

Pacific Basin Working Paper Series

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Working Paper No. PB99-04

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September 15, 1999

Is It True that Insurers Benefit From A Catastrophic Event?

Market Reactions to the 1995 Hanshin-Awaji Earthquake

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Abstract

Previous studies, investigating how the market in general viewed the impact of a big earthquake (e.g., the 1989 Loma Prieta earthquake in the San Francisco Bay Area) on insurance firm values, found a positive reaction of insurers' stock prices. This "gaining from loss" may be caused by the subsequent increased demand for insurance coverage. This paper investigates the impact of the 1995 Hanshin-Awaji earthquake on Japanese insurers' value. Contrary to the results for U.S. earthquakes, we find significant negative stock price reactions. Furthermore, our results demonstrate that Japanese stock markets are considerably efficient in assessing the new information generated by the Hanshin-Awaji earthquake. Finally, we also find a negative relationship between stock price reaction and the extent to which an insurer wrote earthquake coverage in the damaged area.

[Key Words] Hanshin-Awaji Earthquake, Earthquake Insurance, Gaining from Loss, Japanese Insurance Companies, Event Study.

The authors appreciate Ramon Moreno and Guillermo Pinczuk for their valuable comments. Also, the authors appreciate the Marine and Fire Insurance Association of Japan for answering our questions about earthquake insurance.

1. Introduction

The Hanshin-Awaji earthquake occurred around the areas of Kobe and Osaka at 5:14 a.m. on January 17, 1995. The earthquake, which registered 7.2 on the Richter scale, caused 5,502 people to die and 41,527 to be injured.¹ Also, 100,282 commercial and residential buildings were completely destroyed, 108,402 were half destroyed, and 185,756 were partially destroyed. Insurance companies paid approximately 77 billion yen earthquake insurance payments. While these payments were relatively small, if compared to a total estimated loss of about 10 trillion yen, (including 3.9 trillion yen of residential losses), they were the largest insurance payments since the Japanese earthquake insurance system started in 1966.

It is natural to assume that these catastrophic losses would result in a negative impact on insurers' stock prices because of large potential insurance payments. However, previous studies showed that, on the contrary, insurers could benefit from a catastrophic event because of subsequent increased demand for insurance coverage. For example, Shelor, Anderson, and Cross (1992) found that the 1989 California (Loma Prieta) earthquake had a positive impact on insurers' stock prices.

Although many previous studies find that insurers' stock prices respond positively to a big earthquake, these studies covered only U.S. earthquakes and insurers. In this paper, we investigate the impact of the Hanshin-Awaji earthquake on equity values of Japanese insurance companies. This is the first attempt to empirically investigate a non-U.S. stock market reaction to a large earthquake.

The implications of paper are important for Japanese regulators and investors, since earthquakes of a magnitude higher than 8.0 on the Richter scale are expected in the near future for the Tokai and South Kanto Metropolitan areas, which include Tokyo. As earthquake insurance payments resulting from these earthquakes are estimated more than 1.8 trillion yen, the

¹ These numbers were estimated by the Fire Department of the Japanese Government.

earthquakes will seriously damage the financial position of Japanese insurance companies.² However, if the earthquake, as previous U.S. studies have demonstrated, benefits insurers, investors and regulators of insurance companies do not have to worry about the potential earthquake risks. To assess the potential impact of future earthquakes, it is instructive to investigate the impact of the Hanshin- Awaji earthquake on Japanese insurance companies.

This paper consists of six sections. In Section 2, we review previous studies. In Section 3, we describe the Japanese earthquake insurance because it is different from its U.S. counterpart. Section 4 details the data and methodology we used in this paper. Section 5 provides the results. Finally, Section 6 concludes this paper.

2. Previous Studies

As previous studies (e.g., Shelor, Anderson, and Cross; 1992) point out, an earthquake has both unfavorable and favorable effects on the equity values of insurance firms. The unfavorable effect of catastrophic events is obvious because the rapid depletion of surplus accounts fostered by catastrophic events causes investors to discount insurance firm stock values. The favorable effect is rather indirect. Namely, the insurers may benefit from an isolated catastrophic event because of subsequent increased demand for coverage. As we cannot a priori judge whether the induced demand increases outweigh the depletion of surplus accounts, we should investigate this issue empirically.

In fact, there are several papers that investigate the impact of catastrophic disasters (e.g., earthquakes and hurricanes) on insurers' stock prices.³ Two studies of insurance stock prices

² There are several estimations regarding human and financial losses caused by these earthquakes. For example, according to Tokyo Yomiuri Shinbun (January 18, 1995), the National Land Agency estimates that the South Kanto earthquake will kill 152,000 people and Tokai Bank estimates that the financial losses caused by the South Kanto earthquake will amount to 80.4 trillion yen.

³ There are some papers dealing with the impact of catastrophic events other than earthquakes and hurricanes on stock prices. Davidson and Thornton (1985) investigated the effect of an overheated core at the Three Mile Island nuclear power plant on stock prices of insurance companies. They found no significant negative impact caused by that event. Also, Davidson, Chandy, and Cross (1987), investigating the impact of airplane crashes on stock prices, found that airplane crashes did not generate a significant prolonged negative impact on airline shareholders.

following the 1989 San Francisco (Loma Prieta) earthquake have been published. One is Shelor, Anderson, and Cross (1992) and the other is Aiuppa, Carney, and Krueger (1993).⁴

Shelor, Anderson, and Cross (1992) find that the stock prices of property-liability insurers, on average, rose after the 1989 San Francisco earthquake. Using a different sample and methodology, Aiuppa, Carney, and Krueger (1993) also find that earthquake insurers offering coverage in California experience significant stock price increases.⁵ Therefore, both studies support the “gaining from loss” hypothesis that insurers could benefit from subsequent increased earthquake coverage.

The impact of the 1994 Los Angeles (Northridge) earthquake on insurance firm’s values is studied by Aiuppa and Krueger (1995) and Lamb and Kennedy (1997). Lamb and Kennedy (1997) find significant positive abnormal returns for exposed insurers and insignificant negative abnormal returns for unexposed insurers after the Los Angeles earthquake. This is consistent with previous studies on the San Francisco earthquake.

Aiuppa and Krueger (1995), using a sample different from Lamb and Kennedy (1997), obtained the significant *negative* abnormal stock returns on the day of the earthquake for both exposed and unexposed insurers. In this respect, their result appears different from that of previous studies. However, their results are essentially similar since the cumulative abnormal returns for the ten-day period after the earthquake are positive for exposed insurers, although they are not significant. Furthermore, Aiuppa and Krueger (1995) find that unexposed insurers suffer greater losses than exposed insurers from the earthquake. This result indicates that stock market investors consider the information associated with the earthquake as relatively favorable to insurers with premium volume in California.

Therefore, all previous studies dealing with large U.S. earthquakes have commonly provided evidence supporting the “gaining from loss” hypothesis.

⁴ Shelor et. al. (1992) maintained that there were no analyses of the impact of catastrophic losses on insurance firm value at that time.

⁵ Aiuppa, Carney and Krueger (1993) found that the insurers not offering coverage in California experienced a decline of stock prices.

Before going to the next section, we briefly mention the results of studies on the impact of Hurricanes Hugo and Andrew. Lamb (1995) investigated the impact of Hurricane Andrew on insurance firm values and Cargle (1996) investigated the impact of Hurricane Hugo on insurance firm values. Unlike the above earthquake studies, these hurricane studies found significant *negative* abnormal returns for exposed insurers and insignificant responses for unexposed insurers.

3. Japanese Earthquake Insurance

Japan has frequently suffered from big earthquakes. For example, the Kanto Great earthquake, which struck the Tokyo Metropolitan area in 1923 killed 99,331 people and left 43,476 missing. The financial losses were estimated at about 5.5 billion yen, which was three and a half times as large as the annual expenditures of the national government, or 36.8% of GNP at that time.⁶

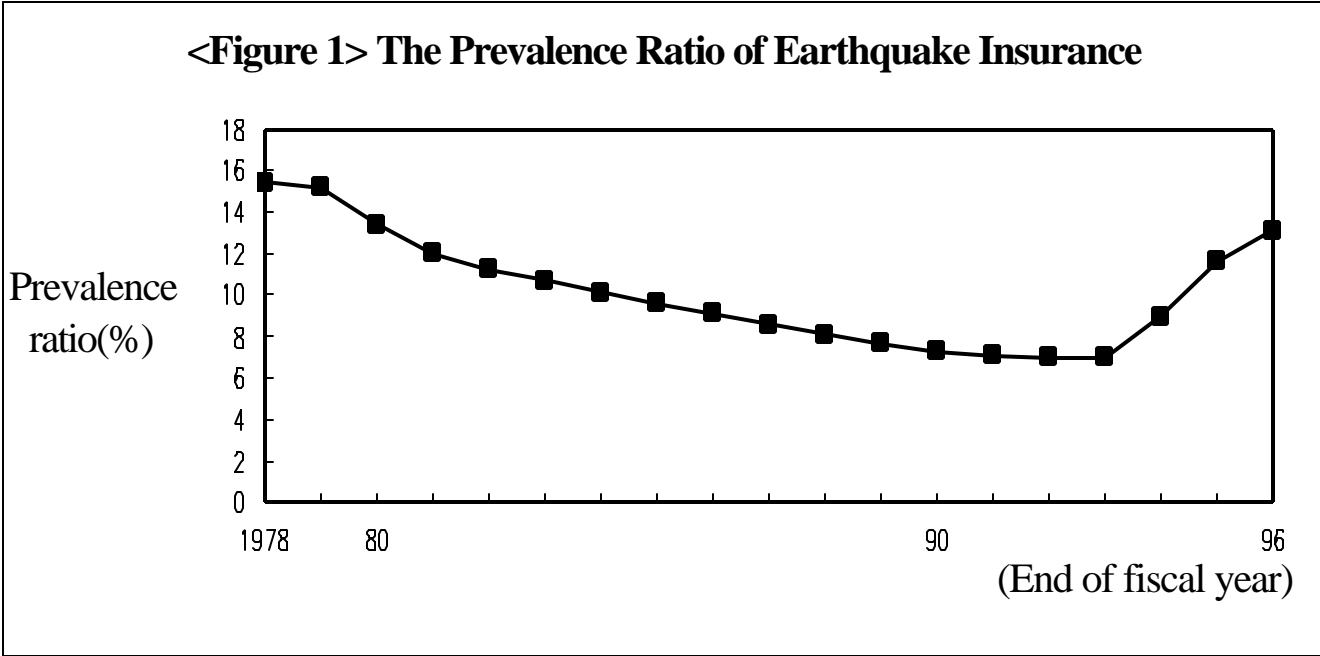
Although the earthquake insurance was badly needed for many years, private insurers hesitated to provide earthquake insurance coverage because the damage could be too large and widespread. Finally, responding to the political pressure after the 1964 Niigata earthquake, the Japanese government proposed the establishment of the Japanese Earthquake Insurance Act and the Earthquake Insurance Act was made effective in 1966. The Earthquake Insurance Act had been reformed several times since its establishment. The character of the Earthquake Insurance at the time of the Hanshin-Awaji earthquake was as follows.

- (1) The Earthquake Insurance covered only residential buildings and household belongings. Only for people who buy fire insurance are eligible for earthquake insurance coverage. Japanese fire insurance does not cover any losses caused by an earthquake. For example, when a house was lost due to a fire caused by an earthquake, the insurer would pay only 5% of total losses as a solatium or an Earthquake Fire Expenses Insurance.⁷

⁶ GNP in 1923 is estimated 14.9 billion yen. The source is *Estimates of Long-Term Economic Statistics of Japan Since 1868, Vol.1*, edited by K. Ohkawa, N. Takayama, and Y. Yamamoto (Toyo Keizai Shinposha, Tokyo, 1974).

⁷ Strictly speaking, there is a 3-million-yen limit for this solatium.

- (2) The Earthquake Insurance provision covered only 30-50% of losses and the maximum coverage was 10 million yen for residential buildings and 5 million yen for household belongings.
- (3) The high cost of earthquake insurance has limited coverage. For example, a yearly insurance premium for a timber house of 10 million yen in Tokyo was 47,500 yen. Therefore, only 16.0% of houses in Tokyo, 2.99% in Hyogo, and 4.91% in Osaka carried the Earthquake Insurance protection when the Hanshin-Awaji earthquake occurred.
- (4) These low ratios of coverage provided room for subsequent increased demand for earthquake insurance. In fact, Figure 1 shows that the prevalence ratio decreased before the Hanshin-Awaji earthquake, and increased after the earthquake. Therefore, it is possible that insures “gained from loss.”



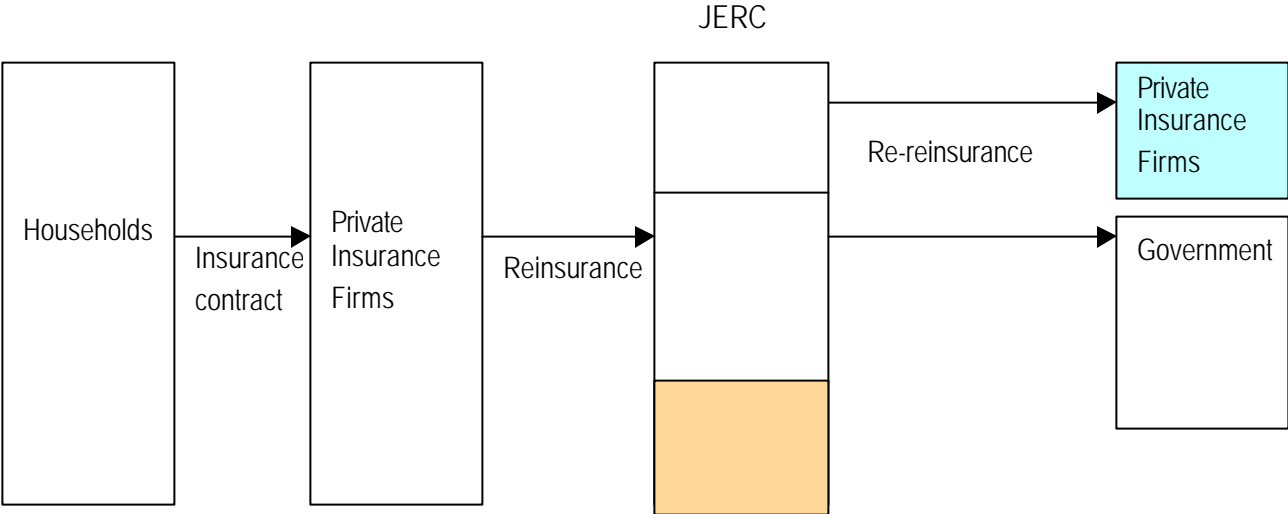
Notes 1. The prevalence ratio = the number of earthquake insurance contracts / total number of households in Japan.
 2. Source: *Kinyu Nenpo* (Finance Annual), published by Kinyu Zaisei Jijo Kenkyukai.

(5) The earthquake insurance premiums were controlled at the “no loss, no profit” level by the government. If the earthquake insurance premiums that insurance companies received were greater than the payments after netting out the payments and receipts of reinsurance, all the “profit” of the insurance firms regarding the earthquake insurance were kept in the firms as special reserves for future earthquake insurance payments.

Because of the “no loss, no profit” policy, the increased sales of earthquake insurance were expected to have only a marginal positive effect on insurance companies because the government permitted them to take only 10% of the premium as a sales fee.⁸

(6) The Earthquake Insurance system was constituted to limit the risks of private insurance companies. When a private insurer assumes an earthquake risk, the insurer reinsures all the risk with the Japan Earthquake Reinsurance Co. Ltd. (JERC), which was established and managed by the Marine and Fire Insurance Association of Japan. The JERC re-reinsures a small part of the risks with private insurance companies and a substantial portion of them with the Japanese government. (See Figure 2).

<Figure 2> The Structure of Japanese Earthquake Reinsurance

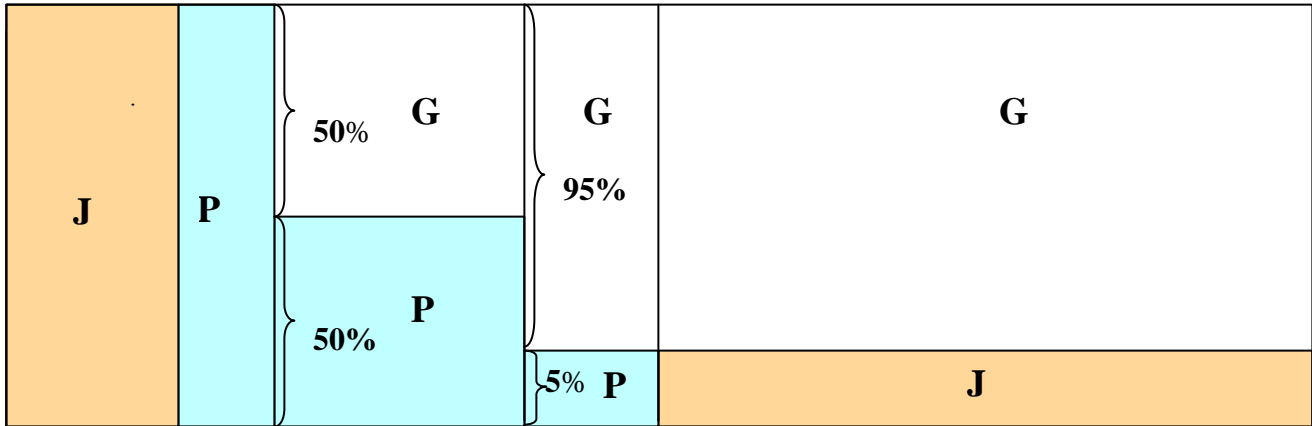


Source: *Kinyu Business* (Financial Business) published by Toyo Keizai Shinposha, April 1995.

⁸ Another 10% can be paid to insurance agents to compensate their sales efforts.

<Figure 3> The Risk Sharing Structure of Earthquake Risks

40	66	336	476	1.8
billion	billion	billion	billion	trillion
yen	yen	yen	yen	yen



Notes: J: Japan Earthquake Reinsurance Co. Ltd.
P: Private insurance firms.
G: Japanese Government.

4. Data and Methodology

(1) Data

Following previous studies, we use the standard event study methodology to investigate the impact of the Hanshin-Awaji earthquake on the equity values of Japanese insurance firms.

We found 15 publicly-held property-liability insurers, one of which is traded on the OTC market and the others are listed at the Tokyo Stock Exchange. Two insurers, whose stocks were thinly traded, were eliminated from the sample of this study. Except for insurance firms headquartered in Okinawa, most Japanese insurers operate nation-wide. Therefore, all insurance companies in our sample have several branches in the Hyogo and Osaka prefectures.

Standard event-study methodology is applied to calculate the abnormal returns around the earthquake. We use the Tokyo Stock Exchange Price Index (TOPIX) to calculate daily market portfolio returns.

(2) Event Study Methodology

The earthquake occurred in the Hanshin-Awaji area in the early morning on January 17 (Tuesday), 1995. As the stock markets were not open at that time, January 17 is set as the event date ($t=0$).

According to the standard market model, the return of each security can be expressed as follows.

$$R_{it} = \mathbf{a}_i + \mathbf{b}_i r_{mt} + \mathbf{e}_{it}, \quad (1)$$

where R_{it} is the return of security i and r_{mt} is the return of TOPIX on date t .⁹ Using the 150 trading days ending 10 trading days prior to the event day as an estimation period, we estimate the above equation and obtain the parameters \mathbf{a}_i and \mathbf{b}_i .

The abnormal return for security i on date t is defined as the difference between the actual return and the predicted return:

$$AR_{it} = R_{it} - \mathbf{a}_i - \mathbf{b}_i r_{mt}.$$

The average abnormal return (AAR) for date t is calculated as follows.

$$AAR_t = \frac{1}{N} \sum_{i=1}^N AR_{it},$$

where N is the number of firms in the sample.

The standard deviation of the daily prediction error is estimated as:

$$S_t = \left\{ \mathbf{s}^2 \left[1 + \frac{1}{150} + \frac{(r_{mt} - \bar{r}_m)^2}{\sum_{s=-11}^{-160} (r_{ms} - \bar{r}_m)^2} \right] \right\}^{1/2}$$

where \mathbf{s}^2 is the residual variance from estimating the market model for portfolio j using trading days $s = -11, \dots, -160$ and \bar{r}_m is the mean return on TOPIX during this period.

⁹ R_{it} is defined as follows.

$$R_{it} = \log(P_{it}) - \log(P_{it-1}).$$

Here, P_{it} is the closing price of security i on day t .

Assuming that the prediction errors are normally distributed, the standardized prediction errors will be distributed as a t-distribution for a small sample and as unit normal for a large sample under the null hypotheses that the earthquake had no effect on portfolio returns. Therefore, the following Z test statistic is calculated to measure if the AAR is significantly different from zero.

$$Z_t = \frac{AAR_t}{S_t} .$$

The cumulative abnormal return for days t_1 and t_2 , $CAR(t_1, t_2)$, is calculated as:

$$CAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AAR_t .$$

The test statistic to measure if the CAR is significantly different from zero is:

$$Z_k = \frac{\sum_{t=t_1}^{t_2} AAR_t / S_t}{\sqrt{k}}$$

where k is the number of days in period (t_1, t_2) .

(3) Market Response and Exposure

One of the main questions addressed by the literatures is whether the market reaction depends on the exposure to a catastrophic event. This is of interest for several reasons.

First, addressing this question sheds light on the Japanese stock market's ability to discriminate among insurers based on their exposures. As it is commonly believed that the Japanese stock market is not as sophisticated as its U.S. counterpart, its ability to discriminate is unclear.

Second, the previous results are mixed in terms of the relationship between exposure and market response. The four earthquake studies surveyed in Section 2 concluded that the U.S.

stock market regarded exposed insurance firms more favorably than unexposed firms, while the two hurricane studies surveyed in Section 2 reached the opposite conclusion.

Therefore, it is interesting to investigate the relationship between market response and insurers' exposure to catastrophic events. However, Japanese insurers have not disclosed the actual amount of insurance payments caused by the Hanshin-Awaji earthquake, or the amount of exposure in the Hanshin-Awaji area. We use the following three variables as alternative measures of the exposure.

(i) Employees at Disaster Location

The annual report of each insurer provides information about the number of employees working at each branch. Firms that hired many employees in Hyogo and Osaka might underwrite a large magnitude of insurance and thus have a high exposure in the area. As a rough measure of vulnerability to the Hanshin-Awaji earthquake, the ratio of employees working at offices in Hyogo and Osaka to total employees is calculated. Data on employees at the end of fiscal year 1993 (March 31, 1994) are obtained from the annual reports of every firm.

That is, the first measure of exposure, EMPY, is defined as:

$$\text{EMPY} = \frac{\text{Numbers of employees working at offices in Hyogo and Osaka}}{\text{Total employees}}$$

The high-exposure portfolio consists of six insurers with values greater than the median. A low-exposure group includes the remaining seven insurers.

(ii) Fire Insurance

In Japan, homeowner's standard fire insurance policy essentially does not cover losses due to an earthquake. However, earthquake insurance must be accompanied by homeowner's fire insurance. Hence insurers that had written a large amount of fire insurance might have large exposure to the earthquake. We calculate the ratios of written premiums of fire insurance (including earthquake insurance) to total premiums. Data on premiums in fiscal year 1994 (from

April 1, 1994, to March 31, 1995) are obtained from the annual report of each firm.

$$\text{FIRE} = \frac{\text{Net premium income of fire insurance}}{\text{Total net premium income}}$$

The high-exposure portfolio consists of six insurers with values greater than the median. A low-exposure group includes the remaining seven insurers.

(iii) Ex Post Earthquake Insurance Payment

In fiscal year 1994, claims paid by the thirteen insurers in our sample amounted to 84.9 billion yen in terms of earthquake insurance policy.¹⁰ However, as substantial parts of the claims were recovered through reinsurance, the net claims paid are small relative to the capital of insurers (i.e., 2.4 trillion yen at the end of March 1994).

Data on net claims paid as earthquake insurance in fiscal year 1994 and total capital at the end of fiscal year 1993 are obtained from *Hoken Nenkan (Insurance Annual)*.¹¹ Therefore, our third measure is as follows.

$$\text{PAID} = \frac{\text{Net claims paid in fiscal year 1994}}{\text{Total capitals}}$$

Note that other insurance policies, such as the Earthquake Fire Expenses Insurance and some kinds of cargo insurance, also cover some losses caused by an earthquake. Therefore, this measure does not completely indicate the payments for the losses due to the earthquake.

Table 1 shows these three ratios of insurance firms in our sample.

¹⁰ The figure includes small payments for losses due to other earthquakes.

¹¹ This is edited by the Life Insurance Association of Japan and the Marine and Fire Insurance Association of Japan and published by Ohkura Zaimu Kyokai

<Table 1> Exposure Ratios

	Employee (%) EMPY	Net premium income (Fire insurance) (%) FIRE	Net claim paid (earthquake)(%) PAID
Chiyoda Fire and Marine	9.33	14.88	0.54
Dai-Tokyo Fire and Marine	5.24	12.13	0.65
Dowa Fire and Marine	20.40*	17.55*	0.76
Fuji Fire and Marine	21.19*	16.60*	1.81*
Koa Fire and Marine	12.54*	26.30*	0.84*
Mitsui Marine and Fire	12.25*	13.25	0.78
Nichido Fire and Marine	10.19	22.21*	1.60*
Nippon Fire and Marine	10.67*	16.22*	0.60
Nissan Fire and Marine	8.13	14.97	1.24*
Nissin Fire and Marine	10.60	17.66*	0.93*
Sumitomo Marine and Fire	14.00*	15.44	0.69
Tokio Marine and Fire	10.28	11.99	0.59
Yasuda Fire and Marine	9.36	12.99	0.93*

* High-exposure group.

5. Results

Table 2 shows the result for the full sample. It is obvious that the average abnormal return on date 0 (i.e., the day of the earthquake) was highly significant and negative. This negative abnormal return (-2.8%) is sharply contrasted with previous studies investigating U.S. insurers' stock price responses to the earthquakes.

<Table 2> Reaction to the Hanshin-Awaji Earthquake: Full sample

Event date	Average abnormal returns	t-value	Cumulative average abnormal returns
0	-0.0272	-6.0724***	-0.0272***
1	-0.0039	-0.8621	-0.0310***
2	0.0046	1.0119	-0.0264***
3	0.0034	0.7505	-0.0230**
4	-0.0059	-1.1302	-0.0289***
5	0.0083	1.8193*	-0.0206*
6	-0.0059	-1.3122	-0.0265**
7	-0.0021	-0.4722	-0.0287**
8	0.0004	0.0993	-0.0282**
9	-0.0080	-1.6153	-0.0362**

(Notes) *** Significant at 1% level.
 ** Significant at 5% level.
 * Significant at 10% level.

Table 2 also demonstrates that the market was quite efficient in assessing the information produced by the Hanshin-Awaji earthquake, as the significant response was concentrated only on Date 0. The third column of Table 2 shows cumulative abnormal returns (CAR) during the post earthquake period. CARs are significantly negative.

Tables 3, 4, and 5 show the difference in the stock price responses between insurers that had high and low exposures. Irrespective of proxies measuring the degree of exposure, the results are almost the same. That is, the significant negative abnormal returns were recorded only on date 0 for both the highly exposed sample and the less exposed sample.

**<Table 3> Reaction of the Hanshin-Awaji Earthquake and Exposure:
Exposure Measure = EMPY**

Event date	High-exposure group			Low-exposure group		
	Average abnormal returns	t-value	Cumulative abnormal returns	Average abnormal returns	t-value	Cumulative abnormal returns
0	-0.0270	-4.3926***	-0.0270***	-0.0273	-5.3963***	-0.0273***
1	-0.0082	-1.3304	-0.0352***	-0.0001	-0.0276	-0.0274***
2	0.0082	1.3180	-0.0271**	0.0015	0.2870	-0.0259***
3	-0.0010	-0.1561	-0.0280**	0.0072	1.3974	-0.0188*
4	0.0016	0.2177	-0.0265*	-0.0122	-2.0860**	-0.0310**
5	-0.0011	-0.1675	-0.0275*	0.0162	3.1668**	-0.0147
6	-0.0118	-1.9023*	-0.0393**	-0.0009	-0.1702	-0.0156
7	-0.0079	-1.2809	-0.0472***	0.0028	0.5619	-0.0128
8	0.0021	0.3454	-0.0451**	-0.0010	-0.1977	-0.0138
9	-0.0044	-0.6404	-0.0495**	-0.0111	-1.9873**	-0.0249

(Notes) *** Significant at 1% level.
 ** Significant at 5% level.
 * Significant at 10% level.

**<Table 4> Reaction to the Hanshin-Awaji Earthquake and Exposure:
Exposure Measure = FIRE**

Event date	High-exposure group			Low-exposure group		
	Average abnormal returns	t-value	Cumulative abnormal returns	Average abnormal returns	t-value	Cumulative abnormal returns
0	-0.0277	-4.6074***	-0.0277***	-0.0267	-5.1619***	-0.0267***
1	-0.0134	-2.2248**	-0.0411***	0.0043	0.8368	-0.0223***
2	0.0072	1.19275	-0.0339***	0.0023	0.4355	-0.0201**
3	0.0005	0.08125	-0.0334***	0.0059	1.1259	-0.0142
4	0.0023	0.3312	-0.0311**	-0.0128	-2.1487**	-0.0270**
5	-0.0043	-0.7080	-0.0354**	0.0190	3.6335***	-0.0080
6	0.0034	0.5538	-0.0320**	-0.0139	-2.6639***	-0.0218
7	-0.0104	-1.7281**	-0.0425**	0.0050	0.9675	-0.0168
8	-0.0019	-0.3233	-0.0444**	0.0025	0.4827	-0.0144
9	-0.0086	-1.2863	-0.0530***	-0.0075	-1.3125	-0.0219

(Notes) *** Significant at 1% level.
 ** Significant at 5% level.
 * Significant at 10% level.

**<Table 5> Reaction to the Hanshin-Awaji Earthquake and Exposure:
Exposure Measure = PAID**

Event dates	High-exposure group			Low-exposure group		
	Average abnormal returns	t-value	Cumulative abnormal returns	Average abnormal returns	t-value	Cumulative abnormal returns
0	-0.0250	-4.6898***	-0.0250***	-0.0291	-4.9828***	-0.0291***
1	-0.0034	-0.6319	-0.0283***	-0.0043	-0.7339	-0.0333***
2	0.0057	1.0661	-0.0226**	0.0036	0.6077	-0.0298***
3	0.0140	2.5859**	-0.0086	-0.0057	-0.9534	-0.0354***
4	-0.0153	-2.4791**	-0.0239*	0.0022	0.3290	-0.0332**
5	0.0079	1.4657	-0.0160	0.0085	1.4453	-0.0246*
6	-0.0024	-0.4402	-0.0183	-0.0090	-1.5251	-0.0336**
7	-0.0066	-1.2423	-0.0249	0.0017	0.2990	-0.0319*
8	-0.0040	-0.7464	-0.0289*	0.0042	0.7252	-0.0276
9	-0.0113	-1.9161*	-0.0402**	-0.0052	-0.8025	-0.0328*

(Notes) *** Significant at 1% level.
 ** Significant at 5% level.
 * Significant at 10% level.

These tables also demonstrate that the market was quite efficient in assessing the information produced by the Hanshin-Awaji earthquake, as the significant response was concentrated only on date 0. All CAR(0,1) in these tables are significant and negative for both highly exposed firms and less exposed firms.

Tables 3, 4, and 5 seem to suggest that the highly exposed firms recorded a larger negative stock price reaction than the less exposed firms. To test this observation formally, following previous studies, we regress CAR(0,1) on the three measures of exposures by using the ordinary least squares method. The numbers in the parentheses are standard errors.

$$\text{CAR} = -0.002431 - 0.00205 \text{FIRE}, \quad R^2 = 0.1942 \\ (0.001258)$$

$$\text{CAR} = -0.02519 - 0.0004898 \text{EMPL}, \quad R^2 = 0.0136 \\ (0.0012578)$$

$$\text{CAR} = -0.03018 - 0.00089 \text{PAID}, \quad R^2 = 0.0003 \\ (0.01438)$$

All coefficients of the three measures are negative, though insignificant. This estimation result has sharply different implications from the U.S. earthquake results. Namely, the high exposure group in Japan recorded larger negative cumulative abnormal returns than the low exposure group. This is rather similar to the results of the U.S. hurricane studies.

Therefore, we can reject the hypothesis that Japanese insurers benefit from a catastrophic event, at least in the case of the Hanshin-Awaji earthquake.

6. Concluding Remarks

This paper is the first attempt to investigate the reaction of insurer stock prices in a non-U.S. market to a big earthquake. That is, we investigated the impact of the 1995 Hanshin-Awaji earthquake on Japanese insurance companies.

The Hanshin-Awaji earthquake resulted in a significant negative stock price response for Japanese property-liability insurance companies. This is inconsistent with previous studies dealing with the San Francisco earthquake and the Los Angeles earthquake, but consistent with the studies dealing with hurricanes.

Although the Japanese insurance system limits the insurers' financial obligations due to an earthquake, investors and regulators should have serious concerns about the potential impact of our expected strong earthquakes on the financial condition of Japanese insurance firms.

Also, our results demonstrate that Japanese stock markets are highly efficient in assessing the new information generated by the Hanshin-Awaji earthquake.

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