Social Inflation

Sangmin S. Oh*

15th August 2022

Abstract

I study the risk and economic consequences of *social inflation* – shifts in the insurer's loss distribution due to factors such as large jury awards and broader definitions of liability – which poses a novel source of aggregate risk to the insurance sector. Using a dataset spanning jury awards, financial statements, and insurance rate filings, I show that the price impact of social inflation is greater in regions with higher legal exposure, greater for insurers that are more financially constrained, and is economically significant even for insurers not directly affected by verdicts and settlements. Consistent with empirical patterns, a theoretical model of social inflation shows that a shock to the insurer's loss distribution has a "double kick" effect on insurance supply through increased effective marginal cost and interaction with the capital requirement. I discuss factors that affect the future dynamics of social inflation and implications for the role of insurers.

Keywords: social inflation, nuclear verdicts, insurance regulation, financial stability, jury awards, property and casualty insurance, social norms

JEL Codes: G10, G20, G22, G41

*The University of Chicago, Kenneth C. Griffin Department of Economics and Booth School of Business (oh@chicagobooth.edu). First draft: July 2020. For helpful comments, suggestions, and discussions, I thank David Abrams, Douglas Baird, Alexandru Barbu (discussant), Aditya Chaudhry, Emanuele Colonnelli, Philip Dybvig, Lars Hansen, Jessica Jeffers, Pab Jotikasthira (discussant), Adam Jørring (discussant), Steve Kaplan, Ashley Keller, Elisabeth Kempf, Sanghee Kim, Ralph Koijen, Don Noh, Sojung Park (discussant), Ishita Sen (discussant), Ana-Maria Tenekedjieva, Luigi Zingales, and Cong Zhang. I also thank participants at IRMC 2020, EGSC 2020, CAFM 2020, EFA 2021, WFA 2021, 2021 Joint Program Conference at Chicago Booth, and SGF 2022 conference. I have also benefited from correspondence with analysts at Milliman and thank Emanuele Colonnelli and Niels Gormsen for providing their data. Results are preliminary, and all remaining errors are my own. Any opinion, findings, and conclusions or recommendations expressed in this material are those of the author. This research was funded in part by the John and Serena Liew Fellowship Fund at the Fama-Miller Center for Research in Finance, University of Chicago Booth School of Business.

1 Introduction

While insurers are adept at using the law of large numbers to insure idiosyncratic risk, it is more challenging to hedge aggregate shocks that cannot be easily diversified away. Traditionally, the sources of these aggregate risks have been technological and largely exogenous to insurer behavior, most saliently featured in catastrophe and weather risks (Froot and Posner, 2002), mortality and longevity risk (Milevsky et al., 2006), and forecast uncertainty associated with long-term insurance (Cutler, 1996). While these remain key challenges for the insurance sector, I argue that the legal environment, when interacted with changing social norms, presents a novel source of aggregate risk in insurance.

The subject of this study is a phenomenon widely known as *social inflation*, which refers to rising insurance prices due to factors such as large jury awards and broader definitions of liability. The related concerns within the insurance sector have been accumulating rapidly: as shown in Figure 1, the proportion of conference calls among the largest insurers that contain the phrase "social inflation" has stayed essentially at zero until 2017 while rising to over 50% in 2019.

From the insurer's perspective, social inflation poses a fundamental challenge to the supply of insurance. In its simplest form, the provision of insurance can be expressed as a mapping from an event to payout: payout $= f\,(\text{event})$. The traditional view is that the mapping f remains stable from the time of insurance underwriting to the time of actual payout by insurers. Social inflation questions this assumption by introducing sizable uncertainty to the underwriting process in two key dimensions. First, the recent prevalence of "nuclear awards" – defined as jury awards and settlements exceeding $10 million – shifts the underlying loss distribution that insurers face. Second, broader definitions of liability and retroactive modification of existing policies challenge the very definition of what constitutes an "event."

In this paper, I study the risk of social inflation and its economic consequences. While the exposure of insurers to large verdicts and settlements is hardly new, the recent decade is unique in that the related discussions have been conspicuous across multiple lines of business and have paralleled debates on the role of large corporations in our society. Understanding the impact of social inflation on insurance supply also has important ramifications as a large debate currently surrounds whether the rise in prices is due to a coordinated effort by insurers to profit without a discernible change in the underlying risk (Hunter et al., 2020). Given that the regulators actively expend efforts in determining how much to regulate prices (Oh et al., 2021), understanding the precise economic impact of social inflation is of first-order importance for policymakers as well.

To this end, I provide three main contributions. First, I document using novel data that the rise in nuclear verdicts and settlements is real and economically significant: the total value of the awards has increased threefold over the past decade, despite limited change in salient accident

characteristics and traditional factors in jury awards. Second, I provide first empirical evidence on the price impact of social inflation. Consistent with the interpretation of social inflation as aggregate risk, I show that the price impact is (i) greater in regions with higher legal exposure, (ii) greater for insurers that are more financially constrained, and (iii) economically significant even for insurers that are not directly affected by nuclear awards. Finally, I show that the risk of social inflation is likely to persist given the presence of factors that contribute to both a larger supply of potential jury awards and the increased tail risk in each case. I also highlight how insurers can play an active role in managing the future dynamics of social inflation risk.

For my empirical analysis, I focus on commercial auto liability insurance which pertains to claims that arise from the business use of automobiles. The impact of social inflation has been most evident in this line of business (SwissRe, 2019). The objective of the paper, however, is not to give the final word on whether commercial auto rates have risen due to rising verdicts and settlements. Instead, I show through a detailed study of this line of business how social inflation has a general material impact on the insurance sector. Importantly, its reverberations are felt in multiple lines that span medical malpractice, directors and officers liability, casualty insurance related to the opioid crisis, and general umbrella coverage.[1]

The analysis centers on a novel dataset that includes detailed information on verdicts and settlements, combined with the annual financial statements of insurers and their historical rate filings between 2001 and 2019 (See Section 2). I first show in Section 3 that the total dollar value of nuclear awards has increased threefold from $300 million in 2011 to nearly $1 billion in 2019. This rise has been driven by increasing number of cases greater than $20 million, while the number of cases less than $20 million actually decreased during the same time period. I also document significant heterogeneity across geographic regions: cases are concentrated in a small number of states – most notably California, Florida, Georgia, Illinois, New York, and Texas – which feature high trucking activities or are known for court procedures generally applied at the disadvantage of defendants (ATRA, 2019).

This salient trend in nuclear awards is not explained by recent trends in the traditional drivers of jury awards, which I show via two approaches. In the first approach, I employ a hedonic regression approach to relate the size of the verdicts and settlements to the characteristics of the accidents. While the number of deaths and plaintiffs in any given accident prove to be significant predictors of the award amounts, I do not find that the sensitivity of the award amount to case characteristics has changed materially over time. In the second approach, I compare the the rise in nuclear awards to the historical growth in traditional determinants of jury awards. During the threefold rise in nuclear awards, the price of living and medical care costs have only risen by 32% and 54% respectively, and the number of fatal trucking accidents has actually decreased. Overall,

[1] Appendix C details the recent developments in each line of business.

the results are consistent with the existence of a latent component orthogonal to the case profiles, such as changing jury sentiment towards corporate defendants.

To highlight the economic consequences of these trends, I provide in Section 4 a stylized model of social inflation to illustrate how social inflation manifests itself into an aggregate risk for insurers. In the model, an insurance company makes a pricing decision at the beginning of the period but is subject to the regulatory requirements at the end of the period. The price of a policy therefore depends on the firm's estimate of social inflation risk throughout the period, which is modeled as uncertainty in the loss distribution of a given policy.

The model shows that social inflation risk has a "double kick" to the price of insurance. Initially, it increases the effective marginal cost of the insurer since the policy has a higher probability of becoming a tail risk. More importantly, heightened uncertainty in the loss distribution increases the amount of statutory reserves required to satisfy the risk-based capital requirement. The outstanding policies make the capital requirement more likely to bind, thereby contributing to the second channel. The model also yields testable empirical predictions regarding how the price impact of social inflation depends across geographies based on their legal environment, the level of financial constraint, and learning from cases involving other insurers.

Using the model as a guide, I then empirically examine the impact of social on insurance supply. I first quantify the impact of social inflation on insurance prices in a difference-in-difference specification. The baseline identification strategy is to compare commercial and personal auto insurance prices before and after the famous Tracy Morgan settlement in 2015, which is widely known as the watershed moment for social inflation.[2] The comparison between commercial and personal auto lines is motivated by the observation that corporate defendants are more exposed to social inflation risk than are individual defendants (Haran et al., 2016). I find that the magnitude of the main coefficient is positive and significant across different specifications. Specifically, the estimate indicates that the change in commercial auto insurance rate was on average around 1.3% higher than the change in personal auto insurance rates. Given that the average rate increase for commercial auto liability is around 6.2% per year, the difference is economically significant.

I next proceed to test three empirical predictions provided by the model. First, I ask if insurers raise prices more in regions that are highly exposed to social inflation. Using a triple-difference estimator, I find that the difference in the rate increase between commercial and personal auto lines is about 1.7 percentage points higher in states that are known to have court procedures applied at the disadvantage of defendants. But the rate differential is positive and statistically significant

[2]Morgan and five others were seriously injured on June 7, 2014 when a Wal-Mart truck crashed into his limousine van on the New Jersey Turnpike. On May 27, 2015, Walmart settled the lawsuit for an undisclosed amount taking full responsibility. Wal-Mart's payouts to Morgan and Fuqua have not been disclosed, but court documents suggest the figure to be around $90 million. The case received extensive media scrutiny including Morgan's Netflix show in 2017 where he jokes about Walmart and the lawsuit.

even for states with low exposure, indicating that the price impact is not only limited to only a subset of the states.

Second, I ask if more financially constrained insurers raise prices more. Intuitively, increased uncertainty in the loss distribution makes the capital requirement more likely to bind, thereby contributing to higher insurance prices. Consistent with this prediction, I find that constrained insurers, defined as insurers whose risk-based capital ratio is below the cross-sectional mean in each year, are responsible for almost entirety of the price increase since 2016. Repeating the test by classifying firms based on past one-year asset growth yields a similar pattern but with a smaller magnitude differential between constrained and unconstrained insurers.

Third, I ask if insurers still raise prices despite no direct exposure to nuclear verdicts and settlements. This is likely the case if insurers learn from cases involving other insurers and update their estimate of social inflation risk. Consistent with this model prediction, I find that insurers without any involvement in nuclear awards have also significantly requested significantly higher rate increases since 2016. While their price response is more muted than those with direct exposure, this pattern highlights the aggregate nature of social inflation risk.

To complete the discussion of how insurance supply is affected, I examine insurer exits. I find that insurer exits are quite rare and that they are concentrated among medium- and small-sized insurers. In addition, I find that there is no significant heterogeneity across insurers in a state with large number of nuclear awards compared to those in a state with a smaller number of nuclear awards. These findings are consistent with the interpretation in which insurers have been able to sufficiently address social inflation risk thus far by raising prices but not exiting the market. To further corroborate this claim, I focus on each nuclear award in my sample and ask if the incidence of the award has led to an exit of an insurer in subsequent years. I find that of the 389 cases for which insurance companies are identified, only six insurers have exited from the state of operation, most of which are subsidiaries of Zurich.

Having shown that the supply of insurance has been significantly impacted by shifts in the loss distribution induced by social inflation, I conclude by discussing the factors that affect the future trajectory of its risk. In doing so, I distinguish *extensive* margin factors, which affects the supply of verdicts and settlements, from the *intensive* margin factors that lead to greater tail risk conditional on a jury award being delivered.

The extensive margin factors are responsible for a greater supply of potential verdicts and settlements. One such example is the increase in insurance frauds: the expected return to committing an insurance fraud increases as the size of the reward gets larger. To address this hypothesis quantitatively, I scrape data on historical insurance frauds and find suggestive evidence that insurance frauds have increased more in states highly exposed to nuclear awards than in states that are not. In addition, the rise of third-party litigation funding as well as the availability of attorneys may

have also contributed to greater supply of potential nuclear awards.

The intensive margin factors lead to greater tail risk for the insurer conditional on a jury award being delivered. One major factor is the limited nature of past tort reforms that are originally designed to explicitly limit the amount that can be awarded by the jury. Another factor is related to changing social norms: survey evidence suggests that the negative sentiment towards insurance companies and financial services may have become particularly more acute over the recent years. Altogether, both the extensive and the intensive margin factors suggest that social inflation risk is likely to persist. Nonetheless, insurers may be in a unique position to counteract this trend through investments in technologies and regulations.

Literature Review This work primarily relates to the literature on the frictions on the supply side of insurance markets. As mentioned in the introduction, a body of work studies the importance of aggregate risk for the insurance sector (Cutler, 1996; Froot and Posner, 2002; Milevsky et al., 2006). A complementary literature has also focused on financial and regulatory frictions (Froot and O'Connell, 1999; Merrill et al., 2012; Becker and Opp, 2013; Becker and Ivashina, 2015; Ellul et al., 2015; Sen and Humphry, 2018). In Koijen and Yogo (2015), the two key frictions are the financial friction, represented by the leverage constraint on statutory capital, and product market friction, which is a form of search friction that makes future demand increasing in statutory capital through higher ratings. In Koijen and Yogo (2018), the key frictions are the financial friction and market power, given the assumption that insurers compete by Bertrand pricing in an oligopolistic market. In my work, I retain financial frictions but introduce shifts in the loss distribution as another source of friction. By extending this literature on insurance supply, I contribute by showing how shifts in the loss distribution have a profound aggregate impact on the pricing behavior and operations in the insurance market.

This work also contributes to our understanding of the importance of legal environment in financial markets. Since the pioneering work by La Porta et al. (1998), the literature at the intersection of law and finance has addressed the role of legal institutional environments in a range of issues including long-term growth (La Porta et al., 1997; Selvin and Picus, 1987; La Porta et al., 2006; Glaeser et al., 2004), competitiveness of the economy (Zingales, 2006; Kempf and Spalt, 2019), investments (Kaplan et al., 2003; Lerner and Schoar, 2005), investor protection (Atanassov and Kim, 2009; Fernandes et al., 2010; Acheson et al., 2019) and shareholder activism (Klein and Zur, 2009). A different strand of the literature also looks at the effects of culture on economic growth and development (e.g. see Spolaore and Wacziarg (2013) for a review) and the role of trust and social capital (See, among many, Guiso et al., 2004; Guiso et al., 2011; Lins et al., 2017; Gennaioli et al., 2020) This paper contributes to both strands by illustrating how the legal system, interacted with social norms, can potentially undermine the stability of the insurance sector.

This work also relates to a recent literature that examines the systemic manifestation of idiosyncratic shocks. Existing works have focused on granular micro-foundations (Gabaix, 2011; Acemoglu et al., 2013; Baqaee and Farhi, 2018) and the mainstream adoption of innovative technology (Pástor and Veronesi, 2009; Acemoglu et al., 2016) as relevant channels. In this work, I contribute by documenting a new channel: idiosyncratic realizations of large verdicts have lasting aggregate consequences for other insurers in the same sector.

Outline Section 2 provides information on the data and institutional background, and Section 3 documents social inflation in the commercial auto liability industry. In Section 4, I develop a basic model of social inflation to illustrate its role as an aggregate source of risk. Section 5quantifies the impact of social inflation risk on insurance supply while also testing the model predictions. Section 6 discusses the factors that contribute to the future dynamics of social inflation risk, and Section 7 concludes. The appendix contains the proofs and details.

2 Institutional Background and Data

I first describe the determination of jury awards, the insurer's exposure in the process, and regulatory environment that governs the supply of insurance (Section 2.1). I then describe the data that includes detail on historical jury awards, financial statements, and insurance rate filings (Section 2.2).

2.1 Institutional Background

2.1.1 Insurer's Exposure to Jury Awards

A person injured because of another person's negligence may have a ground to file a lawsuit against the party and receive compensation. This lawsuit may first result in a settlement; otherwise, it may led to a verdict, in which a judge or jury decides on the case. When the jury announces the verdict and the amount of compensation, the insurance company pays the losses. This system implies that while the insurance companies are not named in the lawsuits, the outcome of the verdict directly translates into their realized losses.

The jury awards *compensatory* damages and *punitive* damages. Compensatory damages in a civil lawsuit come in two strands: pecuniary (economic) damages and non-pecuniary (non-economic) damages. Pecuniary damages encompass readily quantifiable damages such as medical costs, lost wages, future care costs, and physical damages. Non-pecuniary damages, on the other hand, include measures that rely on subjective interpretation of the jury such as pain and suffering,

emotional distress, and loss of consortium. Finally, as the name suggests, punitive damages are awarded when the defendant's behavior is found to be especially harmful.

For various reasons, insurers may be exposed to losses that exceed the maximum amount indicated in their policies. In other words, if an insurance policy covers up to X dollars, the payout can equal αX where $\alpha > 1$. One common scenario is when an attorney obtains an "assignment of claims" from the defendant and takes legal action against the defendant's insurers for the excess verdict (Le, 2015). Another common case involves invoking the bad faith on the part of the insurer. A claim of bad faith against an insurance company arises when the company allegedly had the opportunity to settle a claim for an amount within the policy limits but did not do so. In this case, the company may be held liable for the full amount of damages.

2.1.2 Insurance Rate-Making and Regulation

Each state has a regulator who is in charge of regulating insurance companies and markets. Most states require rates to be filed to each state's regulator, and regulators typically do not approve the full extent of the requested rate.[3]

All states have fixed minimum capital and surplus requirements as well as risk-based capital (RBC) requirements. The states' fixed minimum capital and surplus requirements range from $500,000 to $6 million, depending on the state and the lines that an insurer writes. For the RBC requirement, regulatory actions are required if an insurer's total adjusted capital falls below a certain level of risk-based capital.

In addition to capital requirements, insurers are subject to other regulations with respect to their financial structure and operations. A principal requirement is that insurers maintain adequate reserves for their liabilities for future claims and benefit payments. The primary challenge for property-liability insurers is to determine reserves for claims that have been incurred but not yet paid, and it is particularly difficult for long-tail lines where claims obligations can extend many years beyond the termination of policy.

2.2 Data

This section describes the data, and Appendix B provides greater detail and summary statistics. I collect detailed information on settlements and verdicts involving commercial auto liability from VerdictSearch, restricting to those with awards greater than $5 million from 2001 and onward. From SNL Financial, I obtain the annual financial statements for insurance companies that sell commercial auto liability policies.

[3]The nature of the review of rates, rating rules, and policy forms vary across the states, and a most recent comparison can be found in Table 11.1 of Klein (2005).

I also obtain the historical rate filings for calendar years 2001 to 2019 through SNL Financial. Table 1 presents the summary statistics for commercial auto liability rate filings. For each year, I report the mean, median and standard deviation of two variables: rate change received and rate changed requested. The unconditional averages of rate received and rate requested are 6.04% and 12.70%, respectively. There is notable time trend in the rate changes: the average rate growth over the years is consistent with anecdotal evidence of a hard market for commercial auto liability in the early 2000s and the recent past years. Across all years, there is significant variability in rate change across insurers. In the past ten years, the rate received by insurers is roughly about half the rate requested, consistent with the findings in Oh et al., 2021.

3 How Pervasive is Social Inflation?

In this paper, I focus on commercial auto liability insurance, which pertains to liability that can arise from the business use of automobiles or from the operation of an employee's automobiles on behalf of the business. The impact of social inflation has been most evident in the commercial auto line (SwissRe, 2019) and thus it proves a particularly useful setting for understanding its implications. I start by documenting the rise of nuclear awards – which includes both verdicts and settlements – both in the aggregate and across geographies (Section 3.1). I also show that this trend does not seem to be driven by traditional drivers of jury awards or increasingly risky accident profiles, thereby indicating a role for a latent component that may be captured by the jury's sentiment towards the corporate defendants (Section 3.2).

3.1 The Rise of Nuclear Awards

I first study the ubiquity of social inflation in the insurance sector by documenting the rise of nuclear awards for commercial auto liability insurance. The general trend in the frequency and magnitude of nuclear awards represents one particular manifestation of social inflation. While here I focus on commercial auto liability, the findings from this analysis readily extend to other lines of business. Appendix C details these extensions.

Figure 2 shows the number and magnitude of nuclear verdicts and settlements for commercial auto liability cases from 2001 to 2019 across all states. In panel (a), I report the total dollar value of awards greater than or equal to $50 million, those between $20 and $50 million, and those between $10 and $20 million. It shows that the dollar amount of awards for commercial auto liability thus has rapidly grown more than threefold in the past decade from $300 million in 2011 to nearly $1 billion in 2018 and 2019.

In panel (b), I report the number of cases separately depending on whether the award amount

exceeds $20 million. Interestingly, the number of cases greater than $20 million has been increasing in the past ten years, while the number of cases less than $20 million has decreased during the same time period. This compositional change is consistent with the interpretation in which a case that typically leads to $5 million or $10 million verdict now yields a $20 or $50 million verdict. As I show later in Section 3.2, this pattern is not due to increasingly riskier accident profiles or greater sensitivity to salient accident characteristics, thereby lending support to this interpretation.

There is also significant heterogeneity in the occurrence and magnitude of nuclear awards across states. Table 2 reports the number of verdicts and settlements greater than $20 million in each state from 2001 to 2019. Texas and California constitute the largest share, followed by New York, Illinois, Florida and Georgia. Surprisingly, half of all U.S. states, which are omitted from the table, did not have a single case exceeding $20 million during my sample period for commercial auto liability.

The high number of cases in Texas, California, and Florida can be partially explained by the high number of fatal crashes involving a large truck. Figure 3 captures this intuition in the scatterplot where I show that the number of nuclear awards correlates positively with the cumulative number of fatal motor vehicle crashes during the sample period. There are also states with frequent nuclear awards without a notably large number of fatal crashes such as Georgia, Illinois, Louisiana, and New York. Unsurprisingly, all these states are characterized as regions in which laws and court procedures are often applied in an "unfair and unbalanced manner, generally to the disadvantage of defendants." (ATRA, 2019).

3.2 Limited Role of Traditional Factors in Jury Awards

One aspect of the narrative behind social inflation is that the changing sentiment regarding corporate defendants, including insurance companies, is responsible for this rise in nuclear verdicts and settlements. While investigating the origins of this trend is beyond the scope of this paper, it is nonetheless informative to see how the rise in nuclear awards compares to the recent trends in traditional drivers of jury awards.

3.2.1 Are Accidents Profiles Changing?

I first test whether observable characteristics related to the accident profiles can explain the rise in nuclear awards. To this end, I employ a hedonic regression approach to relate the size of the verdict and settlement to the characteristics of the accidents (Rosen, 1974). The goal is to test whether a similar accident yields a much higher verdict and settlement amount today than before.

I proceed by regressing the award amounts on a variety of case-specific descriptors as shown in

Equation (1):

$$y_i = \gamma_0 + \sum_c \gamma_c x_{c,i} + \epsilon_i \tag{1}$$

where y_i is the amount of award for case i in \$ millions, and $x_{c,i}$ refers to the cth characteristic of the case i. γ_c thus represents the marginal contribution or the "hedonic price" of characteristic c. For the estimation, I use all cases whose award amounts are greater than or equal to \$5 million and collect the following characteristics for each case: number of deaths, number of injury types, number of plaintiffs, number of experts for plaintiffs, number of experts for defense. The results are reported in Table 3.

Column (1) reports the results of the baseline estimation in which the award amount is regressed on the case characteristics and an indicator that is equal to 1 if the case occurred after the famous Tracy Morgan settlement on May 27, 2015.. The coefficients on $NumDeaths$ and $NumPlaintiff$ are statistically significant with coefficients of 2.864 and 1.513 respectively. The number of deaths and plaintiffs involved in the accident are also economically significant: holding all other characteristics fixed, an additional death contributes about \$2.8 million to the award amount and an additional plaintiff about \$1.5 million. Consistent with the rising nuclear awards, the coefficient on the variable $PostTracyMorgan$ is also statistically and economically significant: awards after the settlement has received an additional award of \$9.4 million, controlling for other determinants of the award amount. The finding is corroborated in an alternate test shown in column (5), in which I include the year as another dependent variable instead of the indicator.

In columns (2) through (4), I next explore whether the sensitivity of the award amount to important case characteristics has increased over time. The coefficients on the interaction between $PostTracyMorgan$ indicator and each characteristic are not statistically significant, which is consistent with the possibility that the sensitivity may not have changed drastically in recent years.

Even if the sensitivity has not changed, one possibility is that the number of deaths and plaintiffs associated with each accident may have gone up over time. Figure A1, however, shows that the average number of deaths and plaintiffs associated with each accident has remained stable from 2001 to 2019.

3.2.2 Comparison to Other Sources of Risk

It is also acknowledged that medical costs and economic inflation are a large component of jury awards. To examine their ability to explain such trends, I plot in Figure 4 the historical growth of the relevant economic series from 2004 to 2019. Specifically, I plot the cumulative growth in the following three quantities: inflation, costs of medical care, and the number of fatal motor vehicle accidents involving large trucks. Inflation and medical costs are obtained from the FRED Economic

Database, and data on accidents are obtained from the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA). I normalize each series to its value in 2004, which is the first year for which the NHTSA data is available.

From the figure, it is clear that the rise in awards is unmatched by the rate of inflation or medical care costs. The sum of nuclear awards has increased by more than 300% from 2004 to 2018, whereas the consumer price index increased by 32% and the medical care costs by 54%. The number of fatal trucking accidents in the U.S. has in fact decreased during the same period, although it has risen quite sharply in the past five years. In summary, the cost increases due to general inflation and medical costs seem to be muted, while the incidence of fatal trucking accidents may have become more relevant but only for the recent few years.

Overall, the results jointly suggest that social inflation is not driven mainly by an increased sensitivity of the award amount to salient case characteristics, increasingly risky accident profiles or macroeconomic trends. Rather, the results are consistent with the existence of a latent component that is orthogonal to the case profiles, such as the jury sentiment towards corporate defendants.

4 Theory: Social Inflation as Aggregate Risk

In this section, I incorporate social inflation into standard models of insurance supply to illustrate how it manifests itself into an aggregate risk for insurers. The key assumption is that the insurance company makes a pricing decision at the *beginning* of the period but is subject to the reserve requirements at the *end* of the period. Therefore, the model is general in the sense that it applies to any type of risk in which the loss distribution underlying the insurance contract changes dynamically due to factors such as heightened uncertainty.

The key insight from the model is that social inflation has a "double kick" effect on insurance supply. The first, which is present even when idiosyncratic risk can be sufficiently diversified comes from a higher effective marginal cost of insurance as exemplified by the rising cost of nuclear awards. The second comes from the fact that due to the uncertainty in the loss distribution, the amount of statutory reserves required to satisfy the risk-based capital requirement is now higher than before. Importantly, the second effect can be present even if the first effect is not, which implies that uncertainty regarding the dynamics of the loss distribution alone can play an important role in insurance supply decisions.

4.1 Setup

I adopt the basic setup from Koijen and Yogo (2015) and simplify it to a one-period setting. At the beginning of the period, an insurance company sells $Q(P)$ policies at price P and incurs a

fixed cost C [4], which corresponds to marketing and administrative cost. Denote A_0 and L_0 as the insurance company's assets and statutory reserves, respectively, at the beginning of the period, and R as the return on its assets over the same period. $\bar{V}$ is the actuarial value of the sold policies, and S is the amount of statutory reserves per policy set aside to pay for future policy claims. Since I focus on property and casualty (P&C) business, I assume $S = \bar{V}$.[5]

4.1.1 Insurer Marginal Cost

I first describe how the insurer's marginal cost is determined. We write the realized loss to an insurer for a given policy i in period t as the sum of a constant mean, an aggregate risk component and an idiosyncratic component:

$$\tilde{C}_{it} = \mu + \rho\tilde{X}_t + \tilde{\epsilon}_{it} \tag{2}$$

where $\tilde{\epsilon}_{it}$ is a i.i.d. with mean 0 and $\tilde{X}_t$ is the social inflation risk with cdf F_X. Importantly, ρ measures the degree of exposure to social inflation risk. Averaging the losses across N policies, we obtain

$$\frac{1}{N}\sum_i \tilde{C}_{it} = \mu + \frac{1}{N}\sum_i \tilde{\epsilon}_{it} + \rho\tilde{X}_t$$

As N increases, $\frac{1}{N}\sum_i \tilde{\epsilon}_{it}$ goes to zero as idiosyncratic risk gets diversified away. Therefore, the cost to the insurer per policy can be written as

$$\tilde{V}_t = \mu + \rho\tilde{X}_t \tag{3}$$

and thus it depends on the exposure of the insurer (ρ) as well as the level of social inflation risk $\left(\tilde{X}\right)$.

4.1.2 Balance Sheet Dynamics

The insurance company's assets at the end of period t, after the sale of new policies, is

$$A_t = RA_{t-1} + P_tQ_t - C \tag{4}$$

The reserves at the start of period t is L_{t-1}. Throughout period t, social inflation risk is realized and the statutory reserves at the end of period t is

$$\tilde{L}_t = RL_{t-1} + \tilde{V}_tQ_t \tag{5}$$

[4] While the magnitude of C does not matter in this model, I include the parameter for completeness.

[5] For property and casualty insurers, the statutory reserve regulation requires that $S/\bar{V} \geq 1$. Since the regulation is not the object of interest, I set $S = \phi\bar{V}$ where $\phi = 1$.

I then define the insurance company's statutory capital as the value of its assets relative to statutory reserves:

$$\tilde{K}_t = A_t - \tilde{L}_t \tag{6}$$

Together, the equations imply that the law of motion for statutory capital is

$$\begin{aligned} \tilde{K}_t &= RK_{t-1} + \left(P_t - \tilde{V}_t\right) Q_t - C \\ &= RK_{t-1} + \left(P_t - \mu - \rho\tilde{X}_t\right) Q_t - C \end{aligned} \tag{7}$$

4.1.3 Risk-Based Capital Constraint

To account for the randomness in the statutory capital, I introduce the risk-based capital constraint of the following form:

$$\mathbb{P}\left(\tilde{K}_t \geq K^*\right) \geq \alpha \tag{8}$$

where K^* is some threshold capital level and α is a probability threshold very close to 1. The idea is that the statutory capital must be kept above a certain threshold with a very high probability. Setting $K^* = 0$ and $\alpha = 1$ yields the case without uncertainty: $K_t \geq 0$, which is used in Koijen and Yogo (2015).

Using (7), (8) can then be rewritten as:

$$\left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) Q_t \geq K^* + C - RK_{t-1} \tag{9}$$

Note that $F_X^{-1}(\alpha)$ represents the minimum amount of statutory reserves required to satisfy the leverage requirement of threshold α under the distribution $F(\cdot)$ at the end of period 1.

4.2 Optimal Insurance Pricing

Now I derive an expression for the optimal insurance price. The insurance company's profit is

$$\tilde{\Pi}_t = \left(P_t - \mu - \rho\tilde{X}_t\right) Q_t - C \tag{10}$$

The insurance company chooses the price P_t to maximize profits:

$$\mathbb{E}\left[\tilde{\Pi}_t\right] \tag{11}$$

Therefore, combining (9) and (11) yields the insurance company's maximization problem:

$$\begin{aligned} \max_{P_t} \quad & \mathbb{E}\left[\tilde{\Pi}_t\right] \\ \text{subject to} \quad & \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) Q_t \geq K^* + C - RK_{t-1} \end{aligned} \tag{12}$$

Let $\lambda_t \geq 0$ be the Lagrange multiplier on the leverage constraint. The Lagrangian is then:

$$\mathcal{L}_t = \mathbb{E}\left[\tilde{\Pi}_t\right] + \lambda_t \left(\left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) Q_t - \left(K^* + C - RK_{t-1}\right)\right) \tag{13}$$

Taking the first-order condition with respect to P and setting it equal to zero, I obtain the price of policy:

$$P_t = \left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right)\left(1 - \frac{1}{\epsilon_D}\right)^{-1} \left(\frac{1 + \lambda_t \left(\frac{\mu + \rho F_X^{-1}(\alpha)}{\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]}\right)}{1 + \lambda_t}\right) \tag{14}$$

where

$$\epsilon_D = -\frac{\partial \log Q_t}{\partial \log P_t} \tag{15}$$

is the elasticity of demand.

4.2.1 Interpretation of the Pricing Equation

With $\lambda_t = 0$ and no social inflation risk $\left(\tilde{X} = 0\right)$ and, the insurance price reduces to:

$$\bar{P}_t = \mu\left(1 - \frac{1}{\epsilon_D}\right)^{-1} \tag{16}$$

which is the pricing formula in which price is equal to the marginal cost μ times a markup that is decreasing in the elasticity of demand.

When $\lambda_t = 0$ in the presence of social inflation risk, the price equals:

$$\hat{P}_t = \left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right)\left(1 - \frac{1}{\epsilon_D}\right)^{-1} \tag{17}$$

Intuitively, $\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]$ is the effective marginal cost based on the insurance company's best estimate of social inflation risk. Nuclear awards, one particular form of social inflation risk, puts more mass on the right tail of the distribution of $\tilde{X}$, increasing the effective marginal cost and subsequently prices.

When $\lambda > 0$, the component of price affected by social inflation risk is the following

$$\left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right)\left(1 + \lambda_t\left(\frac{\mu + \rho F_X^{-1}(\alpha)}{\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]}\right)\right) = \left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right) + \lambda_t\left(\mu + \rho F_X^{-1}(\alpha)\right) \tag{18}$$

The first term relates to the effective marginal cost of insurance as before. Importantly, the second term represents the amount of statutory reserve required to satisfy the requirement at level α. Therefore, given an increase in the right tail of the distribution of $\tilde{X}$, both the marginal cost and the amount of required statutory reserve increases, thereby leading to higher prices. Notably, the first term depends only on the first moment of $\tilde{X}_t$, while the second term depends on the full distribution F_X.

Equation (18) also implies that even if there is no change in the marginal cost $\left(\mathbb{E}\left[\tilde{X}_t\right]\right)$, the price can increase through increased in required statutory reserves $\left(\lambda_t \rho F_X^{-1}(\alpha)\right)$. Figure 5 clarifies this insight through a simple simulation. The left panel plots the probability distribution of $\tilde{X}_t$. The red solid line is a distribution with lower mass on the right tail, while the black dotted line is the distribution with greater mass on the right tail. Importantly, both distributions have the same mean at 1. In the right panel, I plot $F_X^{-1}(\alpha)$ for different values of α, and the vertical line represents the case when $\alpha = 0.9$. Examining the intersections of the vertical line with the solid and dashed lines shows that $F_X^{-1}(\alpha = 0.9)$ is higher when social inflation risk is also higher.

4.2.2 Role of Outstanding Policies

In the model presented above, social inflation risk only pertains to newly issued policies. To examine the role of outstanding policies, suppose that fraction α of outstanding liabilities are also affected by social inflation risk, which implies a modified version of (5):

$$\tilde{L}_t = RL_{t-1} + \tilde{V}_t\left(Q_t + \alpha L_{t-1}\right)$$

This modification changes the leverage constraint in (12) through the addition of $\alpha L_{t-1} F_X^{-1}(\alpha)$:

$$\left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) Q_t \geq K^* + C - RK_{t-1} + \alpha L_{t-1} F_X^{-1}(\alpha)$$

Thus, the existing outstanding policies make it more likely that $\lambda_t > 0$, thereby impacting supply through the "second kick" described previously.

4.2.3 Limitation of the Model

I have abstracted away from contract characteristics in that the insurer's underlying loss distribution changes only due to changes in the distribution of social inflation risk $\tilde{X}$. But it is possible

that insurers adjust the policy limits rather than the price margin, thereby reducing the exposure to potential losses. Koijen and Yogo (2018) provides one such model in which the life insurer may stop offering minimum return guarantees to reduce risk exposure.

4.3 Testable Predictions

The model yields the following empirical predictions, which I test using detailed data on jury awards and insurance rate filings. Since I observe changes in prices than the level of prices, the empirical predictions center around ΔP_t, the quarterly or yearly change in insurance rates.

- **Prediction 1** (Risk Exposure Channel): For a given level of social inflation risk $\mathbb{E}\left[\tilde{X}_t\right]$, higher risk exposure ρ implies a higher marginal cost of the insurer. Therefore, the price response of insurers to rising social inflation risk is greater in regions with high exposure to social inflation. In other words, ΔP_t is increasing in ρ, all else being equal.
- **Prediction 2** (Balance Sheet Channel): When $\lambda_t > 0$, the capital constraint is binding and imposes an additional shadow cost in the insurer's supply decision. Therefore, the price response of insurers to rising social inflation risk is greater for more financially constrained insurers. In other words, ΔP_t is increasing in λ_t, all else being equal.
- **Prediction 3** (Learning Channel): Insurer's estimate of the loss distribution, F_X, is a critical input in the pricing formula. As $\tilde{X}_t$ is an aggregate risk that affects all insurers, albeit to a varying degree, insurers may update their estimate of F_X from observing jury awards affecting other insurers. Therefore, insurers may raise prices even if they are not directly exposed to verdicts and settlements, as long as they learn from other insurers and update their estimate of social inflation risk.

5 The Pricing of Social Inflation Risk

In this section, I empirically examine the impact of social inflation on the supply of insurance. I start with a case study of the Zurich Insurance Group (Section 5.1) and present the baseline results using a difference-in-difference specification (Section 5.2). I then test the empirical predictions of the model using triple-difference specification and subsample analyses (Sections 5.3 – 5.5). I conclude by discussing insurer exits (Section 5.6).

5.1 A Case Study of the Zurich Insurance Group

Figure 6 shows the historical growth in rates and reserve development for Zurich Insurance Group from 2001 to 2019. In Panel (a), I plot the rate change requested by Zurich along with two major

verdicts. The Tracy Morgan settlement did not involve Zurich, while a famous 2013 Texas Verdict that yielded $281 million in award involved Zurich directly. Subsequently, Zurich has requested much higher rate increases not only in Texas but for other states as well, consistent with the interpretation of social inflation as aggregate risk.

In Panel (b), I plot the one-year reserve development for Zurich's commercial auto liability line. The reserve development refers to changes in reserves due to re-estimation of claims and related expenses, and thus increasing reserves implies an updated expectation of greater claims in the future. Zurich has experienced favorable reserve development between 2007 and 2012, benefiting from increased rates without any realizations of nuclear awards. Then in 2013 and onwards, Zurich has developed adverse reserve development, most saliently with over $20 million in 2015.

After suffering adverse reserve developments, Zurich in 2016 closed a portion of the transportation underwriting unit for U.S. companies including long-haul trucking and some passenger transport services (Baskin, 2016). This particular development indicates that social inflation risk can be addressed only partly through changes in rates or deductibles. After a series of adverse shocks, it may altogether be unprofitable for the insurer to cover such liability, thereby leading to a market exit.[6] More recently, in November 2021, Zurich has also appointed a new role – Head of Claims Judicial and Legislative Affairs – to "influence the judicial and legislative agendas in key jurisdictions across the United States." The creation of this role can be thought of as Zurich's attempt to influence future dynamics of social inflation risk, which is further discussed in depth in Section 6.

5.2 Price Response of Insurers: Baseline Results

Motivated by the results from the preceding section, I next proceed to identify and estimate the causal impact of social inflation risk on insurance rates.

5.2.1 Empirical Strategy

It is often suggested that commercial auto liability lines, which feature corporate defendants, are more exposed to social inflation risk than are personal auto liability lines (Haran et al. (2016)). This insight suggest exploiting the type of auto liability lines – commercial vs. personal – as a first source of variation to assess the impact of social inflation risk on insurance rates. While settlements and verdicts have been rising since 2011, the 2014 truck collision in New Jersey involving the comedian Tracy Morgan has also been pivotal in galvanizing the public's awareness of the risk (Baskin (2016)). The claims were settled in May 2015, and thus I use the settlement date of this accident as the second source of variation in my empirical strategy. In sum, I employ a

[6] Additional empirical evidence on insurer exits is also given in Section 5.6.

difference-in-differences (DD) estimator by comparing the increase in rates for commercial auto insurance to the increase for personal auto insurance, before and after the Tracy Morgan verdict. Ultimately the identification assumption is that of parallel trends. Specifically, the difference in price growth between commercial and personal auto lines should have evolved similarly over time for high exposure versus low exposure state in absence of treatment.

To this end, I estimate the following regression:

$$\Delta P_{\ell(i)t} = \beta + \beta_1 IsComm_{\ell(i)} + \beta_2 Post_t + \beta_3 IsComm_{\ell(i)} \times Post_t + Controls + \alpha_{\ell(i)} + \epsilon_{\ell(i)t} \quad (19)$$

where t denotes quarter and $\ell\,(i)$ denotes insurer i's line of business ℓ, where ℓ is either commercial auto liability or personal auto liability. The dependent variable is the average quarterly change in rates. As I observe the rate changes at the state-level, the dependent variable $\Delta P_{\ell(i)t}$ is constructed as an average rate weighted by the premiums to which the rate change is applied. $IsComm_{\ell(i)}$ is equal to one if the ℓ is commercial auto liability, and $Post_t$ is equal to one if quarter t is after the date of the initial Tracy Morgan verdict. I also include contemporaneous GDP growth as a control variable and allow for differential loadings between commercial and personal lines. This choice of control is motivated by the fact that commercial trucking industry is highly cyclical (Baudendistel (2020)). I also include insurer-line fixed effects $\alpha_{\ell(i)}$ to control for unobserved time-invariant factors that may contribute to price increases such as market power. The main coefficient of interest is β_3, and I focus on four year (16 quarters) before and after the Tracy Morgan verdict.

5.2.2 Baseline Results

As shown in columns (1) and (2) of Table 4, the magnitude of the main coefficient is 1.3, which is positive and statistically significant. The estimate indicates that the change in commercial auto insurance rates was on average 1.3 percentage points higher than the change in personal auto insurance rates due to social inflation. The economic magnitude is also large, as it accounts for 20% of the average annual rate increase of about 6.04%. In column (3), I show the coefficients of the same regression using rate requested by insurers, which is before regulators apply a discount to the desired rate change. Consistent with columns (1) and (2), the requested change in commercial auto insurance rates is nearly 3% higher than its counterpart for personal auto insurance. To assess the validity of the identification strategy and look for pre-treatment trends, I also replace $Post_t$ with year dummies and re-estimate the regression. Figure 8 plots the coefficient for each year for both rate change received as well as rate change requested. It shows that neither exhibits pre-treatment trends. Furthermore, it shows that the effect of treatment lasts beyond four years and continues to the most recent period.

One concern with the results in Table 4 and Figure 8 is that insurers may be offering better

product features and higher prices at the same time. Under this explanation, the price increases for commercial auto liability may be compensation for better protection against legal liabilities. To test this, I exploit the fact that insurers are also required to file product changes with state regulators. Column (4) of Table 4 estimates the same regression with the number of rule filings as the dependent variable. It shows that the change in rate filings in commercial auto insurance is not significantly different from that in personal auto insurance.

5.3 Heterogeneous Exposure to Social Inflation Risk

One of the key empirical predictions of the model is that in response to rising social inflation risk, insurer raise prices more in regions with high exposure to social inflation. To test this hypothesis, I split states into two groups based on their exposure to social inflation risk: high exposure vs. low exposure states. To classify these states, I rely on the American Tort Reform Association's annual "Judicial Hellholes" report which provides a list of regions in which laws and court procedures are often deemed to be applied at the disadvantage of defendants. To avoid concerns about potential endogeneity of these classifications with the price increases, I obtain the 2014-15 report and classify all states designated as judicial hellholes and on the watch list as high exposure states. The remaining states not on the list are then classified as low exposure.

I then estimate the following equation:

$$\begin{aligned}\Delta P_{\ell(i)st} = \beta &+ \beta_1 HighExposure_s + \beta_2 IsComm_{\ell(i)} + \beta_3 HighExposure_s \times IsComm_{\ell(i)} \\ &+ \delta_0 Post_t + \delta_1 HighExposure_s \times Post_t + \delta_2 IsComm_{\ell(i)} \times Post_t \\ &+ \delta_3 HighExposure_s \times IsComm_{\ell(i)} \times Post_t + \alpha_{\ell(i)} + Controls + \epsilon_{\ell(i)st} \end{aligned} \tag{20}$$

where as before, $\ell(i)$ denotes insurer i's line of business ℓ and t is quarter. Importantly, s is the state group, high vs. low exposure. $\Delta P_{\ell(i)st}$ now represents the average rate change in state group s. In this specification, δ_3 is the main variable of interest. The triple-difference estimate exploits the change over time in average rate growth for the high exposure states versus low exposure changes, and I then net out the change in means for commercial auto liability lines versus the personal auto liability lines.

Table 6 shows the result of estimating equation (20) where I report the estimates of δ_2 and δ_3 from the regression. Column (1) presents the results on an unbalanced panel, and column (2) presents the rests for the balanced panel; for both columns, the dependent variable is the rate received. The magnitude of δ_3 is positive and statistically significant across both specifications, and the magnitudes indicate that the difference in the rate increase between commercial and personal auto lines is about 1.7 percentage points (or 0.8 percentage points) higher in high exposure

states. Even for low exposure states, however, the estimate of δ_2 is positive and statistically significant. Overall, the results lend support to the role of social inflation risk in describing the rise in commercial auto liability rates.

5.4 Role of Balance Sheet Capacity

As shown in the pricing equation (14), a binding leverage constraint today ($\lambda_t > 0$) increases prices further. Therefore, the model predicts that the price response of insurers to rising social inflation risk is greater for more financially constrained insurers. To this end, I re-estimate equation (19) separately for constrained insurers and unconstrained insurers.

To identify which insurers are financially constrained, I follow Ge (2022) and classify an insurer i to be financially constrained in year t if its risk-based capital ratio is below the cross-sectional mean. Columns (1) and (2) of Table 7 reports the estimates using rate change received as the dependent variable, and columns (3) and (4) reports the analogous results for rate requested. The coefficient on $IsComm_{\ell(i)}$ is significant and comparable in magnitudes across both constrained and unconstrained insurers. However, the coefficient on the interaction between $IsComm_{\ell(i)} \times Post_t$ is only significant for constrained insurers in columns (1) and (3).

In Table A5, I provide an alternate test of the balance sheet channel by following Koijen and Yogo (2015) and classifying an insurer i to be financially constrained in year t if its past-year asset growth is below the cross-sectional mean. Qualitatively, the results are consistent with Table 7: constrained insurers have raised commercial auto prices more relative to personal auto prices after 2016. Quantitatively, the differential in magnitudes between constrained and unconstrained is much more muted here than in Table 7. One reason for this pattern is that higher asset growth also implies greater quantity of outstanding policies, and as argued in Section 4.2.2, they also make more likely that financial constraints bind. By turning insurance policies into lawsuits, social inflation essentially makes the previous policies much longer-dated than before, and thus higher asset growth may have the effect of constraining insurers as well.

Overall, both results suggest that the balance sheet capacity of insurers is a critical component in transmitting social inflation risk to prices. Unconstrained insurers are generally able to weather the increase in legal liabilities through their balance sheets, while constrained insurers pass through the risk of social inflation into prices and ultimately consumers.

5.5 Learning about Social Inflation

The insurer's estimate of the loss distribution F_X plays a critical role in the pricing formula.As a result, insurers may update their estimate of F_X from observing jury awards affecting other

insurers. Therefore, insurers may raise prices even if they are not directly exposed to verdicts and settlements as they learn from other insurers and update their estimate of social inflation risk.

To test this prediction of the model, I classify insurers into three groups based on the intensity of their direct exposure to nuclear verdicts and settlements. The *Top 20* group includes top 20 insurers with the highest number of nuclear awards experienced during my sample, and the *Remaining* group includes all other insurers with direct involvement in at least one nuclear award. The final group, *No Direct Exposure*, includes the remaining insurers who are not directly exposed to any of the nuclear awards. I then re-estimate equation (19) across the three sets of insurers.

Columns (1) – (3) of Table 8 presents the results of the estimation for each subsample. Across all three subsamples, the coefficient on $IsComm_{\ell(i)} \times Post_t$ is positive and statistically significant, even for the *No Direct Exposure* group of insurers. While their price response is more muted than those with direct exposure in columns (1) and (2), the positive and economically meaningful response of these insurers is consistent with the learning channel of social inflation.

The institutional features of the insurance sector makes learning an important and relevant channel as well. For example, there are dedicated sessions to the topic of social inflation at regular meetings of the National Association of Insurance Commissioners (NAIC), the largest body for standard-setting and regulatory support in the insurance sector. There are also frequent educational articles offered by the Insurance Information Institute (III) and reports written by individual insurers and reinsurers, designed to raise awareness and share ideas to address social inflation.

5.6 Insurer Exits

When social inflation risk is substantially high, it is no longer profitable for the insurer to provide coverage and therefore finds it optimal to exit the market. In this section, I examine the extent to which insurers have responded to social inflation risk by exiting the market. Given the large influence of state-specific legal system, I focus on exits of an insurer from a particular state. Specifically, I define $Exit_{i,s,t} = 1$ if an insurer i provides commercial auto liability coverage in state s at time $t-1$ but does not provide coverage at time t in the same state.

Table 5 provides a summary of insurer exits in commercial auto liability from 2011 to 2019. In panel (a), I split insurers by their market share in each state and group them into large, medium, and small. The large insurers are defined as those who have more than 2% market share in a state at any given year, while the small insurers are defined to be those with less than 0.5% market share in a state at any given year. The medium group encompasses the remaining insurers. Given that there are nearly 2,000 firms on average, the panel shows that insurer exits are rare and that they are concentrated among medium- and small-sized insurers. Importantly, there is no discernible

increase in insurer exits over time. The number of exits is around 60 over time with a slight dip in recent years, and the lack of trend is also found across insurers of different sizes.

The price trends documented in Section 5.3 suggests that insurer exits may be more pronounced in states that are more exposed to social inflation risk. To address this possibility, I provide another breakdown of the summary statistics in panel (b), this time by the classification of states based on their exposure. Just as before, the no-award states are states without any nuclear verdicts and settlements between 2001 and 2015. The low-award states correspond to those with less than the median number of nuclear awards between 2001 to 2015, which is equal to four. The high-award group encompasses the remaining states. Here I find that there is also no significant heterogeneity across these state classifications – the lack of time-series trend is found in all three groups.

So far, the results are consistent with the interpretation in which insurers have been able to address social inflation risk by raising prices in states that are more exposed. To further corroborate this claim, I provide an additional analysis, this time focusing only on states and insurers that have been directly affected by the nuclear awards in my sample. Specifically, I focus on the 57 insurers that have experienced at least one nuclear award in my sample across a set of 34 states.

For each nuclear award, I ask if the incidence of this award for an insurer i in state s at time t is followed by the insurer i's exit in state s at time t, $t+1$, and $t+2$.[7] The results are shown in Table A4. Of the 389 cases for which insurance companies are identified, only six insurers have exited from the state of operation, most of which are subsidiaries of Zurich. These exits corroborate both the case study presented in Section 5.1 and the finding that insurers have so far responded by raising prices rather than exiting the markets altogether.

6 The Dynamics of Social Inflation Risk

The results on rising nuclear verdicts and insurers' pricing response show that the supply of insurance has been significantly impacted by shifts in the loss distribution induced by social inflation. Therefore, whether this shift is temporary or permanent has important ramifications for insurers going forward. To shed light on this question, I discuss the factors that affect the future dynamics of social inflation risk. I distinguish the extensive margin factors, which affects the supply of verdicts and settlements, from the intensive margin factors that lead to greater tail risk conditional on a jury award being delivered.

[7] For this exercise, I expand my sample to include awards greater than or equal to $5 million.

6.1 Extension Margin: Factors affecting the supply of nuclear awards

I discuss four factors that affect the supply of potential verdicts and settlements: (i) trends in insurance frauds, (ii) the rise of third-party litigation funding, and (iii) the increased availability of attorney.

6.1.1 Insurance Frauds

Insurance frauds often involve situations in which the plaintiffs may bill excessive or exaggerated medical treatments, accompanied by deliberate misdiagnosis of injuries and harm. The recent trend in nuclear awards therefore implies that the potential expected return to committing such fraud increases and thus may contribute positively to the supply of potential nuclear awards. Consistent with this hypothesis, a survey of large property and casualty insurers in 2018 showed that fraud has increased in the past three years, an 11-point increase since 2014 (SAS (2019)).

To quantify the impact of rising nuclear verdicts and settlements on insurance frauds, I scrape data on historical insurance frauds from the Coalition Against Insurance Fraud's Fraud Tracker. The Fraud Tracker provides information on the basic description of the fraud, type of insurance, location, and the date. I restrict the sample to all insurance frauds related to auto insurance from 2011 to 2019. I also classify each state into three groups that become my unit of observation: no-award states, low-award states, and high-award states. The no-award states are states without any nuclear verdicts and settlements between 2001 and 2015. The low-award states correspond to those with less than the median number of nuclear awards between 2001 to 2015, which is equal to four. The high-award group encompasses the remaining states.

I then estimate the following regression:

$$\begin{aligned} y_{st} = \beta_0 + \beta_1 HighAward_s + \beta_2 LowAward_s + \beta_3 Post_t \\ + \beta_4 HighAward_s \times Post_t + \beta_5 LowAward_s \times Post_t + \epsilon_{st} \end{aligned} \tag{21}$$

where s denotes the state group and t indicates the quarter. The dependent variable y_{st} is the number of insurance frauds in state group s at time t. This difference-in-differences estimation therefore exploits the change over time in the number of insurance frauds across the high-award, low-award, and no-award state groups.

Table 9 shows the results. In column (1), I compare the number of auto insurance frauds in high-award states vs. low- and no-award states. The coefficient on the interaction between $HighAward_s$ and $Post_t$ is significant and positive, which indicates that number of auto-insurance frauds has increased more substantially in high-award states than it has in low- and no-award states. In column (2), I further add an indicator for low-award states to facilitate a three-way comparison

across the state groups. It shows that the number of auto-insurance frauds has increased the most for high-award states, but the difference is not statistically different between low-award and no-award groups. Column (3) estimates the same equation for the total number of insurance frauds and finds a similar pattern. Overall, the results confirm that rising nuclear awards have contributed to rising insurance frauds.

6.1.2 Third-Party Litigation Funding

Litigation financing refers to a growing business that finances litigations upfront in exchange for a percentage of future awards and settlements.The litigation finance market is made up of three major segments: commercial litigation finance, personal litigation finance, and mass tort litigation finance. Nuclear awards pertain to personal litigation finance which covers personal injury and automotive crashes. While the data on the growth in personal litigation finance is limited, the data on commercial litigation finance market provides an estimate of similar developments. For example, the percentage of law firms using litigation finance grew from 36% from 2013 to 2017 (Clair and Klevens (2018)).

In a related study, Abrams and Chen (2012) focuses on the Australian market and finds that third-party funding corresponds to an increase in litigation and court caseloads. This finding is consistent with the interpretation that litigation financing increases the supply of potential nuclear awards by lowering the cost for an individual to take their claims to court.

6.1.3 Availability of Attorney

Advertising by law firms had been legal until 1908 when the American Bar Association (ABA) created the Canons of Professional Ethics that banned advertising. In the 1977 case *Bates v. State Bar of Arizona*, however, the Supreme Court ruled that commercial speech such as advertising merits First Amendment protection.

Since then, the scale of advertising for lawsuits has seen rapid growth. In 2016, lawyers, law firms, and legal-service providers spent $770 million on television advertisements (Silverman (2017)). For paid Google keyword search terms, a 2015 study by the CMAG and the U.S. Chamber of Commerce Institute for Legal Reform also found that nine out of the top 10 and 23 of the top 25 were legal terms (Association (2017)). The increased availability of attorney also works to reduce the individual's cost of taking their claim to court, thereby expanding the supply of potential nuclear awards.

6.2 Intensive Margin: Factors affecting the tail risk

I next discuss two factors that affect the tail risk component of social inflation: (i) limited tort reforms and (ii) changing social norms.

6.2.1 Tort Reform

It is worth noting that the legal system's vulnerability to large verdicts and settlements is hardly new. For example, the increasing frequency and size of damage awards already posed a significant concern at the end of the 20th century (Montgomery and Nahrstadt (2003)). Below I provide suggestive answers to the following key question: what is unique about the legal environment in the past decade of nuclear awards? As a preview, I find that the changing legal climate – rise in third-party litigation financing, limited tort reforms, and aggressive legal advertising – seems to be most pertinent.

Tort reforms are proposed changes to the justice system aimed at reducing the ability of victims to litigate or to cap the damages one can receive. In the U.S., an active ground for tort reform has been the area of medical malpractice law. The Medical Injury Compensation Reform Act of 1975, often hailed as starting a nation-wide trend in tort reform, set a $250,000 cap on non-economic damages.

Tort reform has largely been successful at curtailing medical malpractice litigation in states where caps have been put in place. In the case of ordinary personal injury, however, it has been less effective (Justia (2018)). In most states, there is no limit to the economic or non-economic damages that may be recovered by a plaintiff who can prove liability. As of June 2019, only nine states have non-economic damage cap in place.[8] In fact, five out of the remaining 41 states prohibit caps for general torts.

The limited nature of past tort reforms is consistent with the earlier observations regarding the composition of nuclear awards. The punitive damages have not seen a particular trend in the past decade, whereas share of non-economic damages has increased. Without explicit caps on non-economic damages, there seems to be potential for inflation in non-punitive components of the awards.[9]

[8] These states are Arkansas, Colorado, Hawaii, Idaho, Maryland, Mississippi, Ohio, Oregon, and Tennessee. For a more detailed breakdown, please see for Justice and Democracy (2019).

[9] There is also the potential for a rollback of implemented reforms, the possibility of which depends critically on the political landscape. Traditionally, Republicans have been in favor of tort reform, while Democrats have been more receptive to the trial bar's interests.

6.2.2 Social Norms

Existing research has shown that the jury does seem to exhibit an anti-corporate attitude, thereby requiring corporate defendants to pay more for the same injury than individual defendants (Hans (2000), Greene and Bornstein (2003), Haran et al. (2016)). Numerous surveys offer evidence that the sentiment towards large corporations and insurance companies may have become more hostile in recent years.

One study surveys individuals on their opinions about the role and responsibility of corporations and show that respondents are much less favorable towards large corporations compared to small business (PSB (2014)). Another study in 2018 based on respones from 7,000 individuals in seven mature economies finds that only a fifth of interviewees consider insurers trustworthy with relative minor differences across age groups (Schanz (2018)). In a recent work, Colonnelli and Gormsen (2020) show that higher big business discontent translates into lower support for corporate bailouts.

Other studies offer a panel evidence. For example, one study which polls college-educated, above median-income households acroas the ss 27 markets shows that the financial services is the least trusted of all sectors consistently from 2015 to 2018 (Edelman (2019)). Another panel of responses is available through the Gallup's Confidence in Institutions poll, which surveys the general American public for the degree of confidence in different types of institutions (Gallup (2019)).[10] For big business, the share of respondents who place a "Great deal" or "Quite a lot" of confidence has remained quite stable around 20%.

7 Conclusion

Using data on nuclear verdicts and settlements in commercial auto liability insurance, I provide the first study of the risk of social inflation and its economic consequences. Empirically, I rigorously document the extent of social inflation and provide a causal estimate of its impact on insurance supply. Theoretically, I provide a model of social inflation that places the shifts in the loss distribution at the center of the pricing decision.

Social inflation risk is an aggregate risk that cannot be easily diversified away and affects multiple lines of insurance businesses. Importantly, it plausibly explains the rapid increase in insurance rates over the past decade, posing a new, major source of risk for the real economy as well. Social inflation risk will likely be more pronounced with the onset of the COVID-19 pandemic, especially with increasing attempts at retroactive modification and extended interpretation of outstanding insurance policies.

[10] The survey is based on telephone interviews of a random sample of around a thousand adults living in all 50 U.S. states and the District of Columbia.

While social inflation is likely to persist in the near future, insurers can provide a countervailing force against this trend by investing in technologies and lobbying regulations aimed at reducing the probability of the cases in the first place. For example, many underwriters already invest significantly in improving the trucker's safety by mandating the installation of collision-avoidance technology and minimum safety scores on the federal government's Compliance, Safety, Accountability (CSA) program. This role of insurers in reducing aggregate risk has an interesting parallel to how they respond to other emerging risks in the insurance sector, in which insurers visit policyholder premises to prevent home losses due to climate risk and meet with firms to improve their resilience to cyber risk.

Another policy implication for insurance regulators is that insurance regulation can interact in unexpected ways with the underlying risks in the insurance sector. Therefore, understanding trend in social inflation as well as its economic consequences will therefore be key to ensuring a stable insurance sector and the economic activities that depend on it.

References

Abrams, D. S. and Chen, D. L. (2012). A market for justice: A first empirical look at third party litigation funding. *U. Pa. J. Bus. L.*, 15:1075.

Acemoglu, D., Akcigit, U., and Kerr, W. R. (2016). Innovation network. *Proceedings of the National Academy of Sciences*, 113(41):11483–11488.

Acemoglu, D., Ozdaglar, A., and Tahbaz-Salehi, A. (2013). The network origins of large economic downturns. Technical report, National Bureau of Economic Research.

Acheson, G. G., Campbell, G., and Turner, J. D. (2019). Private contracting, law and finance. *The Review of Financial Studies*, 32(11):4156–4195.

Association, A. B. (2017). Legal advertising blows past 1 billion and goes viral.

Atanassov, J. and Kim, E. H. (2009). Labor and corporate governance: International evidence from restructuring decisions. *The Journal of Finance*, 64(1):341–374.

ATRA (2019). *Judicial Hellholes*. American Tort Reform Association.

Autor, D., Dorn, D., Katz, L. F., Patterson, C., and Van Reenen, J. (2020). The fall of the labor share and the rise of superstar firms. *The Quarterly Journal of Economics*, 135(2):645–709.

Baqaee, D. R. and Farhi, E. (2018). Macroeconomics with heterogeneous agents and input-output networks. Technical report, National Bureau of Economic Research.

Baskin, B. (2016). Nuclear verdicts have insurers running from trucks.

Baudendistel, M. (2020). Why are truck orders a cyclical, seasonal and lagging demand indicator?

Becker, B. and Ivashina, V. (2015). Reaching for yield in the bond market. *The Journal of Finance*, 70(5):1863–1902.

Becker, B. and Opp, M. (2013). Regulatory reform and risk-taking: Replacing ratings. Technical report, National Bureau of Economic Research.

Chubb (2018). Rising volume and cost of securities class action lawsuits is a growing tax on u.s. business, chubb data reveals.

Clair, A. and Klevens, S. (2018). The widespread use of litigation finance.

Colonnelli, E. and Gormsen, N. J. C. (2020). Selfish corporations. *Chicago Booth Research Paper*, (20-51).

Cutler, D. M. (1996). Why dont markets insure long-term risk? Technical report, Citeseer.

Edelman (2019). 2019 edelman trust barometer. Technical report, Edelman.

Ellul, A., Jotikasthira, C., Lundblad, C. T., and Wang, Y. (2015). Is historical cost accounting a panacea? market stress, incentive distortions, and gains trading. *The Journal of Finance*, 70(6):2489–2538.

Fernandes, N., Lel, U., and Miller, D. P. (2010). Escape from new york: The market impact of loosening disclosure requirements. *Journal of Financial Economics*, 95(2):129–147.

for Justice, C. and Democracy (2019). Fact sheet: Caps on compensatory damages: A state law summary.

Froot, K. A. and O'Connell, P. G. (1999). The pricing of us catastrophe reinsurance. In *The Financing of Catastrophe Risk*, pages 195–232. University of Chicago Press.

Froot, K. A. and Posner, S. E. (2002). The pricing of event risks with parameter uncertainty. *The Geneva Papers on Risk and Insurance Theory*, 27(2):153–165.

Gabaix, X. (2011). The granular origins of aggregate fluctuations. *Econometrica*, 79(3):733–772.

Gallup (2019). Confidence in institutions. Technical report, Gallup.

Ge, S. (2022). How do financial constraints affect product pricing? evidence from weather and life insurance premiums. *The Journal of Finance*, 77(1):449–503.

Gennaioli, N., Porta, R. L., Lopez-de Silanes, F., and Shleifer, A. (2020). Trust and insurance contracts. Technical report, National Bureau of Economic Research.

Glaeser, E. L., La Porta, R., Lopez-de Silanes, F., and Shleifer, A. (2004). Do institutions cause growth? *Journal of economic Growth*, 9(3):271–303.

Greene, E. and Bornstein, B. H. (2003). *Determining damages: The psychology of jury awards.* American Psychological Association.

Guiso, L., Sapienza, P., and Zingales, L. (2004). The role of social capital in financial development. *American economic review*, 94(3):526–556.

Guiso, L., Sapienza, P., and Zingales, L. (2011). Civic capital as the missing link. In *Handbook of social economics*, volume 1, pages 417–480. Elsevier.

Hans, V. P. (2000). *Business on trial: The civil jury and corporate responsibility*. Yale University Press.

Haran, U., Teichman, D., and Feldman, Y. (2016). Formal and social enforcement in response to individual versus corporate transgressions. *Journal of Empirical Legal Studies*, 13(4):786–808.

Hunter, J. R., Doroshow, J., and Heller, D. (2020). How the cash-rich insurance industry fakes crises and invents social inflation.

Huskins, P. C. (2018). 2019 d&o insurance trends: A looking ahead guide.

III (2018). Florida's assignment of benefits crisis.

Justia (2018). Tort reform.

Kaplan, S. N., Martel, F., and Stromberg, P. (2003). How do legal differences and learning affect financial contracts? Technical report, National Bureau of Economic Research.

Kempf, E. and Spalt, O. G. (2019). Litigating innovation: Evidence from securities class action lawsuits. *European Corporate Governance Institute-Finance Working Paper*, (614).

Klein, A. and Zur, E. (2009). Entrepreneurial shareholder activism: Hedge funds and other private investors. *The Journal of Finance*, 64(1):187–229.

Klein, R. W. (2005). *A Regulator's Introduction to the Insurance Industry*. NAIC.

Koijen, R. and Yogo, M. (2018). The fragility of market risk insurance. Technical report, National Bureau of Economic Research.

Koijen, R. S. and Yogo, M. (2015). The cost of financial frictions for life insurers. *American Economic Review*, 105(1):445–75.

La Porta, R., Lopez-de Silanes, F., and Shleifer, A. (2006). What works in securities laws? *The Journal of Finance*, 61(1):1–32.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. W. (1997). Legal determinants of external finance. *The journal of finance*, 52(3):1131–1150.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. W. (1998). Law and finance. *Journal of political economy*, 106(6):1113–1155.

Le, E. (2015). Setting the stage to make the insurers pay the excess verdicts. Accessed: 2010-06-16.

Lerner, J. and Schoar, A. (2005). Does legal enforcement affect financial transactions? the contractual channel in private equity. *The Quarterly Journal of Economics*, 120(1):223–246.

Lins, K. V., Servaes, H., and Tamayo, A. (2017). Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. *The Journal of Finance*, 72(4):1785–1824.

LLC, B. (2019). Beazley u.s. hospital claims data: Medical malpractice more costly; steep increase in largest claims.

Mello, M. M., Chandra, A., Gawande, A. A., and Studdert, D. M. (2010). National costs of the medical liability system. *Health affairs*, 29(9):1569–1577.

Merrill, C. B., Nadauld, T. D., Stulz, R. M., and Sherlund, S. (2012). Did capital requirements and fair value accounting spark fire sales in distressed mortgage-backed securities? Technical report, National Bureau of Economic Research.

Milevsky, M. A., Promislow, S. D., and Young, V. R. (2006). Killing the law of large numbers: Mortality risk premiums and the sharpe ratio. *Journal of Risk and Insurance*, 73(4):673–686.

Montgomery, C. B. and Nahrstadt, B. C. (2003). A primer for the entertainment community: Legal and practical issues about venue safety-what you should know. *Va. Sports & Ent. LJ*, 3:257.

Oh, S., Sen, I., and Tenekedjieva, A.-M. (2021). Pricing of climate risk insurance: Regulatory frictions and cross-subsidies. *Available at SSRN*.

Pástor, L. and Veronesi, P. (2009). Technological revolutions and stock prices. *American Economic Review*, 99(4):1451–83.

PSB (2014). Corporation perception indicator. Technical report, Penn, Schoen, and Berland.

Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of political economy*, 82(1):34–55.

SAS (2019). The state of insurance fraud technology.

Schanz, K.-U. (2018). The role of trust in narrowing protection gaps. Technical report, The Geneva Association.

Selvin, M. and Picus, L. (1987). *The debate over jury performance: Observations from a recent asbestos case*. Rand Corporation.

Sen, I. and Humphry, D. (2018). Capital regulation and product market outcomes.

Silverman, C. (2017). Bad for your health: Lawsuit advertising implications and solutions.

Soich, R. (2019). Three rising trends in d&o insurance.

Spolaore, E. and Wacziarg, R. (2013). How deep are the roots of economic development? *Journal of economic literature*, 51(2):325–69.

SwissRe (2019). Social inflation: a building pain point in us liability insurance.

West, Z. (2020). What's the deal with social inflation?

Woleben, J. and Ross, H. (2019). Insurers seek to reduce exposure to opioid risks as toll mounts from crisis.

Zawacki, T. (2019). Signs of social inflation evident in highest-in-14-years med mal loss ratio.

Zingales, L. (2006). *Interim Report of the Committee on Capital Markets Regulation*, chapter Competitiveness.

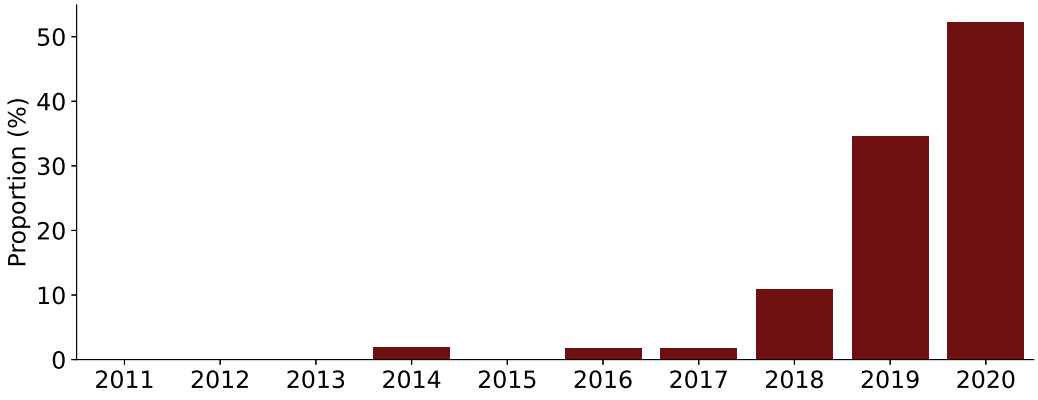
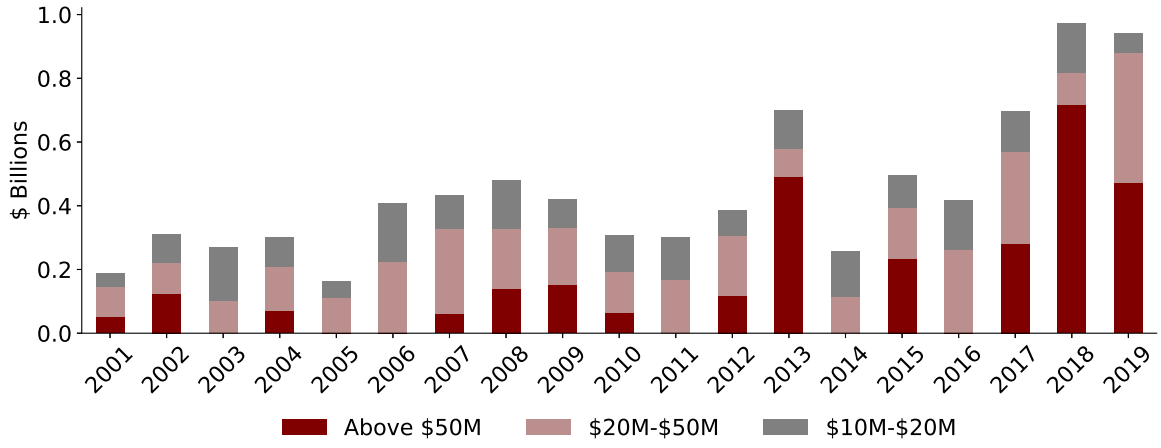


Figure 1: **Mentions of "Social Inflation" in Conference Calls**

This figure plots the proportion of unique conference calls that contain the term "social inflation" among the 15 largest commercial auto liability insurance groups as measured by market share at the end of 2020. (Data Source: Capital IQ Transcripts Data via WRDS)

(a) Award Amounts by Year



(b) Award Counts by Year

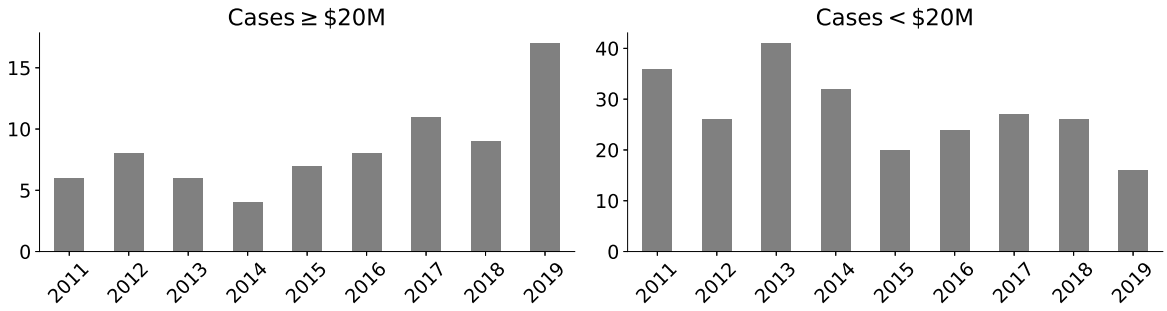


Figure 2: **Nuclear Awards in Commercial Auto Liability Cases**

This figure plots the number and magnitude of verdicts and settlements for commercial auto liability accidents with corporate defendants. The time period is from 2001 to 2019. In panel (a), I report the sum of awards greater than or equal to $50 million, those between $20 and $50 million, and those between $10 and $20 million. In panel (b), I report the number of awards that are greater than $20 million and those less than $20million during the most recent ten years. (Data Source: Verdict Search)

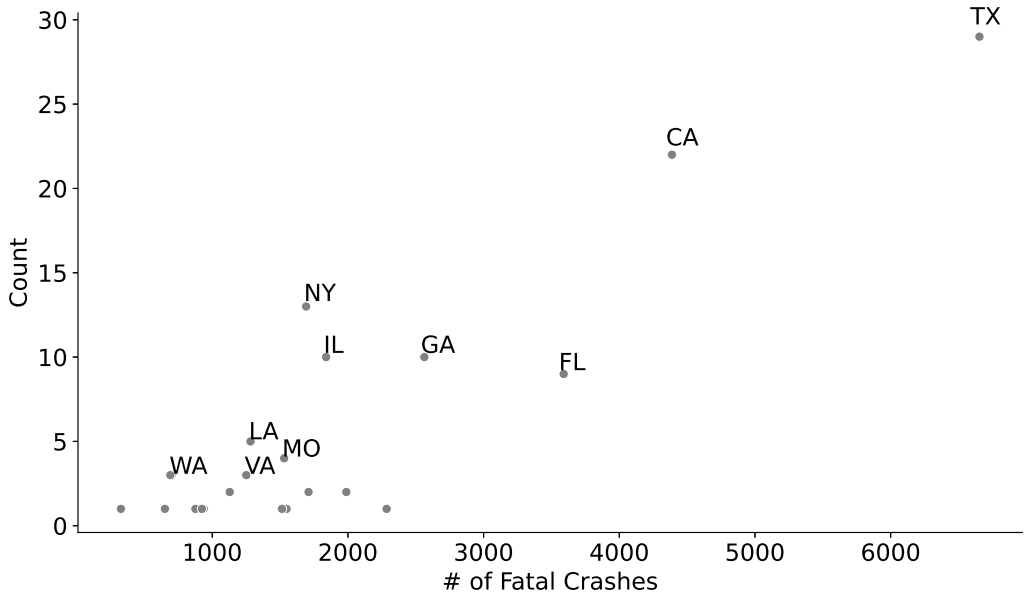


Figure 3: **Nuclear Awards and Fatal Motor Vehicle Crashes**

This figure plots the number of nuclear awards in each state and the cumulative number of fatal motor vehicle crashes during the sample period. (Data Source: VerdictSearch, U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA))

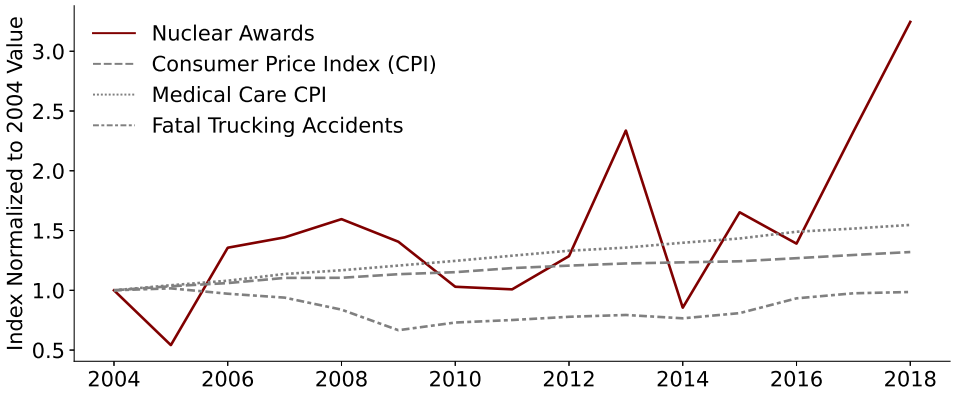


Figure 4: **Comparison to Other Risks in Insurance**

This figure plots the historical growth of three economic time series: inflation, costs of medical care, and the number of fatal motor vehicle accidents involving large trucks. I plot their cumulative growth after normalizing the series to the 2004 level for each series. For comparison, I also include the cumulative sum of nuclear awards that pertain to commercial auto liability, normalized to the 2004 level. (Data Source: VerdictSearch, FRED, U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA))

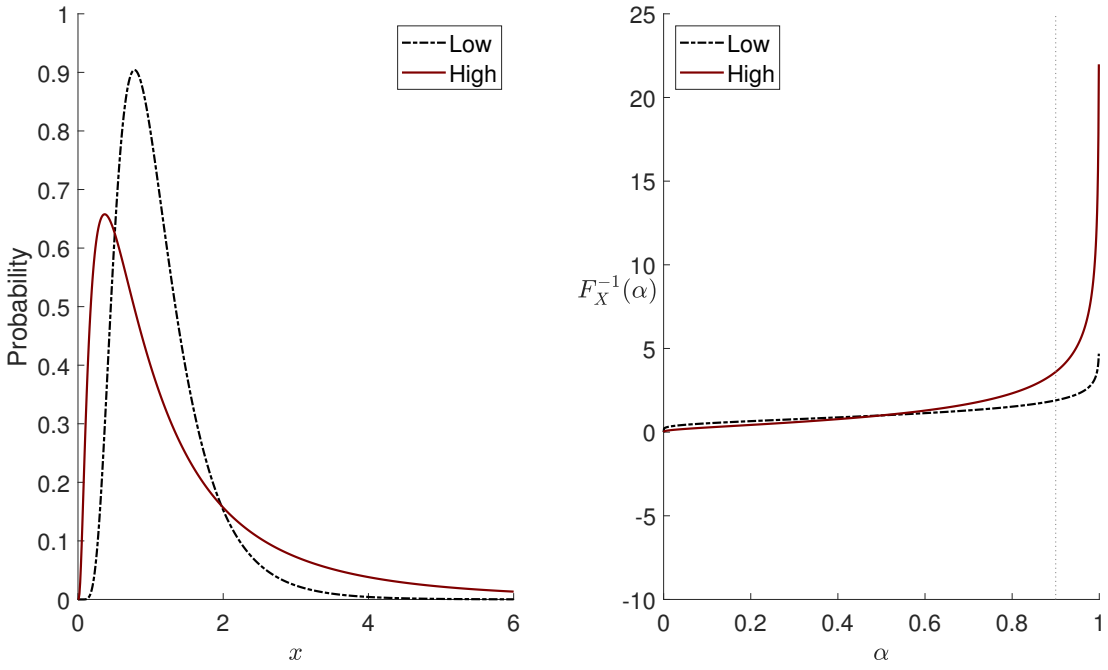


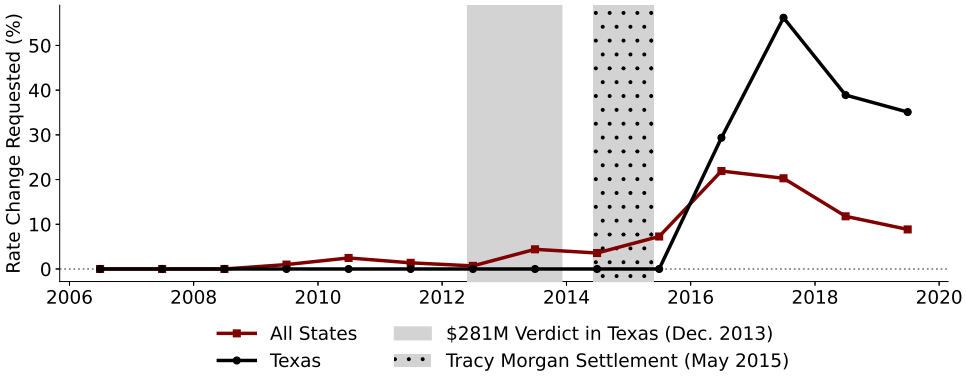
Figure 5: **Effect of Uncertainty via Financial Constraints**

This figure illustrates the effect of social inflation risk on insurance prices. The left panel plots the probability distribution of $\tilde{X}$ introduced in Section 4, where $\tilde{X}$ captures the social inflation risk. The red solid line is a distribution with low uncertainty, while the black dotted line is the distribution with high uncertainty. Both distributions have the same mean at 1. The right panel plots $F_X^{-1}(\alpha)$ for different values of α, where α appears in the statutory capital requirement for insurers:

$$\mathbb{P}\left(\tilde{K}_1 \geq K^*\right) \geq \alpha$$

and $K^*$is some threshold capital level. The vertical line represents the case when $\alpha = 0.9$.

(a) Rate Change Requested (%)



(b) One-Year Reserve Development

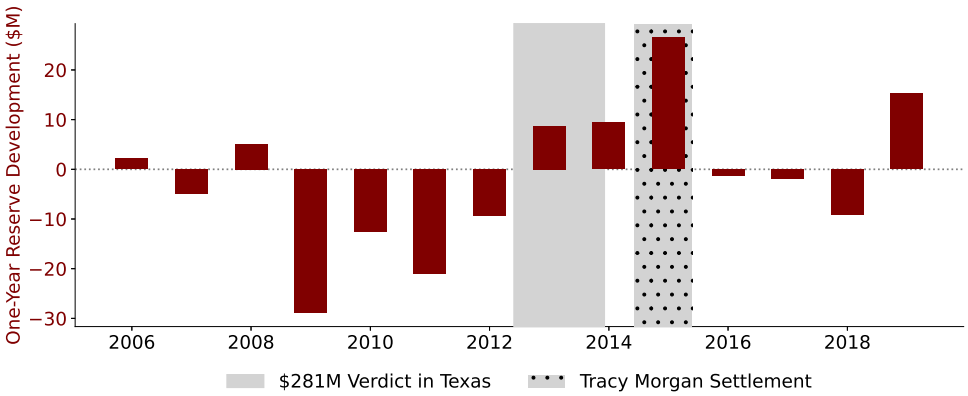
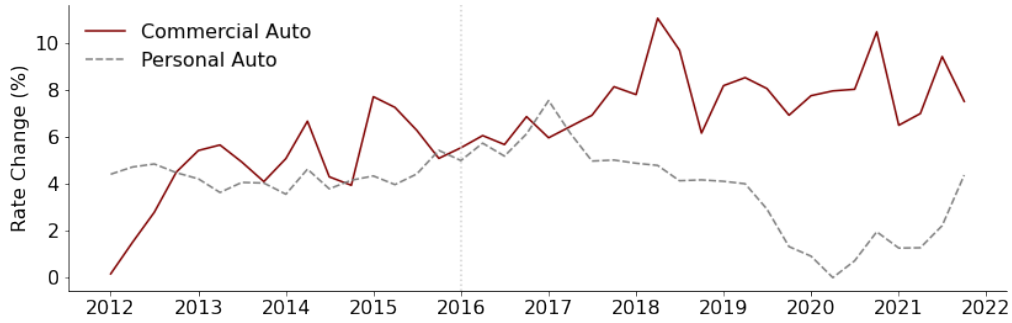


Figure 6: **Case Study of Zurich Insurance Group**

This figure illustrates the rate growth and reserve development for Zurich Insurance Group. The data on insurance rates is aggregated at the annual level based on the submitted date. The data on one-year reserve development is annual. Panel (a) plots the average rate change requested by Zurich in each year. Panel (b) plots the one-year commercial auto liability reserve development reported in calendar year. (Data Source: NAIC via SNL Financials)

(a) Across Insurance Types



(b) Across Insurance Types within State Groups

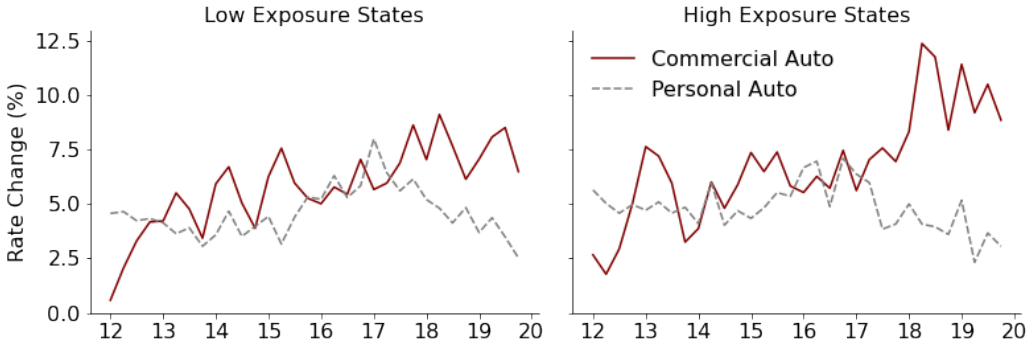
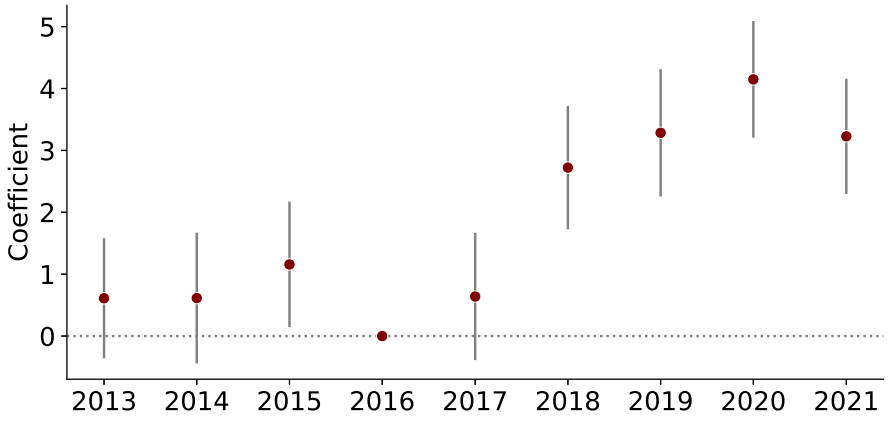


Figure 7: **Rate Change Received by Insurers**

This figure plots the average rate change received by insurers during our sample period. In panel (a), I plot the average rate change received in commercial auto liability and personal auto liability where the average is taken across all insurers in my sample.. In panel (b), I plot the average separately for states depending on their exposure to social inflation. A states s is deemed to be high exposure if it's included in the list of "judicial hellholes" as designated by the American Tort Reform Foundation in its 2014-15 report. (Data Source: NAIC via SNL Financials, American Tort Reform Foundation)

(a) Rate Change Received (%)



(b) Rate Change Requested (%)

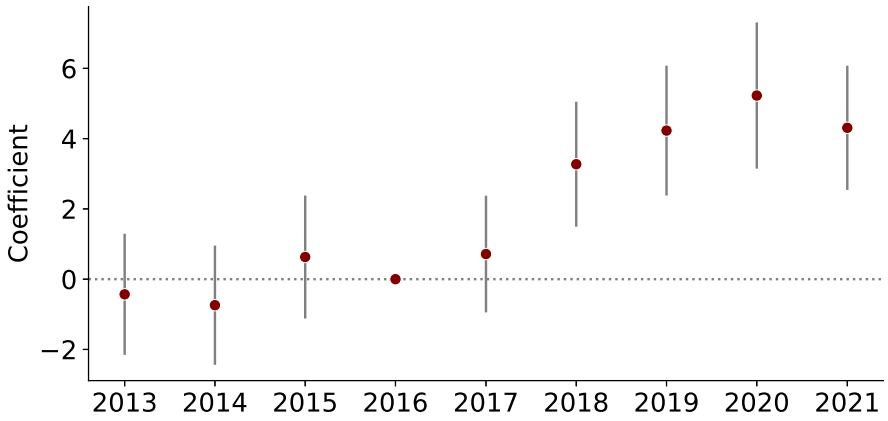


Figure 8: **Dynamic Effects**

This figure plots the coefficient for each year estimated from Equation (19) by replacing $Post_t$ with year dummies using the 2016 year as the baseline. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table 1: **Summary Statistics for Commercial Auto Liability Rate Filings**

	Rate Received (%)			Rate Requested (%)		
	Mean	Median	SD	Mean	Median	SD
2001	9.47	6.95	8.89	20.47	14.15	16.41
2002	9.83	6.90	9.84	23.73	14.30	19.69
2003	8.08	5.90	7.53	17.02	11.50	16.49
2004	7.46	2.55	13.43	14.19	5.30	20.04
2005	0.69	1.30	10.41	5.79	2.30	12.19
2006	-0.23	-0.30	8.15	4.54	0.80	11.38
2007	-2.23	-0.30	9.21	2.19	0.00	11.46
2008	-0.56	2.70	9.45	3.02	4.60	13.83
2009	0.95	3.00	12.13	4.80	5.20	20.77
2010	0.10	2.50	7.16	5.56	5.30	42.37
2011	0.19	2.50	7.20	6.20	4.60	15.68
2012	9.30	4.40	13.33	16.51	8.30	20.92
2013	5.96	4.30	7.71	10.37	7.62	15.27
2014	6.18	4.40	7.63	11.96	8.20	16.42
2015	6.46	4.90	6.42	13.93	9.60	14.60
2016	6.04	5.20	6.71	13.89	10.50	15.40
2017	7.94	6.20	7.30	15.40	12.30	13.21
2018	9.20	5.78	8.71	15.99	10.40	14.89
2019	8.49	5.00	7.91	14.72	8.90	15.23
2020	7.83	4.00	9.05	17.05	8.90	18.96
2021	7.32	5.00	7.00	15.23	9.12	13.65

This table presents the summary statistics for commercial auto liability rate filings. For each year, we report the mean, median, and the standard deviation of two variables: rate change received and rate change requested. The unconditional averages of rate received and rate requested are 6.04% and 12.70%, respectively. (Data Source: NAIC via SNL Financials)

Table 2: **Trends in Commercial Auto Liability Awards: Number of Cases by State**

	2001-2005	2006-2010	2011-2015	2015-2019	Total
Texas	5	6	6	14	31
California	5	8	7	7	27
New York	1	6	2	4	13
Illinois	3	5	2	2	12
Florida	3	3	1	3	10
Georgia	0	2	2	6	10
Louisiana	0	2	2	1	5
Missouri	2	2	0	0	4
Virginia	1	0	3	0	4
Washington	0	1	0	2	3
New Mexico	0	0	2	1	3
Indiana	0	1	1	0	2
Ohio	0	0	1	1	2
New Jersey	1	1	0	0	2
Alabama	2	0	0	0	2
Arizona	0	1	1	0	2
Kansas	0	1	0	0	1
Kentucky	1	0	0	0	1
Oklahoma	0	1	0	0	1
Oregon	0	0	0	1	1
Pennsylvania	0	0	1	0	1
Minnesota	0	0	0	1	1
Connecticut	0	0	0	1	1
Colorado	0	0	0	1	1

This table reports the number of verdicts and settlements greater than $20 million in each state from 2001 to 2019. States without any during the time period are omitted. (Data Source: VerdictSearch)

Table 3: **Estimation of the Hedonic Model for Nuclear Awards**

	(1)	(2)	(3)	(4)	(5)
NumDeaths	2.864***	2.762***	2.910***	2.936***	2.782***
	(0.806)	(0.815)	(0.808)	(0.825)	(0.804)
NumInjuryType	0.177	0.207	0.346	0.192	0.046
	(0.266)	(0.268)	(0.320)	(0.269)	(0.273)
NumPlaintiff	1.513***	1.479***	1.479***	1.398***	1.554***
	(0.330)	(0.332)	(0.332)	(0.430)	(0.329)
NumExpertsPlaintiff	0.458	0.466	0.460	0.465	0.536
	(0.357)	(0.357)	(0.357)	(0.358)	(0.358)
NumExpertsDefense	0.348	0.363	0.358	0.327	0.333
	(0.411)	(0.411)	(0.411)	(0.414)	(0.410)
PostTracyMorgan	9.375***	8.229***	12.117***	8.646***	
	(2.235)	(2.588)	(3.632)	(2.840)	
NumDeaths*PostTracyMorgan		3.084			
		(3.511)			
NumInjuryType*PostTracyMorgan			-0.521		
			(0.544)		
NumPlaintiff*PostTracyMorgan				0.273	
				(0.654)	
Year					0.838***
					(0.184)
Dep. Var.	Amount ($M)	Amount ($M)	Amount ($M)	Amount ($M)	Amount ($M)
Observations	684	684	684	684	684
R^2	0.105	0.107	0.107	0.106	0.109

This table reports the results of the estimation of the hedonic model for nuclear awards. Specifically, we regress the award amounts on a variety of case-specific descriptors as in Equation (1). The sample consists of all cases whose award amounts are greater than or equal to $5 million, and the following characteristics are included in the estimation: number of deaths, number of injury types, number of plaintiffs, number of experts for plaintiffs, and number of experts for defense.

Table 4: **Price Response of Insurers: Difference-in-Difference**

	(1)	(2)	(3)	(4)
Commercial Auto * Post2016	1.364***	1.363***	2.812***	0.008
	(0.256)	(0.254)	(0.428)	(1.329)
Commercial Auto	-0.053	3.448***	4.790***	20.140***
	(0.205)	(1.028)	(1.733)	(5.378)
Post2016	0.531***	0.532***	0.691**	-0.118
	(0.175)	(0.174)	(0.293)	(0.910)
Intercept	5.469***	-0.105	0.942	0.306
	(1.046)	(1.039)	(1.752)	(5.436)
Dep. Var.	RateReceived (%)	RateReceived (%)	RateRequested (%)	# Product Filings
Fixed Effect	Insurer	Insurer-Line	Insurer-Line	Insurer-Line
Controls	O	O	O	O
Panel Type	Balanced	Balanced	Balanced	Balanced
Observations	8,383	8,383	8,383	8,383
R^2	0.127	0.147	0.221	0.564

This tables reports the results from estimating the following regression:

$$\Delta P_{\ell(i)t} = \beta + \beta_1 IsComm_{\ell(i)} + \beta_2 Post_t + \beta_3 IsComm_{\ell(i)} \times Post_t + Controls + \alpha_{\ell(i)} + \epsilon_{\ell(i)t}$$

where t denotes quarter and $\ell(i)$ denotes insurer i's line of business ℓ, where ℓ is either commercial auto liability or personal auto liability. The dependent variable is the quarterly change in rates which is constructed as an average rate weighted by the premiums to which the rate change is applied. $IsComm_{\ell(i)}$ is equal to one if ℓ is commercial auto liability, and $Post_t$ is equal to one if quarter t is after the date of the initial Tracy Morgan verdict. As controls, I include contemporaneous GDP growth and allow for differential loadings between commercial and personal lines. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table 5: **Insurer Exits**

(a) Summary by Insurer Size

	All Sample	Large	Medium	Small
2011	65	6	24	35
2012	71	4	19	48
2013	65	2	8	55
2014	96	1	22	73
2015	41	0	5	36
2016	61	2	9	50
2017	75	2	13	60
2018	61	5	10	46
2019	53	0	9	44

(b) Summary by State Group

	High Award	Low Award	No Award
2011	23	17	25
2012	22	26	23
2013	20	24	21
2014	30	43	23
2015	16	12	13
2016	15	20	26
2017	18	34	23
2018	25	17	19
2019	21	13	19

This table documents the counts of insurer exits in commercial auto liability insurance from 2011 to 2019. An exit for insurer i in state s at time t is defined as when the insurer i provides commercial auto liability coverage in state s at time $t-1$ but not at time t in the same state. To avoid spurious results, the sample is limited to insurers operating in U.S. states with at least 0.1% market share in any given state. In panel (a), we provide summary by the size of the insurers. The large insurers have more than 2% market share in a state at any given year, and small insurers have less than 0.5% market share in a state at any given year. The medium group encompasses the remaining insurers. In panel (b), we provide summary by state groups. The no-award states are states without any nuclear verdicts and settlements between 2001 and 2019. The low-award states correspond to those with less than the median number of nuclear awards between 2001 to 2019, which is equal to four. The high-award group encompasses the remaining states. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table 6: **Price Response of Insurers: Heterogenenous Exposure to Social Inflation Risk**

	(1)	(2)	(3)
Commercial Auto * Post	0.973***	0.790***	0.698
	(0.300)	(0.202)	(0.726)
Commercial Auto * Post * High Exposure State	1.732***	0.812**	-1.776
	(0.532)	(0.349)	(1.256)
Dep. Var.	RateReceived (%)	RateReceived (%)	# Product Filings
Fixed Effect	Insurer-Line	Insurer-Line	Insurer-Line
Controls	O	O	O
Panel Type	Unbalanced	Balanced	Balanced
Observations	9,924	16,991	16,991
R^2	0.216	0.115	0.320

This tables reports the results from estimating the following regression:

$$\begin{aligned}\Delta P_{\ell(i)st} = \beta + \beta_1 HighExposure_s + \beta_2 IsComm_{\ell(i)} + \beta_3 HighExposure_s \times IsComm_{\ell(i)} \\ + \delta_0 Post_t + \delta_1 HighExposure_s \times Post_t + \delta_2 IsComm_{\ell(i)} \times Post_t \\ + \delta_3 HighExposure_s \times IsComm_{\ell(i)} \times Post_t + \alpha_{\ell(i)} + Controls + \epsilon_{\ell(i)st}\end{aligned}$$

where t denotes quarter and $\ell(i)$ denotes insurer i's line of business ℓ, where ℓ is either commercial auto liability or personal auto liability. s denotes the state group, high vs. low exposure. High exposure states contain states designated as judicial hellholes or on the watch list in the 2014-15 Judicial Hellholes report from the American Tort Reform Foundation. $IsComm_{\ell(i)}$ is equal to one if ℓ is commercial auto liability, and $Post_t$ is equal to one if quarter t is after the date of the initial Tracy Morgan verdict. As controls, I include contemporaneous GDP growth and allow for differential loadings between commercial and personal lines. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table 7: **Price Response of Insurers: Role of Balance Sheet Capacity**

	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)
Commercial Auto * Post2016	2.620***	-0.413	4.895***	-0.383
	(0.338)	(0.395)	(0.582)	(0.642)
Commercial Auto	2.919***	2.527***	4.263**	3.488**
	(1.079)	(0.944)	(1.858)	(1.533)
Post2016	-0.107	1.000***	-0.592	1.999***
	(0.240)	(0.256)	(0.414)	(0.416)
Intercept	0.095	0.714	1.180	1.675
	(1.088)	(0.961)	(1.874)	(1.559)
Dep. Var.	Rate Received (%)	Rate Received (%)	Rate Requested (%)	Rate Requested (%)
Measure of Constraint	RBC Ratio	RBC Ratio	RBC Ratio	RBC Ratio
Fixed Effect	Insurer-Line	Insurer-Line	Insurer-Line	Insurer-Line
Controls	O	O	O	O
Panel Type	Balanced	Balanced	Balanced	Balanced
Observations	5,479	3,288	5,479	3,288
R^2	0.143	0.180	0.203	0.274

This tables reports the results from estimating the following regression separately for constrained and unconstrained insurers:

$$\Delta P_{\ell(i)t} = \beta + \beta_1 IsComm_{\ell(i)} + \beta_2 Post_t + \beta_3 IsComm_{\ell(i)} \times Post_t + Controls + \alpha_{\ell(i)} + \epsilon_{\ell(i)t}$$

where t denotes quarter and $\ell(i)$ denotes insurer i's line of business ℓ, where ℓ is either commercial auto liability or personal auto liability. To identify which insurers are financially constrained, I follow Ge (2022) and classify an insurer i to be financially constrained in year t if its risk-based capital ratio is below the cross-sectional mean. The dependent variable is the quarterly change in rates which is constructed as an average rate weighted by the premiums to which the rate change is applied. $IsComm_{\ell(i)}$ is equal to one if ℓ is commercial auto liability, and $Post_t$ is equal to one if quarter t is after the date of the initial Tracy Morgan verdict. As controls, I include contemporaneous GDP growth and allow for differential loadings between commercial and personal lines. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table 8: **Price Response of Insurers: Role of Learning by Insurers**

	Top 20	Remaining	No Direct Exposure
	(1)	(2)	(3)
Commercial Auto * Post2016	3.936***	3.968***	2.430***
	(1.123)	(0.754)	(0.612)
Commercial Auto	-7.099***	-1.824	3.200*
	(1.660)	(1.753)	(1.757)
Post2016	-2.107**	-0.334	1.562***
	(0.869)	(0.575)	(0.372)
Intercept	16.660***	7.453***	1.036
	(1.793)	(1.810)	(1.793)
Dep. Var.	Rate Requested (%)	Rate Requested (%)	Rate Requested (%)
Fixed Effect	Insurer	Insurer	Insurer
Controls	O	O	O
Panel Type	Balanced	Balanced	Balanced
Observations	1,087	2,752	4,544
R^2	0.237	0.210	0.210

This tables reports the results from estimating the following regression separately for three groups of insurers based on the intensity of their direct exposure to nuclear verdicts and settlements:

$$\Delta P_{\ell(i)t} = \beta + \beta_1 IsComm_{\ell(i)} + \beta_2 Post_t + \beta_3 IsComm_{\ell(i)} \times Post_t + Controls + \alpha_{\ell(i)} + \epsilon_{\ell(i)t}$$

where t denotes quarter and $\ell\,(i)$ denotes insurer i's line of business ℓ, where ℓ is either commercial auto liability or personal auto liability. The *Top 20* group includes top 20 insurers with the highest number of nuclear awards experienced during my sample, and the *Remaining* group includes all other insurers with direct involvement in at least one nuclear award. The final group, *No Direct Exposure*, includes the remaining insurers who are not directly exposed to any of the nuclear awards. The dependent variable is the quarterly change in rates which is constructed as an average rate weighted by the premiums to which the rate change is applied. $IsComm_{\ell(i)}$ is equal to one if ℓ is commercial auto liability, and $Post_t$ is equal to one if quarter t is after the date of the initial Tracy Morgan verdict. As controls, I include contemporaneous GDP growth and allow for differential loadings between commercial and personal lines. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table 9: **Impact of Social Inflation Risk on Insurance Frauds**

	Auto Frauds	Auto Frauds	All Frauds
	(1)	(2)	(3)
Intercept	7.80**	4.21	58.20***
	(3.16)	(3.74)	(21.39)
Post	5.77*	4.79	50.60**
	(3.10)	(4.27)	(24.39)
High Award	46.00***	49.58***	287.32***
	(5.47)	(5.74)	(32.80)
High Award * Post	10.45*	11.42*	176.73***
	(5.36)	(6.04)	(34.50)
Low Award		7.17*	56.72**
		(4.27)	(24.39)
Low Award * Post		1.94	41.06
		(6.03)	(34.49)
Dep. Var.	# Auto Frauds	# Auto Frauds	# All Frauds
Observations	108	108	108
R^2	0.79	0.80	0.86

This table reports the coefficient estimates of the regressions relating insurance frauds to the exposure to social inflation risk:

$$y_{st} = \beta_0 + \beta_1 HighAward_s + \beta_2 LowAward_s + \beta_3 Post_t + \beta_4 HighAward_s \times Post_t + \beta_5 LowAward_s \times Post_t + \epsilon_{st}$$

where t denotes quarter and s denotes state group, which is one of the following: no-award states, low-award states, and high-award states. The no-award states are states without any nuclear verdicts and settlements between 2001 and 2015. The low-award states correspond to those with less than the median number of nuclear awards between 2001 to 2015, which is equal to four. The high-award group encompasses the remaining states. The dependent variable y_{st} is the number of auto insurance frauds in state group s at time t. Column (1) presents the baseline results comparing high-award states to low- and no-award states. Column (2) facilitates a three-way comparison across the state groups and column (3) repeats the regression using total number of insurance frauds instead of restricting to those related to auto liability.. (Data Source: NAIC via SNL Financials, Coalition Against Insurance Fraud)

A Model Proofs

I provide omitted derivations for some of the steps in Section 4.

Risk-Based Capital Constraint Note that we have

$$\begin{aligned}
\mathbb{P}\left(\tilde{K}_t \geq K^*\right) \geq \alpha \Leftrightarrow & \mathbb{P}\left(R\tilde{K}_{t-1} + \left(P_t - \mu - \rho\tilde{X}_t\right) Q_t - C \geq K^*\right) \geq \alpha \\
\Leftrightarrow & \mathbb{P}\left(\tilde{X}_t \leq \frac{R\tilde{K}_{t-1} + (P_t - \mu) Q_t - C - K^*}{\rho Q_t}\right) \geq \alpha \\
\Leftrightarrow & F_X\left(\frac{R\tilde{K}_{t-1} + (P_t - \mu) Q_t - C - K^*}{\rho Q_t}\right) \geq \alpha \\
\Leftrightarrow & \frac{R\tilde{K}_{t-1} + (P_t - \mu) Q_t - C - K^*}{\rho Q_t} \geq F_X^{-1}(\alpha) \\
\Leftrightarrow & R\tilde{K}_{t-1} + (P_t - \mu) Q_t - C - K^* \geq \rho Q_t F_X^{-1}(\alpha)
\end{aligned}$$

Rearranging yields (9). □

Optimal Insurance Pricing Recall that the Lagrangian is given as:

$$\mathcal{L}_t = \mathbb{E}\left[\tilde{\Pi}_t\right] + \lambda_t \left(\left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) Q_t - \left(K^* + C - RK_{t-1}\right)\right)$$

Taking the first-order condition with respect to P_t and setting it equal to zero yields:

$$\begin{aligned}
\frac{\partial \mathcal{L}_t}{\partial P_t} &= \frac{\partial \mathbb{E}\left[\tilde{\Pi}_t\right]}{\partial P_t} + \lambda_t \left(Q_t + \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) \frac{\partial Q_t}{\partial P_t}\right) \\
&= \mathbb{E}\left[\frac{\partial \tilde{\Pi}_t}{\partial P}\right] + \lambda_t \left(Q_t + \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) \frac{\partial Q_t}{\partial P_t}\right) \\
&= \mathbb{E}\left[\left(Q_t + \left(P_t - \mu - \rho\tilde{X}_t\right) \frac{\partial Q_t}{\partial P_t}\right)\right] + \lambda_t \left(Q_t + \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) \frac{\partial Q_t}{\partial P_t}\right) \\
&= Q_t + P_t \frac{\partial Q_t}{\partial P_t} - \mu \frac{\partial Q_t}{\partial P_t} - \rho \frac{\partial Q_t}{\partial P_t} \mathbb{E}\left[\tilde{X}_t\right] + \lambda_t \left(Q_t + \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) \frac{\partial Q_t}{\partial P_t}\right) = 0
\end{aligned}$$

Rearranging above, we have:

$$\begin{aligned}
P_t\frac{\partial Q_t}{\partial P_t} &= \mu\frac{\partial Q_t}{\partial P_t} + \rho\frac{\partial Q_t}{\partial P_t}\mathbb{E}\left[\tilde{X}_t\right] - \lambda_t\left(Q_t + \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right)\frac{\partial Q_t}{\partial P_t}\right) - Q_t \\
P &= \mu + \rho\mathbb{E}\left[\tilde{X}_t\right] - \frac{\partial P_t}{\partial Q_t}\lambda_t\left(Q_t + \left(P_t - \mu - \rho F_X^{-1}(\alpha)\right)\right)\frac{\partial Q_t}{\partial P_t} - \frac{\partial P_t}{\partial Q_t}\frac{Q_t}{P_t}P_t \\
&= \mu + \rho\mathbb{E}\left[\tilde{X}_t\right] \underbrace{-\lambda_t\frac{\partial P_t}{\partial Q_t}\frac{Q_t}{P_t}}_{=\lambda_t/\epsilon_D} P_t - \lambda_t\left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) \underbrace{-\frac{\partial P_t}{\partial Q_t}\frac{Q_t}{P_t}}_{=1/\epsilon_D} P_t
\end{aligned}$$

Rearranging:

$$\begin{aligned}
P_t\left(1 - \frac{1+\lambda_t}{\epsilon_D}\right) &= \mu + \rho\mathbb{E}\left[\tilde{X}_t\right] - \lambda_t\left(P_t - \mu - \rho F_X^{-1}(\alpha)\right) \\
P_t\left(1 + \lambda_t - \frac{1+\lambda_t}{\epsilon_D}\right) &= \mu + \rho\mathbb{E}\left[\tilde{X}_t\right] + \lambda_t\left(\mu + \rho F_X^{-1}(\alpha)\right) \\
P_t\left(1+\lambda_t\right)\left(1 - \frac{1}{\epsilon_D}\right) &= \mu + \rho\mathbb{E}\left[\tilde{X}_t\right] + \lambda_t\left(\mu + \rho F_X^{-1}(\alpha)\right) \\
P_t\left(1+\lambda_t\right)\left(1 - \frac{1}{\epsilon_D}\right) &= \left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right)\left(1 + \lambda_t\frac{\mu + \rho F_X^{-1}(\alpha)}{\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]}\right) \\
P_t &= \left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right)\left(1 - \frac{1}{\epsilon_D}\right)^{-1}\left(\frac{1 + \lambda_t\left(\frac{\mu + \rho F_X^{-1}(\alpha)}{\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]}\right)}{1+\lambda_t}\right)
\end{aligned}$$

Therefore, we have:

$$P_t = \left(\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]\right)\left(1 - \frac{1}{\epsilon_D}\right)^{-1}\left(\frac{1 + \lambda_t\left(\frac{\mu + \rho F_X^{-1}(\alpha)}{\mu + \rho\mathbb{E}\left[\tilde{X}_t\right]}\right)}{1+\lambda_t}\right)$$

□

Extension with Outstanding Policies Now suppose that fraction α of outstanding liabilities are also affected by social inflation risk. This implies a modified version of (5):

$$\tilde{L}_t = RL_{t-1} + \tilde{V}_t\left(Q_t + \alpha L_{t-1}\right)$$

and (7):

$$\begin{aligned}\tilde{K}_t &= A_t - \tilde{L}_t \\ &= RA_{t-1} + P_tQ_t - C - \left(RL_{t-1} + \tilde{V}_t\left(Q_t + \alpha L_{t-1}\right)\right) \\ &= R\left(A_{t-1} - L_{t-1}\right) + \left(P_t - \mu - \rho\tilde{X}_t\right)Q_t - C - \alpha\left(\mu + \rho\tilde{X}_t\right)L_{t-1} \\ &= RK_{t-1} + \left(P_t - \mu - \rho\tilde{X}_t\right)Q_t - C - \alpha\left(\mu + \rho\tilde{X}_t\right)L_{t-1}\end{aligned}$$

Therefore,

$$\begin{aligned}\mathbb{P}\left(\tilde{K}_t \geq K^*\right) \geq \alpha \Leftrightarrow &\mathbb{P}\left(R\tilde{K}_{t-1} + \left(P_t - \mu - \rho\tilde{X}_t\right)Q_t - C - \alpha\left(\mu + \rho\tilde{X}_t\right)L_{t-1} \geq K^*\right) \geq \alpha \\ \Leftrightarrow &\mathbb{P}\left(\tilde{X}_t \leq \frac{R\tilde{K}_{t-1} + \left(P_t - \mu\right)Q_t - C - K^*}{\rho\left(Q_t + \alpha L_{t-1}\right)}\right) \geq \alpha \\ \Leftrightarrow &F_X\left(\frac{R\tilde{K}_{t-1} + \left(P_t - \mu\right)Q_t - C - K^*}{\rho\left(Q_t + \alpha L_{t-1}\right)}\right) \geq \alpha \\ \Leftrightarrow &\frac{R\tilde{K}_{t-1} + \left(P_t - \mu\right)Q_t - C - K^*}{\rho\left(Q_t + \alpha L_{t-1}\right)} \geq F_X^{-1}\left(\alpha\right) \\ \Leftrightarrow &R\tilde{K}_{t-1} + \left(P_t - \mu\right)Q_t - C - K^* \geq \rho\left(Q_t + \alpha L_{t-1}\right)F_X^{-1}\left(\alpha\right)\end{aligned}$$

□

B Additional Details on Data

B.1 Settlements and Verdicts

We collect data on cases involving commercial auto liability from 2001 to 2019. The primary data source is VerdictSearch, a major verdict-reporting outlet that actively solicits contributions from attorneys on each side of the case. The reports are written by professional journalists and contains detailed information including date, venue, accident description, and list of insurance companies involved. We focus on verdicts and settlements with awards greater than or equal to $5 million and hand-collect the relevant information.

The details of the sample construction are as follows. we first search for all cases with type "Motor Vehicle – All" from January 1st, 2001 to December 31st, 2019 for all state and federal courts. The search results span decisions, arbitrations, settlements, and verdicts, and we restrict my search to award amounts greater than $10 million. This step yields a total of 802 cases.

We manually read through the case details to identify accidents with corporate defendants that involve commercial auto coverage. In doing so, we exclude the following common types: product

liability cases against car manufacturers, personal injury cases between individuals, and workplace negligence such as negligent service of alcohol at eateries or improper repair at auto shops. we also exclude cases involving city transit and local departments of transportation. We also exclude cases in which the defendant on the case is an insurance company. This step yields a total of 299 cases.

The set of 299 cases is the final set of verdicts in my sample. For each verdict, we collect the data on type (verdict, settlement), state and county, basic descriptions of the case, the insurance companies involved, and award amounts. For a subset of the analyses, we expand the sample to include verdicts and settlements with awards greater than or equal to $5 million. The expanded sample comprises a total of 684 cases.

B.2 Summary Statistics

Table A2 reports the top 15 insurance groups for commercial auto liability insurance in terms of direct premiums written at the end of 2019. There are 314 insurance groups with positive direct written premiums. The largest provider group of commercial auto liability is Progressive Corporation, which wrote approximately $4.5 billion in direct premiums and accounted for nearly 13% of the total in 2019. The top 15 groups together account for nearly 53% of the total $34 billion of commercial auto liability premiums written in 2019.

Table A3 reports the similar statistics at the individual company level. The largest provider company is United Financial Casualty Co. – a subsidiary of Progressive – which accounts for 3.53% of the written premiums in 2019. There are 856 insurance companies, and the top 15 account for 24% of the total premiums in 2019.

Figure A2 plots the time-series trends in direct premiums written and the Herfindahl-Hirschman Index (HHI) for the commercial auto liability industry from 2001 to 2019. The HHI index remains relatively stable around 300 in my sample period with a slight dip around 2015. The level of concentration, measured by HHI, is smaller compared to other industries[11] and does not display an upward trend. Overall, the results imply some level of concentration in the market for commercial auto liability insurance, which still seems modest compared to concentrations in other markets.

B.3 Composition of Nuclear Awards

As mentioned in Section 2, the jury award consists of five components: past and future pecuniary (economic) damages, past and future non-pecuniary (non-economic) damages, and punitive damages. For a majority of the verdicts, I observe the breakdown of jury awards; I do not observe it

[11] According to Autor et al. (2020), the average HHI for manufacturing, utilities, finance, retail and wholesale trade are all over 2,000 between 2001 and 2019.

for settlements. I exclude punitive damages and restrict to samples in which all four components – past / future economic and non-economic damages – are observable, which amounts to a final set of 133 cases.

Figure A3 plots the composition of nuclear awards in commercial auto liability cases from 2002 to 2019. In the left panel, the ratio of non-economic damages to economic damages in each year has gone up over time. In the right panel, however, the ratio of future damages to past damages has remained relatively stable across years. One theory that is consistent with this observation is that the applied multiple between economic and non-economic damages has increased over time.

C Social Inflation in Other Insurance Lines

While this paper's empirics focuses on commercial auto liability, nuclear awards and the subsequent increase in rates are a salient concern across many other lines as well (West (2020)). In this section, I outline the rising nuclear awards in other commercial insurance lines.

C.1 Directors and Officers (D&O)

Directors and officers insurance, which protects board members and company leadership for their decisions and actions, has also experienced significant risk exposure to social inflation. The increase in number of suits filed is driven by a 2018 unanimous court decision *Cyan Inc. v. Beaver County Employees Retirement Fund*, which set a new precedent on the jurisdiction where securities action lawsuits can be tried. The conclusion from the case now allows the lawsuits to proceed in state courts, which eliminates the ability to consolidate cases and thereby multiplying the number of cases (Soich, 2019).

Total claim costs are also growing. The combination of attorney's fees and settlements have increased 63% to $4.5 million from 2012 to 2016. For dismissed cases, total costs have increased 162% to $2.3 million during the same period. (Chubb, 2018). In a 2018 survey, 96% of D&O insurers stated that social inflation risk from increased lawsuits is increasing and 80% of them expected rates to go up for mature public companies in the next year (Huskins, 2018).

C.2 Medical Malpractice

Medical professionals have historically argued that medical malpractice lawsuits are a leading cause of rising medical costs (Mello et al., 2010). Reforms in the 1970s and the 1980s sought to limit both the frequency and the intensity of the suits. For example, some states limit the maximum amount of non-pecuniary losses or even total damages for which a single plaintiff can sue. Another

reform has been introduced to decrease the statute of limitations for malpractice cases, currently around two to six years for most states.

Despite the attempts at reform, social inflation in medical malpractice has re-emerged. The average cost of a U.S. medical malpractice claim increased by 50% since 2009 with a sharp rise in the number of claims valued in excess of $5 million more recently (LLC, 2019). A report by S&P global also finds that the direct incurred loss ratios in the physicians' and surgeons' liability portion of the business surged to 52.6% in the third quarter and 53% for the first nine months of 2019 from 46.6% and 46.1% in the same periods of 2018 (Zawacki, 2019).

C.3 Opioid Crisis and Casualty Insurance

In 2017, the Department of Health and Human Services declared a nationwide public health emergency over the opioid crisis.[12] Lawsuits related to opioids have since been filed by state and local governments against manufacturers, distributors and retailers. Given the wider legal trends, insurance companies have increasingly sought purchasing adverse development cover and introduced exclusions for opioids (Woleben and Ross, 2019).

C.4 Assignment of Benefits (AOB) in Florida

Assignment of Benefits refers to a legal process that allows policyholders to grant a third party to directly bill an insurer to settle a claim. Such lawsuits, especially for auto glass coverage and homeowners insurance, have been on a rapid rise in Florida. Compared to roughly 1,300 AOB lawsuits in 2000, there were more than 79,000 in 2013 and nearly 135,000 in 2018, a 70% increase over the period of five years (III, 2018). The lawsuits have been historically localized to a few counties such as South Florida and metro areas around Tampa Bay and Orlando. Now they have been spreading rapidly to other counties, making their manifestation a state-wide phenomenon.

The rising legal costs and settlements have translated into increasing insurance costs. The average premium for homeowners insurance in Florida has risen approximately 30% between 2007 and 2015. In 2019, Citizens Property Insurance Corp, Florida's state-owned residual property insurer, also recommended a rate increase to Miami-Dade, Broward, and Palm Beach counties nearing 10% per year, which is the statutory limit in Florida.

[12] See https://www.hhs.gov/opioids/about-the-epidemic/index.html.

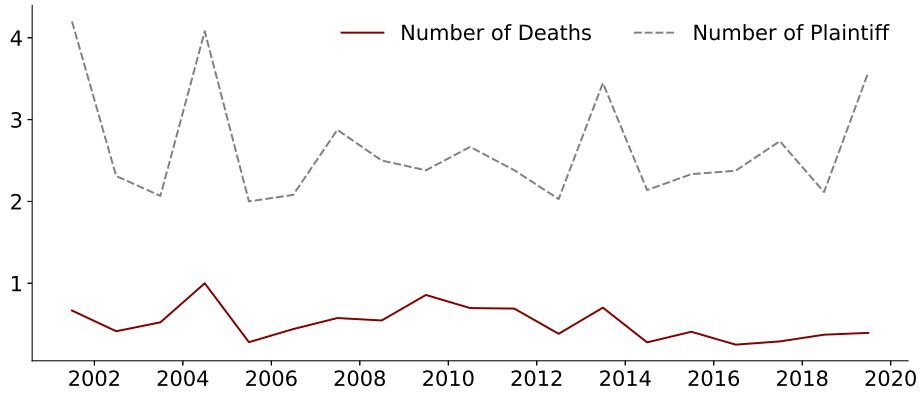


Figure A1: **Average Number of Deaths and Plaintiffs over Time**

This figure plots the average number of deaths and plaintiffs associated with each accident from 2001 to 2019. we use all cases whose award amounts are greater than or equal to $5 million in my sample.

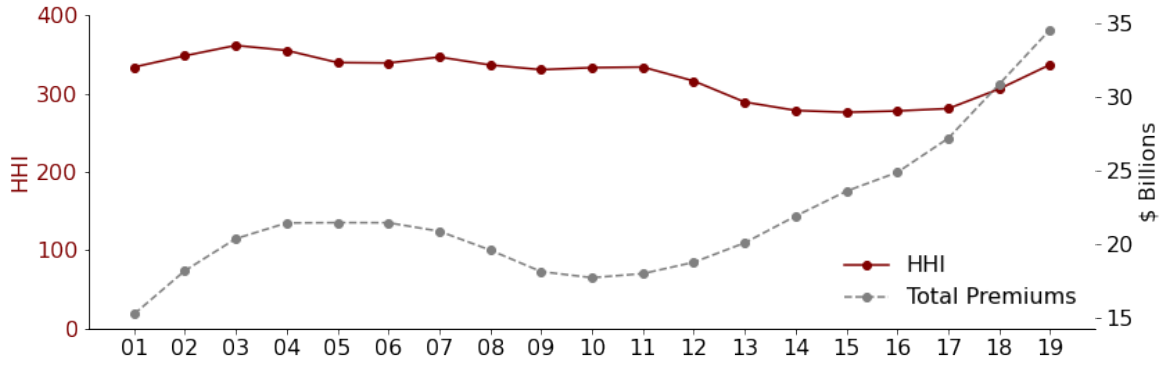


Figure A2: **Commercial Auto Liability: Market Size and Concentration**

This figure documents the time-series trend in direct premiums written and the Herfindahl-Hirschman Index (HHI) for the commercial auto liability industry from 2001 to 2019. The red solid line plots the HHI calculated using each insurance group's written premiums, and the gray dotted line plots the total direct premiums written for commercial auto liability. (Data Source: NAIC via SNL Financials)

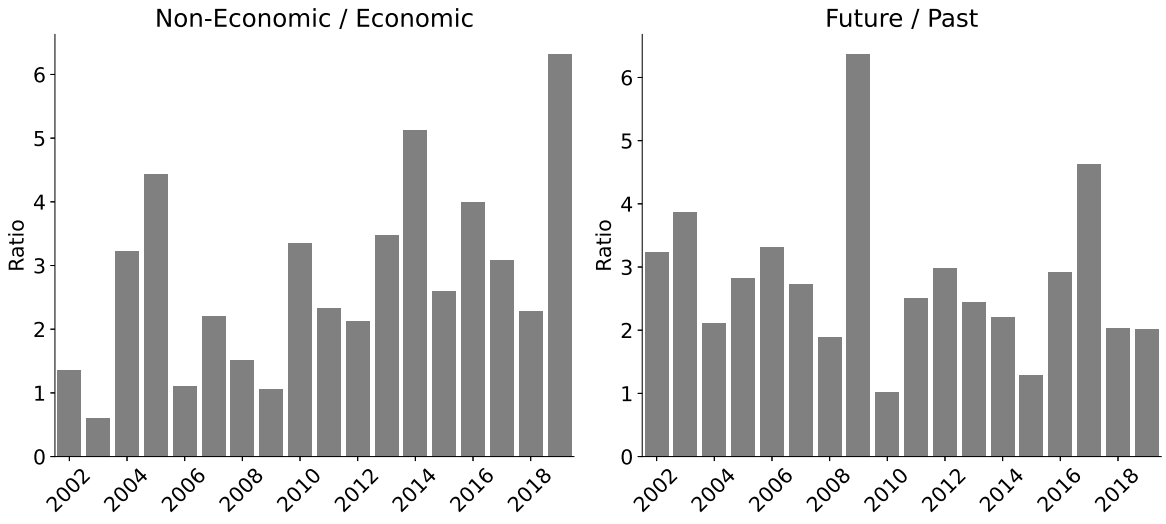


Figure A3: **Composition of Nuclear Awards Over Time**

This figure plots the composition of nuclear awards in commercial auto liability cases from 2002 to 2019. I first decompose each award amount into five components: past and future economic damages, past and future non-economic damages, and punitive damages. I exclude punitive damages since they are infrequently observed in the data. The sample is restricted to cases in which all four components (excluding punitive damages) are observable, which amounts to a final set of 133 cases. In the left panel, for each year, I compute the ratio of the sum of past and future non-economic damages to the sum of past and future economic damages. In the right panel, for each year, I compute the ratio of the sum of future economic and future non-economic damages to the sum of past economic and past non-economic damages. Data for 2001 is excluded as it only contains one case for which the breakdown of awards is observable. (Data Source: VerdictSearch)

Table A1: Trends in Commercial Auto Liability Awards: Insurance Companies

	Total Count	Total Amount ($M)
AIG	107	1951.68
Zurich	53	936.54
Liberty Mutual	50	718.87
Chubb	47	674.66
Travelers	35	417.17
Great American Insurance	20	242.43
Berkshire Hathaway Inc.	19	223.85
State Farm	17	140.97
Nationwide	17	158.13
The Hartford	13	290.62
W. R. Berkley Corp.	12	394.33
Progressive	12	270.55
Allstate Corp	12	180.83
Allianz	11	154.25
Fairfax Financial	10	133.56
Amer Bus. & Mctl Ins Mutl Inc.	9	176.33
CNA	7	91.89
AXA SA	7	97.31
Selective	6	59.02
Swiss Re	6	86.67

This table reports the list of insurance companies involved in nuclear verdicts and settlements from 2001 to 2019. We report the 20 insurers with the largest number of awards. (Data Source: VerdictSearch)

Table A2: Top 15 Commercial Auto Liability Insurance Groups in 2019

SNL Group Name	Direct Premiums Written ($ Million)	Share 2019 (in %)
Progressive	4456.98	12.89
Travelers	2163.06	6.26
Liberty Mutual	1453.15	4.20
Nationwide	1291.93	3.74
Berkshire Hathaway Inc.	1282.79	3.71
Old Republic Insurance	1157.44	3.35
Zurich	1066.44	3.08
Chubb	850.09	2.46
Allstate Corp	779.79	2.26
Auto-Owners Insurance	761.30	2.20
State Farm	632.71	1.83
The Hartford	632.32	1.83
Tokio Marine	626.87	1.81
AIG	620.10	1.79
W. R. Berkley Corp.	532.88	1.54
Total (Top 15)	18307.87	52.94
Total (Industry)	34580.29	100.00

This table reports the top 15 insurance groups for commercial auto liability insurance in terms of direct premiums written. The data is from NAIC at the group level, and we use the numbers from 2019 annual filing. For 2019, there are 314 insurance groups with positive direct written premiums. (Data Source: NAIC via SNL Financials)

Table A3: Top 15 Commercial Auto Liability Insurance Companies in 2019

SNL Statutory Entity Key	Direct Premiums Written ($ Million)	Share 2019 (in %)
United Financial Casualty Co.	1221.18	3.53
Progressive Express Ins Co.	717.53	2.07
Zurich American Insurance Co.	709.30	2.05
Allstate Insurance Co.	614.64	1.78
Great West Casualty Co.	577.28	1.67
Ohio Security Insurance Co.	512.85	1.48
Progressive County Mutl Ins Co	492.59	1.42
Travelers Ppty Cas Co. of Am	491.03	1.42
Philadelphia Indemnity Ins Co.	487.94	1.41
ACE American Insurance Co.	485.15	1.40
State Farm Mutl Automobile Ins	420.51	1.22
Cincinnati Insurance Co.	411.58	1.19
National Union Fire Ins Co.	410.43	1.19
James River Insurance Co.	402.96	1.17
American Transit Insurance Co.	349.48	1.01
Total (Top 15)	8304.45	24.01
Total (Industry)	34580.29	100.00

This table reports the top 15 insurance companies for commercial auto liability insurance in terms of direct premiums written. The data is from NAIC at the company level, and we use the numbers from 2019 annual filing. For 2019, there are 856 insurance companies with positive direct written premiums. (Data Source: NAIC via SNL Financials)

Table A4: **Insurer Exits after Nuclear Awards**

Year of Nuclear Award (t)	Award Amount	State	Insurance Group
Panel A. Exit in Year t			
2004	\$27,000,000	Montana	Allstate Corp
2008	\$9,000,000	New York	Zurich
2008	\$5,000,000	New York	Zurich
Panel B. Exit in Year $t+1$			
2005	\$25,000,000	Montana	Zurich
2003	\$6,523,434.93	New York	Zurich
Panel B. Exit in Year $t+2$			
2006	\$11,000,000	New York	Zurich

This table examines the insurer exits after the incidence of nuclear awards. We expand my sample to include awards greater than or equal to \$5 million. For each nuclear award, we ask if the incidence of this award for an insurer i in state s at time t is followed by the insurer i's exit in state s at time t, $t+1$, and $t+2$. (Data Source: NAIC via SNL Financials, VerdictSearch)

Table A5: **Price Response of Insurers: Role of Asset Growth**

	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)
Commercial Auto * Post2016	1.250***	1.112***	2.798***	2.146***
	(0.434)	(0.323)	(0.664)	(0.617)
Commercial Auto	3.659**	3.075***	3.894	4.892**
	(1.847)	(1.133)	(2.827)	(2.164)
Post2016	-0.020	0.987***	-0.497	1.916***
	(0.299)	(0.221)	(0.457)	(0.422)
Intercept	-0.438	0.166	1.784	0.327
	(1.859)	(1.144)	(2.846)	(2.186)
Dep. Var.	Rate Received (%)	Rate Received (%)	Rate Requested (%)	Rate Requested (%)
Measure of Constraint	Asset Growth	Asset Growth	Asset Growth	Asset Growth
Fixed Effect	Insurer-Line	Insurer-Line	Insurer-Line	Insurer-Line
Controls	O	O	O	O
Panel Type	Balanced	Balanced	Balanced	Balanced
Observations	4,136	4,631	4,136	4,631
R^2	0.183	0.203	0.263	0.249

This tables reports (Data Source: NAIC via SNL Financials, VerdictSearch)