The impact of tort reform on intensity of treatment: Evidence from heart patients☆

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ABSTRACT

This paper analyzes the effect of non-economic damage caps on the treatment intensity of heart attack victims. We focus on whether a patient receives a major intervention in the form of either a coronary artery by-pass or angioplasty. We find strong evidence that treatment intensity declines after a cap on non-economic damages. The probability of receiving a major intervention in the form of either an angioplasty or bypass declines by 1.25–2 percentage points after non-economic damage caps are enacted, and this effect is larger a year or two after reform. However, we also find clear evidence of substitution between major interventions. When doctors have discretion to perform a by-pass and patients have insurance coverage, caps on non-economic damages increase the probability that a by-pass is performed. The effect of non-economic damage caps on costs is not always statistically significant, but in models with state-specific trends, total costs decline by as much as four percent. We conclude that tort reform reduces treatment intensity overall, even though it changes the mix of treatments. Using the Center for Disease Control's Vital Statistics data, we find that tort reform is not associated with an increase in mortality from coronary heart disease; if anything, mortality declines.

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Advocates of tort reform argue that limitations on medical malpractice liability, particularly non-economic damages, will reduce treatment intensity without compromising patient care. However, liability limitations could change provider behavior in ways that increase or decrease treatment intensity, with ambiguous consequences for patient outcomes. For example, limitations to physician liability could reduce so-called defensive medicine, and thereby reduce costs and unnecessary procedures. On the other hand, liability limitations could increase agency costs in the physician–client relationship through reduced caretaking and increases in induced demand (also called offensive medicine). Recent work has found evidence for both effects, depending on the practice area examined. However, few papers have considered shifting doctors' incentives

to provide defensive medicine or induce demand under various combinations of liability and reimbursement schemes. As a result, the effect of tort reform on treatment intensity and patient outcomes remains an important question of study.

This paper employs a unique data set comprised of a large sample of hospital inpatients, the Nationwide Inpatient Sample, to analyze the effect of non-economic damage caps on treatment intensity for patients experiencing acute myocardial infarctions (AMI or heart attacks). The data contains information on almost 1.5 million inpatients observed between the years 1998 and 2009 and aged 45–90 whose primary diagnosis was AMI. Roughly 25 percent of all heart attack victims in this period in states covered by the NIS are included in the sample. We find evidence that treatment intensity declines after a cap on non-economic damages, but that offsetting effects also exist and vary by insurance coverage. There are three treatment options for heart attack: medical management, Percutaneous Transluminal Coronary Angioplasty (PTCA), and CABG (Coronary-Artery Bypass Graft). The probability of receiving any major intervention in the form of either PTCA or CABG declines by 1.25–2 percentage points after non-economic damage caps are enacted, depending on the specification. These results provide evidence that damage limitations can reduce treatment intensity. However, we also find offsetting effects. PTCA

and CABG are almost never performed at the same time; they are effectively mutually exclusive. PTCAs decline by roughly 2 percentage points after caps on non-economic damages are imposed, while CABGs, which are more invasive and remunerative than PTCA, rise by .5–.6 percentage points. Further analysis finds that the increase in CABG is observed primarily when doctors (1) have discretion between treatment options and (2) patients have insurance coverage. On balance, however, costs seem to decrease. Though the cost data has limitations, we find in some specifications that total costs decline by as much as four percent.

To evaluate the effect of tort reform on quality of care, we study age-adjusted mortality rates from coronary heart disease. We find that mortality rates from coronary heart disease either decrease or are unchanged after a cap is imposed, suggesting that treatment quality was not impaired by either the reduction in PTCA or the substitution toward CABG. Mortality of course does not encompass all measures of quality of care, but it is well-recorded.

We focus on heart attacks for several reasons. First, heart disease, which includes heart attacks and related complications caused by blockages in vessels supplying blood to the heart, is the leading cause of death in the United States and accounts for nearly one-seventh of all medical spending (Cutler et al., 1996). Second, heart patients have been the focus of the study of the effect of medical liability pressure, but these studies have found conflicting results. Third, an inpatient sample raises selection issues for most conditions. An AMI, however, almost always results in admission. Over 90% of the admissions in the AMI sample are via the emergency room or transfer from a different hospital, and 93% of the AMI admissions in the data are coded as non-elective (Agency for Healthcare Research and Quality, 2006). Fourth, there is significant liability pressure for cardiac care. Heart surgeons are among the most sued group of physicians, so liability reforms should be especially salient to cardiac care providers.

Finally and most importantly, AMIs provide a unique opportunity to study substitution between treatment regimes because doctors often have discretion between PTCA and CABG. CABG is generally more profitable than PTCA, yet because it is more invasive, performing CABG may expose healthcare providers to greater liability risk. For patients with blockages in three or four arteries, the preferred treatment option in almost all cases is CABG. But for patients with blockages in one or two arteries, PTCA and CABG are often substitutes, with PTCA being the more commonly chosen option and generally preferred when there are no other complicating factors such as diabetes. Thus, by studying AMI patients, we can examine the effect of reduction in liability risks via tort reform on providers' choice between two discrete and mutually exclusive treatments, and, by considering patient insurance status, the additional influence of financial incentives to perform the different treatments.

The shift to more CABG after reform is consistent with two different interpretations. Under the offensive medicine interpretation, enacting liability limitations increases the ability of doctors to induce demand for a more remunerative and riskier procedure. Limitations on liability changes the provider's private cost-benefit analysis and makes CABG more appealing to the provider. Under the defensive medicine interpretation, enacting liability limitations increases the ability of doctors to perform a procedure that was better for patients, but (as an invasive procedure) may have created more liability risk. To separate these effects, we examine whether reform had differential impacts by insurance coverage. We find that the CABG rate only increased for those with insurance coverage, where financial incentives would be present. We argue that this pattern is most consistent with tort reform freeing doctors to pursue more remunerative procedures even if on

balance treatment intensity declines, though we consider competing explanations too.

Most papers studying the effect of medical malpractice focus either on costs of a particular procedure, overall medical costs, or the use of additional diagnostic procedures. Our paper makes several additional contributions. First, we confirm that tort reform reduces treatment intensity in heart patients by reducing costs and the probability of a major intervention. The effect of tort reform on cardiac care has been the subject of some controversy and is an important policy question considering that cardiac care accounts for roughly one-seventh of total health spending. Second, we find that tort reform leads to some substitution between treatment options, from the less invasive PTCA to the more invasive CABG, but only for those with insurance. Third, we find that even though tort reform reduced treatment intensity and altered treatment choice, mortality rates did not change (if anything, mortality declines for those aged 45–65) suggesting provisionally that tort reform might not have had negative welfare effects on AMI patients.

The rest of the paper is organized as follows. Part 1 surveys the theoretical background on tort reform and intensity of treatment. Part 2 discusses the identification strategy and data. Part 3 discusses the treatment intensity results. Part 4 considers quality as measured by coronary heart disease mortality and Part 5 concludes.

1. Theoretical background and literature review

The goal of malpractice liability is to align the interests of health care providers and patients by making providers internalize risks of poor treatment. By reducing incentives to provide proper care, however, limiting medical malpractice liability may cause patients' outcomes to worsen. Excessive liability pressures, on the other hand, may push doctors to excessive caretaking through the practice of defensive medicine. Defensive medicine is the practice of prescribing unnecessary (or non-cost-justified) tests, procedures, and medications as liability shields. Defensive medicine can also be achieved through avoidance of high-risk patients by either screening patients or leaving high-risk states or practice areas.

Defensive medicine may be pervasive due to hidden information and externalized costs. Hidden information exists because both patients and insurers cannot fully monitor providers' decisions. Externalities are present because healthcare providers and their patients do not bear the full costs of prescribing tests or procedures due to third-party health insurers. In contrast, providers may bear significant costs for medical liability. Although most physicians are fully insured against malpractice claims, incentives to practice defensive medicine remain. These incentives include the desire to avoid reputational harm, the stress of litigation and bad publicity, and the lost time associated with defending a claim, all of which can affect physician status and income (Dranove et al., 2012). Indeed, most doctors report practicing defensive medicine. A recent survey found that ninety-three percent of Pennsylvania doctors admitted that they sometimes or often engage in defensive medicine practices (Studdert et al., 2005). Moreover, hospitals, clinics, and practice groups also face significant financial liability for malpractice claims, and they are key players in setting practice standards and monitoring physician behavior. Thus, defensive medicine may provide significant benefits to healthcare providers by decreasing their exposure to various costs associated with malpractice liability. Tort reform should limit both the probability and magnitude of litigation, thereby reducing the incentives of health care providers to practice defensive medicine. Heart surgeons in particular face significant liability pressure. Each year, about 19% of heart surgeons are sued for malpractice, and nearly 20% of the claims involve a payout, making heart surgery the second riskiest practice area from a

medical malpractice standpoint. The liability risk to cardiologists, in contrast, is less than half of that. (Jena et al., 2011).

Induced demand or offensive medicine occurs when health-care providers pursue treatments that may not be best for the patient but offer large reimbursements. Improper or unnecessary treatment, of course, is malpractice. Moreover, aggressive treatments may have higher complication rates and expose doctors to greater litigation risk. Studies of induced demand have examined incentives related to insurers' reimbursement schemes, physician-owned hospitals, and the potential for self-referral, and have often found evidence consistent with induced demand (Currie and Gruber, 1995; Guterman, 2006; Gruber and Owings, 1996). In the case of heart patients, there are some glaring examples of induced demand. In 2002, the Redding Medical Center in California (also known as the "little house of horrors") was subject to an FBI investigation which discovered that up to 50% of the 1000 bypasses preformed at the Hospital each year were not medically justified. The hospital eventually settled for more than $450 million with patients and the government (Klaidman, 2007).[1] In 2010, a Maryland hospital paid $22 million to settle allegations involving an illegal kickback scheme in which one of its cardiologists allegedly performed hundreds of unnecessary PTCAs.[2] Most recently, Hospital Corporation of America (HCA), the largest for-profit hospital chain in the country with more than 150 facilities in 20 states, has faced allegations of unnecessary cardiac treatments at some of its medical centers (The New York Times, 2012). Of course, these are egregious examples, but even generally honest providers will likely be influenced at the margins by reimbursement and liability incentives.

It is also possible that for many patients treatment is not aggressive enough. Card et al. (2009) compared pre-sixty-five-year-old and post-sixty-five-year-old emergency room patients and found that Medicare eligibility is associated with significant increases in hospital list charges, the number of procedures performed in hospital, and the rate at which patients are transferred to other care units in the hospital. Importantly, they found that Medicare eligibility reduces the death rate of this patient group by 20 percent, which suggests substantial benefits from health insurance and the greater treatment intensity it enables. By contrast, Kim (2011), using a much earlier version of the National Inpatient Sample (NIS) data used in this paper, compared the provision of CABG and PTCA to Medicare patients before and after a 1983 Medicare payment reform which made it more profitable to perform CABG. He found an increase of 50–60% in the provision of CABG and no change in the provision of angioplasty, without any reduction in ischemic heart disease mortality.

There are several strands of literature examining the impact of tort reform on treatment intensity. As mentioned, surveys of physicians have been employed, but physician response to such surveys may be self-interested. Another line of studies has used broad data sets on costs or procedures to study defensive medicine. Avraham et al. (2010) find that some tort reforms, including caps on non-economic damages, reduce health insurance premiums and Avraham and Schanzenbach (2010) find that caps on non-economic damages increase insurance coverage for price-sensitive groups. The authors interpret their findings as evidence that tort reform reduces treatment intensity, but the authors cannot distinguish between reductions in cost-justified caretaking or defensive medicine. Baicker and Chandra, 2007 found that a 10 percent increase in average malpractice liability payments per physician within a state was associated with a 1.0 percent increase in Medicare payments for total physician services and a 2.2 percent increase in the imaging component of these services. Baicker and Chandra (2007) did not find that higher malpractice liability costs were associated with reductions in total or disease-specific mortality, potentially indicating that these increases in payments are the result of defensive medicine.

Another line of studies examines individual practice areas. This approach has the significant advantage of being able to directly measure treatment choices and follow patient outcomes more closely. The downside is that the results may not be generalizable to other practice areas. These studies have focused either on obstetrics patients, often finding that liability exposure is correlated with rates of Cesarean section (C-section),[3] or on heart patients, with more mixed results. For example, Currie and MacLeod (2008) found that caps on non-economic damages increase unnecessary C-sections as well as the chance of complications in labor and delivery. They attribute these effects to reduced care-taking and more aggressive treatment resulting from limitations on liability. On the other hand, they find that reform of joint and several liability rule reduces C-section rates, which they attribute to more liability being placed on the obstetrician, who is the primary decision-maker.

The leading study of liability pressures and heart patient care is considered by many to be that of Kessler and McClellan (1996) who examined Medicare beneficiaries treated for serious heart disease in 1984, 1987, and 1990 and found that malpractice reforms that directly reduce provider liability pressure lead to reductions of 5–9 percent in medical expenditures without substantial effects on mortality or medical complications. As a result they concluded that liability reforms can reduce defensive medical practices for patients with heart diseases. In a later study, Kessler and McClellan (2002) repeated their 1996 work but controlled for cost containment achieved by managed care. The magnitude of the results of their 1996 study were reduced by half. Clouding the picture further, a 2004 study by the Congressional Budget Office, applying the methods used in the Kessler and McClellan study to a broader set of ailments as well as heart disease, could not replicate their results (Beider and Hagen, 2004). Another recent study on Medicare heart patients by Sloan and Shadle (2009) also failed to find significant effects of tort reform on costs or outcomes for cardiac patients. Unfortunately, however, Sloan and Shaddle had significantly smaller sample sizes than the Kessler and McClellan sample, sometimes as little as one-percent, so Sloan and Shaddle's failure to replicate could be attributed to sample-size differences.[4]

To our knowledge, Shurtz (2014) is the only paper that attempts to disentangle defensive from offensive medicine by examining physician's financial incentives to offer treatment that are

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[1] This is not the first time in the history of the U.S. that doctors performed aggressive heart treatments for monetary reasons. See Jacobs (1980) reporting that doctors at Paramount General Hospital in California were "anxious to operate on almost anything".

[2] Committee on Finance United States Senate, Staff Report on Cardiac Stent Usage at St. Joseph Medical Center, (2010).

[3] Localio (1993) found an association between malpractice claims risk and the rate of cesarean delivery in the state of NY in 1984 and Dubay and Waidmann (1999) found that greater malpractice pressure leads to a higher probability of cesarean delivery for the period 1990–1992, without any significant improvement in health outcome. However, Sloan et al. (1995) found no systematic improvement in birth outcomes due to medical malpractice pressure and Baldwin (1995) found no association between the malpractice exposure of individual physicians and an increase in the use of prenatal resources or cesarean deliveries for the care of low-risk obstetric patients.

[4] Dhankhar and Bagga (2007) examined heart conditions with the data employed here, but only considered one year of data, and hence their analysis was cross sectional. They considered the more limited question of the effect of medical malpractice costs on resource use and mortality of heart patients, finding that an increase in medical malpractice risk leads to a *reduction* in resource use and *improvement* in health outcome.

potentially substitutes. Looking at C-section rates for privately insured mothers versus mothers insured by Medicaid, Shurtz found that, when treatment is profitable, Texas's non-economic damage cap leads to an increased intensity of treatment, increasing offensive medicine. In contrast, in less remunerative cases reducing liability leads to a decreased intensity of treatment. Thus, Shurtz finds evidence that limiting tort liability has offsetting effects: defensive medicine decreases while offensive medicine increases.

2. Identification strategy and data

We identify the effect of liability pressure primarily based on the passage of a cap on non-economic damages. Non-economic damages are damages for any loss beyond loss of income and direct medical costs, including pain and suffering, loss of consortium, and hedonic loss (loss of enjoyment of life). These damages often constitute a significant portion of total recovery and have been found to significantly reduce payouts (Paik et al., 2013; Avraham, 2006).

Throughout our analysis we carefully consider the risk of legislative endogeneity, i.e., the possibility that pre-existing trends in treatment intensity are correlated with the passage of laws. This may be of particular concern because at times tort reforms were limited to medical malpractice instead of applying generally in tort law (e.g., to product liability and automobile accidents). We will rely on trends in the data immediately prior to the passage of reforms to assess the likelihood of this threat to the identification strategy.

2.1. Timing of reform

We date tort reforms using the fourth edition of the Database of State Tort Law Reforms (DSTLR 4rd). This dataset was assembled by reviewing the laws and court cases of the 50 states (and Washington DC) from 1980 to 2010 and comparing them to existing tort law compilations (Avraham, 2011). The process revealed that commonly used dating schemes suffer from missed reforms, missing or erroneously coded effective dates of reforms, and missing or erroneously coded state supreme court decisions striking down or upholding reforms.

There are five common tort reforms enacted during the period under study. They include a variety of damage caps, damage payment reforms, and reforms of joint and several liability. However, since the NIS dataset we use to track patients does not have all 50 states, we have sufficient variation during our study period (1998–2009) to analyze only caps on non-economic damages. As Appendix Table A1 shows, eight states have adopted or abandoned this reform during the years of our dataset. When we consider leads and lags, additional states contribute identifying information. In the sample time frame, two states also adopted reforms to the collateral source rule and three states adopted reforms of joint and several liability rule. These reforms have been found in other work to affect health-care provider behavior (e.g., Avraham et al., 2010; Currie and MacLeod, 2008; Kessler and McClellan, 2002). However, three of the states adopting these reforms (Georgia, Nevada and West Virginia) also adopted non-economic damage caps at the same time.[5] To account for these three states that adopted significant reforms apart from non-economic damages, we include and report a variable for "other reform" in the regression results. We also tried specifications allowing interactions or separate effects for states that adopted other reforms at the same time as caps, but

we lacked the power to identify separate or additional effects. However, readers should bear in mind that other tort reforms may be reflected in the coefficient estimates, though the primary reform is non-economic damage caps. Moreover, because "other reform" includes only three changing states, it should be considered merely a control variable and is likely not valid for making an inference in the difference-in-differences approach.

2.2. The healthcare cost and utilization project data

The Healthcare Cost and Utilization Project (HCUP) was developed through a partnership between states and the federal government and sponsored by the Agency for Healthcare Research and Quality (AHRQ). The Nationwide Inpatient Sample (NIS) is the largest all-payer inpatient care database that is publicly available in the United States, containing data from 5 to 8 million hospital stays from about 1000 hospitals sampled per year to approximate a 20 percent stratified sample of U.S. community hospitals.[6] All discharged patients from each sampled hospital are included in the data set. Many hospitals are sampled more than once, with the average hospital in the sample observed 2.6 times. Also, the HCUP sampling scheme often resamples the largest hospitals (and the very largest are sampled every year). This is important for our study because these large hospitals are likely capable of supporting invasive cardiac procedures and our preferred specifications will usually employ hospital fixed effects.

Because the NIS is a stratified sample, we account for stratification by using discharge weights to make the sample nationally representative, although weighting generally made little difference to the results. Thus, we measure the effect of reform on a portion of a nationally representative sample exposed to it. Second, we employ both hospital and state fixed effects. While hospital fixed effect results are more precise than state fixed effects and allow us to sweep out a lot of heterogeneity, state fixed effects allow more hospitals within a state to identify the effect of reform. The hospital and state fixed effect results are usually identical, thereby reducing concern that a selected group of repeatedly sampled hospitals are providing an unrepresentative estimate. However, the hospital fixed effects results are much more precisely estimated. Third, we note that approximately 700,000–800,000 AMIs occur annually in the U.S. during the sample time frame. We estimate that we observe roughly 25% of all heart attacks that occurred in the sample time frame in the states included in the NIS.

The NIS is available for a 21-year time period, from 1988 to 2009, allowing analysis of trends over time.[7] Whereas in 1988 there were only 8 states in the NIS, by 2009 there were 44 (see Appendix Table A3). The sampling design and other aspects of the data changed markedly in 1998, so for the purposes of consistency we use data only from 1998 onward.

The NIS isolates the procedures in question while avoiding complications that arise from the periodic changes to the ICD-9-CM coding system. In addition, the dataset includes many relevant variables: hospital characteristics, patient characteristics, hospital identifier, primary payer (uninsured, private insurance, Medicare, or Medicaid), patient diagnosis and treatments, disease severity and stage, in-hospital mortality, number of procedures performed, length of stay in hospital, and hospital charges. Hospital charges are

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[5] Pennsylvania adopted reforms to the collateral source and joint and several liability rules in 2002, but did not adopt a cap on non-economic damages.

[6] This universe of U.S. community hospitals is divided into strata using five hospital characteristics: ownership/control, bed size, teaching status, urban/rural location, and U.S. region. Community hospitals are defined by AHRQ as non-Federal, short term, general, and other specialty hospitals.

[7] Analyses of time trends are recommended from 1993 forward. See U.S. Healthcare Cost and Utilization Project (2006).

notoriously noisy measures of actual charges, so we translate hospital charges into an actual reimbursement rates based on Medicare policies using a regional and hospital-specific data set provided by HCUP to complement the NIS.

We exclude those under 45 in part because heart attacks in that age group are not only rare but also associated with drug use. We also exclude those over age 90. Treatment decisions for very aged patients are more limited, and in the event of malpractice, their damages will tend to be lower and issues of proof more complicated (though prior work often includes them). Results tended to be weaker when those aged 90 and over were included. Our reduced data set of patients aged 45–90 is comprised of almost 1.5 million patients diagnosed with AMI in years 1998–2009.[8]

Appendix Table A2 shows a summary statistics of the NIS dataset from 1998 to 2009. In general, treatment intensity increased a great deal during this period, while demographic characteristics and insurance coverage rates remained stable, with the exception of a 3-percentage point shift from privately insured to uninsured. Average charges per inpatient, the number of procedures, PTCA rates, and admission rates rose significantly over the years of the study. Average charges rose from about $35,000 in 1998 to about $68,000 in 2009 (both in 2009 dollars). The average number of procedures also rose, from about 3 in 1998 to more than 5 in 2009. There was a steady increase in the rate of AMI patients receiving PTCA, rising from about 25% in 1998 to 45% in 2009, whereas there is a decrease in patients getting CABG from about 11% in 1998 to 8% in 2009. In contrast, the average length of hospital stay dropped from 5.9 days to 5.2 days. Of course, not every hospital is sampled each year and consequently some of the changes may reflect changing composition of hospitals and states in the sample (though hospital-level fixed effects control for such changes). However, the stability of the demographic and insurance variables gives us some confidence that the sample is consistent.

2.3. Estimation

Our basic estimation strategy is given by the following equation:

$$
\begin{aligned}
Outcome_{ijt} = {} & \alpha Constant + \sigma NonEconCap_{jt} + +\eta Demographic_{ijt} \\
& + \tau CoMorbidity_{ijt} + \rho Insurance_{ijt} + \theta \%HMO_{st} \\
& + \pi Hospital\ Characteristics_{jt} + \lambda Year_t \\
& + \psi Hospital_j + E_{jt}
\end{aligned} \tag{1}
$$

where $Outcome_{ijt}$ is a measure of intensity of treatment on patient i in hospital j at time t. The coefficient of interest, σ, is the change in the outcome variable after the enactment of a cap on non-economic damages, $NonEconCap_{jt}$. We measure outcomes in four different ways, which if dichotomous are estimated via a linear probability model: (1) the probability of receiving a major intervention (PTCA or CABG) (2) whether PTCA was performed (1 if PTCA, 0 otherwise); (3) whether CABG was performed (1 if CABG, 0 otherwise), and (4) log costs using hospital-level cost-to-charge ratios.

$Hospital_j$ are hospital fixed-effects. Hospital dummies are perfectly collinear with state dummies, so no state dummies are included in the equation. Because we use hospital dummies, a hospital must be sampled by the HCUP before and after reform to contribute identifying information. The average hospital in the

sample is observed 2.6 times. We also will report specifications in which state fixed effects are used (instead of hospital fixed effects) to allow a broader set of hospitals to identify the effect of reform.

$CoMorbidity_{ijt}$ are a set of dummy variables that measure comorbidities including diabetes, liver disease, renal disease, and various cancers. The comorbidities are measured based on: (1) the eighteen individual components of the Charlson score and (2) the comorbidity measures reported by Elixhauser et al. (1998). Both these measures are a widely used and have been shown to have a strong relationship with mortality (Li et al., 2008).[9]

$Hospital\ characteristics_{jt}$ are a set of dummy variables for number of hospital beds (coded in three categories in the data), whether hospital is a teaching hospital, and whether the hospital is a for-profit, not-for-profit, public, or university hospital. Of course, for $Hospital\ characteristics_{jt}$ to be identified, the hospital must change its status in the sample time frame in the hospital fixed-effect results. Hospitals occasionally move between for-profit and not-for-profit designations. $Insurance$ is divided into four categories: Medicare, Medicaid, private insurance, and uninsured. No distinction is made between HMOs and other insurance plans in the data. To control for possible effects of changes in HMO coverage, we use as a control the variable HMO_{st}, which is the percent of the state's population covered by HMO insurance and was gathered from the Census Bureau's Statistical Abstract. The only $Demographic$ variables are age (entered as a quadratic) and sex. Race is available only for a small fraction of the data and we therefore do not use it.

In addition to this baseline specification, we perform some important extensions. First, we report results with and without state-specific time trends. Second, we report a specification that includes leads and lags of the reform dummy in the regression equations. Leads of the reform may expose a potentially biasing trend before the reform was enacted, while lags can show whether the reform had a delayed impact since health-care providers may take time to respond to a change in liability standards. Third, we report separate results by insurance status: Medicare, Medicaid, private coverage, and uninsured. We do this because it is possible that insurance status is an important component of induced demand. Moreover, defensive and offensive medicine may be practiced differently based on reimbursement schemes. For example, defensive medicine may be practiced by avoiding low-reimbursement but high-risk patients. Offensive medicine should be directed primarily to the insured, for whom payment is guaranteed. Separating our results by insurance type also differentiates between those aged 65 and older and those younger than 65 because almost all Medicare recipients are over 65 years of age.

Physicians can use any of the following three treatments: medical management, Percutaneous Transluminal Coronary Angioplasty (PTCA), and Coronary Artery Bypass Graft (CABG) surgery. Of the almost 1.5 million patients in our dataset, about 135,000 receive CABG, 474,000 receive PTCA and 722,000 receive other treatment or no treatment at all. In the data, very few PTCAs are followed by CABGs. Those who do not receive PTCA or CABG most often receive medical management, i.e., noninvasive procedures that involve drug therapies (like beta blockers and thrombolytics) and monitoring. We distinguish between induced demand (or offensive medicine) and defensive medicine as it relates to the choice of major procedures. We analyze the effect of tort reforms on the choice between two coronary revascularization procedures: PTCA and CABG. However, because the data only reflect discrete hospital stays and do not include unique patient identifiers, we cannot

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[8] Specifically, we look at all patients which single-level CCS diagnoses in the first diagnosis variable is equal to 100 (Acute Myocardial Infarction). CCS (Clinical Classification Software) is a tool for clustering more than 13,600 patient IDC-9-CM diagnoses into 231 clinically meaningful categories.

[9] The individual factors in the Charlson score and Elixauser Index were computed using the commands "elixhaus" and "charlson" in STATA.

Table 1
Major intervention (PTCA or CABG) and tort reform.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Non-econ cap	−0.0127* (0.00506)	−0.0143* (0.00637)	−0.0125* (0.0062)	−0.0197+ (0.0119)	−0.0200* (0.0100)		
Other reform	0.0060 (0.00905)	0.00840 (0.00695)	0.00859 (0.00573)	−0.0115 (0.0120)	0.00619 (0.00793)	0.00896 (0.00736)	0.00896 (0.00736)
≤−3 years non-econ cap							0.00668 (0.0145)
−2 years non-econ cap							0.00658 (0.0114)
−1 year non-econ cap							0.00794 (0.0123)
Year of non-econ cap						−0.00697 (0.0129)	
+1 year non-econ cap						−0.00842 (0.00957)	−0.00149 (0.0118)
≥+2 years non-econ cap						−0.0170** (0.00614)	−0.0101 (0.0141)
Basic controls		×	×	×	×	×	×
Comorbidity controls			×	×	×	×	×
Discharge weights		×	×	×	×	×	×
Hospital fixed effects	×	×	×		×	×	
State fixed effects				×			×
State trends					×		

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
Linear probability regressions where dependent variable equals one if the patient had a PTCA or CABG performed. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Basic controls are year dummies and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit), and a quadratic in HMO penetration. Non-Econ Cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends. Inpatient obs. = 1,455,852; Hospitals = 3855.

tell how many patients are later readmitted with complications or required additional procedures.

CABG produces higher physician and hospital fees than PTCA and consequently may be more lucrative (and therefore provides an incentive for providers to choose it on induced demand or offensive medicine grounds). Most recently, Huckman (2006) calculated that the profit margin for CABG is 25% higher than that of PTCA.[10] PTCA is a substitute only for CABG when there is a blockage on one or two arteries. If the blockage is on three or four arteries, the prevailing standard is to perform CABG (Manchanda et al., 2009; Eagle et al., 2004). We therefore distinguish between CABG with 1 or 2 arteries bypassed and CABG with 3 or 4 arteries bypassed. Tort reform should have an impact only when physicians have discretion about the choice of treatment, and we therefore expect to see an impact mostly when one or two arteries are blocked.

There could be incentives to choose PTCA on defensive medicine grounds, even if CABG would be a potentially better treatment option. PTCA is far less invasive and consequently may be safer for the doctor because of lower short-run complication rates relative to CABG, and lower liability risk for less intensive interventions (Jena et al., 2011).[11] We use those who are uninsured as a potential control group. Defensive medicine incentives to provide care should be similar for the uninsured and the insured, whereas offensive medicine incentives should be different (hospitals have little financial incentive to provide the uninsured with more care for reimbursement purposes.)

3. Treatment intensity results

Tables 1–4 present the effect of reform for any major treatment, PTCA, CABG, and CABG by number of arteries respectively. In the first three tables, Column 1 presents unweighted results with only hospital fixed effects (the remaining columns report weighted results); Column 2 presents results with "basic" controls, which include demographic controls and health insurance status and are weighted according to NIS patient discharge weights; Column 3 adds controls for comorbidity factors to the basic controls and is our preferred specification; Column 4 reruns the regression of Column 3 but with state fixed effects instead of hospital fixed effects; and Columns 5 through 7 explore the effect of linear state trends and lead and lags of reform.[12] The remaining tables extend this analysis to test for whether the effects of reform are different by insurance status (Table 5), whether overall costs are affected (Table 6), whether hospital or patient characteristics change as a result of reform (Tables 7 and 8), and whether tort reform affects mortality rates (Table 9).

Table 1 presents the results for "Any Major Treatment," defined as having had PTCA or CABG performed. Depending on the specification, the probability of receiving any major treatment declines between 1.25 and 2 percentage points after adoption of caps on non-economic damages. The rate of major interventions overall for the sample is 41%, suggesting that tort reform leads to a relatively modest percentage decline in the intervention rate. This outcome is also consistent with most previous work that finds that tort reform has, if anything, a small effect on costs and practice behavior. The coefficient on *Non-Economic Cap* is robust to the inclusion of state

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[10] Huckman cites additional studies which claim that open heart surgery has been the most profitable procedure in many hospitals for at least three decades, and that average margins have usually been 40%.

[11] Cram (2005) found that the rate of death for PTCA compared with CABG was 2.1 versus 4.7 percent for specialty hospitals and 3.2 versus 6.0 percent for general hospitals. It should be noted that CABG is often performed if PTCA results in complications. It is unclear from the paper whether this fact was taken into account in determining the odds of death.

[12] As an additional robustness check, in unreported regressions we excluded one adopting state in each regression. The results show that no one adopting state is driving the outcome. The magnitude of the PTCA and CABG results remained roughly the same, though they at times lose significance. However, if we cut the sample to large or urban hospitals, we get significant results for CABG again.

Table 2
PTCA and tort reform.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Non-econ cap	−0.0195** (0.00538)	−0.0209** (0.00600)	−0.0175** (0.00710)	−0.0198+ (0.0103)	−0.0206* (0.00791)		
Other reform	0.00623 (0.0113)	0.00803 (0.00949)	0.0076 (0.00949)	−0.00833 (0.0119)	0.0103 (0.00870)	0.00856 (0.00980)	0.00861 (0.00976)
≤−3 years non-econ cap							0.0154 (0.0114)
−2 years non-econ cap							0.00912 (0.00963)
−1 year non-econ cap							0.0122 (0.00839)
Year of non-econ cap						−0.0137 (0.00984)	
+1 year non-econ cap						−0.0186+ (0.00941)	−0.00485 (0.00836)
≥+2 years non-econ cap						−0.0223** (0.00572)	−0.00829 (0.0103)
Basic controls		×	×	×	×	×	×
Comorbidity controls		×	×	×	×	×	×
Discharge weights		×	×	×	×	×	×
Hospital fixed effects	×	×	×		×	×	
State fixed effects				×			×
State trends					×		

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
Linear probability regressions where dependent variable equals one if the patient had a PTCA performed. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Basic controls are year dummies and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit), and a quadratic in HMO penetration. Non-Econ Cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends. Inpatient obs. = 1,455,852; Hospitals = 3855.

dummies instead of hospital fixed effects (see Column 4) as well as state-specific linear trends (Column 5). Column 6, which allows reform to have lagged effect, suggests an increasing effect of reform two years out. Column 7, testing leads and lags, demonstrates that there was no measureable pre-reform trend. *Other Reform* is never significant. While some of the estimated effects of *Non-Economic Cap* are barely significant at the 5% level, the lagged results are much stronger, suggesting that the effect of reform is somewhat delayed and is biased downward in the straightforward before and after specifications. In sum, there is robust evidence of a modest decline in major interventions after tort reform, the effect increases a bit over time, and there is no evidence of legislative endogeneity.

Table 3
CABG and tort reform.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Non-econ cap	0.00674* (0.00265)	0.00615* (0.00244)	0.00510* (0.00252)	0.00548 (0.00567)	0.00112 (0.00359)		
Other reform	−0.0002 (0.00508)	0.0006 (0.0053)	0.00100 (0.00489)	−0.0073 (0.00497)	−0.00274 (0.00435)	0.000405 (0.00537)	0.000352 (0.00528)
≤−3 years non-econ cap							−0.00872 (0.00556)
−2 years non-econ cap							−0.00254 (0.00358)
−1 year non-econ cap							−0.00423 (0.00444)
Year of non-econ cap						0.00673 (0.00475)	
+1 year non-econ cap						0.0102* (0.00402)	0.00336 (0.00609)
≥+2 years non-econ cap						0.00524* (0.00262)	−0.00184 (0.00527)
Basic controls		×	×	×	×	×	×
Comorbidity controls		×	×	×	×	×	×
Discharge weights		×	×	×	×	×	×
Hospital fixed effects	×	×	×		×	×	
State fixed effects				×			×
State trends					×		

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
Linear probability regressions where dependent variable equals one if the patient had a CABG performed. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Basic controls are year dummies and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit), and a quadratic in HMO penetration. Non-Econ Cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends. Inpatient obs. = 1,455,852; Hospitals = 3855.

Table 4a

CABG probabilities on one or two arteries only.

	(1)	(2)	(3)	(4)	(5)	(6)
Non-econ cap	0.00442*	0.00619*	0.00634*	0.00142		
	(0.00222)	(0.00228)	(0.00265)	(0.00243)		
Other reform	−0.00371	−0.00614	−0.00332	−0.00595	−0.00372	−0.00371
	(0.00370)	(0.0489)	(0.00404)	(0.00305)	(0.00341)	(0.00353)
≤−3 years non-econ cap						−0.00201
						(0.00515)
−2 years non-econ cap						0.00313
						(0.00410)
−1 year non-econ cap						−0.000731
						(0.00520)
Year of non-econ cap					0.0009	
					(0.00475)	
+1 year non-econ cap					0.00830*	0.00738
					(0.00356)	(0.00457)
≥+2 years non-econ cap					0.00503*	0.00391
					(0.00236)	(0.00540)
Basic controls	×	×	×	×	×	×
Comorbidity controls	×	×	×	×	×	×
Discharge weights	×	×	×	×	×	×
Hospital fixed effects	×	×	×	×	×	×
State fixed effects	×	×	×	×	×	×
Only large hospitals		×				
Only urban hospitals			×			
State trends				×		

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
Linear probability regressions where dependent variable equals one if the patient had a CABG performed on one or two arteries. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Basic controls are year dummies and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit), and a quadratic in HMO penetration. Non-Econ Cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends. Inpatient obs. = 1,455,852/Hospitals = 3855 for full sample; Inpatient obs. = 1,268,591/Hospitals = 2346 for Urban Sample; Inpatient obs. 939,616/Hospitals = 1519 for Large Hospital Sample.

Table 4b

CABG probabilities on 3 or 4 arteries.

	(1)	(2)	(3)	(4)	(5)	(6)
Non-econ cap	0.00066	−0.00119	0.00169	0.0004		
	(0.00213)	(0.00359)	(0.00223)	(0.0239)		
Other reform	0.00490*	0.00197	0.00582*	0.00553*	0.00461*	0.00460*
	(0.00227)	(0.00435)	(0.00243)	(0.00245)	(0.00227)	(0.00225)
≤−3 years non-econ cap						−0.0052+
						(0.00265)
−2 years non-econ cap						−0.0045**
						(0.0016)
−1 year non-econ cap						−0.00198
						(0.00218)
Year of non-econ cap					0.00435*	
					(0.00197)	
+1 year non-econ cap					0.00132	−0.00312
					(0.00195)	(0.00211)
≥+2 years non-econ cap					−0.0001	−0.00491*
					(0.00219)	(0.00208)
Basic controls	×	×	×	×	×	×
Comorbidity controls	×	×	×	×	×	×
Discharge weights	×	×	×	×	×	×
Hospital fixed effects	×	×	×	×	×	×
State fixed effects	×	×	×	×	×	×
Only large hospitals		×				
Only urban hospitals			×			
State trends				×		

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
Linear probability regressions where dependent variable equals one if the patient had a CABG performed on three or four arteries. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Basic controls are year dummies and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit), and a quadratic in HMO penetration. Non-econ cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends. Inpatient obs. = 1,455,852/Hospitals = 3855 for full sample; Inpatient obs. = 1,268,591/Hospitals = 2346 for Urban Sample; Inpatient obs. 939,616/Hospitals = 1519 for Large Hospital Sample.

Table 5
Triple differences, private, medicare, medicaid coverage relative to no coverage.

	(1) PTCA	(2) CABG	(3) CABG 1 or 2 Arteries	(4) CABG 3 or 4 Arteries
Regression with any coverage				
Non-econ cap × any coverage	−0.00321	0.0101[+]	0.00660*	0.00410
	(0.00702)	(0.0059)	(0.00328)	(0.00458)
Regression with coverage type				
Non-econ cap × private coverage	−0.0001	0.0100*	0.00610[+]	0.00402
	(0.00570)	(0.00506)	(0.00340)	(0.00416)
Non-econ cap × medicare coverage	−0.00413	0.0104	0.00628[+]	0.00417
	(0.00851)	(0.00637)	(0.00337)	(0.00479)
Non-econ cap × medicaid coverage	−0.0108	0.0161	0.0124*	0.00302
	(0.0105)	(0.0101)	(0.00496)	(0.00704)

** Sig. at <0.01 level; * Sig. at <0.05 level; [+] Sig. at <0.10 level.
Each column reports two regressions, the first for any health insurance, the second allowing for separate effects by coverage type. In both cases, those with no insurance coverage are the excluded group. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses a Huber–White heteroskedasticity robust with clustering by state. All controls are as before, but include hospital-year, insurance-year, and insurance-state interactions.

Table 6
Log costs and tort reform.

	(1)	(2)	(3)	(4)	(6)	(7)
	Total charges		Costs measured by cost-to-charge ratio			
Non-econ cap	0.0254	−0.0476	−0.0151	−0.0411**		
	(0.0229)	(0.0327)	(0.0218)	(0.0134)		
Other reform	0.0244	0.0219	−0.0210	0.0132	−0.0216	−0.0210
	(0.0286)	(0.0154)	(0.0205)	(0.0218)	(0.0213)	(0.0218)
≤−3 years non-econ cap						0.0326
						(0.0501)
−2 years non-econ cap						0.00519
						(0.0340)
−1 year non-econ cap						0.0329
						(0.0289)
Year of non-econ cap					−0.0285	
					(0.0431)	
+1 year non-econ cap					−0.0114	0.0167
					(0.0191)	(0.0377)
≥+2 years non-econ cap					−0.0143	0.0153
					(0.0230)	(0.0437)
Basic controls	×	×	×	×	×	×
Comorbidity controls	×	×	×	×	×	×
Discharge weights	×	×	×	×	×	×
Hospital fixed effects	×	×	×	×	×	×
State trends		×		×		
	N = 1,417,513 patients; 3826 hospitals			*N* = 1,133,449 patients; 2923 hospitals		

** Sig. at <0.01 level; * Sig. at <0.05 level; [+] Sig. at <0.10 level.
Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Basic controls are year dummies and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit), and a quadratic in HMO penetration. Non-econ cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends.

Table 7
Extensive margin (Hospital Level).

	Large hospital		Teaching hospital		Hospital performs CABG		Hospital performs PTCA	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Non-econ cap	0.0335	0.0180	0.00592	0.00157	0.00252	0.00186	−0.0151[+]	0.0060
	(0.0200)	(0.0222)	(0.00500)	(0.00784)	(0.00890)	(0.00411)	(0.00889)	(0.0205)
Other reform	0.0018	0.0105	−0.00183	0.0003	0.0106	0.00481	0.0199*	−0.0306**
	(0.0202)	(0.0067)	(0.0102)	(0.0138)	(0.0109)	(0.00539)	(0.00817)	(0.0105)
State trends		×		×		×		×

** Sig. at <0.01 level; * Sig. at <0.05 level; [+] Sig. at <0.10 level.
N = 6053 hospital-year observations based on 2346 hospitals. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses a Huber–White heteroskedasticity robust with clustering by state. All regressions are linear probability models and include hospital dummies and year dummies. Non-econ cap is a tort reform which caps damages paid for non-economic harm. State trends are state linear time trends.

Table 8
Effect of non-economic damage caps on control variables.

	Female		Age		Private insurance		Medicare/medicaid	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Non-econ cap	0.0022	0.0013	−0.229	0.0342	−0.00505	0.00541	0.00464	−0.00516
	(0.0015)	(0.0056)	(0.173)	(0.185)	(0.00769)	(0.0117)	(0.0107)	(0.0106)
Other reform	0.0013	0.0016	−0.113	−0.0033	−0.00884	−0.00372	0.0170**	0.00417
	(0.0052)	(0.0047)	(0.206)	(0.0486)	(0.00536)	(0.00805)	(0.00444)	(0.00648)
State trends		×		×		×		×

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
$N = 1,268,591$. Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Non-econ cap is a tort reform which caps damages paid for non-economic harm. State trends are state-specific linear time trends.

Tables 2 and 3 present results for each major intervention, PTCA and CABG, separately. The PTCA results are remarkably similar across specifications: caps on non-economic damages are associated with a 1.75–2 percentage point decline in the PTCA rate on a baseline PTCA rate of 32 percent. In the lagged results, there was an increasing effect of reform after 2 years and no evidence of a pre-reform trend. These results qualitatively mirror those of Table 1 but are slightly larger and much more precisely estimated, with our preferred specification in Column 3 significant at less than the 1% level.

The results of Table 3 for CABG, in stark contrast to those for PTCA, generally find that reform *increases* the CABG rate. For the first four specifications, the effect of reform increases CABG by 0.51–0.67 percentage points on a baseline CABG rate of 9.1 percent. The results for CABG are less precisely estimated than those for PTCA, with the coefficient on *Non-EconCap* in the first three columns significant at less than the 5% level. In the state-fixed effects results in Column 4, the coefficient on *Non-EconCap* is almost identical to the hospital fixed effect results (0.55 versus .51 percentage points), but is not statistically significant. When state-specific trends are included in Column 5, the coefficient shrinks to 0.11 percentage points and is no longer statistically significant. However, Columns 6 and 7 suggest that there is potentially a delayed effect of reform. In such cases, state-specific trends may bias the effect of reform to zero (for a discussion of this possibility, see Wolfers, 2006).

CABG by itself may not be the ideal dependent variable. CABG is the preferred treatment for those with blockages in more than two arteries and such cases may not be responsive to a reduction in liability or patients' insurance status. When one or two arteries are blocked, however, PTCA and CABG may be substitutes. We therefore anticipate that CABG rates on 1 or 2 arteries should be most responsive to a cap on non-economic damages and insurance status because healthcare providers have more discretion in that case. Moreover, small hospitals and rural hospitals are unlikely to offer CABG given the substantial fixed costs of the procedure. Thus, providers do not have discretion on the intensive or extensive margins in such circumstances. Only 24% of all hospital-year observations in the sample provide CABG compared to 40% and 45% for samples limited to urban or large hospitals respectively. Therefore, we report subsample results on larger and urban hospitals, and get larger and more precisely estimated coefficients. (The PTCA results for these groups, while not reported, did not change appreciably by the subgroup.)

With this in mind, Tables 4a and 4b divide CABG into CABG on one or two arteries and CABG on three or four arteries respectively. CABG12 takes on the value one if CABG was performed on one or two arteries and zero otherwise, and CABG34 takes on the value one if CABG was performed on three or four arteries and zero otherwise.

Column 1 of Table 4a shows the coefficient on *Non-EconCap* for CABG12 is .44 percentage points and is significant (p-value of .042).

Table 9
Non-economic damage caps and death rates from coronary heart disease.

	Death rate per 100k ages 45–90				Death rate per 100k ages 45–65				Death rate per 100k ages 65–90			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Non-econ cap	−3.33	−4.32			−5.10*	−2.89			−17.1	−4.08		
	(5.10)	(3.67)			(2.53)	(1.98)			(14.4)	(13.8)		
≤−3 years non-econ cap				0.32				2.57				10.3
				(4.78)				(3.55)				(20.4)
−2 years non-econ cap				1.90				4.43				3.87
				(4.46)				(2.84)				(12.2)
−1 year non-econ cap				2.46				3.74				6.43
				(4.03)				(2.92)				(11.7)
Year of non-econ cap			−0.77				−2.92				−9.13	
			(4.05)				(3.09)				(16.3)	
+1 year non-econ cap			−2.86	−2.12			−5.17+	−2.26			−4.85	4.28
			(5.27)	(2.54)			(2.84)	(2.68)			(18.3)	(8.07)
≥+2 years non-econ cap			−3.89	−3.24			−5.49*	−2.65			−20.6	−11.1
			(5.50)	(3.69)			(2.66)	(2.72)			(14.6)	(13.4)
State trends		×				×				×		

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
$N = 1000$ state-year observations, 1990 through 2009. Data from the NIH Vital Statistics Death Records. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Non-econ cap is a tort reform which caps damages paid for non-economic harm. Control variables are state dummies, year dummies, percent in the state lacking insurance coverage, percent covered by HMOs, the unemployment rate, the poverty rate, and per capita income. State trends are state-specific linear time trends. Caps on punitive damages, collateral source reform, and joint and several liability reform were also included in regressions but were never individually significant. Average death rate per 100,000 for the sample is 240; 103 for ages 45–65; and 730 for ages 65–90.

By contrast, the coefficient on *Non-EconCap* for CABG34 (Table 4b) is 0.06 percentage points with a standard error of .21. When state trends are added, the effect of *Non-EconCap* on CABG12 is reduced to 0.14 percentage points and is no longer statistically significant (see Table 4a, column 4). However, when we investigate lagged effects in Column 5 we find a stronger result for CABG12. There is little effect the first year, but much larger effects one and two-plus years post-reform, both of which are easily significant at less than the 5% level. Moreover, there is no evidence of a pre-reform trend in adopting states. In such circumstances, state-specific trends will bias the estimated effect of reform downward. Given the necessary time and expense for adding capacity for CABG, the delayed effect of reform is expected.[13] By contrast, the lagged effects and pre-reform trends for CABG34 show there is a small, positive blip at the time of reform, but no consistent or long-term impact and no evidence of a pre-reform trend. Our preferred estimates are therefore those without state trends, and both the strongest and theoretically most credible results allow for a lagged effect.

To test explicitly for the relative effects of tort reform among those with different insurance, we estimate triple-difference regressions reported in Table 5. Appendix Table A4 also reports results separately by insurance status. True triple differences in this context would include hospital-year, insurance-year, and hospital-insurance interactions. However, many hospitals report no or very few uninsured or Medicaid patients, so we opt for state-insurance interactions instead of hospital-insurance interactions. Those without insurance are the excluded category, and we report two regressions in each column: the first is an estimate of the effect of reform if one has insurance coverage versus not, and the second a regression which allows for different effects by private coverage, Medicare coverage, and Medicaid coverage. Triple differences have the effect of absorbing a great deal of time variation, and allow for hospital-year effects, which would help account for unobservable changes in hospital managements and patient populations over time. The results demonstrate no differential effect of PTCA by insurance type. However, CABG increases after reform for those with insurance coverage (Table 5, column 2), and in particular for CABG performed on one or two arteries (Table 5, column 3), where doctors have more discretion. The effect is not statistically different between insurance coverage types (i.e., the effect of reform on CABG for those with Medicare or Medicaid coverage is not different than those with private insurance).

The CABG results demonstrate an interaction between tort reform (which reduces doctors' liability risk), doctor discretion, and reimbursement mechanisms. When doctors have discretion and patients have the ability to pay, tort reform increased the provision of the most invasive and remunerative procedure, CABG, even while reducing the provision of PTCA. (See also Appendix Table A4). We believe this result is consistent with reform enabling health care providers to steer patients to more remunerative care which is only valuable if providers are confident of payment. It is possible, however, that tort reform created more flexibility in the provision of care, but that this flexibility was extended only to those who could pay.

To further explore the net effect of tort reform on treatment intensity, Table 6 reports results for log costs and total charges. The total charge results for *Non-Econ Caps* are statistically insignificant and change signs when state trends are added. This is perhaps not surprising as hospital charges are notoriously variable across institutions. When we adjust charges by the cost-to-charge ratio files

provided by the NIS, the coefficient on *Non-Econ Cap* in Column 3 is negative but not statistically significant. When state trends are added in Column 4, costs decline by over four percent after enactment of a cap, and this result is significant at the less than 1% level. Moreover, the coefficient on *Non-Econ Cap* in Column 4 is quite similar to that estimated for total charges in Column 2. Columns 6 and 7 report lagged effects and then leads and lags. The pre and post-reform dummies suggest a trend toward increasing costs that was broken by reform, but the effects of leads and lags are very imprecisely estimated. In sum, the cost results do not present the same clear picture as the other measures of treatment intensity. A decrease in costs is only present when state trends are included in the specification. On balance, the strong upwards trends over time in medical costs are well-known, and perhaps militate toward a specification that includes state specific trends. Moreover, the coefficient estimates of the effect *Non-Econ Cap* on costs are in line with other estimated effects liability limitations on heart patients presented in Kessler and McClellan (2002) of around four percent.

Table 7 examines whether tort reform changed the *extensive* margin by changing the probability that a hospital offers PTCA or CABG, becomes a teaching hospital, or becomes "large." We find no statistically significant changes. Given the small impacts on treatment choices, it is unlikely that tort reform itself would cause measurable changes in hospital structure due to the fixed costs associated with performing PTCA and CABG. Therefore, we regard Table 7 as something of a placebo test of reform. The coefficient on *Other Reform* is significant in the "Hospital Performs PTCA" regressions, but it changes signs when we include state trends.

Finally, Table 8 reports dependent variables of patient demographics as a straightforward placebo test. We run our basic specification taking age, sex, and insurance status of the patients as the dependent variables and find no change in patient demographics after tort reform.

4. Tort reform and mortality

The changes to treatment intensity documented here suggest that practitioners are sensitive to liability exposure and insurance coverage. However, the intensity results do not answer questions about quality of care. To gauge the effect of tort reform on quality of care, we consider changes in state-level myocardial infarction and coronary heart disease mortality rates before and after tort reform. Mortality is not the only measure of care quality, but it is well measured and is undeniably an important aspect of care, particularly since heart disease remains a leading cause of death. Mortality results will also verify that deaths outside of the hospital or emergency room deaths did not change the composition of the in-patient sample.[14]

We collected data on deaths for coronary heart disease and myocardial infarction from the National Vital Statistics Mortality files for 1990–2009.[15] The cause of death on death certificates is often recorded as "coronary heart disease" instead of the more specific "myocardial infarction" or "angina" (National Institutes of Health, 2012). For this reason, the NIH prefers to use deaths from

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[13] Huckman (2006) finds that the average fixed cost associated with initiating a CABG surgery programs is about $14 million, while only about $2.7 million for PTCA. These costs do not include the cost of nurses and technologists.

[14] The NIS data report in-hospital mortality rate, but this is not a good measure of long-term outcomes. Deaths outside the hospital would not be reflected in the data. Moreover, the in-hospital death rate might theoretically be affected by changes in practice resulting from caps on non-economic damages. Reducing PTCA and increasing CABG could affect both the length of hospital stay, thereby changing the time at risk for in-hospital deaths, and the composition of patients who remain in the hospital. In unreported regressions we investigated the impact of tort reform on in-hospital mortality rate and found no statistically significant effect.

[15] We increased the sample time frame to get more power, although the results were similar qualitatively if we limited our mortality sample to 1998–2009.

coronary heart disease to track mortality rates from heart disease over time. However, myocardial infarctions are by far the most common cause of death from coronary heart disease. Following the NIH, our preferred specifications report results based on mortality due to coronary heart disease. In the Appendix, we report mortality rates based on myocardial infarctions and obtain qualitatively similar results. The data also code both the "state of occurrence" of death as well as "state of residence" of the decedent. In practice the two are quite correlated, but we choose to use "state of occurrence" as that will most likely reflect the tort law in the jurisdiction that administered primary treatment.

The risk of death from coronary heart disease increases dramatically with age. We deal with this in two ways. First, we report full sample results, but we also divide the sample into those aged 45–64 and those aged 65–90. This cuts the sample at Medicare eligibility, which has been shown to affect mortality, particularly for emergency-room type admissions such as heart attacks (Card et al., 2009). In addition, it helps us test for differential effects by age group. For example, improvements in mortality for younger patients with heart disease may show up later as mortality in the older group. Second, we control for the percent of the sample contained within each five-year age group by state. This data is from the U.S. Census Bureau yearly state population estimates.

Death rates for coronary heart disease have declined dramatically since their peak in 1968, falling nearly 75 percent on an age-adjusted basis (NIH 2012). Incidence, prevalence, and hospitalization rates for coronary heart disease have all declined in a similar fashion (Id). Nonetheless, a great deal of interstate heterogeneity persists in coronary heart disease death rates, with the worst state, New York, having more than two-and-a-half times the age-adjusted death rate of the best performing state, Utah (Id.). To account for the heterogeneity across states and the potential for biasing time trends, we include state-specific trends in some specifications and carefully consider leads and lags of reforms.[16] We also control for the percent in the state lacking insurance coverage, HMO penetration, the unemployment rate, the poverty rate, and per capita income.

Table 9 reports OLS regressions taking the mortality rate for coronary heart disease per 100k of the age group specified as the dependent variable. The level of observation is state-year. (Appendix Table A5 reports the mortality rate for only those coded as myocardial infarctions.) Column 1 shows that a cap on non-economic damages is associated with a decline of 3.3 deaths per 100,000 for those aged 45 to 90 with a standard error of 5.1. When state trends are added in Column 2, the results do not change qualitatively. Columns 3 and 4, which report leads and lags of reform, show that the lagged effect of reform may increase over time, but this is not precisely estimated.

When the sample is split into the two age groups, the results are much more precisely estimated for those aged 45–65. The baseline result (Column 5) suggests a decline in mortality of around 5.1 per 100,000 after reform for this age group, but this result is no longer significant when state trends are added. However, the leads and lags suggest both that there is no pretrend, but there is statistically significant delayed effect of reform. This is similar to the results obtained for treatment intensity, in which the effect of reform increases in the second and third years. Under such circumstances, the inclusion of state-specific trends is likely to bias the estimated effect of reform toward zero because including state trends conditions out some of the increasing effect of reform.

The point estimates for the older age group, 65–90 year olds, are much larger, which is perhaps to be expected given their much higher mortality rate. However, the effect of reform is much less precisely estimated. Indeed, it may well be more difficult to affect mortality for this age group, and any benefit to mortality for younger patients with heart conditions may show up as later mortality.

Relative to the underlying mortality rates, tort reform is associated with a decrease in mortality from coronary heart disease. For example, the mortality rate for the 45–90 population in the sample time frame is 240 per 100,000. Taking the point estimate of 3.3 from column 1, this implies a roughly 1.4 percent decline in mortality after tort reform. (Regressions taking the log of the mortality rate were of a similar magnitude.) However, the results are only significant for the younger age group, and sometimes the confidence intervals allow for small increases in the mortality rate. We interpret these results as evidence that tort reform either slightly decreases or has no meaningful effect on coronary heart disease mortality rates, despite a measureable effect on treatment intensity.

5. Conclusion

Using data on almost 1.5 million inpatients observed between the years 1998 and 2009 and aged 45–90 whose primary diagnosis was acute myocardial infarction (heart attack), we find robust evidence that caps on non-economic damages simultaneously increase and decrease treatment intensity, with an overall net decrease. Accounting for state-specific trends, costs decline by as much as four percent after a non-economic damage cap is adopted, and the probability of receiving angioplasty declines by two percentage points with or without state trends. Overall, the probability of an invasive procedure (PTCA or CABG) declines between 1.25 and 2 percentage points. There is no evidence of legislative endogeneity, and the effect of reform increases in the two years after reform. These results provide evidence that damage limitations can reduce treatment intensity. Moreover, based on mortality data, patient outcomes did not change greatly, and may have slightly improved, even though treatments changed. Taken together, the intensity and mortality results suggest that tort reform reduced intensity of treatment without increasing adverse outcomes as measured by death. This combination of results is most consistent with a decrease in defensive medicine following tort reform.

This conclusion is tempered by our findings regarding CABG rates. We find that caps on non-economic damages increase the probability a by-pass is performed, particularly when providers face patients whose medical condition enables providers to choose between PTCA or CABG. This effect is most evident for insured patients, which is when healthcare providers have the strongest financial incentives to pursue CABG.

Although there is some evidence of offensive medicine or induced demand, the overall effect of a non-economic damage cap is a net reduction in treatment intensity. Overall, the probability of an invasive procedure (PTCA or CABG) declines, and net costs probably decrease. This raises a couple important policy implications. First, the effect of tort reform may be heterogeneous across treatments and conditions. In cases such as heart disease or birth where there are substitute procedures available to doctors, tort reform may encourage riskier but more remunerative procedures. Second, for tort reform to be fully effective in reducing treatment intensity in such cases, additional interventions in the form of payment scheme management is necessary.

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[16] In unreported regressions, we included quadratic time trends as well with much the same results.

Our results lend some support to the prior work of Kessler and McClellan (1996, 2002) which found that cardiac care was sensitive to liability rules. More importantly, these results are consistent with a growing literature that finds that tort reform has heterogeneous affects by practice area and, moreover, would not necessarily lead to a decrease in treatment intensity (Currie and MacLeod, 2008; Shurtz, 2014). Moreover, our results contribute to the broader literature on treatment intensity and induced demand. They are qualitatively similar in some respects to those of Kim (2011), who used NIS data and changes in Medicare reimbursement policies, instead of tort reform, to assess the probability of receiving CABG.

Appendix.

Tables A1–A5.

Table A1
Year of reform enactments (Strike-Downs) in states which appear in NIS dataset 1998–2009.[a]

Caps on non-economic damages	Periodic payment	Joint and several liability	Caps on punitive damages	Collateral source rule reform
FL 2003	GA 2005	NV 2003	MO 2006	PA 2002
GA 2005	NY 2004	PA 2002	OH 2005	WV 2003
NV 2003	OH 2003	SC 2006		
OK 2004	PA 2002			
(OR 2000)	TX 2004			
SC 2006				
TX 2004				
(WI 2007)				
WV 2003				

[a] Note that Georgia, Nevada, South Carolina, Texas and West Virginia adopted other reforms at the same time as a non-economic damage cap. Oklahoma has not entered the NIS dataset until 2005 (See Appendix Table A3).

Table A2
Summary statistics.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
# Observations	111,225	111,031	119,841	116,881	120,110	120,250	102,965	98,642	99,193	96,706	100,795	98,264
% Caps	30.3%	27.9%	25.9%	20.2%	22.6%	31.4%	40.0%	43.7%	45.0%	46.1%	45.0%	42.2%
AGE (years)	68.7	68.9	68.9	69.1	68.8	68.7	68.5	68.8	68.2	68.2	68.3	67.9
% Female	39.9%	40.2%	40.5%	40.7%	40.6%	40.7%	40.6%	40.5%	39.7%	39.9%	39.9%	39.3%
% Admission	75.1%	75.7%	77.0%	77.1%	79.1%	80.6%	80.6%	82.5%	83.4%	83.4%	83.2%	85.0%
Length of stay (days)	5.9	5.8	5.8	5.7	5.7	5.7	5.7	5.5	5.4	5.3	5.2	5.2
Number of procedures	3.09	3.19	3.36	3.57	3.7	3.80	3.93	4.28	4.84	4.86	5.05	5.18
Charges (2009$)	35,241	36,039	39,965	41,671	49,200	54,564	57,385	59,925	61,633	61,904	64,390	67,949
Costs (apicc)	–	–	–	0.45	0.42	0.40	0.38	0.37	0.36	0.35	0.34	0.33
Costs (gapicc)	–	–	–	0.47	0.45	0.44	0.41	0.40	0.39	0.38	0.38	0.35
% Medicare insurance	58%	60%	60%	60%	60%	61%	60%	61%	59%	59%	58%	58%
% Medicaid	5%	4%	4%	5%	5%	5%	5%	5%	5%	5%	6%	6%
% Private insurance	34%	32%	32%	31%	31%	30%	30%	29%	30%	30%	30%	29%
% Uninsured	4%	4%	4%	4%	4%	4%	5%	5%	6%	6%	6%	7%
% CABG	11.3%	11.05%	11.4%	10.9%	10.9%	10.0%	8.2%	12.5%	8.5%	8.7%	8.1%	8.8%
% PTCA	24.8%	26.0%	28.9%	32.2%	33.3%	35.2%	32.6%	36.7%	39.3%	41.6%	43.4%	44.9%
%Hospitals performingPTCA	32.1%	30.6%	30.8%	30.6%	30.9%	33.0%	33.2%	34.2%	35.0%	36.0%	36.8%	36.7%
%Hospitals performingCABG	19.5%	19.8%	22.0%	22.6%	23.0%	24.8%	23.9%	24.8%	26.3%	26.0%	25.6%	26.9%

Data is from the H-CUP National Inpatient Sample for years 1998–2009. Sample is aged 45 through 90 whose primary diagnosis is having an acute myocardial infarction.

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Table A3
States included in the NIS dataset, 1998–2009.

Year	Number of states	States in the dataset	Changes
1998	22	AZ CA CO CT FL GA HI IL IA KS MD MA MO NJ NY OR PA SC TN UT WA WI	
1999	24	AZ CA CO CT FL GA HI IL IA KS MD MA ME MO NJ NY OR PA SC TN UT VA WA WI	Added ME, VA
2000	28	AZ CA CO CT FL GA HI IL IA KS KY MD MA ME MO NC NJ NY OR PA SC TN TX UT VA WA WI WV	Added KY, NC, TX, WV
2001	33	AZ CA CO CT FL GA HI IL IA KS KY MD MA ME MI MN MO NC NE NJ NY OR PA RI SC TN TX UT VA VT WA WI WV	Added MI, MN, NE, RI, VT
2002	35	CA CO CT FL GA HI IL IA KS KY MD MA ME MI MN MO NC NE NJ NY NV OH OR PA RI SC SD TN TX UT VA VT WA WI WV	Added NV, OH, SD; AZ data were not available
2003	37	AZ CA CO CT FL GA HI IL IN IA KS KY MD MA MI MN MO NC NE NH NJ NY NV OH OR PA RI SC SD TN TX UT VA VT WA WI WV	Added AZ, IN, NH; ME data were not available
2004	37	AR AZ CA CO CT FL GA HI IL IN IA KS KY MD MA MI MN MO NC NE NH NJ NY NV OH OR RI SC SD TN TX UT VA VT WA WI WV	Added AR; PA data were not available
2005	37	AR AZ CA CO CT FL GA HI IL IN IA KS KY MD MA MI MN MO NC NE NH NJ NY NV OH OK OR RI SC SD TN TX UT VT WA WI WV	Added OK; VA data were not available
2006	38	AR AZ CA CO CT FL GA HI IL IN IA KS KY MD MA MI MN MO NC NE NH NJ NY NV OH OK OR RI SC SD TN TX UT VA VT WA WI WV	Added VA
2007	40	AR AZ CA CO CT FL GA HI IL IN IA KS KY MD MA ME MI MN MO NC NE NH NJ NY NV OH OK OR RI SC SD TN TX UT VA VT WA WI WV WY	Added ME and WY
2008	42	AR AZ CA CO CT FL GA HI IL IN IA KS LA KY MD MA ME MI MN MO NC NE NH NJ NY NV OH OK OR PA RI SC SD TN TX UT VA VT WA WI WV WY	Added LA and PA
2009	44	AR AZ CA CO CT FL GA HI IL IN IA KS LA KY MD MA ME MI MN MO MT NC NE NH NJ NM NY NV OH OK OR PA RI SC SD TN TX UT VA VT WA WI WV WY	Added NM and MT

Table A4
Effect of reform by insurance status.

	(1) Log costs (Hospital)	(2) CABG or PTCA	(3) PTCA	(4) CABG	(5) CABG 1 or 2 arteries	(6) CABG 3 or 4 arteries
Medicare						
Non-econ cap	0.00110	−0.0118[+]	−0.0200**	0.0081*	0.0062*	0.0016
	(0.0244)	(0.0061)	(0.0052)	(0.0032)	(0.0026)	(0.0021)
Non-econ cap (state trends)	−0.0384**	−0.0207[+]	−0.0209*	0.000226	0.00295	−0.00294[+]
	(0.0131)	(0.0105)	(0.00801)	(0.00332)	(0.00296)	(0.00146)
Observations	694,032	894,335	894,335	894,335	894,335	894,335
Private insurance						
Non-econ cap	−0.0349	−0.0157[+]	−0.0230*	0.00739[+]	0.00499	0.00221
	(0.0215)	(0.00812)	(0.00895)	(0.00418)	(0.00418)	(0.00275)
Non-econ cap (state trends)	−0.0469*	−0.0240[+]	−0.0294**	0.00539	0.000198	0.00423
	(0.0206)	(0.0130)	(0.0103)	(0.00767)	(0.00671)	(0.00303)
Observations	339,574	435,054	435,054	435,054	435,054	435,054
Medicaid						
Non-econ cap	0.00252	−0.0243[+]	−0.0297**	0.00537	0.00723	−0.00167
	(0.0241)	(0.0120)	(0.0109)	(0.00774)	(0.00564)	(0.00732)
Non-econ cap (state trends)	0.00422	−0.00692	−0.00630	−0.000621	0.000388	−0.000288
	(0.0215)	(0.0201)	(0.00973)	(0.0145)	(0.0104)	(0.00703)
Observations	46,471	59,503	59,503	59,503	59,503	59,503
Uninsured						
Non-econ cap	−0.0270	−0.0140	−0.00875	−0.00525	−0.00400	−0.00202
	(0.0345)	(0.00846)	(0.00950)	(0.00695)	(0.00583)	(0.00325)
Non-econ cap (state trends)	−0.0736[+]	−0.0242	−0.00386	−0.0203	−0.0103	−0.0117
	(0.0386)	(0.0285)	(0.0215)	(0.0168)	(0.0112)	(0.00832)
Observations	47,935	59,872	59,872	59,872	59,872	59,872

** Sig. at <0.01 level; * Sig. at <0.05 level; [+] Sig. at <0.10 level.
Data is from the H-CUP National Inpatient Sample for years 1998–2009. Standard errors in parentheses a Huber–White heteroskedasticity robust with clustering by state. Sample is aged 45 through 90 whose primary diagnosis is acute myocardial infarction. Regressions (2) through (6) are linear probability regressions. All regressions include hospital dummies, year dummies, and demographic controls for age, age squared, health insurance (Medicaid, Medicaid, private insurance, uninsured), sex, and hospital controls (dummies for three categories of hospital size, types of hospital: teaching versus non-teaching and for-profit versus not-for-profit). Non-econ cap is a tort reform which caps damages paid for non-economic harm such as pain and suffering, emotional distress, etc. State trends are state linear time trends.

Table A5
Non-economic damage caps and death rates from myocardial infarction.

	Standardized death rate per 100k (ages 45–90)				Death rate per 100k Ages 45–65				Death rate per 100k Ages 65–90			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Non-econ cap	−2.59	−3.39			−4.40*	−2.31			−0.78	−4.71		
	(4.82)	(4.54)			(2.10)	(1.88)			(7.94)	(8.30)		
≤−3 years Cap				0.689				3.13				0.36
				(8.89)				(2.41)				(4.83)
−2 years Cap				−0.825				3.87				−0.36
				(7.62)				(2.38)				(4.89)
−1 year Cap				3.640				3.68				1.80
				(5.92)				(2.47)				(4.24)
Year of Cap			−0.90				−3.28				−0.47	
			(7.20)				(2.20)				(3.99)	
+1 year Cap			−2.49	−1.63			−4.40*	−1.12			−0.81	−1.33
			(8.85)	(6.93)			(2.14)	(1.38)			(5.16)	(3.17)
≥+2 years Cap			−0.46	0.35			−4.18+	−0.94			−1.79	−0.38
			(8.60)	(7.05)			(2.16)	(1.46)			(5.29)	(3.70)
State trends			×				×				×	

** Sig. at <0.01 level; * Sig. at <0.05 level; + Sig. at <0.10 level.
N = 1000 state-year observations, 1990 through 2009. Data is from the NIH Vital Statistics Death Records. Standard errors in parentheses are Huber–White heteroskedasticity robust with clustering by state. Non-econ cap is a tort reform which caps damages paid for non-economic harm. Control variables are state dummies, year dummies, percent in the state lacking insurance coverage, percent covered by HMOs, the unemployment rate, the poverty rate, and per capita income. State trends are state-specific linear time trends. Caps on punitive damages, collateral source reform, and joint and several liability reform were also included in regressions but were never individually significant. Average death rate per 100,000 for the sample is 240; 103 for ages 45–65; and 730 for ages 65–90.

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