Differential Analysis of the Impact Catastrophic Loss has on Publicly Traded Property/Casualty Insurers

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SUMMARY

The purpose of this paper is to examine the capital market effect major catastrophes have on property/casualty insurers operating in the United States. It is widely accepted that capital markets are semi-strong efficient, i.e., prices of securities incorporate all currently available public information. A number of studies using event methodologies have examined capital market reaction to firm announcements of financial bankruptcy. These investigations have focused primarily in stock price reaction to single firm announcement effects. The present study seeks to measure capital market reaction to the announcement of catastrophic natural disasters for publicly traded property/casualty companies operating in the U.S.A. A one-factor market model using CRSP data covering the period from 1970 to 1992 is used to compute the vector of excess (abnormal) returns for the period before and after major natural disasters. Capital market reaction to adverse natural disasters may impact the ability of property/casualty insurers to tap equity markets as a source of funding. Financial risk exposure to the announcement effect from natural disasters may be hedged using stock-index futures over periods when such catastrophic events are likely to occur. Financial risk exposure tends to vary with the distribution and line of business for publicly traded NYSE listed property/casualty insurers across the U.S.A.

Analyse différentielle de l'impact des pertes catastrophiques sur les assureurs de biens et de risques divers faisant appel à l'épargne publique

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Résumé

L'objet de cet article est d'examiner l'effet que les grandes catastrophes ont sur le marché des capitaux pour les assureurs de propriétés ou de risques divers opérant aux Etats-Unis. Les marchés des capitaux sont largement considérés aux Etats-Unis comme *semi-strong efficient*, c'est-à-dire que le cours des valeurs mobilières à un moment donné reflète toutes les informations qui sont à la disposition du public. Plusieurs études, utilisant diverses méthodologies, ont étudié la réaction des marchés de capitaux aux déclarations de faillite émises par des entreprises. Ces études ont principalement porté sur le comportement de l'action en bourse aux annonces publiées par une seule société. La présente étude cherche à mesurer la réaction du marché des capitaux à l'annonce de catastrophes naturelles et leurs répercussions pour les compagnies d'assurance de biens et de risques divers faisant appel à l'épargne publique aux Etats-Unis. Un modèle de marché à un seul facteur, utilisant des données du CRSP, couvrant la période s'étendant de 1970 à 1992, est utilisé pour calculer le vecteur d'excédent (anormale) pour les périodes précédant et suivant immédiatement des catastrophes naturelles de grande envergure. La réaction du marché des capitaux aux désastres naturels peut influer sur la capacité des assureurs de biens ou de risques divers de recourir à l'épargne publique comme source de fonds. L'exposition aux risques financiers que représente l'annonce de catastrophes naturelles peut être limitée par l'utilisation de pour les périodes au cours desquelles ces événements sont susceptibles de se produire. L'exposition aux risques financiers varie aux Etats-Unis pour les assureurs de biens mobiliers ou de risques divers cotés à la bourse de New York (NYSE), selon la répartition et le secteur d'activité.

I. INTRODUCTION

Over the last decade, actuaries and financial managers have raised concerns about the financial consequences extremely large, natural disasters have on property/casualty insurers. As early as 1981, James Shamberger, senior vice president of the Reinsurance Association of America, urged the development of a federal loan program in the U.S. to financially assist casualty companies in the aftermath of catastrophic, natural disasters (Friedman(1981)). His argument was that without the availability of loan guarantees in the event of super catastrophes, there would be massive sales of insurer securities to meet claim demand. These security sales would depress market prices on reserve securities thereby increasing the likelihood of insurer insolvency.

The consequences of large losses on property casualty insurers may be two fold. The first, macroeconomic effect, is the impact the sell-off of insurer reserves has on securities markets following large, natural disasters. The second, microeconomic effect, is the influence catastrophes have on investor opinion and share prices of publicly traded property/casualty firms. The short-term nature of the P/C contract requires that insurers maintain highly liquid reserves to meet claims on written business. U.S. insurers are required to use either (1) federal, state or municipal bonds, (2) bonds or notes secured by mortgages or deeds of trust on improved or unencumbered real estate, or (3) marketable securities to meet minimum capital requirements.

An insurer's liquidity preference for marketable securities relates directly to claim experience. Large catastrophic loss will require property/casualty companies to liquidate reserve holdings. The sale of reserve securities creates excess supply of these financial instruments in the market thereby depressing prices. At issue is whether the volume of trading in these markets is strong enough to overcome short-term sales by property/casualty companies after severe disasters. A study of municipal bond market activity following natural catastrophes from 1979 to 1983 shows that general obligation municipal bond prices may decrease due to liquidity reserve selling (Thompson, Bowyer, Srinivasan, and Fisher (1985)). However, this macroeconomic effect is difficult to analyze. A significant portion of insurer reserves are committed to municipal or general obligation bonds, and yet, the market is thinly traded precluding daily price information. Thompson et.al. (1985) utilized price data on the 20-year General Obligation Bond Index and the 30-year Revenue Bond index to approximate daily movements in the municipal bond market. Nevertheless, the use of these series may only capture a portion of the effect property/casualty liquidity preferences have on the municipal bond market following large natural disasters.

Another possible microeconomic effect catastrophes have on the property/casualty insurance industry is with share prices of the companies themselves. It is widely accepted that capital markets are semi-strong form efficient, i.e., prices of securities

incorporate all currently available public information. Catastrophic events represent new public information that is impounded into share prices of publicly traded casualty companies. Under CAPM pricing these exogenous events may alter the capital structure of the insurer (Grossman, Stiglitz (1980), Meyers (1989),Cummins (1990)). In such a market, where prices reflect the average beliefs of all investors, financial economists have studied how a variety of events ranging from public announcements to changes in tax policy may influence common stock prices over time (Cowan, Nayar and Singh (1990), Davidson, Chandy and Cross (1987), Lloyd-Davies, and Canes (1978), and Rozeff and Zaman (1988)). What has yet to be examined is the impact natural catastrophes have on share prices of publicly traded property/casualty insurers.

The purpose of this paper is to examine the capital market effect major catastrophes have on property/casualty insurers operating in the United States. The present study seeks to measure capital market, investor reaction to the announcement of catastrophic natural disasters on publicly traded property/casualty companies operating in the U.S.A. A one-factor market model using data contained on the CRSP (Center for Research on Securities Prices) tapes for 1970 through 1992. Table 1 provides a summary of U.S. the most costly insured natural disasters over this period above $250 million.

Table 1

Insured Natural Disasters Having the Greatest Estimated Losses from 1970 through 1992
($ millions)

Dates	Insured Peril	Estimated Insured Loss
8/23-8/24/92	Hurricane Andrew	10,700
10/17/89	San Francisco Earthquake	7,000
9/17-9/18/89	Hurricane Hugo	4,200
9/11/92	Hurricane Iniki	1,600
10/20/91	Oakland Wildfire	1,500
9/12-9/14/79	Hurricane Frederic	753
8/17-8/20/83	Hurricane Alicia	676
8/30-9/3/85	Hurricane Elena	543
9/26-9/27/85	Hurricane Gloria	419
8/3/70	Hurricane Celia	310

Source: The Fact Book 1993 Property/Casualty Insurance Facts (1993).

II. REVIEW OF PRIOR LITERATURE

Previous studies on catastrophic loss and property/casualty insurance may classified into two broadly defined areas. One set of investigations within casualty insurance literature concentrates on how to measure the impact catastrophes have on insurer operations (Levi, Partrat (1989), MacDonald, White, Taube, Huth (1990), Brillinger (1992). These studies consider rate making, loss distribution and risk classification factors related to insuring contingencies where catastrophic loss is possible..

Another group of articles examines how casualty company stock returns may be affected by catastrophic events (Sprecher, Pertl (1983), Davidson, Chandy, Cross (1987), Cross, Davidson, Thornton (1988)). Such studies utilize event study methodologies (Dimson, Marsh (1986), and Cowan, Singh (1990)) to define the impact certain

catastrophic occurrences have on risk management or casualty insurer operations.

A small, but growing set of actuarial literature deals with how to measure the frequency and severity of loss following natural disaster. The aim of this research is to incorporate loss distribution, market, and physical damage information into the ratemaking and reserving decisions of the insurer. The study by Levi and Partrat (1989) provides a foundation for further work in this area. Using ISO data covering the period from 1954 to 1986, Levi and Partrat examined loss frequency and severity data related to hurricanes in the United States. After testing for independence between the number and amount of loss, and various separate loss frequency and severity distributions, they conclude that a Poisson Log-normal distribution provides the best fit to hurricane experience in the U.S. The same model may apply equally to other natural disasters, such as tornadoes, earthquakes or fires.

A 1990 study by MacDonald, White, Taube and Huth uses market driven information to determine flood insurance risk. This investigation uses sales price differentials in the U.S. housing market to measure flood hazard pricing for casualty insurers. Based on an efficient markets hypothesis the authors develop a hedonic pricing model for houses located inside and outside the flood plain in Monroe, Louisiana. Using 1988 cross-sectional data on 301 houses, their research indicates that house price

differentials in flood areas may be explained partly by differences in insurance premiums and levels of coverage.

A recent study by Brillinger (1992) provides a survey of some of the actuarial, governmental, geological and environmental issues related to earthquake loss in the United States. Brillinger shows how qualitative, as well as, quantitative information about geology, seismology and earthquake engineering may be incorporated into insurer assessment of catastrophic loss. He argues that while risk assessment is an important issue, equally significant, are the physical factors impacted by the intensity, and acceleration of earthquakes in insured regions. This paper identifies geological research findings related to the Loma Prieta (California) earthquake that may help insurers better understand and rate coverages against earthquake damage.

An entirely different set of literature examines how external events influence share prices of publicly traded casualty insurers or companies with risk management operations. The first use of event study methodology by Sprecher and Pertl (1983) uses data on 27 NYSE exchange firms from 1969 to 1978 examine share price reaction to large losses. Large losses were defined as those having a value equal to or greater than 10% of net worth. They find that large losses have a significant impact on share value using a abnormal returns model. Sprecher and Pertl argue that these results indicate the importance risk management activities

have for the firm in terms of preservation of shareholder value. A similar study by Davidson, Chandy and Cross (1987) examine how stock returns in the airline industry move with announcements related airplane crashes. They studied 57 airplane crashes occurring over the period from 1965 to 1984 and find little stock price reaction to airline announcements. A later study by Cross, Davidson, and Thornton (1988) employing the same methodology analyzes the impact a change in U.S. Tax policy has on captive insurance subsidiaries. This investigation considers investor reaction to the changes in the tax code following the Carnation Three Flowers case. Using a database of 54 firms with captive insurance subsidiaries, the authors were able to show significant negative abnormal returns for the period preceding the Tax Court decision. They were not able to find significant differences in share price returns after the Carnation announcement.

The present study will incorporate the concerns raised in the first set of literature with the methodologies utilized in the latter. At the same time, the paper serves to show how finance and actuarial research findings may be integrated (D'Arcy (1989)). Actuarial literature on the topic of natural disasters focuses on the distribution of loss, assessment of risk, and development of premiums and reserves for insurers. Risks are examined on the basis of their loss characteristics and insurance coverage. Financial literature in the area of catastrophic loss utilizes a market model to measure financial risks. Given an efficient market

for a firm's stock investors are able to distinguish differences in risk. By directly analyzing the impact catastrophic loss has on share price returns of casualty companies, a market driven assessment of risk may be obtained. While the financial method of measuring risk may be less direct, the results may add to an understanding of how catastrophic loss impacts casualty insurers.

DATA AND METHODOLOGY

This study uses a sample of property and casualty insurance companies (SIC codes 6331,6351 & 6361) whose securities traded on the New York Stock Exhange (NYSE), the American Stock Exchange (AMEX) and the NASDAQ market during the years 1970 through 1992. There were 129 firms represented in our initial set of casualty companies. In an effort to obtain those firms that were actively traded during the dates of major natural disasters a further restriction creiteria was imposed. The firms had to have at least 270 days trading data on the Center for Research in Security Prices (CRSP) tapes surrounding the event date to facilitate estimation of market model parameters. The distribution of the final sample is given in Table 2. This table provides a distribution of the sampled firms according to the date of occurrence for natural disasters resulting in major loss.

Table 2

No. of Sample Firms by Exchange Listing

Event	Date	NYSE/AMEX	NASDAQ
Hurricane Andrew	8/23-24/92	41	51
San Fran. Earthquake	10/17/89	32	54
Hurricane Hugo	9/17-18/89	32	54
Hurricane Iniki	9/11/92	41	50
Oakland Wildfire	10/20/91	39	53
Hurricane Frederic	9/12-14/79	15	32
Hurricane Alicia	8/17-20/83	16	35
Hurricane Elena	8/30-9/3/85	18	36
Hurricane Gloria	9/26-27/85	18	36
Hurricane Celia	8/2/70	13	__*

* CRSP began collecting and reporting data on NASDAQ firms in 1972.

To assess the impact of catastrophic events on stock prices, the following one factor market model is used to estimate a stock's expected returns:

$$\tilde{R}_{jt} = \alpha_j + \beta_j \tilde{R}_{Mt} + \tilde{\epsilon}_{jt} \qquad (1)$$

and

$$e_{jt} = R_{jt} - \hat{\alpha}_j - \hat{\beta}_j R_{Mt} \qquad (2)$$

where R_{jt} and R_{mt} are returns on the firm's stock and the value-weighted market portfolio respectively, $\tilde{\epsilon}$ is the random iid $N(0, \sigma^2_{\epsilon})$ error term. e_{jt} is the observed error based on the OLS estimation of equation (1); '^' denotes estimates and '~' denotes random variables. The entire analysis is conducted over the period day -249 to day +20 relative to day 0 as explained below.

Day 0 is defined as the earliest date of a catastrophic event in our investigation. Parameters in equation (1) are estimated using returns from day -249 to day -100. The parameters so estimated are then used to compute the vector of excess (abnormal) returns 'e' for the trading window [-99,+20]. This segment is employed for asssessing the performance of the stock before, after, and around the catastrophic event by arithmetically cumulating the daily returns of firms over this period. The effect of the catastrophic event on the firm's stock price is measured by the cummulative excess returns over the two-day [-1,0] and the seven-day (-1,5) windows. The long-term post-catastrophic performance is measured over the day +6 to day +20 period. Statistical test are based on standardized residuals corrected for serial dependence, as

in Mikkelson and Partch (1988).

Define $PE_{jt} = R_{jt} - (\alpha_j + \beta R_{mt}) = e_{jt}$

Then, $Z = 1/\sqrt{(n)} \sum_{1}^{N} [\sum_{t_1}^{t_2} PE_{jt}/\sqrt{(var \sum_{t_1}^{t_2} PE_{jt}]}$

Where, $Var(\sum_{t_1}^{t_2} PE_{jt}) = V_j^2 [T + T^2/ED + \sum_{t_1}^{t_2} R_{mt} - T(\bar{R}_m)^2/\sum_{1}^{ED} (R_{mi} - \bar{R}_m)^2]$

and, ED = number of days used to estimate equation above.
t_1 and t_2 are the first and last day of the cumulation period and $T = t_2 - t_1 + 1$.

Since variance around the distrubution date may change, we also test the significance of our results on the basis of cross-sectional variance during that period. Both methods provide similar levels of significance.

EMPIRICAL RESULTS

Table 3

Cumulative Abnormal Returns for Property and Casualty Insurance Common Stock Around Catastrophic Events.

Panel A - NYSE/AMEX Firms

Period	Cumulative Abnormal Returns	Z	No. Positive/Negative
-99,-2	1.28%	2.39*	141/124*
-1,0	-.11	-0.27	127/138
-1,+5	-.06	+0.07	122/143
6,20	2.30	6.06 ***	164/101 ***

Panel B - NASDAQ/Firms

Period	Cumulative Abnormal Returns	Z	No. Positive/Negative
-99,-2	1.37%	0.91	202/184 ***
-1,0	-0.54	-3.65 ***	145/240 *
-1,+5	-1.20	-4.19 ***	168/217 *
6,20	.24	1.87 $	195/189 **

$ Significant @ 10% Level
* Significant @ 5% Level
** Significant @ 1% Level
*** Significant @ 0.1% Level

Table 3 presents an interesting picture of how casualty company investors respond to natural disasters. Those companies listed on organized exchanges (NYSE and AMEX) appear to have investor responses different from those firms found in the over-the-counter market (NASDAQ). For NYSE and AMEX listed companies abnormal positive returns occurred 2 days before (-99,-2) and 6 days after (6,20) catastrophic events. The term in between is marked by negative, but nevertheless, insignificant abnormal returns. During the two periods of significant returns more firms posted positive than negative results (141/124 for 2 days prior and 164/101 for 6 days after catastrophic loss).

The return for casualty companies listed on the NASDAQ market appear more sensitive to the occurrence of natural disaster than those found on organized exchanges. A significant negative abnormal return is found the day of and one day prior to a natural disaster. The period defined one day prior to a disaster and 5 days after a catastrophic loss is marked by significant negative abnormal returns on NASDAQ casualty stocks. The only apparent similiarity between NASDAQ listed casualty insurers and those listed on organized exchanges is the recovery during the period following a disaster. Both sets of stocks tend to recover positively 6 to 20 days out from a catastrophic event.

CONCLUSION

The present investigation shows that casualty investors may react differently to large natural disasters based on where firms are listed. NASDAQ listed insurers showed significant abnormal returns over periods shortly before and after major catastrophic events. NYSE and AMEX listed casualty insurers were subject to slightly negative stock returns that proved insignificant over the 22 year observation period.

One possible explanation for these differing results may be found in investor perception of each insurer's financial ability to withstand loss. Listing requirements on the organized exchanges (NYSE and AMEX) require firms have sufficient capital, market strength as measured by trading volume, and credit worthiness to withstand shocks to the market. NASDAQ company stocks are not subject to the same capital and market requirements. They sell over-the-counter and must meet only the minimal capital requirements set by the SEC (the firm's aggregate indebtedness must not exceed 15 times net capital). For these reasons, the NASDAQ market is dominated by smaller, more thinly traded companies. The larger volume of trading in NYSE and AMEX casualty stocks, coupled with their higher capital position, appears to dampen the impact natural disasters have on share returns.

What is common to both NASDAQ and organized exchange casualty stocks is the negative returns found in the short 6 day period prior to and after a natural disaster. For NASDAQ stocks the returns are significant. In the case of NYSE and AMEX stocks the returns are negative, but not significant. In either case, casualty insurers may wish to hedge their reserve exposure by trading in the futures markets. In this study, all casualty firms earned positive abnormal returns in the window 99 to 2 days prior to catastrophic loss. In the case of hurricane or fire season exposure, casualty insurers could seek to hedge loss exposure over this period by trading in stock-index futures. The need to hedge external investor reaction to natural disasters appears greatest with NASDAQ listed firms, as opposed to those found on the NYSE and AMEX markets.

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