**Distribution Agreement**

In presenting this thesis as a partial fulfillment of the requirements for a degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis in whole or in part in all forms of media, now or hereafter know, including display on the World Wide Web. I understand that I may select some access restrictions as part of the online submission of this thesis. I retain all ownership rights to the copyright of the thesis. I also retain the right to use in future works (such as articles or books) all or part of this thesis.

_____Suzie Noh_____ _____04/16/2013_____

Name Today's Date

# How Much Can the US Property and Casualty Insurers Cover Catastrophic Losses?

- Measuring the capacities of the property and casualty insurance markets in California, Delaware, Iowa, New York, Oklahoma, Texas, Washington, and Connecticut

by

Suzie Noh

Department of Economics

Dr. Kaiji Chen
Advisor

Dr. Hao Gao
Committee Member

Dr. Bumyong Choi
Committee Member

April 4, 2013

# How Much Can the US Property and Casualty Insurers Cover Catastrophic Losses?

- Measuring the capacities of the property and casualty insurance markets in California, Delaware, Iowa, New York, Oklahoma, Texas, Washington, and Connecticut

by

Suzie Noh

Advisor Kaji Chen

An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Arts with Honors

Department of Economics

2013

## Abstract

How Much Can the US Property and Casualty Insurers Cover Catastrophic Losses?

by Suzie Noh

This paper provides a detailed study of the financial strength of the property and casualty insurance market in the US, by estimating the ability of the property and casualty insurers to respond to abnormal losses. This study begins by constructing an estimation model for lower-bound payout capacity of each state. Using the constructed model, it then investigates the percentages of the claimed losses that property and casualty insurers in California, Delaware, Iowa, New York, Oklahoma, Texas, and Washington can pay, in case of catastrophes of $1 billion, $5 billion, $10 billion, and $50 billion losses. The results of the empirical analysis suggest that Connecticut and Delaware have more than enough financial capacity; New York, California, Texas, Iowa, and Washington have adequate levels of capacity; Nonetheless, Oklahoma has an alarmingly insufficient level of capacity for catastrophes.

# How Much Can the US Property and Casualty Insurers Cover Catastrophic Losses?

- Measuring the capacities of the property and casualty insurance markets in California, Delaware, Iowa, New York, Oklahoma, Texas, Washington, and Connecticut

by

Suzie Noh

Advisor Kaiji Chen

A thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Sciences with Honors

Department of Economics

2013

## Table of Contents



Tables and Graphs

# 1. Introduction

The purpose of property and casualty insurance is to provide critical financial assistance in the event of a loss, so that a company or an individual can continue to operate with as little disruption as possible. Property and casualty insurance covers a wide range including houses, automobiles, workers' compensation, capital assets, and liabilities. Because policyholders of property and casualty insurance companies rely on these insurers to partially or fully pay for their losses in the event of an accident or a hazard, the capacity of the property and casualty insurance industry to pay its claims is important to not only policyholders but also investors of the insurers and the government.

The term "catastrophe" in the property and casualty insurance industry denotes a natural or man-made disaster that exceeds a dollar threshold in claims payouts. This threshold has changed over the years with inflation and the increase in development vulnerable to natural disasters. In 1997, the definition of a catastrophe was raised from $5 million to $25 million in insured damages. Insured catastrophe losses in the US totaled $33.6 billion in 2011, which is far above the average of $23.8 billion between 2000 and 2010 according to figures from the Property Claim Services (PCS) (Table 1). Over the 20-year period, 1991 to 2010, hurricanes and tropical storms made up 44.0 percent of total catastrophe losses, followed by tornado losses (30.0 percent), winter storms (7.4 percent), terrorism (6.8 percent), and earthquakes and other geologic events (5.1 percent) (I.I.I. 2013).

Catastrophes are costly because they immediately cause significant losses. Everyday, the policyholder faces a possibility that he or she can lose some of his or her wealth by events such as car crashes and robberies. The insurer spreads its risk over tens of thousands of policyholders

and can therefore predict the amount of losses. The diversification of these risks comes from the fact that the correlation of losses among the policyholders is low. However, catastrophes such as hurricanes and floods do not fit this explanation. So, it is vital that the US government figure out how big of a catastrophe the US property and casualty insurance market can cover without a large proportion of the insurers going bankrupt.

The number of insolvencies of insurers is not insignificant. Since 1990, 76 insurers, which constitute approximately 2.5% of the total property and casualty insurers in the US, have gone insolvent, or bankrupt (Table 2).[1] For example, in 2006, Vesta Insurance Company in Texas declared bankruptcy in 2006 after a series of losses from major hurricanes such as Ivan in 2004 and Rita in 2005. The impact of an insurer's insolvency might not seem that detrimental, as there is an Insurance Guaranty Association in each state that covers policy claims on behalf of the insolvent insurer. However, there are three realistic barriers that cause some losses to the policyholders in the event of an insurance company's insolvency. First, each state's Insurance Guaranty Association has a maximum amount it will guarantee depending on the state's coverage limits. As a result, the claimants may not receive what they are otherwise eligible for under their policies. Also, although most claims are covered by Guaranty Associations, coverage for a few types of claims may be excluded. Secondly, some delays in claim payouts are inevitable. It takes time for the liquidator to collect the assets of the insolvent company and verify the liabilities, such as claim payments and bills, before claim files are forwarded to the state's Insurance Guaranty Association. In some instances, it may take 30-60 days after the order of liquidation for a payment to be processed. Thirdly, there are many other inconvenient and

[1] According to The National Conference of Insurance Guaranty Funds (NCIGF), there have been about 500 insolvencies of property and casualty insurers since 1970.

complex hassles to go through. For example, all the claims to the defunct insurer must be filed with the Guaranty Association before the claims cut-off date, which is a relatively short period of time. For these reasons, it is the policyholders' best interest to not have their insurers bankrupt. Thus it is important for the government and policyholders to understand approximately how large a disaster the industry is capable of covering.

Because property and casualty insurers are required to have a financial cushion to pay an unexpectedly large number of claims, they must maintain a certain level of surplus to underwrite risks. This financial cushion is known as "capacity." When the industry is hit by high losses, such as a major hurricane, capacity is diminished. It can be restored by increases in net income, investment returns, or raising additional capital (Cummins and Nini 2000). However, maintaining high capacity—or holding equity capital—in an insurance company is costly because of regulatory costs, agency costs, corporate income taxation, and many other factors. Thus, it is crucial for insurance companies to hold an adequate level of equity capital that both minimizes insolvency risk and avoids inefficiencies. Studying the capacity of the insurance market may help to see whether the government needs stricter regulations on the level of equity capital held by insurers.

As development and urbanization flourished in the 1980s, insurers' exposure to hurricane losses soared (Graph1). In the past few decades, major catastrophic events have drawn attention to the risks the insurance industry faces. The insured losses were estimated at $16.5 billion for Hurricane Andrew, $4.2 billion for Hurricane Hugo, and $2.5 billion for the Loma Prieta earthquake (Angbazo 1996). In fact, insurers have paid more than $32 billion in claims in 2011, according to the Insurance Information Institute (I.I.I.). Also, underwriting losses more than

tripled from $10.5 billion in 2010 to $36.5 billion in 2011, marking the industry's second-largest annual underwriting loss. This was topped only by 2001's $52.3 billion loss (Table 3). It is worth noting that the insured losses in the US in 2012, reaching nearly $60 billion USD, were the second highest on record after 2005, the year of Hurricane Katrina and Rita (Graph 2).

According to I.I.I., markets for many types of property and casualty insurance are cyclical to some extent. The industry cycle is characterized by soft market periods, where falling premium rates cause low profitability, and subsequent hard market periods, where premium rates and insurers' reported profits significantly increase (Harrington 2004). It is believed that soft and hard markets occur in a regular "underwriting cycle" in terms of accounting profitability. A dominant factor in the property and casualty insurance cycle is intense competition within the industry (Gron 1990). Graph 3 shows the inflation-adjusted growth of property and casualty net written premiums over more than three decades. It can be learned from Graph 3 that the length of each "underwriting cycle" has recently been approximately 4-8 years.

There is uncertainty as to the maximum level of catastrophe losses that the property and casualty insurance can absorb. Therefore, in this paper, I measure the capacity of property and casualty insurers of several US states using the data ranging from 2002 to 2011, which sufficiently covers one underwriting cycle. First, I use a simple regression model to find the ratio of each property and casualty insurer's losses to the total market losses for each state. Then, I use the ratios to estimate the additional amount of payout that each insurer has to cover in case of catastrophic events that respectively cost 1 billion, 5 billion, 10 billion, and 50 billion USD to the state in which the insurer is doing business. Finally, I measure how much of the extra claimed amount each insurer can pay, and add them up to compute how much percentage of catastrophic

losses each state can cover. This percentage will represent the capacity of the property and casualty insurers in each state.

While most auto insurance policies offer "comprehensive" coverage, the majority of home insurance policies do not cover damages from floods and earthquakes and only covers losses from wind, fire, and rain. However, people can separately purchase earthquake or flood insurance. Many residents in Florida and Louisiana purchase flood insurance, while many residents in California buy earthquake insurance. The private insurers providing these insurance policies will be included in this study's property and casualty insurer data.

On another note, the National Flood Insurance Program (NFIP), created in 1968, allows property owners in participating communities to buy insurance to protect against flood losses. Participating communities are required to adopt and enforce ordinances to reduce the risk of flooding. For example, the NFIP paid out $1.3 billion to cover claims in all states affected by flooding due to Hurricane Irene in 2011 and the industry racked up $4.3 billion in losses in that storm. It is important to note that this study does not include this federally administered NFIP as a member of property and casualty insurers, and the word "capacity" in this paper indicates the ability of the private property and casualty insurers in the US to cover losses.

Some might criticize my work saying that, given the ceilings on insurance payouts, this study will not correctly measure the true capacity of the insurers. However, in this study, "capacity" refers to the insurers' ability to pay for their contracted amount of compensation. The capacity of 100% indicates that insurers are capable of paying the full amount of their claims, not the full cost of damages incurred. The total amount of losses is not related to my study, and in fact, all the graphs and tables used in this paper refer to the "insured" losses not the total losses.

The remainder of the paper is organized as follows: Section 2 investigates some previous literature related to the financial conditions of the property and casualty insurance industry. Section 3 elaborates the data and methodology employed and discusses the rationale underlying the basic procedure. Section 4 presents empirical results in the capacity of the property and casualty insurers in California, Delaware, Iowa, New York, Oklahoma, Texas, Washington, and Connecticut. This paper ends with the discussion on limitations of my study and future possible research topics in Section 5.

## 2. Literature Review

There have been numerous studies on the premium rates of property and casualty insurance, and there exist countless pricing models for insurance. However, relatively little research has been conducted on the performances and the financial capacity of the property and casualty insurance industry. The two topics of literature relevant to this research are the effects of catastrophic events on the industry and the financial strength of the insurers.

Angbazo and Narayanan (1996) examined the effects of Hurricane Andrew and its regulatory aftermath on the stock prices of property and casualty insurers. More specifically, they showed that there was a large negative effect of Hurricane Andrew on the stock prices of the affected insurers, which was only partially offset by the following premium increases. Additionally, they showed evidence of a contagion effect to insurers with no claims exposure in the areas affected by Andrew.

Lamb (1995) found out that Hurricane Andrew in 1992, which largely affected South Florida and Louisiana, produced a significant negative property-casualty stock price reaction on insurers with direct premium volume in Florida or Louisiana. However, in contrast to what Angbazo and Narayanan (1996) concluded, he claimed that the insurers with no exposure in the two states sustained no significant stock price response. It was concluded that the market efficiently interpreted the information generated by the hurricane and discriminated among property-liability insurers based on the existence and magnitude of insurance written. Similarly, Cagle (1996) reported a significant negative reaction for insurers which were most vulnerable to damage claims, and not for others, in his studies of Hurricane Hugo in South Carolina.

Turning to the financial stability and capacity of the property and casualty insurance market, Harrington and Nelson (1986) used a new methodology for assessing property and casualty insurers' financial strength. They first identified the insurers with premium-to-surplus ratios that are substantially higher and showed that those insurers are more likely to become insolvent. Conway and McCluskey (2006) attempted to build a bridge between the traditional methods of looking at financial risk and insurance risk, by combining insurance risk into a VAR modeling structure of economic capital used in banking. They asserted that, given that finding an appropriate measurement of required capital has become an increasingly important issue for the property and casualty insurers, the VAR model for the insurer's loss reserve risk can be a very useful tool for effective risk and capital management.

Motivated by the sharp decline in industry leverage between 1985 and 2000, Cummins and Nini (2000) investigated the use of equity capital in the property and casualty insurance industry. They concluded that the run-up in equity capital in the period between 1985 and 2000 is primarily attributable to capital gains on investments and to the fact that insurers are reluctant to pay out capital accumulations as dividends, preferring to maintain internal funds to cushion the next loss or investment shock.

Another paper by Cummins et al. (2002) measured the capacity of the US property and casualty insurance industry to finance catastrophic property losses in the $100 billion range, using their own option-like model of insurer responses to catastrophes. Their results indicated that national industry efficiency ranges from about 83.3% to 1.6% based on catastrophe losses ranging from zero to $300 billion, and from 76.6% to 70.2% based on catastrophe losses ranging from $200 to $100 billion. They concluded that the industry has more than adequate capacity to

pay for catastrophes of moderate size.

Most of the existing literature on the property and casualty insurance companies focuses on indirect methods to analyze the financial conditions of the insurers—Lamb (1995), Angbazo and Narayanan (1996), and Cagle (1996) all relied on the changes in the stock price to quantify the effects of natural disasters. However, analyzing the stock prices can be inaccurate because they are often influenced by random noises such as speculative bubbles.

Furthermore, the majority of the previous theoretical research papers develop company-specific models in that they can only be applied to each insurance company, not the entire insurance industry. For instance, the VaR model of insurance loss reserve risk developed by Conway and McCluskey (2006) only measures potential fluctuations in the market value of an insurer in relation to that of the entire insurance market. Their work is not useful in calculating the market value of the total insurance industry, nor is it applicable to measuring the capacity of the industry. Similarly, the model constructed by Harrington (1986) only works for roughly estimating the likelihood that an insurer goes insolvent. After conducting analysis with the data for seventy insurers, Harrington (1986) simply compared his results with the National Association of Insurance Commissioners (NAIC) data in concluding that there is a higher possibility of an insurer with higher premium-to-surplus ratio to go bankrupt. Therefore, his results are not statistically justified and thus little about the entire market can be concluded from his work.

In addition, Cummins et al. (2002) calculated only the capacity of the US property and casualty insurance market as a whole. However, it would have been more useful to calculate the capacity of the insurers in each state, given each state differs noticeably in surplus, premium

rates, and its vulnerability to natural catastrophes. Also, their model does not take into account the additional loss adjustment expenses that insurers need to pay, in case the losses skyrocket if a catastrophic event occurs.

My paper is unique in three aspects: first, I use a wide data range. While most of the previous literature only conducts theoretical analysis or uses samples of a small size, I use data of all the property and casualty insurers existent in California, Delaware, Iowa, New York, Oklahoma, Texas, Washington, and Connecticut—approximately 600 insurance companies—for the time period of 2002 to 2011. This will give results that are more statically significant and reliable. Secondly, this paper gives a more focused examination on the capacities of the property and casualty insurers. By looking at each state, instead of the entire US market, I make estimations that are much more useful. The local capacity levels are more practical, because each state has noticeably different characteristics in terms of the number of insurers, average surplus, premium rates, and the expected losses. Thus, this paper expands the work by Cummins et al. (2002) who only calculated the capacity of the entire US property and casualty insurance market. Thirdly, because this study not only considers each insurer's financial data—such as losses, loss adjustment expenses, and surplus—but also the relationship between an insurer's losses and the state's total losses, it gives an accurate and comprehensive investigation of the capacities of respective insurance markets in the eight states.

# 3. Data and Methodology

## 1) Data

I obtained the regulatory annual financial statements from 2002 to 2011 submitted by all the insurers to the National Association of Insurance Commissioners (NAIC). NAIC is the US standard-setting and regulatory support organization created and governed by the chief insurance regulators from the fifty states, the District of Columbia, and five US territories. The most recent report year available at the time the study was conducted is 2011, and the 10-year-period between 2002 and 2011 is long enough to cover one underwriting cycle.

The information in the NAIC financial statements includes but is not limited to: each insurer's assets, liabilities, surplus, cash flows, premiums written and earned, losses paid and incurred, loss adjustment expenses, and net investment income.

According to NAIC, at least for the past 30 years, the average premium rates for property and casualty insurance in Texas and Oklahoma have been among the highest, and those in California and New York among the second highest, those in Iowa and Connecticut among the middle, and those in Delaware and Washington among the lowest. As such, these eight states are good representatives of all the states in the US. In fact, it seems that these insurance rates are related to the number of insolvencies since 1970 in each state (Graph 4). Graph 4 indicates that Texas, Oklahoma, California, and New York have had the higher number of insolvencies than Iowa, Connecticut, Delaware, and Washington.

## 2) Methodology

Here I explain and justify my estimation model that measures the market capacity of each state. I begin by examining a payout-maximizing case in which there is one insurer. I then derive a model of market capacity used for the empirical analysis in Section 4.

It should be noted that the assets of the insurers consist of total liabilities and equity, with "equity" being equivalent to net worth, net asset, or surplus. In the insurance market, the term "policyholder's surplus" is used instead of "equity" in order to emphasize the priority given to satisfying policyholder's obligations. There are two ways to calculate policyholder's surplus. The surplus can be calculated by adding change in policyholder's surplus—due to net underwriting gain/loss, net investment gain/loss, other income, etc.—to policyholder's surplus of the prior year. Alternatively, it can be calculated by subtracting an insurer's liabilities from its total assets. Thus, policyholder's surplus represents the excess capital, or the remainder of the assets, of a company after deducting all of its liabilities. Consequently, it is regarded as a financial cushion to protect the policyholders. By using policyholder's surplus, which includes net underwriting gain/loss, my study intrinsically takes into account the effects of reinsurance on capacity, because net underwriting gain/loss includes reinsurance transactions.

Let the state's total losses be L, and the losses for an insurer i be $L_i$. So,

$$\sum L_i = L.$$

Limited liability indicates the following:

$$\text{Payout for insurer i} = \text{Min}\{L_i, S_i\},$$

where $L_i$ is losses and $S_i$ is policyholder's surplus of insurer i.

If $L_i < S_i$ for an insurer i and thus

$$\text{Payout for insurer i} = \text{Min}\{L_i, S_i\} = L_i ,$$

then the capacity of insurer i for loss $L_i$ is:

$$\frac{L_i}{L_i} \times 100 = 100\%$$

On the other hand, if $L_i > S_i$ for an insurer i, and thus

$$\text{Payout for insurer i} = \text{Min}\{L_i, S_i\} = S_i ,$$

then the capacity of insurer i for loss $L_i$ is:

$$\frac{S_i}{L_i} \times 100\ \%$$

In the second case of $L_i > S_i$, the insurer i is likely to go through court-ordered rehabilitation under the state regulators and possibly become even insolvent.

The ability of an insurer to pay the losses depends on its policyholder's surplus. However, the ability of the market to pay losses depends not only on the aggregate policyholder's surplus, but also on how the losses and surplus are distributed across insurers. I use this concept to construct an estimation model for market capacity. Starting from a baseline situation, where there is only one insurance company in the property and casualty insurance market, the market capacity for loss L is:

$$\frac{\text{Min}\{\text{L}, \text{S}\}}{L} \times 100\ \%,$$

$$\text{where } S_i = S \text{ and } L_i = L.$$

This situation represents the maximum capacity utilization, because the market uses all of its aggregate surplus before one (and unique, in this case) insurer goes insolvent.

However, in the real world, there are more than one insurer. Also, these insurers do not act as a single insurer. That is, the losses or surplus of an insurer is not transferred to another insurer. If one of the insurers is not able to pay all of its claims, other solvent insurers are not responsible to pay the rest of that insurer's claims. Therefore, it is *incorrect* to define the market capacity as the following: [2]

$$\frac{\text{Min}\{\text{L}, \text{S}\}}{L} \times 100\ \%,$$

$$\text{where } \sum S_i = S \text{ and } \sum L_i = L.$$

The *correct* market capacity is:

$$\frac{\sum \text{Min}\{L_i, S_i\}}{L} \times 100\ \%,$$

$$\text{where } \sum L_i = L.$$

This accurately measures the percentage of insured losses that the market in each state can cover.

[2] Each state's market capacity for a 10 billion dollar catastrophe calculated by this incorrect model is the following: 100% (California), 100% (Delaware), 58% (Iowa), 100% (New York), 9.2% (Oklahoma), 100% (Texas), 23% (Washington), 100% (Connecticut). These figures are noticeably different from the results using the correct model shown in Table 5.

Before computing the capacities for the losses of 1 billion, 5 billion, 10 billion, 50 billion USD, $L_i$ of each insurer for the state's total loss L must be derived. Once I find the ratio of each insurer's losses to the state's total losses, I can calculate $L_i$ of each insurer for the market loss L. To estimate the ratio, I use a simple linear regression model without the intercept term. An insurer's losses is a dependent variable and the state's total losses is a unique independent variable. Thus, the regression model is:

$$insurer\ i\ losses = \beta_i \times state\ total\ losses.$$

I use a linear model without the intercept term because I am looking for a fraction of the market loss L that goes to each insurer. The null and alternative hypotheses for the regression are:

$$H_0 = \ insurer\ i\ does\ not\ have\ a\ constant\ share\ of\ market\ losses,$$

$$H_A = insurer\ i\ has\ a\ constant\ share\ of\ market\ losses.$$

Between 2002 and 2011, there were some changes in the number of insurers in the eight states (Graph 5). The changes in the number of insurers may be due to insolvencies, new entrants to the market, exits out of the market, merges and acquisitions, etc. I compute only the loss ratios for the insurers present for the entire sample period (which will be referred to as "Full-period Insurers"), because it is believed that data of a ten-year period—which sufficiently covers one underwriting cycle—should be used to yield reliable loss ratios. So, I use the sum of the losses for the Full-period Insurers as the state total losses.[3] For approximately 97% of the Full-period

[3] When running regression, there is no need to adjust the insurers' losses and the state's losses to the inflation rate, because the losses of insurer i is matched with the state's aggregate loss for the same year.

Insurers, I have found statistically significant $\beta$ (loss ratio) at 5% significance level.[4] Thus it is sensible to conclude that the alternative hypothesis $H_A$ holds. That is, the insurers, which were in business for the entire sample period between 2002 and 2011, have constant shares or ratios of the state's aggregate losses.[5] Also, for every state, the loss ratios add up very close to 1.00, e.g. 0.99977 or 1.00023, which provides another layer of reliability to the regression results. Therefore, it is legitimate to write the following equation for each state:

$$L_i = \beta_i \times L$$

$$where \sum L_i = L.$$

Specifically speaking, using the Full-period Insurers will only allow us to figure out what percentage of the insured losses will be paid by the Full-period Insurers in the case of a catastrophe whose losses to *the Full-period Insurers* are 1 billion, 5 billion, 10 billion, or 50 billion USD. However, it is well justified that we can regard the percentages as the market capacity for the following reasons. First, the Full-period Insurers constitute more than 90% of all the insurers in each of the eight states. The set of Full-period Insurers is large enough for such a generalization. Also, statistically, the Full-period Insurers, which have been in the market for at least ten years, are more likely to stay in the market than other new entrants, so it is sensible to use the Full-period Insurers for the estimation of capacity for future catastrophes. Secondly, we can interpret our results as the lower-bound capacity of the market in each state. For any year between 2002 and 2011, the actual number of insurers who were in business is equal to or greater

[4] More than 90% of $\beta's$ for insurers were significant at 1% level.
[5] When sorting the NAIC financial data by state, I referred to the state of domicile not the location of home office. State of Domicile indicates the state in which the insurance company is charted and licensed to operate under the state's insurance regulations and statutes. There are many cases where the state of domicile is different from the location of home office, especially when the insurer is under a group.

than the number of Full-period Insurers. Therefore, only taking into account the policyholder's surplus of these Full-period Insurers is equivalent to giving more financial pressure to the Full-period Insurers than the pressure they would meet in reality, where the losses are shared by more insurers. That is, if a catastrophe occurs, each insurer in the Full-period Sample would be subject to lower losses when the Full-period Insurers are in the market with other insurers than when they are the only insurers. Therefore, we can accept the results of this study, which gives more financial burden to the Full-period Insurers than reality, as the lower-bound market capacity for each state.

There are some clarifications to be made about the data and the method used. For the value of losses, I use the "losses incurred." The "losses incurred" is computed in accordance with the following formula:

$$Current\ year's\ outstanding\ losses + net\ losses\ paid - prior\ year's\ outstanding\ losses.$$

Additionally, it can be observed from Table 4 that the ten most costly catastrophes in US history cost roughly from 7 billion to 50 billion 2011 USD. These numbers indicate the total losses for all the affected states. This study looks at each state and estimates the capacity of the property and casualty insurance market for catastrophes of given losses *specifically* to the state. It thus makes sense to calculate the capacities for catastrophes of lower magnitudes. Therefore, I calculate the market capacities of each state for catastrophes of 1 billion, 5 billion, 10 billion, and 50 billion 2011 USD losses.

For simplicity and applicability of this study, I make the following three logical assumptions. Firstly, the amount of surplus will not be too different in the near future. One of the goals of

conducting this research is to estimate the capacities of the property and casualty insurers if there is a catastrophic event that costs 1 billion, 5 billion, 10 billion, or 50 billion 2011 USD. Because I am using the data from 2011 to estimate the capacity for future catastrophes, the results of this study are only useful if the amounts of surplus kept by the insurers do not vary greatly from those of 2011.

Secondly, I assume that, for every additional dollar loss, the loss adjustment expenses incurred increase by 0.143, or 1/7, dollar. The loss adjustment expenses incurred are costs associated with investigating, administering, defending, or paying an insurance claim. Thus, the expenses will increase as well if the insurers are subjected to catastrophic claimed losses. I calculated the ratio of loss adjustment expenses incurred to losses incurred for all the insurers from 2002 to 2011, and the average ratio was approximately 1/7, or 0.143.[6] So, when 1 billion, 5 billion, 10 billion, and 50 billion dollar catastrophes occur, the actual extra losses for insurers will be greater due to additional loss adjustment expenses. In order to accurately measure the capacity, I let L be the magnitude of a catastrophe (i.e., \$1 billion, \$5 billion, \$10 billion, and \$50 billion) multiplied by 1.143, or 1+1/7, Then, I find the loss distribution $L_i$ among the insurers according to their loss ratios. Finally, I calculate the state's market capacity by finding $\text{Min}\{L_i, S_i\}$ for each insurer i and dividing the sum of $\text{Min}\{L_i, S_i\}$ by the total losses L.

Lastly, I assume that every insurance company stands on its own and the policyholder's surplus is not shared among insurers. Many insurance firms are organized as insurance groups consisting of several companies under common ownership. A few examples of such insurance

[6] There are slight differences in the average losses incurred to loss adjustment expenses ratios among eight states. Texas has the lowest average ratio, while Iowa has the highest. However, I use the average of the ratios for all the eight states because there are large differences among the insurers even in the same state. This observation is not surprising given that the loss adjustment expenses largely depend on the processing efficiency of each insurer.

groups are Allstate, State Farm, and Berkshire Hathaway. I regard all the insurers as separate entities, and assume that the members of groups are freestanding companies. This means that I assume that groups do not bail their failing subsidiaries. It is a logical assumption given that most of the troubled insurers in group affiliations usually go out of business without receiving aids from other group subsidiaries. For example, Frontier Insurance went through rehabilitation in 2011, while St. Lancer Insurance and Lancer Insurance remained active in the market. All of the three companies are operated under the same group—Lancer Financial Group. Additionally, Northwestern Insurance underwent rehabilitation in 2011, while Compass Insurance, the other subsidiary of the same group remained active. Even if there are some cases where their funding is shared, there is little or no reason for groups to aid their subsidiaries when their subsidiaries are under severe financial difficulty due to catastrophic losses. Helping them with catastrophic losses will cost the groups much money. So, it would be more profitable and reasonable for the groups to let their subsidiaries under such serious financial distress to go insolvent. Therefore, in my study, I assume that policyholder's surplus in each subsidiary of the same group is not shared.

In this part, I have fully explained and justified the model for capacity of the property and casualty insurance market. This model yields the percentage of claim payouts, conditional on the state's total losses of any given size. By varying the level of the state's total losses between 1 billion, 5 billion, 10 billion, and 50 billion USD, I find the estimates of the percentage of losses that would be paid for catastrophes of different sizes in Texas, Oklahoma, California, New York, Iowa, Connecticut, Delaware, and Washington. In addition, after calculating how the surplus in each insurer has changed from 2002 to 2011, I find the changes in market capacities from 2002 to 2011.

# 4. Empirical Results

In this section, I present the results of my empirical analysis on the NAIC data 2002-2011 using the model developed in the previous section. Graph 6 shows the annual losses incurred (in 2011 USD) between 2003 and 2011.[7] It can be observed that each state had a different range of losses. New York had the highest annual losses every year between 2003 and 2011. California, Connecticut, Texas, and Delaware were in the middle tier, while Iowa, Washington, and Connecticut were in the lower tier. Oklahoma had the lowest annual losses throughout the ten-year data period. Delaware had particularly high losses in 2003 and 2004, due to Tropical Storm Henri in 2003, which damaged hundreds of houses and businesses, and the remnants of Hurricane Jeanne in 2004, which caused an F2 tornado[8] in northern Delaware. Also, New York had higher losses in 2008 in relation to other years due to Hurricane Hanna, which affected southern New York, including New York City. Graph 7 shows the total losses incurred between 2003 and 2011. New York had the greatest losses, followed by California. This makes sense because New York is close to the east coast of the US, which is highly subject to hurricanes and tornadoes. Also, California has a high risk of earthquakes. Oklahoma had noticeably the lowest losses between 2003 and 2011. It is somewhat surprising that Oklahoma, which has historically been exposed to numerous tornadoes, was not affected by any big natural disaster between 2003 and 2011 and had the lowest losses incurred.

Graph 8 illustrates how the total policyholder's surplus in each state has changed between 2002 and 2011. The policyholder's surplus in all of the eight states decreased in 2008, due to an

[7] The data for losses incurred is available for the range from 2003 to 2011, not from 2002 to 2011, because the prior year's losses is needed to calculate the current year's losses incurred.

[8] The Fujita scale (F-Scale) is a scale for rating tornado intensity. F1 indicates light expected damages, and F5 indicates incredible expected damages.

economic recession that started that year. This is an evitable result given that the policyholder's surplus is dependent on capital gains/losses and investment gain/losses. Despite the sudden drop in 2008, there was a noticeable trend of increasing policyholder's surplus for all the eight states from 2002 to 2011. The total surplus of New York, Connecticut, Delaware, California, and Texas increased approximately 1.5 times from 2002 to 2011. It is worth noting that Oklahoma had the lowest amount of surplus throughout the data range. Significant losses usually lead to a significant decrease in policyholder's surplus and motivate the insurer to tighten underwriting standards, raise rates, and thus increase surplus. Because insurers in Oklahoma did not experience any significant losses between 2002 and 2011 (Graph 6 and Graph 7), they had no pressure or motivation to increase the amount of policyholder' surplus—which is costly to maintain—and kept a low level of surplus.

I now discuss the capacities of the eight states for losses in the ascending order of numerical value: $1 billion, $5 billion, $10 billion, and $50 billion. Table 5 shows the estimated market capacities for various catastrophic losses based on the levels of policyholder's surplus in 2011. These results are useful in predicting the market capacity for catastrophes in the near future. For 1 billion 2011 USD losses, California, Washington, and Connecticut have 100% capacities.[9] The other states also have very high capacities of more than 95%, except for Oklahoma. Oklahoma's property and casualty insurance market has the capacity of 56.8% for a catastrophe of $1 billion losses. It follows that a number of insurers in Oklahoma fail to have enough policyholder's surplus to pay their shares of $1 billion losses. Given that Oklahoma has been considered one of the most vulnerable areas for tornadoes (which have resulted in relatively

[9] It can be inferred that, given the level of policyholder's surplus for each insurer does not change significantly, California, Washington, and Connecticut had 100% capacities in 2012 for a catastrophe of $ (1 billion × inflation rate for 2012) losses.

high premium rates for property and casualty insurance), this 56.8% capacity seems dangerously low.

For catastrophic losses of 5 billion 2011 USD, only Connecticut among the eight states has 100% capacity. California, Delaware, Texas, and New York have capacities higher than 95%. Iowa has the capacity of 87.4%. However, Iowa is considered a mid-risk state for catastrophes, so the capacity of 87.4% for one-time $5 billion losses—which is unlikely to occur in Iowa—is not low. Washington has 40% and Oklahoma has 15.7% capacities, which are significantly low compared to their capacities for $1 billion losses. This indicates that there are many insurers in Washington and Oklahoma that have enough policyholder's surplus to cover their loss shares for a $1 billion catastrophe, but not sufficient enough for a $5 billion catastrophe. Washington is a state relatively safe from natural disasters, so it is statistically very unlikely for Washington to have one-time $5 billion losses. Thus, the 40% capacity for $5 billion losses is not risky. However, Oklahoma, as previously stated, has a high exposure to natural catastrophes and therefore seems to not have enough financial cushion for possible losses.

No state would be able to pay full claimed losses in case of a $10 billion (2011 USD) catastrophe, but Connecticut, California, Delaware, Texas, and New York will be able to cover most of the insured losses. Iowa's capacity for one-time $10 billion losses, i.e., 54.7%, is noticeably lower than that for $5 billion losses, i.e., 87.4%. This means insurers in Iowa can pay most of the claimed losses only in case of a catastrophe whose costs to the state are less than $5 billion. Considering that Iowa is not exposed to a great risk of natural catastrophes, it is reasonable to conclude that the financial conditions of insurers in Iowa are sound enough. For a

similar reason, Washington's 21.1% capacity for $10 billion losses does not bring caution. Nonetheless, Oklahoma's capacity of 8.3% deserves further attention and concern.

The probability of having a catastrophe that costs each state as much as $50 billion (2011 USD) is very low. However, given that eight out of the ten most costly catastrophes in US history occurred after the year 2000 (Table 4), there is an increasing need to have a rough idea of how much the market can cover in such an extreme case. Connecticut and New York have capacities of 72.7% and 65.21% respectively and Delaware, Texas, and California all have capacities between 50% and 54%. Iowa's capacity is 11.9%, but it should not be considered too low since the likelihood that Iowa will be affected by a big catastrophe is extremely low. Likewise, Washington's 4.3% capacity for a $50 billion catastrophe should not be considered dangerous. Oklahoma has the lowest capacity, i.e., 1.66%. This indicates that the property and casualty insurers in Oklahoma can only pay a negligible percentage of total claimed losses. Given that Oklahoma is highly exposed to natural hazards, this low figure is alarming.

I take an additional step to find the change in the capacities between 2002 and 2011. Graph 9 shows how the market capacities in each state have improved, especially for $50 billion (2011 USD) losses.[10] For the entire data period, Connecticut had the highest capacity for losses of any size, while Oklahoma had the lowest. Graph 9 also indicates that the capacities of insurers in all eight states generally decreased in 2008, the starting year of the current economic/financial crisis. It is noticeable that Iowa's capacity improved significantly from 2002 to 2007 especially for $5 billion and $10 billion losses. Also, Oklahoma's capacity for $1 billion losses was greatly raised between 2003 and 2007. However, it needs to be increased further, given that Oklahoma is

[10] Policyholder's surplus from 2002 to 2010 has been inflation-adjusted, since the capacities for losses denoted by 2011 USD are being measured.

one of the high-risk states for natural disasters. It can also be observed that the orders of capacity among the eight states are roughly consistent. That is, the states that have high capacities for losses of a moderate magnitude are likely to have high capacities for the losses of greater magnitudes as well. Additionally, the states that have high capacities in one year are likely to have high capacities in other years.

In summary, Connecticut, New York, Delaware, California, and Texas have relatively high capacities for a catastrophe of any given size. It is necessary for New York, California, and Texas to have high capacities, because they are greatly exposed to tornadoes, hurricanes, or earthquakes. In addition, New York, California, and Texas host highly urbanized areas such as New York City, Los Angeles, San Francisco, Dallas, and Houston (U.S. Census Bureau 2013). However, given that Connecticut and Delaware have historically been less exposed to natural disasters, their high capacities indicate that they have more than enough financial cushion to cover most of the catastrophes of magnitudes that are likely to occur in these two states. It is clear that Oklahoma has an inadequate level of surplus to cover the expected losses. As previously mentioned, even though Oklahoma had the lowest losses incurred between 2003 and 2011 among the eight states, Oklahoma has experienced numerous small and big natural disasters for at least the last fifty years and has therefore been regarded as one of the riskiest states in terms of natural hazards. It can be concluded that it is an urgent matter for property and casualty insurers in Oklahoma to increase the level of their policyholder's surplus. This argument can be evidenced by the fact that Oklahoma has the highest percentage of the number of insolvent insurers since 1975 and the highest number of insolvent insurers since 2002.

It is important not to be confused between the amount of annual claimed losses that an insurer can pay and the amount of claimed losses that an insurer can cover at once. The first refers to the insurer's annual capacity, while the second refers to the insurer's capacity for one-time catastrophic losses. This study measures the latter. The total amount of losses that insurers can pay for one year should be more than the amount that they can pay at once, because there is more time for insurers to liquidify assets, increase debt, or raise the level of surplus.

# 5. Conclusion

The task of this paper is to estimate the lower-bound ability of the property and casualty insurers in each state to respond to abnormal losses. For the last 20 years, more than 92% of the catastrophic insured losses have come from natural disasters (I.I.I. 2013). I develop a model that measures the capacity of the insurers in each state based on each insurer's level of policyholder's surplus—the current reserves to pay future losses—and its share of total state's losses. The empirical analysis based on 2011 parameters suggests that Connecticut and Delaware have more than enough capacities and that New York, California, and Texas have adequate capacities to pay for the relatively severe catastrophes likely to occur in these three states. Also, Iowa and Washington have a moderate level of capacity that could fully cover the catastrophic losses of a reasonable size. However, Oklahoma has a very low level of capacity, which is not enough to cover most of the catastrophes. Given that Oklahoma has historically suffered from various natural disasters whose damages exceed $1 billion, there is clearly a need for a change towards higher equity capital.

I also compare the changes in each state's capacity for $1 billion, $5 billion, $10 billion, and $50 billion losses (2011 USD) respectively, using annual policyholder's surplus in each state between 2002 and 2013. It can be concluded that the capacity of each state has generally increased from 2002 to 2011, despite a sudden drop in 2008 due to an economic crisis. Additionally, it can be seen that the states with high capacities for losses of one size are likely to have high capacities for losses of other sizes and that the states with high capacities in early 2000s also currently have high capacities.

As urbanization continues and global warming advances, there is a rising necessity for all property and casualty insurers to have sufficient levels of policyholder's surplus. As mentioned earlier, eight out of the ten most costly catastrophes in the US took place in the last 13 years (Table 4). In particular, the Northeast area of the US has experienced noticeable changes in its climate. Since 1970, the average annual temperature has risen by 2°F and the average winter temperature has increased by 4°F. Heavy precipitation events have increased in magnitude and frequency (Global Climate Change Impacts 2009). As severe weather events are happening more often and more intensely, there need to be stricter regulations on insurers' capacities.

The NAIC risk-based capital (RBC) system, created in the early 1990s, provides a capital adequacy standard and regulatory authority for timely action. It establishes a hypothetical minimum policyholder's surplus level and a law that grants the state insurance regulators to take specific actions, in case an insurer holds the level of policyholder's surplus far off from the advised level. The RBC formula exists for each of the primary insurance types, i.e., Life, Property/Casualty, and Health. However, the RBC formula for property and casualty insurers only takes into account 1) the asset risk from interests, bonds, loans, common stocks, etc. and 2) the underwriting risk from pricing and reserving errors. Moreover, the formula is uniform among all the states. Considering that the likelihood that each state is affected by a catastrophe of a given size greatly varies, I claim there needs to be a state-specific risk factor in the RBC formula, that will result in higher level of policyholder's surplus in states at high risk of natural disasters, including Oklahoma.

One of the drawbacks of the capacity estimation model developed in the paper is that it cannot be applied to the states that have had a significant change in the number of insurers for a

given period, which increases the possibility of non-constant loss shares among Full-period Insurers. For example, the number of insurers in Florida was 55 in 2002 but was 85 in 2011, and so the regression gives insignificant loss ratios for many of the Full-Period Insurers. Also, the sum of the total loss shares is 0.74, far off from 1.00, which indicates that these loss ratios among insurers are not accurate. Additionally, even supposing significant loss shares were found for Full-period Insurers in Florida, the estimated level of capacity would be of limited utility, because this capacity—specifically speaking—represents the percentage of the losses that will be paid only by the Full-period Insurers in the case of a catastrophe. Thus, if these Full-period Insurers do not constitute the majority of the currently existing insurers, the capacity is not helpful in predicting the market capacity for a catastrophe in the near future. Perhaps the use of a more advanced theoretical model will help find the reliable market capacity.

This study also gives potential ideas for future research. Instead of adding one-seventh of additional claimed losses to account for additional loss adjustment expenses, one could find the complex relationship between claimed losses and loss adjustment expenses for more accurate estimation of the capacity for catastrophic losses. Also, given that there is a clear need to improve capacity for some insurers, one could conduct research on how insurers can effectively raise the level of policyholder's surplus to increase their capacities.

## References

Angbazo, L.A., Narayanan, R., 1996. Catastrophic Shocks in the Property-Liability Insurance Industry: Evidence on Regulatory and Contagion Effects. Journal of Risk and Insurance, Vol. 64, No.4, Symposium on Catastrophic Risk, 619-637.

Cagle J. A. B. (1996) Natural disasters, insurer stock prices and market discrimination: the case of Hurricane Hugo, Journal of Insurance Issues, 19(1), 53–68.

Conway, T., McCluskey, M., 2006. Property Casualty Insurer Economic Capital using a VAR Model. The Society of Actuaries, Enterprise Risk Management Symposium Society of Actuaries, Chicago, IL, April 23-26, 2006.

Cummins, J.D., Doherty, N., Lo, A., 2002. Can insurers pay for the "big one"? Measuring the capacity of the insurance market to respond to catastrophic losses. Journal of Banking and Finance 26, 557-583.

Cummins, J.D., and O. Mahul (2009). Catastrophe Risk Financing in Developing Countries: Principles for Public Intervention. The World Bank. Washington, DC.

Cummins, J.D., Nini, G., 2000. Optimal Capital Utilization By Financial Firms: Evidence From the Property-Liability Insurance Industry. Journal of Financial Services Research 21, 15-53.

Global Climate Change Impacts in the United States 2009. United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

Gron, A., 1990. Property-casualty insurance cycles, capacity constraints, and empirical results, Ph.D. Thesis, Massachusetts Institute of Technology, Dept. of Economics.

Harrington, S.E., 2004. Tort Liability, Insurance Rates, and the Insurance Cycle. Brookings-Wharton Papers on Financial Services 2004, 97-138.

Harrington S.E., Nelson J.M., 1986. A Regression-Based Methodology for Solvency Surveillance in the Property-Liability Insurance Industry. Journal of Risk and Insurance 53(4), 583-605.

Insurance Information Institute. (I.I.I.) Online Insurance Fact Book 2013 <http://www.iii.org/factbook/> (visited February 19th, 2013).

Lamb R. P., 1995. An Exposure-Based Analysis of Property-Liability Insurer Stock Values around Hurricane Andrew, Journal of Risk and Insurance, 62(1), 111–23.

National Conference of Insurance Guaranty Funds (NCIGF) Facts and Statistics <http://www.ncigf.org/media-facts> (visited February 19th, 2013).

U.S. Department of Commerce. United States Census Bureau. <http://www.census.gov/geo/reference/ua/ualists_layout.html> (visited April 4th, 2013)

**Table 1**: Estimated Insured Property Losses, US Catastrophes, 2002-2011 (1)

| Year | Number of catastrophes | Number of claims (millions) | Dollars when occurred ($ billions) | In 2011 dollars (2) ($ billions) |
|---|---|---|---|---|
| 2002 | 25 | 1.8 | $5.90 | $7.20 |
| 2003 | 21 | 2.7 | $12.9 | $15.5 |
| 2004 | 22 | 3.4 | $27.5 | $32.2 |
| 2005 | 24 | 4.4 | $62.3 | $70.6 |
| 2006 | 31 | 2.3 | $9.2 | $10.1 |
| 2007 | 23 | 1.2 | $6.7 | $7.2 |
| 2008 | 36 | 4.1 | $27 | $28.2 |
| 2009 | 27 | 2.2 | $10.5 | $10.9 |
| 2010 | 33 | 2.4 | $14.3 | $14.6 |
| 2011 | 30 | 4.9 | $33.6 | $33.6 |

(1) Includes catastrophes causing insured property losses of at least $25 million in 1997 dollars and affecting a significant number of policyholders and insurers. Does not include losses covered by the federally administered National Flood Insurance Program.

(2) Adjusted for inflation through 2011 by ISO using the GDP implicit price deflator.

Source: The Property Claim Services (PCS) unit of ISO, Verisk Analytics company.

**Table 2**: Property and Casualty Insurance Insolvency List, 1975-2012

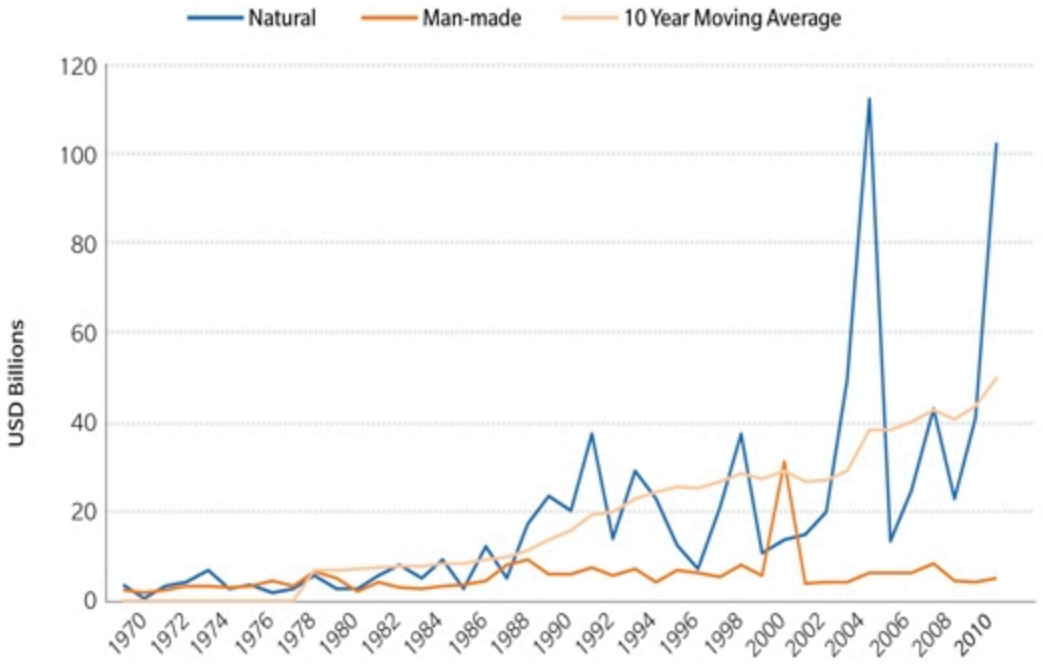
| Insolvent Company | Date of Insolvency | State of Insolvency |
|---|---|---|
| Medallion | September 12, 1975 | Missouri |
| Manchester | February 13, 1976 | Ohio |
| Yorktown | February 7, 1979 | Illinois |
| Reserve | May 7, 1979 | Illinois |
| Proprietors | August 5, 1981 | Ohio |
| Security Casualty | December 4, 1981 | Illinois |
| Gulf American | March 3, 1984 | Florida |
| Excalibur | September 5, 1984 | Texas |
| Aspen Indemnity | September 6, 1984 | Colorado |
| Horizon | January 11, 1985 | New York |
| Pacific American | January 23, 1985 | Delaware |
| Early American | February 1, 1985 | Alabama |
| Eastern Indemnity | February 1, 1985 | Maryland |
| Transit Casualty Company | February 3, 1985 | California |
| Ideal Mutual | February 7, 1985 | New York |
| Union Indemnity | July 16, 1985 | New York |
| Commercial Standard | October 4, 1985 | Texas |
| Carriers Insurance | January 16, 1986 | Iowa |
| Heritage | February 26, 1986 | Illinois |
| Lloyds of Louisiana | March 6, 1986 | Louisiana |
| American Fidelity Fire | March 14, 1986 | New York |
| Midland | April 3, 1986 | New York |
| American Druggists | April 30, 1986 | Ohio |
| Allied Fidelity Insurance | July 15, 1986 | Indiana |
| National Allied | October 31, 1986 | Texas |
| Enterprise | February 24, 1987 | California |
| Mission | February 24, 1987 | California |
| Mission National | February 24, 1987 | California |
| Integrity | March 25, 1987 | New Jersey |
| Reliable Insurance | January 29, 1988 | Ohio |
| American Guaranty & Accidental | February 26, 1988 | Louisiana |
| Great Global Assurance | April 27, 1988 | Arizona |
| American Excel | May 31, 1988 | Texas |
| Sunbelt Southern Lloyds | December 2, 1988 | Louisiana |
| South Central | January 5, 1989 | Louisiana |
| American Mutual Boston | March 9, 1989 | Massachusetts |
| American Mutual Liability | March 9, 1989 | Massachusetts |
| Anglo-American | March 20, 1989 | Louisiana |
| Champion | June 5, 1989 | Louisiana |
| Pacific Marine | June 7, 1989 | Washington |
| American Lloyds | June 21, 1989 | Louisiana |
| Paxton National | June 26, 1989 | Pennsylvania |
| New England International | September 22, 1989 | Louisiana |
| U.S. Indemnity Assurance | October 13, 1989 | Louisiana |
| Cadillac Insurance | January 2, 1990 | Michigan |
| Intercontinental | January 12, 1990 | Illinois |
| Laramie Insurance | February 14, 1990 | Wyoming |

| | | |
|---|---|---|
| Ohio General | March 28, 1990 | Ohio |
| Mid-American Casualty | November 7, 1990 | Illinois |
| Dixie Lloyds | December 20, 1990 | Louisiana |
| American Universal | January 7, 1991 | Illinois |
| Industrial Fire & Casualty | March 6, 1991 | Illinois |
| Western Employers | April 19, 1991 | California |
| Protective Casualty | May 24, 1991 | Missouri |
| Sovereign Fire & Casualty | May 29, 1991 | Louisiana |
| Imperial Lloyd's | August 8, 1991 | Louisiana |
| International Services | August 20, 1991 | Texas |
| Rockwood | August 26, 1991 | Pennsylvania |
| Fidelity Fire & Casualty | September 4, 1991 | Louisiana |
| Universal Security | October 28, 1991 | Tennessee |
| Old Hickory Casualty | October 31, 1991 | Louisiana |
| Presidential Fire & Casualty | November 13, 1991 | Louisiana |
| Comco Insurance | January 13, 1992 | Texas |
| Great Plains | March 4, 1992 | Nebraska |
| Southern American | March 26, 1992 | Utah |
| Colonial Lloyds | March 27, 1992 | Louisiana |
| Andrew Jackson General | April 6, 1992 | Mississippi |
| Arist Nat./Certified Lloyds | May 4, 1992 | Louisiana |
| North American Indemnity | May 26, 1992 | Louisiana |
| Alliance Casualty | June 19, 1992 | Louisiana |
| American Surety & Fidelity | July 8, 1992 | Louisiana |
| First Southern Insurance | October 31, 1992 | Florida |
| CAR/Automotive Casualty | January 20, 1993 | Louisiana |
| Pelican State Mutual | February 26, 1993 | Louisiana |
| Gulf Coast Casualty | April 2, 1993 | Louisiana |
| Magnolia Fire & Casualty | May 14, 1993 | Louisiana |
| ANA | May 17, 1993 | Louisiana |
| Liberty Lloyds | May 17, 1993 | Louisiana |
| Cascade | August 12, 1993 | Texas |
| MCA | October 21, 1993 | Oklahoma |
| Bonneville-Oregon | October 22, 1993 | Oregon |
| Employers Casualty | January 31, 1994 | Texas |
| Employers National | February 14, 1994 | Texas |
| Lloyds Assurance | June 21, 1994 | Louisiana |
| Premier Alliance | August 2, 1994 | California |
| Commonwealth General | September 1, 1995 | Missouri |
| United Community Insurance Corp. | November 10, 1995 | New York |
| Lutheran Benevolent | December 2, 1996 | Missouri |
| Merit Casualty | April 1, 1997 | Illinois |
| Insurance Corporation of America (ICA) | April 28, 1997 | Texas |
| United Southern Assurance | September 18, 1997 | Florida |
| U.S. Capital Insurance | November 20, 1997 | New York |
| American Eagle | December 22, 1997 | Texas |
| Pinnacle | September 20, 1999 | Georgia |
| Hamilton | August 3, 2000 | Pennsylvania |
| California Compensation | September 26, 2000 | California |
| Commercial Compensation | September 26, 2000 | California |

| | | |
|---|---|---|
| Superior National | September 26, 2000 | California |
| Credit General | January 5, 2001 | Ohio |
| Acceleration National in Liquidation | February 28, 2001 | Ohio |
| Reliance | October 3, 2001 | Pennsylvania |
| Savant | November 7, 2001 | Louisiana |
| Far West | November 9, 2001 | Nebraska |
| PHICO | February 1, 2002 | Pennsylvania |
| United Agents | March 3, 2002 | Louisiana |
| Petrosurance Casualty | March 14, 2002 | Oklahoma |
| Patterson Insurance Co. | March 17, 2003 | Louisiana |
| Millers | March 24, 2003 | Texas |
| Home | June 13, 2003 | New Hampshire |
| Reciprocal of America | June 20, 2003 | Virginia |
| Fremont Indemnity Co. | July 2, 2003 | California |
| Legion Insurance Co. | July 28, 2003 | Pennsylvania |
| Villanova Insurance Company | July 28, 2003 | Pennsylvania |
| Commercial Casualty Ins. Co. of N.C. | April 2, 2004 | North Carolina |
| Casualty Reciprocal Exchange/EMIC | August 18, 2004 | Missouri |
| South Carolina Ins Company/CAIC | March 21, 2005 | South Carolina |
| Realm Insurance Company | June 10, 2005 | New York |
| Vesta Insurance Company | August 1, 2006 | Texas |
| Park Avenue Property and Casualty Insurance Company | November 18, 2009 | Oklahoma |
| Imperial Casualty and Indemnity Company | May 12, 2010 | Oklahoma |

Source: National Conference of Insurance Guaranty Fund (NCIGF)

**Graph 1**: Global Catastrophe Insured Losses 1970-2011




Source: Swiss Re, Guy Carpenter & Company, LLC.

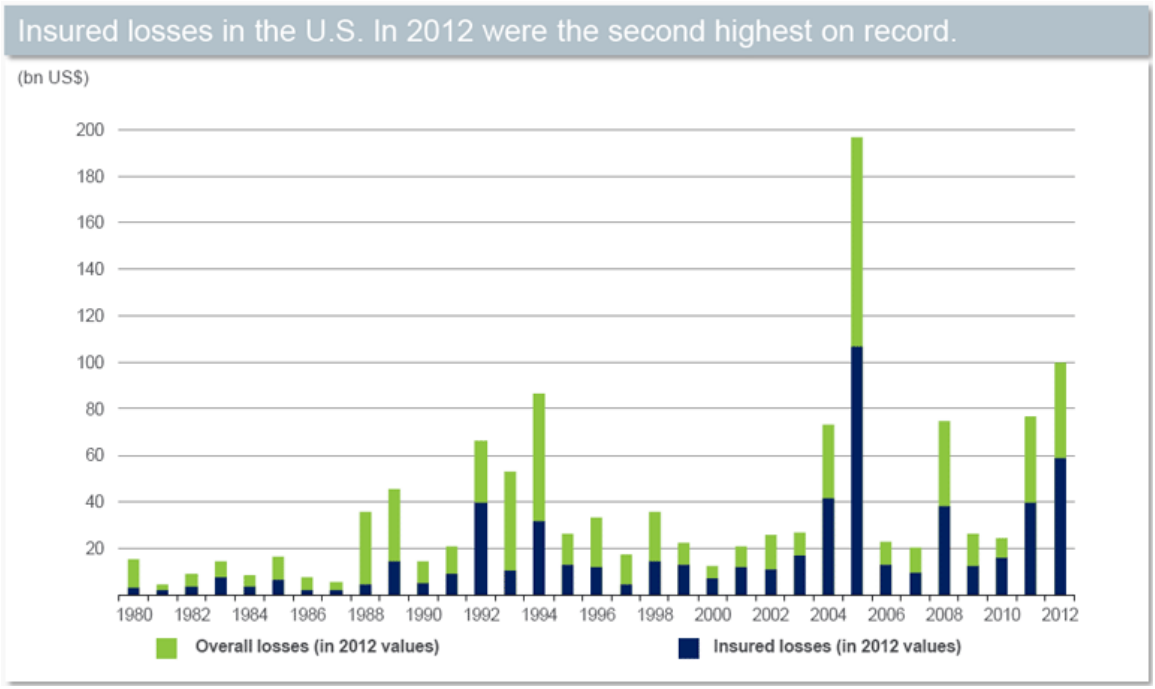
**Table 3**: Property and Casualty Insurance Industry Income Analysis 2007-2011 ($billions) (1)

| | **2007** | **2008** | **2009** | **2010** | **2011** |
|---|---|---|---|---|---|
| Net written premiums | $440.60 | $434.90 | $418.40 | $423.80 | $437.60 |
| Percent change | **-0.60%** | **-1.30%** | **-3.80%** | **1.30%** | **3.30%** |
| Earned premiums | $438.90 | $438.30 | $422.30 | $422.20 | $433.90 |
| Losses incurred | 244.7 | 286.3 | 253.8 | 257.7 | 290.8 |
| Loss adjustment expenses incurred | 52.3 | 51.7 | 52.5 | 52.9 | 53.7 |
| Other underwriting expenses | 120.1 | 119.6 | 117 | 119.8 | 124.1 |
| Policyholder dividends | 2.4 | 2 | 2 | 2.3 | 1.8 |
| Underwriting gain/loss | 19.3 | -21.2 | -3 | -10.5 | -36.5 |
| Investment income | 55.1 | 51.5 | 47.1 | 47.6 | 49 |
| Miscellaneous income/loss | -1 | 0.4 | 0.9 | 1.1 | 2.3 |
| Operating income/loss | 73.4 | 30.6 | 45 | 38.2 | 14.8 |
| Realized capital gain/loss | 8.9 | -19.8 | -7.9 | 5.9 | 7.2 |
| Income taxes/credit | 19.8 | 7.8 | 8.4 | 8.8 | 2.9 |
| Net income after taxes | 62.5 | 3 | 28.7 | 35.2 | 19.1 |

(1) Data in this chart exclude state funds and other residual market insurers and may not agree with similar data shown elsewhere from different sources.

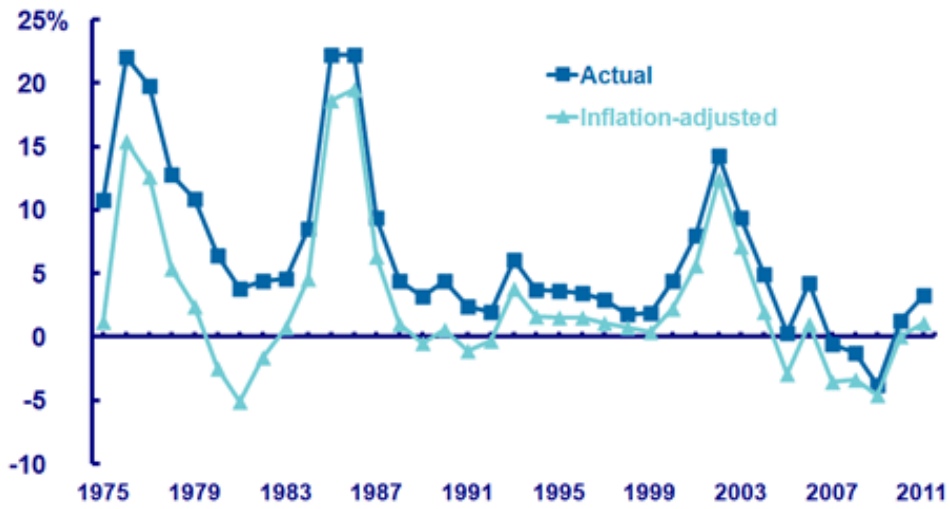
Source: ISO, Verisk Analytics company

**Graph 2**: Insured Losses in the US, 1980-2012



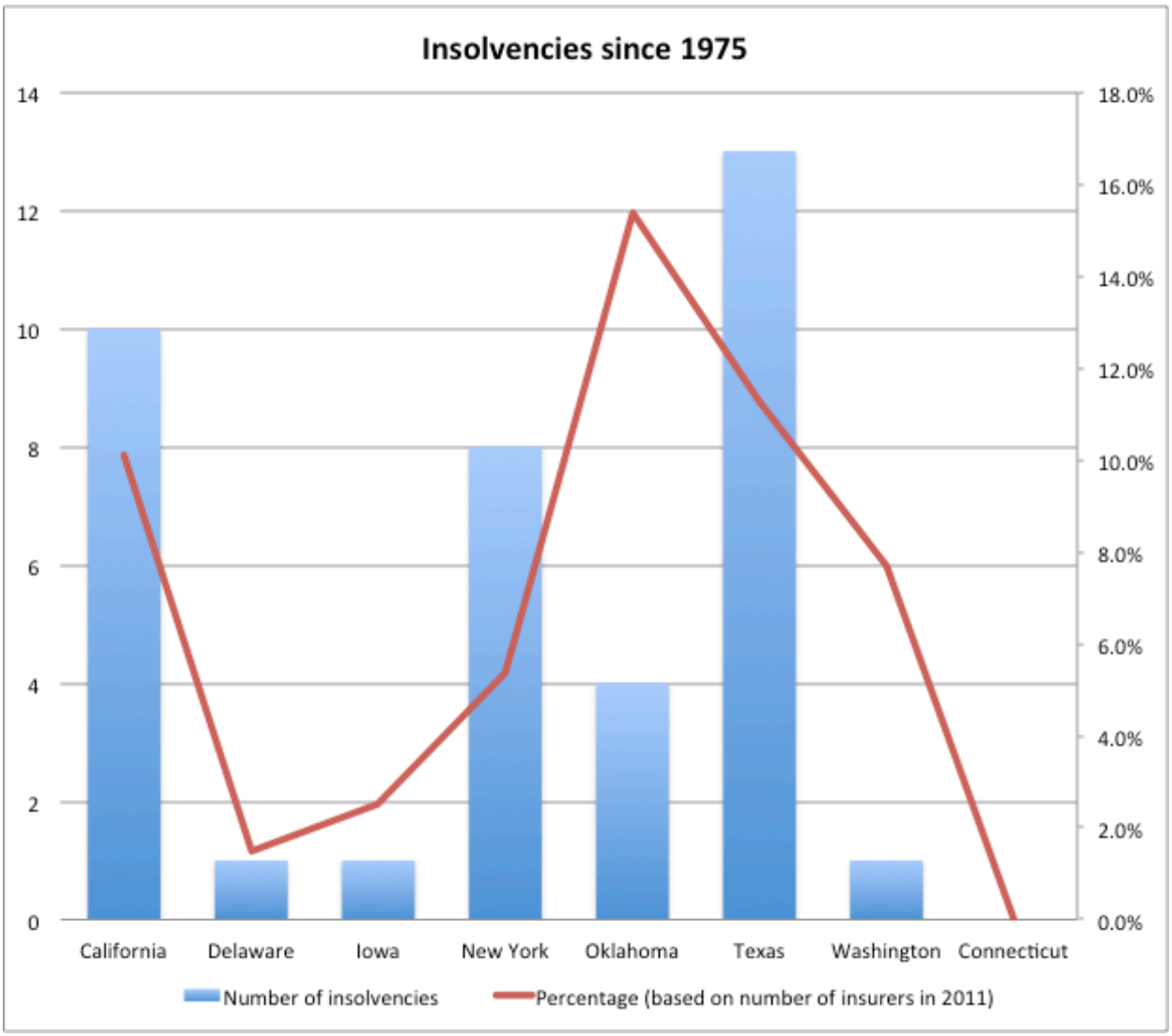

Source: © 2012 Munich Re, NatCatSERVICE; The Property Claim Services (PCS) unit of ISO.

**Graph 3**: Net Premiums Written Percent Change From Prior Year, 1975-2011



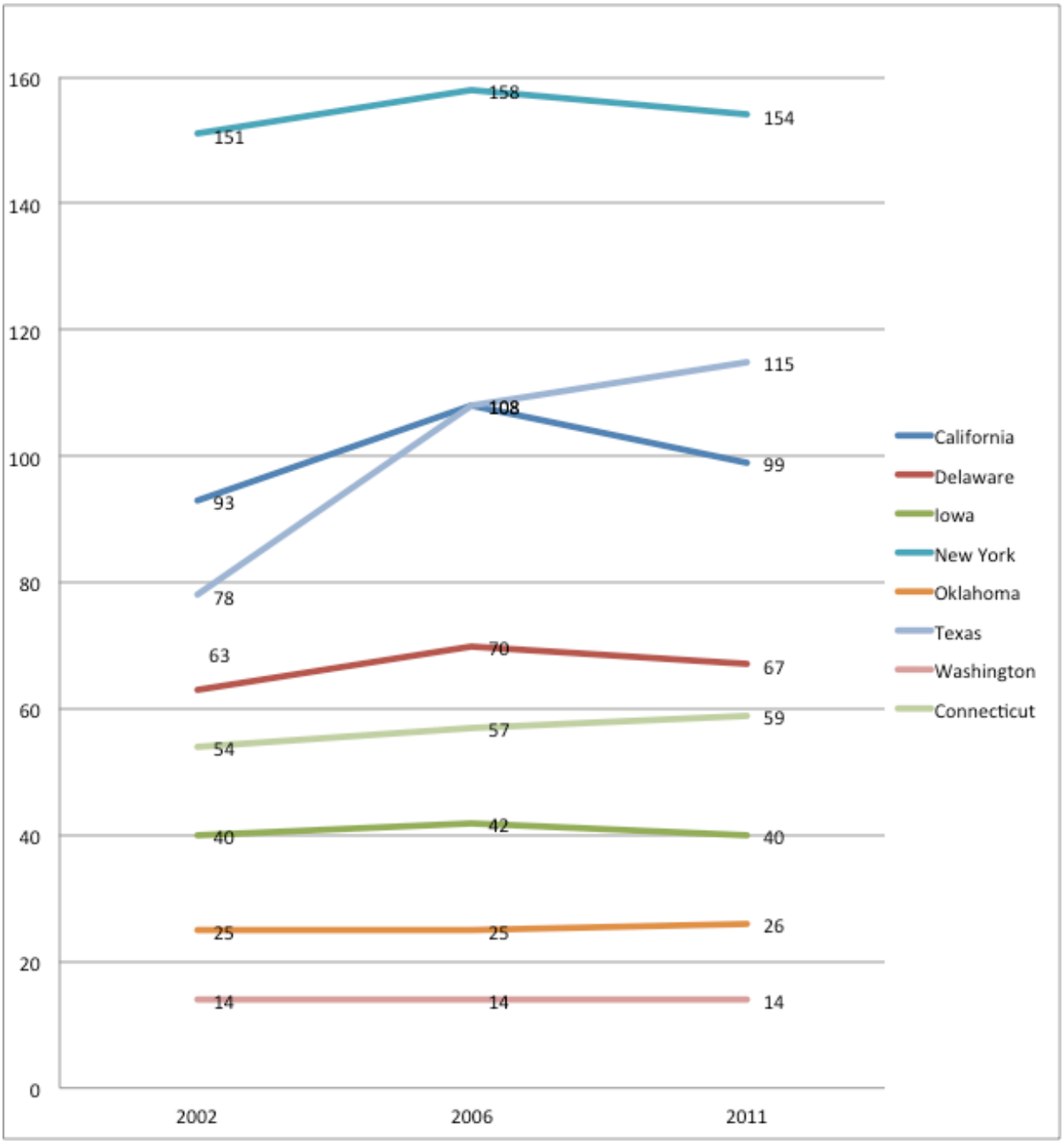

Source: ISO, Verisk Analytics company.

**Graph 4**: Number and Percentage of Property and Casualty Insurer Insolvencies Since 1975




Source: The National Conference of Insurance Guaranty Fund (NCIGF)

**Graph 5**: Number of Property and Casualty Insurers in 2002, 2006, and 2011




Source: The National Association of Insurance Commissioners (NAIC)

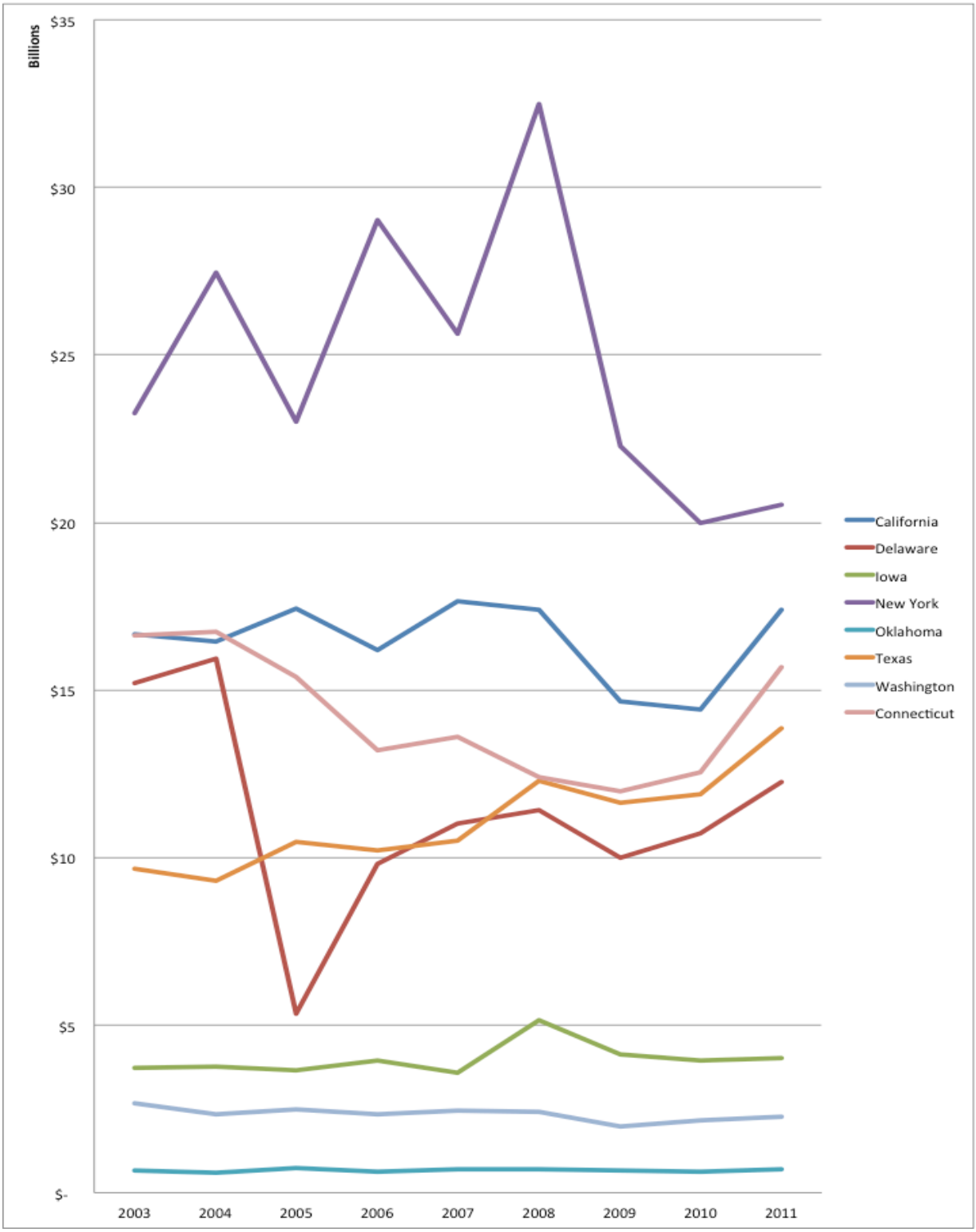
**Table 4**: The 10 Most Costly Catastrophes, United States (1) ($ millions)

| | | | Estimated Insured Property Losses | |
|---|---|---|---|---|
| Rank | Date | Peril | Dollars when occurred | In 2011 dollars (2) |
| 1 | Aug. 2005 | Hurricane Katrina | $41,100 | $46,591 |
| 2 | Sep. 2001 | Fire, explosion: World Trade Center, Pentagon terrorist attacks | $18,779 | $23,463 |
| 3 | Aug. 1992 | Hurricane Andrew | $15,500 | $22,939 |
| 4 | Jan. 1994 | Northridge, CA earthquake | $12,500 | $17,726 |
| 5 | Sep. 2008 | Hurricane Ike | $12,500 | $13,050 |
| 6 | Oct. 2005 | Hurricane Wilma | $10,300 | $11,676 |
| 7 | Aug. 2004 | Hurricane Charley | $7,475 | $8,755 |
| 8 | Sep. 2004 | Hurricane Ivan | $7,110 | $8,327 |
| 9 | Apr. 2011 | Flooding, hail and wind including The tornados that struck Tuscaloosa, AL and other locations | $7,300 | $7,300 |
| 10 | May 2011 | Flooding, hail and wind including the tornados that struck Joplin, MO and other locations | $6,900 | $6,900 |

(1) Property coverage only. Does not include flood damage covered by the federally administered National Flood Insurance Program.
(2) Adjusted for inflation through 2011 by ISO using the GDP implicit price deflator.

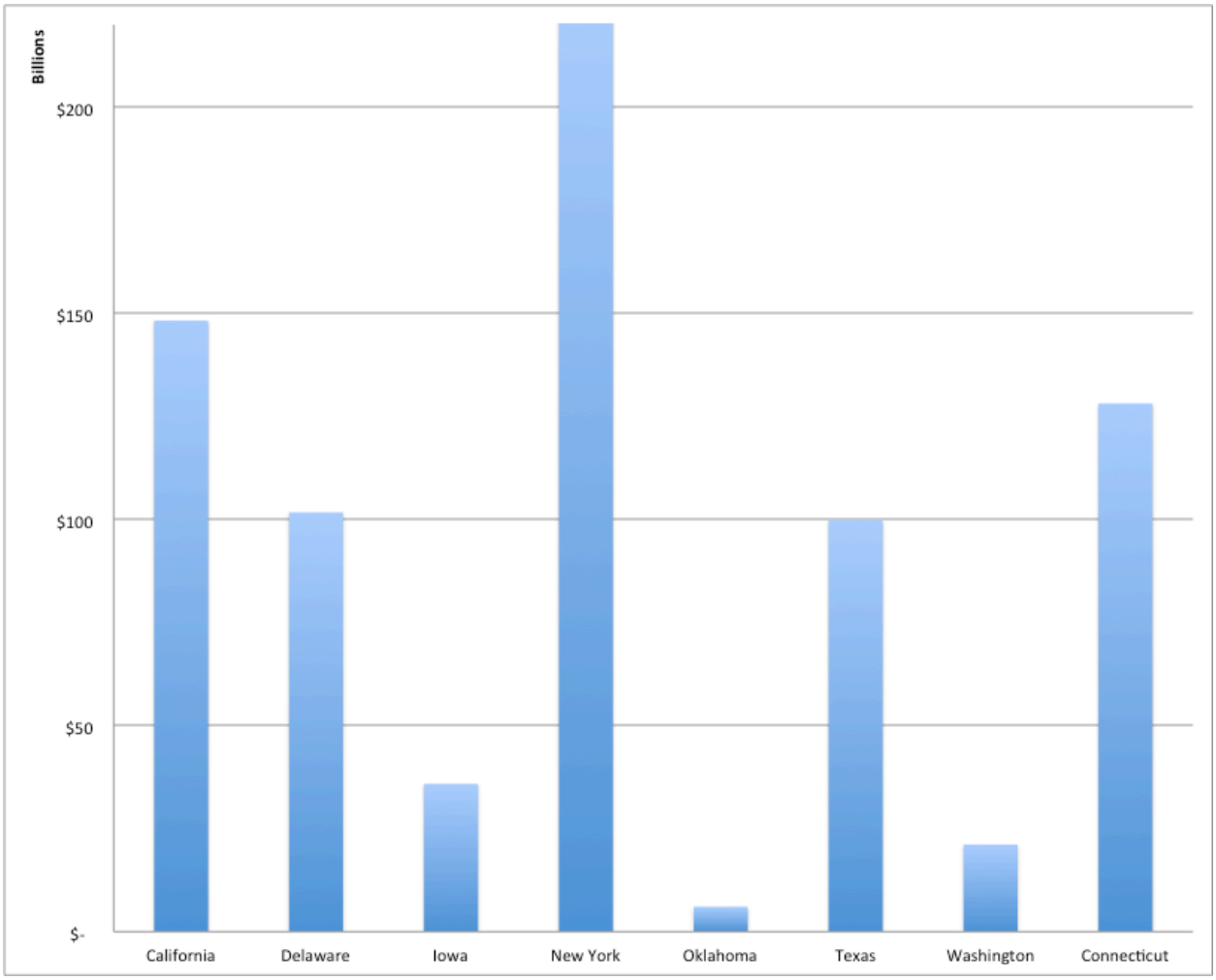
Source: The Property Claim Services (PCS) unit of ISO, Verisk Analytics company

**Graph 6**: Annual Losses Incurred, 2003-2011 (in 2011 USD)



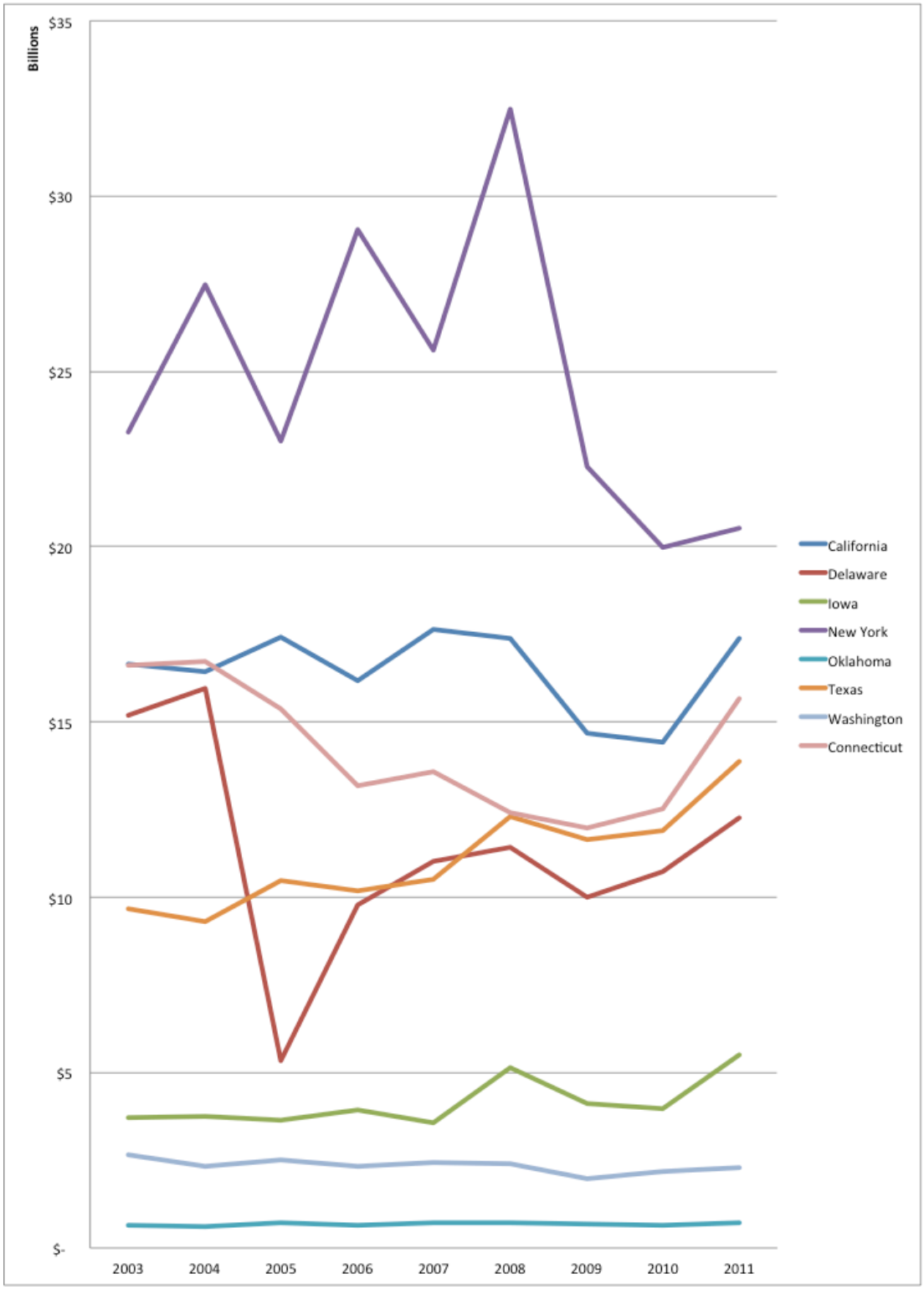

Source: The National Association of Insurance Commissioners (NAIC)

**Graph 7**: Total Losses Incurred between 2003 and 2011 (in 2011 USD)




Source: The National Association of Insurance Commissioners (NAIC)

**Graph 8**: Annual Policyholder's Surplus, 2002-2011 (in 2011 USD)



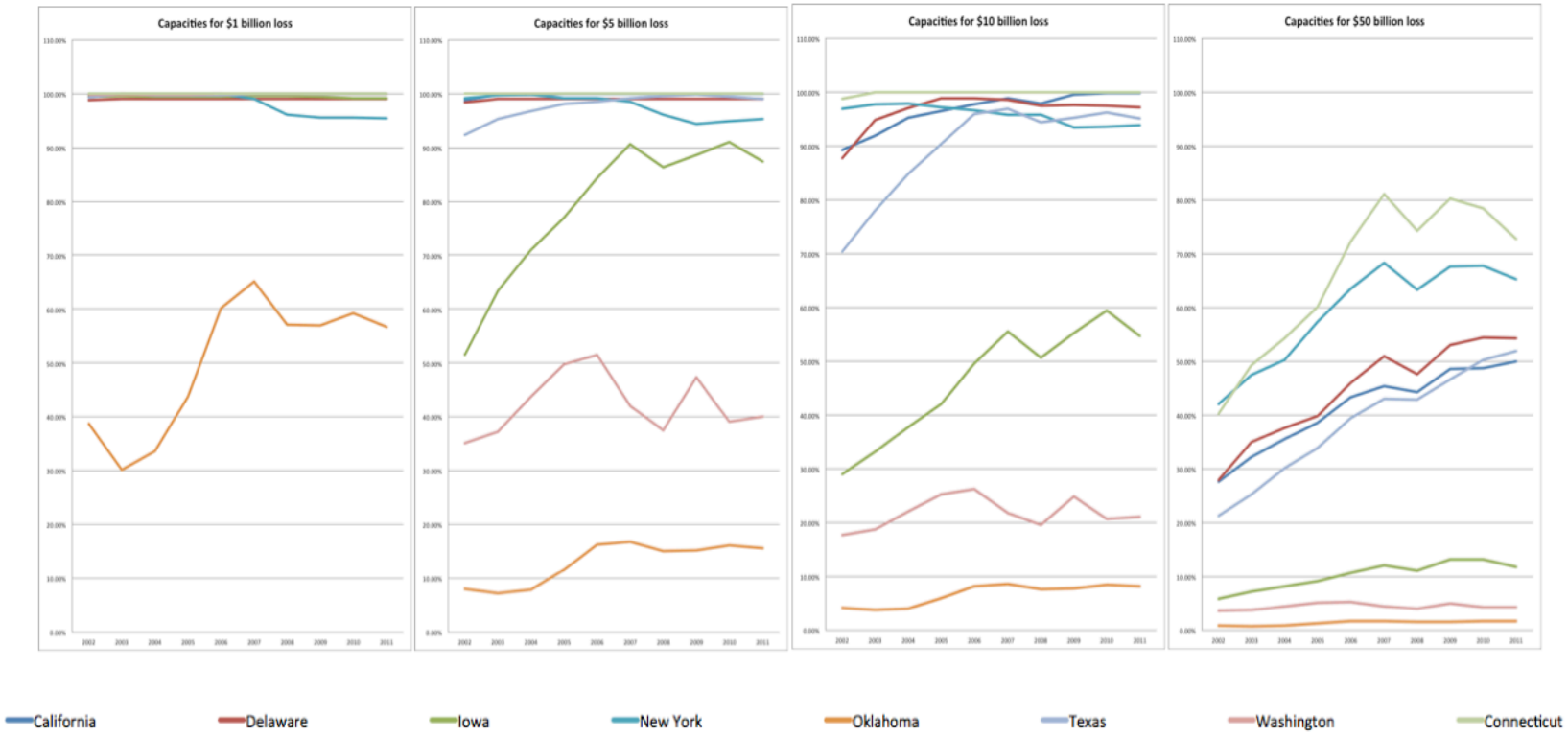

Source: The National Association of Insurance Commissioners (NAIC)

**Table 5**: Market Capacities of 2011 for Catastrophic Losses

| Magnitude of Catastrophe | California | Delaware | Iowa | New York | Oklahoma | Texas | Washington | Connecticut |
|---|---|---|---|---|---|---|---|---|
| $ 1 billion | 100.00% | 98.97% | 99.12% | 95.41% | 56.76% | 99.93% | 100.00% | 100.00% |
| $ 5 billion | 99.96% | 98.96% | 87.40% | 95.32% | 15.65% | 98.95% | 40.02% | 100.00% |
| $10 billion | 99.85% | 97.19% | 54.73% | 93.88% | 8.30% | 95.15% | 21.14% | 99.98% |
| $50 billion | 50.02% | 54.27% | 11.88% | 65.21% | 1.66% | 51.89% | 4.32% | 72.74% |

Source: The National Association of Insurance Commissioners (NAIC)

**Graph 9**: Capacities for 1 billion, 5 billion, 10 billion, and 50 billion Dollar Catastrophes between 2002 and 2011




Source: NAIC