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

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ABSTRACT

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

JEL Classification: G22, G28, E53

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

* This paper has benefited from comments and suggestions by Richard Butler, Conrad Ciccotello, Martin Grace, Stephen Shore and Sharon Tennyson, and seminar participants at University of Georgia, 2015 Huebner Doctoral Colloquium, 2015 ARIA conference, 2015 FMA Doctoral Consortium, and 2015 FMA meeting for helpful comments. Travel support from the Huebner Foundation for Insurance Education is gratefully acknowledged. Please address all correspondence to Yiling Deng.

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

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

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

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

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

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

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

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

price growth than it is for premium growth. The results suggest that the reduced sensitivity of premium growth by guaranty funds applies to both price and volume changes.

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

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

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

I. Property-Liability Insurance Guaranty Funds

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

Guaranty fund protection is not complete in several respects. First, guaranty funds do not cover all lines of insurance. The lines most commonly excluded are: accident and health, credit, fidelity, mortgage guaranty, financial guaranty, ocean marine, surety, title, and warranty. However, there is variation in the excluded lines across time[3] and significant variation across the states.[4] Second, guaranty funds do not pay claims beyond maximum amounts. The maximum claim amount ranges from $100,000-$5,000,000. Table 1 shows that a majority of states have a maximum amount in the $300,000-$500,000 range. In most states, the caps do not apply to workers compensation insurance, and some states establish separate guaranty funds for workers compensation. Third, some states apply policyholder net worth provisions, in which claims are not paid for policyholders that have a net worth that exceeds specified levels. The typical net worth provision is $25,000,000, the net worth cap ranges from $5,000,000 to $50,000,000 (see Table 1). Fourth, the policyholders of insurers not licensed in the state (surplus lines insurers) are not covered by guaranty funds. Surplus lines insurers underwrite risks that do not meet the underwriting guidelines of licensed insurers or require specialized coverage, pricing or underwriting. Surplus lines insurers have flexibility both in contract language and pricing that

[2] New York uses a pre-funding model instead of an ex-post funding model.

[3] Several states changed their excluded lines during our sample years. For example, NV started to exclude financial guaranty, warranty and credit in 1993; OH started to exclude financial guaranty, fidelity and credit in 1994; and PA started to exclude financial guaranty and warranty in 1995.

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

allow them to underwrite a variety of risks---including ones that are unusual and/or substandard--that do not conform to typical insurer appetites.

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

II. Data and Sample Construction

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

We use A.M. Best rating changes to proxy insurer financial strength changes. The insurance market is evaluated by several credit rating agencies such as A.M. Best, Fitch, Moody's and Standard and Poor's (S&P). Among them, A.M Best has, by far, the most comprehensive coverage over the sample period. From A.M. Best's *Insurance Reports, Property-Casualty Edition and Best's Key Rating Guide*, we obtain insurer financial strength ratings from 1989 to 2011. Similar to Epermanis and Harrington (2006), we use rating changes to proxy for changes in insurer default risk. The financial strength ratings are on a scale from A++ (the highest) to F (the lowest). Bohn and Hall (1997) find that insurers approaching insolvency have unusually high premium growth two years prior to failure. As a result, we exclude the small number of insurers with financial strength ratings below C- (less than 0.1% of total observations).[5] Firm-year observations in which the firm was not assigned a rating by A.M. Best – for reasons such as insufficient size, company request, or failure to submit an NAIC annual statement – are excluded from our analysis, as are observations rated on the parallel Financial Performance Rating (FPR) scale that was used

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

during the 1990's. A.M Best updates ratings throughout the year with most changes occurring before July. To allow comparability with other studies (e.g., Epermanis and Harrington, 2006), we treat any rating change from August of last year through July of this year as a rating change in this year, and any rating change after August of this year as a rating change in the next year. Table 2 shows A.M. Best ratings and how we categorize the ratings into high (above A-), A-, and low (below A-) ratings.

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

To be included in the sample, firms must have positive direct and net premiums written and write business in a certain line in the three years around a rating change (i.e. year t-1, t, t+1).[7] Insurers that specialize in reinsurance or international business are excluded. The original sample has 4,615,898 firm-line-year-state level observations and is aggregated to 245,934 firm-line-year level observations with many observations being zero in premiums written. The sample screens described above reduce the sample to 147,999 firm-line-year level observations. The inclusion of lagged rating variables in our regressions further reduces the sample to 142,250 firm-line-year level observations. In our analysis of the impact of market discipline on prices, we exclude all observations with negative prices. This step reduces the price sample to 120,533 observations at the firm-line-year level. All variables are winsorized at the 1% and 99% levels to mitigate the effect of outliers.

III. Identification strategy

A. Firm-line level specification

Our identification strategy is to exploit the features of guaranty funds that vary across the states and time. The variations in guaranty fund coverage are quasi-natural experiments—they directly protect insureds but are exogenous to the insurers' financial strength. We first examine how government guarantees and rating changes affect premium growth at the firm-line level, with controls for firm observed and unobserved (invariant) heterogeneity, line of business unobserved (invariant) heterogeneity and unobserved time heterogeneity. Insurance lines with a higher proportion of premiums not covered by guaranty funds are hypothesized to be more risk sensitive

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

and, thereby, more affected by rating changes. To measure this effect, we aggregate direct written premiums to the firm-line-year level to obtain total direct premiums, direct premiums not covered by guaranty funds (called uncovered premiums) and direct premiums covered by guaranty funds (called covered premiums).[6] Specifically, we calculate $Prop_{ijt}$ as the proportion of direct premiums written not covered by guaranty funds to total direct premiums written at the firm-line-year.

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

To address these concerns, we use three strategies. First, to address unfavorable changes in the environment for writing insurance we include indicator variables for one-year leaded, contemporaneous, and one-year lagged rating changes (i.e. rating change indicators in t-1, t, and t+1). We interact these indicators with guaranty fund coverage in the previous year to identify evidence on market discipline across different levels of protected financing. The strategy of using leading and lagged indicators is also employed by Epermanis and Harrington (2006). The one year lagged rating change is used to account for the *ex post* effects of the rating change. The coefficients of leaded variables provide insight into whether market discipline occurs in the year prior to a rating change. The differences among the coefficients of the leaded, contemporaneous, and lagged rating change variables provide information on whether market discipline occurs before, during, or after the year of the rating change. Second, to address the concern that the proportion of uncovered premiums may vary through time, we include the interaction of a linear time trend with the proportion of uncovered premiums in the regressions. Third, to further control for the

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

possibility that the insurers and markets anticipate rating changes we include a non-ratings based measure of firm risk. In particular, we include the variable, *Anticipation*, which is the average value of default-value-to-liability ratio (*Risk)* for the year's t-1 and t-2.[8]

The main estimating equation is:

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

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

The expected premium growth conditional on no rating change is:

$$E(\Delta P_{ijt} \mid no\ rating\ change) = \beta_0 + \beta_1 P_{ijt\text{-}1} + \beta'_2 X_{it} + \varepsilon_{ijt} \quad (2)$$

where $P_{ijt\text{-}1}$ is lagged log premiums; X_{it} is a vector of covariates that includes controls for firm time variant characteristics such as asset, leverage, reinsurance, geographical diversification, line of business diversification, organizational form, direct writer, premiums subjected to prior approval rate regulation and rating categories (A- or LOW) in the previous year (see extended models in Table 8 for more details), and also guaranty fund related controls such as claim caps and net worth provisions.[9] All variables are winsorized at the 1% and 99% levels. This research design allows us to account for both the time-invariant characteristics of firm and lines of business and the time-varying characteristics of firms.

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

[8] The precise definition of the variable *Anticipation* is in Appendix A.
[9] The hypotheses and precise definitions of the control variables can be found in Appendix A.

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

B. Firm-line-state level specification

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

State variations:

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

Insurance line of business variations:

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

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

IV. Impact of State Guaranty Funds on Market Discipline

A. Summary statistics and control group tests for premium growth

Figure 1 shows the quantile plot of the proportion of uncovered premiums to total direct premiums at the firm-line level. More than 80% of the firm-line-year observations are fully covered by guaranty funds (the proportion of uncovered premiums equals 0). Beyond this 80th percentile threshold, the proportion of uncovered premiums increases sharply from 0% uncovered to above 50%. Amongst the firm-line-year observations that write uncovered insurance, less than 3% have less than 25% in uncovered premiums. We categorize firm-line-year observations into "covered" and "uncovered" groups using a threshold of 25% of business written in uncovered premiums for control group tests.[10]

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

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

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

amount of $300,000 or more; and 41.1% are in states with net worth provisions beyond $25,000,000.

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

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

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

Table 6 shows the control group test results by pre-change rating category (high, A-, or low) – Panel A for insurer downgrades and Panel B for upgrades. The mean abnormal premium growth for downgrades is negative and statistically significant in year *t* and *t+1* for both the covered and uncovered group. However, for firms rated A- and below, the mean and median abnormal premium growth for the covered and uncovered group are significantly different. Specifically, in the A- rating category mean abnormal premium growth is -30.01% in year *t* and -31.65% in year *t+1* for the uncovered-group. It is -14.80% in year *t* and -17.28% in year *t+1* for

the covered-group. The difference between the uncovered and covered-groups is -14.22% and -14.37% in year *t* and *t+1*, respectively. For low rated firms, mean abnormal premium growth is -26.01% in year *t* and -17.01% in year *t+1* for the uncovered-group and -13.04% and -11.61% for the covered-group. The difference is -12.96% in year *t* and -5.40% in year *t+1*. The difference in mean and median abnormal premium growth between the two groups in year *t-1* is not statistically significant for downgrades, suggesting that there is no pattern change in premiums prior to the downgrade. The results indicate that the uncovered-group experiences more negative mean abnormal premium growth with a rating downgrade compared to the covered-group.

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

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

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

Table 7 reports the least squares and fixed effects estimates of the model described by equations (1) and (2) for direct premium growth. Model (1) reports the OLS results, Model (2) shows the results with firm-line, and year fixed effects, Model (3) adds "Anticipation" and firm and guaranty fund controls. In order to account for the possibility that the size of the insurer influences the effect of market discipline, we use weighted fixed effects in Model (4).[11] Model (5),

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

which we discuss in detail below, is a 2SLS regression, which is designed to address the concern that changes in the proportion of uncovered premiums may arise endogenously with rating changes.

The implications of the regressions are broadly consistent with those of the control group tests, but the magnitudes of the estimated coefficients on the rating change variables are smaller in the fixed effects regressions. A Hausman test rejects the null hypothesis that differences in the coefficients of OLS and fixed effects are not systematic, suggesting the fixed effects approach is appropriate. The results are robust to the inclusion of the firm and guaranty fund controls and to the interaction of the linear year trend with the proportion of uncovered premiums. The results support the hypothesis that guaranty fund protection reduces policyholder sensitivity to risk---the coefficients for $\beta_{current}$ are about -0.047 for downgraded insurers and 0.034 for upgraded insurers in Model (2). The coefficient on *Anticipation* is not significant in all Models, indicating that market anticipation of the insurer risk change is weak. We get similar results using weighted fixed effects (Model (4)). The magnitudes which guaranty funds dull risk sensitivity are marginally higher in the weighted fixed effects model.

Table 8 extends equations (1) and (2) by incorporating pre-change rating categories. The coefficients in fixed effects model for β_{pre} provide little evidence that premium growth the year prior to a rating change varies with the proportion of uncovered premiums. The coefficients for $\beta_{current}$ for A- insurer downgrades (-0.200) and $\beta_{current}$ for Low insurer downgrades (-0.143) are significantly negative, indicating that firm-lines with relatively higher proportion of uncovered premiums experience more negative premium reactions to downgrades, ceteris paribus.

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

While the features of guaranty funds in each state (i.e. which lines are covered, the maximum claim amount, and the net worth provisions) are exogenous for individual insurers, it is possible that the proportion of uncovered premiums is endogenous, as insurers that experience downgrades may rely more on covered business, and vice versa.[12] To deal with this potential problem, we use an instrumental variables (2SLS) procedure based on the weighted fixed effects model. The first stage regression instruments the proportion of uncovered premiums with its value lagged by three years, *Mutual*, *Group*, *Busherf,* and *Geoherf.* The R^2 of the first regression (not reported here) is around 0.89. The predicted value of the first-stage regression is then used in the second stage regression instead of the actual value. The results, shown in Table 8 Model (5), indicate that the magnitude by which guaranty funds dull risk sensitivity is marginally higher than the original weighted fixed effects model.

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

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

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

To see whether this state-variation effect is driven by non-traditional lines of insurance, we re-do the analysis using only traditional lines of insurance or only non-traditional lines. We classify non-traditional lines of insurance as credit, surety, fidelity, financial guaranty, mortgage guaranty, ocean marine, warranty, and title insurance. These are the lines of insurance that are most commonly not covered by guaranty funds. Column 2 shows the results using the traditional lines of insurance. Column 3 shows the results for non-traditional lines. For traditional lines, the coefficients on the interaction terms of ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant for downgrades of A- and low rated firms. A

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

downgrade yields a 21.2% drop in premium growth for A- rated firms. The drop is 11.9% for low rated firms. For non-traditional lines, the coefficients on the interaction terms of ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant for downgrades. A downgrade yields a 3.0% drop in premium growth for high rated firms, a 7.9% drop for A- rated firms and an 8.4% drop for low rated firms. The results indicate that the effect of guaranty funds is not being driven by non-traditional lines of insurance. In fact, the magnitudes of the declines are greater for traditional lines than non-traditional lines. The results also indicate that customer sensitivity to risk is greater for lower rated insurers in traditional lines, but higher for higher rated insurers in non-traditional lines, suggesting that financial quality is perhaps more important in non-traditional lines.

Columns 4 and 5 test state variation for personal lines and commercial lines.[13] The results imply that guaranty funds mainly influence downgrades in commercial lines. The results are in line with the findings in Epermanis and Harrington (2006) that market discipline works more in commercial lines than personal lines.

As shown in Table 11 (line of business variation model described in equation (4)), a downgrade yields a 5.8% drop in premium growth for high rated firms and 5.3% for A- rated firms in lines of insurance not protected by guaranty funds. A downgrade also yields a 5.5% drop in premium growth for low rated firms. The effect is also manifest in nontraditional and commercial lines.

In Table 10 and Table 11, the effects are from insurers running both covered and uncovered business at the same time, i.e. insurers in the same firm and line of business but running business in different states, or insurers in the same firm and state but running business in different lines. We find premium declines greater in the uncovered business following downgrades. Thus we find that guaranty funds shield insurers from the full costs of market discipline.

D. Robustness checks

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

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

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

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

We explore the dynamic effect of rating changes by applying an event study framework with a long window (-7 years to 7 years surrounding the rating change). We use this flexible event study framework to non-parametrically estimate the pattern of premium growth for downgrades (e.g. Gallagher, 2014).[14] The model is:

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

(5)

where ΔP_{ijt} is premium growth for firm i, line j, and year t; γ_{ij} is a firm-line fixed effect and δ_t is a year fixed effect. The independent variables of interest are the event time indicator variables, 1_{ijx}. These variables track the year of a rating change and the years preceding and following a rating change. The indicator variable $1_{ij,0}$ equals 1 if a firm has a rating change in that calendar year. The indicator variable $1_{ij,x}$ equals 1 if the firm has rating change in $-x$ years. Many firms have more than one rating change during the sample period. For these firms, each rating change is coded with its own set of indicator variables.[15] To make the results comparable with the previous research design, the event time indicator variable $1_{ij,-2}$ is normalized to zero. In practice, this is done by excluding $1_{ij,-2}$ from the regression. We also create $1_{ij,head}=1$ if $x \in [-20, -7]$, and $1_{ij,tail}=1$ if $x \in [7, 20]$. Equation (5) is then estimated with these two bin indicators. The estimated coefficient $\beta_{u'x}$ captures the percentage response in premium growth per unit change of the proportion of uncovered premiums x $(-x)$ year after (before) rating change.

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

[14] We also estimate the pattern of premium growth for upgrades. We do not find any significant evidence that there are different effects of guaranty fund protections on market discipline for insurer upgrades.

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

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

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

D.2 Test for the alternative explanation

Another potential concern is that covered business and uncovered business may differ in their business characteristics and in particular their profitability and riskiness. Firms may reduce their exposure to less profitable or higher risk business after a downgrade. Thus, the observed drop in uncovered business may be due to changes in the composition of the insurer's underwriting portfolio and not because of guaranty fund protection. We investigate the alternative explanation in two ways. First, we examine whether uncovered business is more or less profitable than covered business. We test whether the mean value of the ratio of losses to premiums (the loss ratio) differs by guaranty fund status. A higher loss ratio implies less profitable business. We first divide all insurers' business into covered business and uncovered business at the firm-line-state-year level. We then aggregate direct losses incurred and direct premium earned for covered and uncovered business, at the line and year level. We then divide aggregate losses by aggregate premiums. Table 12 reports differences in the means by guaranty fund covered status. In general, the results show that the loss ratio of uncovered business is largely the same as the loss ratio of covered business.

We do not find significant differences in the mean values of the loss ratio between covered business and uncovered business, except for workers compensation, special liability and warranty. We find the mean value of the loss ratio is higher for uncovered business in workers compensation, [16] but the measure is lower for uncovered business in special liability and warranty. Based on these results, we cannot conclude that uncovered business is more or less profitable than covered business.

Second, we examine whether premium growth differs by the risk characteristics of business surrounding rating changes. If our results are driven by downgraded insurers' trimming risky business, then we should observe that behavior across all lines of business (i.e., firms would also cut back on riskier covered business). To examine riskiness, we calculate the variance of the loss ratio by line of business (shown in Table 12). A more volatile loss ratio suggests a higher risk line of business (Lamm-Tennant and Starks, 1993). We sort the lines of business into high and low risk groups – if the variance of the loss ratio is in the top seven lines among the 14 lines it is classified as high risk and it is in the bottom then it is classified as low risk.[17] The seven high risk lines are homeowners/farmowners, medical malpractice, special liability, special property, fidelity/surety, product liability and financial guaranty/mortgage guaranty. We run two models using our previous identification strategies. First, we calculate the *proportion of high risk business* as the fraction of direct premiums written of high risk business to total direct premiums written and repeat our first identification strategy in equation (1) and (2). As shown in the Table 13 Panel A, we do not identify any negative coefficients on interactions of downgrades and the proportion of high risk business. Second, we use data on the firm-line-state-year level. To be included in these regressions, a firm-line-state-year observation is required to be downgraded in that year. We run the regressions similar to equation (4) but we include a firm-year fixed effect, a state fixed effect and a line of business fixed effect. The firm-year fixed effect sweeps out the variation between firms, making the estimates based on only the variation within each firm across line of business and states. We use a dummy variable *High Risk Business,* which equals one to indicate if the business is high risk,

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

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

and 0 otherwise. The results are shown in Table 13 Panel B. We again do not find any negative coefficients on the interactions of the pre-change rating categories and *High Risk Business*. These results suggest that the greater premium declines in uncovered business relative to covered lines are not driven by insurers changing the risk composition of their underwriting portfolios.

V. Prices, Market Discipline, and Government Guarantees

A. Prices and Market Discipline

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

We study the relationship between insurance prices and changes in financial strength ratings. In particular, we use equation (1) and equation (2), but replace the dependent variable, premium growth, with price growth. We calculate insurance price growth (Δ*Log Price*). Since explicit contract prices are not available, we follow the literature and use an implicit measure of price (e.g. Cummins and Danzon, 1997; Cummins et al., 2005).[18] We measure price at the firm-line level as information on business net of reinsurance is not available at firm-line-state level.[19] Since premiums are revenues (price times quantity), the impact of downgrades on prices will yield insight on the price mechanism and because we have already studied the impact on premiums, we can impute the impact on quantity.

The results of fixed effects estimates of price growth using net business are reported in Table 14. The regressions in Models (1) and (2) do not consider guaranty fund characteristics, while Models (3) and (4) do. The regressions reported in Table 15 incorporate the pre-change rating categories. We document several noteworthy price effects. First, the coefficients on all current and leading variables in rating change indicators for downgrades are negative and significant, providing clear evidence that insurers have slower price growth the year before and the year of a downgrade. The coefficients on *Anticipation* are negative and statistically significant,

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

possibly indicating that insurers anticipate downgrades and adjusts prices accordingly. In Table 14, current and lagging coefficients on upgrades are positive and significant but leading variables are not significant, indicating that price growth increases after upgrades. In Table 15, all the current and leading coefficients on rating change indicators for downgrades are significant, suggesting that price deterioration may precede downgrades in the market. This phenomenon can be explained in several ways. It could be that insurers have poor underwriting results in the year before a downgrade, which explains a drop in measured price as well as the subsequent downgrade. Another explanation could be that the market anticipates rating deterioration, and prices adjust accordingly. The effect of upgrades on price growth is statistically significant---upgrades are associated with price increases for A- and low-rated insurers, with pre-rating change increases also evident for low-rated insurers.

Second, we compare coefficients across regressions of premium growth and price growth (results shown in Appendix Table C.1). The magnitudes of the coefficients on downgrades in the current price growth regression are smaller than those for premium growth change for A- and lower rated insurers.[20] We find that price growth decreases significantly in the year of a downgrade, but that the magnitude of the decrease is much smaller for price growth than it is for premium growth in the year of insurer downgrades. The results suggest that policyholders respond to increases in insurer risk both by demanding lower prices and by shifting their contracts. Insurance prices, however, are only slightly affected the year after insurer downgrades, suggesting policyholders continuously react to downgrades by switching to safe insurers.

In addition, we control for price growth in the premium growth regression, since premium growth endogenously depends on price growth. We employ the two-stage least squares method (2SLS) to investigate how premium growth changes after controlling price growth change (Results are shown in Table 17, Model (1)). Predicted price growth is included in the premium growth regression in the second step. Although the regression sample size is reduced by fifteen percent because negative prices are excluded in our analysis, we can still identify market discipline in the form of premium growth. The magnitudes of the coefficients on the rating change variables estimated for premium growth rates are smaller than the previous fixed effects regressions (Table 8, Model 2). The signs of these estimated variables in 2SLS are consistent with the previous

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

regressions (i.e. Table 8). Overall, the results suggest that price growth depends on the direction of the rating action and the magnitude of the difference is fairly small for downgrades after rating changes.

B. Price, Market Discipline and Guaranty Funds

Consistent with previous reasoning, guaranty funds may dull market sensitivity to risk changes in the price domain as well as the overall volume domain. Accordingly, we study the influence of guaranty funds on price growth in the time periods surrounding changes in insurer risks. The results are reported in Table 14 Model (3) and Model (4). Overall the evidence suggests that the guaranty fund scheme weakens market discipline in the price channel. Specifically, absence of guaranty fund protections is associated with more negative price growth after a downgrade. We extend our analysis to consider pre-change rating categories in Table 16. Our variables of interest in Table 16, the interaction term of downgrades and the proportion of uncovered premiums, generally confirms that the extent of market discipline through the price channel depends on the extent of the safety net. Specifically, the results show that the absence of guaranty fund protection significantly enhances the sensitivity of price growth to insurer downgrades. For insurers rated A- or lower prior to being downgraded, the contemporaneous coefficients are negative and significant. The coefficient estimates in Table 16 Model (2) indicate that A- insurers with a 10% higher proportion of uncovered direct premiums experience a 1.0% decrease in price growth with a downgrade in year t. We do not find significant results for upgrades. These results echo the asymmetric findings in prior literature that the market reaction to rating downgrades is stronger than the reaction for upgrades (e.g. Halek and Eckles, 2010).

We then explore the dynamic effect of rating changes on price growth by applying an event study framework with a long window (-7 years to 7 years surrounding downgrades). The results are reflected on Figure C.2 and consistent with regression result. There is significant decrease in price growth the year before downgrades and the year of downgrades. After a downgrade price growth remains negative and statistically significant for one year. However, the difference of price growth between the uncovered and covered groups disappears after one year. We also conduct the price growth analysis at the firm-line-state-year level using equation (3). We calculate the price using the information of direct premium written and the results are reported in Table C.3. The coefficients on the interaction terms of the ratings level and the indicator for lack of guaranty fund protection are negative and statistically significant only for low rated insurers only. A downgrade yields a 20.3% drop in price growth for low rated firms in business not protected by guaranty funds,

comparing to business protected by guaranty fund in the same insurers. The effect is stronger in personal lines.

Again, we employ the two-stage least squares method (2SLS) to investigate how premium growth changes after controlling for price growth changes conditional on guaranty fund protection (results are shown in Table 17 Model (2)). The results of Table 16 Model (2) and Table 17 model (2) suggest that the effect of guaranty funds on market discipline are through both the price channel and the quantity channel.

VI. Concluding Remarks

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

The study is important from a public policy perspective. Policymakers are increasingly aware of the role of market discipline in the regulation of financial firms and modern regulatory policy tries to encourage market discipline (e.g. Solvency Modernization Initiative, Basel II and Solvency II). In fact, both Basel and Solvency II include market discipline as a fundamental pillar and attempt to enhance it through public disclosure of risk-related information by banks and insurance companies. The benefit of stronger market discipline is believed to reduce the need for government intervention. Our study finds that consumer protection schemes, even ones that consumers are less aware of, impair market discipline, as such regulators must take these programs into consideration in the design of solvency regulatory policy.

Combined with the evidence on the huge cost of insurer failures (Bohn and Hall, 1997; Grace, Klein and Phillips, 2009; Leverty and Grace, 2012), our findings suggest that policy makers should address the adverse incentives that guaranty funds create in order to better discipline insurers and protect policyholders. Potential changes could be the creation of a first layer of private loss of guaranty fund coverage (e.g., coinsurance or a high deductible) or the adoption of risk-based guaranty fund assessments. Further research in the context of the insurance industry can

make use of additional sources of variation, including the varying maximum claim limits on guaranty fund coverage, as well as the unique institutional setting of the industry, which features coexistence of various organizational forms and a periodic underwriting cycle.

Indeed, the results for the insurance industry have interesting implications for the financial sector more broadly. This supports the view that deposit insurance and other public guarantees in banking have significant effects on market discipline. Further research in the context of the insurance industry can make use of additional sources of variation, including the varying maximum claim limits on guaranty fund coverage, as well as the unique institutional setting of the industry, which features coexistence of various organizational forms and a periodic underwriting cycle.

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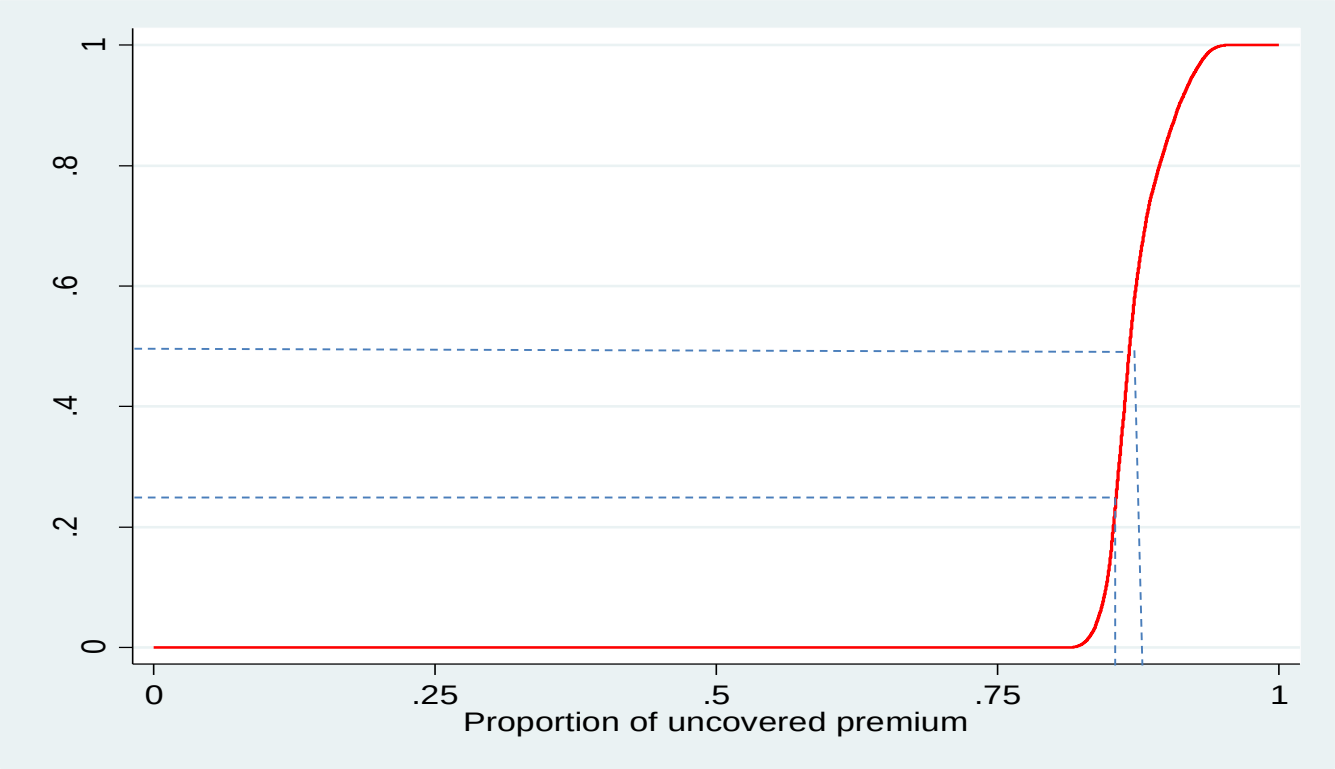
Figure 1: The Quantile Plot of the Proportion of Uncovered Premiums at Firm-Line-Years, 1990-2011



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

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

Figure 2 Panel A: Percentages of Upgrades across Years

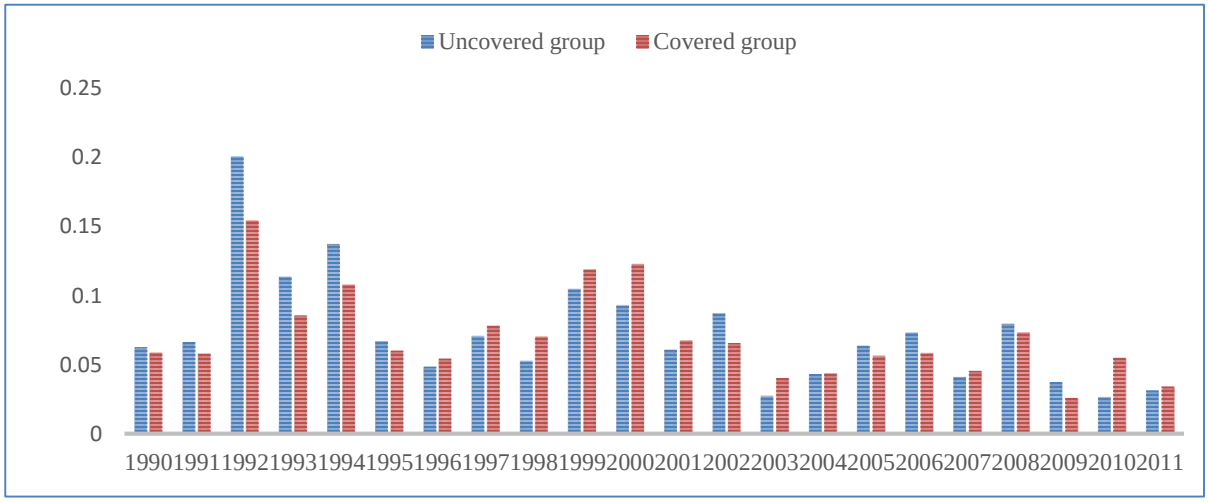


Figure 2 Panel B: Percentages of Downgrades across Years

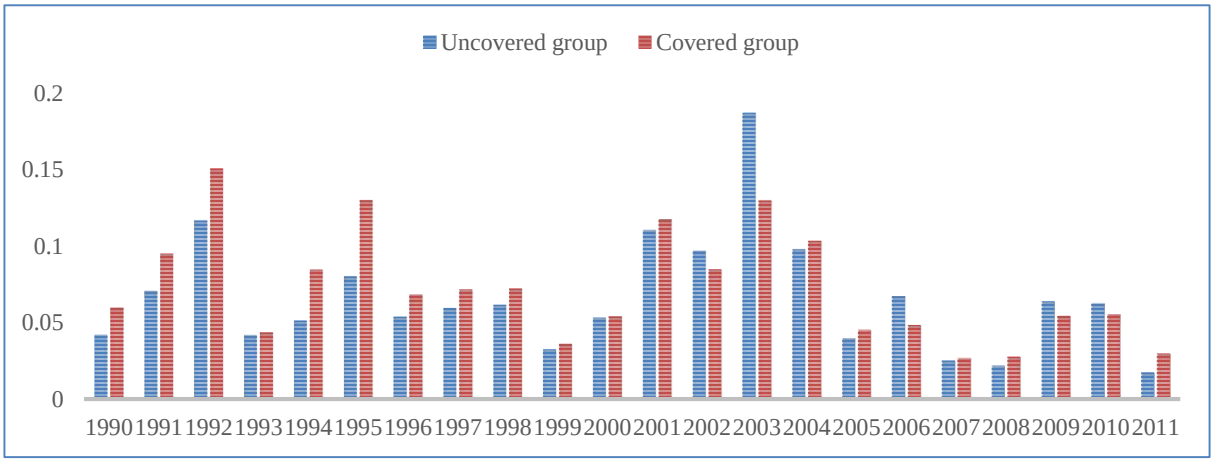


Figure 2 Panel C: Percentages of No Rating Change across Years

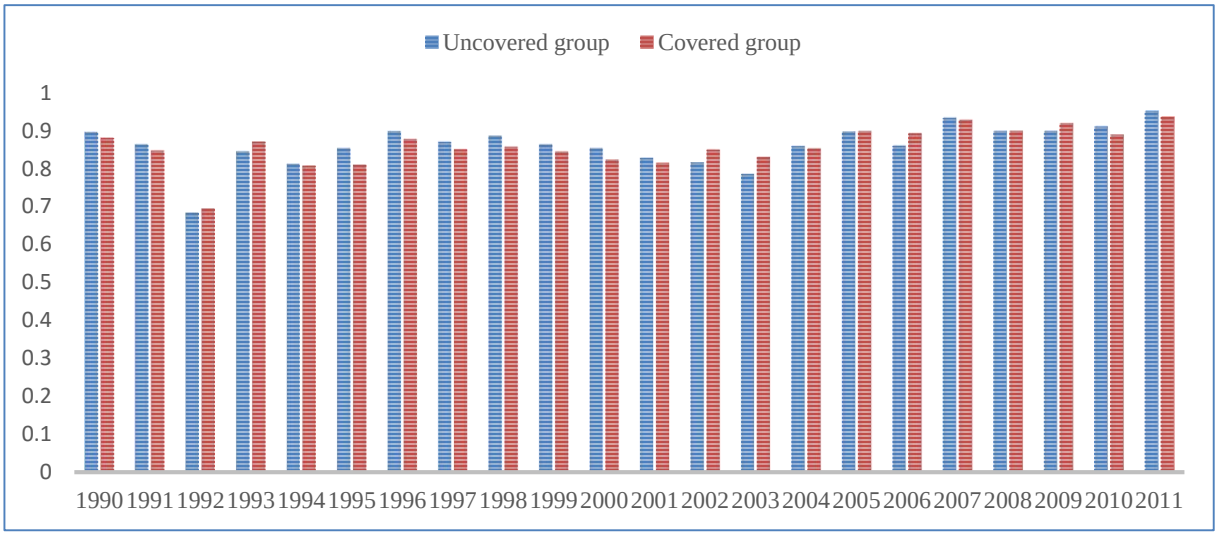
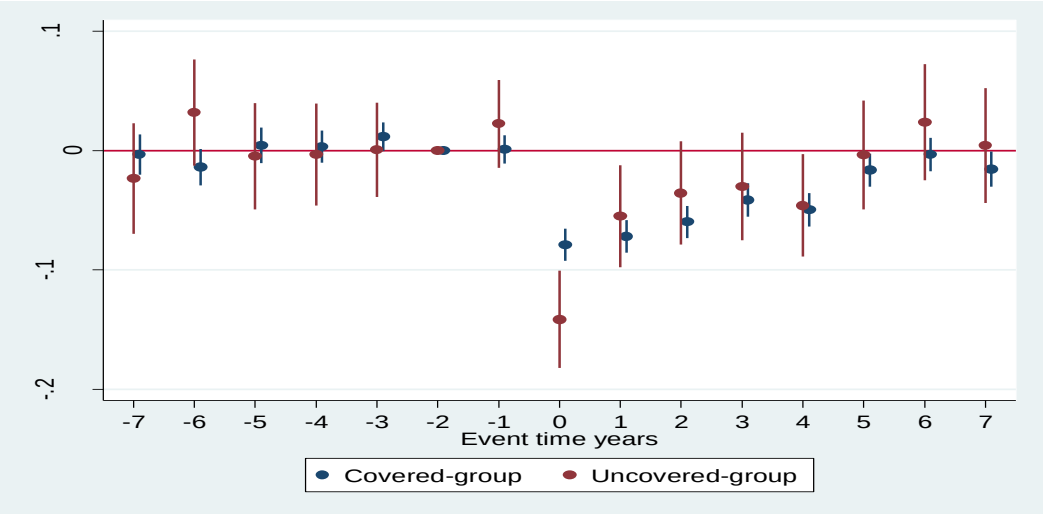


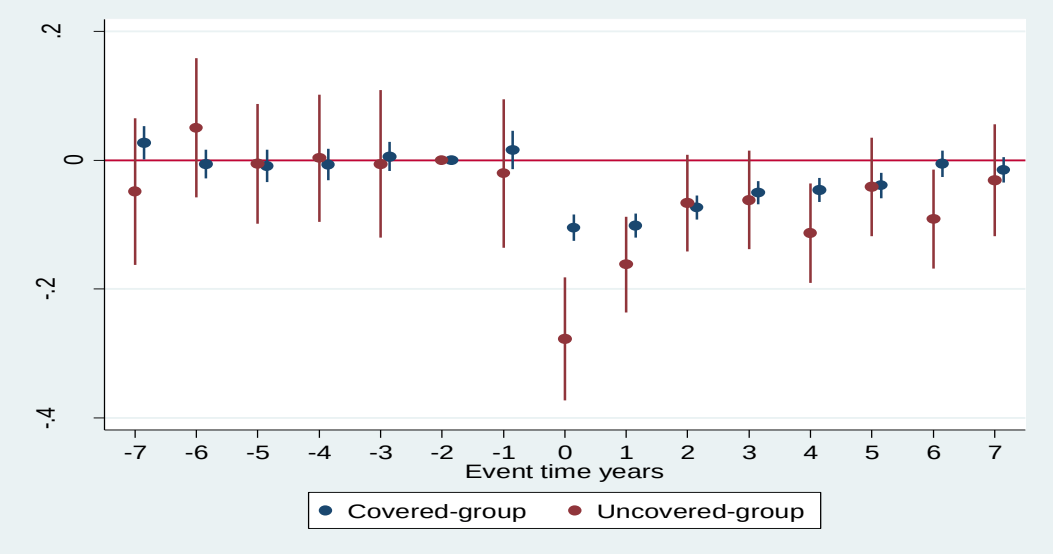
Figure 3 : Premium Growth for Insurer Downgrades at Firm-Line-Years, 1991–2011

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

Panel A:



Panel B:



Panel C:

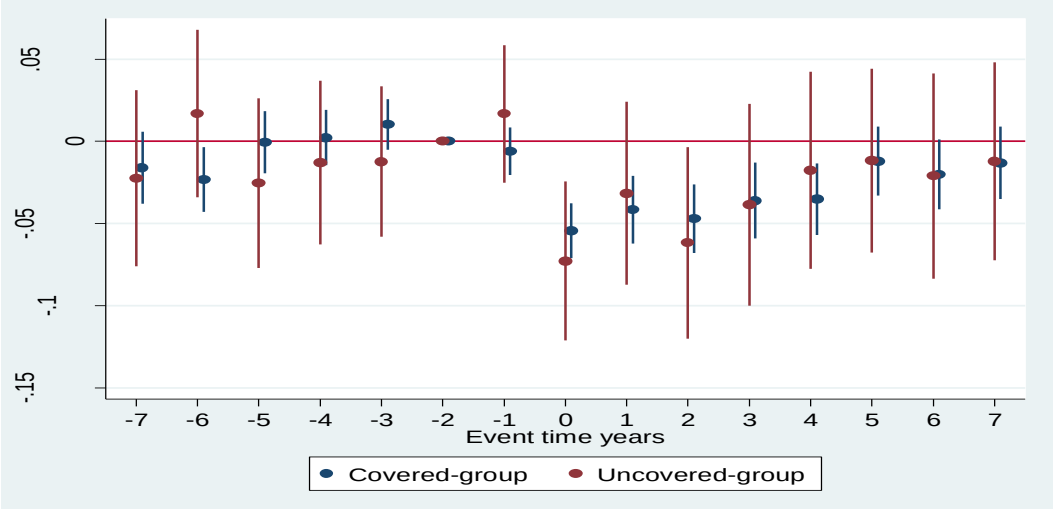


Table 1
Summary of Property-Liability Insurance Guaranty Funds, By State[22]

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

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

Table 2
Rating categories of A.M Best rating

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

Table 3
Summary Statistics at Firm-Line Level

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

Variables	**Mean**	**SD**	**Min**	**25%**	**50%**	**75%**	**Max**
Panel A: Full sample (N=147,999)							
Log Direct Premium	15.167	2.606	6.783	13.667	15.481	16.998	23.561
Δ Log Direct Premium	0.043	0.400	-1.000	-0.095	0.035	0.177	1.000
Proportion of Uncover Premiums	0.137	0.323	0.000	0.000	0.000	0.000	1.000
Panel B: Regression sample (N=142,250)							
Δ Log Direct Premium	0.042	0.401	-1.000	-0.096	0.035	0.177	1.000
High	0.610	0.488	0.000	0.000	1.000	1.000	1.000
A-	0.232	0.422	0.000	0.000	0.000	0.000	1.000
Low	0.159	0.366	0.000	0.000	0.000	0.000	1.000
Down	0.072	0.259	0.000	0.000	0.000	0.000	1.000
UP	0.071	0.258	0.000	0.000	0.000	0.000	1.000
High × Down	0.048	0.213	0.000	0.000	0.000	0.000	1.000
A- × Down	0.012	0.107	0.000	0.000	0.000	0.000	1.000
Low × Down	0.013	0.113	0.000	0.000	0.000	0.000	1.000
High × Up	0.020	0.141	0.000	0.000	0.000	0.000	1.000
A- × Up	0.019	0.136	0.000	0.000	0.000	0.000	1.000
Low × Up	0.032	0.177	0.000	0.000	0.000	0.000	1.000
Proportion of Uncover Premiums	0.138	0.324	0.000	0.000	0.000	0.000	1.000
Portfolio_Risk (sigma)	0.143	0.070	0.011	0.099	0.118	0.161	0.485
Default-value-to-liability ratio (Risk)	0.001	0.006	0.000	0.000	0.000	0.000	0.117
Anticipation	0.004	0.012	0.000	0.000	0.000	0.001	0.117
Size	18.991	1.816	13.636	17.712	18.885	20.142	25.485
Leverage	0.595	0.157	0.110	0.518	0.629	0.707	0.840
Directw	0.127	0.334	0.000	0.000	0.000	0.000	1.000
Mutual	0.171	0.377	0.000	0.000	0.000	0.000	1.000
Group	0.816	0.388	0.000	1.000	1.000	1.000	1.000
Busherf	0.330	0.213	0.068	0.178	0.266	0.407	1.000
Geoherf	0.436	0.365	0.030	0.097	0.306	0.825	1.000
Reg%	0.246	0.371	0.000	0.000	0.000	0.509	1.000
Max%	0.877	0.223	0.000	0.860	0.971	1.000	1.000
Prov%	0.411	0.353	0.000	0.067	0.351	0.692	1.000

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

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

Panel B: Covered	Rating	No. of observation	% Total	No change	% No change	Upgrade	% Upgrade	Downgrade	% Downgrade
High	**A++**	7704	6.17%	6979	90.59%	0	0.00%	725	9.41%
	A+	29294	23.47%	26019	88.82%	773	2.64%	2502	8.54%
	A	37832	30.31%	33649	88.94%	1536	4.06%	2647	7.00%
	Total	74830	59.95%	66647	89.06%	2309	3.09%	5874	7.85%
	A-	28606	22.92%	24878	86.97%	2259	7.90%	1469	5.14%
Low	**B++**	8097	6.49%	6240	77.07%	1215	15.01%	642	7.93%
	B+	7657	6.13%	5446	71.12%	1594	20.82%	616	8.05%
	B	3416	2.74%	2422	70.90%	720	21.08%	274	8.02%
	B-	1274	1.02%	791	62.09%	358	28.10%	125	9.81%
	C++	362	0.29%	205	56.63%	127	35.08%	30	8.29%
	C+	320	0.26%	154	48.13%	131	40.94%	35	10.94%
	C	217	0.17%	113	52.07%	97	44.70%	7	3.23%
	C-	41	0.03%	27	65.85%	12	29.27%	2	4.88%
	Total	21384	17.13%	15398	72.01%	4254	19.89%	1731	8.09%
Total		124820	100.00%	106923	85.66%	8822	7.07%	9074	7.27%

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

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

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

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

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

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

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

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

The dependent variable is ΔLog Premium$_t$. The sample consists of 142,250 firm-line-years. *Prop* is the proportion of uncovered premiums to total premiums in the previous year. *Anticipation* is the average value of the default-value-to-liability ratio (*Risk*) calculated as in Myers and Read (2001) for the year t-1 and t-2. The *Firm & Guaranty funds Controls* include *Size, Leverage, Group, Mutual, Geoherf, Busherf, Reg%, Max%, Prov%, Directw* and the interaction of *Prop* with a linear year trend (variables are defined in Table 3). The last column shows the results of Two-Stage Least Square estimates of ΔLog Premium$_t$. The proportion of uncovered premiums is instrumented by its value lagged of three years, *Size, Geoherf, Busherf, Mutual* and *Group* in the first stage of regression and the predicted value is used in the second stage. The interaction of the proportion of uncovered premiums with a linear trend is included in 2SLS. The sample for 2SLS regression includes 138,878 observations, as the data of 1991 is deleted. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)	F.E. (3)	Weighted FE (4)	2SLS (5)
Log premium $_{t-1}$	-0.021***	-0.105***	-0.121***	-0.104***	-0.113***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Prop. of Uncovered Premiums $_{t-1}$	-0.040***	-0.042*	0.054**	0.034	-0.001
	(0.006)	(0.023)	(0.027)	(0.031)	(0.022)
Up_{post}	0.007	-0.009*	0.005	-0.004	0.004
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
$Up_{current}$	-0.004	-0.025***	-0.011**	-0.015***	-0.013***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Up_{pre}	-0.020***	-0.031***	-0.022***	-0.027***	-0.023***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Down_{post}$	-0.068***	-0.051***	-0.046***	-0.049***	-0.045***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Down_{current}$	-0.065***	-0.058***	-0.056***	-0.062***	-0.059***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Down_{pre}$	0.006	0.011**	0.008*	-0.003	0.002
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Prop $_{t-1}$ × Up_{post}	0.041**	0.030*	0.017	0.024	0.030*
	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)
Prop $_{t-1}$ × $Up_{current}$	0.057***	0.034**	0.016	0.019	0.011
	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)
Prop $_{t-1}$ × Up_{pre}	-0.025	-0.026	-0.042**	-0.034*	-0.029
	(0.017)	(0.018)	(0.018)	(0.018)	(0.019)
Prop $_{t-1}$ × $Down_{post}$	0.015	0.009	0.012	0.001	0.017
	(0.019)	(0.020)	(0.020)	(0.022)	(0.021)
Prop $_{t-1}$ × $Down_{current}$	-0.047***	-0.047**	-0.049**	-0.057***	-0.068***
	(0.018)	(0.020)	(0.019)	(0.021)	(0.020)
Prop $_{t-1}$ × $Down_{pre}$	0.012	0.023	0.017	0.006	0.020
	(0.017)	(0.018)	(0.018)	(0.019)	(0.018)
Anticipation	—	—	-0.101	-0.308	-0.318
			(0.114)	(0.229)	(0.220)
Constant	0.367***	1.655***	1.853***	1.149***	1.203***
	(0.010)	(0.027)	(0.080)	(0.103)	(0.098)
Firm-Line, Year Fixed Effects	NO	YES	YES	YES	YES
Firm & Guaranty funds Controls	NO	NO	YES	YES	YES
R^2	0.022	0.261	0.275	0.259	0.263
Observations	142,250	142,250	142,250	142,250	138,878

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

The dependent variable is ΔLog Premium$_t$. The sample consists of 142,250 firm-line-years. *Anticipatio*n is the average value of default-value-to-liability ratio (*Risk*) calculated as in Myers and Read (2001) for the years t-1 and t-2. The *Firm & Guaranty Funds Controls* include *Size*, *Leverage*, *Group*, *Mutual*, *Geoherf*, *Busherf*, *Direct writer*, *Reg%*, *Max%*, *Prov%* and the interaction of *Prop* with a linear year trend. All regressions include pre-change rating categories, the interaction of *Prop* with pre-change rating categories, the variables of rating upgrades and downgrade and rating categories as shown in Table 3, and the interaction of the rating changes with *Prop*. The last column shows the results of Two-Stage Least Square estimates of ΔLog Premium$_t$. The proportion of uncovered premiums is instrumented by its value lagged of three years, *Size*, *Geoherf*, *Busherf*, *Mutual* and *Group* in the first stage of regression, and the predicted value is used in the second stage. The sample for 2SLS regression includes 138,878 observations as the data of 1991 is deleted. Standard errors are adjusted for heteroskedasticity and clustered at firm-line level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	OLS (1)	F.E. (2)	F.E. (3)	Weighted FE (4)	2SLS (5)
$Prop_{t-1} \times High \times Down_{post}$	0.021	0.020	0.021	0.020	0.019
	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)
$Prop_{t-1} \times High \times Down_{current}$	-0.010	-0.012	-0.017	-0.009	-0.040*
	(0.021)	(0.022)	(0.021)	(0.023)	(0.023)
$Prop_{t-1} \times High \times Down_{pre}$	0.044**	0.047**	0.039*	0.026	0.034
	(0.020)	(0.021)	(0.021)	(0.021)	(0.022)
$Prop_{t-1} \times A- \times Down_{post}$	-0.059	-0.079	-0.065	-0.166**	-0.047
	(0.058)	(0.061)	(0.059)	(0.073)	(0.063)
$Prop_{t-1} \times A- \times Down_{current}$	-0.204***	-0.192***	-0.200***	-0.330***	-0.178***
	(0.047)	(0.053)	(0.051)	(0.060)	(0.056)
$Prop_{t-1} \times A- \times Down_{pre}$	-0.081*	-0.045	-0.047	-0.040	-0.024
	(0.043)	(0.046)	(0.044)	(0.048)	(0.045)
$Prop_{t-1} \times Low \times Down_{post}$	-0.070	-0.103	-0.093	-0.116	0.020
	(0.076)	(0.083)	(0.081)	(0.102)	(0.082)
$Prop_{t-1} \times Low \times Down_{current}$	-0.115**	-0.151**	-0.143**	-0.265***	-0.187***
	(0.058)	(0.072)	(0.069)	(0.087)	(0.072)
$Prop_{t-1} \times Low \times Down_{pre}$	-0.033	-0.064	-0.066	-0.155**	-0.011
	(0.063)	(0.059)	(0.059)	(0.078)	(0.064)
$Prop_{t-1} \times High \times Up_{post}$	0.024	0.021	0.013	0.034	-0.007
	(0.029)	(0.029)	(0.028)	(0.027)	(0.030)
$Prop_{t-1} \times High \times Up_{current}$	0.041	0.026	0.013	0.017	-0.022
	(0.029)	(0.029)	(0.029)	(0.027)	(0.031)
$Prop_{t-1} \times High \times Up_{pre}$	0.003	-0.002	-0.015	0.002	-0.028
	(0.028)	(0.029)	(0.029)	(0.030)	(0.031)
$Prop_{t-1} \times A- \times Up_{post}$	0.061**	0.055*	0.049*	0.048	0.066**
	(0.028)	(0.029)	(0.029)	(0.032)	(0.031)
$Prop_{t-1} \times A- \times Up_{current}$	0.006	0.009	-0.003	0.019	0.005
	(0.032)	(0.036)	(0.035)	(0.038)	(0.037)
$Prop_{t-1} \times A- \times Up_{pre}$	-0.042	-0.038	-0.051	-0.047	-0.046
	(0.030)	(0.032)	(0.032)	(0.034)	(0.034)
$Prop_{t-1} \times Low \times Up_{post}$	0.053**	0.049*	0.043	0.023	0.042
	(0.027)	(0.027)	(0.027)	(0.031)	(0.028)
$Prop_{t-1} \times Low \times Up_{current}$	0.117***	0.078**	0.070**	0.045	0.039
	(0.031)	(0.035)	(0.035)	(0.046)	(0.037)
$Prop_{t-1} \times Low \times Up_{pre}$	-0.057	-0.038	-0.041	-0.054	-0.028
	(0.035)	(0.038)	(0.037)	(0.042)	(0.038)
Firm-Line &Year Fixed Effects	NO	YES	YES	YES	YES
Firm & Guaranty funds Controls	NO	NO	YES	YES	YES
R^2	0.031	0.264	0.283	0.264	0.266
Observations	142,250	142,250	142,250	142,250	138,878

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

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

Lines	$Down_{post}$	$Down_{current}$	$Down_{pre}$	Up_{post}	$Up_{current}$	Up_{pre}	$Prop_{t-1} \times Down_{post}$	$Prop_{t-1} \times Down_{current}$	$Prop_{t-1} \times Down_{pre}$	$Prop_{t-1} \times Up_{post}$	$Prop_{t-1} \times Up_{current}$	$Prop \times Up_{pre}$
Homeowners /Farmowners	-0.037*** (0.011)	-0.014 (0.011)	-0.001 (0.011)	0.013 (0.012)	-0.009 (0.012)	-0.003 (0.012)	0.111 (0.097)	-0.174 (0.185)	0.103 (0.123)	0.145 (0.128)	0.234*** (0.095)	0.158 (0.160)
Auto physical damage	-0.050*** (0.012)	-0.069*** (0.012)	-0.001 (0.011)	0.007 (0.011)	-0.009 (0.011)	-0.025** (0.012)	0.199 (0.139)	-0.023 (0.140)	0.098 (0.125)	-0.040 (0.084)	0.024 (0.086)	-0.073 (0.093)
Auto liability	-0.040** (0.016)	-0.098*** (0.016)	-0.023 (0.015)	-0.003 (0.014)	-0.021 (0.015)	-0.033** (0.015)	0.068 (0.112)	-0.181 (0.134)	0.055 (0.118)	0.160 (0.109)	-0.079 (0.119)	0.001 (0.096)
Workers' compensation	-0.044*** (0.017)	-0.119*** (0.018)	0.029* (0.017)	-0.018 (0.017)	-0.031** (0.016)	-0.024 (0.017)	0.104 (0.260)	-0.076 (0.237)	0.210 (0.298)	0.206 (0.252)	0.141 (0.332)	-0.038 (0.169)
Commercial multiple Peril	-0.033*** (0.014)	-0.055*** (0.015)	-0.005 (0.014)	0.004 (0.014)	-0.025 (0.015)	-0.039*** (0.015)	-0.032 (0.109)	-0.175* (0.093)	-0.054 (0.094)	0.110* (0.060)	-0.006 (0.077)	0.007 (0.064)
Commercial liab.	-0.040*** (0.012)	-0.057*** (0.013)	0.001 (0.012)	0.012 (0.012)	-0.016 (0.012)	-0.028*** (0.012)	-0.077 (0.074)	-0.124* (0.067)	0.017 (0.048)	0.052 (0.042)	0.042 (0.042)	0.006 (0.045)
Special property	-0.027 (0.047)	-0.072 (0.044)	-0.024 (0.044)	0.019 (0.041)	-0.029 (0.044)	-0.061 (0.046)	-0.004 (0.061)	-0.021 (0.057)	0.033 (0.058)	0.005 (0.053)	0.018 (0.058)	-0.032 (0.060)
Misc. commercial lines	-0.034** (0.012)	-0.048*** (0.012)	-0.008 (0.011)	-0.002 (0.011)	-0.007 (0.012)	-0.001 (0.011)	-0.013 (0.075)	-0.085 (0.079)	0.013 (0.070)	0.017 (0.059)	0.006 (0.059)	-0.144* (0.063)

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

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

Variables	**All Lines**	**Traditional Lines**	**Nontraditional Lines**	**Personal Lines**	**Commercial Lines**
Log Premium $_{t-1}$	-0.088***	-0.088***	-0.090***	-0.034***	-0.101***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Uncover × High	-0.013	0.054	-0.030***	-0.079	-0.017*
	(0.010)	(0.035)	(0.010)	(0.109)	(0.010)
Uncover × A-	-0.152***	-0.212***	-0.079***	-0.045	-0.159***
	(0.025)	(0.038)	(0.030)	(0.082)	(0.026)
Uncover × Low	-0.097**	-0.118**	-0.084*	0.251	-0.112**
	(0.035)	(0.055)	(0.045)	(0.191)	(0.035)
Insurance GSP	0.003	0.003	0.006	-0.003	0.005
	(0.003)	(0.004)	(0.012)	(0.008)	(0.004)
State Income	0.017*	0.016	0.026	-0.015	0.025**
	(0.009)	(0.010)	(0.030)	(0.022)	(0.011)
Insurance Employment	0.005**	0.005**	0.004	0.004	0.004*
	(0.002)	(0.002)	(0.007)	(0.005)	(0.003)
Firm-Line-Year Fixed Effect	YES	YES	YES	YES	YES
State Fixed Effect	YES	YES	YES	YES	YES
R^2	0.414	0.416	0.403	0.446	0.417
Observations	229,410	204,124	25,286	36,750	192,660

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

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

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

Table 12
Univariate Tests of Loss Ratio by Guaranty Fund Covered Status by Lines

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

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

Table 13 Insurers' Risk Management Behavior

The dependent variable is ΔLog Premium$_t$. The sample period is 1991-2011. Risky business is defined as the first seven insurance lines with high variances of loss ratio based on Table 12. Regressions include only business covered by guaranty funds. In Panel A, the sample is at firm-year level. The sample consists of 33,104 firm-years. Firm controls are included in the regression, which are *Size, Leverage, Group, Mutual, Geoherf, Busherf, Directw*, *Anticipation* and the interaction of *Prop Risk* with a linear year trend (variables are defined in Table 3). *Prop Risk* is defined as the proportion of direct premiums written in risky business to total premiums written in a firm. Standard errors are adjusted for heteroskedasticity and clustered at firm level and are reported below the coefficients in parentheses. In Panel B, the sample is at firm-line-state-year level. Regressions include only firms with a ratings downgrade. *Risk* equals 1 if the premiums are in a line which is risky business, 0 otherwise. The set of control variables include logarithm of lagged premium, firm-year, state and insurance line of business fixed effects. Standard errors are adjusted for heteroskedasticity and clustered at firm-year level and are reported below the coefficients in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A: Variables	Firm-Year Level
Log premium $_{t-1}$	-0.108***
	(0.005)
Prop. Risk	-0.110***
	(0.041)
Up_{post}	0.008
	(0.011)
$Up_{current}$	0.001
	(0.011)
Up_{pre}	-0.018*
	(0.011)
$Down_{post}$	-0.051***
	(0.013)
$Down_{current}$	-0.074***
	(0.013)
$Down_{pre}$	-0.004
	(0.012)
Prop Risk× Up_{post}	-0.003
	(0.021)
Prop Risk × $Up_{current}$	-0.012
	(0.024)
Prop Risk × Up_{pre}	-0.014
	(0.024)
Prop Risk × $Down_{post}$	0.002
	(0.026)
Prop Risk × $Down_{current}$	0.038
	(0.026)
Prop Risk × $Down_{pre}$	0.003
	(0.025)
Firm, Year Fixed Effect	YES
R^2	0.250
Observations	33,104

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

Table 14
Prices, Market Discipline and Guaranty Funds at Firm-Line-Year Level

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

Variables	OLS (1)	F.E. (2)	OLS (3)	F.E. (4)
Log price $_{t-1}$	-0.278***	-0.463***	-0.279***	-0.463***
	(0.003)	(0.004)	(0.003)	(0.004)
Prop. of Uncovered Premium$_{t-1}$	—	—	0.032***	0.043
			(0.007)	(0.031)
Up$_{post}$	0.009*	0.015***	0.011**	0.019***
	(0.005)	(0.005)	(0.005)	(0.005)
Up$_{current}$	0.014***	0.016***	0.014***	0.017***
	(0.005)	(0.005)	(0.005)	(0.005)
Up$_{pre}$	-0.004	0.004	-0.004	0.005
	(0.005)	(0.006)	(0.005)	(0.006)
Down$_{post}$	-0.006	-0.009*	0.001	-0.001
	(0.005)	(0.006)	(0.005)	(0.006)
Down$_{current}$	-0.031***	-0.032***	-0.033***	-0.033***
	(0.005)	(0.005)	(0.005)	(0.006)
Down$_{pre}$	-0.057***	-0.044***	-0.057***	-0.044***
	(0.005)	(0.005)	(0.005)	(0.005)
Prop $_{t-1}$ × Up$_{post}$	—	—	-0.019	-0.032
			(0.020)	(0.021)
Prop $_{t-1}$ × Up$_{current}$	—	—	-0.006	-0.013
			(0.019)	(0.020)
Prop $_{t-1}$ × Up$_{pre}$	—	—	-0.004	-0.008
			(0.020)	(0.022)
Prop $_{t-1}$ × Down$_{post}$	—	—	-0.073***	-0.079***
			(0.022)	(0.024)
Prop $_{t-1}$ × Down$_{current}$	—	—	0.013	0.005
			(0.021)	(0.022)
Prop $_{t-1}$ × Down$_{pre}$	—	—	-0.002	-0.001
			(0.020)	(0.022)
Anticipation	—	-0.633***	—	-0.630***
		(0.241)		(0.242)
Constant	0.006***	-0.045	0.002	-0.056
	(0.002)	(0.098)	(0.002)	(0.101)
Firm-Line & Year Fixed Effects	NO	YES	NO	YES
Firm Controls	NO	YES	NO	YES
Guaranty fund Controls	NO	NO	NO	YES
R^2	0.185	0.360	0.186	0.360
Observations	120,533	120,533	120,533	120,533

Table 15
Prices and Market Discipline at Firm-Line-Year Level based on Pre-change Rating Categories

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

Variables	OLS (1)	F.E. (2)
Log price $_{t-1}$	-0.279***	-0.464***
	(0.003)	(0.004)
High × Down$_{post}$	0.003	-0.000
	(0.006)	(0.006)
High × Down$_{current}$	-0.013**	-0.023***
	(0.006)	(0.007)
High ×Down$_{pre}$	-0.055***	-0.047***
	(0.006)	(0.007)
A-× Down$_{post}$	0.000	-0.012
	(0.015)	(0.015)
A- × Down $_{current}$	-0.090***	-0.079***
	(0.014)	(0.015)
A- × Down$_{pre}$	-0.081***	-0.065***
	(0.012)	(0.013)
Low × Down$_{post}$	-0.014	-0.019
	(0.014)	(0.015)
Low × Down$_{current}$	-0.045***	-0.045***
	(0.013)	(0.014)
Low × Down$_{pre}$	-0.039***	-0.028**
	(0.012)	(0.013)
High × Up$_{post}$	0.015*	0.010
	(0.009)	(0.009)
High × Up$_{current}$	-0.013	-0.014
	(0.009)	(0.010)
High × Up$_{pre}$	-0.023***	-0.013
	(0.009)	(0.009)
A- × Up$_{post}$	0.014	0.023**
	(0.009)	(0.010)
A- × Up$_{current}$	0.021**	0.031***
	(0.010)	(0.010)
A- × Up$_{pre}$	-0.019*	-0.002
	(0.010)	(0.011)
Low × Up$_{post}$	0.002	0.009
	(0.007)	(0.008)
Low × Up$_{current}$	0.045***	0.042***
	(0.008)	(0.009)
Low × Up$_{pre}$	0.045***	0.042***
	(0.009)	(0.009)
Fixed Effects & Firm Controls	NO	YES
R^2	0.187	0.417
Observations	120,533	120,533

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

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

Variables	OLS (1)	F.E. (2)	2SLS (3)
Prop $_{t-1}$ × High × Down$_{post}$	-0.074***	-0.073***	-0.074***
	(0.024)	(0.027)	(0.027)
Prop $_{t-1}$ × High × Down$_{current}$	0.013	0.015	0.014
	(0.023)	(0.026)	(0.027)
Prop $_{t-1}$ × High ×Down$_{pre}$	-0.013	-0.005	-0.001
	(0.023)	(0.025)	(0.027)
Prop $_{t-1}$ × A-× Down$_{post}$	-0.037	-0.043	-0.045
	(0.066)	(0.071)	(0.073)
Prop $_{t-1}$ ×A- × Down$_{current}$	-0.065	-0.098*	-0.110*
	(0.054)	(0.056)	(0.059)
Prop $_{t-1}$ ×A- × Down$_{pre}$	-0.021	0.001	-0.001
	(0.054)	(0.057)	(0.058)
Prop $_{t-1}$ × Low × Down$_{post}$	-0.146*	-0.172	-0.170
	(0.080)	(0.107)	(0.110)
Prop $_{t-1}$ × Low × Down$_{current}$	0.067	0.038	0.099
	(0.077)	(0.086)	(0.087)
Prop $_{t-1}$ × Low × Down$_{pre}$	0.107*	0.023	0.003
	(0.065)	(0.078)	(0.077)
Prop $_{t-1}$ × High × Up$_{post}$	-0.063**	-0.072**	-0.083**
	(0.031)	(0.033)	(0.036)
Prop $_{t-1}$ × High × Up$_{current}$	0.055*	0.028	0.040
	(0.031)	(0.032)	(0.034)
Prop $_{t-1}$ × High × Up$_{pre}$	0.028	0.007	0.014
	(0.031)	(0.033)	(0.035)
Prop $_{t-1}$ × A- × Up$_{post}$	-0.052	-0.036	-0.037
	(0.035)	(0.036)	(0.038)
Prop $_{t-1}$ × A- × Up$_{current}$	-0.112***	-0.061	-0.062
	(0.034)	(0.038)	(0.041)
Prop $_{t-1}$ × A- × Up$_{pre}$	-0.014	0.034	0.028
	(0.035)	(0.039)	(0.041)
Prop $_{t-1}$ × Low × Up$_{post}$	0.044	0.012	0.019
	(0.033)	(0.035)	(0.037)
Prop $_{t-1}$ × Low × Up$_{current}$	0.052	0.051	0.033
	(0.038)	(0.047)	(0.050)
Prop $_{t-1}$ × Low × Up$_{pre}$	0.000	-0.030	-0.063
	(0.040)	(0.047)	(0.049)
Fixed effects and Controls	NO	YES	YES
R^2	0.187	0.361	0.358
Observations	120,533	120,533	118,539

Table 17
Market Discipline and Guaranty Funds at Firm-Line-Year Level after Controlling for Price

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

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

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

Appendix A: Definitions of Independent Variables

A. Firm and guaranty funds controls

Various features of state guaranty funds might affect market discipline and our model attempts to control for these effects. Guaranty funds have a maximum claim payment, which may dampen the cost of undercutting market discipline. If there is a significant proportion of private loss in excess of the caps in the case of an insurer's insolvency, policyholders might have additional incentive to monitor insurers. We construct a continuous variable *Max%* to represent the percentage of the insurer's direct premium written in a state with maximum claim paid of guaranty fund exceeding $300,000.[24,25] Another feature of state guaranty funds is net worth provisions. Given these provisions, wealthier policyholders have a greater incentive to monitor their insurers. We apply a continuous variable *Prov%* to represent the percentage of the insurer's direct premium written in states with state guaranty funds that have the net worth provision above $25,000,000.[26] More stringent rate regulation may dampen the impact of market discipline on prices, if the regulated rate is not a function of insurer risk. To account for rate regulation, we use *Reg%* (Grace and Leverty, 2010): it represents the percentage of the insurer's direct premium written in states with strict rate regulation laws (with prior approval or state made rate regulation) for regulated lines such as medical malpractice, auto insurance, homeowner insurance and workers compensation at the firm-line-year level.[27]

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

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

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

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

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

calculated by the sum of the squares of the percentages of direct premium written across all lines of business (all states for geographic Herfindahl index) for the insurer. Other firm characteristic control variables are *Size*, the natural logarithm of total assets; *Leverage*, the ratio of total liability to total asset; *Mutual*, a dummy variable set equal to one if the insurer is a mutual organization; and *Group*, an indicator if the firm belongs to some affiliated group.

B. Default-value-to-liability ratio

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

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

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

$$\sigma_V^2 = \sum_i^M \sum_j^M x_i x_j \rho_{V_i V_j} \sigma_{V_i} \sigma_{V_j} \tag{A2}$$

$$\sigma_L^2 = \sum_i^N \sum_j^N y_i y_j \rho_{L_i L_j} \sigma_{L_i} \sigma_{L_j} \tag{A3}$$

$$\sigma_{VL}^2 = \sum_i^M \sum_j^N x_i y_j \rho_{V_i L_j} \sigma_{V_i} \sigma_{L_j} \tag{A4}$$

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

[28] Assets are divided into six classes: stocks, bonds, real estate, mortgages, cash and other invested, and other assets.

liability line i and j with N number of lines of insurance business[29], and $\rho_{V_iL_j}$ is the correlation coefficient of the logarithms of liability line i and asset j. The volatilities and correlation matrix of insurers' assets are calculated using industry wide quarterly time series of return for each asset[30] and liability class[31].

C. Loss ratio and loss volatility and state variables

We have three variables as state time-variant controls in equation (3). First, we use employment in the insurance sector (*Insurance Employment*) divided by total state population as a proxy for the power of the insurance labor. Second, we use insurance gross state product per capita (*Insurance GSP*) as a proxy for the magnitude of economic size of insurance sector in a state. Last, income per capita (*income*) is used to proxy the relative household wealth for each state each year. All state variables are obtained from the Bureau of Economic Analysis.

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

Appendix B: Insurance Price Calculation

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

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

[29] Lines of insurance business are divided into 12 classes based on Schedule P.

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

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

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

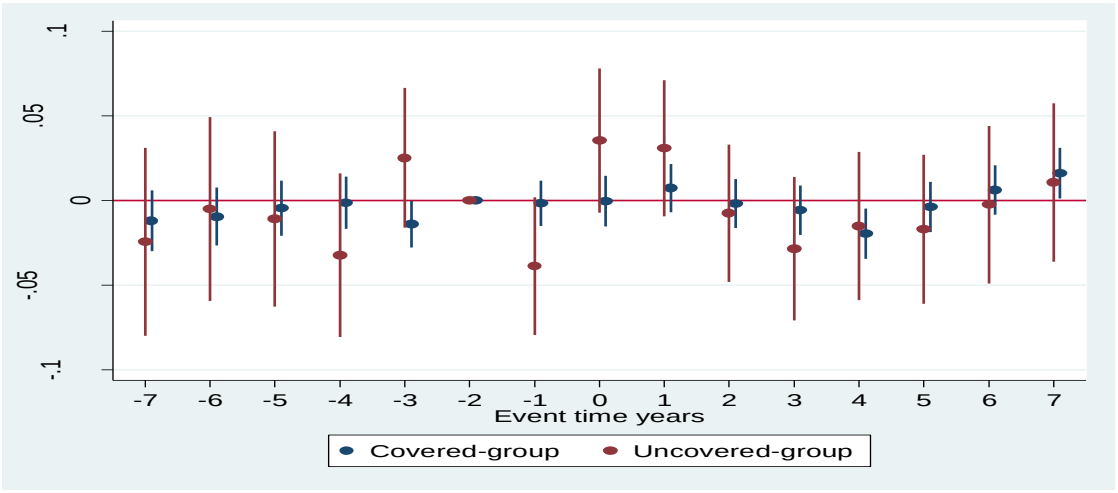
[32] Schedule P of the NAIC regulatory annual statement aggregates each insurer's lines of business into 12 categories: homeowner/farmers, auto liability, commercial multiple peril, workers' compensation, medical malpractice, special liability (ocean marine, aircraft and boiler & machinery), other liability,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

Appendix C. Extra Tables and Figures

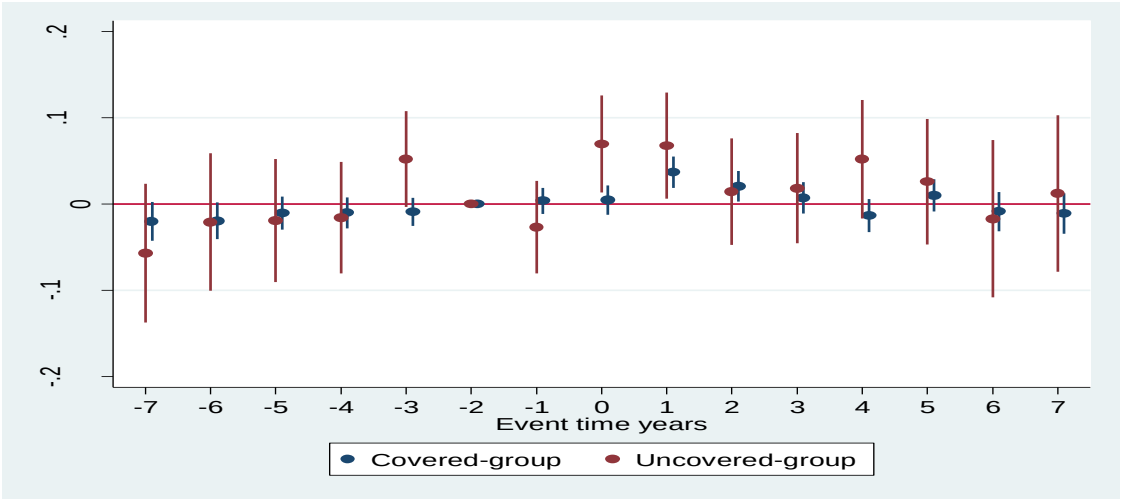
Figure C.1 : Premium Growth for Insurer Upgrades at Firm-Line-Years, 1991–2011

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

Panel A:



Panel B:



Panel C:

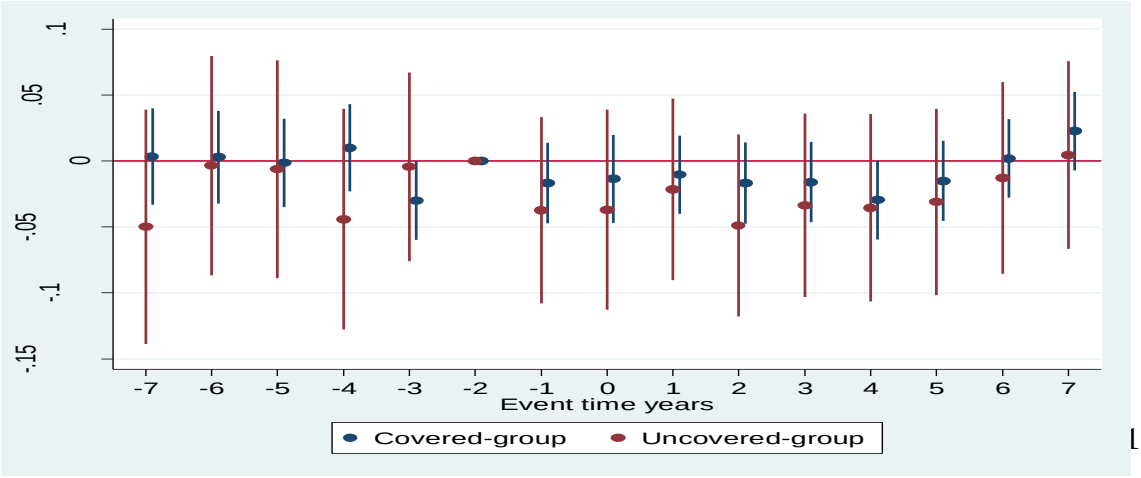
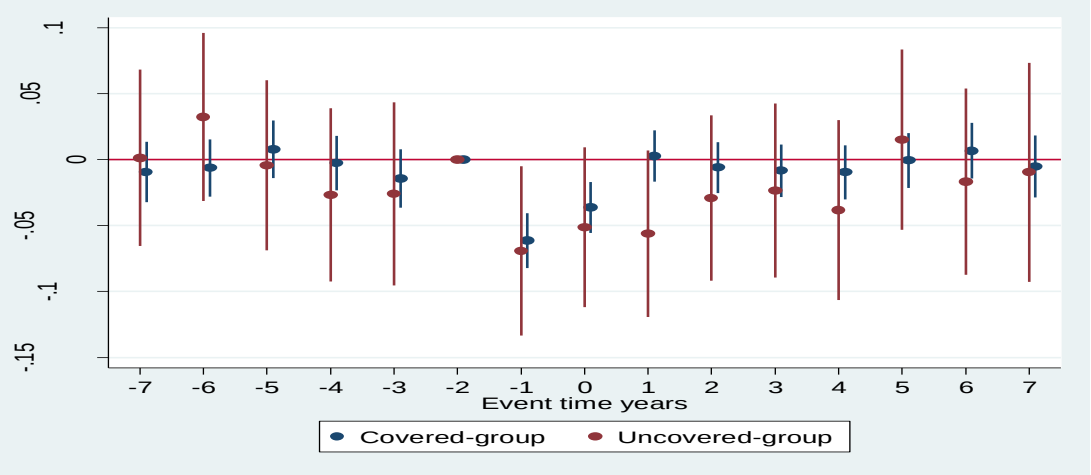


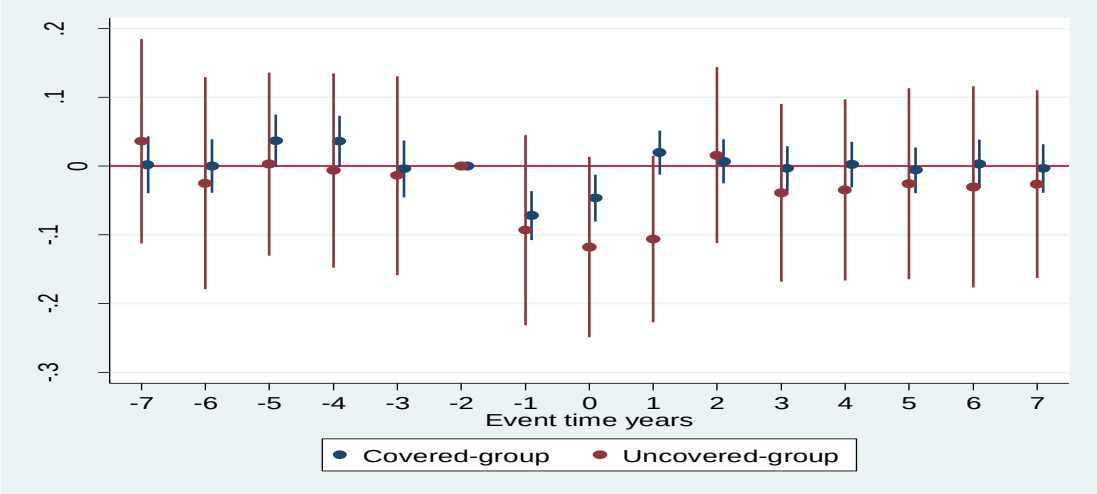
Figure C.2: Price Growth for Insurer Downgrades at Firm-Line-Years, 1991–2011

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

Panel A:



Panel B:



Panel C:

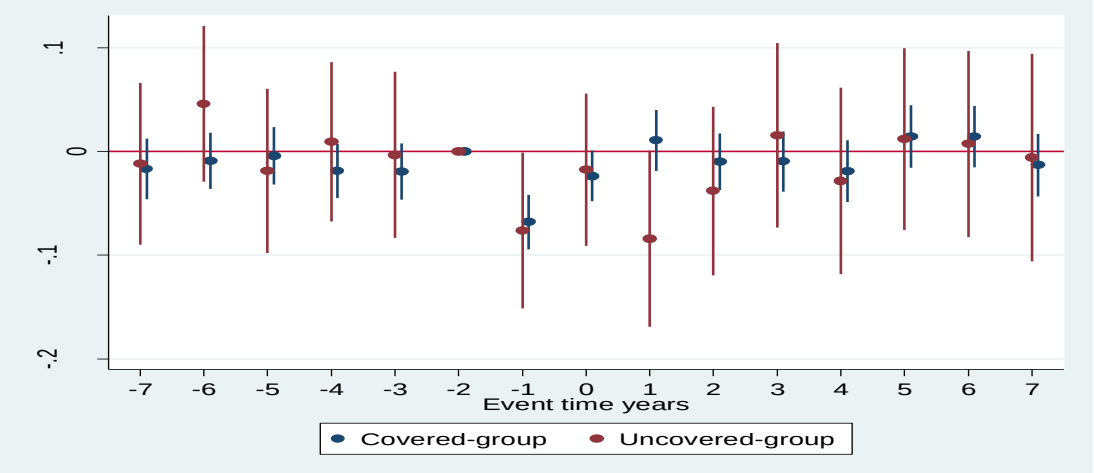


Table C.1
Seemingly Unrelated Regression for Premium Growth and Price Growth

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

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

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

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

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

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

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

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