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Catastrophes and Performance in Property Insurance

A Comparison of Personal and Commercial Lines

Patricia H. Born and Barbara Klimaszewski-Blettner

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Executive Summary

THE AFTERMATH of the natural disasters of 2005—with Hurricanes Katrina, Rita, and Wilma resulting in the most expensive year for property insurers since 1906—reflects this decade's trend of increasing frequency and severity of losses from catastrophic events. While insurers make immediate attempts to control losses by accurately appraising damage and investigating possible fraud, further action may include reevaluations of their portfolio of risks, leading to changes in premiums and coverage levels and exit from some markets. This ability to adapt to changes in risk exposure is currently restricted by regulatory regimes.

Market regulation is intended to protect insurance consumers from unfair insurance prices. However, when regulators impose restrictions on premium adjustments intended to guarantee the affordability of insurance coverage, insurers may choose to exit the market if they cannot maintain solvency. As a result, regulators then impose exit restrictions or cancellation bans. Finding that the homeowners insurance market receives more public policy attention than the commercial property market and thus differential treatment by regulators, the study examines insurers' responses to unexpected catastrophic events over the period of 1984–2007.

The authors consider personal and commercial insurers in their empirical analysis. The dataset is drawn from the annual statement data from the National Association of Insurance Commissioners, containing underwriting and financial information for all U.S. property insurers from the period studied, and supplemented with rate regulations and the incidence, by state, of natural catastrophes. They also reveal evidence to support the following hypotheses regarding insurers' loss ratios, insurers' losses, and insurers' premiums.

Unexpected catastrophic events lead to a growth in loss ratios and losses incurred by insurers, effects less intense among commercial insurers compared to homeowners insurers. This is due to different regulatory constraints and underwriting flexibility, and both are higher if insurers operate in a strict rate regulation regime, especially following catastrophes. Additionally, insurers increase premiums and/or reduce their exposure following unexpected catastrophic events. Due again to differences in constraints and flexibility, commercial insurers increase premiums more so than homeowners insurers and reduce their business more intensely. Strict rate regulation also has a negative impact on total premiums written by insurers.

Although the study is limited to an analysis of insurers' underwriting performance, the authors encourage further examination of regulatory reform, such as a reform of residual market solutions, deregulation by state, and direct state subsidization of premiums for low income people, rather than disrupting market forces by keeping premiums at artificially low prices.

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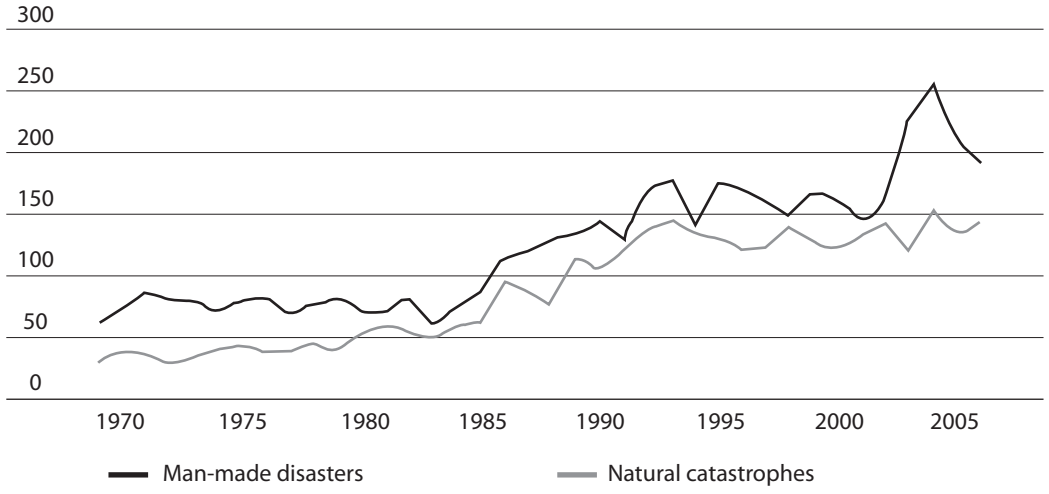
Introduction

HURRICANES KATRINA, Rita and Wilma made the year 2005 the most expensive year for property insurers since 1906, the year of the San Francisco earthquake. With total losses of $45 billion, Katrina alone claimed 7.5 percent of US non-life premium volume. Rita and Wilma each caused another $10 billion in losses for the property insurance industry.[1] The natural disasters of 2005 cannot be seen as unusual outliers, but reflect the continuing trend of increasing frequency and severity of losses from natural catastrophes during the last decades. Figure 1 from Swiss Re (2008) shows the striking trend of an increasing number of such events worldwide.

Figure 1: Number of catastrophic events worldwide, 1970–2007



Source: *Swiss Re*

Catastrophic property risks pose a variety of problems for insurers, thus affecting the supply of insurance coverage for such perils. Limitations on the availability of coverage mainly result from insurability constraints, most notably the characteristic lack of independence between insured units and the serious loss potential of catastrophic risks.[2] Moreover, although insureds cannot directly influence loss probabilities, they may certainly affect loss size by deciding on loss prevention and mitigation measures such as investments in adequate building materials or protective dams in flood areas. So, there is potential for moral hazard if prevention efforts are not observable by insurers and/or if risk dependent premiums do not reward loss prevention via an adequate premium reduction. Furthermore, the insurability of catastrophic risks is aggravated by the difficulty in predicting the probability of loss, compared to other "high frequency, low severity risks" (for example, auto accidents). Besides the fact that these are "low frequency, high severity, and strongly dependent" perils, increased construction activity in high risk areas, climate change, and apparent cycles of storm activity complicate the determination of insurability of these risks.

Catastrophic events resulting in large unexpected property losses may induce insurers to take a variety of actions to stabilize their underwriting performance. Immediate attempts to control losses are limited to accurate appraisals of damage and investigation of possible fraud. But subsequent activities may include a reevaluation of the portfolio of risks borne by the insurer, leading to changes in premiums, changes in coverage levels, exit from some markets, and perhaps entry into others.

The need for regulatory intervention in the property insurance market hinges on private insurers' ability to adapt to changes in the risks they choose to bear, and consequently to meet the demand for coverage. Conversely, the ability of private insurers to adapt to changes in the underlying risk exposure is affected by the regulatory regimes in which they operate. The homeowners insurance market receives much more public policy attention than does the commercial property market; this differential treatment by regulators provides a natural experiment in which to evaluate and compare personal and commercial insurers' behavior in response to unanticipated events. In this project, we evaluate insurers' responses to unexpected catastrophic events over a long time period in an effort to discover the more successful private strategies for dealing with these risks.

Our empirical analysis addresses some fundamental aspects of how catastrophic events affect property insurance markets. We use information on losses incurred and premiums earned by firm and by state, for all U.S. personal and commercial property insurers for the period 1984 to 2007. We supplement the data with information on state regulatory requirements and the incidence, by state, of natural catastrophes, as compiled from the Swiss Re Sigma reports. This comprehensive dataset enables us to analyze the effects of catastrophic events on insurance company performance and behavior in subsequent years.

We begin our analysis with an evaluation of the market structure, focusing on changes in the number of insurers and market concentration over the period of observation.[3] We consider two main segments of the property insurance market—the personal lines (homeowners) and the commercial lines (fire, allied lines, commercial multiperil)—and explore the extent that insurers operate in one or both of these segments. Next, we shift our analysis to the performance and conduct of insurers in response to natural disasters.[4]

Following Born and Viscusi (2006), we evaluate the role of *unanticipated* catastrophes (number of catastrophic events relative to the number *expected* based on previous years) as they affect the underwriting performance of property insurance markets. We suspect insurers operating in the personal lines will respond differently than those operating in commercial lines due to differences in the size of exposures, treatment under state regulation, and the nature in which contracts are negotiated.

Our paper proceeds as follows: In the next section, we provide an overview of the personal and commercial property insurance markets with a special focus on regulatory issues. Then we outline our data and the methodologies we apply to assess the differential performance of personal and commercial property insurers. We conclude with a discussion of our findings, implications for regulatory reform, and a motivation for further research.

Background

Insurance regulation has two main targets: financial performance and market conduct.[5] Financial regulation attempts to protect policyholders against the risk of financial distress or insolvency of the insurance company that endangers the fulfilment of the financial obligations towards the insured. The main goal of market regulation is to protect insurance consumers from unfair insurance prices, products, and trade practices. Efforts for solvency and market regulation are intended to protect insurance consumers but often the goals of different regulatory activities may conflict. For example, affordability and availability issues aggravate solvency considerations if regulators suppress insurers' rate levels or impose other tying obligations, such as exit restrictions or policy renewal duties following catastrophic events. Florida, for example, has imposed severe pressure on the financial viability of its insurance markets by instituting restrictive rules for operating within the state. Following Hurricane Andrew, insurers were forbidden to raise premiums and reduce their insurance portfolio in coastal areas. After Hurricane Wilma, regulators imposed restrictions on canceling or non-renewing policies and set policies to compel insurers to exit all lines of business if they seek to exit a line subject to availability problems. Such regulatory actions, like premium limitations or exit restrictions, may cause severe market distortions resulting in an inadequate supply of insurance coverage against catastrophic threats in the long run. The balancing of financial and market regulatory objectives therefore seems to be an important issue in catastrophe insurance (see Wharton, 2008, p. 35).

In discussing how to adequately prepare for catastrophic events, it is necessary to consider how binding regulatory constraints influence insurers' performance and their decisions with respect to supplying insurance and structuring their underwriting portfolios. We expect insurers to raise rates following catastrophes if such events indicate a higher rate of catastrophes in the future. Such increases are justified by an enhancement of the actuarial risk. If regulators, however, impose restrictions on premium adjustments aimed at guaranteeing the affordability of insurance coverage for consumers, insurers may instead choose to exit the market if rates are not adequate to maintain solvency. This, in turn, prompts regulators to impose exit restrictions or cancellation bans that force insurers to retain a larger number of high-risk exposures than they might choose in the absence of such constraints.

Another regulatory response to ensuring the availability of insurance coverage is through re-

sidual market solutions offering insurance at affordable prices below competitive premiums. Such approaches can create severe market distortions and incentive-incompatible structures, resulting in further crowding out of private insurers who cannot compete with the cheap residual insurance products, but are consequently penalized through an assessment for the losses of these insurance programs according to their market share.[6] Such chain reactions, whereby one regulatory intervention establishes the necessity of another, might not only influence insurers' underwriting performance, but also expose insurance consumers and taxpayers to significant risk and assessments when catastrophes occur. We specifically address the former aspect in our empirical investigation.

In a recent study, Grace and Klein (2008, 36) suggest that the most prominent and criticized policy is rate regulation.[7] They note that the homeowners insurance market is especially subject to stringent rate regulation, and although most state regulators do not attempt to impose severe price constraints, there might occur severe conflicts if cost pressures compel insurers to raise prices while regulators do not allow insurers to risk-adjust premiums according to an increase in the faced risk exposure. If the market is competitive, such regulation should not be needed because insurers would be forced to compete at the premium that just allows a fair profit. A great deal of empirical research affirms that insurance markets are competitive.[8] Authorizing regulators to regulate rates invites political pressure and interference (Grace and Klein, 2008, 36). Although premium and policy regulations are to be favored from the insureds' perspective at first glance, such restrictions can force insurers to tighten their coverage offers if expected losses increase but premiums cannot be adjusted accordingly.

Unexpected catastrophic events should elicit similar responses by all property insurers to the extent that such events call for a change in underwriting policy. However, we might observe certain features of personal and commercial lines to intervene. A first important difference between personal and commercial insurance business lies in the underlying risk exposure. Commercial risks are usually smaller in number, but bigger in size and more heterogeneous than personal ones (that is, typically many small homogeneous risks, such as homes and automobiles). As a higher number of insured risks normally corresponds with a smaller deviation between actual and estimated expected losses, premiums calculated on the basis of expected losses more often cover actual losses. Thus, we might expect homeowners insurers' underwriting performance (that is, their loss ratios) to be more stable. On the other hand, accumulation risk seems to be a bigger problem in the personal-lines insurance market, aggravating the balance within the portfolio and adversely affecting insurers' performance.

Another difference between the homeowners and commercial insurance business results from distinct levels of regulation intensity. Premiums, policy forms, and contract terms are more intensely regulated in the homeowners insurance context than among commercial property. Regulators assert this is generally justified because the personal insured is less sophisticated in insurance matters than the commercial client, who is more likely to be a "professional" insurance consumer. However, rate regulation that constrains insurers from setting adequate rates may actually exacerbate losses, as consumers have less incentive to manage risk when rates cannot increase (Harrington & Danzon, 2001).

On the other hand, especially large commercial consumers have more alternative risk transfer

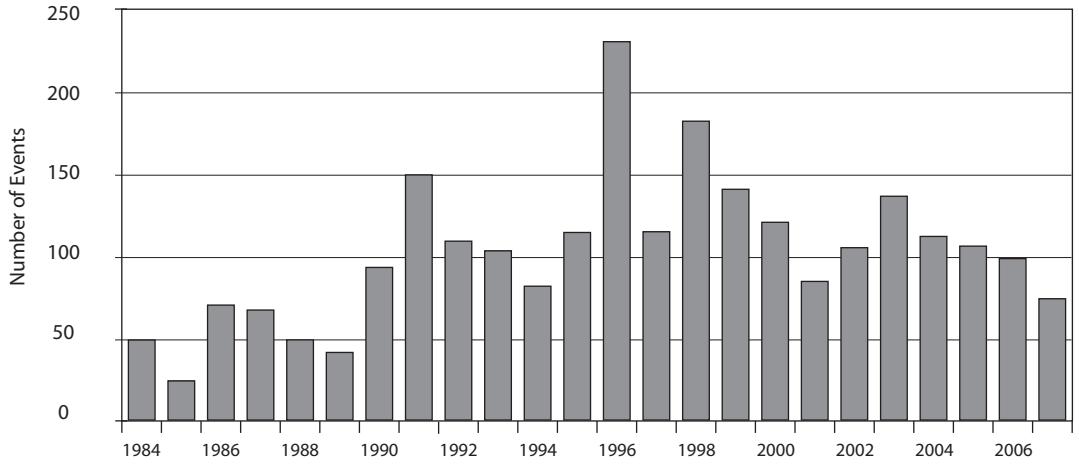
mechanisms at their disposal if insurance premiums increase significantly. They are sometimes able to access alternative markets that allow them to transfer part of their risk to the capital markets (for example, by issuing catastrophe bonds) or form their own internal insurance companies by so-called captive solutions. This reduces incentives for large commercial clients to insist on regulatory premium limitations. In addition, the heterogeneity of risk exposure and coverage needs aggravates standard regulation of premiums and coverage terms.[9] Rejda (2008, 157) discusses an obvious trend towards commercial lines rate deregulation. Our compilation of state statutes confirms Rejda's observation: although there are some deregulation efforts in homeowners insurance markets, the commercial lines are less regulated, especially for large commercial risks. Our data on rate regulation in the U.S. property lines is provided in the Appendix.

Closely related to a differing degree of regulation are different habits in insurers' pricing and underwriting decisions. As a result of business clients' heterogeneous coverage needs, products are much less standardized in this insurance context. Especially large commercial clients negotiate both prices and coverage terms with their insurers (mostly with the help of brokers).[10] For example, *ex post* premium adjustments depending on the actual loss development at the end of the contract year. Thus, commercial underwriters are much more flexible in their underwriting conditions, which should lead to more risk-adjusted premiums in the commercial insurance context.[11] We examine this further in our empirical investigation.

Data

For our analysis we compiled an especially large and detailed dataset, starting with the annual statement data from the National Association of Insurance Commissioners (NAIC), which contains underwriting and financial information for all U.S. property insurers for the period 1984–2007. We consider two main segments of the property insurance market: personal (homeowners)[12] and commercial lines (fire, allied, and multiperil).[13] In particular, we use information on losses incurred and premiums earned by firm,

Figure 2: State-level catastrophic events, by year

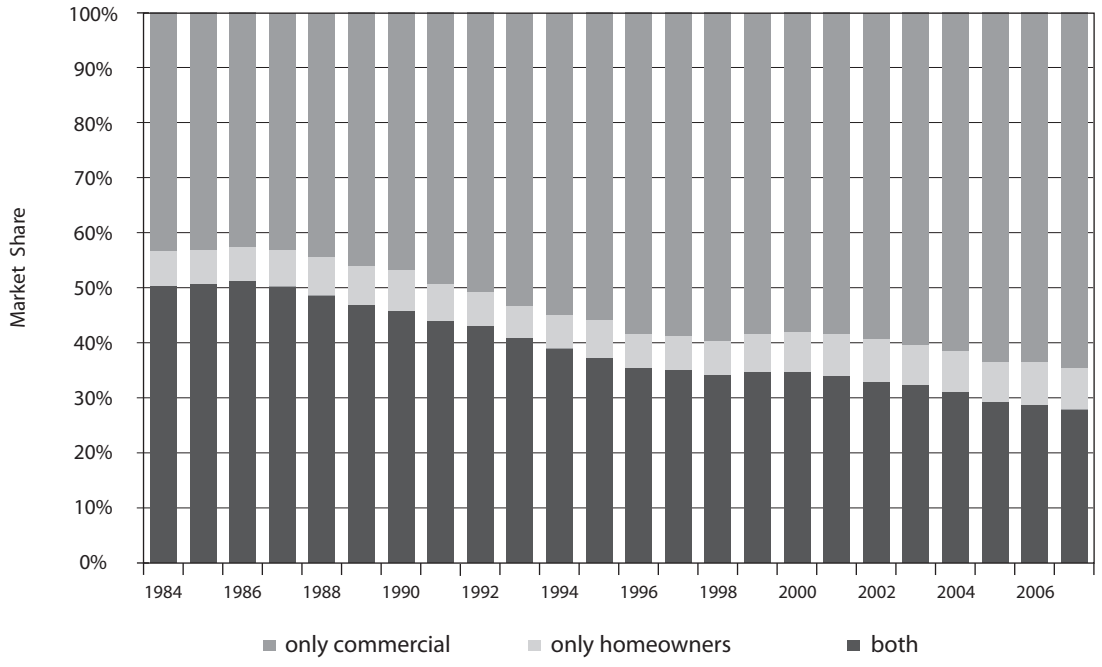


Source: *Swiss Re Sigma* Reports (1984–2007) and NAIC.

by line, and by state over this twenty-three-year period. We supplement the data with information on state rate regulations and the incidence, by state, of natural catastrophes. Regulation data are obtained from state statutes. Catastrophic events are compiled from figures reported in the annual Swiss Re Sigma reports on catastrophic events, which are based on data from the Property Claims Service (PCS), a division of the Insurance Services Office (ISO). The PCS currently defines catastrophes as "events that cause $25 million or more in direct insured losses to property that affect a significant number of policyholders and insurers." This comprehensive dataset enables us to analyze the effects of catastrophic events over time on insurance company behavior and performance in subsequent years.

Figure 2 shows the number of catastrophes over our time period. To be consistent with our empirical approach, we account for these events on a state-by-state basis. Thus, for each catastrophic event noted in the Swiss Re reports, we may have multiple "state-level" events if the event spanned multiple states. In other words, an insurer that writes in two states that are hit by the same hurricane is assumed to have been hit by two separate catastrophes, each affecting losses in a particular state "market." While the number of state-level events appears to have increased and then decreased through our sample, the data do not indicate whether these changes are necessarily due to changes in the number of catastrophes, changes in the scope of events, on average, across states, or both. Other data from Swiss Re (2008), presented in Figure 1, show more distinctly that the number of such events worldwide has increased rather substantially since the mid 1980s.

Figure 3: Distribution of all property insurers, by market segment focus



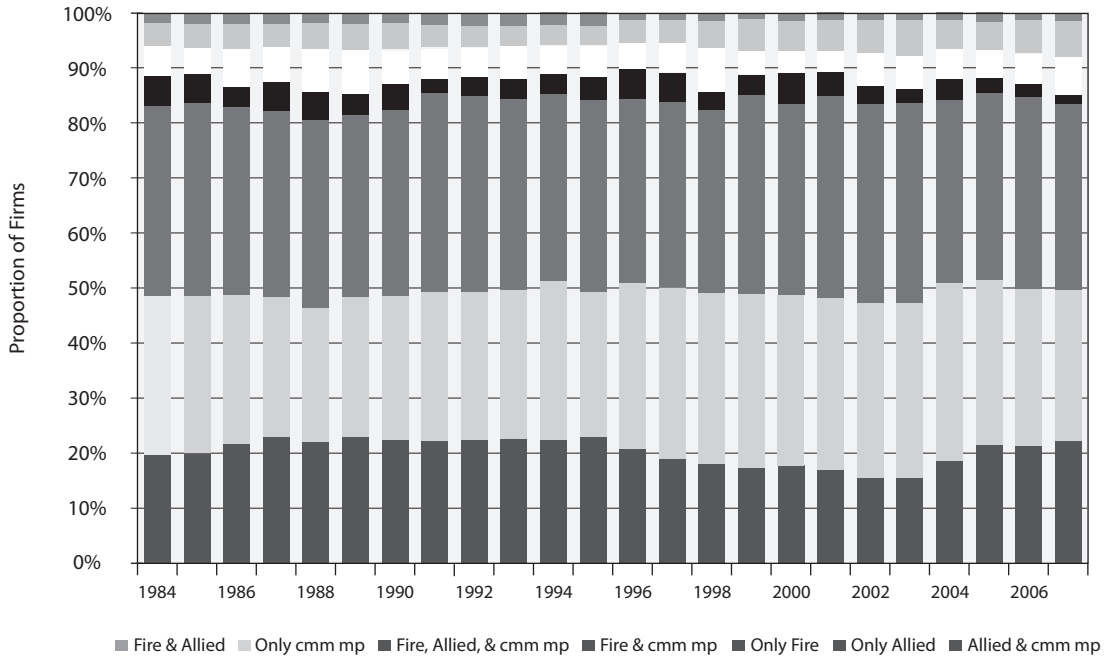
Source: NAIC annual statement data.

Market Overview

We start our analysis with a short overview of the personal and commercial property insurance markets. The *structure* of the overall property market can be described by examining the number of insurers that focus on the personal lines segment, the commercial lines segment, or both. Figure 3 shows that only a small number of insurers writes only homeowners insurance coverage, while many companies offer merely commercial insurance or both lines of business. The figure shows that the proportion of insurers selling only commercial insurance grows during the period of observation. A possible reason for this is reduced regulatory requirements as well as more flexible underwriting conditions. Figure 4 shows the most common combinations of the different lines of commercial business for insurers writing only commercial insurance coverage. The most favored offer combinations are "fire & allied," "only commercial multiple peril," and "fire & allied & commercial multiple peril."

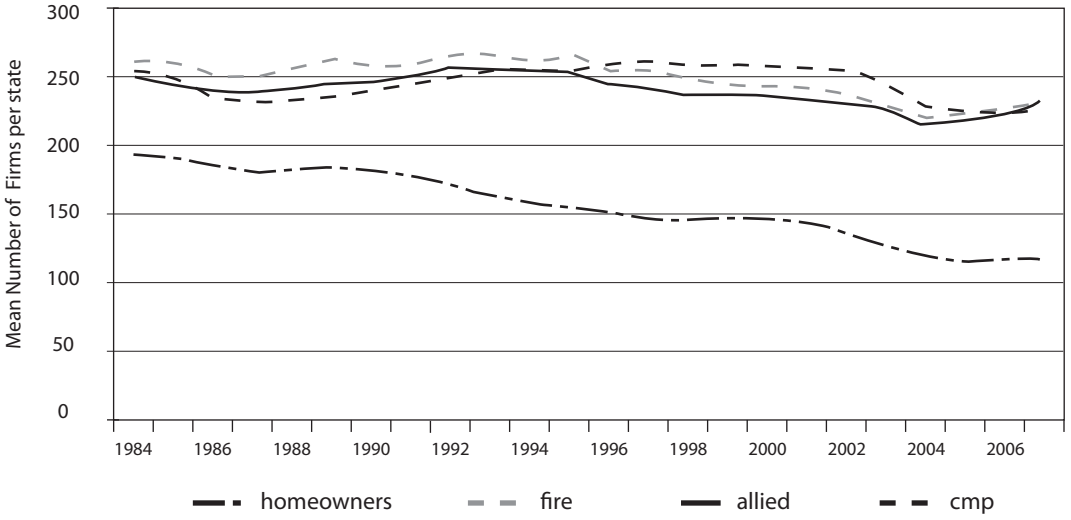
The number of insurers writing business in the different lines allows for a comparison of *market concentration* in each line for the period of observation. It can be seen in Figure 5 that market concentration, measured simply by the number of firms providing coverage, seems to be quite constant in commercial lines whereas there is a downside trend in the average number of insurers per state in the homeowners market supporting a trend towards consolidation. Furthermore, the average number of insurers offering homeowners coverage per state is substantially lower throughout the time period, which confirms a higher concentration in this market.

Figure 4: Distribution of commercial property insurers, by line combinations



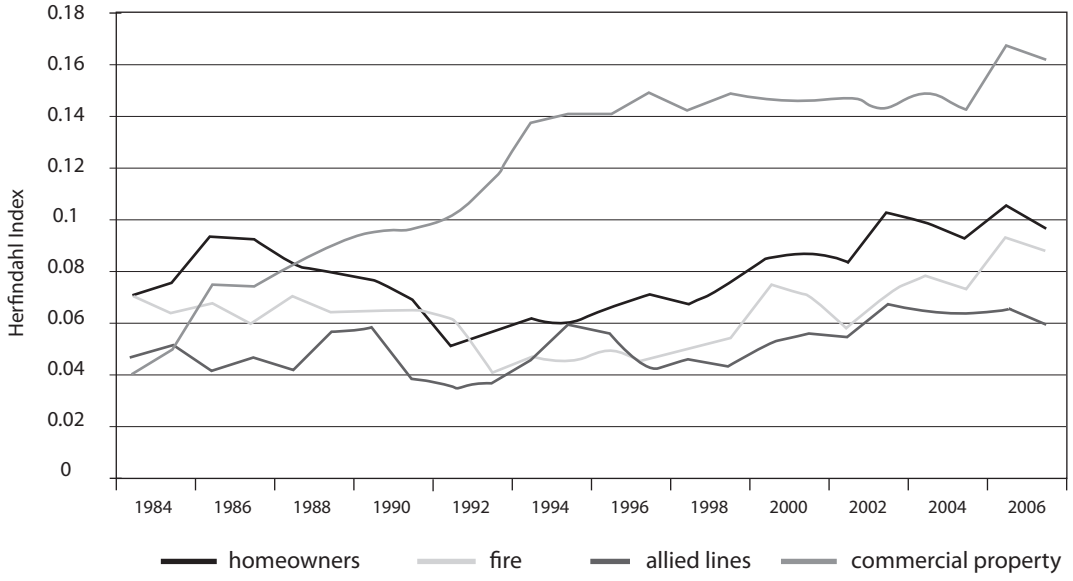
Source: NAIC annual statement data.

Figure 5: Average number of firms per state, 1984–2007



Source: NAIC annual statement data.

Figure 6: Line of business concentration, 1984–2007

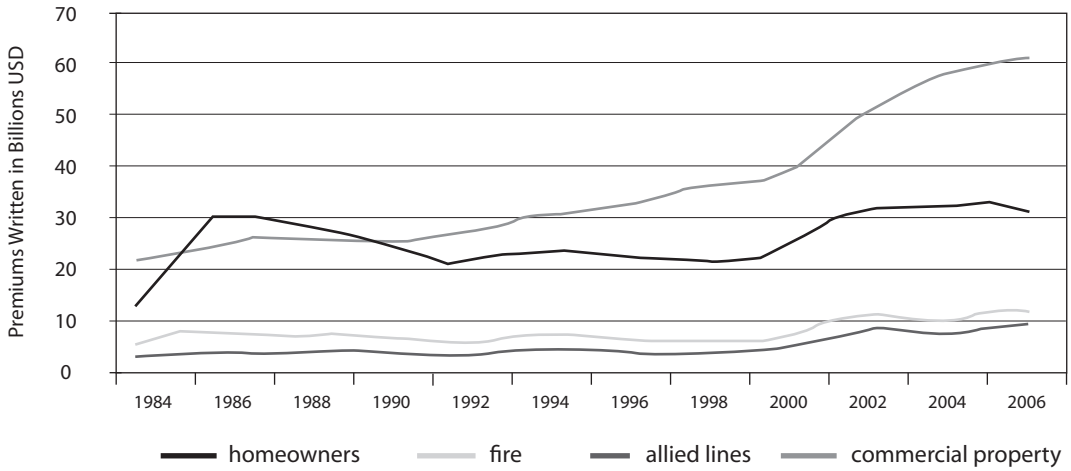


Source: NAIC annual statement data.

Increased concentration is also evident when the line of business concentration is calculated by market shares. Figure 6 presents the market concentration, measured by the Herfindahl Index, for each line of property business based on premiums written. We see that premium volume in the homeowners line is typically more concentrated than in the commercial lines, which corresponds to our observations above.

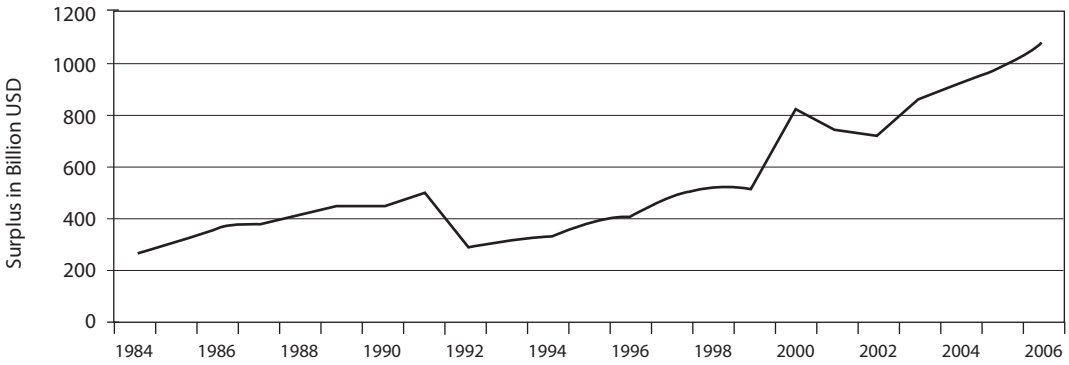
We complete our market overview by examining the development of premiums written (as a measure for the volume of business) as well as

Figure 7: Total premiums written, by line, 1984–2007



Source: NAIC annual statement data.

Figure 8: Total surplus of U.S. property insurers, 1984–2007



Source: NAIC annual statement data.

total surplus of all U.S. property insurers over the period of observation. The data on premiums and surplus, shown in Figures 7 and 8, suggest substantial variation over time.[14] We will measure correlation of this variable with catastrophic events. The exact statistical impact of catastrophes on insurers' performance is examined with the help of regression analysis in the following parts of this report.

Empirical Analysis of Insurer Performance

We now turn to the performance and conduct of insurers in response to natural disasters, with a special focus on loss ratios, losses, and premiums, and then we provide some preliminary remarks on insurers' market exit and entry decisions. We expect short-run responses to catastrophes to in-

clude reduced total premiums[15] and increased exits from markets experiencing unanticipated events, although such reactions may be limited by state regulations. We suspect that insurers operating in personal lines will respond differently from those operating in commercial lines due to the reasons described above. Homeowners insurers might not raise their premiums to the same extent as commercial ones because of a higher degree of rate regulation whereas commercial insurers are more flexible regarding their premium (and coverage) design. Commercial premiums are more loosely regulated and sometimes result from unique negotiations among insurers, brokers, and firms. This flexibility may imply that commercial premiums are more risk-adequate than homeowners prices, and might also lead to a greater reduction of policies written following unanticipated catastrophic events if these insurers have greater flexibility in avoiding the underwriting risk (for example, via exit). Altogether, the consequence should actually be lower commercial loss ratios following catastrophic events.

We start our analysis with a series of regressions to assess the relationship between catastrophic events and three measures of underwriting performance: loss ratios, losses incurred, and premiums earned. The sample characteristics of these and the other variables included in our regressions are shown in Table 1. As hurricanes in Florida and tornadoes in the Midwest should not take insurance companies entirely by surprise, we calculate an unexpected catastrophes variable that comprises the actual number of catastrophic events per state minus the average number of catastrophic events, by state, for the prior four years as a measure for the expected number of events.[16] From our calculation, insurers through this sample period faced an average of just 0.086 unexpected events each year across all states, but the value ranges from – 6.667 to 7.667.[17] We include interactions of this variable with dummies for firms writing only homeowners, only commercial, or both kinds of coverage so that we can compare the effects of catastrophes across the different types of insurers. Specifically, these terms allow us to analyze the impact of unexpected catastrophes on the dependent variable, given the firm is writing only homeowners, only commercial, or both types of coverage.

Table 1. Sample statistics, 1984–2007 (N=429.692)

Variable		Mean	Std. Dev.
Panel A. Line of Business Comparison			
	Fire	318,503.10	2,216,548.00
Total Premiums Written	Allied Lines	226,720.90	1,484,221.00
	Commercial MP	1,259,419.00	5,789,978.00
	Homeowners	1,730,053.00	16,434,250.00
Panel B. Firm Characteristics			
Total Assets		1,200,000,000.00	3,410,000,000.00
Total Surplus		369,000,000.00	1,120,000,000.00
Organizational Form	Mutual	0.136	0.343
(Omitted: Stock)	Reciprocal	0.022	0.146
	Lloyds	0.004	0.067
Unexpected Catastrophic Events		0.086	2.000
Number of States in Which Insurer Operates		35.515	16.506
Total Property Premiums Earned		3,425,918.00	19,600,000.00
Total Property Losses Incurred		2,157,646.00	17,700,000.00
Loss Ratio on All Property Business		0.789	1.362

Source: NAIC annual statement data.

We claim that the main reason for differences in the intensity of responses to catastrophic events across personal and commercial insurers is due to their different regulatory environments. Thus, we also test if rate regulation has a significant impact on insurers' underwriting performance. To control for distinct regulatory environments, we therefore include a dummy variable for *restrictive rate regulation* as a proxy for regulatory intensity in a certain state. If a state's premiums are subject to "prior approval," we refer to this as "restrictive rate regulation." In these states, firms must obtain prior approval before using or changing their insurance rates. As we especially want to test whether insurers respond differently to catastrophes if they are constrained by strict rate regulation, we add *variables capturing possible interactive effects* of the regulatory regime with the effect of the unexpected catastrophe variable. We also lag these interactions one and two years, so that we may assess a possible lingering influence of above-average catastrophic events.

Finally, we include in our analysis several variables to control for other factors affecting insurers' underwriting. In particular, we add three variables that reflect the overall size of the insurance companies' operations. The national measures are the *number of states* in which the insurer operates[18] and the *total national premiums* written by the insurance company in all lines of insurance. We also include *total premiums in state in all lines of insurance* as a measure of the scale of the firm's operations within the state. We expect smaller firms to be more susceptible to shocks than larger firms, and we anticipate that firms with a substantial presence in the state will be more reluctant to substantially reduce their volume of business (or leave the state) after a catastrophic event because of the losses associated with other lines.[19]

Analysis of Loss Ratios

We start with a regression of the natural logarithm of loss ratios on the set of explanatory variables described above. In general, unexpected catastrophes should increase firms' *loss ratios* in the year of the catastrophic event(s). Given potential lags in the ability to increase rates for subsequent years, due to the delay in receiving accurate loss information and any restrictive rate filing rules, this effect may linger for one or more years following the event(s). If commercial lines insurers are less regulated and thus more flexible regarding their premium design, such that premiums reflect more precisely the actuarial risk compared to homeowners lines, we expect that this positive effect on loss ratios would be less intense among commercial insurers. For firm *i* in state *s* at year *t,* we estimate:

$$
\begin{aligned}
Ln(loss\_ratio)_{ist} &= \alpha_1 + \beta_1 UnexpCat_{ist} + \beta_2 UnexpCat_{is,t-1} \\
&+ \beta_3 UnexpCat_{i,s,t-2} + \beta_4(cm\_only*UnexpCat_{ist}) \\
&+ \beta_5(both*UnexpCat_{ist}) + \beta_6(cm\_only*UnexpCat_{i,s,t-1}) \\
&+ \beta_7(both*UnexpCat_{is,t-1}) + \beta_8(cm\_only*UnexpCat_{is,t-2}) \\
&+ \beta_9(both*UnexpCat_{i,s,t-2}) + \beta_{10} RateReg_{st} \\
&+ \beta_{11}(UnexpCat_{ist}*RateReg_{st}) + \beta_{12}(UnexpCat_{i,s,t-1}*RateReg_{s,t-1}) \\
&+ \beta_{13}(UnexpCat_{i,s,t-2}*RateReg_{s,t-2}) + \beta_{14} LnPrems_{is,t-1} + \beta_{15} LnNumsts_{ist} + \\
&\beta_{16} LnStatePrems_{ist} + \beta_{17} LnNatPrems_{ist} + \sum_{j=1}^{23} \delta_j Y_j + \sum_{i=1}^{n} \eta_i F_i + \varepsilon_{ist}
\end{aligned}
$$

Where Y_j are dummy variables for each year, j=1989–2007 and F_i are dummy variables for each firm included to capture firm-specific effects.[20]

Our hypotheses regarding insurers' loss ratios are the following:

Hypothesis (1): Unexpected catastrophic events lead to an increase in loss ratios.

Hypothesis (2): This effect is less intense among commercial insurers compared to insurers writing only homeowners insurance (due to different regulatory constraints and underwriting flexibility).

Hypothesis (3): Loss ratios are higher if insurers operate in a strict rate regulation regime, especially following unexpected catastrophic events.

The results from estimating equation (1) are shown in Table 2. First, unexpected catastrophic events lead to an increase in the contemporaneous loss ratios which confirms hypothesis (1). The results suggest that, all else being equal, an increase by one in the number of unexpected catastrophic events corresponds to a 6.5 percent increase in insurers' loss ratios (on average). Next, we find that the response among commercial insurers is lower than that for insurers writing only homeowners insurance. The results show the expected positive effect of the current value of the unexpected catastrophe variable, but the coefficient on the first interaction term (firm writes only commercial property) is negative. In other words, for commercial insurers, an increase by one in the number of unexpected catastrophic events corresponds on average with a 2.4 percent increase in the loss ratio, compared to the 6.5 percent increase experienced by firms only writing homeowners insurance. Thus, loss ratios for commercial insurers seem to increase less intensely than those for homeowners insurers, which supports hypothesis (2) and fits with our theory that commercial insurers are more "risk adequate" in their underwriting decisions.

The significantly positive coefficient on the Strict Rate Regulation variable confirms hypothesis (3) postulating that loss ratios are higher if insurers operate in a strict rate-regulation regime. The interaction terms for unexpected catastrophes and strict premium regulation in equation (1) allow us to compare the impact of regulation on insurers' performance following catastrophic events. The results indicate that in years when unexpected catastrophic events strike (and even two years after), the loss ratios of insurers are significantly higher if they operate in a strict rate regulation regime.[21] This also confirms hypothesis (3) and suggests that restrictive premium regulation might aggravate risk-adequate underwriting behavior with the consequence of higher loss ratios. These results support our assumption that differing regulatory regimes among personal and commercial insurers might be a sound reason for differences in insurers' performance following catastrophic events.

Interestingly, the results do not indicate much of a lingering effect of unexpected catastrophes. The previous year's unanticipated events have a significant positive effect on current year loss ratios, but the effect is quite small compared to that of the current year events, and the lagged line of business interactions reveal no significant effect across the types of insurers. Given the especially random nature of catastrophic events, this result is not surprising. Furthermore, if the number of such events is increasing over time, we expect insurers to make premium adjustments in order to provide sufficient coverage in case of future disasters. We explore the potential for any lingering effect on premiums and losses below, and simply

Table 2. Regression Results for Insurer Loss Ratios

Explanatory Variable	Coefficient
	(Standard Error)
Unexpected Catastrophic Events$_t$	0.065***
	(0.005)
Unexpected Catastrophic Events$_{t-1}$	0.015***
	(0.005)
Unexpected Catastrophic Events$_{t-2}$	0.000
	(0.005)
UnexpCat$_t$* (Insurer writes commercial lines only)	-0.041***
	(0.006)
UnexpCat$_t$* (Insurer writes both homeowners & commercial lines)	-0.023***
	(0.006)
UnexpCat$_{t-1}$* (Insurer writes commercial lines only)	-0.005
	(0.006)
UnexpCat$_{t-1}$* (Insurer writes both homeowners & commercial lines)	0.005
	(0.006)
UnexpCat$_{t-2}$* (Insurer writes commercial lines only)	-0.003
	(0.006)
UnexpCat$_{t-2}$* (Insurer writes both homeowners & commercial lines)	-0.001
	(0.006)
Strict Rate Regulation$_t$	0.091***
	(0.016)
UnexpCat$_t$* strict rate regulation$_t$	0.017***
	(0.003)
UnexpCat$_{t-1}$* strict rate regulation$_{t-1}$	-0.008***
	(0.003)
UnexpCat$_{t-2}$* strict rate regulation$_{t-2}$	0.011***
	(0.003)
Ln(number of states in which the insurer writes property coverage)	-0.261***
	(0.013)
Ln(insurer's total premiums in state)	-0.085***
	(0.004)
Ln(firm's total premiums in U.S.)	-0.067***
	(0.006)
Intercept	2.603***
	(0.093)
Adjusted R^2	0.021

Regression includes year and firm fixed effects, not shown.

*, **, and *** denote significance at the 90 percent, 95 percent, and 99 percent level, two-tailed test.

note that two years after the unexpected catastrophe, there appears to be no statistically significant evidence of any effect on loss ratios.

We can also derive some conclusions regarding diversification and economies of scale from the regression: the number of states in which an insurer operates can be interpreted as a measure of geographical diversification. Our results indicate that loss ratios decrease as the number of states in which insurers write business increases. Similarly, we can confirm our hypothesis that larger firms should be less susceptible to shocks than smaller firms, as higher total premiums written on state and national level are associated with lower empirical loss ratios.

Analysis of Losses Incurred

We now turn to the separate analysis of losses and premiums to better understand the changes in property markets following catastrophic events. Controlling for the scale of the insurer's operations by including the total premium volume on the right-hand side of the equation, unexpected catastrophes should clearly boost the contemporaneous losses incurred by the insurance company. Table 3 shows the results of estimating the following equation:

Our hypotheses regarding insurers' losses are the following:

Hypothesis (4): Unexpected catastrophic events boost the losses incurred by the insurers.

Hypothesis (5): Controlling for the firm's premium volume, this effect is less intense among commercial insurers compared to insurers writing only homeowners (due to more flexible / risk-adequate underwriting).

Hypothesis (6): Controlling for the firm's premium volume, losses of insurers increase even more in a strict rate regulation regime, especially following catastrophes.

We can conclude from the regression of losses incurred that both homeowners' and commercial insurers' losses are higher in the years with positive unexpected catastrophic events. This confirms hypothesis (4). An increase by one in unexpected catastrophic events results on average in a 6.2 percent increase in losses for the homeowners insurers, and about a 2.4 percent increase for commercial insurers, all else being equal. The lower increase of commercial insurers' losses supports hypothesis (5). Besides the argument of differences in the regulation intensity among the different insurer types, these different intense re-

$$
\begin{aligned}
Ln(Losses\_inc)_{ist} = {} & \alpha_1 + \beta_1 UnexpCat_{ist} + \beta_2 UnexpCat_{is,t-1} \\
& + \beta_3 UnexpCat_{i,s,t-2} + \beta_4 (cm\_only * UnexpCat_{ist}) \\
& + \beta_5 (both * UnexpCat_{ist}) + \beta_6 (cm\_only * UnexpCat_{i,s,t-1}) \\
& + \beta_7 (both * UnexpCat_{is,t-1}) + \beta_8 (cm\_only * UnexpCat_{is,t-2}) \\
& + \beta_9 (both * UnexpCat_{i,s,t-2}) + \beta_{10} RateReg_{st} \\
& + \beta_{11} (UnexpCat_{ist} * RateReg_{st}) + \beta_{12} (UnexpCat_{i,s,t-1} * RateReg_{s,t-1}) \\
& + \beta_{13} (UnexpCat_{i,s,t-2} * RateReg_{s,t-2}) + \beta_{14} LnPrems_{is,t-1} + \beta_{15} LnNumsts_{ist} \\
& + \beta_{16} LnStatePrems_{ist} + \beta_{17} LnNatPrems_{ist} + \sum_{j=1}^{23} \delta_j Y_j + \sum_{i=1}^{n} \eta_i F_i + \varepsilon_{ist}
\end{aligned}
$$

Table 3. Regression results for insurer losses

Explanatory Variable	Coefficient
	(Standard Error)
Unexpected Catastrophic Events$_t$	0.062***
	(0.005)
Unexpected Catastrophic Events$_{t-1}$	0.013**
	(0.005)
Unexpected Catastrophic Events$_{t-2}$	-0.003
	(0.005)
UnexpCat$_t$* (Insurer writes commercial lines only)	-0.038***
	(0.005)
UnexpCat$_t$* (Insurer writes both homeowners & commercial lines)	-0.019***
	(0.005)
UnexpCat$_{t-1}$* (Insurer writes commercial lines only)	-0.002
	(0.005)
UnexpCat$_{t-1}$* (Insurer writes both homeowners & commercial lines)	0.007
	(0.005)
UnexpCat$_{t-2}$* (Insurer writes commercial lines only)	0.001
	(0.005)
UnexpCat$_{t-2}$* (Insurer writes both homeowners & commercial lines)	0.003
	(0.005)
Strict Rate Regulation$_t$	0.070***
	(0.015)
UnexpCat$_t$* strict rate regulation$_t$	0.016***
	(0.003)
UnexpCat$_{t-1}$* strict rate regulation$_{t-1}$	-0.007**
	(0.003)
UnexpCat$_{t-2}$* strict rate regulation$_{t-2}$	0.010***
	(0.003)
Ln(premiums earned)$_{ist}$	0.806***
	(0.003)
Ln(number of states in which the insurer writes property coverage)	-0.092***
	(0.013)
Ln(insurer's total premiums in state)	0.080***
	(0.004)
Ln(firm's total premiums in U.S.)	-0.041***
	(0.006)
Intercept	1.669***
	(0.092)
Adjusted R^2	0.380

Regression includes year and firm fixed effects, not shown.

*, **, and *** denote significance at the 90 percent, 95 percent, and 99 percent level, two-tailed test.

actions might also be explained by a higher accumulation risk or portfolio issues in the homeowners market. But since we control for total premium volume in our regression, such effects should be captured otherwise. As in the results for the loss ratio equation (above), previous years' unexpected catastrophes do not have a consistent effect on current year losses, although the significant effects are all positive.[22]

The results also confirm hypothesis (6) that—controlling for total premium volume—the losses of insurers operating in a strict rate-regulation regime seem to be more affected by catastrophic events, supporting our theory that strict rate regulation matters to insurers' performance and allowing us to draw the conclusion that differences in the intensity of personal and commercial lines insurers' reactions might at least partly be explained by differences in the way they are regulated.

Analysis of Premiums Earned

The results so far fit our theory quite well. Finally, we investigate the relationship between unexpected catastrophic events and premiums earned. Specifically, we estimate the following equation:

Our hypotheses regarding insurers' premiums are the following:

Hypothesis (7): Insurers increase premiums and/or reduce their exposure following unexpected catastrophic events.

Hypothesis (8): Commercial insurers increase premiums more so than homeowners insurers, and also reduce their business more intensely (due to different regulatory constraints and underwriting flexibility).

Hypothesis (9): Strict rate regulation has a negative impact on total premiums written by insurers.

The results of estimating equation (3) are shown in Table 4. In this equation, we include the lagged value of premiums earned in order to capture any autoregressive character to insurance underwriting, as firms that write a large amount of premiums in the state in a given year will tend to continue to do so in subsequent years.

We do not expect that current catastrophic events will have an influence on contemporaneous premiums, since such events occur in the aftermath of the establishment of premiums. However, we are curious to determine any lingering effect of these events on premiums in subsequent

$$
\begin{aligned}
Ln(Prems\_earned)_{ist} &= \alpha_1 + \beta_1 UnexpCat_{ist} + \beta_2 UnexpCat_{is,t-1} \\
&+ \beta_3 UnexpCat_{i,s,t-2} + \beta_4 (cm\_only * UnexpCat_{ist}) \\
&+ \beta_5 (both * UnexpCat_{ist}) + \beta_6 (cm\_only * UnexpCat_{i,s,t-1}) \\
&+ \beta_7 (both * UnexpCat_{is,t-1}) + \beta_8 (cm\_only * UnexpCat_{is,t-2}) \\
&+ \beta_9 (both * UnexpCat_{i,s,t-2}) + \beta_{10} RateReg_{st} \\
&+ \beta_{11} (UnexpCat_{ist} * RateReg_{st}) + \beta_{12} (UnexpCat_{i,s,t-1} * RateReg_{s,t-1}) \\
&+ \beta_{13} (UnexpCat_{i,s,t-2} * RateReg_{s,t-2}) + \beta_{14} LnPrems_{is,t-1} + \beta_{15} LnNumsts_{ist} \\
&+ \beta_{16} LnStatePrems_{is,t-1} + \beta_{17} LnNatPrems_{ist} + \sum_{j=1}^{23} \delta_j Y_j + \sum_{i=1}^{n} \eta_i F_i + \varepsilon_{ist}
\end{aligned}
$$

Table 4. Regression results for insurer premiums

Explanatory Variable	Coefficient
	(Standard Error)
Unexpected Catastrophic Events$_t$	-0.001
	(0.003)
Unexpected Catastrophic Events$_{t-1}$	0.002
	(0.003)
Unexpected Catastrophic Events$_{t-2}$	0.005*
	(0.003)
UnexpCat$_t$* (Insurer writes commercial lines only)	0.002
	(0.003)
UnexpCat$_t$* (Insurer writes both homeowners & commercial lines)	0.000
	(0.003)
UnexpCat$_{t-1}$* (Insurer writes commercial lines only)	-0.003
	(0.003)
UnexpCat$_{t-1}$* (Insurer writes both homeowners & commercial lines)	-0.001
	(0.003)
UnexpCat$_{t-2}$* (Insurer writes commercial lines only)	-0.002
	(0.003)
UnexpCat$_{t-2}$* (Insurer writes both homeowners & commercial lines)	-0.006*
	(0.003)
Strict Rate Regulation$_t$	-0.008
	(0.008)
UnexpCat$_t$* strict rate regulation$_t$	-0.002
	(0.002)
UnexpCat$_{t-1}$* strict rate regulation$_{t-1}$	0.001
	(0.002)
UnexpCat$_{t-2}$* strict rate regulation$_{t-2}$	-0.001
	(0.002)
Ln(Premiums earned)$_{t-1}$	0.627***
	(0.001)
Ln(number of states in which the insurer writes property coverage)	0.329***
	(0.007)
Ln(insurer's total premiums in state)	0.413***
	(0.002)
Ln(firm's total premiums in U.S.)	0.048***
	(0.003)
Intercept	-3.339***
	(0.047)
Adjusted R^2	0.675

Regression includes year and firm fixed effects, not shown.

*, **, and *** denote significance at the 90 percent, 95 percent, and 99 percent level, two-tailed test.

years. We would expect firms to increase premiums following catastrophes if insurers anticipate a higher rate of catastrophes to continue. Thus, for any given number of policies written, the total premiums should rise. On the other hand, major catastrophes may also reduce the quantity of insurance business, because of higher rates, insurance rationing, and the exit of firms from the state.

What we see in our results is therefore a combination of two issues: increases in the price of coverage and reductions in the volume of insurance provided. To the extent that these effects balance out, we might not observe a significant relationship between past events and premiums. However, we do get a significant result for the two years lagged unexpected catastrophe variable. The coefficient allows us to make a statement on the combined effects described in hypothesis (7): the significant positive relation might be the result of rising premiums following catastrophic events dominating the opposite effect of a possible reduction of the quantity of insurance written, and also the consequence of a rising number of firms offering additional coverage being attracted by the usually growing demand for insurance in the immediate aftermath of catastrophic events.[23]

If we look at the lagged unexpected catastrophe variables for commercial lines insurers, we can see that the effect of catastrophes on total premiums seems to be changed. The issue of insurers reducing their business following catastrophes appears to be dominant in the commercial insurance context. Besides simply reducing their coverage offers, insurers might also decide to leave the market. Homeowners insurers might not be able to do that to the same extent because of regulatory constraints forcing them to renew policies and forbidding them to cancel contracts as well as compelling them to exit all lines of business if they decide not to offer homeowners insurance. Unfortunately, the results for the insurer-type interactions are not statistically significant, so we cannot draw general valid conclusions regarding these issues and therefore cannot confirm or reject hypothesis (8).

Furthermore, insurers' total premium volume seems to be negatively influenced by a strict premium regulatory environment, especially following catastrophic events, supporting hypothesis (9). The reasons for a reduced total premium volume might be a reduced total coverage offer by insurers combined with a restricted ability to adjust prices as a result of regulatory constraints. But since these results do not come in statistically significant, we are not allowed to make a general empirical statement.

Market Structure Following Unexpected Catastrophic Events

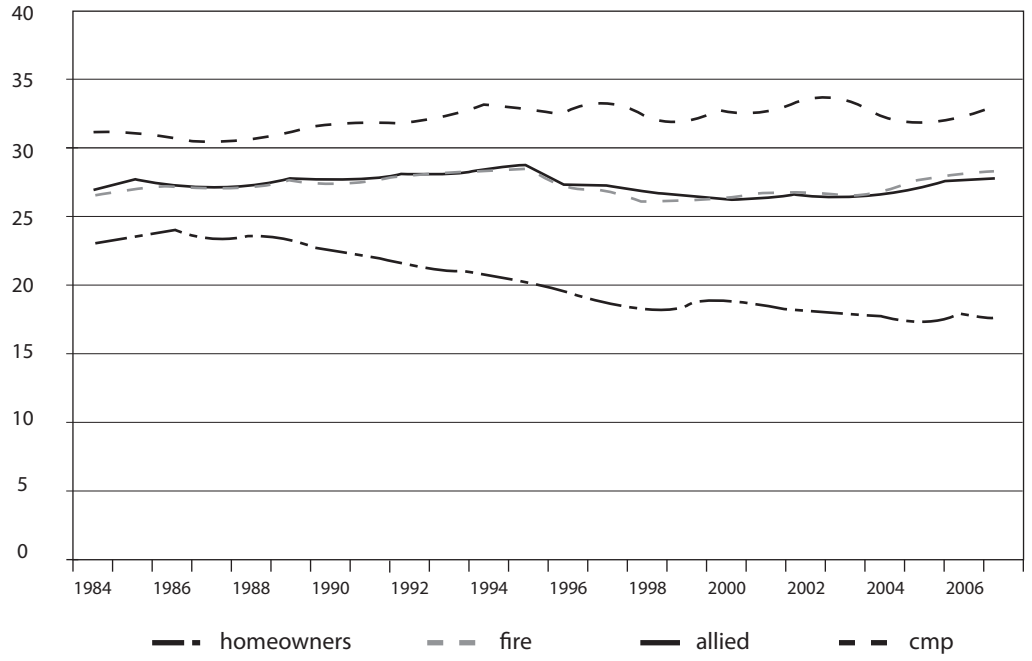
Our previous analysis documents the effects of unexpected catastrophic events on insurers' losses and loss ratios, but does not clearly explain insurance companies' responses. The regression results for loss ratios suggest that insurers adjust their premiums following catastrophic events, especially if they are not constrained by restrictive rate regulation: while unexpected catastrophes increase insurance companies' loss ratios during the year when the catastrophe strikes, the boosting effect does not hold to the same extent for one and two years later. This may be the result of lower losses in these years, but it might also be evidence that insurers increase premiums in anticipation of a new expected exposure to catastrophic events. The results of the premium regression also

imply an adjustment of insurers' premiums following catastrophes.

Nevertheless, we are not able to separate price and quantity effects in our data and therefore cannot make general conclusions on insurers' actual responses. In order to comment on the availability and affordability of property insurance coverage, we might therefore have to consider whether, and to what extent, these events affect the structure of state property insurance markets. Our preliminary analysis suggests that opportunities to obtain affordable property coverage may have changed significantly over the considered time period. In particular, Figure 6 shows that market concentration increased greatly in the homeowners property line relative to that of the commercial lines. This higher market concentration might be a consequence of a trend towards insurer consolidations, but may also result from insurers exiting from the homeowners property insurance market. The correlation between increasing market concentration, market exits, and catastrophic events is a subject for further work.

With the goal of improving the market of insurance for catastrophic risks, current public policy is largely focused on creating reinsurance mechanisms and various methods of securitizing catastrophe risk. Also, we note that some states are experimenting with measures to encourage private insurers to enter their markets.[24] If regulatory requirements are impacting insurers' ability to diversify geographically, regulatory reform aimed at reducing the duplication of licensing and reporting activities might be given more consideration. For example, allowing insurers to opt for a federal charter could greatly reduce these barriers to diversification.[25] As shown in Figure 9, our preliminary analysis indicates that

Figure 9: Average number of states per firm, 1984–2007



Source: NAIC annual statement data.

the average number of states in which an insurer operates has slightly increased for the commercial lines, but has declined for the homeowners line. This is preliminary proof that diversification may be easier for commercial lines due to less binding regulatory requirements, and we use this as our primary motivation for exploring constraints on geographic diversification in our future research.

Conclusion

In the aftermath of several years of large catastrophic losses, it is not surprising that property insurance issues remain at the top of public policy agendas in Washington and in many states. The importance of achieving consensus on how best to prepare for the "next big one" is elevated even more with the spate of failures in the financial services industry in general. Surely, the ability to absorb large losses is only more doubtful and calls for increased attention. Regulatory intervention, however, might entail a loosening of those regulations that may have distorted incentives for insurers to develop effective private solutions.

In this report, we highlight changes in the U.S. property insurance industry over the past twenty-three years. We show trends in the number and types of firms providing property coverage, and assess changes in the market structure that might have important implications for the availability and affordability of coverage. More important, our analysis establishes a significant difference in the way that personal and commercial insurers respond in the aftermath of unexpected catastrophes. We show that such events have a stronger boosting effect on losses and loss ratios of homeowners insurers which should mainly be a consequence of distinct regulatory treatment. We also provide evidence that rate filing restrictions on insurers constrain their ability to maintain underwriting profitability following catastrophic events. The regression results suggest that restrictive premium regulation aggravates risk-adequate underwriting behavior resulting in higher loss ratios, which supports the necessity and importance of further deregulation in this context. The relatively smooth operation of less intensely regulated commercial lines insurers over our sample period suggests that successful strategies for responding to catastrophic events may call for less, not more, regulation of insurer activities. Deregulation of insurance prices would be a first step to improve the efficiency of insurance markets, enabling insurers to deal with mega-catastrophes.

In the discussion about alternative regulatory systems, there are a number of possible ways to restructure and improve efficiency and competition while at the same time enhancing consumer protections. Feldhaus and Klein (1997, 8) discuss various suggestions for the commercial market. "We recommend not deregulation *per se,* but a shift in regulatory emphasis from review and approval of rates and forms and other restrictions, to increased emphasis on market monitoring and strategic intervention only when necessary." By reviewing state statutes, we observed a trend towards deregulation, but further changes may be warranted. Options such as a reform of residual market solutions should be top priorities on the regulatory agenda, with emphasis on allowing market forces to operate more freely in responding to the insurance needs and avoiding severe incentive conflicts that endanger successful private solutions for dealing with catastrophic events.[26] "Regulatory chain reactions," noted earlier as the

phenomenon in which one regulatory intervention induces the necessity of another, might not only influence insurers' underwriting performance, but also expose insurance consumers and taxpayers to significant risk and assessments when catastrophes occur. If regulators attempt to solve availability and affordability issues by suppressing rates or imposing tying obligations, such as exit restrictions or policy renewal duties, following catastrophic events they may exacerbate the problem in the long run.

More freedom in underwriting which results in more accurate risk adjustment can, of course, aggravate goals for achieving more universal coverage for property risks. Some insureds in high risk areas may simply not be able to afford the price of coverage and cannot be expected to move or invest in other loss control mechanisms. A possible solution might be direct state subsidization of these premiums for low income people. This way of subsidizing premiums seems preferable to artificially low and thus indirectly subsidized premiums, as this allows market forces to continue to work.[27] However, incentive-incompatible subsidization of premiums—for example, for new buildings in high risk areas—has to be strictly avoided in order to prevent people from building new houses in these areas and externalizing a portion of the risk.

While our study is limited to an analysis of readily observable responses to catastrophic events, that is, insurers' underwriting performance, we propose that further investigation into the actual responses of commercial and personal property insurers (like, for example, insurers' decisions to exit the market or enter into others) will yield important insight for the discussion on regulatory reform in the property insurance lines.

Appendix. Rate Regulation in the Property Lines

State	Premium Approval System: Commercial Lines	Changes and Comments: Commercial Lines	Premium Approval System: Homeowners	Changes and Comments: Homeowners
AL	FR	changed from PA in 2001	PA	
AK	FR	changed from PA in 2005	FR	changed from PA in 2005
AZ	U&F	NF for industrial insured	U&F	
AR	F&U/NF	F&U for small commercial risks; NF for large commercial risks	F&U	
CA	PA		PA	
CO	F&U	NF for exempt commercial policyholders	F&U	
CT	F&U		F&U	
DE	F&U	NF for certain large risks	F&U	

State	Premium Approval System: Commercial Lines	Changes and Comments: Commercial Lines	Premium Approval System: Homeowners	Changes and Comments: Homeowners
DC	F&U	from 2001 on NF for exempt commercial risks	F&U	
FL	F&U/U&F	optional for insurers	F&U/U&F	
GA	F&U/NF	NF for large commercial risks	F&U	
HI	PA		PA	
ID	U&F		U&F	
IL	U&F/NF		U&F	
IN	F&U/NF	NF for large commercial insured	F&U	
IO	PA		U&F	
KS	F&U/NF	NF for large commercial insured	F&U	
KY	FR	NF for industrial insured and exempt commercial policyholders	FR	
LA	FR/NF	NF for exempt commercial policyholders; changed from PA to FR 2004; change to NF 2006	FR	changed from PA 2004
ME	F&U/NF	NF for large commercial risks	F&U	
MD	F&U		F&U	
MA	F&U/NF	NF for large commercial policyholders	F&U	
MI	PA or F&U	optional for insurers; NF for exempt commercial policyholders	F&U	
MN	F&U		F&U	
MS	PA		PA	
MO	NF	commercial casualty and property are filed for informational purposes only	U&F	
MT	F&U		F&U	
NE	F&U/NF	NF for large commercial policyholders	F&U	changed from PA 2005
NV	NF		PA	
NH	U&F/NF	NF for large commercial risks	F&U	

State	Premium Approval System: Commercial Lines	Changes and Comments: Commercial Lines	Premium Approval System: Homeowners	Changes and Comments: Homeowners
NJ	U&F	NF for special risks	PA	
NM	F&U	change to NF 2007	PA	change to F&U 2007
NY	F&U/FR		F&U	
NC	F&U		PA	
ND	PA		PA	
OH	PA/F&U	property: PA; commercial multiple peril: F&U	F&U	
OK	U&F/NF	NF for special large commercial risks; changed from F&U 2004	U&F	changed from F&U 2004
OR	F&U	FR (15% increase/decrease for commercial casualty)	F&U	
PA	FR/NF		FR	
RI	F&U/NF	NF for large commercial risks	FR	changed 2005
SC	NF	NF for exempt commercial policies	FR	changed from PA 2004
SD	F&U/NF	NF for large commercial risks	F&U	
TN	U&F		PA	
TX	F&U		F&U	
UT	U&F	NF for commercial excess and umbrella liability	U&F	
VT	U&F		U&F	
VA	F&U		F&U	
WA	U&F/NF	NF for large commercial property casualty accounts; changed from PA 1997	PA	
WV	F&U		PA	
WI	U&F		U&F	
WY	NF		NF	

Sources: Feldhaus and Klein (1997), Mercer Oliver Wyman (2004), NAIC (2005), Wharton (2008). Changes of regulations over time are obtained from state statutes.

Notes

1. See Swiss Re (2006).

2. For a discussion of the criteria of insurability of risks see, for example, Berliner (1982) or Coomber (2006).

3. See Grace / Klein (1998), Grace / Klein(2003) and Grace et al. (2005) for similar research, although our focus differs and we evaluate trends over a much longer period.

4. See Klein / Kleindorfer (1999), Grace / Klein (2006) and Grace / Klein (2007) for a detailed description of the conduct and performance of the Florida insurance market with a special focus on prices, availability of coverage, policy terms, and profitability. The analyses document the restructuring of the market, the rising price and tighter availability of insurance, and the substantial losses suffered by insurers that have adversely affected the supply of coverage.

5. For a detailed description of these regulatory aspects see, for example, Wharton (2008), chapter 2, Harrington / Niehaus (2003), chapter 6, Klein (1995), Klein (2000), and Klein (2007). For an overview of various theories of regulation see Klein (1995). The principles of and reasons for insurance regulation are also explained in Feldhaus / Klein (1997), Grace / Klein (1999), and Wharton (2008).

6. For a discussion of the problems and incentive conflicts linked with residual market solutions and insurance guaranty funds see, for example, Harrington / Niehaus (2003), 287ff., Mercer Oliver Wyman (2004), 39ff. and Wharton (2008), 48ff.

7. That is also the reason why we use the kind of rate regulation as proxy for the intensity of regulation in a certain state in our regression approach (see below).

8. See, for example, Feldhaus / Klein (1997).

9. See Harrington / Niehaus (2003), 98, 503, 523. Also see www.commercialinsurancefacts.org. For further contributions on regulation of property insurance markets in relation to catastrophic risks see Klein (1998), Klein (2007), and Wharton (2008), chapter 2. These studies comment on regulatory issues (regulation of prices, underwriting and policy terms, etc.) with a special focus on catastrophe-prone states (Florida, Texas, California, New York).

10. For a description of the typical distribution channels in commercial lines see Feldhaus / Klein (1997), 30 ff.

11. See Harrington / Niehaus (2003), 504, 522ff. Also see www.commercialinsurancefacts.org.

12. There are eight different forms of homeowners' policies offering different coverage possibilities for the insureds' various coverage needs. The most common HO-3-policy comprises building and content coverage with a liability component covering all perils except for the ones that are specially named ("all risk" policy). For details see Harrington / Niehaus (2003), chapter 14, and Rejda (2008), chapter 20 and 21.

13. There are several different lines of business offering coverage for commercial property risks. In our analysis we include commercial multiple peril, fire, and allied lines. Commercial multiple peril policies are—similar to homeowners contracts—building and content policies for commercial clients including a liability component as well as some further arbitrary coverage extensions like business interruption insurance, etc. Fire insurance covers property losses caused by fire and lightning. Allied lines refer to coverages that are usually purchased with fire insurance, such as coverage for windstorm, hail, and vandalism. Indirect losses can also be covered, including the loss of business income and extra expenses. While commercial multiple peril policies are usually bought by small and medium-size businesses, fire policies are purchased by companies of all sizes. Especially big industrial clients usually insure their property risks by fire and allied policies leading to a heterogeneous risk structure in these insurance portfolios. For details see Feldhaus / Klein (1997), 38ff., Harrington / Niehaus (2003), chapter 23, and Rejda (2008), chapter 25.

14. The underlying data for Figures 7 and 8 are adjusted for inflation. We note that surplus is calculated at the firm level, and is not exclusively allocated to the insurer's property business.

15. Our analysis of premium changes is limited to assessing changes in the total volume of business, as we are not able to evaluate the separate effects on prices or quantities.

16. This approach differs somewhat from Born / Viscusi (2006), which used the average catastrophic events over the sample period as the measure of expected catastrophes for each state. We use a four-year rolling window to allow for trends in the number of events over time. Of course, there is much potential for discussion on how to model the variable "Unexpected Catastrophes" and there are certainly several other reasonable ways to do that. We also tried several alternative definitions, for example, a dummy variable that equals one if the actual number of catastrophic events is larger than two times the standard deviation of the number of events per state over the time period. The results (not shown) confirm

the robustness of our findings, as the direction of influence is generally unchanged. We chose our approach as we wanted to make sure to capture trends of changes in the number of catastrophes over the observation period.

17. Since our focus is on firm-state units, we do not, at this time, account for the fact that the total number of unexpected events for firms with multi-state operations ranges from -46 to 107.

18. This can also be interpreted as a measure of the insurer's diversification efforts.

19. We do not include variables pertaining to the organizational form as we run the regressions with firm fixed effects. For a review of the effect of organizational form on insurers' performance see Born et al. (1998).

20. We lose several years of data due to the inclusion of the lagged covariates.

21. The effect of a contemporaneous (time *t*) unexpected catastrophe on insurers is determined via a combination of the coefficients of the following variables: *Unexpected Catastrophic Events*$_t$, *UnexpCat*$_t$*(*Insurer writes Commercial lines only),* and *UnexpCat*$_t$**Strict Rate Regulation*$_t$.

22. The effect of reducing losses two years after an unexpected catastrophe might result either from a reduced quantity of insurance written or the exit of the firm from the state insurance market altogether. But this result is not statistically significant.

23. This was, for example, the case in Florida following the latest years' major hurricanes when new start-up insurers saw the opportunity of doing business in certain areas.

24. According to the Florida Office of Insurance Regulation, since early 2006, when the legislature made affordable, competitive-priced insurance a priority, 31 new insurers have entered the Florida market.

25. For the discussion of an optional federal charter/regulation system with a summary of the arguments for and against state regulation compared with federal regulation see, e.g., Grace / Klein (1999), Harrington / Niehaus (2003), 104ff., and Grace / Klein (2008).

26. For a comparison of the U.S. regulatory regime with the European approach and a discussion on reformation needs including some remarks on how these issues are addressed in Europe (Solvency II), see Klein / Wang (2007). For further reform proposals see Grace / Klein (2008).

27. Moreover, the adverse selection problem resulting from average premiums can be reduced. See Kunreuther (2006); Kunreuther / Pauly (2006).

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