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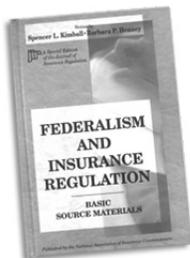
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Catastrophe Risk and the Regulation of Property Insurance Markets

Patricia Born, Ph.D.
Robert W. Klein, Ph.D.

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NAIC Executive Office
444 North Capitol Street, NW
Suite 700
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202.471.3990

NAIC Central Office
1100 Walnut Street
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Catastrophe Risk and the Regulation of Property Insurance Markets

Patricia Born, Ph.D.*
Robert W. Klein, Ph.D.**

Abstract

In this paper, we evaluate state regulation of insurance markets subject to catastrophe risk and, more specifically, homeowners insurance and commercial property insurance. When insurers suffer substantial losses following a catastrophic event, pressures on property insurance markets can increase as insurers attempt to raise their prices and reduce their exposures. This can bring insurers into conflict with regulators who seek to maintain the affordability and availability of insurance. Some states may also use their residual market mechanisms (RMMs) as a means to provide subsidized coverage for high-risk properties. While these regulatory actions may seem well-intended, the concern is that they can interfere with market adjustments and undermine the supply of private insurance. To gain some insight on these issues, we examine how state rate regulation and the relative size of state RMMs affect various outcomes in homeowners and commercial property insurance markets generally and specifically following a large catastrophe in a state. Our findings indicate that regulatory attempts to constrain rates and larger residual markets tend to have negative effects on certain outcomes in homeowners insurance markets, all other things equal. However, we do not find that these effects become more pronounced following a catastrophic event except for market concentration. Further work is needed to develop better ways of measuring how changes in catastrophe risk and rate regulation affect property insurance markets.

* Risk Management & Insurance, Real Estate and Legal Studies, College of Business, 821 Academic Way, Florida State University, Tallahassee, FL 32306-1110; pborn@business.fsu.edu.

** Department of Risk Management and Insurance, Georgia State University, P.O. Box 4036, Atlanta GA 30302-4036; rwklein@gsu.edu.

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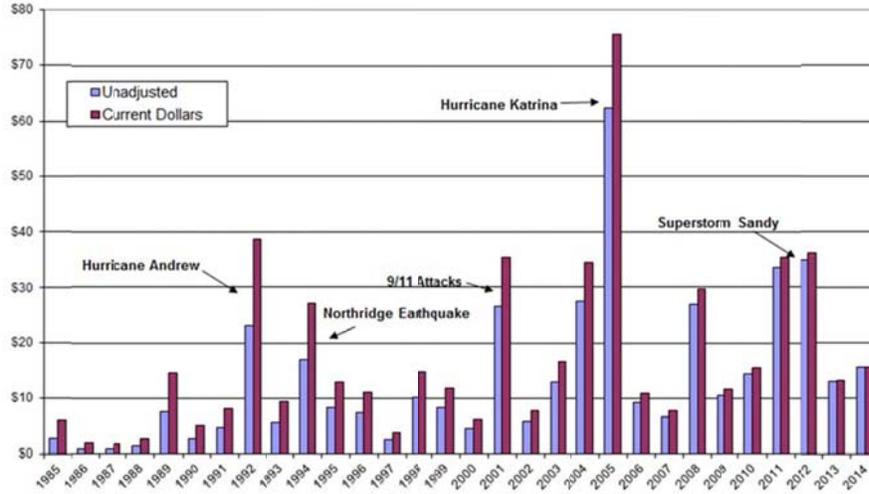
1. Introduction

There is a long line of academic literature on the effects of regulation on property/casualty (P/C) insurance markets. Most of this research has focused on how different rate regulatory systems and residual market mechanisms (RMMs) affect personal auto and workers' compensation insurance markets. There has been some research on the effects of regulation in property insurance markets (primarily homeowners insurance), but with one exception (Born and Klimaszewski-Blettner, 2013), this research has focused on only one state or a just a few states. An important factor involved with the regulation of property insurance markets is the dramatic rise in catastrophe risk and the occurrence of natural disasters (e.g., Hurricane Andrew, the Northridge Earthquake and Hurricane Katrina) as depicted in Figure 1. Regulatory policies in areas prone to natural disasters have important implications for the cost and availability of property insurance and the management of catastrophe risk. There is particular interest in homeowners insurance where market changes following a catastrophe can be a matter of considerable public concern, and regulatory responses to such changes can be contentious. Hence, there is a strong need to gain a better understanding of how regulatory practices affect outcomes in property insurance markets subject to catastrophe risk, particularly homeowners insurance.

The topic of best regulatory practices in insurance was generally addressed in the Federal Insurance Office's (FIO) report on *How to Modernize and Improve the System of Insurance Regulation in the United States* (FIO, 2013). Several parts of this report bear directly or indirectly on how state regulators can continue to ensure a viable private market for insurance against natural catastrophic events. Specifically, the report includes recommendations that urge state regulators to identify "best practices" with regard to both rate regulation and natural catastrophe loss mitigation. With respect to the former, the explicit objective is to identify rate-related regulation that fosters competitive markets for personal lines insurance consumers and, consequently, increases market capacity. Regarding natural catastrophes, the objective is less clear but might include identifying regulations that encourage loss mitigation (e.g., allowing premiums to reflect mitigation activities) or establish/define mitigation measures (e.g., building codes). The FIO issued a subsequent report in 2015 entitled *Report Providing an Assessment of the Current State of the Market for Natural Catastrophe Insurance in the United States* (FIO, 2015). This report did not discuss state rate regulation or mitigation but did review state RMMs for property insurance without offering any opinions on how these mechanisms should be structured or administered.¹

1. The report discussed important developments concerning the Texas Windstorm Underwriting Association (TWIA), the Florida Citizens Property Insurance Corporation (FCPIC) and the Louisiana Citizens Property Insurance Corporation (LCPIC), including their depopulation efforts.

**Figure 1:
Insured Property Losses for U.S. Catastrophes (\$B)
1985–2014**



Note: Excludes losses insured by the National Flood Insurance Program (NFIP)
Source: Insurance Information Institute

Natural disasters can have substantially adverse effects on homeowners and commercial property insurers. These effects include large underwriting losses and the depletion of capital that can compel an insurer to make significant changes in its operations. According to the Insurance Research Council (IRC), the average claim payment for all homeowners insurance claims countrywide rose 228% between 1997 and 2013 (IRC, 2015). Several factors could account for this trend, including the increasing severity of natural disasters and higher replacement costs for homes. Additionally, population growth in coastal areas subject to tropical storms and hurricanes has contributed to higher catastrophe losses, and projections by the National Oceanic and Atmospheric Administration (NOAA) indicate that the number of people living in coastal areas will continue to grow for the foreseeable future (NOAA, 2013).² Hazard mitigation efforts are viewed by experts as insufficient in many areas, and evidence of the effectiveness of incentives to undertake mitigation activities is mixed (FIO, 2013).

To maintain their profitability, insurers adapt to catastrophic events and increased estimates of catastrophe risk by reducing coverage, raising rates, and changing their underwriting and investment strategies. Homeowners respond to these events and the consequent actions of insurers in a variety of ways as well. For example, those with insufficient coverage may seek additional insurance,

2. NOAA projects that, between 2013 and 2020, the number of people living in coastal areas will grow by 11 million to a total of 134 million (NOAA, 2013).

while others may choose to reduce or drop coverage (if they have this option) as the cost of coverage becomes more difficult for them to afford.³ Such responses suggest that, for a period following a catastrophic event, the supply of and demand for coverage will be in flux.

Using a large dataset on homeowners and commercial property insurance coverage by state, by firm and by year for the period 1984–2013, this study assesses changes in the structure and performance of U.S. homeowners and commercial property insurance markets generally and specifically following natural catastrophic events. This long period, characterized by an increasing number of natural disasters, facilitates exploration of how rate regulation and residual market administration affect various dimensions of homeowners and commercial property insurance markets. We analyze both homeowners and commercial property insurance markets to compare the effects of regulation between these lines of business. As we discuss further below, commercial insurance markets are subject to less intensive regulation than personal lines insurance markets. Hence, we would expect regulation to affect commercial property insurance markets to a lesser degree than homeowners insurance markets (Born and Klimaszewski-Blettner, 2013).

Our objective is to contribute to the discussion of what would constitute “best regulatory practices” that help to promote the availability of coverage, insurers’ capacity to bear catastrophic risks and risk-based rates. Some might contend that a regulatory best practice is one that ensures that coverage is “affordable” for all consumers.⁴ In general, rates are not likely to be excessive if the market for coverage is workably competitive, but this may or may not be the case for homeowners insurance in areas subject to very high levels of catastrophe risk.⁵ Moreover, regulatory policies that seek to artificially suppress rates conflict with the goal to ensure that insurers are financially solvent. While it is understandable that regulators will seek to keep the cost of insurance within the bounds of what they consider to be affordable, they also are faced with the challenge of ensuring that insurance coverage is available. Insurers will be more reluctant to provide coverage if they are not allowed to charge rates that are commensurate with the risks they bear and fully cover their costs of providing coverage, at least over the

3. Buying or maintaining homeowners insurance is generally a condition for acquiring or maintaining a mortgage on a home. Homeowners without a mortgage are not subject to this requirement and could choose to go without insurance.

4. The term “affordable” is often used in reference to the cost of insurance without a clear, commonly-understood definition of what this term means. Our impression is that the regulators in a given state may have at least an implicit standard in mind in determining what they believe should be considered an affordable premium for a given type of insurance and insured. In practice, such a standard may be reflected in regulatory policies that seek to constrain insurers from charging premiums higher than what regulators believe consumers should be expected to pay for a specific type of insurance.

5. We discuss the issue of whether homeowners insurance markets subject to a high level of catastrophe risk can be competitive below.

long term. Hence, there can be a tension between the objectives of promoting affordability and availability.

The paper proceeds as follows. The next section reviews the discussion in the two FIO reports concerning catastrophic risks. This is followed by a discussion of the anticipated effects of catastrophic events on the structure and performance of insurance markets. This discussion emphasizes that catastrophic events have differential effects on insurers and proposes that the effectiveness of state regulatory practices should be evaluated based on how they affect a market as a whole, not how they influence any particular insurer(s). This is followed by a review and empirical analysis of the relationship between two more easily identified state regulatory practices—rate regulation and the relative size of RMMs—and changes in five measures of market structure and performance. The paper concludes with a summary and review of our findings and suggestions for further research.

2. The FIO Report: A Challenge to Regulators

The FIO 2013 report considers a wide range of insurance regulatory issues with primary emphasis on the extent of federal government involvement that is desirable and/or necessary for improving the current state-based regulatory system. While the report recommends direct federal involvement in only a few areas (e.g., federal standards and oversight for mortgage insurers), the bulk of the report suggests ways in which the state systems could be reformed. It recognizes that the states continue to serve local needs and that their unique regulatory experiences can provide lessons for others. However, it notes there is room for improvement and calls on regulators to develop “best practices” in several areas, particularly rate regulation and natural catastrophe loss mitigation. With regard to rate regulation, the report states that, generally, the objective should be to foster competition in the personal insurance lines, thereby increasing the availability of coverage. Best practices in catastrophe loss mitigation could include encouraging the adoption of specific mitigation measures (e.g., strong building codes).

Interestingly, the report does not explicitly acknowledge that best practices concerning rate regulation could also be among the best practices for promoting optimal managing of and insuring against natural catastrophe risk. Rather, the section on catastrophes focuses mainly on residual markets and mitigation.⁶ The

6. The report briefly addresses risk classification, though not in a broad sense. In particular, the emphasis in the report is on the use of credit scoring and, to a lesser extent, the use of personal information for insurance pricing. The FIO recommends in this section that “states should develop standards for the appropriate use of data for the pricing of personal lines insurance.” As it pertains to the pricing of catastrophe insurance, variation across markets may

report recognizes that the variation across affected states in building codes and other post-event activities have consequences for smoothly functioning property insurance markets. Hence, it recommends that states “should identify, adopt, and implement best practices for construction standards, including effective building codes, to mitigate losses from natural catastrophes” (p. 61).

The report also addresses controversies surrounding government-run insurance and reinsurance programs. Premium increases following catastrophic events affect the affordability and accessibility of coverage and often have led to government intervention (e.g., the establishment or expansion of RMMs). Interestingly, the report stops short of suggesting that best practices for managing catastrophe risk might include reforms to downsize or scale back these mechanisms. The 2015 FIO report discusses RMMs in detail but also does not make any recommendations or offer any opinions as to what would constitute best practices in their design and administration. That said, it should be noted that the FIO attributed decreases in the relative size of RMMs to more competitive insurance markets.

3. The Effects of Catastrophic Events on Property Insurance Markets

The effect of catastrophes on insurers’ underwriting performance can be measured by an insurer’s loss ratio, calculated by dividing the insurer’s total losses incurred by its premiums earned for a specified line of insurance. This commonly used measure captures the extent to which the premiums collected are sufficient for paying incurred claims.⁷ The total losses incurred for a state, relative to the premiums that were earned for that year, provide a good indication of the average weighted effect of a catastrophic event on the state market, as all insurers are not equally affected. Variation in loss ratios across insurers suggests that some may have had more stringent underwriting standards or had few or no exposures in the area where a catastrophe struck and others had less stringent underwriting standards.⁸ As we look at some of the major events in the past 30 years, it is clear that there is great variation in the performance of firms operating in a catastrophe-affected state.

yield important insights into the relationship between underwriting criteria and market structure and performance measures.

7. A loss ratio greater than one indicates an underwriting loss, although underwriting profitability, more generally, would also account for an insurer’s loss adjustment expenses, its other administrative expenses, and the investment income it earns on reserves for unearned premiums and unpaid losses.

8. Generally, insurers that manage their catastrophe risk will avoid having large concentrations of exposures in any geographic area that could be struck by a natural disaster. Insurers that are less cautious in this regard run the risk of incurring large losses in areas where they have high concentrations of exposures.

**Table 1:
Sample of Catastrophic Events and Their Impact on the
State Homeowners Insurance Market**

State	Year	Property Losses Per Capita(\$)	State Loss Ratio (Weighted Avg.)	State Median Loss Ratio	90 th Percentile Loss Ratio
Alabama	2011	881.78	1.811	1.389	3.305
California	1994	934.48	0.746	0.625	1.671
Colorado	1990	255.58	1.921	1.383	2.503
Florida	1992	59.38	3.127	1.956	4.982
Florida	2004	12,910.25	2.861	2.472	4.908
Iowa	2001	32.47	1.603	1.456	3.005
Kansas	1992	69.35	2.561	2.181	3.983
Louisiana	2005	12,806.97	4.421	3.156	5.667
Minnesota	1998	226.50	2.888	2.370	3.849
Missouri	2001	236.48	1.801	1.394	2.711
Mississippi	2005	9,500.72	4.292	3.213	4.908
North Dakota	2001	622.78	2.931	2.111	4.154
Oklahoma	1999	438.62	1.834	1.001	1.926
South Carolina	1989	1,748.55	4.251	3.033	5.306
Tennessee	2011	312.84	2.134	1.750	3.341

Table 1 presents a sample of state-year observations in which the value of total per capita insured homeowners property damages due to catastrophes was significantly higher than in previous years.⁹ As the table shows, loss ratios corresponding to these events indicate a significant aggregate underwriting loss. However, it is clear that these events do not affect insurers equally. The median performance is always better than the state-weighted average, while the 10% of insurers with the worst underwriting performance (the 90th percentile of the loss ratio distribution) report loss ratios as high as 1.5 to 2 times the state average.

Table 2 provides comparable data for the commercial property insurance market for the same sample of events.

Following all but three of the events in this sample, the state aggregate loss ratio for commercial property insurance is lower than the state aggregate loss ratio for homeowners insurance. The median and 90th percentile performance figures indicate that, in most cases, insurers writing commercial property coverage fare better following catastrophic events than their counterparts in homeowners insurance. According to Born and Klimaszewski-Blettner (2013), there are several reasons to expect this. First, insurers have more flexibility in designing coverage

9. By "significantly higher," we mean that reported damages were higher in the identified state-year by at least a factor of 10 compared to the average for that state during the previous three years. The core database used for the empirical analysis consists of the state-level homeowners and commercial property insurance operations for all U.S. insurers from 1984 to 2013. Data on the direct premiums earned, losses incurred, capital and reinsurance amounts are compiled from insurer's annual statutory accounting statements filed with the National Association of Insurance Commissioners (NAIC). Data on catastrophic events and the associated damages were obtained from Sheldus.

for commercial properties, which are also more likely to have certain mitigation features.¹⁰ More importantly, these insurers are less likely than homeowners insurers to be constrained by strict rate regulation, such that the rates charged may be more commensurate with the risks that are borne by a commercial property insurer. Underwriting, policy forms and contract terms also are more intensely regulated for homeowners insurance than for commercial property insurance.¹¹

Table 2:
Sample of Catastrophic Events and Their Impact on the State Commercial Insurance Market

State	Year	Property Losses Per Capita(\$)	State Loss Ratio (Weighted Avg.)	State Median Loss Ratio	90 th Percentile Loss Ratio
Alabama	2011	881.78	2.520	0.967	2.098
California	1994	934.48	0.850	0.543	0.906
Colorado	1990	255.58	0.936	0.581	1.045
Florida	1992	59.38	2.946	1.617	3.510
Florida	2004	1,291.25	2.221	1.521	2.975
Iowa	2001	32.47	1.129	0.749	1.330
Kansas	1992	69.35	1.334	0.876	1.749
Louisiana	2005	12,806.97	5.451	2.649	5.849
Minnesota	1998	226.50	1.497	0.878	1.497
Missouri	2001	236.48	0.888	0.707	1.134
Mississippi	2005	9,500.72	4.269	2.267	4.506
North Dakota	2001	622.78	1.370	0.811	1.568
Oklahoma	1999	438.62	1.306	0.711	1.243
South Carolina	1989	1,748.55	4.088	2.850	4.711
Tennessee	2011	312.84	1.451	0.824	1.643

When states are affected by catastrophes to the degree shown by the examples in Table 1 and Table 2, we would expect that insurers operating in a state are likely to reconsider their decision to participate in its market. Their re-evaluation may result in raising their rates, changing the nature and extent of their exposure in the state, exiting the market, or making no changes. The reaction of a given insurer presumably depends on whether: 1) the insurer perceives that the catastrophic event warrants any changes because it indicates a significant change in risk or

10. Regulators give insurers greater leeway in the insurance contracts purchased by commercial insurance buyers that cover property exposures (Klein, 2014). These contracts are designed in such a way as to give the buyers a number of options with respect to the causes of loss forms used, exclusions, endorsements and optional coverages (Flitner, 2011).

11. Since the mid-1990s, the NAIC and a number of states have undertaken concerted efforts to “deregulate” commercial insurance (Cook and Flitner, 2011). Regulators assert this is justified because individuals and households are less sophisticated in purchasing insurance than commercial insurance buyers, who may work with an experienced broker and are, therefore, more “professional” insurance consumers. However, rate regulation that constrains insurers from setting adequate rates may actually exacerbate losses, as consumers have less incentive to manage risk when rates are suppressed—i.e., the penalty for not mitigating is diminished (Harrington and Danzon, 2001; Derrig and Tennyson, 2011).

other factors affecting its operations; 2) the event substantially reduced its capacity to bear risk (i.e., decreasing its capital or increasing the cost or reducing the availability of reinsurance); and 3) the insurer is not constrained in some way (e.g., by regulation) from responding.¹² Additionally, an insurer may consider how its responses with respect to homeowners insurance in a particular state affect its ability to sell other personal lines of insurance (e.g., personal auto and umbrella insurance) in that state.¹³ Further, an insurer's ability to pool exposures across multiple states may affect how it responds to a catastrophic event in a particular state, noting that insurers are not in a position to perpetually subsidize losses from their operations in one state with revenues they earn from operations in other states and lines of insurance.¹⁴

The data shown in Table 1 and Table 2 suggest alternative ways to determine whether a catastrophe disrupts or destabilizes a state insurance market. A measure that captures the aggregate effect on a state would reflect the impairment of the state's economy. However, because we are concerned with the subsequent responses by homeowners and commercial property insurers, this type of measure would be less informative than a measure that captures the distribution of the catastrophic losses across insurers in the market. Thus, our analysis of insurer responses defines an "economically" catastrophic year as one in which one-half of the homeowners insurers operating in the state report a loss ratio of 1.25 or greater, or 25% of the insurers in the state report a loss ratio of 1.5 or greater. Under this definition, there are 51 state-year observations involving economically catastrophic events over the period 1984–2013.¹⁵ These are shown in Table A-1 in the Appendix A.

While other state-year observations exhibit extreme amounts of insured property losses, these 51 events *should* correspond to a destabilized state market for property insurance. Some outcomes of this instability could include reduced availability of coverage, search costs for consumers who need to find a new source

12. Examples of previous treatments of the insurance of catastrophic risks include special issues of the *Journal of Risk and Insurance* (December 1996) and the Geneva Papers on Risk and Insurance (April 1997). See, e.g., Grace et al, (2004), Angbazo and Narayanan (1996), Gollier (1997), and Kleffner and Doherty, (1996).

13. Typically, many insurers will seek to market multiple products to the same consumer because of the economies of scope associated with this strategy. If an insurer stops offering homeowners insurance, this likely will compromise its ability to sell other types of insurance to consumers who had been purchasing their homeowners coverage from the insurer.

14. Some critics of how insurers have responded to catastrophic risk seem to confuse the pooling of exposures across states with their cross-subsidization. Efficient and economically sustainable pooling requires that each member of the pool pay a premium commensurate with his or her level of risk. An insurer cannot charge higher than actuarially-indicated rates to some insureds to compensate for its charging lower than actuarially-indicated rates to other insureds as this would expose it to adverse selection (Grace and Klein, 2009).

15. Other possible candidates for defining an economically significant catastrophe include the state aggregate loss ratio (total losses incurred divided by total premiums earned) or the ratio of insured property losses to total state income. The measure used here is somewhat arbitrary but captures the essence of an underwriting year in which a majority of insurers are adversely affected. In such a year, heightened media attention and regulatory scrutiny would be expected.

of coverage and the inability of insurers to obtain adequate reinsurance for subsequent years. In addition, as noted above, an evaluation of regulatory practices should generally focus on how such practices affect the market as a whole rather than specific insurers.

4. Discussion of Regulatory Practices

As discussed above, a bad underwriting year, especially resulting from a catastrophic event or a series of catastrophic events, would be expected to motivate insurers to re-evaluate their participation in a market. For example, insurers may seek to implement relatively large rate increases (i.e., rate increases in excess of 10%) and/or significantly reduce the number of policies they write. The more substantial and widespread the changes that insurers seek to make, the more likely regulators may attempt to prevent or limit such changes. Indeed, anticipating sharp market reactions to catastrophic losses may prompt regulators to take pre-emptive actions to limit rate increases and/or the nonrenewal of insurance policies. Some regulatory responses to such economically catastrophic years may be immediate and short-term in nature, such as a freezing of rates or imposing moratoriums on policy cancellations and non-renewals. Other actions can change the state regulatory environment for the longer term (e.g., modifying the process for approving rate changes, establishing a state reinsurance pool, or creating or modifying an RMM).¹⁶

To judge whether a particular regulatory response is positive, neutral or negative, one has to consider what would likely occur in the absence of the regulatory response or other changes in regulatory policies. Following a “large” catastrophic event, absent any regulatory reaction, insurers may raise their rates, reduce the number of policies they write and/or make other changes to reduce their future exposure to catastrophic losses.¹⁷ Regulatory responses to an economically catastrophic event could be viewed as positive if they minimize the adverse effects of such an event on consumers. On the other hand, regulatory responses that exacerbate market changes that are adverse to consumers (e.g., prompting more insurers to exit a market, further reducing the availability of coverage, etc.) are, arguably, counterproductive over the long term.¹⁸ In this paper, we focus on two of

16. Modifications to an existing RMM could include easing its eligibility requirements or broadening the types of coverages offered.

17. Insurers are more likely to make such changes if a specific event or series of events alters their assessment of the risk of catastrophic losses in a given area.

18. We recognize that regulators can be placed in a difficult position when insurers seek to implement substantial rate hikes to cover what they perceive to be a significantly higher risk of catastrophe losses. Homeowners in the highest-risk areas can be especially hard hit by large premium increases. Regulators may be concerned that some homeowners will be unable to afford the premiums that insurers believe are required. On the other hand, if regulators constrain the rates that insurers are allowed to charge, this can induce insurers to reduce the supply of insurance and decrease its availability. Also, if rates are held below the cost of providing

the most critical areas of regulation—rate regulation and residual market administration—which lend themselves to empirical analysis using econometric methods.¹⁹

4.1 Regulation of Rates and Underwriting

It is generally presumed that states with prior approval systems (i.e., “non-competitive rating systems”) are more likely to constrain insurers’ rates.²⁰ It is important to note, however, that a state’s rate regulatory system does not indicate everything that is relevant to how rates are actually regulated in that state. For example, a state that requires prior approval of insurers’ rates before they can be implemented may or may not impose binding constraints on those rates. Further, the severity of the constraints imposed, if any, can vary among states with prior approval systems. We also observe that states with “competitive rating systems” (states that employ a system other than prior approval, such as file and use, use and file, etc.) may or may not seek to constrain insurers’ rates. Additionally, we note that regulators are more likely to disapprove or temper insurers’ filings for rate increases when a market is subject to considerable upward cost pressure and insurers are seeking to substantially raise their rates.

A state’s attempt to constrain or interfere with the prices that insurers would otherwise set can be manifested in two ways that are not mutually exclusive. One of these ways is to impose a ceiling on insurers’ overall rate levels (i.e., a uniform “haircut” is imposed on the rates [or rate increases]) for all risk classifications; we refer to this practice as “rate suppression.” Alternatively, or in conjunction with

coverage, homeowners’ incentives to invest in mitigation will be diminished. Consequently, regulators must consider these competing concerns in determining how they will respond to insurers’ filings for rate increases.

19. It should be understood that other regulatory policies concerning such areas as solvency, underwriting, policy provisions and claims settlement also are important but are not things for which metrics can be readily developed that can be employed in a regression analysis. Hence, while we offer some observations on how the regulation of insurers’ underwriting decisions may affect market outcomes (as insurers’ underwriting is closely tied to their pricing), we are not in a position to evaluate regulatory policies governing underwriting or these other areas based on our empirical analysis. We do offer our opinions on those policies and practices in the areas of rate regulation and RMM administration that are likely to result in more favorable market outcomes and those that are likely to result in less favorable outcomes. Our opinions are informed primarily by economic principles and the results of our empirical analysis, as well as prior research, including state case studies and anecdotal observations.

20. The NAIC places state rate regulatory systems into the following categories: prior approval, modified prior approval, flex rating, file and use, use and file, and no file (Klein, 2014). Prior research on auto insurance and workers’ compensation insurance and anecdotal observation indicate that states with prior approval systems are more likely to impose constraints on insurers’ rates than states employing the other types of systems. Hence, we use prior approval regulation as a proxy for “strict regulation.” The presumption has been that states with the other types of systems tend not to impose constraints on insurers’ rates (these systems are generally characterized as “competitive rating”), but observers familiar with states’ actual practices know that this is not always the case.

rate suppression, a state may seek to cap the differences between the rates that can be charged for different classifications or impose tighter constraints on the rates for high-risk classifications than low-risk classifications; we refer to this practice as “rate compression.”²¹

When regulators cause rates to be inadequate, this would be expected to reduce the supply of insurance, all other things equal. We expect that insurers will be more reluctant to voluntarily provide insurance for homes for which they are not allowed to charge an adequate premium. Insurers may tolerate a small degree of rate inadequacy, but severe regulatory constraints on prices would be expected to result in significant distortions in the supply of insurance (Grace and Klein, 2009). This can force a substantial number of homes into RMMs. It also contributes to moral hazard in that inadequate rates reduce insureds’ incentives to reduce their exposure to losses (e.g., invest in hazard mitigation), which results in higher risk and losses, all other things equal.

Excessive delays in getting rate changes approved can also contribute to market inefficiency. Under a prior approval system, regulators are typically subject to a “deemer provision,” (i.e., rate changes filed by insurers are deemed approved if they are not disapproved within a 30- to 60-day period). Under a competitive rating system, regulators typically have a limited amount of time (e.g., 30 days) to inform an insurer that the rates that it filed are disapproved.²² However, under both systems, regulators can delay an insurer’s implementation of a rate change by informing it that its filing is incomplete, lacks adequate support, etc. Regulators sometimes use this tactic rather than disapproving a rate filing, which requires them to state the grounds for disapproval. Even if a rate increase filed by an insurer ultimately is approved, the delay in receiving approval can lead to inadequate rates until the new rates can be implemented. Also, it is not uncommon for an insurer and regulators to engage in a protracted bargaining process over a rate filing, which results in a considerable delay, as well as approved rates that are significantly below what the insurer initially filed.

Insurers’ underwriting practices are closely tied to their pricing structures. (See, for example, Grace and Klein, 2009.) Regulation of insurers’ pricing can affect their underwriting decisions, and regulation of their underwriting practices can affect their pricing. All other things equal, tighter regulatory constraints on

21. A good illustration of this practice is the imposition of regulatory caps on the rates that insurers are allowed to charge homeowners in coastal areas that are exposed to significant hurricane risk. Rate compression typically results in overall rate inadequacy as it is difficult for insurers to offset inadequate rates for high-risk insureds by charging excessive rates for low-risk insureds.

22. Under a file and use system, regulators may allow an insurer’s filed rates to go into effect and then retroactively determine that the rates were excessive. If this occurs, based on the rates that the regulators will permit the insurer to implement, the insurer will be required to issue refunds to policyholders for the difference in the premiums they paid and what were ultimately approved. Generally, if an insurer believes that the rate changes it has filed may be subject to such retroactive disapproval, it will defer implementing the rate changes until a final determination is made to avoid having to issue refunds.

insurers' rates would be expected to induce insurers to tighten their underwriting standards and reduce their exposures. In turn, greater regulatory restrictions on insurers' underwriting would be expected to result in higher rates.

4.2. Residual Market Mechanisms

There are three principle types of property insurance RMMs. Fair Access to Insurance Requirements (FAIR) plans provide full coverage in some or all areas of a state. The original purpose of FAIR plans was to provide property coverage to urban areas where voluntary market coverage was less available due to the high risks associated with fire and theft. Over time, FAIR plans have been increasingly servicing properties exposed to various weather-related perils as insurers seek to limit their exposure to these perils. Currently, there are 33 FAIR plans in operation in the U.S.

Beach/Windstorm Plans (also called Wind Pools), a second type of mechanism, generally provide windstorm and hail coverage to properties in designated coastal areas that are subject to a high risk of windstorm damage. These plans are designed to address the particular property insurance availability problems in certain coastal areas, although some may also cover other perils, such as fire. Currently, there are five Beach/Windstorm Plans ; the plans in Mississippi, South Carolina and Texas offer wind/hail coverage only, and the plans in Alabama and North Carolina also offer coverage for fire.

A third type of mechanism combines the first two types of plans and essentially functions as a state-run insurance company. There are only two such mechanisms in the U.S.: 1) the Florida Citizens Property Insurance Corporation (FCPIC); and 2) the Louisiana Citizens Property Insurance Corporation (LCPIC). Each comprises something equivalent to a FAIR Plan and a Coastal Plan (Louisiana) or a Beach/Wind Plan (Florida). The FCPIC provides full coverage and wind/hail coverage. Both plans in the LCPIC provide full coverage.

In many states, the three types of property RMMs are targeted toward residential properties, but some also provide also coverage for commercial properties. The availability of residential property insurance coverage is generally the greatest problem and concern, but the supply of insurance coverage for certain commercial properties may also be constrained in some areas.

While these mechanisms may serve as short-term safety valves in the event of disruptions in the supply of private insurance, they are generally not intended to serve as long-term sources of coverage for a substantial portion of a state's property exposures.²³ For this reason, most states seek to properly structure and manage these mechanisms, as well as minimize their size, i.e., retaining or moving as many exposures in or to voluntary markets as possible. Beyond efforts to

23. Even in times when there is an ample supply of insurance in the voluntary market, there may be some properties that meet minimum insurability conditions but are unable to secure voluntary market coverage. Hence, it is common for these mechanisms to insure a relatively small number of exposures for extended periods.

maximize the supply of voluntary insurance, measures aimed at keeping policies out of the residual market include maintaining residual market rates above voluntary market rates and imposing stringent rules with respect to who is allowed to obtain insurance from the residual market.²⁴ Efforts to move policies out of the residual market include “take-out” incentives for private insurers and programs designed to match residual market policyholders with private insurers that are willing to cover them.

Proper administration of an RMM also is important. To that end, a well-managed RMM will charge adequate rates to cover the loss exposures that it insures and also will purchase adequate reinsurance to diversify its exposure to catastrophic losses. Historically, some RMMs failed to employ such measures and, consequently, incurred substantial deficits when they incurred high hurricane losses (Klein, 2009c; FIO, 2015). In such instances, insurers are charged assessments to pay for the deficits, most of which they are allowed to pass on to their policyholders. At the very least, these assessments constitute a cross subsidy between voluntary market insureds and RMM insureds. The amount of assessments that insurers are not allowed to pass on to their policyholders must necessarily be funded out of their premiums and surplus. This can further chill insurers’ willingness to write business on a voluntary basis and increase the size of the residual market, all other things equal.²⁵

5. Empirical Analysis of Rate Regulation and Residual Markets

In our empirical analysis, the two regulatory practices that are the focus of this paper—rate regulation and residual markets—are assessed in relation to five market measures: 1) the number of private insurers operating in a market; 2) the structural competitiveness of the market; 3) the amount of capital supporting the insurance written in the market; 4) the amount of reinsurance that insurers’ purchase to diversify their underwriting risk; and 5) the median loss ratio of insurers operating in the market (a measure of underwriting profitability). In our regression analysis, each of these market dimensions is measured as a net change variable CY_i using the following formula where Y_i is the value of the underlying variable i .

$$CY_{i,t} = (Y_{i,t} - Y_{i,t-2})/Y_{i,t-2}$$

24. An example of such a rule is the requirement that a homeowner applying for insurance coverage from an RMM must provide one or more declinations from voluntary market insurers.

25. Florida and Louisiana offer interesting and contrasting case studies of alternative regulatory approaches with respect to voluntary markets vis-à-vis RMMs (Born and Klein, 2015).

By comparing the supply decisions that insurers make in personal lines and commercial lines following major natural disasters, Born and Klimaszewski-Blettner (2013) demonstrate empirically that “certain regulatory responses may unintentionally impede insurers’ willingness to provide coverage against natural disasters,” especially in the more heavily-regulated personal lines. “Prior approval of rates and regulatory rules like policy cancellation bans discourage insurers from offering insurance in certain lines of business and deter them from developing effective strategies for dealing with changing risk exposures,” they write, adding that there is “statistically significant proof for the expected ‘crowding out’ of private insurers by residual markets.” Born and Klimaszewski-Blettner suggest that regulation should place “more emphasis on the [solvency] monitoring function than on rate approvals and post-disaster regulatory responses that can have unintended consequences of reducing the availability of coverage.”

Whereas Born and Klimaszewski-Blettner focus on how catastrophes and regulation affect individual homeowners and commercial property insurers’ decisions on how much insurance to supply (including fully exiting a market), our analysis examines how catastrophes, rate regulation, and residual markets affect the various dimensions of homeowners and commercial property insurance markets identified above. Variation across states in the rate regulatory systems they employ and the relative size of their residual markets, especially as they follow catastrophic events, may help to yield insights into the best practices for regulation. While the analysis here considers changes in each of the five measures individually following a catastrophic event, the results should not be considered separately. Rather, the results should be considered in concert to identify consistencies and inconsistencies with respect to the estimated effects of catastrophe risk, rate regulation and residual markets on different market dimensions.

5.1 Analytical Approach and Sample

Changes to state homeowners and commercial property insurance markets are analyzed using 30 years of data on homeowners and commercial property insurers reporting data to the National Association of Insurance Commissioners (NAIC). The key measures evaluated below are the relative changes over a two-year period²⁶ in each state-market for each of the following variables: the number of firms; the Herfindahl-Hirschman index of market concentration (HHI); the amount of capital (i.e., surplus as regards policyholders) held by insurers; the reinsurance ratio²⁷; and the median loss ratio.²⁸ The analysis considers three primary factors

26. This two-year period should be long enough to allow affected insurers time to evaluate their operations, but also short enough to avoid the need to control for subsequent catastrophic events or changes in regulations.

27. The reinsurance ratio is defined as the ratio of reinsurance ceded divided by the sum of reinsurance assumed and direct premiums written for all insurers writing business in a given state-market.

that affect these market outcome measures: catastrophic events, prior approval rate regulation and the relative size of the state residual market.

**Table 3:
Variable Descriptions**

Variable	Description
Change in Number of Firms	Net change in the number of homeowners and commercial property insurers
Change in HHI	Net change in the HHI for homeowners and commercial property insurance markets
Change in Surplus	Net change in the total amount of surplus held by insurers
Change in Reinsurance Ratio	Net change in the aggregate reinsurance ratio of insurers
Change in Loss Ratio	Net change in the median loss ratio for insurers
Cat	Dummy variable for natural catastrophe in a state, lagged two years
HO	Dummy variable for homeowners insurance, lagged two years
Prior Approval Regulation	Dummy variable for prior approval rate regulatory system, lagged two years
Residual Market	Residual market share, lagged two years
Change Population	Change in state population from previous year (%)
Housing Starts	Number of new housing starts per capita

Because markets also evolve for reasons other than catastrophic events and regulatory changes, the analysis includes changes in state demographics—population and housing starts—and controls for macroeconomic effects through the use of a time trend variable and other state-specific factors through the inclusion of a state fixed-effects variable. Definitions of the dependent and explanatory variables used in the regression analysis are provided in Table 3. Descriptive statistics for each variable are provided in Table 4, and a summary of the regression results are provided in Table 5.

**Table 4:
Descriptive Statistics**

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Change in No. of Firms	2,646	-0.00541	0.09651	-1.5405	0.5542
Change in HHI	2,646	-0.00442	0.38534	-18.5417	0.9648
Change in Surplus	2,646	0.05879	0.16240	-2.3410	0.7773
Change in Reinsurance Ratio	1,666	0.22158	0.44735	-2.1199	1.0000
Change in Loss Ratio	2,548	-0.12413	0.59081	-7.6335	0.8727
Cat	2,646	0.03477	0.18323	0.0000	1.0000
HO	2,646	0.50000	0.50009	0.0000	1.0000
Prior Approval Regulation	2,646	0.23621	0.42483	0.0000	1.0000
Residual Market Share	2,646	0.44254	0.50113	0.0000	1.2925
Change in Population	2,646	0.00958	0.00941	-0.0637	0.0683
Housing Starts	2,646	0.00505	0.00320	0.0007	0.0286

28. The analysis also was conducted on a sample that excluded Florida. The results were consistent with those reported here.

Table 5:
Summary of Regression Results

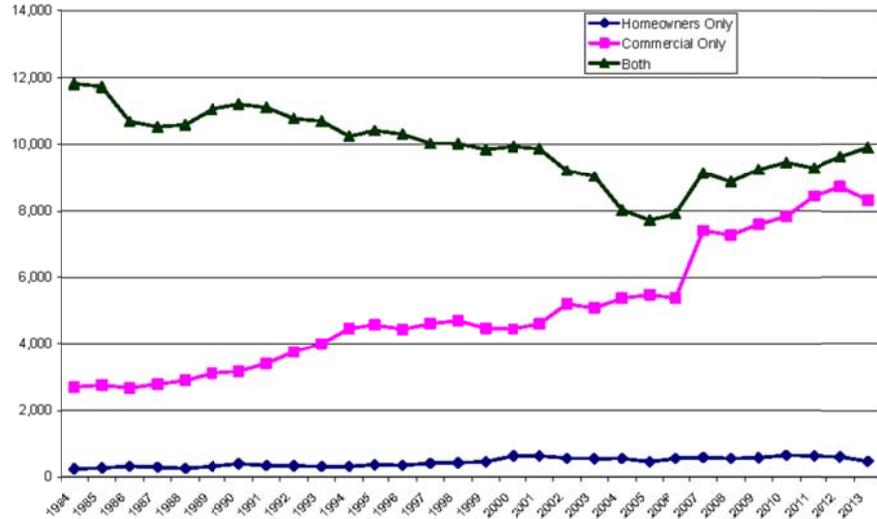
Explanatory Variables	Dependent Variables				
	Change in No. of Firms	Change in HHI	Change in Surplus	Change in Reinsurance Ratio	Change in Loss Ratio
Cat	0.000	0.002	0.020	-0.016	-0.069
	-0.011	-0.029	-0.020	-0.038	-0.064
Cat * HO	-0.007	0.024	-0.001	-0.152	-0.134
	-0.032	-0.036	-0.044	-0.137	-0.907
Prior Approval Regulation	0.006	-0.018	0.004	0.035***	-0.099
	-0.006	-0.015	-0.007	-0.011	-0.070
Prior Approval Reg. * HO	-0.036***	0.029*	-0.032***	-0.053***	0.065
	-0.008	-0.016	-0.011	-0.014	-0.076
Prior Approval Reg. * Cat	0.006	-0.178***	0.006	0.054	-0.057
	-0.017	-0.065	-0.026	-0.049	-0.148
Prior Approval Reg. * Cat * HO	0.040	0.074	0.054	0.065	0.020
	-0.056	-0.100	-0.077	-0.143	-0.170
Residual Market	0.019***	-0.035	0.016***	0.032**	0.073***
	-0.004	-0.028	-0.005	-0.012	-0.028
Residual Mkt. * Cat	-0.014	0.098**	-0.023	0.024	0.196*
	-0.015	-0.046	-0.026	-0.056	-0.109
Residual Mkt. * HO	-0.031***	0.049*	-0.022***	-0.064***	0.032
	-0.003	-0.026	-0.004	-0.011	-0.021
Residual Mkt. * HO * Cat	-0.028	-0.123**	-0.037	0.055	-0.115
	-0.038	-0.057	-0.053	-0.147	-0.274
Change Population	0.724	-1.832*	0.713	1.415	1.419
	-0.663	-1.110	-0.811	-1.161	-2.644
Housing Starts	0.382	0.034	-0.082	-7.497**	-2.238
	-1.555	-2.447	-1.968	-3.358	-7.921
Constant	0.043***	-0.054***	-0.016**	0.034***	-0.014
	-0.003	-0.021	-0.006	-0.012	-0.041
R-squared	0.483	0.023	0.540	0.832	0.128
N	2,646	2,646	2,646	1,665	2,548

Notes: Standard errors terms reported below each coefficient. Results for year dummy variables omitted. *, ** and *** denote significance at the 90%, 95% and 99% confidence levels, two-tailed tests.

The sample includes all homeowners and commercial property insurers operating in the U.S. over a 30-year period. The number of insurers offering homeowners and commercial property insurance coverage varies significantly over time. Figure 2 shows the total number of insurers that reported direct premiums earned in the homeowners insurance market, the commercial property insurance market or both, for the sample period of 1984–2013.²⁹ The figure shows a dramatic increase in the number of firms operating in the commercial market, but a decline in the number of insurers that also write homeowners insurance. The number of insurers that reported writing only homeowners insurance coverage increased from 246 in 1984 to 458 in 2013.

29. The insurers included in our analysis wrote at least \$1 million in premiums in a given year. The commercial property insurers included in our analysis were all insurers with direct written premiums in fire, allied lines and/or commercial multiple peril insurance.

Figure 2:
Number of Insurers Operating in U.S. Property Insurance Markets: 1984–2013



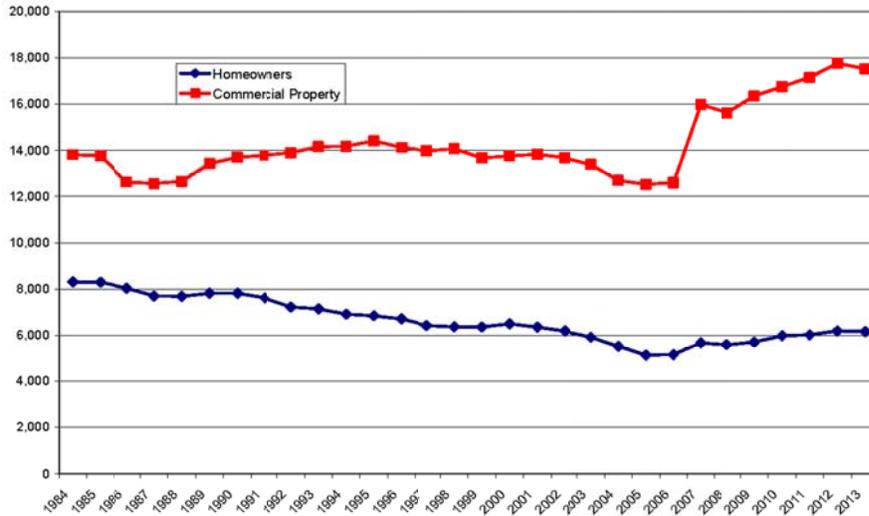
Source: NAIC financial data; authors' calculations

In our analysis, insurer participation and performance are captured at the state level in what is hereafter referred to as an “insurer unit,” i.e., an insurer that operates in 20 states is captured in the analysis as 20 different units. Figure 3 shows the total number of insurer units that reported participating in writing homeowners or commercial property insurance in the U.S. over the period 1984–2013. The data indicate that, over the sample period, the number of homeowners units has declined by about 2,000, while the number of commercial property units has increased by roughly 4,000. The average number of states in which homeowners insurers reported business declined from nearly 7.94 states per insurer in 1984 to 3.43 in 2013. The number of single-state carriers increased from 452 in 1984 to 509 in 1990, but subsequently decreased to 406 in 2013.

5.2 Estimation

The markets for property insurance are affected by a state’s regulatory environment in several ways. While many states have adopted similar approaches to regulating forms and the licensing of agents, rate filing requirements and their application, in particular, can have a significant impact on the ability of an insurer to adjust rates, either by restricting the size of such adjustments or delaying their approval and implementation. Also, as discussed above, regulators may seek to constrain the rate differentials between different risk classifications, e.g., placing a cap on the rate factors an insurer uses for different rate territories.

Figure 3:
Aggregate Number of Property Insurer Units: 1984–2013



Source: NAIC financial data; authors' calculations

Insurers operating in a true competitive rating environment would be expected to have more flexibility in setting their rates than those that must file and wait for approval. Arguments for strict rate regulation are often motivated by a desire to provide “affordable” insurance, while supporters of competitive rating systems suggest that regulators in a prior approval system are more likely to be influenced by political considerations and argue that rate regulation “artificially depresses prices, forcing insurers out of otherwise important markets and distorts the real cost of insurance” (FIO, 2013, p. 55).

After experiencing natural disasters, some states established or expanded existing state-sponsored RMMs. These mechanisms, in theory, are designed to provide coverage for high-risk property owners who cannot obtain insurance from the private (also known as the “voluntary”) insurance market.³⁰ Since private insurers are generally required to participate to some extent in state RMMs, these mechanisms can influence an insurer’s decision on how much business it writes in a state. If an insurer does write business in the voluntary market, it typically will

30. In theory, an RMM should serve as a “market of last resort,” i.e., no other source of coverage is available to its insureds. In practice, under certain conditions, some RMMs may be structured and managed in such a way that they provide an alternative source of coverage even to consumers who could buy insurance in the voluntary market.

be assessed to cover the residual market's deficits based on its relative share of the voluntary market.³¹

Several states have imposed exit restrictions and long-term policy cancellation and non-renewal bans following a catastrophe (Klein, 2016). By design, these measures are intended to force insurers to maintain their participation in the state market even if they would otherwise prefer to reduce their exposures or exit altogether. The use of these measures, and the perception that they could be used again in the aftermath of future catastrophes, must be considered when assessing the role of rate regulation and RMMs, as they may exacerbate the potential negative consequences of regulatory practices on insurers' post-catastrophe decisions.³²

The effects of rate regulation and RMMs on market structure and performance are assessed through the analysis of the five market measures described above. This assessment considers how prior approval regulation and the relative size of RMMs affect market outcomes, generally over time, as well as specifically following an economically catastrophic event. As such, the analysis yields insights on the market dimensions (e.g., structural competitiveness, capacity) for which these regulatory responses are most influential and whether the influence is positive or negative for each dimension. The results of the analysis are reported in Table 5 and discussed in the following sections, with each market dimension analyzed separately.

Some explanation of the exact specification of our explanatory variables is warranted. "Cat" is a dummy variable equal to one when there has been a "catastrophic" event in a state two years earlier. As noted above, we determine that a catastrophic event has occurred when at least one-half of the homeowners insurers operating in the state report a loss ratio of 1.25 and/or greater or 25% of the insurers in the state report a loss ratio of 1.5 or greater.³³

"Prior approval regulation" is a dummy variable equal to one for states/markets with a prior approval regulatory system in effect for the relevant line of business.³⁴ We are using a prior approval regulation as a proxy for "strict regulation" with the understanding that it is an imperfect proxy with no better

31. RMMs are rarely self-sufficient. Where the rates charged to high-risk policyholders are too low to support the program's operation, insurers are generally assessed to make up the difference (Klein, 2009c).

32. In an evaluation of the Florida property insurance market, Medders, et. al. (2014) note that "a focus on price-reducing legislation and regulation has led to increased solvency constraints and negative first-order effects on private industry capacity. Such legislation and regulatory actions impacting Florida's property insurance market create significant uncertainty for private insurers and add to the cost of doing business in Florida" (p. 199).

33. A catastrophic event is determined to have occurred when either or both of these conditions have been met. We also tested the use of an alternative specification of this variable using a three-year lag, but it did not have a material effect on our estimation results.

34. States with a prior approval system for homeowners insurance do not necessarily have a prior approval system for the commercial property lines. In our analysis, the prior approval regulation dummy variable is different for homeowners insurance and commercial property insurance.

alternatives readily available. Some (perhaps many) states with prior approval systems do not attempt to impose significant constraints on insurers' rates at any given point in time. Similarly, some states with "competitive rating systems" (i.e., something other than prior approval) may seek to impose constraints on insurers' rates at different points in time.³⁵

"Residual market" is specified by the amount of direct premiums earned in a state's RMM(s) divided by the amount of direct premiums earned in both the voluntary and residual market. We anticipate that there is some "noise" associated with this variable as the size of state's residual market may be affected by many factors beyond how it is structured and administered, including how rates are regulated in a given state and market.

Our dataset combines separate observations for insurers' homeowners operations and their commercial operations. In the results presented below, the estimated coefficients on our key explanatory variables—catastrophes, prior approval regulation and residual markets—describe the relationships between these explanatory variables and our dependent variables for commercial property insurers and homeowners insurers. We include interactions of these three explanatory variables with a dummy variable, "HO," which equals one if the observation is for homeowners insurance, to further capture the unique relationships for homeowners insurance relative to commercial property insurance. We employ several additional interaction terms to measure the effects of these explanatory variables for other subsets of insurers in our sample—i.e., those affected by a catastrophe and those in a prior approval rate filing regime. As an example, in our first regression reported in Table 5, the coefficient on our variable "Residual Market * HO Insurer * Cat" captures the relationship between the size of the residual market and the change in the number of firms following a catastrophic event for the homeowners insurers in a state affected by a catastrophic event *relative to* the change in the number of commercial or homeowners insurers in states without a catastrophic event *and* the change in the number of commercial insurers in states with a catastrophic event.

Our model includes two control variables (in addition to year dummy variables and state fixed effects): 1) the change in state population from the previous year ("change population") and the number of housing starts per capita ("housing starts").³⁶ All other things equal, we would expect that both of these variables would increase the demand for homeowners and commercial property insurance, which could have effects on all of our dependent variables.

35. Researchers have struggled with developing better measures of regulatory stringency with some success, but the measures of regulatory stringency that have been employed were not available for homeowners or commercial property insurance over the time period used in our analysis. For example, Klein, et. al. (2002) developed rate regulatory stringency measures based on the disposition of advisory rate/loss cost filings in auto and workers' compensation insurance for the period 1986–1997.

36. "Change Population" is equal to a state's population in the previous year minus a state's population in the current year divided by a state's population in the previous year. This is calculated as a percentage and not as a strict ratio.

5.2.1 Number of Insurers in a Market

One easily determined measure of the supply of insurance is the number of firms operating in a market. All other things equal, it would seem preferable to have more insurers offering coverage in a market rather than fewer insurers, with the understanding that the overall size of a market will affect how many insurers can operate and earn what they consider to be an adequate profit. More insurers in a market offer consumers more choices and should also promote greater competition. That said, not all insurers are created equal, and it would be in the best interest of consumers to have insurers in a market that were financially sound and would not be at significant risk of becoming insolvent.³⁷ With these caveats in mind, a net relative increase in the numbers of insurers is viewed as a positive development. Conversely, a persistent decrease in the number of homeowners insurers is cause for concern, as it would have a negative effect on consumers' access to coverage. In our analysis, we employ the net relative change in the number of insurers over a two-year period.

The impact of a catastrophe on the number of insurers is a matter of particular interest. If the likelihood of a catastrophe were fully anticipated by insurers in a competitive and unregulated market, they would not necessarily be prompted to revise their assessments of the risk of writing future homeowners insurance coverage in the state, and we would not expect there to be a significant effect on exit or entry. The losses from the catastrophic event would be viewed as a sunk cost, so that if it was profitable to write insurance coverage in the state prior to the event, then it should continue to be profitable to do so. Because the risks were fully anticipated, insurers would have their premiums in a manner so that, in the long run, they would expect to earn a sufficient profit to make writing coverage desirable. On the other hand, if an insurer perceived that a catastrophe reflected a significant increase in risk, this could prompt it to make various changes in its operations, including withdrawing from the market.

For these reasons and others, it is difficult to predict how a catastrophe will affect the number of insurers in a market. While many catastrophic events may not cause insurers to change their estimates of catastrophe risk, some events may cause insurers to believe that catastrophic risk has increased and that their best course of action is to exit the market to avoid further catastrophe losses. That said, there might be other insurers who view a catastrophe as an opportunity to enter a market to absorb policies shed by insurers that have exited the market or reduced their exposures.

We do expect prior approval regulation to be associated with a decrease in the number of insurers that might be exacerbated after a catastrophe, all else equal. Our reasoning here is that regulators in prior approval states are presumed to be more likely to constrain insurers' rates, which, in turn, would be expected to cause some insurers to exit the market and discourage other insurers from entering the market. We also expect that a larger residual market should be associated with

37. Taking this point a bit further, all other things equal, it would be desirable to have firms that are well capitalized and geographically diversified.

fewer insurers in the voluntary market for at least two reasons. One, a larger residual market may induce insurers to leave a market because of their concerns about their assessments for residual market deficits. Two, we expect that as a residual market increases, the voluntary market would shrink and, hence, would support fewer insurers in that market.³⁸

The results of our analysis of the relative change in the number of insurers operating in a state-market reported in Table 5 indicate the following. While the number of insurers varies substantially over time, changes in the number of insurers in a state are not significantly related to catastrophic events. Prior approval rate regulation is associated with a reduction in the number of homeowners insurers, relative to the number of commercial property insurers operating in a state. However, we do not find a statistically significant relationship between prior approval regulation and the number of homeowners insurers nor commercial property insurers following a catastrophic event.

Our failure to find a statistically significant relationship between catastrophic events and the number of insurers operating in a market is noteworthy. We know that from anecdotal observations that, in at least few cases, a catastrophic event does create a certain amount of turmoil in a market and has led to insurer exits. Further research and testing of different model specifications are needed to determine the circumstances, if any, that could prompt insurers' exit from a market following a catastrophe. It may be the case that only very large catastrophes that cause a significant reassessment of insurers' risk result in a material and measurable reaction in terms of insurers' decisions to stay in or leave a market. It also may be the case that, after a catastrophe, some insurers leave a market while other insurers enter it, seeking opportunities to capture the business of exiting insurers. Another possibility is that insurers' reactions to catastrophes play out over a longer time period than two years.

The number of commercial property insurers in the state increases with the size of the residual market, while the number of homeowners insurers decreases with the size of the residual market. The effect of residual market size on homeowners insurers is actually slightly smaller in years following catastrophes but is not statistically significant. The negative relationship between the size of a state's residual market and the relative change in the number of homeowners insurers is consistent with what we would expect. It is less clear why the size of the residual market would have a positive effect on the number of commercial property insurers. It is possible that the size of the residual market reflects more general perceptions of increased risk in the state that might create new opportunities for commercial insurers to enter the market for property insurance and attract commercial buyers that were previously self-insured.

5.2.2 Market Concentration

Changes in the number of insurers operating in a market, among other factors, would be expected to affect its structural competitiveness. Throughout the sample

38. Born and Klimaszewski-Blettner (2013) refer to this as the "crowding-out effect."

period, no states had fewer than 27 insurers participating in the homeowners market or 97 insurers participating in the commercial property market in any given year. Average insurer market shares were 0.8% and 0.4% for the homeowners and commercial property markets, respectively. The HHI, a measure of market concentration, averaged 880 for homeowners markets and 240 for commercial property markets. A relatively low value of the HHI, which ranges from 0 to 10,000, indicates a competitive market.³⁹ By these indicators, both markets are very structurally competitive across all states. In only one state, Delaware, did any one insurer write more than 50% of the commercial property business.

Compared to changes in the number of insurers, analysis of changes in market concentration not only reflects changes in the number of insurers in the market, but also changes in the distribution of the business across insurers operating in the market. Thus, if one large insurer exits, the effect on the number of insurers is negligible, but the effect on market concentration can be substantial. The occurrence of a catastrophe could be associated with an increase or a decrease in market concentration. If a specific event has particularly adverse effects on smaller companies prompting them to exit the market or reduce their exposures, this could cause market concentration to increase. On the other hand, a catastrophe could cause larger insurers to reduce their exposures (or exit the market), which would lead to decreased market concentration. Indeed, both effects may occur, which would work in opposite directions, so we cannot predict a priori as to whether the occurrence of a catastrophe will increase or decrease market concentration.

As with the number of insurers, we do not find a statistically significant association between catastrophic events and changes in the HHI for either homeowners or commercial insurance markets. Prior approval regulation is associated with an increase in market concentration for homeowners insurance, all else equal. It is, however, negatively related to market concentration following a catastrophe for commercial insurers and homeowners insurers combined. One possible explanation for these results is that for commercial property insurers, catastrophes tend to cause some large insurers to exit the market (or reduce the amount of the business they write), and this tendency is more dominant in relation to catastrophes prompting smaller insurers to exit the market.

The relative size of the residual market is positively related to the concentration of the homeowners market, in general. However, this relationship becomes negative following a catastrophe. It may be the case that, absent a catastrophe, a larger residual market is associated with the exit of smaller insurers from the voluntary market who are unable to compete with the residual market. On the other hand, following a catastrophe, large insurers may become more concerned about the size of the residual market and what this portends in terms of their future assessments for residual market deficits, which could be substantial if

39. According to horizontal merger guidelines promulgated by the U.S. Department of Justice and the Federal Trade Commission, markets with HHI values under 1,500 are considered to be "un-concentrated"; a merger that would not cause a market's HHI to exceed 1,500 would generally not raise any concerns from an antitrust perspective.

there are more catastrophes. Such concerns may prompt some large insurers to exit from or reduce their presence in the homeowners market.

5.2.3 Market Capacity

Another important market dimension is insurers' capacity for bearing risk. One measure of this is the total capital (surplus) of the insurers operating in a market. More capital indicates a greater ability to accommodate larger than expected losses, but there are costs to holding capital. These costs include taxes that must be paid on undistributed reserves, the opportunity cost of not putting the capital to use (investing it) elsewhere and the possibility of becoming a takeover target.⁴⁰

Cummins, et. al. (2002) evaluate the capacity of the U.S. market for bearing risk and suggest a natural definition of industry capacity is “the amount of industry resources that are deliverable conditional on an industry loss of a given size” (p.557). Thus, an evaluation of changes in market capacity following catastrophic events should also consider insurers' use of reinsurance, which allows insurers to increase their capacity for bearing risk. While we would expect insurers to reevaluate their reinsurance arrangements following a catastrophe, Froot and O'Connell (1999) find that supply shocks are more important than demand shocks in explaining the effects of catastrophe losses on reinsurance prices and the amount of reinsurance coverage purchased. Consequently, while holding more capital and securing more reinsurance may be considered substitute approaches to increasing an insurer's capacity, capital reductions, along with a reduction in the availability of reinsurance, can have adverse effects on the availability of property insurance.

Additionally, the amount of capital that is backing the amount of insurance coverage that is being provided in a market has implications for the “quality” of that coverage, with the understanding that the capital is divided among the various insurers. All other things equal, it is desirable to have insurers with adequate capital and reinsurance providing coverage in a market (Grace, et. al., 2004). Concerns arise when insurers with inadequate capital and reinsurance insure large amounts of exposures subject to catastrophe losses. Such insurers are more likely to default on their obligations to policyholders when a catastrophe strikes.⁴¹

Since insurers report capital (i.e., surplus as regards policyholders) at the company level, one can only estimate the amount of capital that is available to cover catastrophic losses in any given state. For many insurers, the reported amounts support their operations in all lines and states in which they do business. For example, if an insurer incurs catastrophe losses in more than one state, its capital will be allocated across all affected states to absorb its losses. Some

40. For further discussion of the costs of holding capital, see Korczyk (2005).

41. The insolvency of the Poe companies in Florida following the 2005 storm season is an example of what can go wrong when insurers with insufficient capacity underwrite large amounts of high-risk exposures (Grace and Klein, 2009). The insolvency of the three Poe companies resulted in approximately \$800 million in unpaid claims that were assumed by Florida's guaranty association.

companies, on the other hand, have created separate “pups” that operate as legally separate entities in a state. When the pup is affected by a catastrophe, only the capital within the pup is at risk.⁴²

The amount of capital held by the property insurers operating in a state varies significantly over time. Over the entire sample period, some states saw an increase of more than 200% while others experienced much smaller increases, and no states saw a reduction. If insurers had not changed their risk exposures over this period, then this would constitute a positive development in that there would be more capital supporting a given amount of exposures. However, risk exposures change, and this capital is supporting other lines of business and exposures in other states. Nonetheless, a significant reduction in the capital available to support the property risks in a state might indicate further instability of the state market and associated availability problems.

Consider a change in capital that occurs in the years following an economically catastrophic event. In the short term, a significant reduction could reflect the higher-than-expected losses due to the catastrophic event. A reduction in total capital that persists over a longer period of time might indicate that larger, well-capitalized insurers have chosen to exit the market.

Our analysis of the state total capital, as reported in Table 5, indicates the following. All else equal, changes in state total capital over time are not significantly related to catastrophic events. This holds across the different types of insurers and states with different regulatory systems. One possible explanation for this is that a catastrophe can have different effects on the amount of capital backing the coverage provided in a market that work in opposite directions. On the one hand, the exit of one or more well-capitalized insurers would have a negative effect on the total amount of capital. Also, some insurers that remain in the market may suffer a reduction in capital due to catastrophe losses. On the other hand, other insurers that continue to write business in the market may choose to maintain or even increase the amount of capital they hold to increase their capacity to cover future catastrophe losses.

In prior approval states, homeowners insurance markets exhibit a significant 3.2% average decline in capital over a two-year period relative to commercial property insurers. This suggests that, all other things equal, stricter rate regulation leads to the exit of highly-capitalized homeowners insurers and/or prompts homeowners insurers remaining in the market to reduce the amount of capital they

42. It should be noted that some of the larger insurer groups have employed the strategy of establishing “pup” companies in high-risk states for at least two reasons. One reason is that the effect of regulation and market conditions in a state are more evident in the financial data of the pup than in the financial data of a company with operations in multiple states. A second reason is that, under extreme conditions and the incurrence of severe catastrophe losses by the pup, its parent company is not obligated to bail out the pup. That said, the parent company may still choose to provide a capital infusion to the pup. Our point here is that the use of pup companies affiliated with large, national insurers is preferable to either the complete withdrawal of large, national insurers (i.e., they have no affiliated insurers in a state) or their replacement by small, regional or single-state insurers with much less capacity and geographic diversification.

hold. What we see here is consistent with the findings of Klein, et. al. (2002), who provide evidence that prior approval regulation has a negative effect on the amount of capital insurers hold. A larger residual market also is associated with a significant reduction in capital among homeowners insurers.

As with the amount of capital, one can only estimate the amount of reinsurance coverage that is available to support catastrophic losses in a state because reported reinsurance amounts support insurers' operations in all states in which they do business. Insurers' reported reinsurance assumed and reinsurance ceded amounts are used to create a state-level reinsurance measure, defined as the ratio of reinsurance ceded divided by the sum of reinsurance assumed and direct premiums written. From 1996 to 2013, the average state reinsurance ratio for all property insurers (commercial and homeowners) increased from about 1% to more than 8%. The state average reinsurance ratio for commercial insurers is roughly four times higher than that for homeowners insurers (12% and 3%, respectively, in 2013).

Our analysis of the state reinsurance ratio reported in Table 5 indicates the following. All else equal, changes in state reinsurance ratios are not significantly related to catastrophic events. This is the case across the different types of insurers and states with different regulatory systems. As with amount of capital, it is possible that a catastrophe can have different effects on the amount of reinsurance purchased that work in opposing directions. On the one hand, a catastrophe could prompt some insurers that purchase large amounts of reinsurance to exit the market. On the other hand, other insurers that continue to write business in the market may choose to maintain or even increase the amount of reinsurance they purchase to increase their capacity to cover future catastrophe losses.

The state reinsurance ratio is generally higher in states with prior approval rate regulation. However, the state reinsurance ratio for homeowners insurers subject to prior approval regulation is significantly lower than the ratio for commercial property insurers. There are at least two possible explanations for these results that are not mutually exclusive. One explanation is that stricter rate regulation, by constraining the rates that homeowners insurers charge, also constrains the amount of reinsurance they can purchase. A second explanation is that stricter rate regulation prompts the exit of homeowners insurers that have higher amounts of reinsurance.

The residual market share, on average, is positively related to the state reinsurance ratio. However, the effect of the residual market share on the reinsurance ratio is negative for the homeowners insurance market. One possible interpretation of this result is that a larger residual market prompts homeowners insurers to purchase less reinsurance as more of their high-risk exposures have moved to the residual market. It also may be the case that the residual market variable is capturing the effect of other regulatory practices or market conditions that induce homeowners insurers to purchase less reinsurance. Additionally, a larger residual market may encourage the exit of homeowners insurers that purchase larger amounts of reinsurance.

When these results are considered in conjunction with those regarding changes in capital, homeowners markets in states with prior rate regulation and/or a relatively large residual market have experienced a significant reduction in the amount of insurance industry resources available to cover catastrophic losses. Regulators need to consider how their policies affect market capacity when contemplating measures aimed at preserving the affordability of coverage and/or expanding the use of residual markets as an alternative source of coverage. More specifically, other considerations aside, regulators should employ practices that encourage insurers to increase the amount of capital and reinsurance that supports the coverage they write in a given market, e.g., allowing them to charge risk-based rates.

5.2.4 Underwriting Performance

Insurers underwriting performance for property insurance is variable by nature, but significant catastrophic events may have substantial effects on insurers' post-catastrophe operations. The loss ratio (losses incurred divided by premium earned) is a commonly used measure of insurers' underwriting performance. State median loss ratios are used here to evaluate how the rate regulatory system in a state, along with other factors, affects insurers' underwriting performance. If a catastrophe prompts insurers to increase their prices, then we would expect the median loss ratio to fall following a catastrophic event. On the other hand, if regulators in prior approval states tend to constrain insurers' rates, this should tend to increase insurers' loss ratios, all other things equal.

In our analysis of state median loss ratios reported in Table 5, we did not find a statistically significant relationship between the median loss ratio and catastrophic events or prior approval regulation. As discussed earlier, it may be the case that only some catastrophes prompt insurers to reassess their estimates of the risk they face and raise their prices. Further, catastrophe-induced price increases may be implemented over a longer time period than two years. Our results also suggest that prior approval regulation per se does not have a material effect on insurers' rates, all other things equal. This could reflect the limitations of using a prior approval system as a proxy for strict regulation of insurers' rates.

Our analysis of loss ratios reveals only one significant finding: The share of premiums in the residual market share is positively related to commercial and homeowners insurers' loss ratios, and this effect is greater following a catastrophe. Larger residual markets could be having a negative effect on market profitability for at least two reasons. One is that if an insurer is charging inadequate rates and accounts for a significant share of the total market, this in itself could increase insurers' loss ratios. We would expect that this would be case in states where the residual market mechanism uses an assigned risk approach and its rates are inadequate. Where this approach is used, the loss ratios of voluntary market insurers would reflect the inadequate rates they would be forced to charge for residual market insureds. A second reason is that inadequate rates in an RMM could undermine insurers' efforts to charge adequate rates for

voluntary market insureds.⁴³ This supports the view that regulators should seek ways to reduce the size of the residual market through the measures we have discussed earlier, including setting residual market rates that do not compete with rates in the voluntary market and imposing strict eligibility requirements for residual market coverage.

6. Summary and Review

Recognizing that insurers react to catastrophic events in a variety of ways, this paper evaluates two important aspects of regulatory policies that can significantly influence homeowners insurance markets. Individual firm experiences and characteristics are not explored. Instead, we examine the features of state regulatory environments that mitigate or exacerbate the adverse economic consequences of natural disasters as they affect the functioning of homeowners and commercial property insurance markets. Two specific areas of regulation are considered: 1) rate regulation; and 2) residual market mechanisms. We conduct an empirical analysis of how the existence of a prior approval rate regulatory system and the relative size of a state's RMM affect five measures of market structure and performance: 1) changes in the number of property insurers; 2) the HHI of structural competition; 3) total insurer financial capital; 4) the reinsurance ratio; 5) and the state median loss ratio.

Our empirical analysis indicates that a prior approval regulation regime is generally associated with less desirable outcomes in homeowners insurance markets. More specifically, for homeowners insurance, prior approval rate regulation is associated with a decrease in the number of insurers, an increase in market concentration and a reduction in capacity (i.e., a decrease in surplus and less reinsurance purchased).

It is important to note, however, that a state's rate regulatory system does not fully reflect how rates are actually regulated in that state at any given point in time. In particular, there may be substantial variation across states in the specific manner in which a "prior approval system" is implemented. Further, regulators in some states with "competitive rating systems" (e.g., file-and-use) may seek to constrain rates as a general policy or at certain times. Hence, we are not in a position to conduct a more precise analysis of how actual rate regulatory practices affect property insurance markets. This specification issue is a matter for further research.⁴⁴ Consequently, while we can surmise when regulators attempt to solve

43. We would expect that this effect would be more pronounced in states where the RMM does not enforce strict eligibility requirements.

44. We have given this matter considerable thought. We identified several possible ways in which actual rate regulatory practices in a given state could be determined. One way would be to examine the rate filings of insurers and the disposition of these filings by a state's regulators. We have explored the feasibility of this approach and determined that it would involve an enormous amount of work and appears to be impractical for developing reliable metrics of regulatory

post-catastrophe availability and affordability issues by suppressing rates that they may exacerbate these problems in the long run, more work is needed to provide stronger empirical support for this thesis.

We also find some evidence that larger residual markets are associated with poorer outcomes in homeowners insurance markets. As with prior approval regulation, a larger residual market is associated with a decrease in the number of insurers, higher market concentration, reductions in market capacity and higher median loss ratios. The existing beach plans and wind pools that were established in the wake of catastrophic events deserve further scrutiny, especially those that retain a large market share in the state, as they seem to be driving some homeowners insurers out of states. The expansion of FAIR plans to properties subject to significant catastrophe risk and the creation of state residual market insurers (i.e., the FCPIC and the LCPIC) also create the potential for adverse effects on homeowners insurance markets.

In essence, when these mechanisms are designed and administered properly as true markets of last resort, they are likely to have only minor adverse effects, if any, on homeowners insurance markets. It is when these mechanisms are designed and administered to achieve questionable objectives (e.g., the supply of “inexpensive” insurance coverage) that more significant problems can occur. Best practices with respect to the design and management of RMMs could include: 1) setting adequate residual market rates that are not competitive with the voluntary market; 2) imposing strict requirements for properties that are eligible for residual market coverage; 3) purchasing adequate reinsurance coverage; and 4) administering “keep-out” and “take-out” programs that reduce the number of residual market policies. Further, measures that maximize the availability of voluntary market coverage (e.g., allowing insurers to charge risk-based rates), should also help to decrease the size of RMMs.

Finally, the different effects of prior approval regulation and RMMs on the homeowners and commercial property insurance markets provide some evidence of the consequences of efforts to ensure affordability at the cost of rate adequacy. Compared to the homeowners insurance market, the commercial market does not appear to experience adverse disruptions due to prior approval regulation and residual market size. This brings us back to the dilemma faced by regulators: how to keep homeowners insurance “affordable” without unduly undermining market stability and efficiency. It may be possible to develop programs that would help homeowners in high-risk areas who can neither afford the full price of coverage nor be expected to move or invest in loss mitigation. Such programs could be preferable to attempts to enforce artificially low and thus indirectly subsidized

stringency across all states for an extended period of time (e.g., 10 years). A second approach would be to compare the loss costs filed by advisory organizations with the loss costs approved by regulators. This approach could be more feasible if the necessary cooperation of advisory organizations could be obtained. A third approach would be to survey insurance companies on their characterization of each state’s rate regulatory environment over time.

premiums for all homeowners in high-risk areas, as it would allow market forces to continue to work.⁴⁵ However, it is important that a subsidization program include appropriate incentives for mitigating against future losses.

We must also acknowledge that our empirical analysis did not reveal a statistically significant relationship between catastrophic events and market outcomes with the exception of market concentration, contrary to what we expected. We know from studies that have examined the effects of specific events or a series of events (e.g., Hurricane Andrew, the 2004–2005 storm seasons) that there were significant disruptions in a number of state homeowners insurance markets along the southeast and Gulf Coasts (Grace and Klein, 2009; Klein, 2009a). Consequently, in conducting a broader empirical analysis across a larger number of states for an extended period of time as we have done here, further work is needed to develop a better approach to estimating how specific events and/or changes in insurers' assessment of catastrophic risk affect state homeowners insurance markets.

Assessing the effects of other regulatory policies with respect to insurers' underwriting and policy provisions would also be desirable but highly challenging. It would be necessary to develop specific metrics for such policies, which would require detailed research on state regulations and rules in these areas. In summary, while the analysis reflected in this paper provides some insights on how regulatory practices can affect market outcomes, further research on various dimensions of the regulation of insurance markets subject to catastrophic risks would provide the basis for more specific recommendations on regulatory practices that best serve the public interest.

45. NRC (2015) provides a thoughtful examination of how flood insurance could be made more affordable for some property owners.

Appendix A

**Table A-1:
Events Corresponding to Economically Catastrophic Years**

State	Year	Event(s)
AL	2004	Hurricane Ivan
AL	2011	Alabama tornado outbreak
AR	1996	Wind, tornadoes, wildfire
AR	2008	Tropical storm Ike, Hurricane Gustav
AZ	2010	Flooding, severe storms, wind, hail and tornado
CO	1990	Severe storms
CO	1991	Winter weather
CO	2009	Lightning/avalanche
FL	1992	Hurricane Andrew
FL	2004	Hurricane Charley
FL	2005	Hurricane Katrina and Hurricane Wilma
GA	2009	Hail and flooding
HI	1992	Hurricane Iniki
IA	2001	Upper Mississippi River spring flood
IA	2011	Tornado/Mississippi River flooding
IN	1996	Blizzard and flooding
IN	2006	Severe storms and flooding
KS	1991	Severe storms and tornado
KS	1992	Wichita hail storm
KS	2011	Severe storms, tornado, hail and flooding
KY	1996	Winter weather
LA	1992	Hurricane Andrew
LA	2005	Hurricane Katrina/Hurricane Rita
LA	2008	Tropical storms
MN	1998	Tornado/flooding
MN	1999	Tornado/flooding
MN	2001	Wind
MN	2008	Flooding
MO	2001	Hail/tornado
MO	2006	Tornadoes
MO	2011	Severe storms, tornadoes and flooding
MS	1985	Winter weather
MS	2005	Hurricanes Katrina, Dennis and Ivan
MT	1991	Winter weather and wind
MT	2010	Flooding
NC	1989	Hurricane Hugo
NC	1996	Hurricane Fran

**Table A-1 (Cont'd):
Events Corresponding to Economically Catastrophic Years**

State	Year	Event(s)
ND	1995	Hail and severe weather
ND	1997	Flooding
ND	2001	Winter weather
NE	1996	Tornado
NE	2001	Flooding and tornado
NJ	2012	Hurricane Sandy
OK	2010	Flooding
SC	1989	Hurricane Hugo
SD	1993	Great Flood of 1993
SD	2001	Flooding and tornadoes
TN	2011	Tornadoes, winds and flooding
TX	2008	Hurricane Ike
VA	2003	Severe winter storm

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National Association of Insurance Commissioners, 1992. *An Update of the NAIC Solvency Agenda*, Jan. 7, Kansas City, Mo.: NAIC.

“Spreading Disaster Risk,” 1994. *Business Insurance*, Feb. 28, p. 1.

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