5-4-2016

Essays on Insurance Markets and Regulation

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BY

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

Doctor of Philosophy

In the Robinson College of Business

Of

Georgia State University

GEORGIA STATE UNIVERSITY
ROBINSON COLLEGE OF BUSINESS
2016

ACCEPTANCE

This dissertation was prepared under the direction of the Yiling Deng Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ABSTRACT

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May 4th, 2016

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Major Academic Unit: Department of Risk Management and Insurance

The dissertation consists of two essays on insurance markets and regulation. The first essay studies the timing of state-level tort reform enactments between 1971 and 2005. Using discrete time hazard models, we find the level of litigation activity---as measured by incurred liability insurance losses, the number of lawyers, and tort cases commenced---to be the most important and robust determinant of tort reform adoption. Political-institutional factors and regional effects---such as Republican control of the state government, single party control of the legislature and governorship, and a (relatively) conservative political ideology among a state's Democrats---are also associated with quicker reform adoption.

In the second essay, we identify the effect of public guarantees on market discipline by exploiting the rich variation in U.S. state guarantees of property-liability insurer obligations. We find government guarantees significantly reduce the sensitivity of premium growth to changes in financial strength ratings, and that this reduced sensitivity applies to both price and volume changes. The effects are concentrated among insurers rated A- or lower by A.M. Best, the leading financial strength rating agency in the insurance industry. For downgraded insurers, we find that premium growth in business not covered by state guarantees falls in relation to growth in its covered business, with the estimate of the difference being as high as 15% for A- rated insurers and 10% for insurers rated below A-.

ACKNOWLEDGEMENTS

First, I would like to thank my family for always supporting me throughout my Ph.D. studies. I would like to express my deeply gratitude to my parents, Hua Deng and Daqiong Yi, for always allowing and supporting me to pursue what I want to do with my life. I am deeply grateful for my beloved and supportive husband, Haibo Yao, and my exuberant and sweet little boy, Charles Liangyi Yao. Words cannot express my appreciation for your love, patience, and encouragement.

Second, I am deeply grateful for the support and advice from my advisor and dissertation committee members in various research projects. As the dissertation chair, Professor George Zanjani offered exceptional advice and enthusiastic support of my research. I will always be appreciative for the many hours of his time that he gave me and for his constant advice, guidance and encouragement. He is not only the chair of my dissertation, but also the mentor of my scholar career. I am also highly indebted to my doctoral program committees (in the last name order), Professors Conrad Ciccotello, Martin Grace, Tyler Leverty, and Stephen Shore. They all offered significant insights and helpful suggestions to my research. I also want to express my heartfelt thanks to all other professors in the Department of Risk Management and Insurance, especially Professor Charlotte Alexander and Ajay Subramanian. Last, I want to thank Ph.D. students at GSU for emotional support, as well as the CEAR, Huebner Foundation and Risk Management foundation for financial support. I met great people at GSU and had great life in Atlanta.

Essay I: What Drives Tort Reform Legislation?
An Analysis of State Decisions to Restrict Liability Torts

ABSTRACT

This paper studies the timing of state-level tort reform enactments between 1971 and 2005. Using discrete time hazard models, we find the level of litigation activity---as measured by incurred liability insurance losses, the number of lawyers, and tort cases commenced---to be the most important and robust determinant of tort reform adoption. Political-institutional factors and regional effects---such as Republican control of the state government, single party control of the legislature and governorship, and a (relatively) conservative political ideology among a state's Democrats---are also associated with quicker reform adoption.

Key words: Tort reform, insurance, liability crisis
JEL Codes: K1, K23, G22

I. Introduction

Over the past several decades, the United States has experienced several waves of tort reform. The first wave came in the mid-1970's, when a number of states enacted reforms such as caps on non-economic damages, changes to collateral source rules, and limitations on the application of joint and several liability. This was followed by a larger wave in the mid-1980's and another wave in the early 2000's. Figures A1 through A7 in Appendix A display the timing of enactment of tort reforms in the various states.

Much research has been devoted to estimating the impact of tort reforms, with many studies finding that tort reforms have large negative effects on various measures of litigation activity. However, relatively little attention[1] has been paid to the question of why states enact tort reforms, and, as can be seen in the figures, the propensity to reform apparently varies significantly across the states. For example, as can be seen in Table 1, Florida has been extremely aggressive in instituting reforms, while, nearby, South Carolina has stood pat; similarly, one moves from an aggressive to a passive reform environment when one crosses the border from Idaho to Wyoming. Why did some states enact tort reforms while others stood pat? This paper maps out the diffusion of tort reforms across states over time and studies the social, economic and political factors associated with reform decisions. Specifically, we focus on adoptions of four of the most common and prominent liability tort reforms---caps on punitive damages, limitations on joint and several liability laws, caps on noneconomic damages, and changes to collateral source rules---during the 1971-2005 period.

Several theories may help explain the political process of legal change. Building on the segmentation offered by Kroszner and Strahan (1999), *private-interest* or *economic theory* (Stigler, 1971; Peltzman, 1989; Becker, 1983) describes the legislative process as one of competition among interest groups, where well-organized industrial and professional interests capture rents at the expense of more dispersed groups such as consumers. In the case of tort reform, lawyers, physicians, the insurance industry, and businesses are all interest groups to be considered. The *public interest theory* (Joskow and Noll, 1981) features a benevolent legislature with a primary concern of social welfare. In this view, lawmakers identify failures in the current civil justice system and attempt to correct them. A third group of theories emphasize the impact of *political-institutional* factors in the legislative process such as Republican versus Democratic

[1] An important exception is Harrington (1994), who studies the adoption of automobile insurance no-fault laws in the early 1970's.

control (Dixit, 1996; and Irwin and Kroszner, 1999), or the nature of state government ideology (Poole and Rosenthal, 1997; and Berry, 1998). A fourth group emphasizes the impact of legislative outcomes in nearby polities, seeking to explain the *diffusion* of law across borders as being facilitated by, for example, the availability of ideas or templates for reform.[2]

It is important to recognize that these theoretical approaches are by no means diametrically opposed, despite some attempts in the literature to cast them as such. To take but one example, one could imagine interest group lobbying reinforcing a push for reform in the "public interest" that was inspired by legislation in neighboring states and consistent with the ideology of the state legislators. This paper recognizes that the factors identified by these theories may work in concert to influence tort reform enactments. To investigate what drives reform enactment, we use a discrete time proportional hazard model to explain the timing of tort reform adoption. We incorporate proxies for the size of various interest groups, the extent of and costs associated with litigation, political-institutional factors, the liability climate, state insurance regulation, economic conditions, and the presence of reforms in nearby states, and regional effects.

Our most robust finding is that various measures of litigation activity are associated with quicker enactment of tort reform. More lawyers, more tort cases in general jurisdiction courts, and higher liability insurance costs are all associated with faster tort reform adoption. Other variables are not consistently associated with tort reforms, with the exceptions of 1) Republican control of the state government and single party control of the legislature and governorship (both of which are positively associated with tort reform enactment in many specifications) and 2) regional effects (with states in the Northeast being significantly less likely to adopt reforms).

Evidence on other influences is mixed. Reform adoption in neighboring states is associated with quicker adoption in some specifications. We also find some evidence of the influence of concentrated interest groups, i.e. insurance industry professionals, on quicker tort reform adoption in some specifications, though it should be noted that seemingly contrary effects are found for lawyers (more lawyers are associated with quicker adoption in most specifications) and physicians (more physicians are associated with slower adoption in some specifications).

The paper is organized as follows. Section II provides background on insurance crises and discusses related literature on tort reforms. Section III describes the hypotheses, proxy

[2] This diffusion literature is notably diffuse. See Twining (2005) for a review.

variables and data sources. Section IV explains the empirical methods and results. Sections V and VI show robustness checks and extensions. Section VII concludes.

II. Tort crises and Tort reforms

A. Three Tort Crises in Liability

Since the 1970s, the United States has experienced three "liability crises." The crises were characterized by sharp rises in insurance premiums, accounting recognition of liability losses by insurance companies, and restrictions in coverage. The first crisis happened in the mid-1970s, and several states enacted tort reforms during that period. The first liability crisis was especially acute in the area of medical malpractice liability, and it led several states to enact tort reforms targeted only at medical malpractice. The second liability crisis occurred in the mid-1980s, and many states passed reforms around this time. Priest (1987) attributes this crisis to the interpretation of modern tort law. He argues that judicial findings of greater levels of liability in insurance contracts, combined with a decline in the interest rate, led to insurers increase prices and restrict coverage. The third and most recent crisis started in the late 1990s and continued into the early 2000's.

B. Four Tort Reforms

There are four prominent reforms: caps on punitive damages, limitations on joint and several liability, caps on noneconomic damages, and reforms to collateral source rules. These reforms have been most widely analyzed by other researchers and also directly impact the determination of awards.[3] Table 1 shows the states that passed each of these four tort reforms by decade. Evidently, the largest tort reform wave took place in the 1980s. Table B1 and Figures A1 to A7 in the Appendix illustrate the history of the four tort reform enactments by state since 1971 in detail.

Prior to 1971, most states did not have caps on punitive damages and limitations on joint and several liability, and no states had caps on noneconomic damages and collateral source reforms related to general liability.[4] Starting in the mid-1970s, however, many states passed

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[3] Two additional reforms that are popular in the literature are contingency fee reform and periodic payments reform. We include neither in our analysis since only five states (AR, IL, ME, NH, and WY) enact contingency fee reform on general liability and only three states enact periodic payments reform on general liability (OH, RI, and SD) during the sample period. The results do not change materially if we include these reforms along with the other four reforms when analyzing the propensity of states to pass any type of tort reform.

[4] "Tort reform on general liability" means that the application of the tort reform was not restricted to medical malpractice. Please see Table 1 for states that enacted tort reform on general liability before 1971.

various reforms to the common law rules under which tort cases are tried in state courts. Most states enacted at least one of the four tort reforms during the 1970s and 1980s. The first wave of tort reform during the 1970s mainly targeted lawsuits related to health care, while the second wave of tort reform enactments during the 1980s was more general (Sloan et al., 1989).

Caps on Punitive Damages Reform Punitive damages are awarded to punish tortfeasors for malicious and reckless behavior and to deter future misconduct (American Tort Reform Association, 2012). Punitive damages awards are infrequent but the awards can be enormous and are often sought in civil lawsuits. Views differ on the predictability and opacity of the awards (see, e.g., the discussion in Viscusi, 2004 and Eisenberg et al., 2010). Caps on punitive damages typically limit the amount of award either to a specific dollar amount (e.g. $250,000 in Alabama) or to a multiple of compensatory damages. Some even prohibit punitive damages entirely.

Joint and Several Liability Reform Joint and several liability permits the plaintiff to recover damages from multiple defendants or from each defendant individually. If one defendant does not have enough resources to pay the tort award, the plaintiff can seek restitution from other defendants. Reform of joint and several liability modifies the joint responsibility that two or more defendants carry, typically by limiting a defendants' financial responsibility for harm to a percent of total damages according to fault. The most common form of the reform is a limit to the application of joint and several liability in awarding noneconomic damages (Lee et al., 1993).

Caps on Noneconomic Damages Reform Damages for noneconomic losses are for pain and suffering and are inherently difficult to measure (Sunstein, 2007). The discretion of juries may result in substantial variation in awards. Caps on noneconomic loss place typically provide numerical guidelines for the award or provide specific dollar ceilings on awards for noneconomic damages.

Collateral Source Rule Reform The collateral source rule forbids the use of evidence at trial that the plaintiff is being compensated from alternative sources such as insurance contracts (American Tort Reform Association, 2012). Collateral source rule reform typically requires that court awards be adjusted for compensation from other sources. Thus, total damages awarded at trial are offset by the amount paid to the plaintiff through other sources such as health insurance, auto insurance and workers compensation insurance.

C. Recent Studies of Tort Reform

The literature on tort reforms is vast and goes back at least 30 years. Previous studies have generally focused on three issues: whether tort limitations have affected the frequency and severity of claims (e.g. Browne and Puelz, 1999); whether tort reforms have affected insurance market quantities, such as premiums, losses, or loss ratios (Born et al., 2006); and whether tort reforms have had a direct influence on health market outcomes, including physician supply, the practice of defensive medicine, hospital expenditures and health insurance market indicators (Avraham et al., 2010).

Analyses of the first issue have provided strong evidence that limitations on tort liability reduce the frequency of claims and the size of claims (Browne and Puelz, 1999; Browne and Schmit, 2006; and Paik et al., 2013). Analyses of the effect of tort reforms on insurance market typically indicate that tort reforms reduce insurance losses (Born and Viscusi, 1998, 1994 and Born et al., 2009), while studies on insurance premiums provide mixed results (Zuckerman et al., 1991; Lee et al., 1994; and Born and Viscusi, 1994). When examining the 1980s tort reforms, some researchers have found significant negative effects on general liability insurance costs but mixed evidence on medical malpractice insurance costs (e.g. Viscusi et al., 1993). Analyses of the last issue provide evidence that medical malpractice tort reforms have had modest effects on defensive medicine and physician supply (Kessler et al., 1996, 2005 and Matsa, 2005), and that reforms lower the cost of health insurance to a certain extent (Avraham et al., 2010; Avraham and Schanzenbach, 2011; and Karl et al., 2013).[5]

With respect to the data structure in tort reform studies, there have been a number of papers examining the effect of liability reforms using either state level data (Viscusi, 1990; Blackmon and Zeckhauser, 1991; Viscusi, et al., 1993) or firm level data from the NAIC database (Born and Viscusi, 1994 and 1998; Viscusi and Born, 1995 and 2005). Since liability insurance claims may develop over long periods, Born et al., (2009) examine the long-run effects of tort reforms using the developed losses of insurers. Grace and Leverty (2012) show that restricting attention to 'permanent' tort reform (tort reform upheld constitutionally within the observation period) can enhance the results on insurance market performance.

Although the content of reforms varies greatly across states (for example, the stringency of a cap is determined by the level and type of the cap), almost all of these papers quantify tort

[5] For example, Avraham et al., (2010) find that the enactments of various tort reforms decrease group self-insured health insurance premiums by 1 to 2 percent.

reform by using binary variables equal to one for all the years in which reforms are effective and zero otherwise (with the exception of Hyman et al., 2009, which studies the impact of various caps). In this paper, we adopt this traditional method of using a dichotomous variable to indicate tort reform enactments.

III. Hypotheses and Variable Definitions

Our empirical analysis considers the timing of four major tort reforms on general torts from 1971 to 2005: caps on punitive damages, limitations on joint and several liability, caps on noneconomic damages, and collateral source rule reforms. The effective year of tort reforms are obtained by state for the years 1971-2005 from Database of State Tort Law Reforms (Avraham 2011 (4^{th} edition)) and complemented by American Tort Reform Association (www.atra.org). Among those reforms, caps on punitive damages and limitations on joint and several liability usually apply to all torts rather than just medical malpractice, as shown in Figure A1 and Figure A2, whereas caps on noneconomic damages and collateral source rule reforms are often targeted exclusively at medical malpractice torts, as shown in Figures A3 to A6.

In the remainder of this section we describe the variables and how they connect to hypotheses suggested by theory concerning the influence of lobbying, public interest, political-institutional factors, state insurance regulation, and regional effects. All the variables and corresponding sources discussed below are described in detail in Table 2. Table 3 reports mean and standard deviations for the explanatory variables used in the analysis and the average waiting time for tort reform adoption. In total, there are 1750 observations (50 states with 35 years) in the whole sample.

Interest Groups

Lawyers, doctors and insurance companies are all concentrated stakeholders with interests in tort reform. Doctors and insurance companies are typically cast in favor of tort reform, and lawyers are typically cast in opposition. [1] Lawyers and injured parties, on the other hand, stand to gain from opposing tort reform. *Private interest* theory predicts that the legislative outcome will thus be influenced by the relative power of these groups.

[1] These characterizations are obviously generalizations based on broad characterizations of self-interest, as well as the presumption that tort reform will restrict or reduce the effectiveness of litigation. The nature of economic self-interest is evident in the case of doctors, as tort reform typically will involve some reduction in their liability exposures. The logic is less clear in the case of insurers; while they pay claims and legal defense costs emanating from tort lawsuits, their future premium revenue volume is connected to the ongoing threat of lawsuits. Lawyers' business volume obviously depends on lawsuits.

We use the number of professionals in each of these groups as an indicator of the power of each group in each state. Specifically, we use per capita employment in the insurance sector (*Employment in insurer*) as a proxy for the power of the insurance industry, and the number of lawyers in the state as a proxy for the power of the legal professionals. Lawyers per capita (*Lawyer*) are obtained from the Lawyer Statistical Report and from the American Bar Association's annual report.[7] Physicians per capita (*Physician*) is taken from the U.S. Statistical Abstract for each state and year. The data is not available for each year, so we interpolate values for the years in which the data are not reported using a method from previous studies (Schmit and Browne, 2008; and Leverty and Grace, 2012).[8]

Litigation Activity

In practice, litigation costs are often fingered as a prime motivation for reform adoption. In theory, litigation activity could either accelerate or delay the reform process. Litigation produces benefits for plaintiffs and lawyers and costs for defendants. The welfare impact of restricting litigation requires balancing those costs and benefits, along with the indirect benefits and costs associated with the tort environment's impact on business activity and other behaviors. The prediction of *public interest* theory thus depends on the outcome of the welfare calculation and could go in either direction. *Private interest* theory offers a similar level of nuance: More litigation activity means more benefits and more costs, raising the stakes for interest groups on both sides. Thus, the direction of influence of high litigation activity is theoretically ambiguous, although its prominence in policy debates suggests that it plays an important role and is usually cast as a motivation for reform action.

Two variables are used to proxy the litigation activity at the state level: Liability insurance losses and tort cases commenced at the state level. The measure of *Liability insurance loss* is the ratio of directed loss incurred in the state to gross state product. The source for the information is loss data aggregated by state and year over the period 1971-2005 provided by A.M. Best. The analyses include aggregate loss incurred in medical malpractice, auto liability, other liability (including product liability before 1992), product liability, and commercial

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[7] Though both would seem to benefit from litigation, it is possible that plaintiffs' lawyers and defense lawyers might have different attitudes toward tort reforms. Our data, however, does not permit us to explore this distinction.

[8] We have 21 years of reported data (1971, 1980, 1985, and 1988-2005). Similar to previous studies, we provide fitted values for the missing years, based on an OLS regression using the 21 data points with the specification: $\text{lawyers per capita} = a + b \times \text{year} + \varepsilon$

multiple liability.[9] Well-known caveats to the situation that liability losses reported by insurers in a given year are subsequently revised years later exists, but we use loss incurred in the current year to evaluate insurers' liability loss for three reasons. First, we want to capture the severe of liability crisis from the insurance companies' point of view in that year, although insurance companies may misreport the loss reserve. Second, the motivations and directions for insurance companies to misestimate the loss reserve are unclear. For example, a firm's failure to take account of all the available information could results in misestimating loss reserve but the directions of loss reserve errors are uncertain. A firm could also deliberately underestimate the loss reserve to avoid regulator actions or it could overestimate the loss reserve because of future claims' uncertainty. Third, the revised loss incurred data is not available by states. We use tort filings in general jurisdiction courts per capita (*Tort cases in state court*) as an alternative measure to proxy litigation activity at the state level. State court data are available for states from 1975 to 2005 from the National Center for State Courts.[10]

We use the number of tort cases commenced per capita in the U.S. federal courts nationwide (*Tort cases in federal court*) to proxy litigation activity at the national level. Jurisdictional rules only allow cases that involve questions of state law, but are 1) between citizens of different states or U.S. and foreign citizens and 2) involve more than $75,000 in losses, to be filed in federal court. The vast majority of tort cases are filed in state courts, not federal courts. We do not include the federal cases in the same analyses with insurance liability loss or state tort cases because the time series is highly correlated with the state-level measures of litigation activity.

It should also be noted that the number of lawyers (as captured in *Lawyer*), in addition to being measure of the power of the legal professionals, could also proxy for state-level litigation activity to the extent that such activity is not fully captured by the tort case or insurance loss variables.

Political-Institutional Arrangements

Tort reforms are often associated with Republicans as opposed to Democrats, suggesting that states controlled by Republicans may favor tort reform (e.g. Rubin and Shepherd, 2007; Finley, 2004). Moreover, one party controlling the legislature and the governorship could also be

[9] We also include four groups of liability insurance (i.e. other liability insurance loss, medical malpractice insurance loss, auto liability insurance loss and commercial multiple loss) separately into our regressions. We get similar results in unreported tables.
[10] Data is not available for SD, NE, VT, IA, IL, LA, KY, MT, OK, SC, VA, and PA.

an advantage for getting legislation of any kind passed (see, for example, Kroszner and Strahan, 1999). The political climate and economic environment could also be correlated within regional areas in the United States. For example, the labels “Conservative” and “Liberal” may suggest different ideologies in different regions of the country.

We use two political variables from the U.S. Statistical Abstract. We measure the influence of Republicans in the legislature by the average ratio of the fraction of the Republicans in the lower house and the upper house (*Ratio of Republican*). Second, we create a dummy variable which equals one if the same party controls the governor’s office and has majorities in both houses. Finally, we use three measures of ideology in the state developed by Berry et al. (1998): *Republican ideology*, *Democratic ideology*, and *Governor ideology*. These variables capture the political ideology of the legislators and governor in the state, using the ideologies of the respective Congressional delegations as a proxy. The indices have high values if the state’s representatives in Congress are liberal and low values if the state’s representatives in Congress are conservative (Berry et al., 2011).

Insurance Regulation Environment

Auto liability insurance premiums account for a significant proportion of liability insurance premiums. No-fault systems provide first party coverage for personal injury protection (medical cost, loss of income, etc.) while limiting the tort liability of negligent drivers. No-fault laws can reduce auto insurance costs if there are strong limitations on the right to sue (Harrington, 1994). In this sense, no-fault legislation could reduce cost pressures associated with tort environments that are in other respects permissive. However, the presence of a no-fault system could also create spillover effects to displace tort activity into other liability markets, or could be reflective of a societal willingness to experiment with tort reform generally. Thus, the predicted association between the presence of no-fault systems and the propensity to enact other tort reforms is not clear.

Rate regulation is also an important aspect of the insurance environment. More stringent regulation may lead to more severe insurance market availability problems in the wake of a shock---accelerating the legislative process in tort reform.

To measure the effect of state insurance laws, we create five variables. First, we use a dichotomous variable which equals one if punitive damages are insurable (*Punitive damage insurable*). Second, we construct an indicator variable that is one if the state has any form of “prior approval” rate regulation (*Rate regulation*). “Prior approval” rate regulation is the toughest type of rate regulation, reflecting circumstances in which rates cannot be used until approved by the insurance commissioner. Last, we include three variables relating to no-fault automobile insurance laws. No-fault systems with value thresholds make the right to sue conditional on compensatory damages exceeding a designated dollar amount. No-fault systems with a small dollar threshold may thus be ineffective in limiting lawsuits. The benchmark variable *No-fault other* equals one for a tort law state or for a no-fault state with a low value threshold (less than $1000). Another variable, *No-fault high value*, equals one if a state has a dollar threshold greater than $1,000 and zero otherwise. States with verbal thresholds have the strictest no-fault system which allows the right to sue only in the cases where victims have severe damages such as death, disfigurement, or permanent loss of body function. The variable *No-fault verbal* equals one if the state has a verbal threshold and zero otherwise.

Spatial Diffusion

When states pass laws, it may influence the likelihood that neighboring states will also pass such legislation. Such a relation is called a spatial diffusion effect or state spillover effect. Diffusion researchers suggest that policymakers often look to the policies adopted by nearby states to help them draft and make decisions about certain policies (Soule and Earl, 2001). A state’s tort reform enactment may affect the timing of its neighbors’ tort reform enactments for several reasons. First, states may be concerned about businesses (e.g. entrepreneurs or physicians) moving out: if a state’s liability costs are higher than those of their neighbors, businesses may be driven away. Under this logic, a state is most influenced by the actions of those states to which its businesses may move. This suggests that a tort reform in one state could produce competitive pressures for corresponding tort reforms in neighboring states.

Voters may also judge politicians’ performance relative to that of politicians in nearby states, especially those nearby states with similar ideology. An example of this is given by Besley and Case (1995), who provide evidence of “yardstick competition.” This could imply that states are most influenced by the actions of those states that their voters judge to be the most similar (Baicker, 2001). All of this suggests that tort reforms in one state may have positive spillover effects on neighboring states, and that the most influential neighbors may be ones with similar ideological profiles. However, a few researchers have documented significant negative spillover effects for geographic proximity as well---states are less likely to pass some controversial laws when they are in close spatial proximity to other states that enact such laws (e.g. Soule and Earl 2001, McMahon-Howard et al., 2008). The direction of influence is thus an empirical question.

We create a continuous variable, *State spillover*, to capture the influence of tort reforms in nearby states. The variable captures the proportion of neighboring states that had adopted tort reforms by the end of the previous year. Neighboring states are defined as states sharing a border with the state in question.[11] We use an alternative proxy, *Ideological state spillover,* to measure the proportion of neighboring states with similar ideology enacting tort reforms before the state in question enacts tort reforms.[12]

Economic Variables

Overall economic conditions, as well as the conditions in industries susceptible to litigation, may create pressures for or against reform. We use gross state product per capita (*GSP per capita*) as a general economic indicator connected with urbanization and business activity. The GSP data are from Bureau of Economic Analysis for each state for each year. We use a credit spread variable (*Credit spread*) to proxy the investment environment each year, measured as the difference between the Moody's seasoned BAA corporate bond yield and the AAA corporate bond yield. We obtain the corporate bond yield data from the Federal Reserve Bank of St. Louis' Federal Reserve Economic Database.

Another potential proxy of interest is health care expenditure as a percentage of household income (*Health care expenditure*). If tort reforms are perceived as a means of reducing health care costs, *public interest* theory would predict a positive relationship between this proxy and tort reforms, especially in the area of medical malpractice. Similar logic could be used to hypothesize a negative coefficient on *Physician,* as tort reform on medical malpractice could be a potential means of encouraging more physicians to practice in the state.

Finally, we create four regional indicator variables representing the North, South, Midwest, and West.

IV. Methods and Empirical Results

[11] For example, Florida shares borders with Georgia and Alabama. Georgia and Alabama enacted joint and several liability in 1988 and after 2005, respectively. Thus *State Spillover* for joint and several liability in Florida is 0 before 1988 and one half from 1988 to 2005.

[12] We describe the construction of this variable in detail in Section V.

In this section, we first use the non-parametric survival model to determine the shape of the baseline hazard function. Next, we investigate how the economic and political variables described above are associated with the timing of tort reform enactments using discrete time survival models with a Weibull baseline hazard. We start by treating reforms as "competing risk events," so that the duration time ends if any of the four tort reforms is enacted. Then we study each of the four reforms independently.

A. Hazard Analysis with Nonparametric Estimates

To model the duration of the 'waiting period' before reform, we need to impose structure on the hazard function. The Kaplan-Meier product-limit estimator[13] offers a nonparametric estimate of the hazard function over time (Greene 2006). Figure 1 graphs survival estimates for the data and shows that each hazard function is relatively flat in the 1970's before dropping steeply in the mid-1980s and then becoming flat again. The graph also implies that joint and several liability limits have the shortest waiting time durations, followed by caps on punitive damages, collateral source rule reforms and caps on noneconomic damages. Figure 1 displays the survival rate for states based on the enactment of *any* of the four tort reforms; 87% of states enact one or more of those tort reforms during the sample period. It shows survival rates for each of the tort reforms during the sample period: about 40% of states enacted caps on punitive damages, 79% enacted limitations on joint and several liability, 35% enacted collateral source rule reforms, and 24% of states enacted caps on noneconomic damages. Table B2 presents the results of the state 'waiting period spells' by Kaplan-Meier product limit estimates in detail. Consistent with Figure A1 to Figure A7, the null hypotheses of equalities of survival functions across the four tort reforms are rejected by log-rank tests. Survival rates when considering caps on noneconomic damages and collateral source rule reforms are significantly higher than when considering caps on punitive damages and joint and several liability, since fewer states enact the former two tort reforms. Figure 1 also shows that the survival rates when considering the enactment of any type of reform drops dramatically during the years of 1985 to 1988. However, the non-parametric method is limited because it cannot provide the impact of independent variables on the likelihood of events.

[13] The Kaplan-Meier product limit formula to estimate the survivorship function for the j^{th} year is $\hat{S}(t) = \prod_j \hat{P}r(T \geq t_j | T \geq t_j - 1) = \prod_j (1 - \frac{d_j}{r_j})$, where d_j is the number of states enacting tort reforms during j^{th} year and r_j is the number of states entering the j^{th} year.

B. Discrete Time Proportional Hazard Model

Tort reform enactments and most of the independent variables are only observed once a year.[14] This implies that the observed durations of tort reform should be grouped into yearly intervals. Moreover, since many of the tort reforms occurred in the mid-1970s or the mid-1980s as Table 1 shows, there exists the substantial problem of tied duration times. The Cox model (or any fully parameterized continuous time model) is inappropriate in this case (Cox and Oakes, 1984), because the Cox model is based on the assumption that duration times can be any real number (rather than certain discrete values corresponding to the number of years), and recorded duration times need to be ordered chronologically. The high number of ties and the discrete time property lead to estimation bias in regression coefficients and in the corresponding covariance matrix.

That the duration variable of interest (time taken to enact the tort reform) is measured yearly means that the feasible approach to modeling the duration is the discrete-time proportional hazard model (also called the discrete-time historical event model). The four tort reforms can be considered as "competing events" in the sense that the state can change its common law civil justice system by enacting different tort reforms. We consider the period from the beginning of the sample (1971) until any tort reform occurs as the duration of interest in the analysis. The states that enacted tort reforms before 1971 are excluded from the analysis as left censored data, but the states that had not enacted tort reform by 2005 remain in the sample as right censored data. The data structure of discrete-time duration models is time-series cross-section, which is organized with as many observations for each state in the sample as there are time periods over which the state is at risk of experiencing the event of interest (Jenkins, 1995)---the enactment of a tort reform. The core variable is discrete elapsed time and event occurrence is a series of binary outcomes denoting whether or not the event occurred at the observation point.

A survival model that can accommodate this structure is a discrete time proportional hazard model with Weibull baseline hazard. Consider an instantaneous force of mortality given by:

$$h(t, X_{it}) = h_0(t)\exp(X_{it}'\beta) \quad \text{or} \quad \log[h(t, X_{it})] = \log[h_0(t)] + X_{it}'\beta \qquad (1)$$

where $h(t, X_{it})$ is the hazard rate function and $h_0(t)$ is the baseline hazard function and X_{it} is a vector of covariates. In this setting, the discrete time hazard rate (see, e.g., Allison (1982)) of

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[14] We recognize that some states are repeat-adopters of tort reforms, and we deal with the problem in robustness section.

enacting tort reform for state i in year k, with a vector of time-varying covariates, X_{ik}, having spent $k-1$ years in the same common law civil justice system, can be given by:

$$h_k(X_{ik}) = 1 - \exp(-\exp(\gamma(k) + X_{ik}'\beta)), \; and \; \gamma(k) = log \int_{a_{k-1}}^{a_k} h_0(\tau) d\tau \qquad (2)$$

where $\gamma(k)$ represents the baseline hazard function of time which can be estimated either parametrically or nonparametrically. The above function can also be written in complementary log-log transformation:

$$log\left[-log\left(1 - h_k(X_{ik})\right)\right] = \gamma(k) + X_{ik}'\beta \qquad (3)$$

To specify the baseline hazard function $\gamma(k)$, we consider the discrete-time specification similar to the Weibull model with a shape characterized by p: $\gamma(k)=\theta\log(k)$, where θ in the discrete time case approximately corresponds to $p-1$ in the continuous time Weibull model. If θ is greater than zero, the hazard increases monotonically, and if it is less than zero the hazard decreases monotonically.[15]

The coefficients can be interpreted as the effect of covariates on the hazard rate of enacting tort reform. Positive coefficients indicate an increase in the hazard rate and thus a reduction in the duration of the 'waiting' period. The $\exp(\beta)$ represent the hazard ratio of tort reform enactments for a one-unit change in the covariates because we use the proportional hazard model. The economic importance of coefficients on covariates can be evaluated by taking the exponential transform of the coefficients multiplying by the standard deviation of the explanatory variables.

We first investigate how economic and political variables influence the timing of general liability tort reform enactments by considering the four reforms together. In other words, an "enactment" happens, and a state "dies," whenever it enacts *any* of the four reforms. Our first analysis considers the association between tort reform adoption and a set of "core" explanatory variables, which will subsequently be expanded to include additional covariates.

Table 4 shows the correlation of the core political economy factors. Highly correlated explanatory variables pose a common problem in empirical studies, especially when the sample size is limited. Multicollinearity may cause regression results to be unstable and inflate standard

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[15] We use a complementary log-logistic hazard function rather than a logistic function since the process of enacting tort reform is intrinsically continuous but only the observations are in discrete time. Steele (2009) argues that the choice of binary model often has little impact on the results. To check the correctness of the proportional hazard specification, we have also estimated a discrete time logistic model and the results are very similar to complementary log-log.

errors. As shown in Table 4, variables representing private interest groups are correlated with *Liability insurance loss* to varying degrees, some significantly so. We address this by using alternative measures of litigation activity (see Table 6) and also by adding explanatory variables to regressions sequentially (see, for example, Table 5) to investigate the stability of the empirical estimates.

Table 5 shows the estimated effects of core time varying covariates on the hazard rate for the discrete time model with Weibull baseline hazard. We have 825 observations in Table 5 and use stepwise methods to select variables. Model 1 tests litigation activity costs by including only two variables: *Liability insurance loss*; Model 2 adds variables proxy for interest groups; Model 3 adds political-institutional variables, and Model 4 further adds variables representing regions.[16]

Overall, we document significant positive coefficients for *Liability insurance loss*, *Ratio of Republicans*, *Same party* and *Lawyer*, and negative positive coefficient of *Physician*. Pressures in the form of higher litigation costs and a relative shortage of physicians seem to be associated with quicker adoptions. An abundance of lawyers is also associated with quicker reform, consistent with the *litigation activity hypothesis* to the extent that greater numbers of lawyers are indicative of high litigation cost environments. Private interest theory is consistent with the results to the extent that the general business size---which is presumably concerned with litigation and health care costs---is interpreted as the predominant private interest. On the other hand, the evidence concerning specific interest groups is weak and even contrary: Greater numbers of lawyers, who presumably would oppose reform, are associated with faster adoptions; Greater numbers of physicians, who presumably support reform, are associated with slower adoptions. Political-institutional variables reflecting Republicans and same party control of the government also are significant, with the expected signs.

Table 6 Model 1 shows the estimated effects of all time varying covariates on the hazard rate for the discrete time model with Weibull baseline hazard. We have 825 observations in Model 1, which extends models in Table 5 by including all variables. Starting with the economic variables, higher *Liability insurance loss* is found to be associated with a higher hazard rate of tort reform enactment: a one-standard-deviation increase in the *Liability insurance loss* leads to a 159.0% increase in the hazard of tort reform enactment. With regard to the political-institutional variables, the structure of the state government---the ratio of Republicans in the legislature,

[16] We also run the regression with variables of private interests only and the results are robust.

single party control of the government, and the nature of Democratic ideology, all have significant impacts on the timing of tort reform. Notably, a one-standard-deviation increase in the *Ratio of Republicans* leads to an 86.0% increase in the hazard rate. The negative coefficient on Democratic ideology indicates that a more liberal character in the state's Democrats delays tort reform, with a one-standard-deviation increase in the *Democratic ideology* decreasing the hazard rate by 45.4%. In addition, *Lawyer* has a positive effect on the hazard rate of reform enactment but *Physician* has a negative but statistically insignificant effect on the hazard rate of tort reform. A one-standard-deviation increase in lawyers per capita results in a 3.7 times higher hazard of enacting any kind of tort reform. The regional dummies indicate that states in Northeast are associated with delayed timing of tort reform.

Model 2 replaces *Liability insurance loss* with tort case filings in state courts and has 521 observations since it uses only data after 1974, and data from SD,NE,VT, IA, IL, LA, KY, MT, OK, SC,VA, PA are now omitted due to the lack of information on tort case filings. The coefficient on tort cases in state general jurisdiction courts in Model 2 indicates a one-standard-deviation rise in tort cases in state court increases the hazard by 82.5%. Model 3 uses tort cases filings in federal courts and the coefficient is significantly positive. A one-standard-deviation increase in tort cases in federal courts increases the hazard by 107.1%. The coefficients on *State spillover* and *Health care expenditure* are not statistically significant in any of the three models.

We then perform the analysis for each of the four reforms individually. The final four columns of Table 6 show the results for the timing of the enactments of each of the four tort reforms using the same method. We use *Liability insurance loss* to proxy the state liability environment in all individual tort reform models.

Starting with caps on punitive damages (GL_CP) and limits on joint and several liability (GL_JS), there are 1346 observations in the regression for caps on punitive damages and 982 observations in the regression for limitations on joint and several liability. The positive and statistically significant coefficients on the *Liability insurance loss* in both models indicate the association between higher insurance losses and enactments of both tort reforms, and these effects are economically important. The coefficient is 0.463 in the punitive damage cap regression, which means a one-standard-deviation increase in liability insurance loss per GSP results in a 2.7 times higher hazard of enacting caps on punitive damages. Similarly, the GL_JS column estimates indicate that hazard of joint and several liability reform enactment is higher by

136.0% with a one-standard-deviation rise in insurance loss. *Lawyer* has a positive effect on the hazard rates in both models: For example, a one-standard-deviation increase in lawyer is associated with a 2.2 times increase in the hazard of caps on punitive damages reform enactments.

The structure of the state government influences the timing of joint and several liability reform as well. Consistent with the political-institutional theory, split control of the branches of government tends to delay limitations on joint and several liability. The negative and statistically significant coefficient of *Physician* indicates that fewer physicians accelerate the timing of joint and several liability reform. States with fewer physicians are found to have a higher hazard of enacting tort reform compared with their counterparts: the effect of a one-standard-deviation decrease in *Physician* is to increase the hazard by 85.6%. Regional effects also appear to be present. The results suggest that states in the Northeast regional variables in both regressions are large in magnitude and have negative signs, which imply the two types of tort reforms occur later in the Northeast.

Turning to caps on noneconomic damages (GL_CN) and changes to collateral source rules (GL_CS), there are 1543 observations in the regression for the GL_CN model and 1368 observations in the regression for the GL_CS model. Both tort reforms occur earlier in states with larger *Liability insurance loss*. A one-standard-deviation increase in the liability insurance loss per GSP leads to an increase of 2.3 times in the hazard rate for caps on noneconomic damages. A one-standard-deviation increase in *Liability insurance loss* results in 5.2 times more in the hazard of changes to collateral source rules. The coefficients on *Democratic ideology* are negative and statistically significant in the case of collateral source rule reforms. The coefficient of *Employment in insurer* is significantly positive for the GL_CS model, a possible indication that insurers' lobbying power accelerates the enactment of changes to collateral source rules. A one-standard-deviation increase in the *Employment in insurer* leads to a 119.8% increase in the hazard of changes to collateral source rules. This finding, however, does not appear in the other models of Table 6.

To summarize the results from the discrete time proportional hazard model in Table 6, litigation activity is strongly associated with reform adoptions. The most consistent positive and significant results are those connecting insurance losses and tort cases with reform adoptions. The two variables could also be connected to the insurance industry and general business interest groups in the context of private interest theory. The number of lawyers exhibits a positive association with tort reform enactments, which is consistent with the hypothesis of high litigation cost environment. That said, effects of the size of legal professionals and medical professionals are not found in the evidence. On the contrary, the number of lawyers exhibits a positive and significant association with enactments and the number of physicians exhibits a negative association with enactments. This finding could be interpreted as supportive of the public interest theory, or as indicators of higher liability/medical costs that could mobilize businesses to lobby for reform as predicted by the economic interest group theory. Political and institutional factors also help to explain the timing of tort reforms to some extent, as Republican influence, one-party governments and conservative Democratic ideology are associated with quicker action in all specifications. We do not find a linkage between the timing of tort reforms and spatial diffusion effects in Table 6.

V. Robustness Checks

In this section, we test robustness of the results in a variety of ways. We consider a nonparametric baseline hazard, various analyses aimed at omitted variables problems, permanent versus transitory tort reforms, different estimation techniques, and alternative explanatory variables.

Nonparametric Baseline Hazard

To check the robustness of the Weibull baseline hazard, we use a discrete time proportional hazard model with a nonparametric baseline hazard. To eliminate assumptions about the functional form of the baseline hazard rate, we add duration dummy variables for time intervals to the same covariates that are used in the parametric model. This method requires events to occur in each time period since the hazard rate cannot be estimated for a period with no events. Since our data has a large number of ties with no events in some years, we split the spell times into decades with four dummies representing the 1970s, 1980s, 1990s and 2000s to ensure that there are events occurring in each time interval. The model can then calculate the hazard ratio for each decade interval. The results are shown in Table 7 in the first column (*Robustness Check with Decade Dummies*). The signs of the significant coefficients are largely consistent with the results from the previous analysis. The coefficient on the 1980s dummy is significantly positive, indicating that more tort reforms are passed during the 1980s than other periods.

Omitted Variables

Many states have enacted a variety of medical malpractice tort reforms to reduce award and settlement amounts. One problem with other kinds of state tort reform concerns potential spillover effects. Specifically, medical malpractice tort reforms could either act on, or reflect changes in, the legislative atmosphere and liability climate in the states. To elaborate, enacting medical malpractice tort reform may partially relieve a tort liability crisis in a state, leading to a delayed enactment of tort reforms related to general liability. On the other hand, medical malpractice tort reform may provide a template for tort reform, or reflect changing attitudes in the state, and thereby be associated with a higher chance of passing general liability tort reform. Thus, these medical malpractice tort reforms may proxy for omitted variables that affect the timing of liability tort reform thereafter.

To proceed, we add four indicator variables to the same set of independent variables that are used in Model 1 in Table 6, which are set to one in state-years with the corresponding medical malpractice tort reforms from 1971 to 2005. The *Robustness Check with MM* in Table 7 shows the results after incorporating these additional controls for medical malpractice tort reform. The coefficients on four medical malpractice tort reforms are mixed and not significant, while the signs of the other independent variables are the same and the magnitudes are virtually unchanged.

Permanent Tort Reform

Tort reform is subject to judicial challenge and is sometimes ruled unconstitutional. Tort reforms that are ultimately declared unconstitutional (temporary) and those that are unchallenged or upheld (permanent) may be fundamentally different. For example, Grace and Leverty (2012) document that 27% of medical liability tort reforms are unconstitutional and provide evidence that interested groups (e.g. insurers and customers) rationally expect tort reforms to be permanent or temporary. In our study, 18% of (19 out of 106) general liability tort reforms were declared unconstitutional. To address this, we redo the analysis by focusing on the enactment of permanent tort reforms only (a reform is considered "permanent" if it was not declared unconstitutional before 2011).

Our results in the *Permanent Reform-GL* column of Table 7 are largely unaffected by the switch to permanent tort reforms. We have 868 observations in the regression, which is slightly more than the earlier specification since states that enact non-permanent reforms remain in the sample until they enact a permanent reform. The signs and magnitudes of the coefficients are largely the same as in Model 1 of Table 6.

Different Estimation Techniques

Another issue that arises when investigating the timing of individual tort reform enactment (while ignoring the other tort reforms) is that some states may pass tort reforms gradually while others pass reforms as a "package." Thus, considering only the first instance of any of the four tort reforms wastes potentially relevant information. Analysis of individual tort reforms, on the other hand, fails to account for the lack of independence of the failure times. We address these issues by stacking the individual tort reform data and applying the "frailty" model (Jenkins, 1995 and 1997) and the "marginal risk set" model (Wei, Lin and Weissfeld, 1989; Spiekerman and Lin, 1996; Box-Steffensmeier and Zorn, 2002). The frailty model explicitly models the association between the timing of tort reform enactments within a state as a random-effect term. Equation 2 is extended as:

$$h_k(X_{ik}) = 1 - \exp(-\exp(\gamma(k) + X_{ik}\beta + u_i)), \gamma(k) = log \int_{a_{k-1}}^{a_k} h_0(\tau)d\tau$$

$$u_i \sim N(0, \sigma_u^2) \quad (4)$$

with u_i representing random effects which are state-specific unobservables and σ_u^2 representing unobserved heterogeneity. To consider the possibility that different tort reforms have different baseline hazard functions, we also stratify the data by type of tort reform and use the marginal risk set model (also called the variance-corrected model), allowing each stratum (tort reform) to have its own baseline hazard function while adjusting the variance matrix of the estimators to account for the dependence of tort reform enactments (Box-Steffensmeier and Zorn, 2002). In Table 7, we report the results of the frailty model in the *Frailty Model—GL* column and results of the marginal risk set model in the *Marginal Risk Set Model—GL* column, respectively.

The results are largely consistent with those already reported. One difference to highlight is the *State spillover* coefficient, which becomes large and statistically significant. The *State spillover* results are consistent with the notion that states respond to the actions of their competitors with tort reforms, and that this response is sensitive to the perceived constitutional strength of the reform in the competing state.

Alternative Measurements

We tried several alternative measurements to further test the robustness of variables. As mentioned in the state spillover discussion, the most influential neighbors may be ones with similar ideological profiles. To address this, we tried an alternative measurement of state spillovers to better capture the effects of "ideological neighbors." We include only bordering states where the neighbor's *state government ideology* differs from the state's own by less than 10 points (Berry et al. (1998, 2011) construct *state government ideology* on a 100 point scale based on the estimated ideology values of the governor and of the Republican and Democratic contingents in the state legislature) in the marginal risk set model with stacked tort reforms. As shown in Table B4 *Alternative A*, the coefficient of ideological state spillover has the same sign and is slightly larger than the coefficient on state spillover.

We tried alternative definitions of several of the political variables. Specifically, we tried specifications using three indicator variables reflecting party controls in the lower house, upper house and governorship separately. The coefficient estimates on these variables have same signs, and the results on other variables are unaffected by the changing of the political-institutional measures. We also tried an alternative measurement indicating the fraction of state government controlled by Republicans (Krozner and Strahan, 1998), e.g., one-third if Republicans control lower house and Democrats control upper house and governorship. As shown in Table B4 *Alternative B*, the coefficient of *Republican control* is significantly positive, implying Republicans accelerate tort reform enactments.

We tried including urbanization in the regressions, which is measured as urban population divided total population for each state by every decade. Previous research has identified a positive association between urbanization and the rate of tort filings (Danzon, 1984a; and Lee et al., 1994); urbanization has also been connected with earlier enactment of tort reform according to Danzon (1984b). However, this variable does not seem to be associated with accelerated adoption of tort reforms (beyond what is already captured in GSP), as shown in Table B4 *Alternative C*.

The tort reform enactment is on a calendar-year basis. Several states passed tort reform after July with some of those occurring in October and November. We tried a different definition of tort reform "effective" enactment: any tort reform enactment after July of year t is treated as effective tort reform in year t+1. Table B4 *Alternative D* reports results using new measurement of tort reform enactment and the result are very similar to previous results with respect to the explanatory variables of interest.

Since the legislative process can be slow, it is possible that contemporaneous variables may not capture the real effects of a liability crisis. We explore this further by using the lagged values of explanatory variables instead of contemporaneous values in the analysis. Table B4 *Alternative E* reports results using the lagged value of all variables except regions, and the results are very similar to previous results, except that *Northeast* becomes insignificant statistically though with the same sign.

Although the discrete time survival model should be used for our data, we report the results from a continuous survival model (Weibull proportional hazard model) in Table B4 *Weibull Model*. The advantage of using the continuous Weibull survival model is that we can map the change of hazard rate to the change in the expected time to pass tort reforms for a given change in our interested variables. The results of Weibull proportional hazard model are similar to those from the discrete time proportional hazard model in Table 6. A continuous survival model with Weibull distribution has a shape coefficient p. By taking $b^* = -b/p$, the new coefficient b^* represents the percentage change in the time to pass tort reform for a one-unit change in the explanatory variables. On average, it took a state 18.3 years from the beginning of the study to pass any kind of tort reform. A one-standard-deviation increase of *Liability insurance loss* results in about 1.7 years decrease in the time until enacting any four tort reforms, 2.2 years for a one-standard-deviation increase in *Ratio of Republican* and 4.5 years for *Lawyer*.[17]

VI. **Extensions**

We first run a pooled time-series cross-section OLS regression with state-level dummies and a fractional logit model with initial values for key explanatory variables to isolate the roles of time-series variation and cross-section variation in explaining tort reform enactments. We make another attempt to detect interest group effects by studying differences in reform responses among the subsample of states experiencing shocks in the 1980s insurance crisis. Finally, we examine whether similar results are obtained when applying the model to medical malpractice tort reforms.

[17] Note that the "time" impact of the explanatory variables is smaller than their impact on the hazard rates due to the impact of the shape coefficient, which implies positive duration dependence in this setting.

Time-series Variation vs. Cross-section Variation

To explore the respective roles of time series and cross-sectional variation in our data, we estimate two probability models with the same set of regressors used in the other models. First, we run a pooled time-series cross-section OLS regression with state-level fixed effects for any of the four tort reforms. Using the same observations from hazard models, this fixed effects model eliminates the cross-state variation from the covariates and emphasizes the time variation. The *Time-series Variation Test* column of Table 8 reports the results, and the coefficient on *Liability insurance loss* is statistically significant, with the same sign as in the discrete time model---indicating that this association persists even after controlling for state effects.

Second, we use measures of variables as of 1971 (with the exception of no fault variables)[18] and thus have one observation per state if it enters into the analysis sample. We invert the duration time until enacting tort reforms to get the estimate probability of tort reform for each state and set the dependent variable to zero if the state does not enact reform by 2005. This method implies that the probability is constant over time and removes the time-series variation in the data. We apply the fractional logit model to the restructured data since the dependent variable is between zero and one. The results are shown in Table 8 *Cross-sectional Variation Test*. The coefficients on *Liability insurance loss, Ratio of Republican, Physician***,** and *Lawyer* are generally consistent with signs of previous models and statistically significant. The results of the fractional logit models suggest that the effects of these variables may be also driven by cross-section variation.

Drivers of Tort Reform during the 1980s' Liability Crisis

The preceding analysis strongly suggests that liability costs are a key predictor of tort reform, but its importance may obscure other effects. One possibility is that an insurance crisis creates ripe conditions for tort reform, but once it happens, then how the state responds---with or without reform--- is determined by private interest groups. With this in mind, we look for interest group and institutional effects after conditioning on the occurrence of a liability cost shock.[19]

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[18] No fault variables are measured as of 1975 since only Massachusetts adopted no fault with threshold value of $500 in 1971.

[19] We do not perform the analysis for the first liability crisis since the first liability crisis was mainly a medical malpractice crisis (as shown in Table B1), and the medical liability insurance loss data by state is available only after 1974. This makes it hard to identify which states experienced pre-crisis shocks. We do not analyze the same issue in the third liability crisis in the early 2000s, because few states passed any tort reforms in the 2000s.

We first measure whether a state experiences a liability insurance loss shock in 1985 and 1986. We define a shock to be the situation where the state's average liability insurance loss per GSP in 1985 and 1986 exceeds a threshold of 33% more than the state's own average liability insurance loss per GSP over the period of 1977 to 1983.[20] We restrict our sample to states that satisfied the criterion[21] and then consider how states responded to the liability shocks by using a binary variable which equals one if states enact tort reform and 0 otherwise during 1980s. We average independent variables for each state over 1985 and 1986 and test four variables: *Lawyer*, *Physician*, *Employment in insurer* and *Republican control*.

Table 9 reports the logit model results. In total, 41 states experienced liability shocks during the mid-1980s. *Lawyer* and *Republican control* are found to be positively associated with states' enactment of tort reform. Insurance company employment is found to be positively associated with collateral source rule reforms only. Physicians are found to be negatively associated with reform efforts, significantly so in the case of collateral source rules and punitive damage caps.

Factors Driving Tort Reform on Medical Malpractice

We now examine whether the forces driving tort reform on general liability also drive tort reform on medical liability. A significant proportion of tort reforms, notably those passed in the 1970's, were targeted exclusively at medical malpractice, especially for caps on non-economic damages and changes to collateral source rules. It is appropriate to study these targeted tort reforms separately from general tort reforms on general liability. Insurance companies' loss concerns and health care cost concerns (e.g. expenditure and number of physicians) are more likely to be active contributors in state legislation process. We redo the analysis as in the Table 6 and Table 7 but now consider all tort reforms which apply to medical liability. The results are reported in Table 10 and Table 11.

The signs of the significant coefficients on the *Medical malpractice insurance loss* and *Ratio of Republican* are largely consistent with the results from the models of tort reform on

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[20] The year of 1977 is chosen as the beginning of benchmark years in order to avoid the aftermath of first liability crisis occurred in the mid-1970s.

[21] We exclude five states (WA, NE, MI, SD, and VT) that had passed tort reform before 1971. Our results are robust to examining liability shocks defined by the situation where the state's average liability insurance loss ratio (directed loss incurred/directed premium earned) in 1985 and 1986 exceeds a threshold of 20% more than the state's own average loss ratio from 1977 to 1983 (37 states are in the sample). As another robustness check, we also use a sample in which states' average loss ratios in 1985 and 1986 are larger than 0.8 and we get very similar results (37 states are in the sample).

general liability. The coefficients on *Health care expenditure* are now significantly positive in almost every specification. We find *Same party* is positive and statistically significant in two of the specifications. Overall, the analysis of tort reform applying to medical malpractice has directionally similar results to the general analysis, thus providing a consistency check.

VII. Discussion and Conclusion

This paper evaluates the factors associated with state adoptions of tort reforms from 1971 to 2005. The study contributes to at least two lines of literature. First, we make a significant contribution to the literature on the diffusion of laws. A few of researchers study the diffusion of other laws across the states (e.g. McMahon-Howard et al, 2009; Romano, 2006; and Smythe, 2008). Our paper is the first study to examine the diffusion pattern of tort reforms and relative importance of social, economic and political factors driving tort reforms across states. Second, a huge literature focuses on the influence of tort reforms after their enactment but ignores the question of what motivated the reform in the first place.

Our most robust and economically significant findings are that measures of litigation activity---such as insurance losses and tort cases filed---are associated with quicker adoption of tort reforms.[22] These findings are broadly consistent with public interest theories of regulation, and generally with the idea that states respond to liability cost problems with tort reforms. The findings can also be interpreted as being consistent with economic interest theories to the extent that the litigation activity measures reflect the interests of the business community and of the insurance industry.

We find no evidence of the influence of sizes of medical or the legal professionals in the context of private interest theories. Lawyers per capita are consistently associated with quicker reform enactments, while physicians per capita are associated with slower enactments. We also

[22] We check whether the ex post consequences of tort reform are consistent with previous studies by measuring the effects of all four tort reforms on the insurance loss across different liability lines (Other Liability, Auto Liability, and Medical Malpractice). The dependent variables representing insurance loss are the direct loss incurred of different insurance liability lines scaled by gross state product and multiplied by 1000 for each state in that year. The four tort reform indicators are equal to one in the years when the tort reforms are effective and zero otherwise. We find coefficients on noneconomic damage caps and joint and several liability reforms to be of the expected negative signs in all four of the equations, and they are statistically significant in the case of Other Liability. The coefficient on noneconomic damage caps is also significant in the case of Auto Liability. The coefficients on noneconomic damage caps are larger in absolute value than any of the other coefficients for those two lines. Our results are in line with prior literature studying the effect of tort reforms on the insurance market (e.g. Born and Viscusi, 1998, 1994 and Born et al., 2009). However, coefficients on collateral source rule reforms and caps on punitive damages are not statistically significant in any of the regressions, and the signs are mixed. See Table B5 in the Appendix for details.

find very little evidence of an insurance industry lobby. We also find that political-institutional factors, such as Republican control and control of the government by the same party, and insurance regulation environments affect tort reform, although these variables are not significant in all specifications.

If the main motivation for tort reform lies in litigation costs, this naturally leads to the question of what drives litigation costs. Indeed, if tort reform is a response to litigation costs, the deeper question about tort reform may not concern its impact, but rather why it was needed in the first place. Why did costs reach critical levels in some states but not others? Such questions are well beyond the scope of this paper, but they deserve more attention from future researchers.

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Table 1 Initial State Tort Reform Legislation on General Liability, by Decade

Reform	States passing reform in 1970s	States passing reform in 1980s	States passing reform in 1990s	States passing reform in 2000s	States passing no tort reforms
Caps on non-economic damages	---	AL, AK, CO, FL, HI,, ID, KS, MD, MN, OR, WA	IL	MS	AZ, AR, CA, CT, DE, GA, IN, IA, KY, LA, ME, MA, MI, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, PA, RI, SC, SD, TN, TX, UT, VT, VA, WV, WI, WY
Caps on punitive damages	---	AL, CO, FL, GA, KS, MT, NV, NH, TX, VA	AK, IL, IN, LA, NJ, NC, ND, OH, OK,	ID, MS	AZ, AR, CA, CT, DE, HI, IA, KY, ME, MA, MN, MO, NM, NY, OR, PA, RI, SC, SD, TN, UT, VT, WV, WI, WY
Collateral source change	FL, ND	AL, AK, CO, CT, GA,HI, IL, IN, IA, KY, MI, MN, MT, OH, OR	ID	---	AZ, AR, CA, DE, KS, LA, ME, MA, MS, MO, NE, NV, NH, NM, NY, NC, OK, PA, RI, SC, SD, TN, TX, UT, VT, VA, WV, WA, WI, WY
Joint and several liability	FL, KS, NV, OK, OR	AL, AK, AZ, CA, CO, CT, GA, HI, ID, IL, IN, IA, KY, LA, MI, MN, MS, MO, MT, NJ, NM, NY, ND, TX, UT, WA, WY	NE, NH, OH, TX, WI,	AR, PA	DE, ME, MD, MA, NC, RI, SC

*Note: MI, NE, WA enacted caps on punitive damages before 1970s; SD, VT enacted joint and several liability before 1970s.

Table 2 Variable Definitions and Sources

	Definition	Sources
Tort reforms		
Caps on punitive damages	An indicator variable equal to 1 if a state sets a cap on the recovery of punitive damages	
Joint and Several liability	An indicator variable equal to 1 if a state limits a party's responsibility for damages to a percent of total damages corresponding to that party's degree of fault	American Tort Reform Association (www.atra.org) and Avraham (2011)
Noneconomic damage caps	An indicator variable equal to 1 if a state has enacted a cap on the size of compensation for injured persons due to intangible but real injuries such as pain and suffering.	
Collateral source rule	An indicator variable equal to 1 if a state permits insurance recovery from a victim's first party insurer to offset the damage judgment	
Economics variables		
Liability insurance loss	Aggregated direct loss incurred of liability insurance (including other liability, auto liability, commercial multiple-peril liability and medical malpractice) at state level divided by GSP and multiplied by 1,000	A.M Best Custom Report
Health care%	Personal health care expenditure on physician and clinic services divided by personal annual income in a state multiplied by 100	CMS Office of the Actuary, 1971-2005
Credit spread	The difference between the Aaa corporate bond yield and Baa corporate bond yield for each year	Federal Reserve Bank of St. Louis' FRED Economic Data
GSP per capita	Gross domestic product (GSP) divided by the total population scaled by 1,000 in a state	Bureau of Economic Analysis, 1971-2005
Politics and regulation variables		
Ratio of Republican	The average ratio of the lower house and the upper house that are Republican	
Republican control*	The fraction of state government (lower house, upper house and governorship) controlled by Republican	Statistical Abstract of the United States, 1971-2005
Same party	An indicator variable equal to 1 if the same party controls the governor's office and has majorities in the lower house and the upper house	
Republican ideology	A measure of the ideology of state Republican party ideology, in which 0 is the most conservative and 100 is the most liberal	
Democratic ideology	A measure of the ideology of state Democratic party ideology, in which 0 is the most conservative and 100 is the most liberal	Berry et.al (1998)
Governor ideology	A measure of the ideology of state governor's ideology, in which 0 is the most conservative and 100 is the most liberal	
Tort cases in state court	Tort cases commenced in state general jurisdiction courts divided by population and multiplied by 1,000 each year	National Center for State Courts, 1975-2005
Tort cases in federal court	Tort cases commenced in federal courts divided by national population and multiplied by 10,000 each year	Statistical Abstract of the United States, 1971-2005
Rate regulation	An indicator variable equal to 1 if the state applies a form of prior approval rate regulation, 0 otherwise	
Punitive damages insurable	An indicator variable equal to 1 if state allows punitive damages to be insured	American Insurance Association, Summary of State Laws and Regulations relating to Insurance, 1971-2005
No-fault verbal	An indicator variable equal to 1 if state has adopted no-fault insurance with verbal threshold, and 0 otherwise	
No-fault high value	An indicator variable equal to 1 if state has adopted no-fault insurance with threshold larger than $1,000, and 0 otherwise	
No-fault other	An indicator variable equal to 1 if state has adopted no-fault insurance with threshold less than $1,000 and tort system, and 0 otherwise	

Other variables		
Employment in insurer	Ratio of the number of employees in insurance carriers to the state population multiplied by 1,000	Bureau of Economic Analysis, 1971-2005
Lawyer	Ratio of the number of lawyers to the total population in a state multiplied by 10,000	The lawyer Statistical Report, various years
Physician	Ratio of the number of physicians to the total population in a state multiplied by 10,000	Statistical Abstract of the United States, 1971-2005
State spillover	The proportion of states surrounding the state passing tort reforms before the state enacts the tort reform.	
Ideological state spillover*	The proportion of states with closed ideology surrounding the state passing tort reforms before the state enacts the tort reform. The surrounding states include only states that average absolute differences between state governments' ideology of neighboring state and the state is less than 10.	
Urban*	The proportion of the number of urban people to total state population, measured by every decade	United States Census Bureau, 1971-2005
South	An indicator variable equals to 1 if state is AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, or WA	
Midwest	An indicator variable equals to 1 if states is IA, IL, IN, KS, MI, MN, MO, NE, ND, OH, SD, or WI	
Northeast	An indicator variable equals to 1 if states is in CT, MA, MD, ME, NH, NJ, NY, PA, RI, VT, and WV	
West	An indicator variable equals to 1 if states are in other states	

*These alternative measurements are used in robustness checks.

Table 3 Summary Statistics of Tort Reforms and Variables in Analysis for General Liability, 1971-2005

Variable	Whole Sample	Four Tort Reforms	Caps on Non-Economic Damages	Caps on Punitive Damages	Collateral Source	Joint and Several
Economic Characteristics						
Liability insurance loss[17]	8.811	8.267	8.721	8.639	8.588	8.343
	(2.725)	(2.910)	(2.775)	(2.799)	(2.757)	(2.853)
Medical liability loss	0.475	0.383	0.487	0.476	0.429	0.437
	(0.367)	(0.321)	(0.388)	(0.385)	(0.350)	(0.358)
Health care expenditure	2.769	2.221	2.644	2.598	2.558	2.331
	(0.941)	(0.792)	(0.913)	(0.912)	(0.907)	(0.841)
Credit spread	1.082	1.225	1.113	1.127	1.137	1.205
	(0.397)	(0.423)	(0.408)	(0.410)	(0.412)	(0.422)
GSP per capita	20.491	14.132	19.089	18.505	18.141	15.130
	(11.398)	(9.413)	(11.073)	(11.025)	(10.887)	(9.767)
Political Characteristics						
Ratio of Republican	0.419	0.356	0.412	0.403	0.399	0.367
	(0.179)	(0.189)	(0.178)	(0.184)	(0.181)	(0.184)
Same party	0.463	0.492	0.465	0.468	0.468	0.481
	(0.499)	(0.500)	(0.499)	(0.499)	(0.499)	(0.500)
Republican ideology	35.078	36.765	35.347	36.134	35.392	36.589
	(8.096)	(8.373)	(8.184)	(8.414)	(8.349)	(8.089)
Democratic ideology	68.169	68.002	67.929	68.645	67.882	67.980
	(7.317)	(7.870)	(7.429)	(7.412)	(7.704)	(7.690)
Governor ideology	53.073	55.799	52.777	54.426	53.531	55.510
	(17.969)	(16.547)	(17.595)	(17.664)	(17.789)	(16.614)
Tort cases in federal court	1.538	1.377	—	—	—	—
	(0.368)	(0.306)				
Tort cases in state court	2.612	2.609	—	—	—	—
	(1.205)	(1.233)				
Rate regulation	0.583	0.655	0.591	0.546	0.624	0.643
	(0.493)	(0.476)	(0.492)	(0.498)	(0.485)	(0.479)
Punitive damage insurable	0.560	0.601	0.566	0.582	0.579	0.587
	(0.497)	(0.490)	(0.496)	(0.493)	(0.494)	(0.493)
No-fault verbal	0.072	0.032	0.070	0.049	0.045	0.051
	(0.259)	(0.175)	(0.255)	(0.216)	(0.208)	(0.220)
No-fault high value	0.185	0.126	0.154	0.160	0.122	0.143
	(0.388)	(0.332)	(0.362)	(0.367)	(0.327)	(0.350)
No-fault other	0.743	0.842	0.776	0.791	0.833	0.806
	(0.335)	(0.443)	(0.560)	(0.311)	(0.280)	(0.303)
Other variables						
Employment in insurer	5.855	5.175	5.782	5.597	5.419	5.301
	(3.345)	(2.687)	(3.405)	(3.367)	(2.833)	(2.672)

[17] Liability insurance loss includes the Other Liability, Auto Liability, Medical Malpractice Liability and Product Liability lines.

Table 3 (continuous)

Lawyer	24.704	21.565	23.835	23.953	23.335	21.875
	(9.321)	(8.744)	(9.257)	(9.595)	(8.805)	(8.329)
Physician	19.435	18.026	19.028	19.222	18.929	18.415
	(6.547)	(7.183)	(6.535)	(7.147)	(6.872)	(7.153)
State spillover	—	0.313	0.059	0.134	0.126	0.252
		(0.307)	(0.113)	(0.215)	(0.215)	(0.286)
West	0.280	0.262	0.246	0.288	0.279	0.238
	(0.449)	(0.440)	(0.431)	(0.453)	(0.449)	(0.426)
Midwest	0.240	0.161	0.243	0.217	0.194	0.198
	(0.427)	(0.368)	(0.429)	(0.412)	(0.396)	(0.398)
South	0.280	0.314	0.295	0.256	0.298	0.319
	(0.449)	(0.464)	(0.456)	(0.436)	(0.458)	(0.466)
Northeast	0.200	0.263	0.216	0.239	0.228	0.245
	(0.400)	(0.441)	(0.411)	(0.427)	(0.420)	(0.431)
Average waiting time	—	18.333	30.860	29.261	27.580	20.458
Observations	1750	825	1543	1346	1368	982

Figure 1 Kaplan-Meier Estimate of Survival Rate, by Tort Reform

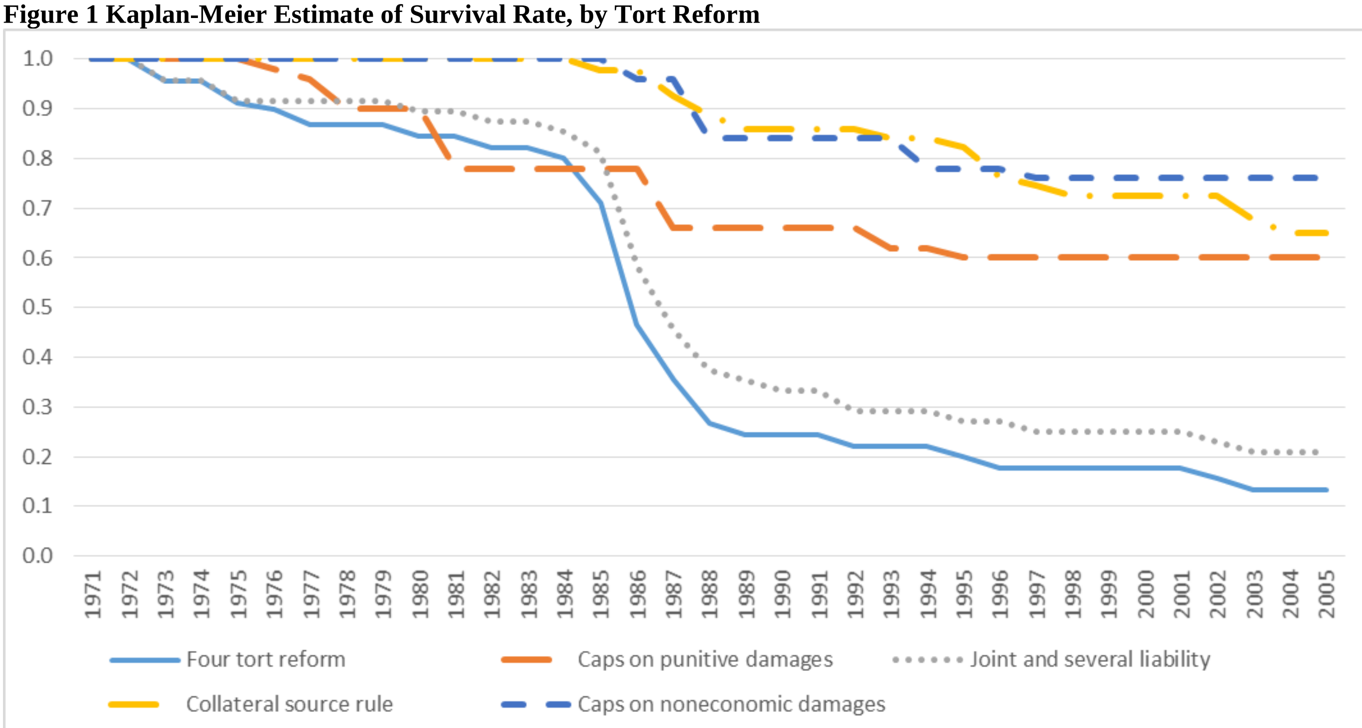


Table 4 Correlations of Core Political Economy Factors Influencing the Timing of State Enactments of Tort Reforms on General Liability, 1971-2005

	Liability ins loss	Heath care exp.	State Tort	Nation. Tort	Ratio of Rep.	Same party	Rep. ideology	Democ. ideology	Governor ideology	Employment in insurer	Physician	Lawyer
Liability insurance loss	1.000											
Tort cases in state courts	0.324	1.000										
Tort cases in federal courts	0.517	0.036	1.000									
Heath care expenditure	0.559	0.080	0.638	1.000								
Ratio of Republican	0.027	0.010	0.037	-0.028	1.000							
Same party	-0.099	-0.001	-0.132	-0.110	-0.433	1.000						
Republican Ideology	0.233	0.194	0.041	-0.018	-0.254	0.113	1.000					
Democratic ideology	0.165	0.041	0.073	0.025	0.295	-0.237	0.414	1.000				
Governor ideology	-0.039	0.013	-0.114	-0.131	-0.010	0.376	0.240	0.286	1.000			
Employment in insurer	0.373	0.318	0.151	0.151	0.131	-0.053	0.491	0.395	0.014	1.000		
Physician	0.510	0.246	0.328	0.371	0.013	-0.157	0.431	0.366	-0.015	0.573	1.000	
Lawyer	0.320	0.124	0.283	0.250	0.031	-0.214	0.426	0.477	0.053	0.571	0.689	1.000

Table 5 Discrete Time Hazard Model of Core Political Economy Factors Influencing the Timing of State Enactments of Tort Reforms on General Liability (Stepwise Regression), 1971-2005

	Model 1	**Model 2**	**Model 3**	**Model 4**
Liability insurance loss	0.131**	0.229***	0.228***	0.317***
	(0.055)	(0.057)	(0.048)	(0.069)
Employment in insurer	—	0.014	-0.031	-0.008
		(0.126)	(0.144)	(0.184)
Physician	—	-0.237***	-0.223***	-0.204**
		(0.054)	(0.064)	(0.088)
Lawyer	—	0.108***	0.139***	0.172***
		(0.031)	(0.033)	(0.038)
Ratio of Republican	—	—	3.066***	3.063***
			(0.753)	(0.881)
Same party	—	—	0.836**	1.079**
			(0.422)	(0.533)
Democratic Ideology	—	—	-0.055	-0.079**
			(0.039)	(0.035)
Northeast	—	—	—	-1.510**
				(0.618)
Midwest	—	—	—	0.919*
				(0.531)
South	—	—	—	-0.235
				(0.707)
Log duration time	0.487**	0.919**	0.902**	0.623
	(0.247)	(0.428)	(0.408)	(0.443)
Constant	-5.410***	-5.626***	-4.200	-3.934
	(0.594)	(0.802)	(2.750)	(2.514)
Log pseudolikelihood	-147.29	-137.34	-129.24	-122.590
Observation	825	825	825	825

The dependent variable for Models 1 to 4 is binary which equals one if a state enacts any type of tort reform on general liability in that year and zero otherwise. Observations of each state are included in the analyses until the state passes the tort reform. All the variables are described as in Table 2. Models report results of the discrete time hazard model with Weibull baseline hazard and have 825 observations. Stepwise forward regression method is used to select variables. Standard errors robust to clustering by year are showed in the parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

Table 6 Discrete Time Hazard Model of All Political Economy Factors Influencing the Timing of State Enactments of Tort Reforms on General Liability, 1971-2005

	Model 1	Model 2	Model 3	GL_CN	GL_CP	GL_CS	GL_JS
Liability insurance loss	0.327***	—	—	0.435***	0.463***	0.662***	0.301***
	(0.116)			(0.126)	(0.102)	(0.076)	(0.070)
Tort cases in state court	—	0.488**	—	—	—	—	—
		(0.208)					
Tort cases in federal court	—	—	2.379***	—	—	—	—
			(0.753)				
State Spillover	0.074	0.412	0.438	0.457	-1.234	2.170	1.350*
	(1.278)	(2.389)	(1.332)	(4.781)	(1.611)	(1.436)	(0.757)
Heath care expenditure	-0.328	0.130	0.077	-0.416	-0.471	-1.765***	-0.043
	(0.736)	(0.880)	(0.069)	(0.531)	(1.023)	(0.523)	(0.811)
Credit spread	-0.154	-0.388	0.549	1.056	-0.338	-0.413	0.114
	(0.513)	(0.718)	(0.563)	(0.726)	(0.782)	(0.784)	(0.476)
GSP per capita	-0.020	-0.089	-0.055	-0.035	0.050	-0.076	-0.007
	(0.047)	(0.061)	(0.039)	(0.083)	(0.065)	(0.079)	(0.031)
Ratio of Republican	3.284**	4.858**	3.117**	2.149*	2.327	2.939	3.276**
	(1.510)	(1.968)	(1.446)	(1.307)	(2.012)	(2.142)	(1.289)
Same party	1.004*	1.240**	0.533	0.868	0.534	-0.166	1.347***
	(0.559)	(0.626)	(0.465)	(0.581)	(0.355)	(0.495)	(0.479)
Republican Ideology	0.019	0.004	0.031	0.084*	-0.108*	0.163***	0.042
	(0.063)	(0.077)	(0.061)	(0.048)	(0.060)	(0.056)	(0.049)
Democratic ideology	-0.077*	-0.026	-0.062**	-0.051	-0.133**	-0.088*	-0.053
	(0.046)	(0.064)	(0.030)	(0.087)	(0.060)	(0.046)	(0.056)
Governor ideology	0.002	-0.013	0.005	0.026	0.008	0.031	-0.005
	(0.011)	(0.011)	(0.012)	(0.019)	(0.016)	(0.021)	(0.013)
Employment in insurer	0.025	0.067	0.111	-0.114	-0.189	0.278**	0.025
	(0.237)	(0.286)	(0.183)	(0.129)	(0.186)	(0.118)	(0.137)
Physician	-0.193	-0.245	-0.142	-0.064	-0.127	-0.532***	-0.271***
	(0.134)	(0.211)	(0.133)	(0.057)	(0.090)	(0.120)	(0.057)
Lawyer	0.178***	0.151	0.126*	0.146**	0.122***	0.301***	0.206***
	(0.063)	(0.108)	(0.068)	(0.060)	(0.029)	(0.076)	(0.032)
No-fault verbal	0.968	2.563**	1.102	-2.053**	0.397	-2.663	0.770
	(0.772)	(1.133)	(1.460)	(0.979)	(1.118)	(2.066)	(0.787)
No-fault high value	-0.042	1.175	-0.055	0.704	1.026	2.688***	-0.191
	(0.877)	(1.297)	(0.897)	(0.661)	(1.119)	(0.700)	(0.602)
Punitive damages insurable	0.364	0.176	0.147	-0.459	1.273	1.715**	0.037
	(0.657)	(0.884)	(0.797)	(0.785)	(0.869)	(0.797)	(0.571)
Rate regulation	-0.107	0.315	-0.166	-0.161	0.934	-1.224***	-0.133
	(0.561)	(1.254)	(0.627)	(0.652)	(0.742)	(0.415)	(0.524)
South	-0.258	2.834	0.622	-0.745	0.492	0.557	-0.540
	(0.846)	(2.198)	(0.557)	(0.841)	(1.318)	(0.547)	(0.524)
Midwest	0.787	-0.071	-0.069	0.172	3.626**	1.274	0.085
	(0.801)	(0.684)	(0.748)	(0.864)	(1.481)	(0.866)	(1.290)
Northeast	-2.096**	0.538	0.233	-4.570***	-1.303*	-3.219***	-2.134
	(1.062)	(0.868)	(0.915)	(1.181)	(0.758)	(1.185)	(1.774)
Log duration time	0.987*	-1.389	-1.843	1.531	1.774	2.710**	0.551
	(0.582)	(1.857)	(1.597)	(1.036)	(1.494)	(1.183)	(0.948)
Constant	-5.151	-9.890**	-7.568**	-15.733**	-4.318	-14.414**	-6.894
	(3.785)	(4.849)	(3.276)	(6.756)	(5.950)	(5.865)	(4.472)
Log pseudolikelihood	-121.662	-91.155	-124.337	-63.018	-80.762	-70.418	-119.593
Observation	825	521	825	1543	1346	1368	982

The dependent variable for model 1 to 3 is binary which equals one if a state enacting any type of tort reform on general liability in that year and zero otherwise. Observations of each state are included in the analyses until the state passed the tort reform. Credit spread and tort cases in federal court are measured yearly from 1972 to 2005. All other variables are measured for each state in each year from 1972 to 2005. All the variables are described as in Table 2. Model 1 reports results of the discrete time hazard model with Weibull baseline hazard and has 780 observations. Model 2 replaces liability insurance loss with tort cases filings in state courts and has 521 observations since it uses samples after 1976 and such data in SD,NE,VT, IA, IL, LA, KY, MT, OK, SC,VA, PA are missing. GL_CN, GL_CP, GL_CS, GL_JS report results of the discrete time hazard model with Weibull baseline hazard for caps on non-economic damages, caps on punitive damages, changes to collateral source and limits on joint and several on general liability. The dependent variable for the four models is binary which equals one if a state enacting the tort reform on general liability in that year and zero otherwise. Cluster standard errors by year are showed in the parentheses. ***, **, and * denote statistically significant at the 1, 5, and 10 percent levels.

Table 7 Robustness Check of Discrete Time Hazard Models of Political Economy Factors Influencing the Timing of General Liability Tort Reforms, 1971-2005

	Robustness Check with Decade Dummies	Robustness Check with MM	Permanent Reform--GL	Frailty Model--GL	Marginal Risk Set Model--GL
Liability insurance loss	0.265**	0.359***	0.267***	0.388***	0.352***
	(0.109)	(0.124)	(0.096)	(0.101)	(0.056)
State Spillover	0.337	-0.205	1.455	2.854***	2.670***
	(1.189)	(1.313)	(1.345)	(0.451)	(0.462)
Heath care expenditure	0.534	-0.343	-0.399	-0.190	-0.206
	(0.622)	(0.813)	(0.707)	(0.591)	(0.380)
Credit spread	-0.817	-0.112	0.177	0.606	0.679**
	(0.946)	(0.529)	(0.501)	(0.398)	(0.279)
GSP per capita	0.016	-0.010	-0.030	-0.015	-0.007
	(0.044)	(0.046)	(0.050)	(0.058)	(0.033)
Ratio of Republican	2.344	4.144**	3.359**	3.083*	2.466***
	(1.594)	(1.903)	(1.538)	(1.684)	(0.891)
Same party	0.918	0.975*	0.889**	0.462	0.464*
	(0.579)	(0.531)	(0.400)	(0.349)	(0.270)
Republican ideology	0.013	0.037	0.048	0.035	0.024
	(0.060)	(0.070)	(0.069)	(0.042)	(0.031)
Democratic ideology	-0.085*	-0.067	-0.074*	-0.052	-0.057**
	(0.044)	(0.047)	(0.045)	(0.037)	(0.028)
Governor ideology	-0.004	0.001	0.005	0.008	0.011
	(0.012)	(0.012)	(0.013)	(0.009)	(0.008)
Employment in insurer	0.075	0.013	0.063	0.029	0.029
	(0.213)	(0.237)	(0.199)	(0.113)	(0.091)
Physician	-0.155	-0.209	-0.189	-0.167*	-0.183**
	(0.101)	(0.148)	(0.143)	(0.100)	(0.078)
Lawyer	0.156***	0.190**	0.181**	0.081**	0.083***
	(0.057)	(0.076)	(0.080)	(0.038)	(0.031)
No-fault verbal	1.637**	1.071	1.063	-0.256	-0.139
	(0.824)	(0.866)	(1.031)	(3.762)	(0.500)
No-fault high value	-0.048	-0.233	-0.288	1.030	1.164***
	(0.855)	(1.143)	(0.913)	(0.657)	(0.365)
Punitive damages	0.412	0.372	0.262	0.444	0.327
insurable	(0.553)	(0.687)	(0.567)	(0.463)	(0.347)
Rate regulation	0.121	-0.053	-0.041	0.225	0.296
	(0.553)	(0.716)	(0.545)	(0.422)	(0.340)
South	-0.734	0.081	0.036	-0.126	-0.174
	(0.845)	(0.993)	(0.726)	(0.613)	(0.460)
Midwest	0.740	0.750	0.123	0.412	0.450
	(0.700)	(0.678)	(0.451)	(0.784)	(0.507)
Northeast	-1.948**	-2.388*	-2.401**	-1.465	-1.225*
	(0.969)	(1.337)	(1.165)	(0.996)	(0.689)
Log duration time	__	0.989	0.799	0.408	0.336
		(0.625)	(0.577)	(0.682)	(0.447)

Table 7 Continued

Duration dummies in 1970s	2.102 (1.733)	—	—	—	—
Duration dummies in 1980s	2.918** (1.218)	—	—	—	—
Duration dummies in 1990s	0.417 (1.209)	—	—	—	—
Medical caps on noneconomic damages	—	0.657 (0.685)	—	—	—
Medical collateral source	—	-0.613 (0.799)	—	—	—
Medical caps on punitive damages	—	0.431 (0.845)	—	—	—
Medical joint and several	—	-0.602 (1.380)	—	—	—
Temp tort reform	—	—	0.162 (0.505)	0.873 (0.567)	0.636 (0.388)
Constant	-5.410 (4.504)	-6.987 (4.971)	-6.370** (2.776)	-8.811*** (3.189)	-7.255*** (2.062)
Log Pseudolikelihood	-116.939	-120.222	-123.909	—	—
Observation	825	825	868	5486	5486

The dependent variable is binary which equals one if a state enacts tort reform on general liability in that year and zero otherwise. The observations of each state are included in the analyses until the state passed any of four tort reforms on general liability. *Robusness Check with Decades Dummies* reports the results of discrete time hazard model with four duration dummies as the baseline hazard. *Robusnest Check with MM* adds medical malpractice tort reforms as dummy variables to *Model 1* in Table 6. The model *Permanent Reform_GL* reports results of permanent tort reforms using discrete-time hazard models. *Temp tort reform* is a dummy variable representing temporary tort reforms in effect but ultimately held unconstitutional. The last two models report results of the timing of state enactments of any of the four permanent tort reforms on general liability gradually by using multivariate survival analysis, in which observations of each tort reform are stacked. The *Frailty Model--GL* uses a frailty model with random effects and the *Marginal Risk Set Model--GL* uses a marginal risk set model to control correlations and different baseline hazard functions of tort reforms. Standard errors (robust to clustering by year in the first 3 columns; robust to heteroscedasticity and serial correlation (jackknife standard error) in the last two columns) are shown in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

Table 8 The Time-series Variation vs. the Cross-sectional Variation of Political Economy Variables Influencing the Timing of Tort Reform Legislations on General Liability, 1971-2005

	Time-series Variation Test	Cross-sectional Variation Test
Liability insurance loss	0.024***	0.210*
	(0.007)	(0.120)
State Spillover	-0.032	2.352*
	(0.068)	(1.272)
Heath care expenditure	2.615	0.156
	(3.641)	(0.551)
Credit spread	0.006	—
	(0.015)	
GSP per capita	0.001	-0.064
	(0.002)	(0.311)
Ratio of Republican	0.210	1.779**
	(0.135)	(0.815)
Same party	0.031	-0.020
	(0.024)	(0.275)
Republican ideology	-0.001	-0.009
	(0.002)	(0.014)
Democratic ideology	-0.001	-0.081***
	(0.003)	(0.017)
Governor ideology	-0.000	0.019***
	(0.001)	(0.007)
Employment in insurer	-0.008	-0.065
	(0.012)	(0.063)
Physician	-0.002	-0.061*
	(0.001)	(0.033)
Lawyer	0.000	0.188**
	(0.002)	(0.089)
Rate regulation	-0.044	-0.081
	(0.049)	(0.297)
No-fault verbal	0.036	0.201
	(0.067)	(0.828)
No-fault high value	0.017	-0.536
	(0.037)	(0.700)
Constant	-0.097	-2.103
	(0.272)	(1.415)
State Fixed Effects	Yes	—
R-square	0.138	—
Observations	825	45

A pooled time-series cross-section OLS regression is used for the time-series variation test. The dependent variable for each regression is binary which equals one if a state enacted any tort reform in that year and zero otherwise. State fixed effects (not reported) are added in the regression. All variables are measured for each state in each year from 1971 to 2005. The fractional logit model is used for a cross-sectional variation test, in which the dependent variable is the inverse of duration time until enacting tort reforms for each state. All the independent variables are measured as of 1971 with the exception of no fault variables. All the variables are described as in Table 2. Heteroscedasticity-robust standard errors are in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

Table 9 Logit Model of Determinants of Tort Reform on General Liability during the 1980s' Liability Crisis

	Four General Liability	Caps on Non-economic Damages	Collateral Source Rule	Caps on Punitive Damages	Joint and Several liability
Lawyer	1.499**	0.997	1.991**	1.161	4.017***
	(0.809)	(0.662)	(0.905)	(0.786)	(2.317)
Physician	-0.143	-0.016	-0.522***	-0.275**	-0.369
	(0.130)	(0.073)	(0.156)	(0.131)	(0.427)
Employment in Insurer	-0.034	-0.308	0.495***	0.068	-0.197
	(0.120)	(0.196)	(0.188)	(0.136)	(0.186)
Republican control	2.840**	0.906	-0.408	-0.709	2.814**
	(1.190)	(1.426)	(1.337)	(1.453)	(1.477)
Constant	-0.847	-2.241	1.443	1.095	-1.748
	(1.653)	(1.672)	(1.631)	(1.453)	(3.313)
Log pseudolikelihood	-22.061	-18.786	-18.744	-21.254	-17.478
Pseudo R2	0.181	0.072	0.260	0.109	0.309
Observations	41	41	39	41	37

The dependent variable is binary which equals one if a state enacted any type of tort reform on general liability in that year and zero otherwise. The observations in the regression only include states experiencing a liability crisis during the 1980s. The state had a liability crisis if the average of its 1985 and 1986 insurance loss (scaled by GSP) was more than 1/3 higher than its average value over the 1977 to 1983 period. *Republican control* is measured as the average value of the fraction of the three parts of the state government (the lower house, the upper house, and governorship) controlled by Republicans from 1985 to 1986. All the independent variables are the mean value of the corresponding variables described as in Table 2 from 1985 to 1986. Heteroscedasticity-robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 10 Discrete Time hazard model of Political Economy Factors Influencing the Timing of State Enacting Tort Reforms on Medical Malpractice, 1975-2005

	MM--Four	MM--CN	MM--CP	MM--CS	MM--JS
Medical Malpractice insurance loss	2.307***	1.549***	0.344	0.371	1.452***
	(0.866)	(0.600)	(0.556)	(0.567)	(0.422)
State spillover	1.542	-0.964	-0.035	1.736**	0.318
	(1.502)	(1.694)	(1.966)	(0.844)	(1.000)
Heath care expenditure	1.644***	1.729***	0.684*	3.075***	0.677
	(0.603)	(0.551)	(0.395)	(0.574)	(0.543)
Credit spread	-0.951	-0.819	-0.319	-0.705	-0.412
	(0.659)	(0.648)	(0.671)	(0.548)	(0.486)
GSP per capita	0.111	-0.063	-0.106	-0.002	-0.060
	(0.072)	(0.040)	(0.091)	(0.066)	(0.039)
Ratio of Republican	5.093***	2.122	0.968	4.893***	3.209**
	(1.880)	(2.139)	(1.716)	(1.061)	(1.279)
Same Party	0.856**	0.429	0.510	0.360	1.090***
	(0.334)	(0.347)	(0.597)	(0.402)	(0.348)
Republican Ideology	0.020	0.003	-0.123***	0.001	0.037
	(0.046)	(0.047)	(0.044)	(0.032)	(0.049)
Democratic ideology	-0.006	0.015	-0.048	-0.046	-0.024
	(0.054)	(0.045)	(0.055)	(0.049)	(0.056)
Governor ideology	-0.022	-0.001	-0.000	-0.000	-0.015
	(0.022)	(0.009)	(0.012)	(0.016)	(0.013)
Employment in insurer	0.044	0.020	0.008	0.120**	0.159
	(0.143)	(0.135)	(0.139)	(0.050)	(0.145)
Physician	-0.062	-0.118	-0.112	-0.095	-0.254***
	(0.148)	(0.160)	(0.077)	(0.084)	(0.077)
Lawyer	-0.044	0.087*	0.112	0.056	0.149***
	(0.050)	(0.047)	(0.075)	(0.058)	(0.040)
No-fault verbal	0.175	-1.846	2.335***	-0.594	0.549
	(1.033)	(1.231)	(0.651)	(1.008)	(0.988)
No-fault high value	0.730	0.239	0.272	1.150	0.381
	(1.071)	(0.567)	(0.817)	(0.882)	(0.915)
Punitive damages insurable	0.318	-0.621	1.260**	-0.440	0.262
	(0.673)	(0.457)	(0.584)	(0.468)	(0.865)
Rate regulation	0.253	0.382	1.391*	1.312*	0.462
	(0.435)	(0.504)	(0.731)	(0.692)	(0.670)
South	0.042	-1.544**	-0.859	-1.188*	-0.931*
	(0.780)	(0.656)	(0.737)	(0.698)	(0.501)
Midwest	0.473	1.019*	1.701**	0.228	-1.350*
	(0.730)	(0.593)	(0.803)	(0.570)	(0.801)
Northeast	0.321	-1.609	-0.743	0.555	-2.477**
	(1.372)	(1.168)	(1.489)	(0.877)	(1.149)
Log of duration time	-4.083***	-1.519	2.139**	-4.391***	1.171
	(1.196)	(1.011)	(1.046)	(1.250)	(1.143)
Constant	1.795	-3.880	-5.597	0.925	-7.231**
	(5.381)	(5.620)	(5.459)	(5.129)	(3.481)
Log Pseudolikelihood	-109.240	-115.197	-94.656	-117.403	-119.275
Observations	367	927	1117	716	816

MM_Four reports results of medical malpractice tort reform enactments, which has fewer (367) observations since medical liability insurance is separated from other liability insurance in 1975 and the focus on medical malpractice involves inclusion of tort reforms focused exclusively on medical malpractice. *MM_CN, MM_CP, MM_CS, MM_JS* report results of the discrete time hazard model with Weibull baseline hazard for caps on non-economic damages, caps on punitive damages, changes to collateral source and limits on joint and several liability. The dependent variable for this model is binary which equals one if a state enacts any type of tort reform on medical malpractice in that year and zero otherwise. Observations of each state are included in the analyses until the state passes the tort reform. Credit spreads are measured yearly from 1971 to 2005. All other variables are measured for each state in each year from 1971 to 2005. All the variables are described as in Table 2. Standard errors robust to clustering by year are shown in parentheses. ***, **, and * denote statistically significant at the 1, 5, and 10 percent levels.

Table 11 Robustness Check of Discrete Time Hazard Models of Political Economy Factors Influencing the Timing of State Enacting Permanent Tort Reform on Medical Malpractice, 1975-2005

	Medical Malpractice--PM	Frailty Model--MM	Marginal Risk set Model --MM
Medical Malpractice insurance loss	2.250***	0.892***	0.939***
	(0.555)	(0.295)	(0.240)
State Spillover	3.317**	1.631***	1.708***
	(1.320)	(0.517)	(0.403)
Heath care expenditure	0.523	0.778**	0.870***
	(0.433)	(0.302)	(0.190)
Credit spread	-0.448	-0.059	-0.144
	(0.646)	(0.231)	(0.193)
GSP per capita	0.025	-0.059	-0.029
	(0.070)	(0.051)	(0.032)
Ratio of republican	7.271***	2.537***	2.499***
	(1.283)	(0.837)	(0.756)
Same party	1.132***	0.677**	0.730***
	(0.411)	(0.261)	(0.210)
Republican ideology	0.120***	0.015	0.012
	(0.036)	(0.020)	(0.020)
Democratic ideology	0.036	-0.008	-0.009
	(0.029)	(0.022)	(0.020)
Governor ideology	-0.035*	-0.003	-0.004
	(0.019)	(0.007)	(0.006)
Employment in insurer	0.030	0.087*	0.094**
	(0.125)	(0.049)	(0.044)
Physician	-0.016	-0.087	-0.088**
	(0.140)	(0.059)	(0.040)
Lawyer	0.009	0.082***	0.076***
	(0.076)	(0.025)	(0.022)
No-fault verbal	0.834	0.517	0.514
	(1.584)	(0.489)	(0.462)
No-fault high value	0.016	0.204	0.186
	(1.082)	(0.300)	(0.313)
Punitive damages insurable	1.069	-0.030	-0.056
	(0.850)	(0.325)	(0.259)
Rate regulation	0.249	0.424	0.406*
	(0.631)	(0.263)	(0.216)
South	0.910	-0.651	-0.612*
	(0.811)	(0.401)	(0.362)
Midwest	-0.726	-0.136	-0.126
	(0.556)	(0.329)	(0.322)
Northeast	-2.111**	-1.702***	-1.630***
	(0.995)	(0.498)	(0.550)
Log duration time	-2.461**	-0.698	-0.088**
	(1.017)	(0.641)	(0.040)
Temp tort reform	-0.626	-0.389	-0.473
	(0.743)	(0.582)	(0.393)
Constant	-8.471*	-5.170**	-5.950***
	(4.801)	(2.342)	(1.694)
Log Pseudolikelihood	-109.604	-498.393	—
Observation	429	3760	3760

Medical Malpractice_PM reports results of using discrete-time hazard models, in which observations of each state are included in the analyses until the state passed any permanent tort reforms on medical malpractice. The last two models report results of the timing of state enactments of four permanent tort reforms on medical malpractice gradually by using multivariate survival analysis, in which observations of each tort reform are stacked. Frailty Model--MM uses a frailty model with random effects and the Marginal Risk set Model --MM uses a marginal risk set model to control correlations for different baseline hazard functions of tort reforms. Medical malpractice models have observations after 1974 since medical liability insurance is separated from other liability insurance since 1974. Robust standard errors are in parentheses. ***, **, and * denote statistically significant at the 1, 5, and 10 percent levels.

Appendix A: Figures

Figure A1 Map of Caps on Punitive Damages on General Liability

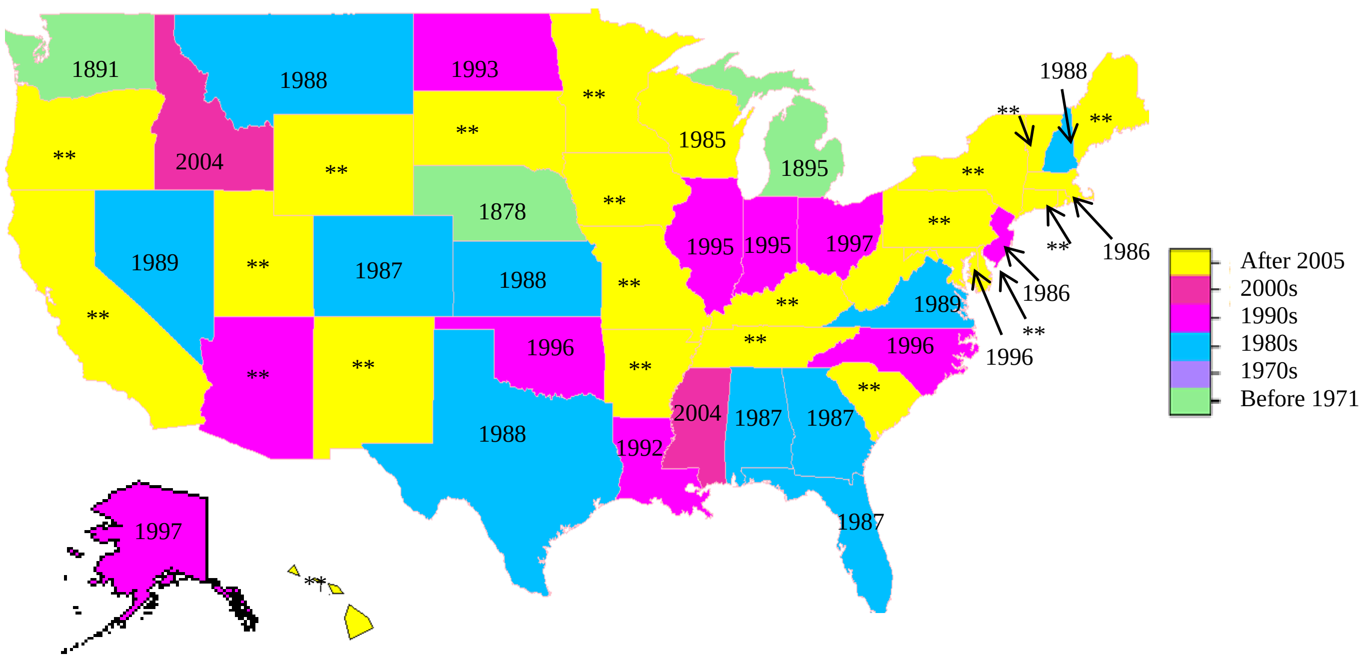


Figure A2 Map of Limitations on Joint and Several Liability on General Liability

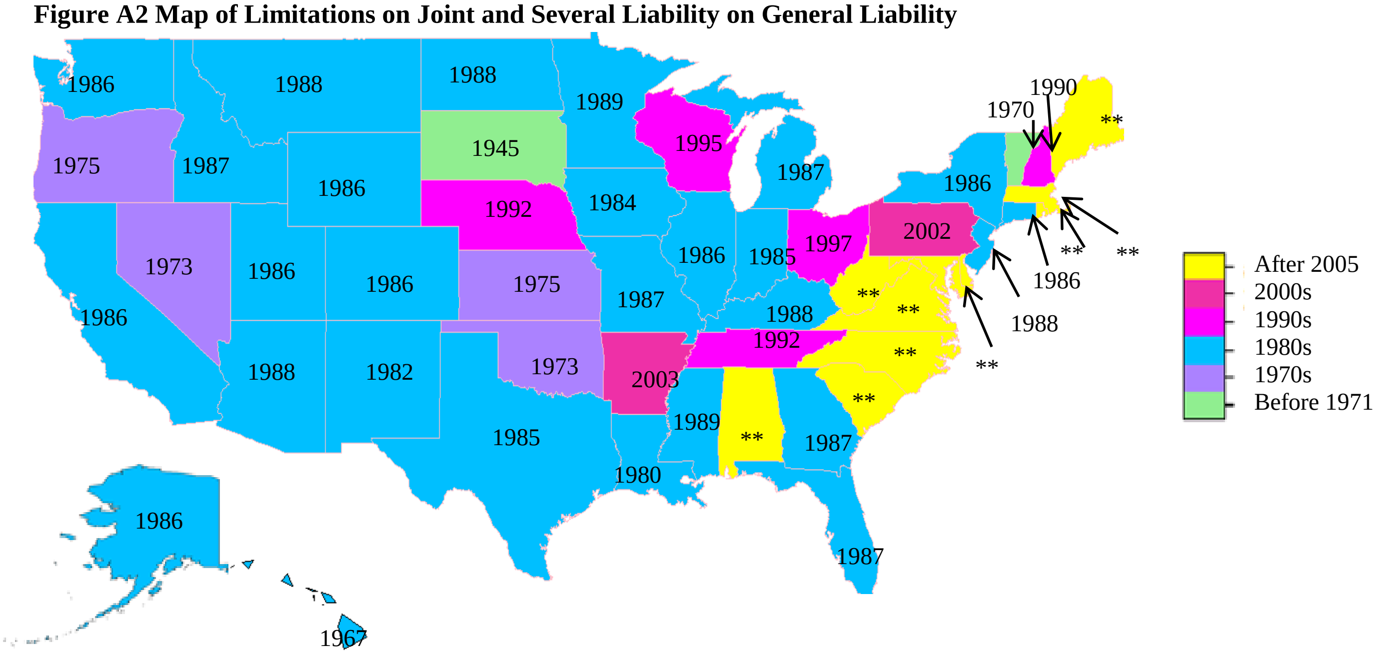


Figure A3 Map of Caps on Noneconomic Damages on General Liability

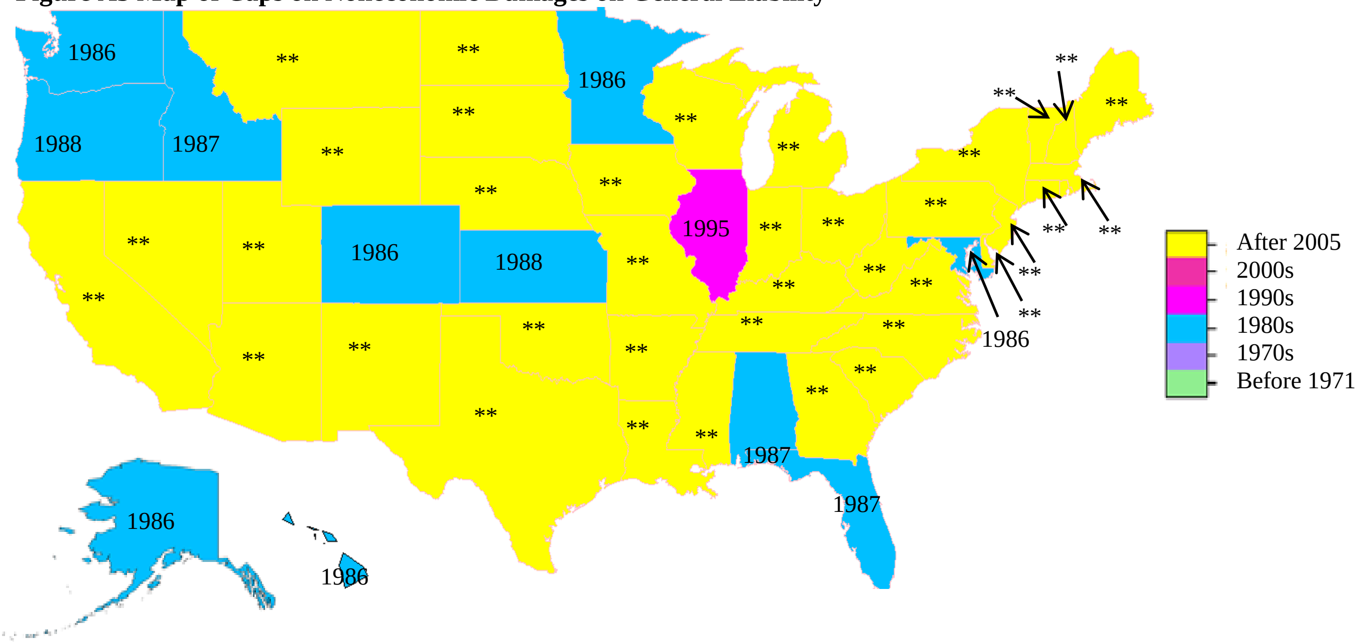


Figure A4 Map of Caps on Noneconomic Damages on General Liability or Medical Malpractice Liability

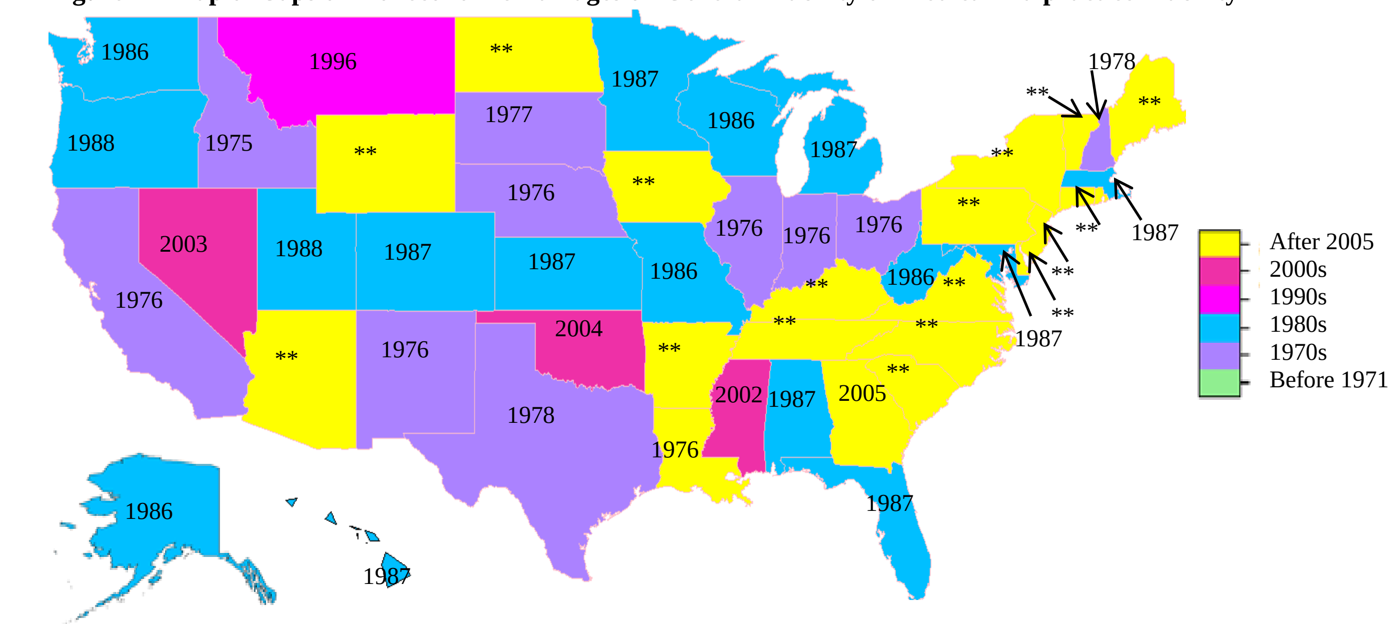


Figure A5 Map of Collateral Source Rules Reform on General Liability

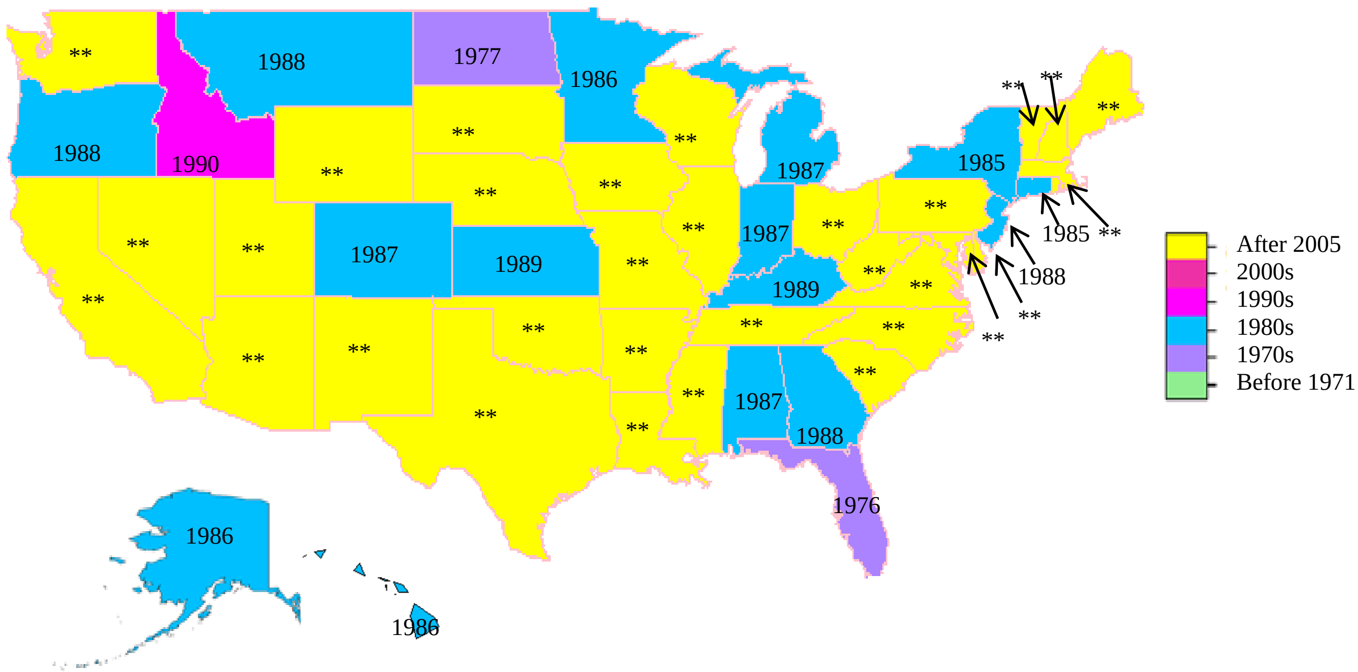


Figure A6 Map of Collateral Source Reform on General Liability or Medical Malpractice Liability

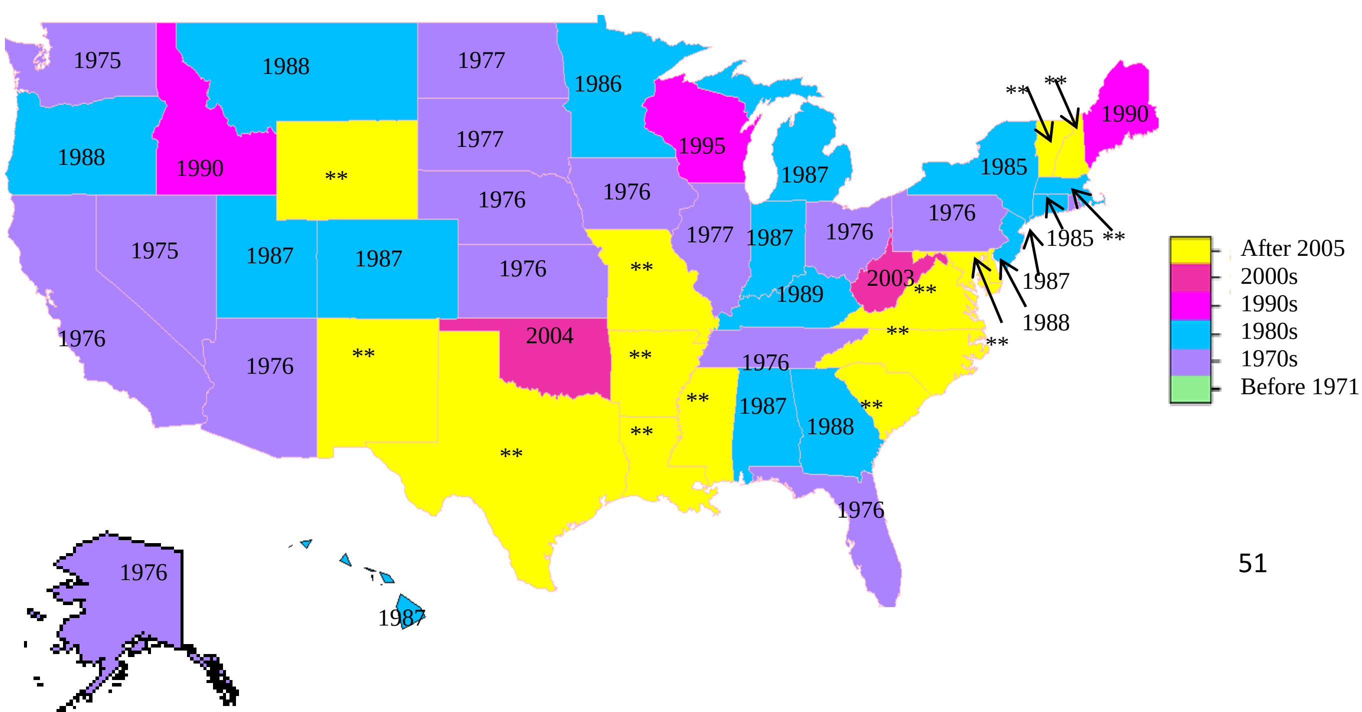
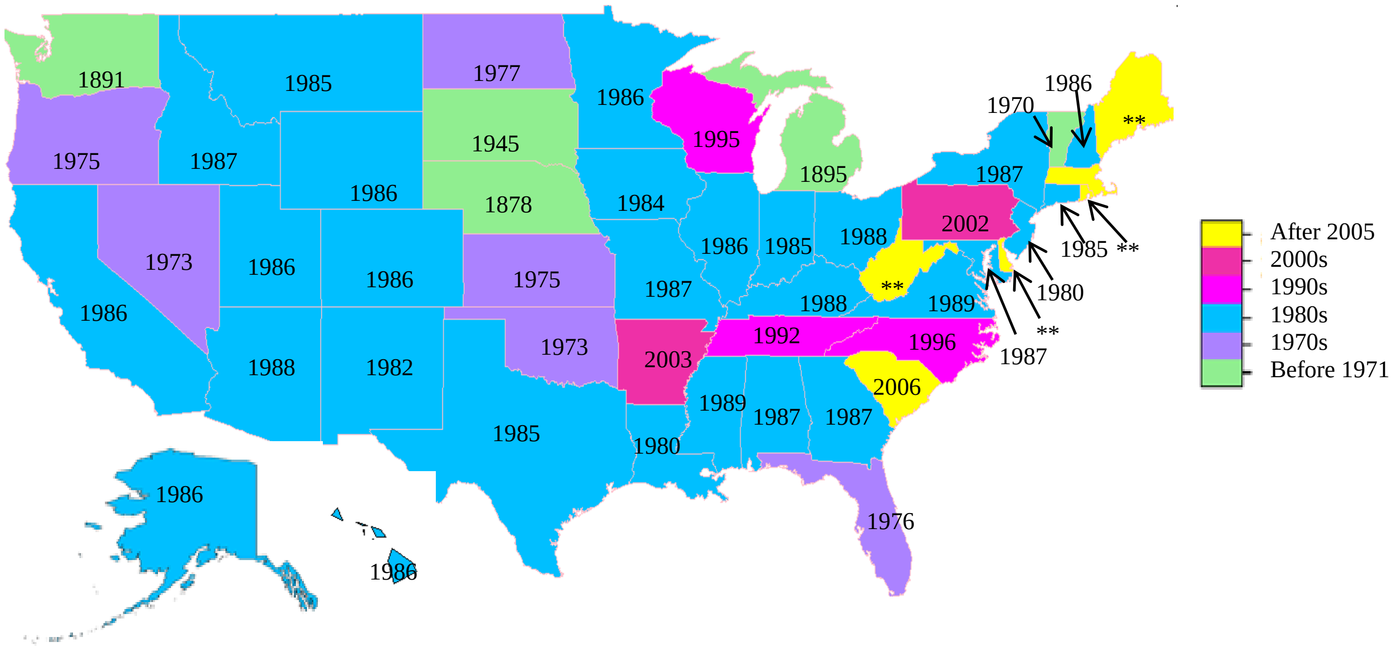


Figure A7 Map of Any of Four Tort Reforms on General Liability



Appendix B

Table B1 Year of the First Tort Reform Legislation on General Liability, by State

State	Caps on Noneconomic Damages	Caps on Punitive Damages	Collateral Source	Joint and Several Liability	Four Tort Reforms
AL	1987	1987	1987	****	1987
AK	1986	1997	1986	1986	1986
AZ	****	****	****	1988	1988
AR	****	****	****	2003	2003
CA	****	****	****	1986	1986
CO	1986	1986	1986	1986	1986
CT	****	****	1985	1986	1985
DE	****	****	****	****	****
FL	1987	1986	1976	1987	1976
GA	****	1987	1987	1987	1987
HI	1986	****	1986	1986	1986
ID	1987	2003	1990	1987	1987
IL	1995	1995	1986	1986	1986
IN	****	1995	1987	1985	1985
IA	****	****	1988	1984	1984
KS	1988	1987	****	1975	1975
KY	****	****	1988	1988	1988
LA	****	1992	****	1980	1980
ME	****	****	****	****	****
MD	1986	****	****	****	1986
MA	****	****	****	****	****
MI	****	<1971	1987	1987	<1971
MN	1986	****	1986	1989	1986
MS	2005	2003	****	1989	1989
MO	****	****	****	1987	1987
MT	****	1985	1988	1987	1985
NE	****	<1971	****	1992	<1971
NV	****	1989	****	1973	1973
NH	****	1986	****	1990	1986
NJ	****	1996	1987	1987	1987
NM	****	****	****	1982	1982
NY	****	****	****	1986	1986
NC	****	1996	****	****	1996
ND	****	1993	1977	1988	1977
OH	****	1997	1988	1997	1988
OK	****	1995	****	1973	1973
OR	1988	****	1988	1975	1975
PA	****	****	****	2002	2002
RI	****	****	****	****	****
SC	****	****	****	****	****
SD	****	****	****	<1971	<1971
TN	****	****	****	1992	1992
TX	****	1987	****	1985	1985
UT	****	****	****	1986	1986
VT	****	****	****	<1971	<1971
VA	****	1988	****	****	1988
WA	1986	<1971	****	1986	<1971
WV	****	****	****	****	****
WI	****	****	****	1995	1995
WY	****	****	****	1986	1986

Note: ** indicates there is no such tort reform before 2005.**

Table B2 Estimated Survivor Functions: Kaplan-Meier Estimates for Tort Reforms on General Liability

Year	Four Tort Reform Survival	Caps on punitive damage	Joint and Several liability	Collateral Source	Caps on non-economic damage
1971	1.000 (—)	1.000 (—)	1.000 (—)	1.000 (—)	1.000 (—)
1972	1.000 (—)	1.000 (—)	1.000 (—)	1.000 (—))	1.000 (—)
1973	0.956 (0.031)	1.000 (—)	0.958 (0.029)	1.000 (—)	1.000 (—)
1974	0.956 (0.031)	1.000 (—)	0.958 (0.029)	1.000 (—)	1.000 (—)
1975	0.911 (0.042)	1.000 (—)	0.917 (0.040)	1.000 (—)	1.000 (—)
1976	0.899 (0.047)	0.980 (0.020)	0.917 (0.040)	1.000 (—)	1.000 (—)
1977	0.867 (0.051)	0.960 (0.028)	0.917 (0.040)	1.000 (—)	1.000 (—)
1978	0.867 (0.051)	0.900 (0.042)	0.917 (0.040)	1.000 (—)	1.000 (—)
1979	0.867 (0.051)	0.900 (0.042)	0.917 (0.040)	1.000 (—)	1.000 (—)
1980	0.844 (0.054)	0.900 (0.042)	0.896 (0.044)	1.000 (—))	1.000 (—)
1981	0.844 (0.054)	0.780 (0.059)	0.896 (0.044)	1.000 (—)	1.000 (—)
1982	0.822 (0.057)	0.780 (0.059)	0.875 (0.048)	1.000 (—)	1.000 (—)
1983	0.822 (0.057)	0.780 (0.059)	0.875 (0.048)	1.000 (—)	1.000 (—)
1984	0.800 (0.060)	0.780 (0.059)	0.854 (0.051)	1.000 (—)	1.000 (—)
1985	0.711 (0.068)	0.780 (0.059)	0.812 (0.056)	0.977 (0.004)	1.000 (—)
1986	0.467 (0.074)	0.780 (0.059)	0.583 (0.071)	0.977 (0.004)	0.960 (0.028)
1987	0.356 (0.071)	0.660 (0.067)	0.458 (0.070)	0.927 (0.007)	0.960 (0.028)
1988	0.267 (0.066)	0.660 (0.067)	0.375 (0.069)	0.887 (0.009)	0.840 (0.052)
1989	0.244 (0.064)	0.660 (0.067)	0.354 (0.069)	0.858 (0.010)	0.840 (0.052)
1990	0.244 (0.064)	0.660 (0.067)	0.333 (0.068)	0.858 (0.010)	0.840 (0.052)
1991	0.244 (0.064)	0.660 (0.067)	0.333 (0.068)	0.858 (0.010)	0.840 (0.052)
1992	0.222 (0.062)	0.660 (0.067)	0.292 (0.066)	0.858 (0.010)	0.840 (0.052)
1993	0.222 (0.062)	0.620 (0.069)	0.292 (0.066)	0.841 (0.010)	0.840 (0.052)
1994	0.222 (0.062)	0.620 (0.069)	0.292 (0.066)	0.841 (0.010)	0.780 (0.059)
1995	0.200 (0.060)	0.600 (0.069)	0.271 (0.064)	0.823 (0.010)	0.780 (0.059)
1996	0.178 (0.057)	0.600 (0.069)	0.271 (0.064)	0.765 (0.011)	0.780 (0.059)
1997	0.178 (0.057)	0.600 (0.069)	0.250 (0.063)	0.745 (0.012)	0.760 (0.060)
1998	0.178 (0.057)	0.600 (0.069)	0.250 (0.063)	0.724 (0.012)	0.760 (0.060)
1999	0.178 (0.057)	0.600 (0.069)	0.250 (0.063)	0.724 (0.012)	0.760 (0.060)
2000	0.178 (0.057)	0.600 (0.069)	0.25 (0.063)	0.724 (0.012)	0.760 (0.060)
2001	0.178 (0.057)	0.600 (0.069)	0.250 (0.063)	0.724 (0.012)	0.760 (0.060)
2002	0.156 (0.054)	0.600 (0.069)	0.229 (0.061)	0.724 (0.012)	0.760 (0.060)
2003	0.133 (0.051)	0.600 (0.069)	0.208 (0.059)	0.675 (0.012)	0.760 (0.060)
2004	0.133 (0.051)	0.600 (0.069)	0.208 (0.059)	0.650 (0.013)	0.760 (0.060)
2005	0.133 (0.051)	0.600 (0.069)	0.208 (0.059)	0.650 (0.013)	0.760 (0.060)

Table B3 Year of the First Tort Reform Legislation on Medical Malpractice Liability, by State

State	Caps on Noneconomic Damages	Caps on Punitive Damages	Collateral Source	Joint and Several Liability	Four Tort Reforms
AL	1987	1987	1987	****	1987
AK	1986	1998	1976	1986	1976
AZ	****	****	1976	1988	1976
AR	****	2003	****	2003	2003
CA	1976	****	1976	1986	1976
CO	1987	1987	1987	1987	1987
CT	****	****	1986	1987	1986
DE	****	****	****	****	****
FL	1987	1987	1976	1987	1976
GA	****	1988	1988	1988	1988
HI	1987	****	1987	1987	1987
ID	1975	2004	1990	1988	1975
IL	1976	1995	1977	1987	1976
IN	1976	1995	1987	1985	1976
IA	****	****	1976	1985	1976
KS	1988	1988	1976	1975	1975
KY	****	****	1989	1977	1977
LA	****	1992	****	1981	1981
ME	****	****	1990	****	1990
MD	1987	****	****	****	1987
MA	1987	****	1987	****	1987
MI	1987	<1971	1987	1987	<1971
MN	1987	****	1986	1989	1986
MS	2002	2004	****	1990	1990
MO	1986	****	****	1988	1988
MT	1996	1985	1988	1988	1985
NE	1976	<1971	1976	1992	<1971
NV	2003	1989	1975	1973	1973
NH	1978	1987	****	1990	1987
NJ	****	1996	1988	1988	1988
NM	1976	****	****	1982	1976
NY	****	****	1985	1987	1985
NC	****	1996	****	****	1996
ND	****	1993	1977	1988	1977
OH	1976	1997	1976	1997	1976
OK	2004	1996	2004	1973	1973
OR	1988	1988	1988	1976	1976
PA	****	1997	1976	2002	1976
RI	****	****	1976	****	1976
SC	****	****	****	****	****
SD	1977	****	1977	<1971	<1971
TN	****	****	1976	1992	1976
TX	1978	1988	****	1986	1986
UT	1988	****	1987	1986	1986
VT	****	****	****	<1971	<1971
VA	****	1989	****	****	1989
WA	1986	<1971	1975	1986	<1971
WV	1986	****	2003	1986	1986
WI	1986	1985	1995	1995	1995
WY	****	****	****	1986	1986

Table B4 Robustness Check with Alternative Measurements of Discrete Time Hazard Models of Political Economy Factors Influencing the Timing of General Liability Tort Reforms, 1971-2005

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Weibull Model
Ideological state spillover	3.298***	—	—	—	—	—
	(0.536)					
Republican control	—	1.187**	—	—	—	—
		(0.482)				
Urban	—	—	0.015	—	—	—
			(0.011)			
Liability insurance loss	0.365***	0.355***	0.340***	0.305***	0.355***	0.223**
	(0.057)	(0.057)	(0.057)	(0.055)	(0.058)	(0.105)
State Spillover	—	2.741***	2.691***	2.778***	2.671***	-0.530
		(0.503)	(0.506)	(0.458)	(0.530)	(1.559)
Heath care expenditure	-0.221	-0.184	-0.235	0.105	-0.179	-1.934***
	(0.396)	(0.399)	(0.395)	(0.334)	(0.353)	(0.679)
Credit spread	0.528*	0.693**	0.638**	0.437	0.764***	-0.809
	(0.274)	(0.285)	(0.280)	(0.318)	(0.242)	(0.856)
GSP per capita	-0.009	-0.010	-0.013	-0.017	0.013	-0.155***
	(0.032)	(0.033)	(0.033)	(0.031)	(0.043)	(0.048)
Ratio of republican	2.932***	—	2.465***	2.021**	2.327***	4.549***
	(0.917)		(0.938)	(0.839)	(0.846)	(1.753)
Same party	0.426	0.426	0.473*	0.354	0.544**	0.856*
	(0.267)	(0.266)	(0.273)	(0.264)	(0.249)	(0.500)
Republican ideology	0.038	0.014	0.029	0.015	0.022	0.086
	(0.031)	(0.030)	(0.032)	(0.030)	(0.029)	(0.082)
Democratic ideology	-0.070**	-0.059*	-0.059**	-0.055*	-0.060**	-0.061
	(0.028)	(0.031)	(0.030)	(0.030)	(0.027)	(0.045)
Governor ideology	0.012	0.022**	0.012	0.006	0.017**	0.011
	(0.008)	(0.010)	(0.008)	(0.008)	(0.008)	(0.013)
Employment in insurer	0.048	0.058	0.027	0.059	0.017	0.128
	(0.088)	(0.093)	(0.093)	(0.095)	(0.095)	(0.162)
Physician	-0.207**	-0.200***	-0.196***	-0.203***	-0.200***	-0.246*
	(0.082)	(0.077)	(0.074)	(0.076)	(0.076)	(0.147)
Lawyer	0.081***	0.085***	0.078***	0.096***	0.080***	0.189***
	(0.027)	(0.027)	(0.028)	(0.026)	(0.025)	(0.073)
No-fault verbal	-0.084	-0.116	-0.122	-0.132	-0.216	1.463
	(0.593)	(0.545)	(0.555)	(0.577)	(0.547)	(1.919)
No-fault high value	1.108***	1.142***	1.131***	1.383***	1.253***	0.325
	(0.377)	(0.366)	(0.387)	(0.370)	(0.363)	(0.938)
Punitive damages insurable $_t$	0.259	0.250	0.481	0.450	0.309	0.371
	(0.339)	(0.351)	(0.372)	(0.329)	(0.335)	(0.793)
Rate regulation $_t$	0.334	0.353	0.315	0.377	-0.078	0.039
	(0.339)	(0.347)	(0.337)	(0.328)	(0.320)	(0.584)
South	-0.703	-0.358	-0.136	-0.333	-0.196	-0.134
	(0.457)	(0.435)	(0.439)	(0.412)	(0.440)	(0.851)
Midwest	0.016	0.460	0.581	0.391	0.533	0.104
	(0.474)	(0.495)	(0.536)	(0.502)	(0.532)	(0.970)
Northeast	-1.712**	-1.321*	-1.074	-1.020	-1.007	-3.859**
	(0.725)	(0.716)	(0.691)	(0.681)	(0.748)	(1.634)
1/P	—	—	—	—	—	0.147
						(0.043)
Log duration time	0.534	0.371	0.551	0.156	0.149	—
	(0.464)	(0.452)	(0.515)	(0.401)	(0.505)	
Temp tort reform	0.558	0.605	0.719*	0.511	-0.586	—

	(0.356)	(0.368)	(0.369)	(0.357)	(0.547)	
Constant	-6.586***	-6.720***	-8.365***	-6.366**	-6.546***	-16.101**
	(2.041)	(2.064)	(2.342)	(2.052)	(2.036)	(6.436)
Observations	5486	5486	5486	5529	5292	825

The dependent variable equals one if a state enacts tort reform on general liability in that year and zero otherwise. The first five models report results of the timing of state enactments of any of the four permanent tort reforms on general liability gradually by using multivariate survival analysis, in which observations of each tort reform are stacked. *Temp tort reform* is a dummy variable representing temporary tort reforms in effect but ultimately held unconstitutional. The fourth column uses a different definition of tort reform "effective" enactment: any tort reform enactment after July of year t is treated as effective tort reform in year t+1. The fifth column reports results when using the lagged value of variables instead of contemporaneous variables. The sixth column reports the results of the continuous Weibull model. Standard errors (robust to heteroscedasticity and serial correlation in the first five columns (jackknife standard error); robust to clustering by year in the last column) are shown in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels.

Table B5 Fixed Effect Regressions of Ex Post Consequences of Liability Tort Reforms, 1971-2005

	Loss of other liability insurance	Loss of auto liability insurance	Loss of medical malpractice insurance
Caps on noneconomic damages	-0.434***	-0.427*	-0.021
	(0.105)	(0.208)	(0.040)
Joint and several liability	-0.269**	-0.131	-0.030
	(0.127)	(0.237)	(0.044)
Caps on punitive damages	-0.106	0.160	-0.062
	(0.100)	(0.289)	(0.047)
Collateral Source	0.114	-0.182	0.020
	(0.118)	(0.251)	(0.043)
No-fault verbal	—	-0.688**	—
		(0.320)	
No-fault high value	—	0.014	—
		(0.324)	
Constant	0.978***	5.447***	0.491***
	(0.058)	(0.134)	(0.047)
Medical malpractice tort reform	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes
R-square	0.580	0.742	0.527
Observations	1750	1750	1550

The dependent variables are direct loss incurred of different liability insurance lines scaled by GSP multiplied by 1000. All variables are measured for each state in each year. The tort reform indicators are equal to one in the years when the tort reforms are effective and zero otherwise. All the variables are described as in Table 2. State fixed effects and year fixed effects are included in all regressions. The medical malpractice model has observations after 1974 since medical liability insurance is separated from other liability insurance only since 1974. The standard errors adjusted for clustering at the state level are in the parentheses.*, **, and *** indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Essay II: Market Discipline and Government Guarantees: Evidence from the Insurance Industry*

ABSTRACT

We identify the effect of public guarantees on market discipline by exploiting the rich variation in U.S. state guarantees of property-liability insurer obligations. We find government guarantees significantly reduce the sensitivity of premium growth to changes in financial strength ratings, and that this reduced sensitivity applies to both price and volume changes. The effects are concentrated among insurers rated A- or lower by A.M. Best, the leading financial strength rating agency in the insurance industry. For downgraded insurers, we find that premium growth in business not covered by state guarantees falls in relation to growth in its covered business, with the estimate of the difference being as high as 15% for A- rated insurers and 10% for insurers rated below A-.

JEL Classification: G22, G28, E53

Keywords: Guaranty Funds; Deposit Insurance; Market Discipline; Regulatory Discipline

* This paper has benefited from comments and suggestions by Richard Butler, Conrad Ciccotello, Martin Grace, Stephen Shore and Sharon Tennyson, and seminar participants at the University of Georgia, 2015 Huebner Doctoral Colloquium, 2015 ARIA conference, 2015 FMA Doctoral Consortium, 2015 FMA meeting, 2016 AEA meeting and 2016 Risk Theory Society for helpful comments. Travel support from the Huebner Foundation for Insurance Education and Center for the Economic Analysis of Risk (CEAR) is gratefully acknowledged.

The system of government guarantees is a double-edged sword: it can help to reduce systemic risk by preventing destabilizing runs on financial institutions, but it also reduces the incentives of consumers to monitor the solvency of their financial institutions. In general, consumers prefer financially strong institutions, but guarantees can reduce the costs associated with weak financial institutions. Understanding whether and how government guarantees reduce market discipline is important for regulatory policy.

Identifying the effect, however, is difficult. Studies from the banking industry have taken a variety of approaches---but most suffer from the drawback that guarantees are applied on a national basis, which makes it difficult to disentangle the effect of the guarantee from other confounding influences. This paper studies the impact of government guarantees on market discipline by exploiting the unique institutional structure of the U.S. property-liability (P/L) insurance industry.

U.S. P/L insurers are licensed and regulated on a state by state basis. Each state has its own guaranty fund, which protects the policyholders of the licensed insurance companies that fail. The types of insurance that receive guaranty fund protection differ across states and time. The generosity of the guaranty also differs across states and time, as states set different maximum claim amounts and net worth provisions. Unlicensed insurers do not receive guarantee fund coverage.[1] This study exploits the cross-sectional and time-series heterogeneity in the breadth and depth of state insurance guaranty fund coverage to identify the influence of public guarantees on market discipline.

We examine whether state insurance guaranty funds dull customer sensitivity to risk by investigating the relationship between firm premium growth and changes in A.M. Best Company financial strength ratings, which assess an insurer's ability to meet ongoing obligations to its policyholders. Since policyholders covered by guaranty funds have less to lose from the failure of their insurer than do policyholders not covered, we hypothesize that premium growth in lines and states protected by guaranty funds will be less sensitive to rating changes. The alternative hypothesis is guaranty funds have no effect on market discipline when there is a change in insurer risk.

[1] Unlicensed insurers provide coverage on risks that were not accepted by the licensed insurers in the state. An insurer can be licensed in one state, yet provide insurance on an unlicensed (surplus lines) basis in another state.

We investigate the question at two levels. The first level of analysis is at the firm-line level and uses the proportion of uncovered premiums as the measure of the extent of guaranty fund protection. We use control group tests and fixed effects regressions to measure the difference between covered and uncovered growth in the aftermath of a change in risk. Our analysis shows that guaranty funds decrease market discipline significantly, but the effect is asymmetric. The presence of guaranty funds consistently and significantly reduces market discipline for the downgrades of A- or low-rated insurers, whereas the effect for upgrades is weaker.

The second level of analysis, which pushes well beyond the level used in previous studies, is at the firm-state-line-year level. Our data allows us to decompose each firm's yearly premiums by state and by line of business, so we are able to classify each state-line combination according to whether it is covered by a state guaranty fund or not. First, we use firm-line-year fixed effects and state fixed effects to exploit variation in guaranty fund coverage across states. The primary source of variation is between licensed business, which receives guaranty fund coverage, and unlicensed business, which does not. A secondary source of variation is differences across states in what lines of insurance are covered by guaranty funds. Second, we use firm-state-year fixed effects and line fixed effects to exploit variation across the lines of insurance within the state that do and do not receive guaranty fund coverage. Third, we use firm-line-state fixed effects and year fixed effects to exploit variation across time, as states add and drop lines from guaranty fund coverage over the years and some insurers write on both a licensed and unlicensed basis over the sample period. The analyses are performed separately for downgraded and upgraded firms. Using these specific levels of analysis, we compare the premium growth of different business segments within the same insurers, i.e. insurers operating the same lines of business across states, or insurers operating different lines within a state. We find that for a downgraded insurer premium growth in business covered by a state guaranty fund falls in relation to growth in its covered business, with the estimate of the difference being as high as 15% for insurers rated A- and 10% for insurers rated below A-. However, when a state eliminates guarantee fund coverage for a line of business, the effect is much greater---30% for insurers rated A- and 46% for insurers rated below A-. Effects are concentrated among insurers rated A- or lower by A.M. Best. In addition, our evidence suggests that the effects are mostly in commercial insurance.

We further investigate the mechanism by which market discipline and guaranty funds work. Policyholders can discipline higher risk insurers by buying less insurance coverage, shifting their insurance contract to a lower risk insurer, or by demanding lower prices. Accordingly, we also investigate the relationship between insurance prices and guaranty funds surrounding changes in financial strength ratings. We do so by interacting the guaranty fund protection with rating changes to test whether the effect of guaranty funds on market discipline is through price changes. We find guaranty funds blunt market discipline: price growth is less sensitive to ratings changes in the presence of guaranty fund protection. The magnitude of the decrease is smaller for price growth than it is for premium growth. The results suggest that the reduced sensitivity of premium growth by guaranty funds applies to both price and volume changes.

This paper contributes to at least three lines of literature. First, our analysis connects closely to studies examining deposit insurance and market discipline in banking (e.g., Billett, Garfinkel and O'Neal, 1998; Park and Peristiani, 1998; Martinez Peria and Schmuckler, 2001; Demirguc-Kunt and Huizinga, 2004; Forssbaeck, 2011; Karas et al., 2013). Insurance guaranty funds are similar to deposit insurance in banking in that both protect small depositors/policyholders against financial institution insolvency, and are designed to stabilize the financial institutions. However, insurance guaranty funds differ from deposit insurance in three important dimensions. First, the FDIC charges risk based premiums but guaranty funds are funded by assessments that are not risk-based. Second, guaranty fund protection is less well known to the public. Banks advertise FDIC protection, while regulations forbid insurance sellers to advertise the presence of guaranty fund protection. Third, and most importantly for our purposes, guaranty funds are organized on a state basis, while deposit insurance is national. Rich variation in guaranty fund coverage across states and time provides us with a unique opportunity to measure the effect of public guarantees without the identification problems present in most banking studies.

Second, there is a growing literature on how market discipline works in insurance sectors (e.g. Eling and Kiesenbauer, 2012; Sommer, 1996; Epermanis and Harrington, 2006; Eling and Schmit, 2012). Perhaps most relevant to our context is the study by Epermanis and Harrington (2006), which examines the impact of discrete risk changes (i.e., ratings downgrades) on the premium growth rate of insurers. They find premium declines for downgrades are larger for commercial insurance than personal insurance. Our research explicitly incorporates the heterogeneity in guaranty fund protection across lines and states and thus enables us to explicitly measure the effect of guaranty funds. We find guaranty funds significantly reduce the sensitivity of premium growth to changes in financial strength ratings. Third, our findings provide additional evidence on the adverse incentives created by guaranty funds, thus connecting to the literature on the effects of guaranty funds on insurance market behavior (Cummins, 1988; Lee, Mayers, and Smith 1997; Lee and Smith, 1999; Grace et al. 2014).

The remainder of the paper is organized as follows. Section I provides background information on guaranty funds and discusses the related literature. Section II reports the data sources and the procedures of sample selection. Section III provides the identification strategy. Section IV discusses the main empirical results and robustness check. Section V explores the possible underlying mechanism of market discipline. Section VI concludes.

I. Property-Liability Insurance Guaranty Funds

State P/L insurance guaranty funds, enacted between 1969 and 1981, cover policyholder losses associated with insurer insolvencies. The funds are administered by nonprofit associations that consist of all the licensed insurers in the state that write insurance in lines covered by the guaranty funds. All states, with the exception of New York,[2] finance these funds by levying post-insolvency assessments on solvent insurers. Assessments, based on the net direct premiums written in the state during the past year, are subject to a statutory ceiling (typically 2%). The assessment is independent of an insurer's risk. Assessed insurers can recoup these fees through rate increases and/or tax offsets at a rate of up to 20% per year. Thus, future policyholders and current taxpayers fund guaranty funds

Guaranty fund protection is not complete in several respects. First, guaranty funds do not cover all lines of insurance. The lines most commonly excluded are: accident and health, credit, fidelity, mortgage guaranty, financial guaranty, ocean marine, surety, title, and warranty. However, there is variation in the excluded lines across time[3] and significant variation across the

[2] New York uses a pre-funding model instead of an ex-post funding model.
[3] Several states changed their excluded lines during our sample years. For example, NV started to exclude financial guaranty, warranty and credit in 1993; OH started to exclude financial guaranty, fidelity and credit in 1994; and PA started to exclude financial guaranty and warranty in 1995.

states.[4] Second, guaranty funds do not pay claims beyond maximum amounts. The maximum claim amount ranges from $100,000-$5,000,000. Table 1 shows that a majority of states have a maximum amount in the $300,000-$500,000 range. In most states, the caps do not apply to workers compensation insurance. Third, some states apply policyholder net worth provisions, in which claims are not paid for policyholders that have a net worth that exceeds specified levels. The typical net worth provision is $25,000,000, the net worth cap ranges from $5,000,000 to $50,000,000 (see Table 1). Fourth, the policyholders of insurers not licensed in the state (surplus lines insurers) are not covered by guaranty funds. Surplus lines insurers underwrite risks that do not meet the underwriting guidelines of licensed insurers or require specialized coverage, pricing or underwriting. Surplus lines insurers have flexibility both in contract language and pricing that allow them to underwrite a variety of risks---including ones that are unusual and/or substandard--that do not conform to typical insurer appetites.

Guaranty funds can be viewed as providing a put option on the value of the insurer's assets with a strike price equal to the value of the insurance policies (e.g. Cummins, 1988). The flat rate premiums in New York and the post-assessment schemes of the other states do not reflect insurer risk. Lee, et al. (1997) and Downs and Sommer (1999) find that stock insurers increased their asset risk with the enactment of guaranty-fund laws.

II. Data and Sample Construction

We use data from the National Association of Insurance Commissioners (NAIC) annual statement database for the period 1989-2012. The database contains underwriting and financial information for all U.S P/L insurers. Our analysis is based on affiliated and unaffiliated single insurers. The Exhibit of Premiums Written (Schedule T) in the annual statement documents the states in which the insurer is licensed and the amount of business an insurer (licensed or unlicensed) writes in each state and line of business. We also collect other firm level information including total assets, leverage, reinsurance ceded, business diversification, and firm

[4] Accident and health insurance is excluded in all but five (5) states: MI, MT, WA, WV, WI , and WY. Credit is excluded in all but two (2) states: MD and MI. Fidelity is excluded in all but eighteen (18) states: AL, AZ, AR, KS, KY, ME, MD, MI, MN, MT, NM, NY, OK, OR, VT, WA WV, and WY. Financial guaranty is excluded by all but twelve (12) states: AL, AZ, KS, MD, MI, MT, NJ, OR, VT, WA, WV, and WY. Mortgage guaranty is excluded by all but one (1) state: MI. Ocean Marine is excluded in all but six (6) states: AK, KS, ME, MD, MI, and NY. Surety is excluded in all but eight (8) states: AR, KS, KY, ME, MD, MI, MN, and NY. Title is excluded in all but eight (8) states: AL, AK, CO, MD, MI, NH, NY, and ND. Warranty is excluded in all but nineteen (19) states: AL, CA, CO, CT, KS, MD, MI, MT, NE, NH, NJ, NM, NY, OK, OR, VT, WA,WV, and WY.

demographics such as organizational form, distribution channel, and whether the insurer is affiliated with a group of insurers. The other firm data are obtained on a calendar-year basis.

We use A.M. Best rating changes to proxy insurer financial strength changes. The insurance market is evaluated by several rating agencies such as A.M. Best, Fitch, Moody's and Standard and Poor's (S&P). Among them, A.M Best has, by far, the most comprehensive coverage over the sample period. AM Best's financial strength ratings are assessments of insurers' claims paying ability.[5] From A.M. Best's *Insurance Reports, Property-Casualty Edition and Best's Key Rating Guide*, we obtain insurer financial strength ratings from 1989 to 2011. Similar to Epermanis and Harrington (2006), we use rating changes to proxy for changes in insurer default risk. The financial strength ratings are on a scale from A++ (the highest) to F (the lowest). Bohn and Hall (1997) find that insurers approaching insolvency have unusually high premium growth two years prior to failure. As a result, we exclude the small number of insurers with financial strength ratings below C- (less than 0.1% of total observations).[6] Firm-year observations in which the firm was not assigned a rating by A.M. Best – for reasons such as insufficient size, company request, or failure to submit an NAIC annual statement – are excluded from our analysis, as are observations rated on the parallel Financial Performance Rating (FPR) scale that was used during the 1990's. A.M Best updates ratings throughout the year with most changes occurring before July. To allow comparability with other studies (e.g., Epermanis and Harrington, 2006), we treat any rating change from August of last year through July of this year as a rating change in this year, and any rating change after August of this year as a rating change in the next year. Table 2 shows A.M. Best ratings and how we categorize the ratings into high (above A-), A-, and low (below A-) ratings.

We match the insurer data with guaranty fund data in the P/L insurance industry. The guaranty fund data has been hand collected from the following sources: the National Conference of Insurance Guaranty Funds, state insurance divisions, and the session laws and compiled statutes of the various states.

[5] A.M. Best also issues credit ratings on the financial instruments issued by insurance companies. We focus on financial strength ratings because the intent of these ratings is to help policyholders make decisions on which insurers to buy coverage from.

[6] All of the results are robust to the inclusion of these very low-rated firms (rated as D, E and F).

To be included in the sample, firms must have positive direct and net premiums written and write business in a certain line in the three years around a rating change (i.e. year t-1, t, t+1).[7] Insurers that specialize in reinsurance or international business are excluded. The original sample has 4,615,898 firm-line-year-state level observations and is aggregated to 245,934 firm-line-year level observations with many observations being zero in premiums written. The sample screens described above reduce the sample to 147,998 firm-line-year level observations. The inclusion of lagged rating variables in our regressions further reduces the sample to 142,247 firm-line-year level observations. In our analysis of the impact of market discipline on prices, we exclude all observations with negative prices. This step reduces the price sample to 120,533 observations at the firm-line-year level. All variables are winsorized at the 1% and 99% levels to mitigate the effect of outliers.

III. Identification strategy

A. Firm-line level specification

Our identification strategy is to exploit the features of guaranty funds that vary across the states and time. The variations in guaranty fund coverage are quasi-natural experiments—they directly protect insureds but are exogenous to the insurers' financial strength. We first examine how government guarantees and rating changes affect premium growth at the firm-line level, with controls for firm observed and unobserved (invariant) heterogeneity, line of business unobserved (invariant) heterogeneity and unobserved time heterogeneity. Insurance lines with a higher proportion of premiums not covered by guaranty funds are hypothesized to be more risk sensitive and, thereby, more affected by rating changes. To measure this effect, we aggregate direct written premiums to the firm-line-year level to obtain total direct premiums, direct premiums not covered by guaranty funds (called uncovered premiums) and direct premiums covered by guaranty funds (called covered premiums).[8] Specifically, we calculate $Prop_{ijt}$ as the proportion of direct premiums written not covered by guaranty funds to total direct premiums written at the firm-line-year.

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[7] Since our unit of analysis is at firm-line-year level, as long as a firm writes the same line of business in any of the 50 states in the three years surrounding rating change, it is included in our sample.

[8] For example, suppose Insurer ABC writes direct business in Other Liability insurance in three states in 2009: \$1,000,000 in Michigan, \$1,500,000 in Wisconsin, and \$200,000 in Illinois. Insurer ABC, however, is not licensed in Illinois, so it writes business as a surplus lines insurer. The total direct premiums are \$1,000,000 + \$1,500,000 + \$200,000 = \$2,700,000. The uncovered premiums are \$200,000 and the covered premiums are \$2,500,000.

A potential concern with the research design is that premium changes may happen before changes in firm financial strength ratings. First, unfavorable changes in the insurance market (e.g. large catastrophes) could deplete insurer capital and lead to changes in premium growth and financial strength ratings. Second, insurers could begin to cut unprofitable business or expand profitable business before the rating agency discloses new information. For example, an insurer that anticipates a weak operating environment in the future may respond by reducing the amount of business they write, while firms that anticipate a strong operating environment may expand. Third, unobservable firm and line of business heterogeneity could be correlated with both premium growth and rating changes. Fourth, premium growth could result from private information and an anticipated change in an insurer's rating.

To address these concerns, we use three strategies. First, to address unfavorable changes in the environment for writing insurance we include indicator variables for one-year leaded, contemporaneous, and one-year lagged rating changes (i.e. rating change indicators in t+1, t, and t-1). We interact these indicators with guaranty fund coverage in the previous year to identify evidence on market discipline across different levels of protected financing. The strategy of using leading and lagged indicators is also employed by Epermanis and Harrington (2006). The one year lagged rating change is used to account for the *ex post* effects of the rating change. The coefficients of leaded variables provide insight into whether market discipline occurs in the year prior to a rating change. The differences among the coefficients of the leaded, contemporaneous, and lagged rating change variables provide information on whether market discipline occurs before, during, or after the year of the rating change. Second, to address the concern that the proportion of uncovered premiums may vary through time and be correlated with the error term, we use the lagged value of the proportion of uncovered premiums. We also include the interaction of a linear time trend with the proportion of uncovered premiums in the regressions. Third, to further control for the possibility that the insurers and markets anticipate rating changes we include a non-ratings based measure of firm risk. In particular, we include the variable, *Anticipation*, which is the average value of default-value-to-liability ratio (*Risk)* for the year's t-1 and t-2.[9]

The main estimating equation is:

[9] The precise definition of the variable *Anticipation* is in Appendix A.

$$\Delta P_{ijt} = E(\Delta P_{ijt} \mid no\ rating\ change) + \beta_p Prop_{ijt-1} + \beta'_d I_{it} + \beta'_{pre} \times Prop_{ijt-1} \times 1_{it,pre} + \beta'_{current} \times Prop_{ijt-1} \times 1_{it,current} + \beta'_{post} \times Prop_{ijt-1} \times 1_{it,post} + \gamma_{ij} + \delta_t + \varepsilon_{ijt}$$

(1)

where ΔP_{ijt} is premium growth for firm *i*, line *j* and year *t*; $Prop_{ijt}$ is the proportion of direct premiums written not covered by guaranty funds to total premiums. Specifically, we measure premium growth using direct premiums written since net premiums written (premium net of reinsurance) is not available at the state level. Growth in direct premiums written ($\Delta Log\ Premium$) is measured as the first difference of the log of direct premium written by insurer i at time t and the log of direct premium written by insurer i at time $t\text{-}1$. The premium growth measures are censored at -1 and 1.[10] $1_{it,\ pre}$, $1_{it,current}$, and $1_{it,post}$ are vectors of binary variables equal to 1 for lead rating changes, contemporaneous changes, and lagged changes (upgrade or downgrade) for firm i in year t. I_{it} is the stack vector of these binary variables. The γ_{ij} represents a firm-line fixed effect, which absorbs unobservable differences at the firm and line of business level; δ_t is a year fixed effect, and ε_{ijt} is an error term.

The expected premium growth conditional on no rating change is:

$$E(\Delta P_{ijt} \mid no\ rating\ change) = \beta_0 + \beta_1 P_{ijt-1} + \beta'_2 X_{it} + \varepsilon_{ijt}$$

(2)

where P_{ijt-1} is lagged log premiums; X_{it} is a vector of covariates that includes controls for firm time variant characteristics such as asset, leverage, reinsurance ceded, geographical diversification, line of business diversification, organizational form, direct writer, premiums subjected to prior approval rate regulation and rating categories (A- or LOW) in the previous year (see extended models in Table 8 for more details), and also guaranty fund related controls such as claim caps and net worth provisions.[11] This research design allows us to account for both the time-invariant characteristics of firm and lines of business and the time-varying characteristics of firms.

$\beta'_{current}$ and β'_{post} in equation (1) capture the current and post yearly premium growth percentage response to a change in the proportion of uncovered premiums for a firm-line-year experiencing a rating change, relative to the current and post premium growth of the control

[10] Our results hold if we do not censor premium growth at -1 and 1, and the effects of guaranty funds are larger.
[11] The hypotheses and precise definitions of the control variables can be found in Appendix A.

group (those with $Prop_{ijt\text{-}1}=0$), respectively. β'_{pre} measures the difference in the premium growth between the firm-line with positive $Prop_{ijt}$ and the control group one year before the firm-line experiences a rating change. Evidence that government guarantees dull market discipline requires that the difference between β'_{pre} and $\beta'_{current}$ (or β'_{post}) to be statistically and economically distinguishable from zero. We also extend equation (1) to incorporate the effects of the A.M. Best rating category (High, A-, Low).

B. Firm-line-state level specification

Many insurers operate the same line of business in multiple states and/or operate multiple lines in one state, providing insurance to both protected and unprotected customers. Some states change their guaranty fund coverage over years as well. Thus, we can use data on the firm-line-state-year level to further control for potentially confounding effects and to detect the source of variation, by using business that is protected by a guarantee fund as a control group. To be included in these regressions, a firm-line-state-year observation is required to be downgraded in that year. We run the regressions three ways. The first regression includes a firm-line-year fixed effect and a state fixed effect. The firm-line-year fixed effect sweep out the variation between firm-lines, making the estimates based on only the variation within each firm-line and across states. The state fixed effect controls constant state unobserved heterogeneity over time. Within firm-line variation occurs when a given firm-line has premiums in two or more states whose guaranty fund protection differs at least once during the sample period. The primary source of identification is driven by surplus lines insurers, i.e., insurance firms that are not licensed in some states and therefore not covered by guaranty funds. A secondary source of identification is the lines of insurance that receive guaranty fund coverage in some states but not others (see footnote 4). The second regression includes a firm-state-year fixed effect and a line fixed effect. The firm-state-year fixed effect sweeps out the between firm-state variation, and the effect of guaranty funds is identified on the basis of protection differences within a firm operating multiple lines of business in a state. In other word, the regression tests for variation across line of business within each firm and state. The third regression includes a firm-line-state fixed effect and a year fixed effect. The two fixed effects identify the effect of guaranty funds over time. The sources of identification are states modifying the lines of business that receive guaranty fund coverage and insurers changing their licensing status over the years of the sample period. Specifically, we estimate the following models:

State variations:

$$\Delta P_{ijst} = \alpha_{ijt} + \gamma_s + \beta_1 P_{ijst-1} + \beta_u^{'} \times Uncover_{ijst} \times PRC_{it} + \beta_s^{'} \times State_{st} + \varepsilon_{ijst} \quad (3)$$

Insurance line of business variations:

$$\Delta P_{ijst} = \alpha_{ist} + \gamma_j + \beta_1 P_{ijst-1} + \beta_u^{'} \times Uncover_{ijst} \times PRC_{it} + \beta_j^{'} \times Line_{jt} + \varepsilon_{ijst} \quad (4)$$

Time variations:

$$\Delta P_{ijst} = \alpha_{ijs} + \gamma_t + \beta_1 P_{ijst-1} + \beta_u^{'} \times Uncover_{ijst} \times PRC_{it} + \beta_j^{'} \times Line_{jt} + \beta_s^{'} \times state_{st} + \varepsilon_{ijst} \quad (5)$$

where ΔP_{ijst} is premium growth for firm *i*, insurance line *j*, state *s*, and year *t*; P_{ijst-1} is the natural logarithm of lagged premiums, PRC_{it} is the pre-change rating category (i.e. A- or Low), and $Uncover_{ijst}$ is an indicator variable that equals 1 if the firm i insurance line *j* is not covered by the guaranty fund in state *s* in year *t*, and 0 otherwise; $State_{st}$ is a vector of state time-variant variables including insurance gross state production per capita, employment in the insurance sector, income per capita and the number of insurers that became insolvent; $Line_{jt}$ is a vector of aggregated line of business time-variant variables including loss ratio and loss volatility; α_{ijt} is the firm-line-year fixed effect; γ_s is the state fixed effect; α_{ist} is the firm-state-year fixed effect; and γ_j is the line fixed effect. The standard errors are clustered at the firm-line-year in (3) and at the firm-state-year in (4).[12]

IV. Impact of State Guaranty Funds on Market Discipline

A. Summary statistics and control group tests for premium growth

Figure 1 shows the quantile plot of the proportion of uncovered premiums to total direct premiums at the firm-line level. More than 80% of the firm-line-year observations are fully covered by guaranty funds (the proportion of uncovered premiums equals 0). Beyond this 80th percentile threshold, the proportion of uncovered premiums increases sharply from 0% uncovered to above 50%. Amongst the firm-line-year observations that write uncovered insurance, less than 3% have less than 25% in uncovered premiums. We categorize firm-line-

[12] The definitions and data sources of control variables in equation (3) to equation (5) are described in the Appendix.

year observations into "covered" and "uncovered" groups using a threshold of 25% of business written in uncovered premiums for the control group tests.[13]

Table 3 presents the summary statistics for the variables used in the analysis. Panel A shows the summary statistics at the firm-line-year level for the full sample. Average direct premium growth is 4.3% and average direct premium written is 3,863,175. The average proportion of direct premiums that are uncovered by guaranty funds is 13.7%.

Panel B shows the summary statistics at the firm-line-year level for the regression sample. The average value for the *default-value-to-liability ratio* (*Risk*) is 0.1%. Nineteen percent of the observations are direct writers of insurance, 17.1% are mutuals, and 81.6% are affiliated with a group. The average observation has a product line Herfindahl of 0.330 and geographical Herfindhal of 0.436. On average, 24.6% of direct premiums written are in business lines and states subject to stringent rate regulation; 87.7% are in states with a guaranty fund maximum claim amount of $300,000 or more; and 41.1% are in states with net worth provisions beyond $25,000,000.

Table 4 shows the number and distribution of firms by rating category and by upgrades and downgrades. Table 4 Panel A provides this information for the sample uncovered by guaranty funds, while Panel B shows it for the covered sample. Comparing Panel A and Panel B, the uncovered sample has a slightly lower percentage of downgraded insurers. Meanwhile, there is a higher percentage of upgrades in the uncovered sample, especially for observations with ratings below A-. Figure 2 Panel A-C show that the patterns of rating changes by year are similar for the covered-and uncovered-samples.

We start with control group tests of premium growth. To measure abnormal growth in premiums, we use time, line, and size adjusted mean (median) abnormal premium growth. For each year and line of business, we rank all insurers by total direct premiums and calculate mean (median) premium growth for insurers in each premium decile. The time, line, and size adjusted premium growth for each insurer equals its growth in line *j* and year *t* minus the mean (median) growth for insurers in its premium decile in line *j* and year *t*. The estimated mean (median) abnormal premium growth for downgraded firms in each rating category equals the difference between the mean (median) adjusted growth for downgraded insurers and for insurers with no rating change. A similar analysis is performed for upgraded insurers.

[13] The results are robust to the use of different thresholds, such as 50%.

The results are shown in Table 5. The mean abnormal premium growth for downgrades is negative and statistically significant in year *t* and *t+1* for both the covered and uncovered groups, but the magnitudes of the premium change are significantly different. Mean abnormal premium growth is -13.50% in year *t* and -10.03% in year *t+1* for the uncovered-group, while it is -7.52% in year *t* and -7.77% in year *t+1* for the covered-group. The mean abnormal premium growth for upgrades is positive and statistically significant in both year *t* (4.38%) and *t+1* (3.72%) for the uncovered group only. Consistent with previous findings in the literature (e.g., Epermanis and Harrington (2006)), insurers experience more premium change when downgraded.

Table 6 shows the control group test results by pre-change rating category (high, A-, or low) – Panel A for insurer downgrades and Panel B for upgrades. The mean abnormal premium growth for downgrades is negative and statistically significant in year *t* and *t+1* for both the covered and uncovered group. However, for firms rated A- and below, the mean and median abnormal premium growth for the covered and uncovered group are significantly different. Specifically, in the A- rating category mean abnormal premium growth is -30.01% in year *t* and -31.65% in year *t+1* for the uncovered-group. It is -14.80% in year *t* and -17.28% in year *t+1* for the covered-group. The difference between the uncovered and covered-groups is -14.22% and -14.37% in year *t* and *t+1*, respectively. For low rated firms, mean abnormal premium growth is -26.01% in year *t* and -17.01% in year *t+1* for the uncovered-group and -13.04% and -11.61% for the covered-group. The difference is -12.96% in year *t* and -5.40% in year *t+1*. The difference in mean and median abnormal premium growth between the two groups in year *t-1* is not statistically significant for downgrades, suggesting that there is no pattern change in premiums prior to the downgrade. The results indicate that the uncovered-group experiences more negative mean abnormal premium growth with a rating downgrade compared to the covered-group.

The results in Panel B show that with a rating upgrade low rated firms in the uncovered-group experience significantly greater mean abnormal premium growth than the covered-group. In particular, mean abnormal premium growth is 18.52% in year *t* and 13.52% in year *t+1* for the uncovered group, while it is 2.75% and 7.44% for the covered group. The difference is 15.76% in year *t* and 6.07% in year *t+1*. Overall, the results are consistent with the hypothesis that the presence of guaranty fund protection reduces the sensitivity of premium growth to changes in insurer's financial strength ratings.

B. Regression results at the firm-line-year level

Negative signs on the A- and LOW rating dummies are consistent with market discipline. A negative (positive) estimate of $\beta_d^{'}$ for the lagged or contemporaneous downgrade (upgrade) indicators is also interpreted as evidence of market discipline. A significant positive (negative) estimate of β_p would indicate that the higher the proportion of uncovered premiums the higher (lower) the premium growth. The interaction of the proportion of uncovered premiums variable with the vector of rating changes estimates whether guaranty funds reduce market discipline. Specifically, a negative and significant $\beta_{current}$ and β_{post} would suggest that the presence of guaranty fund protection reduces market discipline, i.e., guaranty funds dull the risk sensitivity of demand.

Table 7 reports the least squares and fixed effects estimates of the model described by equations (1) and (2) for direct premium growth. Model (1) reports the OLS results, Model (2) shows the results with firm-line, and year fixed effects, Model (3) adds "Anticipation" and firm and guaranty fund controls. In order to account for the possibility that the size of the insurer influences the effect of market discipline, we use weighted fixed effects in Model (4).[14] Model (5), which we discuss in detail below, is a 2SLS regression, which is designed to address the concern that changes in the proportion of uncovered premiums may arise endogenously with rating changes.

The implications of the regressions are broadly consistent with those of the control group tests, but the magnitudes of the estimated coefficients on the rating change variables are smaller in the fixed effects regressions. A Hausman test rejects the null hypothesis that differences in the coefficients of OLS and fixed effects are not systematic, suggesting the fixed effects approach is appropriate. The results are robust to the inclusion of the firm and guaranty fund controls and to the interaction of the linear year trend with the proportion of uncovered premiums. The results support the hypothesis that guaranty fund protection reduces policyholder sensitivity to risk---the coefficients for $\beta_{current}$ are about -0.047 for downgraded insurers and 0.034 for upgraded insurers in Model (2).[15] The coefficient on *Anticipation* is not significant, indicating that market anticipation of insurer risk change is weak. We get similar results using weighted fixed effects

[14] We divide the insurers into ten ranked groups based on their average premium written across years. We assign the number 1-10 to each group and use them as weights.

[15] To identify whether monitoring by policyholders differs between direct writers and firms that use independent agents and brokers, we divide the sample into two subsamples: direct writers and non-direct writers. We find the effects of guaranty funds mainly come from firms that use independent agents and brokers.

(Model (4)), but the magnitudes by which guaranty funds dull risk sensitivity are marginally higher.

Table 8 extends equations (1) and (2) by incorporating pre-change rating categories.[16] The coefficients in the fixed effects model for β_{pre} provide little evidence that premium growth the year prior to a rating change varies with the proportion of uncovered premiums. The coefficients for $\beta_{current}$ for A- insurer downgrades (-0.199) and $\beta_{current}$ for Low insurer downgrades (-0.145) are significantly negative, indicating that firm-lines with a relatively higher proportion of uncovered premiums experience more negative premium reactions to downgrades, ceteris paribus.

Economically, the coefficient in year *t* for the downgrade of an A- rated insurer implies that a 10% increase in the proportion of uncovered premiums is associated with 2.0% decrease in premium growth to a downgrade action. Given that the difference between the average proportion of uncovered premiums for the covered- and uncovered-group is approximately 86% (see the table attached to Figure 1) and statistically significant, the A- rated uncovered-group would, on average, be associated with -17.2% premium growth with a downgrade in year *t*. The low rated uncovered-group would, on average, experience -12.3% premium growth with a downgrade in year *t*. These results suggest that guaranty funds dull the risk sensitivity of financing costs when insurers are downgraded. Similarly, the coefficient on the interaction variable for low rated insurer upgrades is 0.070, suggesting that, on average, the low rated uncovered-group realizes 6.0% additional premium growth with upgrades in year *t*.

While the features of guaranty funds in each state (i.e. which lines are covered, the maximum claim amount, and the net worth provisions) are exogenous for individual insurers, it is possible that the proportion of uncovered premiums is endogenous, as insurers that experience downgrades may rely more on covered business, and vice versa.[17] To deal with this potential problem, we use an instrumental variables (2SLS) procedure based on the weighted fixed effects model. The first stage regression instruments the proportion of uncovered premiums with its value lagged by three years, *Mutual*, *Group*, *Busherf*, and *Geoherf*. The R^2 of the first regression

[16] We also explore different rating thresholds. In particular, we use B++ instead of A-. Our results hold and the effects of guarantees for insurers rated below B++ are larger than those for insurers rated below A-.

[17] A significant proportion of insurance that is not covered by guaranty funds belongs to insurers with stable business or to insurers with a particular organizational structure, e.g. risk retention groups. It is important to note that a number of insurance entities that do not receive guarantee fund coverage (e.g., risk retention groups) are establsihed to provide stable and dependable coverage to their policyholders.

(not reported here) is around 0.89. The predicted value of the first-stage regression is then used in the second stage regression instead of the actual value. The results, shown in Table 8 Model (5), indicate that the magnitude by which guaranty funds dull risk sensitivity is marginally higher than the original weighted fixed effects model.

We run Table 7 model (3) by line of business, and the results are shown in Table 9. We find directionally consistent and statistically significant guaranty fund effects on market discipline in Commercial Multiple Peril and Other Liability. Other lines also exhibit directionally consistent effects, although they are not statistically significant.

C. Regression results at the firm-line-state-year level

Table 10 Column 1 shows the regression results for equation (3) for all lines. The coefficients on the interaction terms of the ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant for A- and low rated insurers. A downgrade yields a 15.2% drop in premium growth for A- rated firms and a 9.7% drop for low rated firms in lines of insurance not protected by guaranty funds.

To see whether this state-variation effect is driven by non-traditional lines of insurance, we re-do the analysis using only traditional lines of insurance or only non-traditional lines. We classify non-traditional lines of insurance as credit, surety, fidelity, financial guaranty, mortgage guaranty, ocean marine, warranty, and title insurance. These are the lines of insurance that are most commonly not covered by guaranty funds. Column 2 shows the results using the traditional lines of insurance. Column 3 shows the results for non-traditional lines. For traditional lines, the coefficients on the interaction terms of ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant for downgrades of A- and low rated firms. A downgrade yields a 21.2% drop in premium growth for A- rated firms. The drop is 11.9% for low rated firms. For non-traditional lines, the coefficients on the interaction terms of ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant for downgrades. A downgrade yields a 3.0% drop in premium growth for high rated firms, a 7.9% drop for A- rated firms and an 8.4% drop for low rated firms. The results indicate that the effect of guaranty funds is not being driven by non-traditional lines of insurance. In fact, the magnitudes of the declines are greater for traditional lines than non-traditional lines. The results also indicate that customer sensitivity to risk is greater for lower rated insurers in traditional lines, but higher for higher rated insurers in non-traditional lines, suggesting that financial quality is perhaps more important in non-traditional lines.

Columns 4 and 5 test state variation for personal lines and commercial lines.[18] The results imply that guaranty funds mainly influence downgrades in commercial lines. The results are in line with the findings in Epermanis and Harrington (2006) that market discipline works more in commercial lines than personal lines.

As shown in Table 11 (the line of business variation model described in equation (4)), a downgrade yields a 5.8% drop in premium growth for high rated firms and 5.3% for A- rated firms in lines of insurance not protected by guaranty funds. A downgrade also yields a 5.5% drop in premium growth for low rated firms. The effect is also manifest in nontraditional and commercial lines. In Table 12 (the time variation model described in equation (5)), there is an 8.4% drop in premium growth for high rated firms and a 30.1% drop for A- rated firms in lines of business not protected by guaranty funds relative to other years in which it received guaranty fund coverage. A downgrade also yields a 46.2% drop in premium growth for low rated firms. The effect is manifest in commercial lines but not in personal lines.

In Table 10 and Table 11, the effects are from insurers writing both covered and uncovered business at the same time, i.e. insurers in the same line of business but writing business in different states, or insurers in the same state but writing business in different lines. In Table 12, the effects are from insurers writing the same business that receives different guaranty fund coverage over time (i.e. states change which lines receive guaranty fund protection or insurers change their licensing status in a state). We find premium declines are greater in uncovered business following downgrades. Thus we find that guaranty funds shield insurers from the full costs of market discipline.

D. Robustness checks

D.1 The internal valid check and dynamic impact of rating changes

The main concerns to our first research design are (1) the correlation between the timing of rating changes and the time-path of premium growth, (2) rating changes being anticipated by the insurance market, and (3) the different patterns of premium growth before rating changes across the different levels of guaranty fund protection. To further provide supporting evidence

[18] Personal lines include farm owners multiple peril, homeowners multiple peril, private passenger auto liability, and private auto physical damage; commercial lines include everything else.

that our results are valid, we perform internal validity checks. To formally test whether (1)-(3) are impacting our results we introduce pre-rating change leads. Moreover, to study the effect of rating changes over time, we add post-rating change lags. The effect of risk changes is likely to diminish over time as the insurer and policyholders adjust to a new reality.

We explore the dynamic effect of rating changes by applying an event study framework with a long window (-7 years to 7 years surrounding the rating change). We use this flexible event study framework to non-parametrically estimate the pattern of premium growth for downgrades (e.g. Gallagher, 2014). The model is:

$$\Delta P_{ijt} = \sum_{x=-T}^{x=T} \beta_{c,x} \times 1_{ij,x} + \beta_{prop} \times Prop_{ijt-1} + \sum_{x=-T}^{x=T} \beta_{u,x} \times Prop_{ijt-1} \times 1_{ij,x} + \gamma_{ij} + \delta_t + \varepsilon_{ijt} \quad (5)$$

where ΔP_{ijt} is premium growth for firm *i*, line *j*, and year *t*, and censored at -1 and 1; γ_{ij} is a firm-line fixed effect and δ_t is a year fixed effect. The independent variables of interest are the event time indicator variables, 1_{ijx}. These variables track the year of a rating change and the years preceding and following a rating change. The indicator variable $1_{ij,0}$ equals 1 if a firm has a rating change in that calendar year. The indicator variable $1_{ij,x}$ equals 1 if the firm has rating change in $-x$ years. Many firms have more than one rating change during the sample period. For these firms, each rating change is coded with its own set of indicator variables.[19] To make the results comparable with the previous research design, the event time indicator variable $1_{ij,-2}$ is normalized to zero. In practice, this is done by excluding $1_{ij,-2}$ from the regression. We also create $1_{ij,head}=1$ if $x \in [-20, -7]$, and $1_{ij,tail}=1$ if $x \in [7, 20]$. Equation (5) is then estimated with these two bin indicators. The estimated coefficient $\beta_{u,x}$ captures the percentage response in premium growth per unit change of the proportion of uncovered premiums x $(-x)$ year after (before) rating change.

Figure 3 Panel A-Panel C plots the event time indicator coefficients, $\beta_{c,x}$ (denoted as covered group) and $\beta_{c,x} + \beta_{u,x}$ (denoted as uncovered group), from the estimation of equation (5) on the 1991–2011 panel for downgrades. Event time is plotted on the x-axis. Year 0 corresponds to the year an insurer experiences a rating change, while years −1,…, −7 and 1,…, 7 are the years

[19] For example, firm A has a downgrade in 2005 and 2009. Thus, in year 2007, $1_{ij,2}$ = 1, since it has been 2 years since the 2005 rating change and $1_{ij,-2}$= 1, since it is 2 years before the 2009 rating change. 1_{ij20} = 1 only if there is a rating change in 1991 and $1_{ij,-20}$ = 1 only if there is a rating change in 2011.

before and after the rating change, respectively. The plotted event time coefficients can be interpreted as the percent change in premium growth relative to two years prior to the rating change. The bands represent the 95 percent confidence interval and show whether each point estimate is statistically different from 0.

There is no discernable trend in premium growth in the years before a rating change. Premium growth is lowest in the year of a downgrade—a 12 percent decrease for the uncovered group and a 7 percent decrease for the covered group. After a downgrade, premium growth remains negative and statistically significant for four years. After four years, premium growth is not statistically different from zero. The difference in the impulse responses between the uncovered and covered groups, however, disappears after one year. The same pattern of decline in insurance premium growth repeats if an insurer has multiple downgrades during the period. The effect of downgrades on premium growth is transitory; however, the shock to total premium, is "permanent": on average, total premium is decreased by 0.5 million for uncovered business the year of a downgrade. Overall, the patterns shown in Figure 3 are in line with the results in Table 8--- the premium decline for A- and low-rated insurers is significantly greater for the uncovered group than the covered group in the year of a downgrade. We also estimate the pattern of premium growth for upgrades. We do not find any significant evidence that there are different effects of guaranty fund protections on market discipline for insurer upgrades (shown in Appendix Figure C.1).

D.2 Test for an alternative explanation

Another potential concern is that covered business and uncovered business may differ in their business characteristics and in particular their profitability and riskiness. Firms may reduce their exposure to less profitable or higher risk business after a downgrade. Thus, the observed drop in uncovered business may be due to changes in the composition of the insurer's underwriting portfolio and not because of guaranty fund protection. We investigate the alternative explanation in two ways. First, we examine whether uncovered business is more or less profitable than covered business. We test whether the mean value of the ratio of losses to premiums (the loss ratio) differs by guaranty fund status. A higher loss ratio implies less profitable business. We first divide all insurers' business into covered business and uncovered business at the firm-line-state-year level. We then aggregate direct losses incurred and direct premium earned for covered and uncovered business, at the line and year level. We then divide aggregate losses by aggregate premiums. Table 13 reports differences in the means by guaranty fund covered status. In general, the results show that the loss ratio of uncovered business is largely the same as the loss ratio of covered business. We do not find significant differences in the mean values of the loss ratio between covered business and uncovered business, except for workers compensation, special liability and warranty. We find the mean value of the loss ratio is higher for uncovered business in workers compensation,[20] but it is lower for uncovered business in special liability and warranty. Based on these results, we cannot conclude that uncovered business is more or less profitable than covered business.

Second, we examine whether premium growth differs by the risk characteristics of business surrounding rating changes. If our results are driven by downgraded insurers' trimming risky business, then we should observe that behavior across all lines of business (i.e., firms would also cut back on riskier covered business). To examine riskiness, we calculate the variance of the loss ratio by line of business (shown in Table 13). A more volatile loss ratio suggests a higher risk line of business (Lamm-Tennant and Starks, 1993). We sort the lines of business into high and low risk groups – if the variance of the loss ratio is in the top seven lines among the 14 lines it is classified as high risk and if it is in the bottom then it is classified as low risk.[21] The seven high risk lines are homeowners/farmowners, medical malpractice, special liability, special property, fidelity/surety, product liability and financial guaranty/mortgage guaranty.

We run two models using our previous identification strategies. First, we calculate the *proportion of high risk business* as the fraction of direct premiums written of high risk business to total direct premiums written and repeat our first identification strategy in equation (1) and (2). As shown in Table 14 Panel A, we do not identify any negative coefficients on the interactions of downgrades and the proportion of high risk business. Second, we use data on the firm-line-state-year level. To be included in these regressions, a firm-line-state-year observation is required to be downgraded in that year. We run the regressions similar to equation (4) but we include a firm-

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[20] We exclude workers compensation and repeat our previous analyses. All of our results are robust.

[21] We also examine whether the variances of the loss ratio differ significantly by guaranty fund status. To avoid the issue that the volatility of the loss ratio is caused primarily by significantly less premium volume in uncovered lines than their covered counterparts, we conduct the analysis for insurers having both uncovered business and covered business. Table C.2 reports the means and variances of the loss ratio by guaranty fund covered status across lines over the sample period. In general, the results show that the business characteristics of uncovered business and covered business are largely the same. We do not find significant differences in the variances of the loss ratio between covered business and uncovered business, except for homeowners/farmowners, product liability and special liability. We find the variances of the loss ratio are higher for the uncovered business in homeonwers/farmowners, but the measure is lower for uncovered business in special liability and product liability.

year fixed effect, a state fixed effect and a line of business fixed effect. The firm-year fixed effect sweeps out the variation between firms, making the estimates based on only the variation within each firm across line of business and states. We use a dummy variable *High Risk Business*, which equals one to indicate if the business is high risk, and 0 otherwise. The results are shown in Table 14 Panel B. We again do not find any negative coefficients on the interactions of the pre-change rating categories and *High Risk Business*. These results suggest that the greater premium declines in uncovered business relative to covered lines are not driven by insurers changing the risk composition of their underwriting portfolios.

V. Prices, Market Discipline, and Government Guarantees

A. Prices and Market Discipline

In this section we explore evidence on the nexus between prices and market discipline. Evidence in this paper has shown that increases in insurer risk are accompanied by reductions in premium growth. This could be because firms are forced to lower prices, or their business volume drops, or both. Accordingly, policyholders can exert market discipline by buying less coverage, not buying insurance, or demanding a lower price from a downgraded insurer. Insurers may respond to market discipline as well, but not all insurers have the same flexibility. Insurers subject to stringent rate regulation may not be able to adjust prices (Grace and Leverty, 2010).

We study the relationship between insurance prices and changes in financial strength ratings. In particular, we use equation (1) and equation (2), but replace the dependent variable, premium growth, with price growth. We calculate insurance price growth ($\Delta Log\ Price$). Since explicit contract prices are not available, we follow the literature and use an implicit measure of price (e.g. Cummins and Danzon, 1997; Cummins et al., 2005).[22] We measure price at the firm-line level as information on business net of reinsurance is not available at firm-line-state level.[23] Since premiums are revenues (price times quantity), the impact of downgrades on prices will yield insight on the price mechanism and because we have already studied the impact on premiums, we can impute the impact on quantity.

The results of the fixed effects estimates of price growth using net business are reported in Table 15. The regressions in Models (1) and (2) do not consider guaranty fund characteristics,

[22] The precise definition and calculation of insurance price are described in Appendix B.
[23] We also calculate price using direct business (premium written and direct loss incurred) instead of net business and our results are robust.

while Models (3) and (4) do. The regressions reported in Table 16 incorporate the pre-change rating categories. We document several noteworthy price effects. First, the coefficients on all current and leading rating change indicators for downgrades are negative and significant, providing evidence that insurers have slower price growth the year before and the year of a downgrade. The coefficients on *Anticipation* are negative and statistically significant, possibly indicating that insurers anticipate downgrades and adjusts prices accordingly. In Table 15, current and lagging coefficients on upgrades are positive and significant but the coefficients on the leading variables are not significant, indicating that price growth increases after upgrades. In Table 16, all the current and leading coefficients on rating change indicators for downgrades are significant, suggesting that price deterioration may precede downgrades. This result can be explained in several ways. Since our price measure is a proxy for profit margin, it could be that insurers have poor underwriting results in the year before a downgrade, which explains a drop in measured price as well as the subsequent downgrade. Another explanation could be that the market anticipates rating deterioration, and prices adjust accordingly. The effect of upgrades on price growth is statistically significant---upgrades are associated with price increases for A- and low-rated insurers, with pre-rating change increases also evident for low-rated insurers.

Second, we compare coefficients across regressions of premium growth and price growth (results shown in Appendix Table C.1). The magnitudes of the coefficients on downgrades in the current price growth regression are smaller than those for premium growth change for A- and lower rated insurers.[24] We find that price growth decreases significantly in the year of a downgrade, but that the magnitude of the decrease is much smaller for price growth than it is for premium growth in the year of insurer downgrades. The results suggest that policyholders respond to increases in insurer risk both by demanding lower prices and by shifting their contracts. Insurance prices, however, are only slightly affected the year after insurer downgrades, suggesting policyholders continuously react to downgrades by switching to safe insurers.

In addition, we control for price growth in the premium growth regression, since premium growth endogenously depends on price growth. We employ the two-stage least squares method (2SLS) to investigate how premium growth changes after controlling price growth

[24] We run the seemingly unrelated regression to test whether coefficients of premium growth and price growth are significantly different. We use the sample with positive calculated insurance price, which includes 120,533 observations. The results shows the coefficients on current variables of price growth are significantly smaller than those for premium growth model for A- and lower insurers (see Appendix C Table C.1 for details).

change (Results are shown in Table 18, Model (1)). Predicted price growth is included in the premium growth regression in the second step. Although the regression sample size is reduced by fifteen percent because negative prices are excluded in our analysis, we can still identify market discipline in the form of premium growth. The magnitudes of the coefficients on the rating change variables estimated for premium growth rates are smaller than the previous fixed effects regressions (Table 8, Model 2). The signs of these estimated variables in 2SLS are consistent with the previous regressions (i.e. Table 8). Overall, the results suggest that price growth depends on the direction of the rating action and the magnitude of the difference is fairly small for downgrades after rating changes.

B. Price, Market Discipline and Guaranty Funds

Consistent with previous reasoning, guaranty funds may dull market sensitivity to risk changes in the price domain as well as the overall volume domain. Accordingly, we study the influence of guaranty funds on price growth in the time periods surrounding changes in insurer risks. The results are reported in Table 15 Model (3) and Model (4). Overall the evidence suggests that the guaranty fund scheme weakens market discipline in the price channel. Specifically, absence of guaranty fund protection is associated with more negative price growth after a downgrade. We extend our analysis to consider pre-change rating categories in Table 17. Our variables of interest in Table 17, the interaction term of downgrades and the proportion of uncovered premiums, generally confirms that the extent of market discipline through the price channel depends on the extent of the safety net. Specifically, the results show that the absence of guaranty fund protection significantly enhances the sensitivity of price growth to insurer downgrades. For insurers rated A- or lower prior to being downgraded, the contemporaneous coefficients are negative and significant. The coefficient estimates in Table 17 Model (2) indicate that A- insurers with a 10% higher proportion of uncovered direct premiums experience a 1.0% decrease in price growth with a downgrade in year t. We do not find significant results for upgrades. These results echo the asymmetric findings in prior literature that the market reaction to rating downgrades is stronger than the reaction for upgrades (e.g. Halek and Eckles, 2010).

We also conduct the price growth analysis at the firm-line-state-year level using equation (3). We calculate the price using the information of direct premium written and the results are reported in Table C.3. The coefficients on the interaction terms of the ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant only for low rated insurers. A downgrade yields a 20.3% drop in price growth for low rated firms in business not protected by guaranty funds, comparing to business protected by guaranty fund in the same insurers. The effect is stronger in personal lines.

Again, we employ the two-stage least squares method (2SLS) to investigate how premium growth changes after controlling for price growth changes conditional on guaranty fund protection (results are shown in Table 18 Model (2)). The results of Table 17 Model (2) and Table 18 model (2) suggest that the effect of guaranty funds on market discipline are through both the price channel and the quantity channel.

VI. Concluding Remarks

This paper explores how government safety-net schemes affect market discipline in the financial sector. We study the state regulated P/L insurance industry because the diversity of guaranty fund protection offered by the states offers a compelling environment in which to identify the effects of public guarantees. The evidence suggests that public guarantees dull customer sensitivity to financial institution risk, and overall the effects are quite large. The effects are especially large for A- and low-rated insurer downgrades. The pattern of decline in premium growth suggests that the process of market discipline is most pronounced within two years of a downgrade. Moreover, the effects are most pronounced within commercial insurance lines.

The study is important from a public policy perspective. Policymakers are increasingly aware of the role of market discipline in the regulation of financial firms and modern regulatory policy tries to encourage market discipline (e.g. Solvency Modernization Initiative, Basel II and Solvency II). In fact, both Basel and Solvency II include market discipline as a fundamental pillar and attempt to enhance it through public disclosure of risk-related information by banks and insurance companies. The benefit of stronger market discipline is believed to reduce the need for government intervention. Our study finds that consumer protection schemes, even ones that consumers are less aware of, impair market discipline, as such regulators must take these programs into consideration in the design of solvency regulatory policy. Combined with the evidence on the huge cost of insurer failures (Bohn and Hall, 1997; Grace, Klein and Phillips, 2009; Leverty and Grace, 2012), our findings suggest that policy makers should address the adverse incentives that guaranty funds create in order to better discipline insurers and protect policyholders. Potential changes could be the creation of a first layer of private loss of guaranty fund coverage (e.g., coinsurance or a high deductible) or the adoption of risk-based guaranty fund assessments. The results for the insurance industry have interesting implications for the financial sector more broadly. This supports the view that deposit insurance and other public guarantees in banking have significant effects on market discipline.

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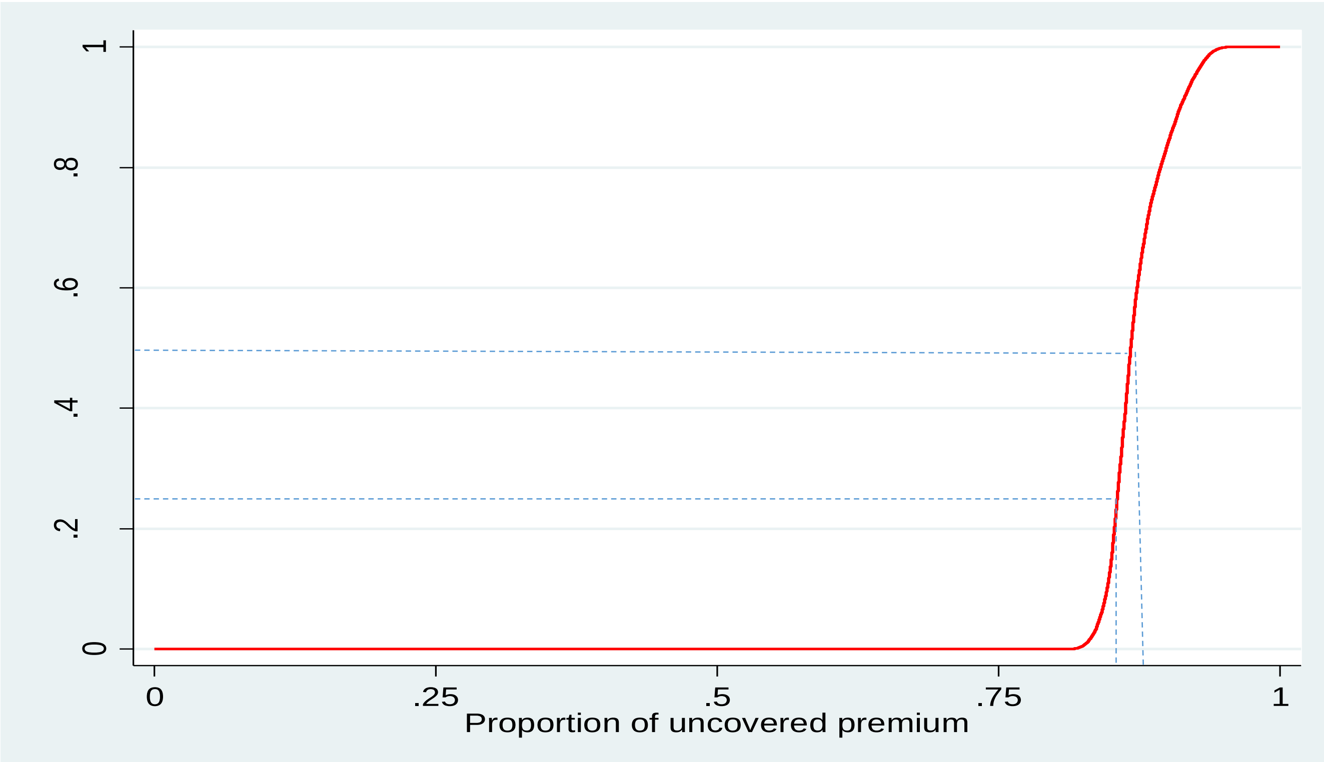
Figure 1: The Quantile Plot of the Proportion of Uncovered Premiums at Firm-Line-Years, 1990-2011



Note: We set the threshold of 25% to categorize our observations into covered- and uncovered groups. The summary statistics of the two groups are as following:

	Mean	**Median**	**STD**	**Min**	**Max**	**N**
Uncovered-group	0.861	0.962	0.194	0.250	1.000	23179
Covered-group	0.003	0.000	0.019	0.000	1.000	124820

Figure 2 Panel A: Percentages of Upgrades across Years

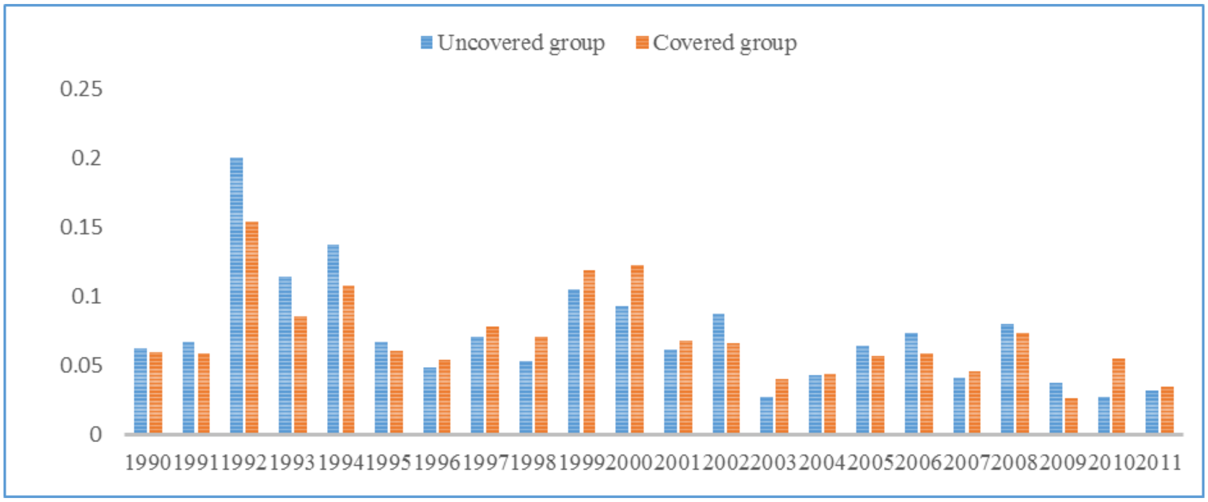


Figure 2 Panel B: Percentages of Downgrades across Years

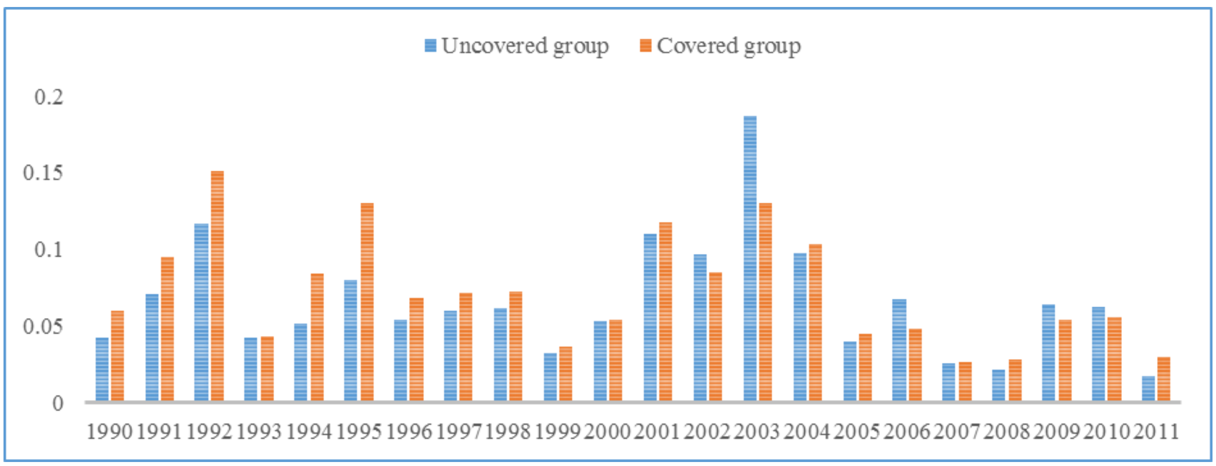


Figure 2 Panel C: Percentages of No Rating Change across Years

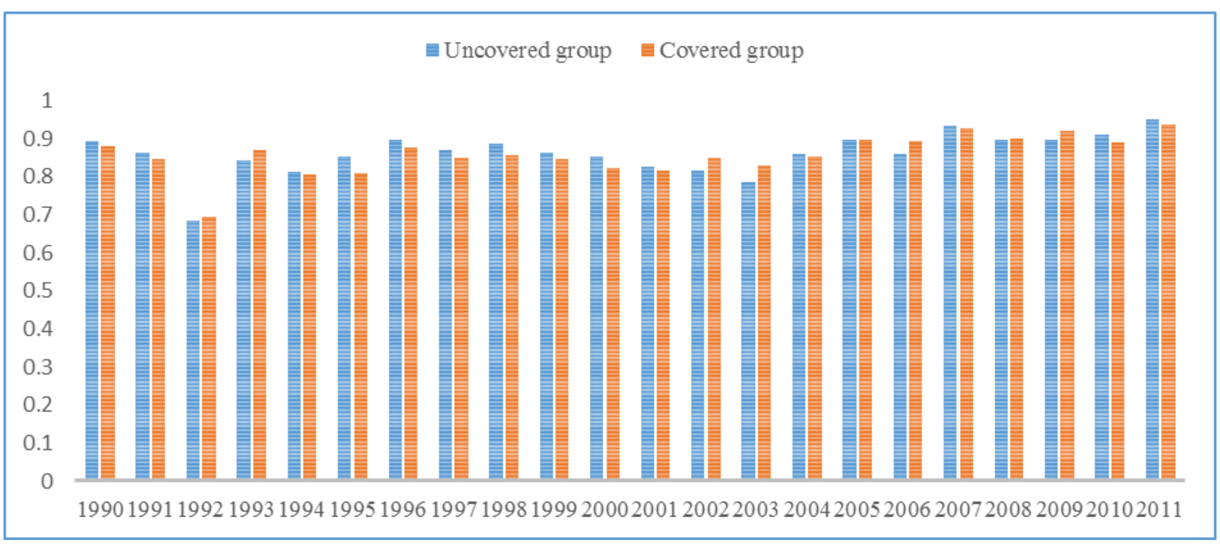
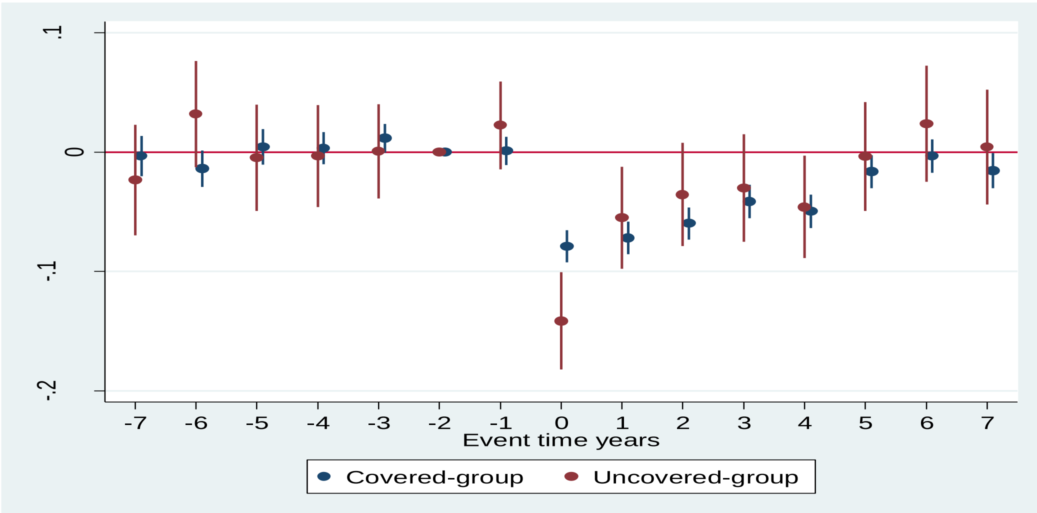


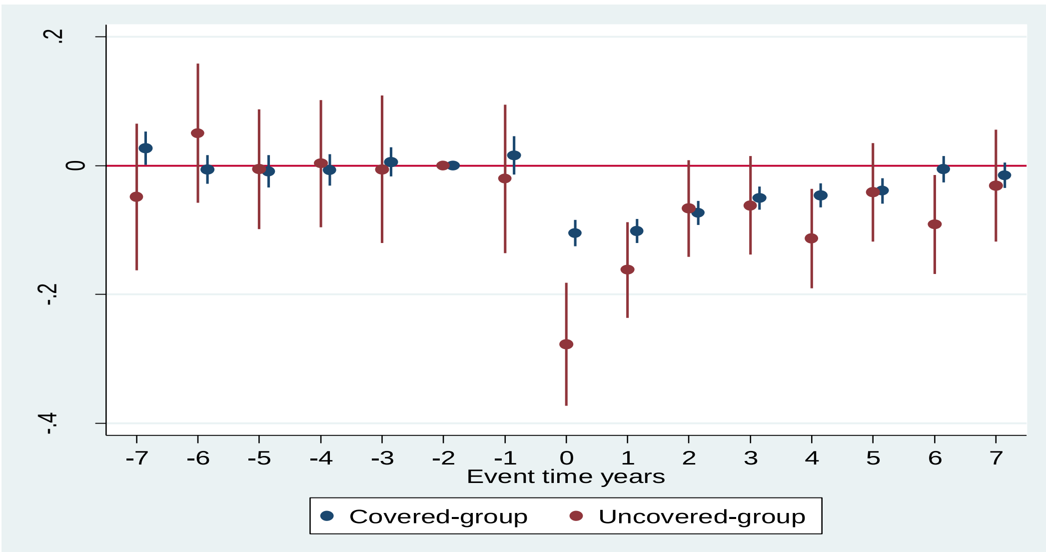
Figure 3: Premium Growth for Insurer Downgrades at Firm-Line-Years, 1991–2011

The figure plots event time premium growth coefficients from estimation of equation (5) on the 1991–2011 panel. Panel A is premium growth for all insurer downgrades, panel B is for A- and lower rated insurer downgrades and Panel C is for higher rated insurer downgrades. The end points on the graph are binned so that −7 (+7) is a bin for years −7 to −20 (+20 to +7). The vertical axis measures *ΔLog Premium*. The coefficient for the last second year before a downgrade is normalized to zero. The bars show the 95% confidence interval. Standard errors are clustered by firm-line level.

Panel A:



Panel B:



Panel C:

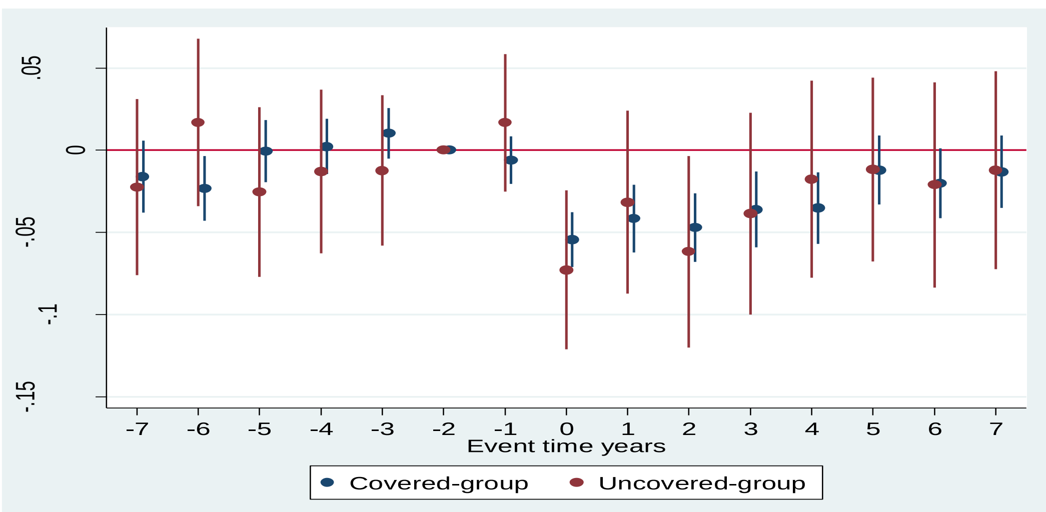


Table 1
Summary of Property-Liability Insurance Guaranty Funds, By State[22]

State	Effective Date	Max Per Claim	Net Worth Provision	State	Effective Date	Max Per Claim[23]	Net Worth Provision
AL	1981	$150,000	$25,000,000	MT	1971	$300,000	$50,000,000
AK	1970	$300,000 before 1990; $500,000	NO	NE	1971	$300,000	NO
AZ	1977	$100,000 before 2007; $300,000	NO	NV	1971	$300,000	$25,000,000
AR	1977	$300,000	$50,000,000	NH	2004	$300,000	$25,000,000
CA	1969	$500,000	NO	NJ	1974	$300,000	$25,000,000
CO	1971	$300,000	$25,000,000	NM	1973	$100,000	NO
CT	1971	$300,000 before 2007; $400,000	NO	NY	1969	$1,000,000	NO
DE	1970	$300,000	$10,000,000	NC	1971	$300,000	$50,000,000
FL	1970	$300,000	NO	ND	1971	$300,000	$10,000,000
GA	1970	$100,000 before 2005; $300,000	$10,000,000	OH	1970	$300,000	$50,000,000
HI	1971	$300,000	$25,000,000	OK	1980	$150,000	$50,000,000
ID	1970	$300,000	NO	OR	1971	$300,000	$25,000,000
IL	1971	$300,000*	$25,000,000	PA	1994	$300,000	$50,000,000
IN	1972	$50,000 before 1988; $100,000	$5,000,000	RI	1970	$500,000	$50,000,000
IA	1970	$300,000 before 2010; $500,000	NO	SC	1971	$300,000	$10,000,000
KS	1970	$300,000	NO	SD	2000	$300,000	$50,000,000
KY	1972	$100,000 before 1998; $300,000	$25,000,000	TN	1971	$100,000	$10,000,000
LA	1970	$150,000 before 2008; $500,000	$25,000,000	TX	2007	$300,000	$50,000,000
ME	1970	$300,000	$25,000,000	UT	1971	$300,000	$25,000,000
MD	1971	$300,000	$50,000,000	VT	1970	$500,000	NO
MA	1971	$300,000	$25,000,000	VA	1970	$300,000	$50,000,000
MI	1969	$5,000,000	$25,000,000	WA	1971	$300,000	NO
MN	1971	$300,000	$25,000,000	WV	1970	$300,000	NO
MS	1971	$300,000	NO	WI	1969	$300,000	$25,000,000
MO	1971	$300,000	$25,000,000	WY	1971	$150,000	No

[22] Detailed information on excluded lines is provided in the footnote.
[23] Maximum claims exclude workers compensation, since coverage for workers compensation is unlimited in 49 states.

Table 2
Rating categories of A.M Best rating

High categories
↓
A++
A+
A
A-
Low categories
↓
B++
B+
B
B-
C++
C+
C
C-
D
E
F
No categories
↓
NR (NR 1, NR 2, NR 3, NR 4, NR5)

Table 3
Summary Statistics at Firm-Line Level

The full sample includes firm-line-years during 1990-2011. The regression sample includes firm-line-years for 1991-2011. *High (A-, Low)* indicates rating of A or above (A-, B+ + or below). *Down* equals 1 if rating downgrade during year, 0 otherwise. *Up* equals 1 if rating upgrade during year, 0 otherwise. *Proportion of Uncover Premiums* is the proportion of uncovered direct premiums to the total direct premiums. *Portfolio_Risk (sigma)* and *default-value-to-liability ratio* (*risk*) are calculated as in Myers and Read (2001). Anticipaton is the average value of *default-value-to-liability ratio* for the year's t-1 and t-2. *Size* is the logarithm of total assets. *Leverage* is the ratio of total liabilities to total assets. *Reinsurance* is the ratio of premiums ceded to total premiums written. *Directw* equals 1 if direct writer, 0 otherwise. *Mutual* equals 1 if mutual company, 0 otherwise. *Group* equals 1 if an insurer is affiliated to a group, 0 otherwise. *Busherf* is calculated by the sum of the squares of the percentages of direct premium written across all lines of business. *Geoherf is* calculated by the sum of the squares of the percentages of direct premium written across all states. *Reg%* is the percentage of the insurer's direct premium written in states with prior approval or state made rate regulation. *Max%* is the percentage of the insurer's direct premium written in states with guaranty fund exceeding $300,000. *Prov%* is the percentage of the insurer's direct premium written in states with a net worth provision above $25,000,000.

Variables	**Mean**	**SD**	**Min**	**25%**	**50%**	**75%**	**Max**
Panel A: Full sample (N=147,998)							
Log Direct Premium	15.167	2.606	6.783	13.667	15.481	16.998	23.561
Δ Log Direct Premium	0.043	0.400	-1.000	-0.095	0.035	0.177	1.000
Proportion of Uncover Premiums	0.137	0.323	0.000	0.000	0.000	0.000	1.000
Panel B: Regression sample (N=142,247)							
Δ Log Direct Premium	0.042	0.401	-1.000	-0.096	0.035	0.177	1.000
High	0.610	0.488	0.000	0.000	1.000	1.000	1.000
A-	0.232	0.422	0.000	0.000	0.000	0.000	1.000
Low	0.159	0.366	0.000	0.000	0.000	0.000	1.000
Down	0.072	0.259	0.000	0.000	0.000	0.000	1.000
UP	0.071	0.258	0.000	0.000	0.000	0.000	1.000
High × Down	0.048	0.213	0.000	0.000	0.000	0.000	1.000
A- × Down	0.012	0.107	0.000	0.000	0.000	0.000	1.000
Low × Down	0.013	0.113	0.000	0.000	0.000	0.000	1.000
High × Up	0.020	0.141	0.000	0.000	0.000	0.000	1.000
A- × Up	0.019	0.136	0.000	0.000	0.000	0.000	1.000
Low × Up	0.032	0.177	0.000	0.000	0.000	0.000	1.000
Proportion of Uncover Premiums	0.138	0.324	0.000	0.000	0.000	0.000	1.000
Portfolio_Risk (sigma)	0.143	0.070	0.011	0.099	0.118	0.161	0.485
Default-value-to-liability ratio (Risk)	0.001	0.006	0.000	0.000	0.000	0.000	0.117
Anticipation	0.004	0.012	0.000	0.000	0.000	0.001	0.117
Size	18.991	1.816	13.636	17.712	18.885	20.142	25.485
Leverage	0.595	0.157	0.110	0.518	0.629	0.707	0.840
Reinsurance	0.351	0.216	0.000	0.151	0.429	0.500	1.000
Directw	0.127	0.334	0.000	0.000	0.000	0.000	1.000
Mutual	0.171	0.377	0.000	0.000	0.000	0.000	1.000
Group	0.816	0.388	0.000	1.000	1.000	1.000	1.000
Busherf	0.330	0.213	0.068	0.178	0.266	0.407	1.000
Geoherf	0.436	0.365	0.030	0.097	0.306	0.825	1.000
Reg%	0.246	0.371	0.000	0.000	0.000	0.509	1.000
Max%	0.877	0.223	0.000	0.860	0.971	1.000	1.000
Prov%	0.411	0.353	0.000	0.067	0.351	0.692	1.000

Table 4
Number and Percentage of Sample Firm-line-years, by Rating Categories

Panel A: Uncovered	Rating	No. of observation	% Total	No change	% No change	Upgrade	% Upgrade	Downgrade	% Downgrade
High	**A++**	2335	10.07%	2142	91.73%	0	0.00%	193	8.27%
	A+	6266	27.03%	5544	88.48%	217	3.46%	505	8.06%
	A	7448	32.13%	6626	88.96%	373	5.01%	449	6.03%
	Total	16049	69.24%	14312	89.18%	590	3.68%	1147	7.15%
	A-	5049	21.78%	4322	85.60%	498	9.86%	229	4.54%
Low	**B++**	878	3.79%	604	68.79%	204	23.24%	70	7.97%
	B+	801	3.46%	492	61.42%	262	32.71%	45	5.62%
	B	257	1.11%	170	66.15%	69	26.85%	18	7.00%
	B-	80	0.35%	47	58.75%	27	33.75%	6	7.50%
	C++	17	0.07%	5	29.41%	9	52.94%	3	17.65%
	C+	31	0.13%	13	41.94%	17	54.84%	1	3.23%
	C	16	0.07%	10	62.50%	6	37.50%	0	0.00%
	C-	1	0.00%	0	0.00%	0	0.00%	1	100.00%
	Total	2081	8.98%	1341	64.44%	594	28.54%	144	6.92%
Total		23179	100.00%	19975	86.18%	1682	7.26%	1520	6.56%

Panel B: Covered	Rating	No. of observation	% Total	No change	% No change	Upgrade	% Upgrade	Downgrade	% Downgrade
High	**A++**	7704	6.17%	6979	90.59%	0	0.00%	725	9.41%
	A+	29294	23.47%	26019	88.82%	773	2.64%	2502	8.54%
	A	37832	30.31%	33649	88.94%	1536	4.06%	2647	7.00%
	Total	74830	59.95%	66647	89.06%	2309	3.09%	5874	7.85%
	A-	28606	22.92%	24878	86.97%	2259	7.90%	1469	5.14%
Low	**B++**	8097	6.49%	6240	77.07%	1215	15.01%	642	7.93%
	B+	7656	6.12%	5446	71.12%	1594	20.82%	616	8.05%
	B	3416	2.74%	2422	70.90%	720	21.08%	274	8.02%
	B-	1274	1.02%	791	62.09%	358	28.10%	125	9.81%
	C++	362	0.29%	205	56.63%	127	35.08%	30	8.29%
	C+	320	0.26%	154	48.13%	131	40.94%	35	10.94%
	C	217	0.17%	113	52.07%	97	44.70%	7	3.23%
	C-	41	0.03%	27	65.85%	12	29.27%	2	4.88%
	Total	21384	17.13%	15398	72.01%	4254	19.89%	1731	8.09%
Total		124819	100.00%	106923	85.66%	8822	7.07%	9074	7.27%

Table 5
Mean and Median Abnormal Premium Growth at Firm-Line-Years, 1990-2011

Table 5 shows the adjusted mean (median) abnormal premium growth rate for downgrades and upgrades. The uncovered-group is defined as firm-line-years with a proportion of uncovered premiums greater than or equal to 25%. The covered-group is defined as firm-line-years with a proportion of uncovered premiums less than 25%. Time, line, and size adjusted mean [median] abnormal premium growth in year t equals the firm-line-year's premium growth in year t minus the mean [median] time, line, and size adjusted premium growth in year t for firm-line-years with no rating change in year t. Medians are reported in square parentheses. Significance of tests of differences in means are based on a two-tailed t-test and the difference in medians are based on a two-sided nonparametric Wilcoxon rank sum test. The one-tailed t-test standard error are reported in parentheses. Bold values are significant at the 5% level.

	Downgrades				Upgrades		
	t-1	t	t+1		t-1	t	t+1
Uncovered group	-1.67%	**-13.50%**	**-10.03%**	Uncovered group	**-5.46%**	**4.38%**	**3.72%**
	(0.02)	**(0.02)**	**(0.02)**		**(0.02)**	**(0.02)**	**(0.02)**
	[-1.50%]	**[-8.36%]**	**[-2.60%]**		[-1.95%]	**[3.53%]**	**[4.14%]**
	19975 no change; 1520 downgrades				19975 no change; 1682 upgrades		
Covered group	-2.42%	**-7.52%**	**-7.77%**	Covered group	**-2.89%**	-0.33%	**1.81%**
	(0.01)	**(0.01)**	**(0.01)**		**(0.01)**	(0.01)	**(0.01)**
	[-1.13%]	**[-4.70%]**	**[-3.62%]**		[-1.23%]	[0.37%]	[0.98%]
	106923 no change; 9074 downgrades				106923 no change; 8822 upgrades		
Mean difference	0.76%	**-5.73%**	-2.26%	Mean difference	-2.57%	**4.71%**	1.91%
Median difference	0.37%	**-3.66%**	1.02%	Median difference	-0.72%	**3.16%**	**3.16%**

Table 6
Mean and Median Abnormal Premium Growth at Firm-Line-Years Level Based on Pre-Change Rating Categories

Panel A shows the adjusted mean (median) abnormal premium growth rate for downgrades from 1990 to 2011. Panel B shows results for upgrades. The uncovered-group is defined as firm-line-years with a proportion of uncovered premiums greater than or equal to 25%. The covered-group is defined as firm-line-years with a proportion of uncovered premiums less than 25%. Time, line, and size adjusted mean [median] abnormal premium growth in year t equals the firm-line-years' time, line, and size adjusted premium growth in year t minus the mean [median] time, line, and size adjusted premium growth in year t for firm-line-years in the same rating category with no rating change in year t. Medians are reported in square parentheses. Significance of tests of differences in means are based on a two-tailed t-test and the difference in medians are based on a two-sided nonparametric Wilcoxon rank sum test. The one-tailed t-test standard error are reported in parentheses. Bold values are significant at the 5% level.

Panel A. Downgrades	High			A-			Low		
	t-1	t	t+1	t-1	t	t+1	t-1	t	t+1
Uncovered group	0.46% (0.03) [-0.33%]	**-7.39%** **(0.02)** **[-5.55%]**	**-3.67%** **(0.02)** [-1.96%]	-5.28% (0.04) [-1.72%]	**-30.01%** **(0.04)** **[-20.05%]**	**-31.65%** **(0.05)** **[-23.86%]**	-2.50% (0.06) [-3.39%]	**-26.01%** **(0.05)** **[-17.49%]**	**-17.01%** **(0.06)** **[-20.56%]**
	14312 no change; 1147 downgrades			4322 no change; 229 downgrades			1341 no change; 144 downgrades		
Covered group	**-1.17%** **(0.01)** [-0.59%]	**-4.02%** **(0.01)** **[-3.48%]**	**-4.26%** **(0.01)** **[-3.59%]**	0.21% (0.01) [-0.44%]	**-14.80%** **(0.01)** **[-10.09%]**	**-17.28%** **(0.01)** **[-8.68%]**	**-3.24%** **(0.01)** [-2.13%]	**-13.04%** **(0.01)** **[-8.69%]**	**-11.61%** **(0.01)** **[-7.86%]**
	66647 no change; 5874 downgrades			24878 no change; 1469 downgrades			15398 no change; 1731 downgrades		
Mean difference	1.63%	**-3.37%**	0.59%	-5.49%	**-15.22%**	**-14.37%**	1.72%	**-12.96%**	-5.40%
Median difference	0.26%	-2.07%	1.63%	-2.16%	**-9.96%**	**-15.18%**	-1.26%	**-8.80%**	-12.7%

Panel B. Upgrades	High			A-			Low		
	t-1	t	t+1	t-1	t	t+1	t-1	t	t+1
Uncovered group	-4.77% (0.03) [-4.09%]	-0.33% (0.03) [1.14%]	1.18% (0.02) [1.09%]	-1.60% (0.03) [-2.64%]	0.05% (0.03) [-0.81%]	1.37% (0.03) [-0.61%]	-0.05% (0.03) [0.01%]	**18.52%** **(0.02)** **[13.77%]**	**13.52%** **(0.02)** **[10.24%]**
	14312 no change; 590 upgrades			4322 no change; 498 upgrades			1341 no change; 594 upgrades		
Covered group	**-2.80%** **(0.01)** [-1.20%]	-0.97% (0.01) [0.30%]	-0.77% (0.01) [0.05%]	0.87% (0.01) [-2.52%]	-0.91% (0.01) [-0.49%]	1.34% (0.01) [1.50%]	-1.02% (0.01) [-0.74%]	**2.75%** **(0.01)** **[2.31%]**	**7.44%** **(0.01)** **[5.36%]**
	66647 no change; 2309 upgrades			24878 no change; 2259 upgrades			15398 no change; 4254 upgrades		
Mean difference	-1.97%	0.64%	1.95%	-2.47%	0.96%	0.03%	0.53%	**15.76%**	**6.07%**
Median difference	-2.87%	0.84%	1.04%	-0.12%	-0.32%	-2.11%	0.75%	**11.46%**	**4.88%**

Table 7
Impact of Guaranty Funds on Market Discipline at Firm-Line-Year Level

The dependent variable is ΔLog Premium$_t$. The sample consists of 142,247 firm-line-years. *Prop* is the proportion of uncovered premiums to total premiums in the previous year. *Anticipation* is the average value of the default-value-to-liability ratio (*Risk*) calculated as in Myers and Read (2001) for the year t-1 and t-2. The *Firm & Guaranty funds Controls* include *Size, Leverage, Reinsurance, Group, Mutual, Geoherf, Busherf, Reg%, Max%, Prov%, Directw* and the interaction of *Prop* with a linear year trend (variables are defined in Table 3). The last column shows the results of Two-Stage Least Square estimates of ΔLog Premium$_t$. The proportion of uncovered premiums is instrumented by its value lagged of three years, *Size, Geoherf, Busherf, Mutual* and *Group* in the first stage of regression and the predicted value is used in the second stage. The interaction of the proportion of uncovered premiums with a linear trend is included in 2SLS. The sample for 2SLS regression includes 138,878 observations, as the data of 1991 is deleted. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)	F.E. (3)	Weighted FE (4)	2SLS (5)
Log premium $_{t-1}$	-0.021***	-0.105***	-0.122***	-0.105***	-0.115***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Prop. of Uncovered Premiums $_{t-1}$	-0.040***	-0.042*	0.050*	0.033	-0.000
	(0.006)	(0.023)	(0.027)	(0.031)	(0.022)
Up_{post}	0.007	-0.009*	0.005	-0.005	0.003
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
$Up_{current}$	-0.004	-0.025***	-0.011**	-0.015***	-0.012***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Up_{pre}	-0.020***	-0.031***	-0.024***	-0.028***	-0.024***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Down_{post}$	-0.068***	-0.051***	-0.045***	-0.048***	-0.043***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Down_{current}$	-0.065***	-0.058***	-0.055***	-0.061***	-0.058***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Down_{pre}$	0.006	0.011**	0.009**	-0.002	0.002
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Prop $_{t-1}$ × Up_{post}	0.041**	0.030*	0.018	0.024	0.030*
	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)
Prop $_{t-1}$ × $Up_{current}$	0.057***	0.034**	0.017	0.019	0.011
	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)
Prop $_{t-1}$ × Up_{pre}	-0.025	-0.026	-0.040**	-0.032*	-0.026
	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)
Prop $_{t-1}$ × $Down_{post}$	0.015	0.009	0.014	0.003	0.019
	(0.019)	(0.020)	(0.020)	(0.022)	(0.021)
Prop $_{t-1}$ × $Down_{current}$	-0.047***	-0.047**	-0.047**	-0.056***	-0.067***
	(0.018)	(0.020)	(0.019)	(0.021)	(0.020)
Prop $_{t-1}$ × $Down_{pre}$	0.012	0.023	0.019	0.008	0.022
	(0.017)	(0.018)	(0.018)	(0.019)	(0.018)
Anticipation	—	—	0.062	-0.293	-0.319
			(0.119)	(0.231)	(0.219)
Constant	0.367***	1.655***	1.901***	1.232***	1.272***
	(0.010)	(0.027)	(0.082)	(0.107)	(0.102)
Firm-Line, Year Fixed Effects	NO	YES	YES	YES	YES
Firm & Guaranty funds Controls	NO	NO	YES	YES	YES
R^2	0.022	0.261	0.278	0.262	0.266
Observations	142,247	142,247	142,247	142,247	138,878

Table 8
Impact of Guaranty Funds on Market Discipline at Firm-Line-Year Level for Different Rating Categories

The dependent variable is ΔLog Premium$_t$. The sample consists of 142,247 firm-line-years. *Anticipation* is the average value of default-value-to-liability ratio (*Risk*) calculated as in Myers and Read (2001) for the years t-1 and t-2. The *Firm & Guaranty Funds Controls* include *Size, Leverage, Reinsurance, Group, Mutual, Geoherf, Busherf, Direct writer, Reg%, Max%, Prov%* and the interaction of *Prop* with a linear year trend. All regressions include pre-change rating categories, the interaction of *Prop* with pre-change rating categories, the variables of rating upgrades and downgrade and rating categories as shown in Table 3, and the interaction of the rating changes with *Prop*. The last column shows the results of Two-Stage Least Square estimates of ΔLog Premium$_t$. The proportion of uncovered premiums is instrumented by its value lagged of three years, *Size, Geoherf, Busherf, Mutual* and *Group* in the first stage of regression, and the predicted value is used in the second stage. The sample for 2SLS regression includes 138,878 observations as the data of 1991 is deleted. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)	F.E. (3)	Weighted FE (4)	2SLS (5)
$Prop_{t-1}$ × High × $Down_{post}$	0.021	0.020	0.024	0.023	0.021
	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)
$Prop_{t-1}$ × High × $Down_{current}$	-0.010	-0.012	-0.014	-0.007	-0.037
	(0.021)	(0.022)	(0.021)	(0.023)	(0.023)
$Prop_{t-1}$ × High ×$Down_{pre}$	0.044**	0.047**	0.041*	0.028	0.037*
	(0.020)	(0.021)	(0.021)	(0.021)	(0.022)
$Prop_{t-1}$ × A-× $Down_{post}$	-0.059	-0.079	-0.065	-0.164**	-0.043
	(0.058)	(0.061)	(0.058)	(0.072)	(0.063)
$Prop_{t-1}$ ×A- × $Down_{current}$	-0.204***	-0.192***	-0.199***	-0.327***	-0.175***
	(0.047)	(0.053)	(0.052)	(0.060)	(0.057)
$Prop_{t-1}$ ×A- × $Down_{pre}$	-0.081*	-0.045	-0.048	-0.040	-0.026
	(0.043)	(0.046)	(0.045)	(0.048)	(0.045)
$Prop_{t-1}$ × Low × $Down_{post}$	-0.070	-0.103	-0.096	-0.117	0.017
	(0.076)	(0.083)	(0.082)	(0.101)	(0.083)
$Prop_{t-1}$ × Low × $Down_{current}$	-0.115**	-0.151**	-0.145**	-0.269***	-0.191***
	(0.058)	(0.072)	(0.069)	(0.088)	(0.072)
$Prop_{t-1}$ × Low × $Down_{pre}$	-0.033	-0.064	-0.067	-0.151**	-0.014
	(0.063)	(0.059)	(0.058)	(0.075)	(0.063)
$Prop_{t-1}$ × High × Up_{post}	0.024	0.021	0.015	0.036	-0.006
	(0.029)	(0.029)	(0.028)	(0.027)	(0.030)
$Prop_{t-1}$ × High × $Up_{current}$	0.041	0.026	0.015	0.019	-0.019
	(0.029)	(0.029)	(0.029)	(0.027)	(0.031)
$Prop_{t-1}$ × High × Up_{pre}	0.003	-0.002	-0.012	0.004	-0.024
	(0.028)	(0.029)	(0.029)	(0.030)	(0.031)
$Prop_{t-1}$ × A- × Up_{post}	0.061**	0.055*	0.047	0.047	0.063**
	(0.028)	(0.029)	(0.030)	(0.032)	(0.031)
$Prop_{t-1}$ × A- × $Up_{current}$	0.006	0.009	-0.005	0.017	0.002
	(0.032)	(0.036)	(0.035)	(0.038)	(0.037)
$Prop_{t-1}$ × A- × Up_{pre}	-0.042	-0.038	-0.053*	-0.048	-0.047
	(0.030)	(0.032)	(0.032)	(0.034)	(0.034)
$Prop_{t-1}$ × Low × Up_{post}	0.053**	0.049*	0.042	0.022	0.042
	(0.027)	(0.027)	(0.027)	(0.030)	(0.028)
$Prop_{t-1}$ × Low × $Up_{current}$	0.117***	0.078**	0.072**	0.045	0.042
	(0.031)	(0.035)	(0.035)	(0.046)	(0.037)
$Prop_{t-1}$ × Low × Up_{pre}	-0.057	-0.038	-0.038	-0.052	-0.023
	(0.035)	(0.038)	(0.037)	(0.042)	(0.038)
Firm-Line &Year Fixed Effects	NO	YES	YES	YES	YES
Firm & Guaranty funds Controls	NO	NO	YES	YES	YES
R^2	0.031	0.264	0.286	0.266	0.269

Observations	142,247	142,247	142,247	142,247	138,878

Table 9
The Effect of Guaranty Fund on Market Discipline at Firm-Line-Year Level by Lines

The dependent variable is ΔLog Premium $_t$. We run Table 7 Model 3 by line of business. Auto liability includes personal and commercial auto liability; commercial liability includes medical malpractice liability, other liability and product liability; special property includes fire, allied lines, inland marine, earthquake and burglary and theft; Misc. commercial lines includes ocean marine, aircraft, boiler and machinery, credit, accident and health, financial guaranty and mortgage guaranty, fidelity and surety, and warranty. Standard errors are adjusted for heteroskedasticity and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Lines	$Down_{post}$	$Down_{current}$	$Down_{pre}$	Up_{post}	$Up_{current}$	Up_{pre}	$Prop_{t-1} \times Down_{post}$	$Prop_{t-1} \times Down_{current}$	$Prop_{t-1} \times Down_{pre}$	$Prop_{t-1} \times Up_{post}$	$Prop_{t-1} \times Up_{current}$	$Prop \times Up_{pre}$
Homeowners	-0.036***	-0.013	-0.001	0.013	-0.009	-0.003	0.106	-0.183	0.100	0.142	0.225**	0.157
/Farmowners	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.107)	(0.124)	(0.107)	(0.108)	(0.097)	(0.140)
Auto physical	-0.050***	-0.069***	-0.001	0.007	-0.009	-0.025**	0.199	-0.021	0.098	-0.041	0.023	-0.072
damage	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)	(0.139)	(0.120)	(0.114)	(0.075)	(0.084)	(0.088)
Auto	-0.040***	-0.098***	-0.022	-0.002	-0.020	-0.033**	0.069	-0.181	0.054	0.159	-0.080	0.001
liability	(0.016)	(0.016)	(0.014)	(0.013)	(0.013)	(0.014)	(0.096)	(0.116)	(0.110)	(0.097)	(0.109)	(0.100)
Workers'	-0.044***	-0.119***	0.029*	-0.018	-0.031**	-0.024	0.104	-0.076	0.210	0.206	0.141	-0.038
compensation	(0.017)	(0.018)	(0.017)	(0.017)	(0.016)	(0.017)	(0.260)	(0.237)	(0.298)	(0.252)	(0.332)	(0.169)
Commercial	-0.032***	-0.055***	-0.003	0.002	-0.027	-0.040***	-0.008	-0.163*	-0.048	0.114*	-0.003	0.016
multiple Peril	(0.013)	(0.013)	(0.012)	(0.013)	(0.013)	(0.015)	(0.101)	(0.091)	(0.081)	(0.062)	(0.076)	(0.071)
Commercial liab.	-0.039***	-0.057***	0.002	0.010	-0.016	-0.028**	-0.076	-0.120**	0.022	0.053	0.043	0.008
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.063)	(0.057)	(0.044)	(0.038)	(0.038)	(0.043)
Special property	-0.027	-0.073*	-0.025	0.018	-0.029	-0.061	-0.004	-0.021	0.033	0.005	0.018	-0.032
	(0.046)	(0.043)	(0.042)	(0.039)	(0.041)	(0.042)	(0.061)	(0.057)	(0.058)	(0.053)	(0.058)	(0.060)
Misc. commercial	-0.034**	-0.049***	-0.009	-0.002	-0.007	-0.001	-0.009	-0.085	0.014	0.017	0.005	-0.144***
lines	(0.011)	(0.011)	(0.010)	(0.010)	(0.011)	(0.011)	(0.067)	(0.079)	(0.070)	(0.059)	(0.053)	(0.053)

Table 10
Impact of Guaranty funds on Market Discipline at Firm-Line-State-Year Level, State Variation

The dependent variable is ΔLog Premium$_t$. The sample is at firm-line-state-year level and the period is 1990-2011. Regressions include only downgraded firms. *Uncover* equals 1 if the premiums in a state are uncovered by guaranty funds, 0 otherwise. Traditional lines exclude ocean marine, fidelity, surety, credit, title, financial guaranty, health and accident, mortgage guaranty and warranty. The control variables include the logarithm of lagged premium, a firm-line-year fixed effect and a state fixed effect. State time-variant variables are included in all regressions, which are insurance employment, insurance gross state product (GSP), state income, and the number of insolvent insurers. All state variables are scaled by state annual population. Standard errors are adjusted for heteroskedasticity and clustered at firm-line-year level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	All Lines	Traditional Lines	Nontraditional Lines	Personal Lines	Commercial Lines
Log Premium $_{t-1}$	-0.088***	-0.088***	-0.090***	-0.034***	-0.101***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Uncover × High	-0.013	0.053	-0.030***	-0.079	-0.017*
	(0.010)	(0.035)	(0.010)	(0.109)	(0.010)
Uncover × A-	-0.152***	-0.212***	-0.079***	-0.045	-0.159***
	(0.025)	(0.038)	(0.030)	(0.082)	(0.026)
Uncover × Low	-0.097**	-0.118**	-0.084*	0.251	-0.111***
	(0.035)	(0.055)	(0.045)	(0.191)	(0.035)
Insurance GSP	0.003	0.003	0.006	-0.003	0.005
	(0.003)	(0.004)	(0.011)	(0.008)	(0.004)
State Income	0.017*	0.016	0.026	-0.015	0.025**
	(0.009)	(0.010)	(0.030)	(0.022)	(0.011)
Insurance Employment	0.004*	0.005**	0.003	0.004	0.004
	(0.002)	(0.002)	(0.007)	(0.005)	(0.003)
Insolvent Insurers	-0.001	-0.000	-0.002	0.001	-0.001
	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Firm-Line-Year Fixed Effect	YES	YES	YES	YES	YES
State Fixed Effect	YES	YES	YES	YES	YES
R^2	0.414	0.416	0.403	0.446	0.417
Observations	229,410	204,124	25,286	36,750	192,660

Table 11
Impact of Guaranty funds on Market Discipline at Firm-Line-State-Year Level, Line of Business variation

The dependent variable is ΔLog Premium$_t$. The sample is at firm-line-state-year level and the period is 1990-2011. Regressions include only downgraded firms. *Uncover* equals 1 if the premiums in a state are uncovered by guaranty funds, 0 otherwise. Nontraditional lines include ocean marine, fidelity, surety, credit, title, financial guaranty, health and accident, mortgage guaranty and warranty. The set of control variables include logarithm of lagged premium, a firm-state-year fixed effect and an insurance line of business fixed effect. Aggregate line of business time-variant variables are included in all regressions, which are loss ratio and loss volatility. Standard errors are adjusted for heteroskedasticity and clustered at firm-state-year level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	All lines	Nontraditional Lines	Commercial Lines
Log Premium $_{t-1}$	-0.059***	-0.037***	-0.070***
	(0.001)	(0.004)	(0.001)
Uncover × High	-0.058***	-0.028	-0.064***
	(0.011)	(0.026)	(0.011)
Uncover × A-	-0.053**	-0.264*	-0.044**
	(0.021)	(0.133)	(0.022)
Uncover × Low	-0.055*	-0.174	-0.059*
	(0.032)	(0.155)	(0.032)
Loss Ratio	-0.007	-0.336**	0.002
	(0.011)	(0.140)	(0.011)
Loss Volatility	0.007	0.196**	-0.003
	(0.008)	(0.091)	(0.008)
Firm-State-Year Fixed Effect	YES	YES	YES
Line Fixed Effect	YES	YES	YES
R^2	0.427	0.726	0.447
Observations	229,410	25,286	192,660

Table 12

Impact of Guaranty funds on Market Discipline at Firm-Line-State-Year Level, Time Variation

The dependent variable is ΔLog $Premium_t$. The sample is at firm-line-state-year level and the period is 1990-2011. Regressions include only downgraded firms. *Uncover* equals 1 if the premiums in a state are uncovered by guaranty funds, 0 otherwise. The set of control variables include logarithm of lagged premium, a firm-line-state fixed effect and a year fixed effect. State time-variant variables are included in all regressions, which are insurance employment, insurance gross state product (GSP), state income, and the number of insolvent insurers. All state variables are scaled by state annual population. Aggregate line of business time-variant variables are included in all regressions, which are loss ratio and loss volatility. Standard errors are adjusted for heteroskedasticity and clustered at firm-state-year level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	**All Lines**	**Personal Lines**	**Commercial Lines**
Log Premium $_{t-1}$	-0.159***	-0.129***	-0.163***
	(0.003)	(0.007)	(0.003)
Uncover × High	-0.084*	0.038	-0.088*
	(0.050)	(0.044)	(0.051)
Uncover × A-	-0.301***	0.047	-0.302***
	(0.058)	(0.238)	(0.060)
Uncover × Low	-0.462***	0.080	-0.462***
	(0.070)	(0.550)	(0.072)
Insurance GSP	-0.015	0.008	-0.018
	(0.012)	(0.020)	(0.014)
State Income	0.020	0.080	0.009
	(0.031)	(0.067)	(0.035)
Insurance Employment	0.011***	-0.017	0.011***
	(0.003)	(0.013)	(0.003)
Insolvent Insurers	0.002	-0.002	0.002
	(0.004)	(0.007)	(0.004)
Loss Ratio	0.027	0.180	0.029
	(0.028)	(0.224)	(0.029)
Loss Volatility	0.003	-0.091	-0.002
	(0.018)	(0.152)	(0.019)
Firm-Line-State Fixed Effect	YES	YES	YES
Year Fixed Effect	YES	YES	YES
R^2	0.261	0.321	0.250
Observations	229,410	36,750	192,660

Table 13
Univariate Tests of Loss Ratio by Guaranty Fund Covered Status by Lines

The table shows results of univariate tests for loss ratio across guaranty funds covered status from 1990 to 2011 by lines, in which loss ratio is calculated at the line by year level. Special liability includes ocean marine, aircraft, and boiler and machinery; special property includes fire, allied lines, inland marine, earthquake and burglary and theft; other includes credit, accident and health. The covered business is defined as premiums covered by guaranty funds and uncovered business is defined as premiums uncovered by guaranty funds at firm-line-state-years. Loss ratio is defined as directed loss incurred divided by directed premium earned, where direct loss incurred and direct premium earned are aggregated at the line by year level. Significance of tests of differences in means are based on a two-tailed t-test.

Lines of Business	Covered Business (1)	Uncovered Business (2)	Difference (1)-(2)	Variance of Loss Ratio
Homeowners / Farmowners	0.690	0.572	0.118	0.031
Auto Liability	0.676	0.633	0.043	0.012
Workers compensation	0.695	1.127	-0..432*	0.020
Commercial Multiple Peril	0.591	0.568	0.023	0.022
Medical Malpractice	0.627	0.602	-0.025	0.040
Special Liability	0.595	0.632	-0.037	0.031
Other Liability	0.651	0.615	0.036	0.022
Special Property	0.634	0.618	0.016	0.051
Auto Physical Damage	0.604	0.571	0.033	0.010
Fidelity/Surety	0.396	0.333	0.062	0.032
Other Lines	0.678	0.724	-0.046	0.011
Product Liability	0.904	0.573	0.331***	0.073
Fin. /Mortg. Guaranty	0.599	0.737	-0.137	0.176
Warranty	0.617	0.747	-0.130**	0.027

Table 14
Insurers' Risk Management Behavior

The dependent variable is ΔLog $Premium_t$. The sample period is 1991-2011. Risky business is defined as the first seven insurance lines with high variances of loss ratio based on Table 13. Regressions include only business covered by guaranty funds. In Panel A, the sample is at firm-year level. The sample consists of 33,111 firm-years. Firm controls are included in the regression, which are *Size*, *Leverage*, *Reinsurance*, *Group*, *Mutual*, *Geoherf*, *Busherf*, *Directw*, *Anticipation* and the interaction of *Prop Risk* with a linear year trend (variables are defined in Table 3). *Prop Risk* is defined as the proportion of direct premiums written in risky business to total premiums written in a firm. Standard errors are adjusted for heteroskedasticity and clustered at firm level and are reported below the coefficients in parentheses. In Panel B, the sample is at firm-line-state-year level. Regressions include only firms with a ratings downgrade. *Risk* equals 1 if the premiums are in a line which is risky business, 0 otherwise. The set of control variables include logarithm of lagged premium, firm-year, state and insurance line of business fixed effects. Standard errors are adjusted for heteroskedasticity and clustered at firm-year level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A: Variables	Firm-Year Level
Log premium $_{t-1}$	-0.113***
	(0.005)
Prop. Risk	-0.065*
	(0.034)
Up_{post}	0.009
	(0.010)
$Up_{current}$	0.002
	(0.011)
Up_{pre}	-0.017
	(0.011)
$Down_{post}$	-0.051***
	(0.013)
$Down_{current}$	-0.075***
	(0.013)
$Down_{pre}$	-0.004
	(0.012)
Prop Risk × Up_{post}	-0.005
	(0.021)
Prop Risk × $Up_{current}$	-0.014
	(0.023)
Prop Risk × Up_{pre}	-0.018
	(0.024)
Prop Risk × $Down_{post}$	-0.000
	(0.026)
Prop Risk × $Down_{current}$	0.040
	(0.026)
Prop Risk × $Down_{pre}$	0.001
	(0.025)
Firm, Year Fixed Effect	YES
R^2	0.250
Observations	33,111

Panel B: Variables	Firm-Year-Line-State Level
Log Premium $_{t-1}$	-0.054***
	(0.002)
Risky business × High	-0.055
	(0.057)
Risky business × A-	-0.035
	(0.061)
Risky business × Low	0.018
	(0.060)
Firm-Year Fixed Effect	YES
Line Fixed Effect	YES
State Fixed Effect	YES
R^2	0.427
Observations	198,468

Table 15
Prices, Market Discipline and Guaranty Funds at Firm-Line-Year Level

The dependent variables are ΔLog $Price_t$. The sample includes 120,533 observations with positive calculated insurance price as in Cummins and Danzon (1997) during 1991-2011. Firm Controls include *Size*, *Leverage, Reinsurance, Group, Mutual, Geoherf, Busherf,* and *Direct writer.* Guaranty fund controls include *Reg%, Max%, Prov%* and the interaction of *Prop* with a linear year trend. Firm-line fixed effects and year fixed effects are included in all fixed effects regressions. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)	OLS (3)	F.E. (4)
Log price $_{t-1}$	-0.278***	-0.463***	-0.279***	-0.465***
	(0.003)	(0.004)	(0.003)	(0.004)
Prop. of Uncovered $Premium_{t-1}$	—	—	0.032***	0.042
			(0.007)	(0.031)
Up_{post}	0.009*	0.015***	0.011**	0.019***
	(0.005)	(0.005)	(0.005)	(0.005)
$Up_{current}$	0.014***	0.016***	0.014***	0.017***
	(0.005)	(0.005)	(0.005)	(0.005)
Up_{pre}	-0.004	0.004	-0.004	0.003
	(0.005)	(0.006)	(0.005)	(0.006)
$Down_{post}$	-0.006	-0.009*	0.001	-0.001
	(0.005)	(0.006)	(0.005)	(0.006)
$Down_{current}$	-0.031***	-0.032***	-0.033***	-0.033***
	(0.005)	(0.005)	(0.005)	(0.006)
$Down_{pre}$	-0.057***	-0.044***	-0.057***	-0.044***
	(0.005)	(0.005)	(0.005)	(0.005)
Prop $_{t-1}$ × Up_{post}	—	—	-0.019	-0.033
			(0.020)	(0.021)
Prop $_{t-1}$ × $Up_{current}$	—	—	-0.006	-0.012
			(0.019)	(0.020)
Prop $_{t-1}$ × Up_{pre}	—	—	-0.004	-0.005
			(0.020)	(0.022)
Prop $_{t-1}$ × $Down_{post}$	—	—	-0.073***	-0.078***
			(0.022)	(0.024)
Prop $_{t-1}$ × $Down_{current}$	—	—	0.013	0.007
			(0.021)	(0.022)
Prop $_{t-1}$ × $Down_{pre}$	—	—	-0.002	0.000
			(0.020)	(0.022)
Anticipation	—	-0.633***	—	-0.600***
		(0.241)		(0.241)
Constant	0.006***	-0.045	0.002	0.069
	(0.002)	(0.098)	(0.002)	(0.103)
Firm-Line & Year Fixed Effects	NO	YES	NO	YES
Firm Controls	NO	YES	NO	YES
Guaranty fund Controls	NO	NO	NO	YES
R^2	0.185	0.362	0.186	0.362
Observations	120,533	120,533	120,533	120,533

Table 16
Prices and Market Discipline at Firm-Line-Year Level based on Pre-change Rating Categories

The dependent variables are ΔLog $Price_t$ for the first two regressions. The sample includes 120,533 observations with positive calculated insurance price as in Cummins and Danzon (1997) during 1991-2011 for the first three regressions. Firm controls include *Size, Leverage, Reinsurance, Group, Mutual, Geoherf, Busherf, Direct writer*, *anticipation* and pre-change rating categories. Firm-line fixed effects and year fixed effects are included in all fixed effects regressions. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)
Log price $_{t-1}$	-0.279***	-0.465***
	(0.003)	(0.004)
High × $Down_{post}$	0.003	0.001
	(0.006)	(0.006)
High × $Down_{current}$	-0.013**	-0.025***
	(0.006)	(0.007)
High ×$Down_{pre}$	-0.055***	-0.048***
	(0.006)	(0.007)
A-× $Down_{post}$	0.000	-0.007
	(0.015)	(0.015)
A- × Down $_{current}$	-0.090***	-0.078***
	(0.014)	(0.014)
A- × $Down_{pre}$	-0.081***	-0.067***
	(0.012)	(0.013)
Low × $Down_{post}$	-0.014	-0.017
	(0.014)	(0.015)
Low × $Down_{current}$	-0.045***	-0.043***
	(0.013)	(0.014)
Low × $Down_{pre}$	-0.039***	-0.027**
	(0.012)	(0.012)
High × Up_{post}	0.015*	0.010
	(0.009)	(0.009)
High × $Up_{current}$	-0.013	-0.014
	(0.009)	(0.010)
High × Up_{pre}	-0.023***	-0.013
	(0.009)	(0.009)
A- × Up_{post}	0.014	0.023**
	(0.009)	(0.010)
A- × $Up_{current}$	0.021**	0.034***
	(0.010)	(0.010)
A- × Up_{pre}	-0.019*	-0.001
	(0.010)	(0.011)
Low × Up_{post}	0.002	0.008
	(0.007)	(0.007)
Low × $Up_{current}$	0.045***	0.045***
	(0.008)	(0.009)
Low × Up_{pre}	0.045***	0.042***
	(0.009)	(0.009)
Fixed Effects & Firm Controls	NO	YES
R^2	0.187	0.362
Observations	120,533	120,533

Table 17
Prices, Market Discipline and Guaranty Funds at Firm-Line-Year Level based on Pre-change Rating Categories

The dependent variable is ΔLog $Price_t$ for the first three regressions. The sample period is 1991-2011. The sample consists of 120,533 observations with positive calculated insurance price. Fixed effects and Controls include firm-line fixed effects, year fixed effects, *Size*, *Group*, *Mutual*, *Geoherf*, *Busherf*, *Direct writer*, *Anticipation*, *Reg%*, *Max%*, and *Prov%* and the interaction of *Prop* with a linear year trend. All regressions include upgrades, downgrades, pre-change rating categories, the interactions of rating change and pre-rating categories, and the interaction of *Prop* with pre-change rating categories. The third regression column shows the results of Two-Stage Least Square estimates of ΔLog $Price_t$. The proportion of uncovered premiums is instrumented by its value lagged of three years, *Size*, *Geoherf*, *Busherf*, *Mutual* and *Group* in the first stage of the 2SLS regression. The sample for the 2SLS regression includes 118,539 since the data of 1991 is deleted. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)	2SLS (3)
$Prop_{t-1} \times High \times Down_{post}$	-0.074***	-0.071***	-0.072***
	(0.024)	(0.026)	(0.027)
$Prop_{t-1} \times High \times Down_{current}$	0.013	0.019	0.018
	(0.023)	(0.026)	(0.027)
$Prop_{t-1} \times High \times Down_{pre}$	-0.013	-0.002	0.002
	(0.023)	(0.025)	(0.027)
$Prop_{t-1} \times A- \times Down_{post}$	-0.037	-0.042	-0.047
	(0.066)	(0.071)	(0.072)
$Prop_{t-1} \times A- \times Down_{current}$	-0.065	-0.101*	-0.113*
	(0.054)	(0.056)	(0.059)
$Prop_{t-1} \times A- \times Down_{pre}$	-0.021	0.001	-0.003
	(0.054)	(0.057)	(0.058)
$Prop_{t-1} \times Low \times Down_{post}$	-0.146*	-0.178	-0.179
	(0.080)	(0.109)	(0.111)
$Prop_{t-1} \times Low \times Down_{current}$	0.067	0.031	0.090
	(0.077)	(0.088)	(0.089)
$Prop_{t-1} \times Low \times Down_{pre}$	0.107*	0.024	0.001
	(0.065)	(0.078)	(0.077)
$Prop_{t-1} \times High \times Up_{post}$	-0.063**	-0.071**	-0.083**
	(0.031)	(0.033)	(0.035)
$Prop_{t-1} \times High \times Up_{current}$	0.055*	0.030	0.042
	(0.031)	(0.032)	(0.034)
$Prop_{t-1} \times High \times Up_{pre}$	0.028	0.012	0.018
	(0.031)	(0.033)	(0.035)
$Prop_{t-1} \times A- \times Up_{post}$	-0.052	-0.034	-0.036
	(0.035)	(0.037)	(0.038)
$Prop_{t-1} \times A- \times Up_{current}$	-0.112***	-0.061	-0.063
	(0.034)	(0.038)	(0.041)
$Prop_{t-1} \times A- \times Up_{pre}$	-0.014	0.034	0.028
	(0.035)	(0.039)	(0.041)
$Prop_{t-1} \times Low \times Up_{post}$	0.044	0.007	0.016
	(0.033)	(0.035)	(0.036)
$Prop_{t-1} \times Low \times Up_{current}$	0.052	0.053	0.038
	(0.038)	(0.046)	(0.049)
$Prop_{t-1} \times Low \times Up_{pre}$	0.000	-0.025	-0.056
	(0.040)	(0.046)	(0.048)
Fixed effects and Controls	NO	YES	YES
R^2	0.187	0.363	0.360
Observations	120,533	120,533	118,539

Table 18
Market Discipline and Guaranty Funds at Firm-Line-Year Level after Controlling for Price

The dependent variables are ΔLog Premium $_{t}$ for the regressions. The 2SLS regression uses predicted price growth, which is instrumented by lagged log price, rating vectors and firm and guaranty funds controls in the first stage. The sample period is 1991-2011. The sample consists of 120,533 observations with positive calculated insurance price. All regressions include upgrades, downgrades, pre-change rating categories, firm controls, and firm-line and year fixed effects. The second model also include *Prop*, guaranty fund controls, the interactions of rating change and pre-rating categories, the interaction of *Prop* with pre-change rating categories, and the interaction of *Prop* with a linear year trend. Firm controls include *Size*, *Group*, *Mutual*, *Geoherf*, *Busherf*, *Direct writer*, *Anticipation*, *Reg%*; and guaranty funds controls include *Max%*, and *Prov%*. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	2SLS (1)
Predicted ΔLog Price $_{t}$	-0.043***
	(0.002)
High × Down$_{post}$	-0.018***
	(0.005)
High × Down$_{current}$	-0.030***
	(0.005)
High ×Down$_{pre}$	-0.002
	(0.005)
A-× Down$_{post}$	-0.057***
	(0.010)
A- × Down $_{current}$	-0.120***
	(0.009)
A- × Down$_{pre}$	0.003
	(0.009)
Low × Down$_{post}$	-0.075***
	(0.010)
Low × Down$_{current}$	-0.081***
	(0.009)
Low × Down$_{pre}$	0.009
	(0.009)
High × Up$_{post}$	-0.022***
	(0.007)
High × Up$_{current}$	-0.020***
	0.007
High × Up$_{pre}$	-0.027***
	(0.007
A- × Up$_{post}$	-0.007
	(0.007)
A- × Up$_{current}$	-0.012
	(0.007)
A- × Up$_{pre}$	-0.009
	(0.007)
Low × Up$_{post}$	0.030***
	(0.006)
Low × Up$_{current}$	0.039***
	(0.006)
Low × Up$_{pre}$	0.009
	(0.007)
R^2	0.126
Observations	120,533

Variables	2SLS (2)
Predicted ΔLog Price $_{t}$	-0.071***
	(0.004)
Prop $_{t-1}$ × High × Down$_{post}$	0.010
	(0.016)
Prop $_{t-1}$ × High × Down$_{current}$	-0.001
	(0.015)
Prop $_{t-1}$× High ×Down$_{pre}$	0.018
	(0.015)
Prop $_{t-1}$ × A-× Down$_{post}$	-0.054
	(0.042)
Prop $_{t-1}$×A- × Down$_{current}$	-0.178***
	(0.035)
Prop $_{t-1}$ ×A- × Down$_{pre}$	-0.002
	(0.035)
Prop $_{t-1}$ × Low × Down$_{post}$	-0.025
	(0.054)
Prop $_{t-1}$ × Low × Down$_{current}$	-0.181***
	(0.047)
Prop $_{t-1}$ × Low × Down$_{pre}$	-0.052
	(0.045)
Prop $_{t-1}$ × High × Up$_{post}$	-0.004
	(0.020)
Prop $_{t-1}$ × High × Up$_{current}$	0.026
	(0.020)
Prop $_{t-1}$ × High × Up$_{pre}$	-0.016
	(0.021)
Prop $_{t-1}$ × A- × Up$_{post}$	0.060***
	(0.022)
Prop $_{t-1}$ × A- × Up$_{current}$	-0.022
	(0.023)
Prop $_{t-1}$ × A- × Up$_{pre}$	-0.012
	(0.024)
Prop $_{t-1}$ × Low × Up$_{post}$	-0.024
	(0.022)
Prop $_{t-1}$ × Low × Up$_{current}$	0.026
	(0.027)
Prop $_{t-1}$ × Low × Up$_{pre}$	-0.036
	(0.029)
R^2	0.124
Observations	120,533

Appendix A: Definitions of Independent Variables

A. Firm and guaranty funds controls

Various features of state guaranty funds might affect market discipline and our model attempts to control for these effects. Guaranty funds have a maximum claim payment, which may dampen the cost of undercutting market discipline. If there is a significant proportion of private loss in excess of the caps in the case of an insurer's insolvency, policyholders might have additional incentive to monitor insurers. We construct a continuous variable *Max%* to represent the percentage of the insurer's direct premium written in a state with maximum claim paid of guaranty fund exceeding $300,000.[25] Another feature of state guaranty funds is net worth provisions. Given these provisions, wealthier policyholders have a greater incentive to monitor their insurers. We apply a continuous variable *Prov%* to represent the percentage of the insurer's direct premium written in states with state guaranty funds that have the net worth provision above $25,000,000.[26] More stringent rate regulation may dampen the impact of market discipline on prices, if the regulated rate is not a function of insurer risk. To account for rate regulation, we use *Reg%* (Grace and Leverty, 2010): it represents the percentage of the insurer's direct premium written in states with strict rate regulation laws (with prior approval or state made rate regulation) for regulated lines such as medical malpractice, auto insurance, homeowner insurance and workers compensation at the firm-line-year level.[27]

We also use a number of firm level control covariates that have been shown in previous research to affect the change of insurance premiums and prices. Although regulations forbid insurers to advertise guaranty funds in selling insurance policies, insurance agents and brokers are aware of guaranty funds and of insurer financial strength ratings. Accordingly, we control for insurer distribution channel by using *Directw,* which is an indicator variable that equals one if an insurer is a direct writer and zero otherwise. To account for firm business diversification we use product line Herfindahl index (*Busherf*) and geographic Herfindahl index (*Geoherf*), which are calculated by the sum of the squares of the percentages of direct premium written across all lines of business (all states for geographic Herfindahl index) for the insurer. Other firm characteristic

[25] Workers compensation is treated as other lines covered by guaranty funds, although most states have infinite coverage for it. The reason is in many cases workers compensations are sold in insurance packages with other insurance contracts. Our results are very similar if we exclude workers compensation from our sample.

$$Max\% = \frac{\sum_{i,j,s,t} Premium\ Written_{ijst} \times Indicators\ of\ guaranty\ fund\ exceeding\ \$300{,}000}{\sum_{i,j,s,t} Premium\ Written_{ijst}}$$

[26] $$Prov\% = \frac{\sum_{i,j,s,t} Premium\ Written_{ijst} \times Indicators\ of\ net\ worth\ provision\ above\ \$25{,}000{,}000}{\sum_{i,j,s,t} Premium\ Written_{ijst}}$$

[27] $$Reg\% = \frac{\sum_{i,j,s,t} Premium\ Written_{ijst} \times Indicators\ of\ stringent\ reg\ law}{\sum_{i,j,s,t} Premium\ Written_{ijst}}$$

control variables are *Size*, the natural logarithm of total assets; *Leverage*, the ratio of total liability to total asset; *Reinsurance*, the ratio of premiums ceded to total premiums written; *Mutual*, a dummy variable set equal to one if the insurer is a mutual organization; and *Group*, an indicator if the firm belongs to some affiliated group.

B. Default-value-to-liability ratio

It is possible that insurers and markets anticipate the rating changes of some firms and thus react less to the rating changes. To control for this possibility, we use a continuous measure of insurer risk. Specifically, we calculate an insurer's default-value-to-liability ratio (*Risk*) (Myers and Read, 2001):

$$d = f(s,\sigma) = N\{z\} - (1+s)N\{z-\sigma\} \quad \text{(A1)}$$

where $N\{\cdot\}$ is the cumulative probability function for the standard normal variable, s is the surplus to liability ratio, $z = \frac{-\log(1+s) + \sigma^2/2}{\sigma}$, and σ is the volatility of the asset to liability ratio. The overall firm's volatility of the asset to liability ratio is calculated as $\sigma = \sqrt{\sigma_V^2 + \sigma_L^2 - 2\sigma_{VL}}$, where σ_V is the volatility of insurer's assets, σ_L is the volatility of insurer's liabilities, and σ_{VL} is the covariance of the natural logarithms of liabilities and assets. The respective volatilities are calculated by the following functions:

$$\sigma_V^2 = \sum_i^M \sum_j^M x_i x_j \rho_{V_i V_j} \sigma_{V_i} \sigma_{V_j} \quad \text{(A2)}$$

$$\sigma_L^2 = \sum_i^N \sum_j^N y_i y_j \rho_{L_i L_j} \sigma_{L_i} \sigma_{L_j} \quad \text{(A3)}$$

$$\sigma_{VL}^2 = \sum_i^M \sum_j^N x_i y_j \rho_{V_i L_j} \sigma_{V_i} \sigma_{L_j} \quad \text{(A4)}$$

where x_i is the proportion of asset from asset type i to total asset, y_i is the proportion of liabilities from line i to the loss liability, $\rho_{V_i V_j}$ is the correlation coefficient of the logarithms of asset classes i and j with M number of asset classes[28], $\rho_{L_i L_j}$ is the correlation coefficient of the logarithms of liability line i and j with N number of lines of insurance business[29], and $\rho_{V_i L_j}$ is the

[28] Assets are divided into six classes: stocks, bonds, real estate, mortgages, cash and other invested, and other assets.
[29] Lines of insurance business are divided into 12 classes based on Schedule P.

correlation coefficient of the logarithms of liability line i and asset j. The volatilities and correlation matrix of insurers' assets are calculated using industry wide quarterly time series of return for each asset[30] and liability class[31].

C. Loss ratio and loss volatility and state variables

We have three variables as state time-variant controls in equation (3). First, we use employment in the insurance sector (*Insurance Employment*) divided by total state population as a proxy for the power of the insurance labor. Second, we use insurance gross state product per capita (*Insurance GSP*) as a proxy for the magnitude of economic size of insurance sector in a state. Income per capita (*state income*) is used to proxy the relative household wealth for each state each year. All above state variables are obtained from the Bureau of Economic Analysis. Last, the number of insolvent insurers (*insolvent insurers*) in a state by year is used to proxy for policyholder knowledge about insurer insolvency. The variable is calculated as the count of the number of insurers that went insolvent in a year that are domiciled in a state. The list of insolvent firms is collected from the NAIC's Global Receivership Information Database (GRID). We classify an insurer as insolvent if it is subject to proceedings for conservation of assets, rehabilitation, receivership, or liquidation in each year.

In equation (4), loss ratio is calculated as aggregated direct loss incurred divided by directed premium earned, for each line and each year. Loss volatility is calculated as the cross-sectional standard deviation of losses incurred for each line and each year. Loss volatility is scaled by the cross-sectional standard deviation of premiums earned for each line and each year

[30] The quarterly estimates of the asset returns on the first five categories are obtained from the standard rate of return series: the total return on the Standard & Poor's 500 stock index for the stock returns, Moody's corporate bond total return for the bond, the National Association of Real Estate Investment Trusts total return for the real estate, the Merrill Lynch mortgage backed securities total return for the mortgages, and 30 day US Treasury bill rate for the cash/other invested assets. The non-invested assets are calculated by the natural logarithm of the gross quarterly percentage change in the total value of asset of the insurance industry net of the value of the first five asset categories.

[31] The quarterly liability return series are defined as the natural logarithm of the present value of incurred losses divided by the earned premium for each quarter.

Appendix B: Insurance Price Calculation

To disentangle quantity and price changes, we calculate insurance price growth ($\Delta Log\ Price$). Since explicit contract prices are not available (i.e., we do not have information on prices at the contract level), we follow the literature and use an implicit measure of price (e.g. Cummins and Danzon, 1997; Cummins et al., 2005). We measure price at the firm-line-year level. Specifically, *Price* for firm i, line j, in year t, is defined as follows:

$$\text{Price}_{\text{ijt}} = \frac{NPW_{ijt} - DIV_{ijt} - EXP_{ijt}}{(NLI_{ijt} + LAE_{ijt}) \times PVF_{jt}} \qquad \text{(B1)}$$

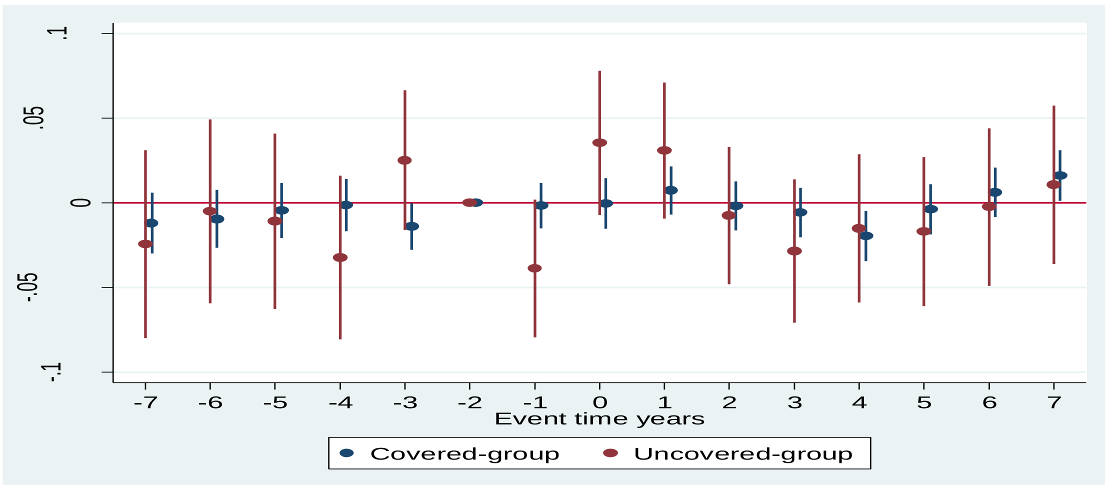
Where *NPW* is net premiums written, *DIV* is dividends to policyholders, *EXP* is underwriting expenses, *NLI* is net losses incurred, *LAE* is loss adjustment expenses incurred, and *PVF* is the present value factor for line j, in year t. Since premiums reflect the discounting of loss in a competitive market, losses incurred and loss adjustment expenses are discounted using a present value factor that accounts for differences in the payout pattern across insurance lines (e.g. long-tail lines vs. short tail lines). To calculate present value factors (*PVF*) we use information about how losses developed in the past to estimate how losses develop in the future. Specifically, we estimate payout proportions for each insurance line by applying the Taylor separation method (Taylor, 2002) to loss reserve data from the Schedule P of the regulatory annual statements.[32] We discount these estimated future payments using US Treasury yields obtained from the Federal Reserve Bank of St Louis. The estimation of payout tail proportions is akin to the method prescribed by the Internal Revenue Service (IRS) for computing loss present values for tax purposes (Cummins 1990).

[32] Schedule P of the NAIC regulatory annual statement aggregates each insurer's lines of business into 12 categories: homeowner/farmers, auto liability, commercial multiple peril, workers' compensation, medical malpractice, special liability (ocean marine, aircraft and boiler & machinery), other liability, special property (fire, allied lines, inland marine, earthquake, burglary and theft), auto physical damages, fidelity/surety, other, and warranty.

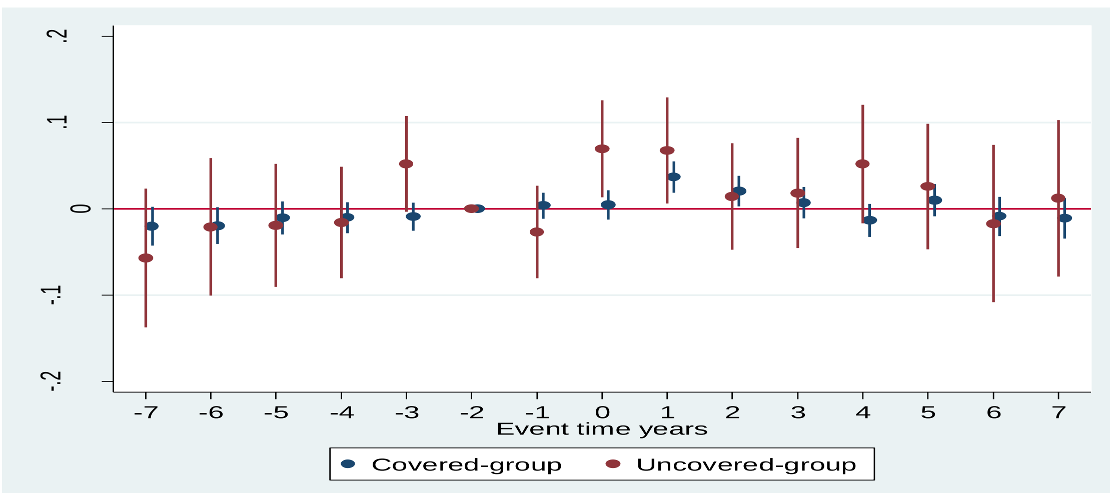
Appendix C. Extra Tables and Figures

Figure C.1 : Premium Growth for Insurer Upgrades at Firm-Line-Years, 1991–2011
The figure plots event time premium growth coefficients from estimation of equation (5) on the 1991–2011 panel. Panel A is premium growth for all insurer upgrades, panel B is for A- and lower rated insurer upgrades and Panel C is for higher rated insurer upgrades. The end points on the graph are binned so that −7 (+7) is a bin for years −7 to −20 (+20 to +7). The vertical axis measures *ΔLog Premium*. The coefficient for the last second year before a downgrade is normalized to zero. The bars show the 95% confidence interval. Standard errors are clustered by firm-line level.

Panel A:



Panel B:



Panel C:

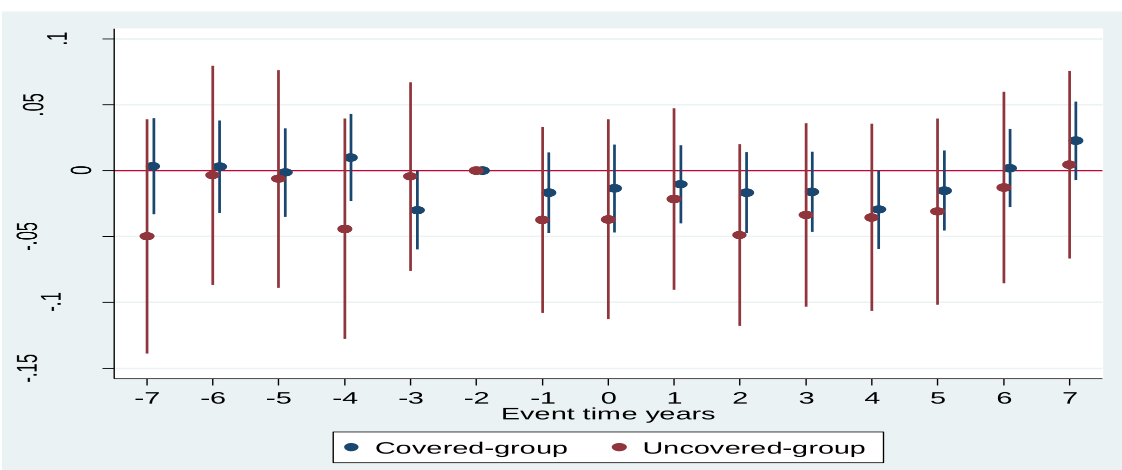


Table C.1
Seemingly Unrelated Regression for Premium Growth and Price Growth

The dependent variables are ΔLog Premium_t and ΔLog Price_t for the SUR regression. The sample includes 120,533 observations with positive calculated insurance price as in Cummins and Danzon (1997) during 1991-2011. Firm controls, line fixed effects and year fixed effects are included in the regressions. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

	F.E. (1) (ΔLog Premium_t)	F.E. (2) (ΔLog Price_t)	Equality of Coefficients
High × Down_{post}	-0.038***	0.000	26.96***
	(0.005)	(0.006)	(0.000)
High × $\text{Down}_{current}$	-0.041***	-0.017***	10.93***
	(0.005)	(0.006)	(0.001)
High ×Down_{pre}	-0.007	-0.051***	33.25***
	(0.005)	(0.006)	(0.000)
A-× Down_{post}	-0.087***	0.005	31.54***
	(0.010)	(0.013)	(0.000)
A- × $\text{Down}_{current}$	-0.137***	-0.088***	10.05***
	(0.010)	(0.012)	(0.001)
A- × Down_{pre}	-0.005	-0.081***	26.05***
	(0.010)	(0.012)	(0.000)
Low × Down_{post}	-0.095***	-0.016	23.56***
	(0.010)	(0.013)	(0.000)
Low × $\text{Down}_{current}$	-0.090***	-0.042***	10.00***
	(0.010)	(0.012)	(0.002)
Low × Down_{pre}	0.030***	-0.031***	16.33***
	(0.010)	(0.012)	(0.000)
High × Up_{post}	-0.008	0.020**	6.80
	(0.007)	(0.009)	(0.009)
High × $\text{Up}_{current}$	0.004	-0.005	0.81
	(0.007)	(0.009)	(0.369)
High × Up_{pre}	-0.006	-0.005	0.00
	(0.007)	(0.008)	(0.998)
A- × Up_{post}	-0.009	0.017*	4.85
	(0.007)	(0.009)	(0.028)
A- × $\text{Up}_{current}$	-0.004	0.030***	8.04
	(0.007)	(0.009)	(0.005)
A- × Up_{pre}	-0.008	-0.008	0.00
	(0.008)	(0.009)	(0.964)
Low × Up_{post}	0.035***	0.004	11.31***
	(0.006)	(0.007)	(0.001)
Low × $\text{Up}_{current}$	0.053***	0.050***	0.13
	(0.006)	(0.008)	(0.719)
Low × Up_{pre}	0.022***	0.049***	6.65***
	(0.007)	(0.008)	(0.010)
Fixed Effects & Firm Controls	YES	YES	—
Observations	120,533	120,533	—

Table C.2
Univariate Tests of Loss Ratio by Guaranty Fund Covered Status for Insurers with Covered Business and Uncovered Business, by Lines

The table shows results of univariate tests for loss ratio across guaranty funds covered status for insurers with both covered business and uncovered business from 1990 to 2011 by lines, in which loss ratio is calculated at the line by year level. Special liability includes ocean marine, aircraft, and boiler and machinery; special property includes fire, allied lines, inland marine, earthquake and burglary and theft; other includes credit, accident and health. The covered business is defined as premiums covered by guaranty funds and uncovered business is defined as premiums uncovered by guaranty funds at firm-line-state-years. Loss ratio is defined as directed loss incurred divided by directed premium earned, where direct loss incurred and direct premium earned are aggregated at the line by year level. The premium earned is scaled by 100,000,000. Significance of tests of differences in means and variance are based on a two-tailed t-test.

Lines of Business	Covered Business (1)			Uncovered Business (2)			Difference of Loss Ratio	
	Loss Ratio Mean	Loss Ratio Variance	Premium Earned	Loss Ratio Mean	Loss Ratio Variance	Premium Earned	Diff. of Mean	Equality of Variances
Homeowners / Farmowners	0.708	0.076	0.359	0.601	0.412	0.443	0.106	3.43**
Auto Liability	0.631	0.022	4.337	0.774	0.031	1.381	-0.025	1.95
Workers compensation	2.243	1.054	0.676	1.921	0.800	0.102	0.677	2.31
Commercial Multiple Peril	0.565	0.067	2.399	0.578	0.064	2.675	0.005	1.13
Medical Malpractice	0.699	0.046	3.315	0.819	0.695	1.894	-0.013	1.04
Special Liability	0.600	0.045	17.327	0.632	0.026	14.837	-0.032	2.92**
Other Liability	0.567	0.039	6.969	0.555	0.035	2.024	0.011	1.24
Special Property	0.506	0.044	3.056	0.602	0.062	5.278	-0.096	2.03
Auto Physical Damage	0.503	0.018	1.919	0.578	0.022	0.631	-0.076**	1.41
Fidelity/Surety	0.394	0.039	9.702	0.332	0.032	32.450	0.062	1.43
Other	0.663	0.011	6.552	0.666	0.013	47.067	-0.003	1.42
Product Liability	0.726	0.221	0.311	0.571	0.056	2.234	0.155	14.93***
Fin. /Mortg. Guaranty	0.654	0.189	2.512	0.685	0.153	44.22	-0.031	1.46
Warranty	0.582	0.014	9.332	0.626	0.011	9.421	-0.044	1.63

Table C.3
Impact of Guaranty funds on Market Discipline through Price (Direct Premium Written) at Firm-Line-State-Year Level

The dependent variable is ΔLog $Price_t$. Price is calculated by direct premium written and direct loss incurred. The sample is at firm-line-state-year level and the period is 1990-2011. Regressions include only downgraded firms. *Uncover* equals 1 if the premiums in a state are uncovered by guaranty funds, 0 otherwise. Traditional lines exclude ocean marine, fidelity, surety, credit, title, financial guaranty, health and accident, mortgage guaranty and warranty. The control variables include the logarithm of lagged price, a firm-line-year fixed effect and a state fixed effect. State time-variant variables are included in all regressions, which are insurance employment, insurance gross state product (GSP) and income. All state variables are scaled by state annual population. Standard errors are adjusted for heteroskedasticity and clustered at firm-line-year level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	**All Lines**	**Traditional Lines**	**Nontraditional Lines**	**Personal Lines**	**Commercial Lines**
Log Price $_{t-1}$	-0.378***	-0.380***	-0.343***	-0.398***	-0.376***
	(0.003)	(0.003)	(0.010)	(0.008)	(0.003)
Uncover × High	-0.045	0.125	-0.172**	-0.338	-0.041
	(0.055)	(0.035)	(0.074)	(0.282)	(0.055)
Uncover × A-	-0.069	-0.055	0.009	-0.156	-0.065
	(0.086)	(0.107)	(0.157)	(0.296)	(0.089)
Uncover × Low	-0.203**	-0.137	-0.299	-0.361***	-0.199**
	(0.098)	(0.104)	(0278)	(0.025)	(0.100)
Insurance GSP	0.002	0.001	0.023	0.011	-0.001
	(0.005)	(0.005)	(0.024)	(0.010)	(0.006)
State Income	0.007	0.010	-0.063	0.007	0.008
	(0.013)	(0.014)	(0.055)	(0.028)	(0.015)
Insurance Employment	0.011***	0.011***	-0.003	0.017***	0.010***
	(0.003)	(0.003)	(0.014)	(0.006)	(0.003)
Firm-Line-Year Fixed Effect	YES	YES	YES	YES	YES
State Fixed Effect	YES	YES	YES	YES	YES
R^2	0.292	0.292	0.328	0.275	0.299
Observations	145,788	138.653	7,135	27,609	118,179