability Rule Reform	The Joint and Several Liability rule is abolished either for noneconomic or total damages in all claims, such that damages payable in a malpractice suit are statutorily allocated in proportion to the tortfeasors' degree of fault.
Periodic Payment of Awards (Permitted)	Part or all of the damages are permitted to be disbursed in the form of an annuity that pays out over time.
Periodic Payment of Awards (Mandatory)	Part or all of the damages must to be disbursed in the form of an annuity that pays out over time.
Physician Compensation Fund	A state-administered excess malpractice liability insurance program exists for physicians.

States mandating collateral source compensation offsets had 50% lower awards by the end of the same time period.   Reduction of the statute of limitations significantly reduced severity, but not frequency. Modifications on arbitration, pretrial screening, and periodic payment of future damages did not have significant effects on either severity or frequency post-1975 (Danzon 1994). [6]

Danzon's (1984) study found that the most significant influence on claims frequency growth was the number of surgical procedures per capita. Similarly, the number of paid claims was most dependent on the number of surgical procedures. Claim frequency was positively related to the number of disciplinary procedures per 1,000 physicians, suggesting that disciplinary actions may be more frequent in states with high claim frequencies (Danzon 1994). Thus, in addition to directly effecting physicians' incentives, malpractice liability may also exert influence on quality of care.

Danzon (1986) found that reducing the statute of limitations for adults by one year reduced claim frequency by 8% and frequency of paid claims by 6-7%, on average. Laws permitting or mandating collateral offset reductions on awards were the only reforms to effect claim frequency. Such a reform reduced frequency of filed claims by 14%. Caps on awards were found to reduce severity by 23% on average. This result is best explained by the observation that a disproportionately small amount of large cases (5%) account for over 50% of dollars paid out (Danzon 1986).

Barker's (1992) study of tort reform continues along these lines by examining how tort reform affected prices, profitability, and underwriting risk in the medical malpractice insurance industry following reforms enacted in 1975. The author examined procedural/evidentiary tort reforms (including statute of limitations and codifying standards of care) and limits on physicians' and insurers' liability (including ceilings on recovery, the

collateral source rule, patient compensation funds, and arbitration). Study results showed that award ceilings limited plaintiff compensation and improved underwriting profits, thus narrowing the range of expected losses and decreasing risk. Defining standards of care within a state also reduced compensation; the author reasoned that codified standards made it clear to providers what standards were expected.   Thus, the two most effective reforms found in this study were award ceilings and codifying standards of care (Barker 1992).

Based on the above information about the varying effectiveness of tort reforms enacted in response to crises, Kessler and McClellan's (1996) study examined how tort reform and malpractice environments impact defensive medicine. This study departed from previous studies on defensive medicine because it examined the practice in the context of cardiac patients. The authors used a difference-in-difference analysis of longitudinal data on Medicare patients from 1984, 1987, and 1990 treated for acute myocardial infarction (AMI) and new ischemic heart disease (IHD). They compared outcomes among states with reforms and without reforms. The authors defined defensive medicine as the practice of administering precautionary treatments with minimal benefits, out of fear of liability. Tort law reforms were divided into two categories: direct, which reduce expected malpractice awards (damage caps and mandatory collateral-source offsets) and indirect (mandatory periodic payments, statute of limitations reductions, or modification of the joint and several liability rule), which have a less discernable impact on malpractice pressures, according to the authors (Kessler and McClellan 1996).[7]

The authors examined the occurrence of adverse outcomes one year after cardiac illness, including subsequent AMI, heart failure requiring hospitalization, and mortality. The magnitude of defensive medicine was estimated by comparing the cost of an additional year of life to treatment intensity used.   Theory predicts that if precaution due to liability causes expenditures per year of life to be low compared to normally accepted costs, the liability system has provided incentive for efficient care. If these costs are high in comparison to normally accepted values, the liability system provides incentive for excessive care (Kessler and McClellan 1996).

Results from Kessler and McClellan's study showed that reform states and nonreform states had similar baseline expenditures and outcomes. However, expenditure growth was lower in reform states (2-6% percent) than in nonreform states for AMI. Trends for IHD showed slightly greater differences. Difference-in-difference (DD) effects show that expenditures in states adopting direct reforms decline 5.3% relative to nonreforming states and expenditures in states with indirect reforms increased 1.8% relative to nonreforming states. Since reforms were adopted at least five years before data used in the study, the results suggest that direct reforms do not result in slower expenditure growth more than five years after adoption. Overall, malpractice reforms result in a decline in cost growth of at least 10%. AMI outcomes coupled with expenditure effects show that the expenditure/benefit ratio for states with higher-pressure liability is over $500,000 per additional one-year AMI survivor (1990 dollars).   The adoption of malpractice reforms lead to reductions in hospital expenditures (5% for AMI and 9% for IHD) by five years after reform adoption. Overall, results of the study show that direct reforms reduce expenditure growth without increasing mortality while indirect reforms have no substantial effects on expenditure or mortality (Kessler and McClellan 1996).

Altogether these studies support tort reform as a means of controlling malpractice crises.   These reforms affect the malpractice environment of states, which in turn affect the practice of defensive medicine. The above studies demonstrate that capping damage awards, permitting or mandating collateral offset, and decreasing state statute of limitations significantly reduce claim severity and frequency. Other reforms, such as mandatory periodic payments, modifications on arbitration, pretrial screening, codifying standards of care, and establishing patient compensation funds have not been found to have a significant influence on malpractice claims. Thus, states enacting the former tort reforms have had a better chance of reducing malpractice crises than those enacting the latter reforms.

II.   Healthcare Utilization Model Of Defensive Medicine

The purpose of this regression analysis is to discover how state malpractice environments influence the practice of positive defensive medicine. The scope of the study has been limited to patients with skull fractures. Since they are associated with a high level of risk and uncertainty, it is likely that physicians practice defensive medicine on them. Thus, reductions in state malpractice pressures could diminish the level of defensive medicine associated with these patients and result in substantial cost savings. The healthcare utilization model of defensive medicine is as follows:

(1) $CHARGES = $ $b_0 + b_1$Patient Demographics $+ b_2$Hospital Demographics $+ b_3 ARBITVOL + b_4 ARBITMAND$ $+ b_5 PREJUDGE + b_6 CONTFEECAP + b_7 COLLSOREF + b_8 DAMCAPNT +$ $b_{10} DAMCAPPUN + b_{11} JNTSEVL + b_{12} PERPAYPERM + b_{13} PERPAYMAND + b_{14} PCF + b_{15} STATLIM$

The dependent variable, total patient expenditures ($CHARGES$), is used as a means of assessing the level of defensive medicine practiced in each state. In order to construct a model that distinguishes the effect of state malpractice environmental factors from other factors contributing to variations in patients' total expenditures, independent variable vectors accounting for patient and hospital demographics have been included. Dummy variables for various tort reforms serve as identifiable measures of differences in state malpractice environments.[8]

Several variables within the patient demographic vector account for differences in patient's hospital experiences and skull fracture injuries. Ultimately each can be held constant to examine the role of tort reform on total charges, though each variable will have its own individual impact on charges. A patient's length of stay (LOS), number of diagnoses (NDX), and number of medical procedures (NPR) positively impact charges. Since hospitals charge a minimum daily fee for inpatient visits on top of charges associated with tests and procedures, increasing a patient's length of stay or increasing the number of procedures performed will increase a patient's total charges. It is also reasonable to expect that a patient with more severe injuries will have more diagnoses recorded on his or her hospital encounter than a patient with less severe injuries; thus, the number of diagnoses on a patient's hospital encounter serves as a proxy for the patient's extent of injury. Based on this theory LOS, NDX, and NPR are expected to have positive coefficients.

General patient demographics are also included in the patient demographic vector. These variables consider age, gender, patient income, and payment source. Since differences in age and gender should not impact the practice of defensive medicine, the variables AGE and $FEMALE$ have been included in this analysis as control factors. Theory does not predict the coefficient sign of either variable.

In this model the median household income in each patient's zip code serves as a proxy for his or her income. The variables $TWENTYFIVE$, $THIRTYFIVE$, and $FORTYFIVE$ account for these income differences.[9] Theory predicts that patients with higher incomes may be more likely to file malpractice claims than patients with lower incomes for several reasons. First, if a higher income patient is harmed as a result of medical care, he or she has the resources to invest in seeking legal action. Secondly, if an injury prevents the patient from working, a patient with a higher income would forgo more earned income than a lower income patient, increasing the likelihood that he or she would seek remuneration for this loss. Thus, if a physician knows that a patient earns a higher income, he or she may order additional tests or procedures in order to decrease his or her chance of being sued. Finally, wealthier patients may be more proactive in requesting tests in the sense that people with higher incomes demand more health care. Thus, one expects the coefficients on $TWENTYFIVE$, $THIRTYFIVE$, and $FORTYFIVE$ to be positive in comparison to patient's whose median household income ranges from zero to $24,999.

The variables $MEDICAID$ and $PRIVATE$ describe patients' insurance programs, where the former includes patients insured through the government Medicaid program and the latter describes patients subscribing to private health insurance.[10]   Since physicians will be reimbursed for the tests and procedures they

order for insured patients, one expects that these patients will have higher expenditures than uninsured patients. Thus, a positive coefficient sign is expected on these variables.

The hospital demographic vector is made up of several variables, including variables describing hospital control, size, location, and teaching status. If government and non-profit facilities are less cost-conscious than for-profit facilities, they may have higher patient expenditures for patients with the same set of diagnoses. In order to control for these differences, the variables *PUBLIC* and *VOLUNTARY* describing public, nonfederal, government facilities (such as county or city hospitals) and privately controlled, non-profit facilities have been included in the model. In line with the theory described above, both of these variables are expected to have positive coefficients. Due to the fact that large hospitals tend to have more technologically advanced equipment available, theory predicts that physicians in large hospitals will practice more defensive medicine than physicians in small or medium sized hospitals, simply because the technology is available. For this reason, the variable *LARGE* is expected to have a positive coefficient.

Hospitals located in urban areas tend to be more specialized than rural hospitals, such that physicians working in urban facilities tend to see more seriously ill patients than rural physicians. Since seriously ill patients require riskier tests and procedures than mildly ill patients, physicians working at urban facilities may be at greater risk for being sued. Additionally, literature on malpractice has shown that attorneys are more densely populated in urban areas, and that this dense attorney population increases the likelihood of malpractice claims being filed. For these reasons, physicians working in urban hospitals can be expected to practice more defensive medicine than physicians working in rural facilities; the variable *URBAN* is expected to have a positive coefficient sign.

Finally, the variable *TEACH* has been included in the model to account for variations in defensive medicine due to physician inexperience. Since teaching hospitals (those associated with medical schools) have higher numbers of medical students and residents than non-teaching hospitals, it is reasonable to expect these individuals to practice more defensive medicine than experienced physicians who have more confidence in their diagnoses. Thus, theory predicts that *TEACH* will have a positive coefficient sign.

In order to consider differences in state malpractice environments, dummy variables for various tort reforms have been included in the model. These variables account for reforms in: arbitration, pre-judgment measures (*PREJUDGE*), contingency fee caps (*CONTFEECAP*), collateral source rules (*COLLSOREF*), damage caps, joint and several liability rules (*JNTSEVL*), periodic payments, physician compensation funds (*PCF*), and state's statutes of limitations (*STATLIM*). Within these reforms, the effects of voluntary arbitration (*ARBITVOL*) versus mandatory arbitration (*ARBITMAND*) and the option to elect periodic payments (*PERPAYPERM*) versus mandatory periodic payments (*PERPAYMAND*) are considered. I also separate damage cap reforms into two groups: those that limit noneconomic or total awards (*DAMCAPNT*) and those that only limit punitive damage awards (*DAMCAPPUN*). Literature on tort reform and defensive medicine holds that physicians working in states that have enacted malpractice tort reforms will feel less malpractice pressure than physicians working in states without malpractice reforms. In turn, these physicians should practice less defensive medicine than their counterparts in non-reform states. Based on this theory, the above mentioned tort dummy variables are expected to have negative coefficients.

III. Data

Data used in my analysis come from two major sources. Information on total expenditures, patient demographics, and hospital demographics for patients who had primary, secondary, or tertiary diagnoses of skull fractures were derived from the 2000 Nationwide Inpatient Sample, part of the Healthcare Cost and Utilization Project sponsored by the Agency for Healthcare Research and Quality. [11] This data set contains 7,450,992 inpatient hospital stays from 994 hospitals in 28 states. Due to missing data, this analysis was limited to 23 states.[12]

In order to make patients as similar as possible several restrictions were placed on the patients considered in this study. Age was restricted to patients 18 to 65 old for two reasons. First, minors were

eliminated because they are subject to different malpractice statutes of limitations in many states. Second, the elderly were eliminated because literature on malpractice suits has shown that successful elderly claimants are awarded low dollar amounts due to their advanced age. Thus, theory holds that physicians are less likely to practice defensive on this demographic group. Also, due to deteriorating health and health complications, the elderly are likely to be outliers with respect to length of stay, number of diagnoses, total charges, etc. In line with the idea that outliers with respect to length of stay and number of diagnoses will also be outliers with respect to total charges, patients considered in this study were restricted to those whose length of stay was ten days or less and who had ten or fewer diagnoses on their hospital encounter. Table 2 describes the means and standard deviations of the variables used in regression analysis.

Table 2: Means And Standard Deviations Of Variables Used In Regression Analysis

Variables	Mean	Standard deviation
Patient Demographics		
(*AGE*): Age	35.190	12.499
(*FEMALE*): Gender	0.190	0.392
(*MEDICAID*): Medicaid Insurance	0.101	0.301
(*PRIVATE*): Private Insurance	0.476	0.499
(*TWENTYFIVE*): Income $25,000-34,999	0.277	0.448
(*THIRTYFIVE*): Income $35,000-44,999	0.256	0.438
(*FORTYFIVE*): Income $45,000 +	0.312	0.463
Patient Hospital Stay Demographics		
(*LOS*): Length of Stay	3.584	2.634
(*NDX*): Number of Diagnoses	5.854	2.438
(*NPR*): Number of Procedures	2.182	2.329
Hospital Demographics		
(*TEACH*): Teaching facility	0.572	0.499
(*URBAN*): Urban location	0.885	0.319
(*LARGE*): Large size	0.690	0.462
(*PUBLIC*): Public facility	0.087	0.282
(*VOLUNTARY*): Non-profit facility	0.149	0.356
Malpractice Tort Law Reforms		
(*ARBITVOL*): Arbitration- Voluntary	0.617	0.486
(*ARBITMAND*): Arbitration- Mandatory	0.098	0.298
(*PREJUDGE*): Pre-judgment	0.535	0.499
(*CONTFEECAP*): Contingency Fee Cap	0.466	0.497
(*STATLIM*): Statute of Limitations	3.950	2.009
(*COLLSOREF*): Collateral Source Rule	0.537	0.499
(*DAMCAPNT*): Damage Caps- Noneconomic/Total damages	0.404	0.491
(*DAMCAPPUN*): Damage Caps- Punitive	0.207	0.405
(*JNTSEVL*): Joint and Several Liability	0.622	0.485
(*PERPEYPERM*): Periodic Payment- Permitted	0.582	0.493
(*PERPAYMAND*): Periodic Payment- Mandatory	0.095	0.293
(*PCF*): Physician Compensation Fund	0.201	0.400

The total charges obtained from the NIS were altered in order to consider state and regional variations in the price of medical care services. This was accomplished by dividing regional or city CPI data for a given state by a base state's CPI, thereby setting patient charges from all states on equal footing. CPI data for the year 2000 were obtained from the Urban Consumer Series "All Items" CPI index available on Bureau of Labor Statistics' website.[13] If data for a metropolitan area within a given state were available or the state was cited as having a CPI value corresponding to a metropolitan area in a nearby state, this CPI value was used. If data for several metropolitan areas within a state or corresponding to a state were available, the average of these values were used. For states in which there were no corresponding metropolitan areas associated, the regional (Northeast, Midwest, South, or West) "All Items" Urban CPI value was used. [14] Kansas was selected as the base state in this analysis because of its baseline number of malpractice tort reforms. This method of CPI base lining is the best approximation that can be made, given the limited amount of CPI information available for locations around the nation.

The second major source of data, from which information on state tort laws was compiled, came from the American Medical Association Advocacy Resource Center's state law charts on liability reform.[15] Dummy variables for the malpractice tort law listed in Table 1 were created for each state.[16] The following laws were coded zero if the state had not reformed the law and one if it had a reform for the law in place: pre-judgment, contingency fee caps, collateral source rule, joint and several liability rule, and physician compensation funds. Two dummy variables were each created to address arbitration, damage caps, and period payment of awards. States that permitted arbitration, but did not mandate it had an *ARBITVOL* value of one. States that mandated arbitration had an *ARBITMAND* value of one. States in which there was no provision for arbitration had zero values for both of these dummy variables. Similarly, states that permitted periodic payments of awards had a *PERPAYPERM* value of one. States that mandated periodic payments of awards had a *PERPAYMAND* value of one.   If a state did not have a provision for periodic payments, both of the dummy variables were coded zero. Finally, states that had caps on noneconomic awards, a cap on total awards, or both had a *DAMCAPNT* value of one. States that only capped punitive awards had a *DAMCAPPUN* value of one. States that did not cap damage awards had zero values for both of these variables. Statutes of limitations were considered by coding the *STATLIM* dummy variable value as the maximum number of years during which a claimant could commence a medical liability action.

IV.   Results

Regression results are reported in Table 3. Results were estimated using ordinary least squares. As measured by the R-squared value, 48.62% of the variation in total charges can be explained by the variation in the independent variables. The mean total charge for patients with skull fractures was $21, 127. In accordance with healthcare utilization models of defensive medicine, a decrease in total charges in the presence of tort reform indicates that less defensive medicine is being practiced, holding patient and hospital characteristics constant. Based on the results of White's test, the null hypothesis of homoscedasticity was rejected.   However, the form of heteroscedasticity was not clear. T values were produced using White's consistent estimators of the variance, clearing the model of heteroscedasticity. Table 3 contains the corrected T values.

Table 3: Regression results (t values in parentheses)[a]

Variables	Coefficient Estimates[b]	Variables	Coefficient Estimates[b]
Intercept	-$130.98 (-0.06)		
Patient Demographics		**Malpractice Tort Law Reforms**	
(*AGE*): Age	-$130.98 (-0.83)	(*ARBITVOL*): Arbitration-Voluntary	$686.81 (0.67)
(*FEMALE*): Gender	-$17.34** (-2.71)	(*ARBITMAND*): Arbitration-Mandatory	-$12,177.00*** (-10.40)
(*MEDICAID*): Medicaid Insurance	$3,596.63** (2.85)	(*PREJUDGE*): Pre-judgment	-$5,174.99*** (-6.18)
(*PRIVATE*): Private Insurance	$30.30 (0.06)	(*CONTFEECAP*): Contingency Fee Cap	-$4,534.50*** (-5.27)
(*TWENTYFIVE*): Income $25,000-34,999	-$1,535.95 (-1.54)	(*STATLIM*): Statute of Limitations	-$1,504.69*** (-8.98)
(*THIRTYFIVE*): Income $35,000-44,999	-$1,410.69 (-1.50)	(*COLLSOREF*): Collateral Source Rule	$3,866.88*** (4.73)
(*FORTYFIVE*): Income $45,000 +	$1,841.90 (1.90)*	(*DAMCAPNT*): Damage Caps- Noneconomic/Total	$2,584.30*** (3.97)
Patient Hospital Stay Demographics		(*DAMCAPPUN*): Damage Caps- Punitive	$2,226.01** (2.01)
(*LOS*): Length of Stay	$3,191.70*** (25.59)	(*JNTSEVL*): Joint and Several Liability	-$2,474.77** (-2.69)
(*NDX*): Number of Diagnoses	$191.68 (1.59)	(*PERPAYPERM*): Periodic Payment- Permitted	$2,775.17*** (3.48)
(*NPR*): Number of Procedures	$3,716.70*** (15.88)	(*PERPAYMAND*): Periodic Payment- Mandatory	-$7,842.91*** (-5.32)
Hospital Demographics		(*PCF*): Physician Compensation Fund	-$1,856.49** (-2.03)
(*TEACH*): Teaching facility	$654.39 (0.64)		
(*URBAN*): Urban location	$7,063.70*** (8.29)		
(*URBAN*): Large size	$3,954.61*** (7.22)		
(*PUBLIC*): Public facility	$2,686.13** (2.29)		
(*VOLUNTARY*): Non-profit facility	$2,714.92** (2.00)		

Adjusted R^2 = 0.4862

Dependent Mean (Total Charges) = $21,127

Condition Index = 35.91244

a T values were produced using White's consistent estimators of the variance.

b All coefficient estimates have been deflated to 2000 dollars.

   *Significant at the 10% confidence level.

  **Significant at the 5% confidence level.

***Significant at the 1% confidence level.

    Three control variables were found to be insignificant: age, private insurance, and hospital teaching status. Since theory predicts variations in defensive medicine due to age when comparing minors to the elderly,

and these age groups were eliminated from the data set, it is not surprising that age is not significant. Theory predicts that physicians could practice defensive medicine based on patients' health insurance status. However, the results show that hospital physicians do not order more tests and procedures, thus leading to additional charges, for privately insured head trauma patients compared to uninsured head trauma patients. Finally, the fact that teaching hospitals have inexperienced physicians on staff, the results do not support the hypothesis that teaching status significantly influences the practice of defensive medicine;
perhaps this is because patients with skull fractures face life or death situations, such that experienced (rather than inexperienced) physicians take charge of patient care decisions.

The majority of the hospital control variables included in the regression were significant and have the expected signs on the coefficients. All three patient hospital stay demographics were significant. For each additional day of patient hospital stay, total charges increased $3,191.70, ceteris paribus. Similarly, each additional procedure increased total charges by
$3,716.70. An additional diagnosis increased patient charges by $191.68 although the level of significance was only 0.1116.

With regard to general patient demographics, gender, Medicaid insurance, and income were found to be statistically significant. Although theory predicted that gender should not significantly influence defensive medicine, the results show that being female significantly increases charges by $17.34, ceteris paribus. Having Medicaid insurance also significantly increased charges by $3596.63, supporting theory that physicians order more tests and procedures for patients insured through government programs since reimbursement is assured.

The results for patient incomes were somewhat surprising. Having an income in the highest salary range ($45,000+) increased total charges $1,841.90 over patients with incomes ranging from $0-$24,999. These results support theory that higher income patients are more likely to file malpractice claims or request additional tests than lower income patients. However, in contrast, patients with salaries ranging from $25,000-34,999 and $35,000-44,999 had lower skull fracture charges than the base salary range. It is unclear as to why this would occur, however, since these variables are used as control variables, the reasons for these findings are not specifically within the scope of this paper.

The location of a hospital, its size, and its ownership all significantly impacted the total charges. In accordance with theory, an urban location increased total charges by $7,063.70. In large hospitals, patients were charged $3,954.61 more than if they had been admitted to a small or medium sized hospital. These findings support the idea that urban patients may be more seriously injured than rural patients and that lawyer density may play a role in physicians practicing defensive medicine. Similarly, increased patient charges in large hospitals supports the idea that the availability of technology increases its use. Both public and non-profit hospitals were found to have significantly increased charges of $2,686.13 and $2,714.92, respectively, in comparison to privately owned hospitals. These findings support theory that physicians in private hospitals are more cost-conscious than those in government or non-profit facilities.

Although all but one tort reform, voluntary arbitration, was found to have a significant impact on the practice of defensive medicine, not all variables had expected signs on their coefficients. The tort reform with the largest coefficient, indicating the most important reform in terms of savings from reduced defensive medicine, was mandatory arbitration. Having a provision for mandatory arbitration reduced total skull fracture charges by $12,177, a significant amount compared to the dependent mean of $21,127. This result supports theory that physicians fear malpractice suits going to court and practice less defensive medicine when suits must first be assessed outside of court. Interestingly, having a voluntary arbitration policy has no impact on charges, thus on defensive medicine, implying the policy needs to have teeth, i.e., be mandated. Similarly, the finding that mandatory periodic payments reduced charges by $7,842.91 supports theory that physicians are afraid of having their assets wiped out in a large court case; they feel less threatened when payments are disbursed annually. Permitting periodic payment actually increased total charges by $2,775.17, in contrast with expectations.

Similar to mandatory arbitration, pre-judgment measures reduce charges by $5,174.99, supporting the theory that physicians will practice less defensive medicine if states screen claims before they can proceed to

court. These findings are significant in light of the total charges mean of $21,127. Enacting contingency fee caps also reduced charges by $4,534.50. One possible explanation for this reduction is that caps force attorneys to more closely scrutinize potential cases, resulting in fewer malpractice cases going to court. In turn, physicians may feel less pressure to practice defensive medicine due to the reduced number of malpractice court cases. Additional research examining the relationship between contingency fee caps and defensive medicine is needed to clearly establish this theory.

Making physicians responsible for the same proportion of damages as their actions contributed in a medical liability case though joint and several liability rule reforms significantly reduces charges by $2,474.77. This finding supports theory that physicians will order fewer extraneous tests or procedures when they have a decreased risk of having their assets wiped out in a malpractice suit. Finally, the existence of state physician compensation funds reduced defensive medical care by $1,856.49. Since there is no theoretical basis for this result, more research on the relationship between physician compensation funds and defensive medicine is needed.

Results indicate that statute of limitation reforms have a significant, but unexpected, effect on total charges. The coefficient on the statute of limitations variable indicates that for each additional year a patient is able to take medical liability action, there is a $1,504.69 decrease in total charges for skull fracture patients. Theory predicts that allowing patients an additional year to take action will increase the volume of malpractice claims filed, thus causing physicians to practice more defensive medicine; if a physician knows that a patient has more years in which he or she can file a malpractice suit, then perhaps the physician orders more tests to protect himself or herself from a suit claiming that the proper standard of care was not met. Thus, although the length of time to bring a suit seems to be the issue, theory suggests that the real issue is the physician's risk of being sued. It is also possible that a risk plateau or peak exists for statutes of limitations such that after a certain number of years, the probability of a malpractice claim being filed either plateaus or drops drastically. More research on the relationship between defensive medicine and statute of limitations reductions is needed before firm conclusions can be drawn.

In contrast to theory, collateral source rule and damage cap reforms significantly increase total charges. Since, in this study, total charges serve as an indicator for the amount of defensive medicine practiced by physicians, these results show increased defensive medicine in states with these reforms. Having a collateral source reform increases skull fracture patient charges by $3,866.88. Caps on noneconomic or total awards increase charges by $2,584.30, while caps on punitive damages only increase charges by $2,226.01. A possible explanation for these unexpected results is that they result from an endogenous relationship between tort reforms and state malpractice environments. Tort reforms are generally enacted in states only when some sort of malpractice crisis exists. These crises resulting from long claim tails, high numbers of malpractice suits, and severe damage awards, are often manifested through large annual physician malpractice premium increases; reforms on the collateral source rule and damage caps are generally enacted when a state is in crisis. Thus, the significantly positive coefficients on collateral source rule reforms, noneconomic/total award damage caps, and punitive damage caps most likely reflect this endogenous relationship between states in malpractice crises and the reforms they enact. The positive coefficients may reflect lingering crises effects originating before the reforms were enacted.

Finally, it is important to discuss the multicollinearity in this model, indicated by the Condition Index of 35.91244. A look at the Pearson Correlation Coefficients shows a significant positive correlation between length of stay, number of diagnoses, and number of procedures, as can be predicted by theory. Teaching hospitals are also significantly correlated with urban and non-profit facilities, while urban hospitals were correlated with public facilities.   With regard to tort reforms, several significant relationships exist, reflecting the tendency for state legislatures to pass tort reforms in groups. For instance, voluntary arbitration is positively correlated with punitive damage caps, joint and several liability rule reforms, and physician compensation funds. A positive significant correlation also exists between contingency fee caps and collateral source rule reforms.   Some reforms had significant negative correlations with other reforms. For instance, mandatory arbitration is negatively related to pre-judgment measures, contingency fee caps, collateral source rule reforms,

punitive damage caps, joint and several liability rule reforms, and physician compensation funds. Although these correlations exist and contribute to multicollinearity, the high significance of the independent variables in this model demonstrates that multicollinearity has not significantly weakened the regression analysis.

V.   Conclusions

The regression results provide strong evidence that variations in state malpractice environments significantly influence the level of defensive medicine practiced by physicians on skull fracture patients. On the upper end, states enacting mandatory arbitration could reduce charges by $12,177, over half the mean hospital charge for skull fracture patients. On the lower end, those enacting various pre-judgment measures could save $5,175. Capping attorney fees could save $4,534 per skull fracture patient. States mandating periodic payment of awards could also significantly reduce defensive medical charges by $7,843 per skull fracture patient. In contrast, damage caps and collateral-source rule reforms were found to increase patient expenditures.

The results are consistent with some of Kessler and McClellan's (1996) findings, though contrary to others. Both studies find that joint and several liability rules and mandatory periodic payments reduce patient expenditures. Kessler and McClellan's results, however, show damage caps reduce expenditures, contrary to findings here. Danzon (1986) finds damage caps decrease claims severity, but not their frequency. If this is the case, then physicians do not perceive a reduced likelihood of being sued with damage caps in place and thus do not practice less defensive medicine, which would contradict Kessler and McClellan's findings. The positive coefficient on damage caps here is not inconsistent with Danzon; the endogeniety between higher medical costs malpractice crises may best explain it.

The major weakness of this study is that health outcomes were not held constant due to lack of data availability. Also, because the scope of this analysis was restricted to high-risk skull fracture patients, further research is needed to clearly establish the relationship between malpractice tort reforms and defensive medicine. Despite these limitations, the results still represent a significant costs savings. Based on the national estimate that approximately 2 million head injuries occur each year (Kraus 1996), enacting mandatory arbitration could save over $24 million in skull fracture defensive medical practices. Considering that this estimate represents savings from only one percent of the total patient population, policy makers should seriously consider the impact of state malpractice tort reforms on the practice of defensive medicine.

VI.   References

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Endnotes

[1] The laws governing malpractice litigation are tort laws. Tort laws are defined as "civil wrongs recognized by law as grounds for a lawsuit" and are created by state legislatures (Legal Information Institute 2002).

[2] Reinsurance occurs when medical malpractice insurance companies purchase insurance on the policies they offer to health care providers; reinsurance is insurance for malpractice insurance companies.

[3] The laws governing malpractice litigation are tort laws. Tort laws are defined as "civil wrongs recognized by law as grounds for a lawsuit" and are created by state legislatures (Legal Information Institute 2002).

[4] A statute of limitations defines the maximum length of time following an injury that a claimant can file a medical liability suit.

[5] Malpractice Tort Law definitions taken from the American Medical Association Advocacy Resource Center *Liability Reform: Common Provisions of State Law*.

[6] Under periodic payment reforms, part or all of the damages are disbursed in the form of an annuity that pays over time.

[7] The joint and several liability rule states that tortfeasors (physicians in a malpractice suit) are fully responsible for damages payable in a malpractice suit. Reforms statutorily allocate payable damages in proportion to the tortfeasors' degree of fault.

[8] Table 2 lists the dummy variables for the malpractice tort laws created for each state.

[9] Each of these variables represents the range in thousands of dollars. For example, *TWENTYFIVE* represents the income range from $25,000-$34,999, *THIRTYFIVE* represents the range from $35,000-44,999, etc.

[10] The variable *MEDICARE*, accounting for patients insured through the government Medicare program, was originally included in this regression analysis. The variable was later eliminated when the data set was restricted to patients under the age of 65, the age at which a person becomes eligible for Medicate benefits.

[11] The diagnoses codes for skull fractures are based on the ICD-9CM codes valid for the patient's discharge date and include: 800.00-800.99 (Fracture of skull vault), 801.00-801.99 (Fracture of skull base), and 803.00-803.99 (Other and unqualified skull fractures). (e-Mds 2003 and UMEA University 2003).

[12] These states include: Arizona, California, Colorado, Connecticut, Florida, Georgia, Illinois, Kansas, Kentucky, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, and Wisconsin.

[13] This data is calculated for various metropolitan areas and regionally throughout the country.

[14] Since no metropolitan CPI data were available for North Carolina, South Carolina, Tennessee, or Virginia these four states were deflated using the South urban CPI value. Similarly, Arizona was deflated using the West urban CPI value.

[15] McCullough, Campbell, and Lane's state summaries of medical malpractice law supplemented this information (McCullough, Campbell, and Lane 2003).

[16] Due to lagging time effects between when reforms are enacted and when physicians behaviorally respond to these reforms, a two-year window of time was permitted. That is, reforms enacted after 1997 are not considered in this analysis.