TWO ESSAYS IN FINANCE:
MARKET RESPONSE TO CATASTROPHIC EVENTS ON THE INSURANCE INDUSTRY
AND
RETURN ON INVESTMENT OF A LAND GRANT UNIVERSITY

by

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ABSTRACT

TWO ESSAYS IN FINANCE:

MARKET RESPONSE TO CATASTROPHIC LOSSES ON THE INSURANCE INDUSTRY
AND
RETURN ON INVESTMENT OF THE UNIVERSITY OF ILLINOIS TO THE
STATE OF ILLINOIS TREASURY

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Based on data on publicly traded insurance firms, the first essay examines questions about the effect of large catastrophic events on insurance firms. Rather than looking at a single event, thirty catastrophic events were aggregated into quintiles and the cumulative abnormal returns around these events were found to be significantly positive over a 25 day trading window. There is no significant evidence that post-catastrophic stock returns are correlated to the magnitude of the catastrophe.

The second essay analyzes the effect of a large land grant university, the University of Illinois, on the State Treasury of Illinois. If the State Treasury were acting as its own agent trying to maximize revenues, would it choose higher education as an investment versus other alternative investments. While it is true the State makes large expenditures for the operations of the University, it is also true that individuals receiving degrees on average receive higher incomes. Taxes or higher incomes offset the cost of operating the University. The study is broken out by the level of student: undergraduate, masters, doctorate, medical professional, and by function of the University. It was found that all levels of education have a positive return not only for the individual, but also for the State Treasury. This is in excess of any non-pecuniary benefits to the State of having a better educated population, or the local taxation effects on the county or city where the campus is located. These returns are found to be higher than other types of investments.

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CHAPTER I

MARKET RESPONSE TO CATASTROPHIC LOSSES ON THE INSURANCE INDUSTRY

I. Introduction

Over the last thirty years the property liability insurance industry has suffered tens of billions of dollars in losses due to catastrophic events such as hurricanes, wind, hail, tornadoes, freezing rains, and earthquakes, as well as damage caused during urban rioting. Because of their size, catastrophes present unique problems for the insurance industry and require special consideration. For example, Hurricane Andrew caused more than $20 billion in property damage and bankrupted seven insurance firms. This paper attempts to measure the impact and predictability of catastrophic events on property-liability equities.

The stock market's reaction to a devastating event such as Hurricane Andrew is hardly supportive of the view that catastrophes are injurious to the insurance industry; preliminary indices have property liability insurance stock prices rising dramatically in the weeks following the hurricane. Shelor, Anderson and Cross (1992) report similar stock market behavior in the aftermath of the Loma Prieta earthquake that rocked the Bay area of California in 1989. These counter-intuitive findings motivate the following questions to be discussed in this paper: Does the stock market generally turn bullish on property casualty stocks following a catastrophe, or was the 1989 California earthquake an atypical event? Is there something special about very large catastrophes that effects insurance stock returns. Do the largest catastrophes have different post-catastrophe stock return behavior than those of smaller magnitude? Are all insurance companies affected in the same way by catastrophic events? Are there institutional factors that may explain this phenomenon?

To help answer these questions we examined a sample of 30 catastrophic events from 1964 through 1992. We find that there are significant positive cumulative abnormal returns out to the 25 trading day window of 1.09%, with a standard error of 0.26%. The sample is then broken into five groups based on the size of the loss (pay-outs adjusted to 1991 dollars.) We do not find a significant correlation between the quintile event size and excess returns. Finally, we ran a cross-sectional regression in order to explain the variation in cumulative abnormal returns in the aftermath of a catastrophe. The results indicate that insurers with a heavy concentration of policies underwritten in a catastrophe affected region have (weak) *positive* excess returns relative to other insurers, and that reinsurers significantly outperform the rest of the industry following a catastrophe.

The study is organized as follows. Section II provides background on previous research in the area of the effects of catastrophic losses on firm value, discusses the ways that insurance firms differ from non-insurance firms and states testable hypotheses. Section III describes the data and event study methodology used in the testing of the hypotheses developed in the previous section. Section IV presents the results. The paper concludes with a summary and a suggestion for future research in Section V.

II. Background

A. *Previous Research*:

The exposure to the risk of catastrophic loss is an important concern for risk managers of non-insurance firms. Studies by Sprecher and Pertl (1983) and Davidson, Chandy and Cross (1987) find that large unforeseen losses due to acts of nature and airline disasters, are quickly incorporated into stock prices with significant negative returns. But when insurance companies are faced with large losses due to catastrophes there is anecdotal evidence that they outperform the market. The stock market reaction following Hurricane Andrew is a striking example. Chart 1.1.1 shows the BI Insurance Index[1] of insurance stocks around the time of Hurricane Andrew. The BI Insurance Index rose from 805 during the

1 The BI Insurance Index is obtained from Business Insurance, various issues, July-November, 1992.

week that Andrew hit land to 883.5 two months later, a nine week growth of almost 10%. In this same period the S & P 500 only advanced 2%. Another example is provided by Shelor, Anderson and Cross (1992) who find that the portfolio of insurance stocks they use in their study experience a 2% cumulative abnormal return over the three weeks following the 1989 California earthquake.

Shelor, Anderson and Cross provide an analysis of the impact of catastrophic losses on insurance stock prices due to an earthquake. However, this study suffers from at least two significant shortcomings. First, the Shelor, Anderson and Cross study only looks at one event: the 1989 Loma Prieta Fault earthquake. The returns around the single event may be contaminated by other major economic factors that may confound insurance stock price reactions to the earthquake with the stock price reactions to the other events. For example, two days after the earthquake the stock market suffered its fifth largest one day price drop in its history. The Federal Reserve rushed in to ease credit and lower interest rates in order to stave off a repeat of "Black Monday" which happened just two years prior. It may be argued that because the assets of insurance companies are relatively more concentrated in interest rate sensitive instruments than in the case for the majority of other firms in the stock market, when the Federal Reserve acts to cut interest rates insurance firms may benefit from the action more than the stock market as a whole. So one may ask whether the 2% cumulative abnormal returns are the result of the earthquake or the actions of the Federal Reserve's efforts to reduce interest rates. Second, they ignore larger non-earthquake catastrophes. The advantage of examining stock price reactions around an earthquake is that the event is unanticipated so there are no informational leakages that might be present in other catastrophic events. In contrast, hurricanes can be tracked for days before any land damage occurs. By the time the hurricane does hit land this information may be old news on the stock market. Avoiding the problem of informational leakages is most important when the day 0, 1 event window is examined, as is done in the cross-sectional studies done in Shelor, Anderson and Cross (1992). But for longer windows, assuming that it takes time for the market to fully assimilate the effects of a catastrophic event on stock prices, it matters less that there is not a clear day 0 event date. In our study we look at longer windows.

The most recent event related article is by Lamb (1995), which examined insurer stock values around one of the largest disasters, Hurricane Andrew. The author of this paper found that insurance firms with large underwriting exposures in states affected by this hurricane had negative cumulative average returns. This study also was a single event study.

The main contribution of this paper is that it looks at 30 events from 1964 through 1992 rather than a single event. We include six events with losses greater than those suffered during the 1989 earthquake. The sample also gives us 681 observations around the events so that we may study the cross-sectional variation of excess returns. We regress cumulative abnormal returns against (a) the 1991 dollar value of insured losses caused by the event; (b) a measure of an insurer's regional concentration of policies written in areas high by catastrophes; and (c) a dummy variable indicating whether a firm is a reinsurer or not.[2]

B. *What Makes Insurance Companies Different from Non-insurance companies*?

In this section we look at possible factors that may explain in what ways catastrophic events may be of some benefit to property casualty insurers. First, consumer psychology may result in an increased demand for insurance. Large catastrophic losses may increase consumer awareness for the need for insurance and hence increase consumer demand for insurance. Shelor, Anderson and Cross (1992) suggest this awareness/demand hypothesis as a potential explanation for the insurance stock performance following the 1989 earthquake. The hypothesis receives some support from Kunreuther, *et.al.*, (1978) who find that consumers have a greater demand for flood insurance after they have experienced a flood,

2 We also regress excess returns against time for reasons discussed in Section III.

or personally know someone else who has had such an experience. However, it seems unlikely that Hurricane Andrew significantly increased the awareness of the need for property casualty insurance for Florida residents--at least to the extent necessary to offset the astounding loss pay-outs caused by the storm. Hurricanes develop every year and are followed by local weather people on the local nightly news. Earthquakes in the San Francisco Bay area are not uncommon events.

The second factor considers the industrial organization of the property casualty insurance industry. When a catastrophe is large enough to have a significant impact on the insurance industry as a group, the event may cause insurers to temporarily retreat from cut-throat competition and allow premium rates to rise. The property casualty insurance industry has long been prone to cycles in underwriting profit margins. Substantial underwriting profits encourage other firms to enter into the market. Competition for market share is fierce, resulting in price competition, eventually bringing about underwriting losses which must be financed from investment income and, for the poorer performers, the liquidation of surplus reserves. Poor performers are eventually forced to exit from the market, allowing prices to rise again. Catastrophes may work to accelerate this process by forcing out the weak firms immediately.

A third factor is based on regulatory constraints and liquidity effects. The stronger firms within the industry are more likely to be the larger public stock issuing firms. Smaller mutual firms may be quite sensitive to catastrophes, but since they do not have publicly traded equity their misfortunes will not be observed. It might be the case that the total property casualty industry is a *net loser* when catastrophes hit, but that large stock companies gain at the expense of smaller non-traded firms. Small insurers are hit hard in two ways: (1) these insurers tend to have a more geographically concentrated market base; and, (2) statutory accounting requirements limit the amount by which these insurers can dip into their surplus assets to pay off their claims. We hypothesize that these two factors make small, geographically concentrated insurers more negatively affected by catastrophic losses than their larger counterparts.

The statutory accounting requirement of maintaining an "unearned premium reserve" account limits the amount of surplus assets an insurer can use in paying off claims. The unearned premium reserve account is a liability to the insurer designed to assure that the insurer would always have enough reserves to cover canceled policies. The full amount of the premium from the sale of a policy must be put into the unearned premium reserve account. This amount is reduced and credited to earnings as the policy period progresses toward its expiration date. To balance the unearned premium reserve account an insurer must transfer funds from other accounts, typically from surplus reserves.[3] When the insurer does this, these surplus reserves cannot be used to cover loss payments on claims. When faced with large claim losses these insurers can become illiquid. Strapped for sources of funds these firms may resort to entering into a reinsurance contract in order to obtain liquid capital.

Reinsuring increases liquidity in two ways. First, the unearned premium reserve is, in effect, transferred to the reinsurer which enables the insurer to free up the surplus reserves it formerly had locked into the unearned premium reserve account. Second, the insurer receives a "ceding" commission from the reinsurer that reimburses the primary insurer for all or part of the costs that were expended in order to issue the policy. This ceding commission is in cash which increases surplus reserves immediately. But when the insurer is in distress they might be forced into accepting a low ceding commission. In this way, insurers with deep pockets can exploit the liquidity crises that smaller firms face in the event of catastrophic losses.

In conclusion, property casualty insurance companies are affected by catastrophic events in more complex ways than most non-insurance firms. While large insured losses contribute to reduction in an

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3 See Reinsurance Fundamentals and New Challenges, 2nd ed., published by the Insurance Information Institute for more details on the unearned premium reserve account requirements, pp. 15-17.

insurer's net worth, catastrophes may also present them with profit opportunities. In this way the insurance industry is like the construction industry. For example, a Florida construction firm may have suffered severe property and equipment losses due to Hurricane Andrew, but they also have tremendous opportunities for revenue generation as they are hired to rebuild the razed properties within their community. Property casualty insurers also have profit opportunities available to them after a catastrophe, particularly the larger firms with deep pockets who can profit at the expense of smaller liquidity-starved insurers. A subset of these deep-pocket firms are the actively traded public stock companies used in the present event study, and also in the event study conducted by Shelor, Anderson and Cross (1992), and Lamb (1995). Hence, any observed post-catastrophe superior price performance of insurance stocks may be an indication of a wealth transfer between big and small insurers rather than an indication that catastrophes are beneficial to the industry as a whole.

C. *Testable Hypotheses:*

The purpose of the preceding discussion is to provide plausible explanations as to *why* insurance stock might increase in value in the wake of a catastrophe. In this section, and in the remainder of the paper, we focus our attention on trying to determine how insurance stocks perform compared to the market, and how different types of insurers react to these events. Specifically, we seek answers to following questions:

Q1: Does the stock market generally turn bullish on property casualty stocks following catastrophes, or are Hurricane Andrew and the 1989 California earthquake atypical events?

Q2: Is there a catastrophic size effect whereby the very largest catastrophes have different post-catastrophe stock return behavior than the smaller catastrophes?

Q3: Are firms with highly concentrated underwritings in the areas hit by catastrophic events more likely to perform poorly after a catastrophe?

Q4: Do the stock prices of all insurers respond the same way, or are reinsurers more likely to perform better than other insurers following a catastrophe?

In order to answer the first question we constructed a portfolio of property casualty insurers, and looked at market model adjusted returns around catastrophic events. We are primarily concerned with testing whether stock prices have positive abnormal returns. The null hypothesis we seek to reject is:

$$H_0^1: \textit{the average cumulative abnormal return for insurance stocks is } \leq \textit{ zero.}$$

Question 1, 2, 3, and 4 will be tested using the following regression:

$$CAR_{ieT} = \alpha_0 + \alpha_1 TIME_{ie} + \alpha_2 \$DAMAGE_{ie} + \alpha_3 CONC_{ie} + \alpha_4 REINSURE_{ie} + \varepsilon_{ie} \qquad (1)$$

where,

CAR_{ieT}= cumulative abnormal return of firm i during event e from event day 0 through T;

$TIME_{ie}$= time trend;

$\$DAMAGE_{ie}$= estimated loss payments in 1991 dollars;

$CONC_{ie}$= variable indicating high concentration of underwriting in the region hit by a catastrophe; and

$REINSURE_{ie}$= variable indicating that firm i is primarily a reinsurance firm.

Question 2 is motivated by the post-earthquake stock returns reported by Shelor, Anderson and Cross (1992) and by the post-Andrew stock performance illustrated in Figure 1. We want to know if the same stock market behavior follows after catastrophes of significant but smaller magnitudes. The coefficient of the $DAMAGE variable in (1) is intended to pick up a catastrophe-magnitude effect. We have no prior expectations on the sign of the coefficient so our null hypothesis is:

$$H_0^2: \ \alpha_2 = 0.$$

Question 3 is motivated by the hypothesis that deep-pocket insurers gain at the expense of liquidity-constrained firms that are hit with large losses relative to their surplus reserves. This hypothesis predicts that firms who have a high concentration of their underwritten policies in an area that is hit by a catastrophe will underperform other insurers in the industry. A negative coefficient on the CONC variable in (1) is consistent with this story, thus we have the following null hypothesis concerning concentration variable:

$$H_0^3: \ \alpha_3 > 0.$$

This same story also predicts that reinsurers have superior performance relative to other insurers following catastrophes. So we expect the coefficient for REINSURE in (1) to be positive, which we will test against the following null hypotheses:

$$H_0^4: \ \alpha_4 \leq 0.$$

The next section provides the data and methodology used in the stock return analysis of the four testable hypotheses presented above. The results of these tests are presented in Section IV.

III. Data and Methodology

A. *The Data:*

From Property Claim Services[4] we obtained catastrophic loss data for the insurance industry from January 1, 1964 to December 31, 1992. Following D'Arcy and France (1992) we inflated the data using the Consumer Price Index (All Urban Consumers) published in the U.S. Bureau of Labor Statistics. Table 1.1.1 shows the sample of 30 catastrophic events used in this study, along with the estimated loss payments, both nominal and real (in 1992 dollars). These events are the top 30 catastrophes in terms of real estimated losses in which the catastrophe spanned fewer than 5 trading days. Not shown in Table 1 is the data of which states were affected by each catastrophe, but this data are also available from Property Claim Services. The day zero event date for non-hurricane catastrophes is the first calendar date in which the event took place. There are twelve hurricanes in the sample and 10 of the top 14 catastrophes are hurricanes. Because hurricanes can be tracked with a fair amount of accuracy, we expect that there is significant information leakage prior to the hurricane's hitting land. For this reason we treat the day zero event day for hurricanes as being two calendar days before they hit land.

The insurance firms used in this study are the 52 firms listed on the Center for Research in Security Prices (CRSP) New York Stock Exchange, American Stock Exchange, and NASDAQ daily stock return data file which have a primary industry code of 6331 (fire, marine, and casualty insurers). We do not include multi-line firms. Data on regional underwriting concentration is obtained from *Best's Insurance Reports--Property Casualty* from 1964 through 1991. *Best's* provides information on the percentage of an insurer's total underwriting done in each state. If a firm *i* has 40% or more of their business concentrated in an affected area during a particular event *e* then the variable, CONC, is given

4 Special thanks to Professor Virginia France at the University of Illinois for help obtaining the data.

the value of 1; otherwise it is zero. There are also three primary reinsurers in our sample, and they are given a value of 1 in the REINSURE variable. All other firms receive a zero value. The subscripts, *ie*, refers to firm *i* during event *e*. Each *ie* is one observation which will be referred to as a firm-event. Not every insurer has return data available during all 30 events, but if they did there would be 1560 firm-event observations (52 firms x 30 events). From this we have a sample of 681 firm-events, or an average of 23 firms with returns during each event.

B. *Event Study Methodology*:

The first part of the stock return analysis consists of calculating abnormal returns around catastrophic events. In our analysis we derive and compare two measures of cumulative abnormal returns. The first measure is the Inverse-Variance Weighted Cumulative Abnormal Return (IVWCAR) used by Shelor, Anderson and Cross (1992).[5] With this method, observations with relatively low variances are more reliable and are weighted more heavily, and, hence play a greater role in the estimation of abnormal returns. A second measure of abnormal returns is the Standardized Cumulative Abnormal Return (SCAR) which is discussed later.

The IVWCAR is calculated as follows: First, the abnormal return on event day *t* (AR_{iet}) is calculated for each firm-event, ie, using market model adjusted returns and is defined as:

$$AR_{iet} = R_{iet} - (a_{ie} + b_{ie} R_{met}) \qquad (2)$$

5 The merits of different event-study weighing schemes is presented in Chandra and Balachandran (1990). If market adjusted abnormal returns are independent, then the inverse-variance weighted portfolio provides the minimum possible portfolio. Even when there is some correlation between abnormal returns, Chandra and Balachandran find this method is proficient in picking up abnormal returns.

where R_{iet} is the observed return on stock *i* during event *e* event day *t*; a_{ie} and b_{ie} are determined from the market model regression on 100 return observation from event day *t* = -125 though -26, with

R_{met} = the CRSP equally weighted market index;

a_{ie} = estimated market model intercept for firm *i*, event *e; and*

b_{ie} = estimated market model slope for firm *i*, event *e*.

Next a portfolio of abnormal returns is formed using the inverse-variance weighing technique. Portfolio abnormal return around event day *t* (AR_{pt}) is:

$$AR_{pt} = \sum_{ie=1}^{681} W_{ie} \, AR_{iet} \tag{3}$$

such that,

$$w_{ie} = \frac{S_{fiet}^{-2}}{\sum_{ie=1}^{681} S_{fiet}^{-2}} \tag{4}$$

where,

$$s_{fiet} = s_{ie}\left\{1 + 1/100 + \frac{\left[R_{met} - R_{me}\right]}{MSER_{me}}\right\}^{1/2}, \tag{5}$$

s_{ie} = sample standard deviation of the market model for firm *i*, before event *e*;

s_{fiet} = prediction period sample standard deviation;[6]

R_{met} = market index return during the event period *t* = -25 through +25;

R_{me} = mean market index return during the estimation period *t* = -125 through -26; and

$MSER_{me}$ = mean squared error of the market index returns during *t* = -125 through -26.

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6 See Judge, et.al., (1988), pp. 166-170, for the derivation of the prediction period sample variance.

Inverse-Variance Weighted Cumulative Abnormal Returns from event date 0 through T can now be defined as:

$$IVWCAR_{pT} = \sum_{t=0}^{T} AR_{pt} \tag{6}$$

Assuming all AR_{iet} are independent and normally distributed, the standard error of AR_{pt} is:

$$s_{pt} = \frac{1}{\sqrt{\sum_{ie=1}^{681} s_{fiet}^{-2}}} \tag{7}$$

and the z-statistic for $IVWCAR_{pT}$ is:

$$z_{pT} = IVWCAR_{pT} \sqrt{\frac{\sum_{ie=1}^{681} s_{fiet}^{-2}}{T+1}} \tag{8}$$

The calculation of standardized cumulative abnormal returns for firm *i* during event *e* is straightforward. Assuming that the AR_{iet} are independent and normally distributed $SCAR_{ieT}$ (from event day 0 through T) is defined as:

$$SCAR_{ieT} = \left(\frac{1}{\sqrt{T + 1}} \right) \left(\sum_{t=0}^{T} \frac{AR_{iet}}{S_{fiet}} \right) \tag{9}$$

$SCAR_{ieT}$ is assumed to be normally distributed with mean zero and variance 1. It should be noted that if one sums the SCARs of a group of firms and divides by the square root of the group size the result will be a quasi-z statistic since this portfolio SCAR is also assumed to be distributed as N(0,1).

C. *Cross-Section Test Methodology*:

Equation (1) is estimated by OLS using the data described in Part A above in order to gauge the impact the magnitude of the catastrophe and the concentration of underwriting in a region hit by a catastrophe on cross-sectional returns, as well as assessing the impact of catastrophes on reinsurers relative to non-reinsurers. There are two brief comments that need to be made about equation (1) before the results are presented.

First, note the time trend variable (1). The TIME variable is added to the equation because, as noted by D'Arcy and France (1992), real insured losses show a slight upward trend over the sample horizon. This trend may be due to shortcomings of adjusting nominal losses by the CPI, or it may be due to the fact that as real GNP grows over the years there are more assets for catastrophes to destroy. For example, Tampa Bay in 1991 is quite a bit larger than it was in 1964, so there is likely to be more real damage from a hurricane in 1991 than from a hurricane of equal intensity in 1964. The TIME variable is incorporated as a watch-all variable to adjust for any time trending macroeconomic and demographic variables that may be important in the model but are excluded.

Second, equation (1) is estimated using both $SCAR_{ieT}$ and CAR_{ieT} as dependent variables, where $SCAR_{ieT}$ is defined in (9) and CAR_{ieT} is simply:

$$CAR_{ieT} = \sum_{t=0}^{T} AT_{iet} \tag{10}$$

The advantage of using SCAR as a dependent variable in (1) is that it provides an automatic adjustment for heteroskedasticity, since, in each event period, CARs are scaled such that SCAR is a random variable with a distribution of Normal (0,1). The disadvantage of the SCAR is that it is difficult to gain economic meaning from the estimated coefficients. So equation (1) is also estimated by CAR as defined in (10).

IV. Results

In this section we will present the results of the event study so that we can answer the four questions raised in Section II. To summarize the results of our study, we find superior stock market performance in our sample of firm-events. However, there does not appear to be any catastrophe size effect. Reinsurers appear to be the biggest winners when catastrophes occur which is consistent with the theory that reinsurers are exploiting distressed firms in need of liquidity. However, the coefficient of underwriting concentration has a weakly positive value which does not support the exploitation of distressed insurers hypothesis. Below we offer some details of our results as well as a discussion of the implications of our findings.

Q1: *Does the stock market generally turn bullish on property casualty stocks following catastrophes, or are Hurricane Andrew and the 1989 California earthquake atypical events*?

We find evidence that the average abnormal returns following catastrophes is indeed positive. Figure 2 illustrates the stock performance for the $IVWCAR_{pt}$ variable , which is the abnormal return for a portfolio with weights given by (4). This portfolio is comprised of 681 firm-event observations. In the "Total Sample" column of Table 2 the left-hand number is the value of $IVWCAR_{pT}$. Cumulative abnormal returns are all significantly different from zero, no matter what the time horizon. The numbers in parentheses are the SCAR values of the total sample. The interesting property of the SCAR variables is that they can also be interpreted as a z statistic, since they are assumed to N(0,1) random variables. All SCARs have significant positive values with the exception of $SCAR_{p0}$. Based on these findings we reject the null hypothesis H_0^1.

Q2: *Is there a catastrophic size effect in that, do the very largest catastrophes have different post-catastrophe stock return behavior than the small catastrophes*?

There does not appear to be any correlation between the size of the catastrophe and cumulative abnormal returns. Table 1.1.3 shows the model (1) regression results,[7] and for both SCAR and CAR, the $DAMAGE coefficient is not significantly different from zero, so we must accept the null H_0^2. Further evidence that there is no size effect is shown in Table 2. We sorted the 30 catastrophes into five groups of six events. The IVWARs for all event windows of the top quintile catastrophes are significantly

7 Regressions were also run using 5-day, 15-day, 20-day, and 25-day cumulative abnormal return variables. The coefficients and their significance levels are all about the same as reported in Table 3, so we do not report them.

greater than zero, but the same can be said for 15 of the 31 event windows of the bottom quintile. Figure 3 graphs the IVWCARs for the five quintiles.

The sharp increase in $IVWCAR_{p10}$ in the third quintile can be largely attributed to the announcement in early February, 1985 of a tender offer on Western Casualty and Surety by Lincoln National Corp, and a subsequent announcement that there was a potential second bidder. Several insurance stocks had dramatic capital gains during this period due to speculation that they too may become targets of attractive tender offers. However, without this non-catastrophic event there would be no significant cumulative abnormal returns in the third quintile. Even though the second, third and fourth event quintile show no signs of positive stock price behavior *that is the result of catastrophes*, the positive stock performance of the bottom quintile IVWARs and SCARs keeps us from concluding that positive stock performance comes only after the largest catastrophes.

Q3: *Are firms with highly concentrated underwritings in the areas hit by catastrophic events more likely to perform poorly after a catastrophe?*

We find no evidence to support the hypothesis that firms that have large concentrations of their business in areas hit hard by catastrophes perform worse than other insurers. In fact the CONC coefficient for both the CAR and SCAR cross-sectional regression are positive and have a t-statistic of around 1.5, this is reflected in Table 1.1.3. This finding is consistent with the hypothesis that catastrophes increase the demand for insurance, but not with the hypothesis that high concentration firms are more likely to be distressed and exploited by other insurers.

Q4: *Do the stock prices of all insurers respond the same way, or are reinsurers more likely to perform better than other insurers following a catastrophe*?

We find fairly strong evidence that reinsurers do indeed have superior stock market performance relative to other insurers. The coefficient for the REINSURE variable when run against CAR_{ie10} is over 5%, indicating that reinsurers have an average 10-day CAR which is 5% greater than non-reinsurers. Thus we reject the null hypothesis H_0^4. This finding is consistent with the hypothesis that reinsurers benefit from distressed insurers following catastrophes.

V. Conclusion

The significant contribution of this paper is that we look at multiple catastrophic events, and in doing so, we conclude that publicly traded insurance stock generally perform quite well after catastrophes. This study examines the effect of 30 catastrophic events for 52 publicly held property casualty insurance firms for the period 1964 to 1992. This study builds on the earlier work of Shelor, Anderson and Cross (1992) and Lamb (1995), who only look at a single event. We find the cumulative abnormal returns to be significantly positive in the 25 trading day period following catastrophic events. There is no significant evidence that post-catastrophe stock returns are correlated to the magnitude of the catastrophe. However, we do find that reinsurers outperformed non-reinsurers. This finding is consistent with the hypothesis that deep-pocket insurers and reinsurers gain at the expense of smaller, poorer performing insurers who are forced to enter into net worth reducing reinsurance contracts in order to obtain short term liquidity. We also find that there is a weak positive relationship between the concentration of a firm's business in an affected area and its post-event stock performance. We did not expect this result, although it is consistent with the hypotheses that catastrophic events increase consumer and industrial demand for insurance in the areas that are effected by the catastrophe.

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VII. Appendix

Table 1.1.1
Sample of Catastrophic Events Sorted by Loss Payments in 1991 Dollars
(Dollars in Millions)

Date of Catastrophic Event	Description of Catastrophe	Nominal Estimated Loss Payments	Estimated Loss Payments in 1991 Dollars
Sept. 17-22, 1989	Hurricane Hugo	$ 4,195.00	$ 4,588.30
Sept. 7-9, 1965	Hurricane Betsey	$ 500	$ 2,165.60
Sept. 12-14, 1979	Hurricane Frederick	$ 752.5	$ 1,351.80
Oct. 20-21, 1991	Fire	$ 1,200.00	$ 1,200.00
Apr. 2-5, 1974	Tornados and Wind	$ 430.6	$ 1,144.30
Aug. 3, 1970	Hurricane Celia	$ 310	$ 1,074.80
Oct. 17, 1989	Earthquake	$ 960	$ 1,050.00
Aug. 17-20, 1983	Hurricane Alicia	$ 675.5	$ 919.2
Aug. 30-Sept. 3, 1985	Hurricane Elena	$ 543.3	$ 685.4
11-Jul-90	Tornados and Wind	$ 625	$ 643.9
Aug. 18-20, 1991	Hurricane Bob	$ 620	$ 620
Aug. 17-18, 1969	Hurricane Camile	$ 165.3	$ 604.7
Sept. 26-27, 1985	Hurricane Gloria	$ 418.8	$ 528.2
Jan. 19-22, 1985	Wind, Snow and Ice	$ 400	$ 504.6
May 3-6, 1989	Tornados and Wind	$ 380	$ 415.6
Apr. 26-29, 1991	Tornados and Wind	$ 365	$ 365
June 13-14, 1984	Tornados and Wind	$ 276.7	$ 362.2
Apr. 2-4, 1982	Tornados and Wind	$ 243.5	$ 343.9
Apr. 11, 1965	Tornados and Wind	$ 70	$ 303
Aug. 26, 1964	Hurricane Cleo	$ 67.2	$ 296.5
May 7-10, 1981	Tornados and Wind	$ 201.5	$ 296.7
May 29-Jun. 1, 1985	Tornados and Wind	$ 231.6	$ 292.2
Mar. 27-30, 1984	Tornados and Wind	$ 217.5	$ 284.7
Nov. 15-16, 1989	Tornados and Wind	$ 225	$ 246.1
8-Jun-66	Tornados and Wind	$ 57	$ 238.8
May 26-29, 1973	Tornados and Wind	$ 76.5	$ 228.1
Mar. 26-30, 1991	Tornados and Wind	$ 210	$ 210
May 6-9, 1975	Tornados and Wind	$ 80.6	$ 200.1
Nov. 23-24, 1982	Hurricane Iwa	$ 137	$ 193.5
Nov. 3-7, 1985	Tornados and Wind	$ 153	$ 193

Table 1.1.2
Inverse-variance weighted cumulative abnormal returns of property and casualty insurance stocks around 30 U.S. catastrophes and also around quintiles of catastrophes sorted by estimated loss value in 1991 dollars.
(Standardized cumulative abnormal returns in parentheses.)

Event Day	Total Sample (N=681)**			Top Quintile (n=135)			Second Quintile (n=153)			Third Quintile (n=164)			Fourth Quintile (n=113)			Bottom Quintile (n=116)		
0	0.14%	*	(1.28)	0.40%	*	(2.43)	0.19%		(1.32)	0.10%		(0.48)	-0.08%		(-0.29)	0.09%		(0.23)
1	0.24%	*	(2.86)	0.63%	*	(2.62)	0.24%		(1.38)	0.07%		(0.19)	0.01%		(0.75)	0.50%	*	(1.55)
2	0.25%	*	(2.69)	0.91%	*	(2.48)	0.40%	*	(1.92)	-0.15%		(-0.97)	-0.04%		(0.52)	0.58%	*	(2.03)
3	0.28%	*	(2.65)	0.68%	*	(1.32)	0.38%		(1.73)	0.41%		(0.89)	-0.08%		(-0.19)	0.63%	*	(2.13)
4	0.32%	*	(2.77)	0.68%	*	(1.17)	0.36%		(1.21)	0.24%		(1.08)	0.01%		(0.52)	0.70%	*	(2.67)
5	0.38%	*	(3.16)	0.68%	*	(0.89)	0.38%		(1.25)	0.16%		(0.82)	0.05%		(0.99)	1.14%	*	(3.32)
6	0.37%	*	(2.75)	0.71%	*	(0.07)	0.26%		(0.69)	0.11%		(0.43)	0.04%		(1.11)	1.38%	*	(3.56)
7	0.29%	*	(2.23)	0.73%	*	(0.80)	0.20%		(0.60)	-0.01%		(0.03)	0.09%		(1.32)	1.00%	*	(2.50)
8	0.30%	*	(2.12)	0.97%	*	(0.76)	0.21%		(0.58)	0.05%		(0.41)	0.04%		(0.99)	0.90%	*	(2.21)
9	0.35%	*	(2.05)	0.91%	*	(0.95)	0.17%		(0.55)	0.25%		(0.65)	0.18%		(1.20)	0.53%		(1.36)
10	0.75%	*	(2.51)	0.94%	*	(0.83)	0.11%		(0.28)	1.62%	*	(2.45)	0.03%		(0.76)	0.44%		(1.20)
11	0.88%	*	(2.79)	1.14%	*	(1.02)	0.09%		(0.15)	4.63%	*	(2.98)	0.02%		(0.69)	0.46%		(1.27)
12	0.82%	*	(2.60)	1.32%	*	(1.27)	0.16%		(0.35)	4.49%	*	(2.84)	-0.25%		(0.07)	0.38%		(1.11)
13	0.82%	*	(2.54)	1.60%	*	(1.50)	0.30%		(0.68)	4.33%	*	(2.38)	-0.23%		(0.13)	.020%		(0.79)
14	0.81%	*	(2.19)	1.53%	*	(1.32)	0.22%		(0.27)	4.33%	*	(2.28)	-0.18%		(0.19)	-0.09%		(0.67)
15	0.75%	*	(1.92)	1.35%	*	(0.83)	0.30%		(0.38)	4.46%	*	(2.41)	-0.38%		(0.27)	0.00%		(0.16)
16	0.87%	*	(2.30)	1.35%	*	(0.97)	0.71%		(0.87)	4.38%	*	(1.98)	-0.26%		(0.49)	0.11%		(0.69)
17	0.90%	*	(2.43)	1.65%	*	(1.45)	0.58%		(1.05)	4.26%	*	(1.48)	-0.25%		(0.45)	0.24%		(0.91)
18	0.84%	*	(2.02)	1.74%	*	(1.45)	0.59%		(0.79)	4.17%	*	(1.24)	-0.44%		(-0.01)	0.90%		(0.95)
19	0.85%	*	(1.89)	1.73%	*	(1.29)	0.33%		(0.60)	4.14%	*	(1.13)	-0.40%		(0.12)	1.25%	*	(1.24)
20	0.98%	*	(2.52)	2.07%	*	(1.63)	0.28%		(0.71)	4.19%	*	(1.04)	-0.25%		(0.52)	1.56%	*	(1.60)
21	1.00%	*	(2.65)	2.06%	*	(1.76)	0.25%		(0.79)	4.19%	*	(1.13)	-0.29%		(0.43)	1.81%	*	(1.85)
22	0.88%	*	(2.63)	2.16%	*	(1.97)	0.34%		(0.95)	4.16%	*	(1.04)	-0.43%		(0.23)	1.68%	*	(1.70)
23	1.07%	*	(2.63)	2.31%	*	(2.32)	0.52%		(1.16)	4.23%	*	(0.92)	-0.38%		(0.23)	1.64%	*	(1.69)
24	1.07%	*	(2.80)	2.26%	*	(2.13)	0.38%		(1.06)	4.11%	*	(0.61)	-0.11%		(0.63)	1.86%	*	(1.91)
25	1.09%	*	(2.82)	2.01%	*	(1.61)	0.65%		(1.41)	4.04%	*	(0.58)	-0.05%		(0.60)	2.08%	*	(2.21)

** n = the number of abnormal return observations around the events in the (sub)sample.
* Inverse - Variance Weighted Cumulative Abnormal Returns with z-statistics at the 5% confidence level.

Table 1.1.3

Estimation of models explaining stock price behavior using event day 10 market model cumulative abnormal returns, CAR, and standardized cumulative abnormal returns, SCAR.

Dependent Variable: $SCAR_{ie}10$ *(t - statistics in parentheses)*
Mean of dependent variable: 0.0061

$Time_{ie}$	$\$DAMAGE_{ie}$	$CONC_{ie}$	$REINSURE_{ie}$	Intercept	R^2	F
-0.0005 (0.84)	-2.01×10^{-6} (-0.63)	0.0181 (1.57)	0.0534 (3.12)	-0.367 (-0.75)	0.019	3.25

Dependent Variable: $SCAR_{ie}10$ *(t - statistics in parentheses)*
Mean of dependent variable: 0.10

$TIME_{ie}$	$\$DAMAGE_{ie}$	$CONC_{ie}$	$REINSURE_{ie}$	Intercept	R^2	F
0.004 (0.35)	-2.90×10^{-5} (-0.50)	0.32 (1.45)	0.66 (2.13)	-0.27 (-0.031)	0.011	1.78

Note: Sample size is 614 insurance company series of abnormal returns observed.

$CAR_{ie}10=\sum_{t=0}^{10} AR_{iet}$, is the cumulative abnormal return ten days after the catastrophic event form firm "i" around the catastrophic event "e"

where AR_{iet} is the market model abnormal return.

$SCAR_{iet}=\sqrt{11}\sum_{t=0}^{10} AR_{iet} / s_{ft}$ is the standardized cumulative abnormal return, where s_{ft} is the forecast standard error of the market model.

$TIME_{ie}$ = time trend (64, 65, 66, ..., 90, 91) for the year in which the catastrophe struck.

$\$DAMAGE_{ie}$ = estimated loss payments in 1991 dollars.

$CONC_{ie}$ is a dummy variable capturing the concentration of an insurer's policies written in the regions hit with a catastrophe:

$$CONC_{ie} = \begin{cases} 1 & \text{if insurer " i" has over 40\% of its policies in the region affected by the catastrophic event " e"} \\ 0 & \text{otherwise} \end{cases}$$

$REINSURE_{ie}$ is a dummy variable indicating whether or not an insurance company is primarily a reinsure:

$$REINSURE_{ie} = \begin{cases} 1 & \text{if insurer's principle line of business is reinsurance} \\ 0 & \text{otherwise} \end{cases}$$

Chart 1.1.1
BI Insurance Weekly Index around Hurricane Andrew (August 23-25, 1992)

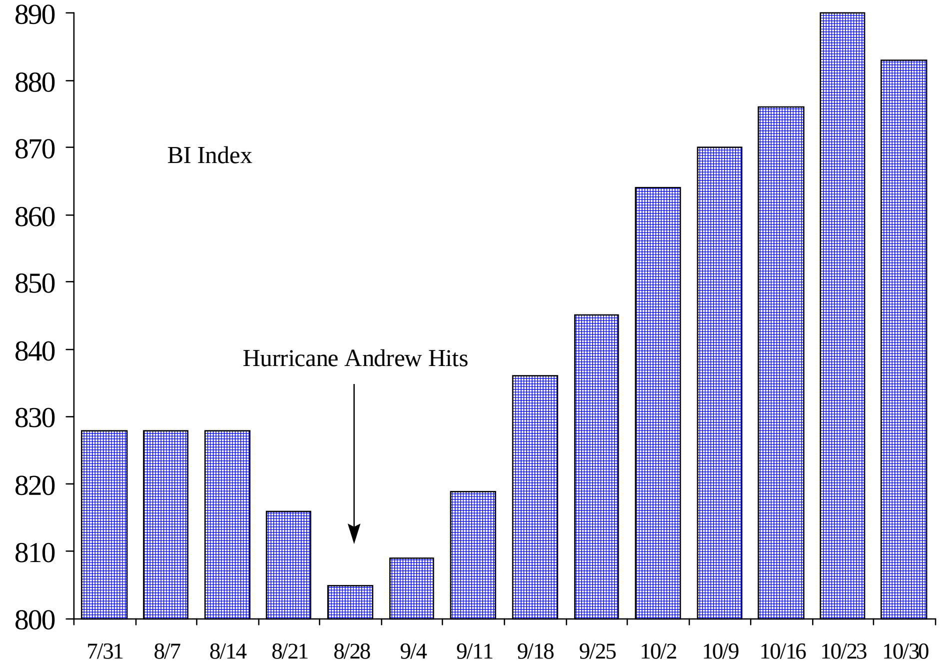

Chart 1.1.2
Inverse-Variance Weighted Cumulative Abnormal Returns
around 30 largest Catastrophic Events

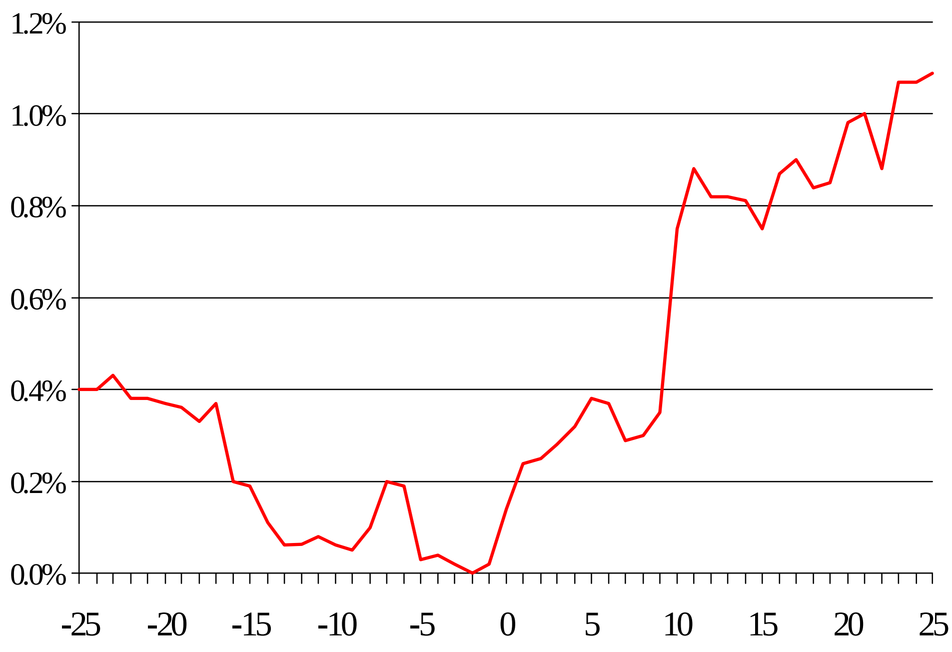

Chart 1.1.3
Inverse-Variance Weighted Cumulative Abnormal Returns around Sample Catastrophe Quintiles

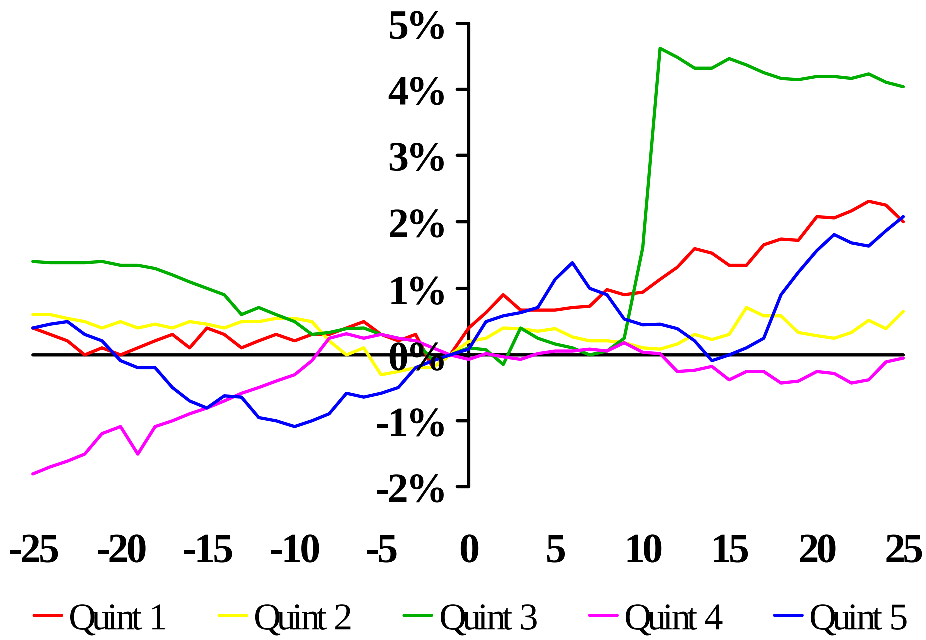

Table 1.1.4
List Of Firms In The Sample
Property And Liability Firms

20th Century Industries	Alfa Corporation
American General Corporation	American Indemnity Financial
American International Group	American Reliance Group Inc.
Agronaut Group Inc.	Belvedere Corporation
Berkshire Hathaway Inc.	Capitol Transamerica Corporation
Chandler Insurance Company Ltd.	Chubb Corporation
Citizens Security Group Inc.	Condor Services Inc.
Criterion Insurance Company	Donegal Group Inc.
Empire Fire & Marine Insurance Company	Employers Casualty Company
First Central Financial Corporation	Frontier Insurance Group Inc.
Geico Corporation	Hanover Insurance Company
Harleysville Group Inc.	Hartford Steam Boiler Inspection
Home Group Inc.	Home Insurance Company
Markel Corporation	Merchants Group Inc.
Meridian Insurance Group Inc.	Nat Re Corporation
Navigators Groups Inc.	New York Marine & General Insurance
Niagara Exchange Corporation	North East Insurance Company
Ohio Casualty Corporation	Orion Capital Corporation
Pan Atlantic	Phoenix Re Corporation
RE Capital Corporation	Regency Equities Corporation
RLI Corporation	Seibels Bruce Group Inc.
Trenwick Group Inc.	Unicare Financial Corporation
United Coasts Corporation	United Fire & Casualty Company
Warwick Insurance Managers Inc.	Western Casualty & Security Company
W. R. Berkley Corporation	Zenith International Insurance Company

ESSAY I:

CHAPTER II

GAINING FROM LOSS: PROPERTY-LIABILITY INSURER STOCK VALUES IN THE AFTERMATH OF THE 1989 CALIFORNIA EARTHQUAKE

I. Comment

Even though the property-liability insurance industry has suffered through many natural and man made catastrophic losses in excess of one hundred million dollars, the academic literature includes only a few studies in which finance theories have been applied to this topic[8]. Shelor, Anderson, and Cross contribute to this literature by studying a single catastrophe, the October 17, 1989, California (Loma Prieta) earthquake.

The author's major finding is that there are abnormal positive returns for publicly held insurance firm's stock prices. They also found that this result is not dependent on:

1) The amount of insurance the firm writes in California.

2) Whether the firm writes any insurance in California.

3) Whether the firm writes any earthquake insurance.

4) The proportion of the earthquake line in the total firm.

Professors Shelor, Anderson, and Cross (SAC) attribute this positive market response to increased demand for the particular line of insurance, and the increased awareness by consumers of their insurance needs. This increased awareness would lead to elevated premium earnings by the industry, even though the known probability of a similar occurrence of this catastrophe has not changed. An alternative theory the authors express is that a catastrophe would cause a depletion of the firm's surplus and drive down the value of the firm, in which case a negative response should be found in the stock market on the firm's value.

8See Shelor, Anderson and Cross (1992) for references.