

On Household Insurance Demand and Loss Control: Evidence from the Great East Japan Earthquake^{*}

YingYing Jiang^a, Yoshihiro Asai^b, Souichiro Moridaira^c

^a *Hitotsubashi University, Japan*

yycommerce@hotmail.com

^b *Meiji University, Japan*

yasai@meiji.ac.jp

^c *Waseda University, Japan*

moridaira@waseda.jp

ABSTRACT

After Japan's largest ever-recorded earthquake on March 11, 2011, a most devastating tsunami hit Japan. Almost 20,000 people died from the combined earthquake, tsunami, and nuclear crisis. As of January 2013, almost 300,000 people made homeless by the disaster continue to live in emergency housing. In this paper, we report the results of a survey of 1,278 Japanese households and analyze insurance demand and loss control following the Great East Japan Earthquake. We find that several respondents newly purchased earthquake insurance and undertook a number of loss-control activities in light of the Great East Japan Earthquake. We also find that people consistently prefer loss-control activities to earthquake insurance as risk management tools. However, while the purchase of earthquake insurance and the engagement in some types of earthquake-related loss control, such as the seismic strengthening of houses, are associated with higher income.

JEL Classifications: D80, G22

Keywords: earthquake insurance; loss control; the great east japan earthquake

^{*} The authors gratefully acknowledge the financial support of the Dai-ichi Life Insurance Company Limited and the Dai-ichi Life Research Institute of Japan, and also a Grant-in-Aid for Scientific Research (KAKENHI) (Young Scientists (B), #23730303). The authors also thank participants in regular meetings of International Project of Insurance Studies held at Hitotsubashi University and two anonymous reviewers for their useful comments and suggestions. The usual disclaimer applies.

I. INTRODUCTION

After Japan's largest ever-recorded earthquake on March 11, 2011, a most devastating tsunami hit Japan. Almost 20,000 people died from the combined earthquake, tsunami, and nuclear crisis. As of January 2013, almost 300,000 people made homeless by the disaster continue to live in emergency housing. In addition, since the nuclear disaster at Fukushima, the authorities in Japan have shut down 52 of its 54 nuclear power plants for security checks. Overall, the Great East Japan Earthquake generated 17 trillion yen (170 billion US dollars) of damage in Japan alone. By comparison, Hurricane Katrina killed 1,800 people and accounted for 100 billion US dollars of damage. As a result, the Great East Japan Earthquake of March 2011 is easily the worst natural disaster in a developed country in recent history in terms of both the number of fatalities and the amount of economic damage.

However, while there has been some study of risk-management activities in light of other natural disasters such as floods and hurricanes, especially in the US, including Useem and Kunreuther (2009), few studies address risk-management process in relation to earthquakes. Thus, the novelty of our paper is to provide evidence on insurance demand and loss control following the Great East Japan Earthquake and empirically explore the relationship between loss finance, such as the purchase of earthquake insurance, and loss control, including seismic-strengthening works, using a unique data set. Our data on Japanese household insurance demand and loss control was obtained from a questionnaire survey conducted by MyVoice Communications¹. This survey, administered in Japan in January 2013, affords us a window of research inquiry simply not available in prior studies.

In short, the unique contribution of our paper is that by using household data from a part of the world where earthquakes occur frequently, we analyze the underlying mechanism that drives people to engage in risk-management activities. Other studies tend to focus on the efforts of local governments to reduce damage arising from natural disaster using data from these same governments. We depart from these conventional approaches by directly testing whether loss-control activities at the household level are associated with greater insurance demand.

We find that the purchase of earthquake insurance and engagement in loss control, such as the seismic strengthening of houses, are associated with higher levels of household income. In other words, both earthquake insurance and loss-control measures are normal goods. In particular, we find that more than 40% of high-income households whose income is over 10 million yen undertake loss control. That is, at higher levels of income, households are well prepared against the costs of earthquakes through loss control and/or loss finance. Following the Great East Japan Earthquake in March 2011, several households newly purchased earthquake insurance and conducted additional loss-control activities, again especially at high income levels. However, we also find that the correlation between these alternative risk-management tools (insurance demand and loss control) is low. Therefore, it would appear that in Japanese households, decisions on the purchasing of earthquake insurance take place separately from those of loss-control measures such as seismic strengthening. We also find that the loss coverage ratio suggested by earthquake insurance is not associated with the level of income.

The remainder of the paper is organized as follows. In Section II, we survey the

existing literature. Section III briefly introduces the data used in the analysis. In Section IV, we provide descriptive statistics on the household earthquake insurance demand and loss-control activities before or after the Great East Japan Earthquake. We also discuss some related issues concerning both insurance demand and loss control. The final section concludes.

II. PREVIOUS RESEARCH

The recent literature on risk management against natural disasters has placed relatively more emphasis on the importance of flood insurance. For example, Grace, Klein, and Kleindorfer (2004) find that consumers purchase more disaster insurance when subsidized through regulatory price constraints. Alternatively, Kriesel and Landry (2004) conclude that proximity to the shoreline, the existing community response to erosion and storm risk, and the requirements of mortgage lenders are important factors in flood insurance demand. Landry and Jahan-Parvar (2011) also suggest that the level of flood and erosion risk increases demand for insurance, while Michel-Kerjan and Kousky (2010) determine that households in Florida choose very low deductibles on flood insurance. In general, most of these studies have focused on whether loss-control activities at the community level promote insurance demand. The limited information on loss control and earthquake insurance at the household level is because of longstanding data constraints.

In response, some other studies have indirectly attempted to estimate the changes in insurance demand using stock market data (Shelor, Anderson and Cross, 1992; Aiuppa, Carney and Krueger, 1994; Aiuppa and Krueger, 1995; Yamori and Kobayashi, 2002). However, these studies do not precisely detect the actual change in insurance demand as they estimate the change in insurance demand at the population average. Our original survey data addresses this problem long faced by extant studies, and therefore enables us to focus on earthquake insurance demand and loss control directly following the incidence of an earthquake.

Some recent studies also shed light on activities directed at loss control, such as seismic strengthening. For example, Asai and Okura (2011) theoretically show that firms have sufficient incentive to conduct loss control in certain environments. Standard risk management textbooks, such as Harrington and Niehaus (2007) and Skipper and Kwon (2007), classify risk management into “loss control” and “loss finance” and emphasize the relative importance of loss control (seismic strengthening, etc.) and loss finance (earthquake insurance). However, despite the theoretical importance of risk management, there has been little direct empirical research concerning the role of earthquake insurance or loss control, especially at the household level. In addition, empirical evidence on household insurance demand outside the US is very limited².

According to the *Disaster Management in Japan 2011*, the earthquakes in Japan account for about 20% of all earthquakes taking place around the world. In other words, Japan is located in a part of the world where earthquakes occur frequently. Japan is then a suitable market to investigate earthquake insurance purchase, as any findings will at least equally applicable to similar experiences in California, Taiwan, Mexico, Iceland, Spain, and Turkey, among others. The global reinsurance company, Swiss Re (2012), also reports that Japan is the second largest insurance market in the world³. Strangely, there has been little research on household insurance using data from this major market⁴.

The present study is then not only unique in accessing household data hitherto unavailable, but also by addressing uncharted territory in the form of one of the world's largest insurance markets. In short, we attempt to fill these critical gaps in knowledge by utilizing a unique data set from a national context comprising both frequent experience of earthquakes and large and developed natural disaster insurance markets.

In terms of related studies, only Naoi, Seko, and Ishino (2012) find that high-income households are more likely to "plan the purchase of earthquake insurance" or to conduct seismic retrofitting of housing using data after the Great East Japan Earthquake. However, they do not investigate actual insurance purchases nor do they address the relationship between loss control and purchase of insurance. In contrast, we provide evidence on both the actual purchase of earthquake insurance and the relationships between alternative earthquake-related risk-management tools.

III. DATA

Our analysis utilizes the Survey of Household Risk Management Issues in the aftermath of the Great East Japan Earthquake conducted in January 2013 with the financial support of the Dai-ichi Life Insurance Company Limited and the Dai-ichi Life Research Institute of Japan. The collection of the survey data was through a questionnaire of risk-management activities of married households in Japan, with the conduct of the survey outsourced to MyVoice Communications, a professional Web survey company. The distribution and collection of questionnaires was by email. As a result, MyVoice Communications collected data on 1,369 households from throughout Japan. However, we removed the data of 91 households in the original sample because the respondents obviously did not respond properly to the questions in the survey. The final sample used in the baseline analysis comprises data from 1,278 married households.

The Appendix 2 includes a copy of the questionnaire. In the questionnaire, we included questions concerning the basic characteristics of the household, such as age, the level of education, the number of dependents, and the household's financial condition. We also included risk-management factors such as insurance purchase and specific measures taken by the household to prevent or mitigate damage arising from natural disasters. As discussed, we administered the survey two years after the Great East Japan Earthquake. This enables us to undertake a dynamic examination of the risk-management activities of Japanese households that has not been performed in existing studies.

The survey data shows that many of the respondents live in metropolitan areas (Figure 1). For example, 45.2% and 19.2% of the survey respondents are respectively from cities, towns, and other areas in the Kanto region (including Tokyo, Japan's largest city) and the Kinki region (including Osaka, Japan's third-largest city). According to the earthquake prediction published by the Headquarters for Earthquake Research Promotion, a special department in the MEXT of Japan, both of these regions have a high probability of an earthquake in the near future⁵.

The survey respondents are distributed over all age groups of the working population (Figure 2). We remove households with respondents aged less than 20 years or over 80 years from our sample because, as Hau (2000) finds, these generations are not important in terms of insurance demand. About 50.1% of the respondents in the sample are the principal householder while the remainders are spouses of the

householder. Most respondents are concentrated in the following annual income classes: 3–5 million yen (34.6%), 3–5 million yen (24.9%), and 7–10 million yen (19.2%) (Figure 3). The socioeconomic distribution of our sample is broadly consistent with the results in the government population census and other surveys, thereby indicating the reliability of our data. In other words, the characteristics of the survey respondents in this analysis reflect population conditions prevailing in Japan.

Figure 1
Regional distribution of respondent Households

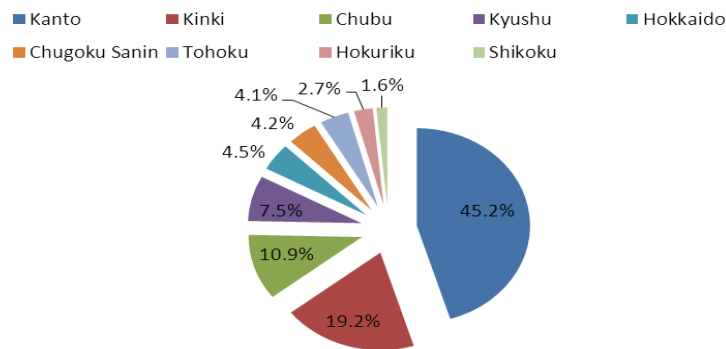


Figure 2
Distribution of respondent age

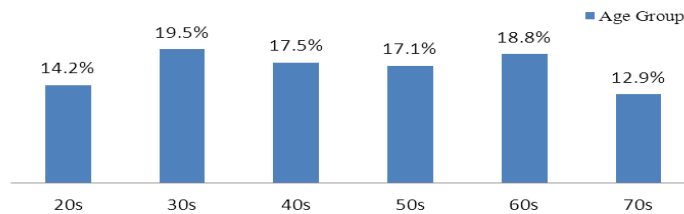
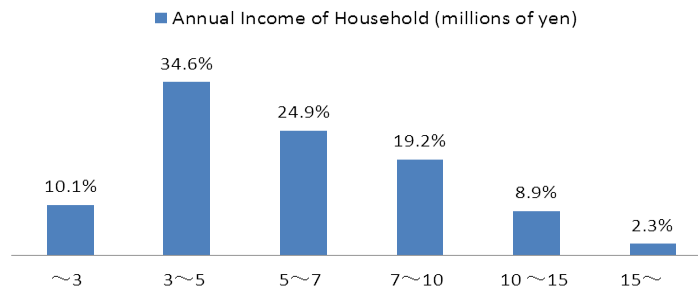


Figure 3
Distribution of respondent household annual income



IV. EMPIRICAL RESULTS

A. Insurance Purchase and Household Income

In this section, we provide several simple statistics concerning insurance purchase and loss control. As numerous existing studies suggest that insurance purchase is significantly associated with the level of income, in this section we mainly analyze insurance purchase and loss control in terms of income level. More than 80% of respondent households did not suffer any damage in the March 11, 2011 earthquake, despite relatively more respondents having had previous experiences of loss from other natural disasters, regardless of income (Table 1).

Table 1
Loss experience from natural disasters

Household Annual Income (millions of yen)	<3	3~5	5~7	7~10	10 ~15	15<
Loss experience from March 11 earthquake						
Yes	16.3%	15.2%	15.4%	18.7%	17.5%	20.7%
No	83.7%	84.8%	84.6%	81.3%	82.5%	79.3%
Loss experience from other natural disasters						
Yes	24.8%	14.0%	17.3%	20.7%	26.3%	10.3%
No	75.2%	86.0%	82.7%	79.3%	73.7%	89.7%

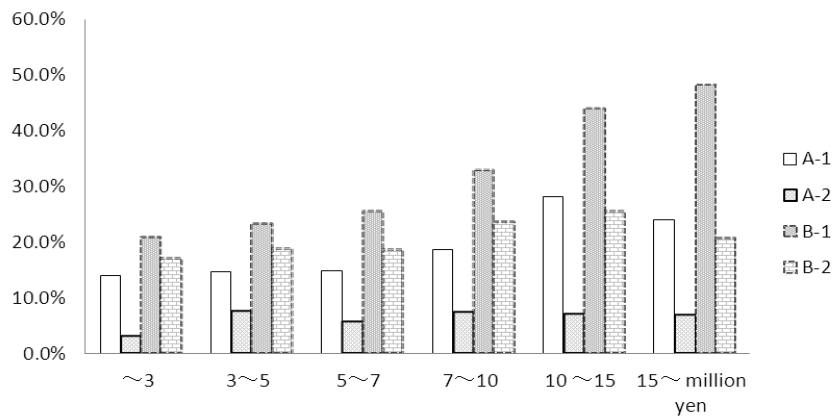
Figure 4 depicts the risk-management activities taken against earthquakes “before” and “after” the Great East Japan Earthquake. Many respondents had already purchased earthquake insurance policies before the earthquake (Figure 4, A-1). After the earthquake, there was no significant increase in the purchase of earthquake insurance and little difference in purchases across the various income classes (Figure 4, A-2). On average, Japanese households have not significantly changed their insurance purchase behavior, and rationally purchase earthquake insurance and conduct household loss-control activities even after the earthquake (Figure 4, B-2).

Figure 4 indicates some interesting tendencies concerning loss-control activities undertaken in light of earthquakes, including earthquake resistance checks and reinforcement work and/or reconstruction. Loss-control activities before the earthquake (Figure 4, B-1) appear more closely associated with the level of income level than the purchase of earthquake insurance. As far as we are aware, few existing studies have considered these broader risk-management activities in relation to earthquakes and other natural disasters.

According to the Japan Meteorological Agency, the aftershocks of the March 11, 2011 earthquake are ongoing. Under these circumstances, we set some questions regarding the possibility that another large earthquake may take place in the future. Unsurprisingly, 62.8% of respondents believed that another large earthquake would occur in future in their current area (Figure 5). The differences in responses to this

question by income class are not significant. On average, respondents from the different income class share similar beliefs concerning the probability of an earthquake. Only for persons with incomes in excess of 15 million yen did relatively more respondents answer “probably not” to the possibility of another large earthquake in the future. This is likely because they have already purchased houses in better and safer areas at some cost.

Figure 4
Earthquake risk-management activities



(A-1): Purchased earthquake insurance policy before March 11, 2011 earthquake.
 (A-2): Purchased earthquake insurance policy after March 11, 2011 earthquake.
 (B-1): Loss-control activities against earthquake risk before March 11, 2011 earthquake.
 (B-2): Loss-control activities against earthquake risk after March 11, 2011 earthquake.

Figure 5
Prediction concerning the likelihood of an earthquake in the current area

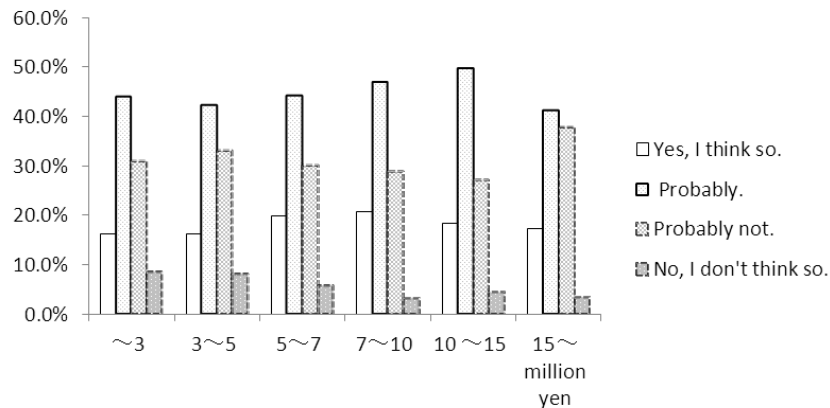


Table 2
Forecast of future earthquake damage

Household Annual Income (millions of yen)	Damage Caused by Earthquake					
	<3	3~5	5~7	7~10	10 ~15	15<
A-1	21.7%	13.1%	11.9%	9.3%	5.3%	0.0%
A-2	15.5%	17.6%	17.6%	15.4%	18.4%	3.4%
A-3	39.5%	38.0%	36.8%	37.0%	43.9%	41.4%
A-4	19.4%	26.7%	29.6%	33.3%	25.4%	48.3%
B-1	3.9%	4.5%	4.1%	4.9%	7.0%	6.9%

(A-1): My house may be destroyed.

(A-2): My house may be half-destroyed.

(A-3): My house may be damaged.

(A-4): Some damage may occur to my possessions, but not to the house.

(B-1): I do not think there will be any damage.

More than 90% of respondents irrespective of the level of annual income were concerned that a future large earthquake would cause some damage to their property (including house and belongings) (Table 2). However, the results differ across the various income classes. For example, the response rate for “My house may be destroyed completely (Table 2, A-1)” is zero for the over 15 million yen income class, whereas 21.7% of households in the less than 3 million yen income class consider that “My house may be destroyed completely.” Presumably, these households either cannot afford to take sufficient measures to counter earthquake risk or are reluctant to do so because of the lower values of their homes.

Interestingly, we found that only 36.7% of household respondents were well aware of the earthquake-resistant strength of their current home (Figure 6). All other things being equal, households with higher annual incomes tend to have greater knowledge of the earthquake resilience of their current home. It is reasonable to assume that higher-income households are more capable of collecting such information. We observe a similar tendency in knowledge of the earthquake hazard map for the current living area (Figure 7). However, it would appear that it is relatively easier for households to acquire knowledge of the earthquake hazard mapping of the family home, as 51.1% of respondents knew this information.

Despite showing relatively low interest on the issue of earthquake-resistance strength of their current home, approximately 90% of our respondents regardless of the income level are very concerned about it when considering to buy or to build a new house in future (Table 3). And about 60% of them even expect a higher level than that of their current houses, except the respondents with an over 15 million yen income whose houses are probably already strong enough to resist earthquakes. This result possibly reflects the subjective valuations of respondents on the investment of earthquake-resistant house. Namely, people would rather conduct such investment on a new house than the exiting one.

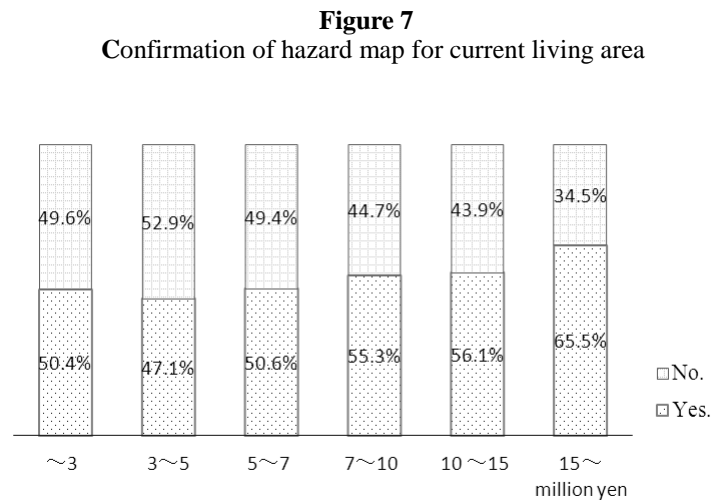
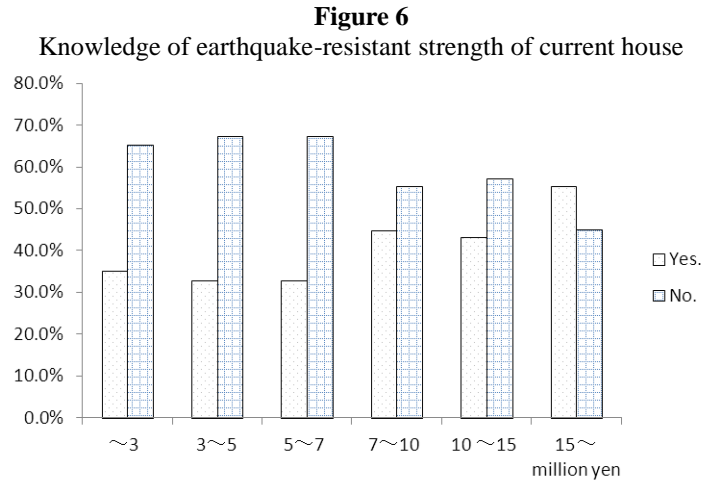


Table 3
Expectation of earthquake-resistant strength of new house purchases

Earthquake-resistance Strength Related	Household Annual Income (millions of yen)					
	<3	3~5	5~7	7~10	10~15	15<
A-1	2.3%	1.6%	0.6%	0.8%	1.8%	3.4%
A-2	27.1%	27.4%	29.9%	32.1%	28.9%	48.3%
A-3	61.2%	62.4%	59.1%	56.9%	60.5%	37.9%
B-1	9.3%	8.6%	10.4%	10.2%	8.8%	10.3%

(A-1): It is unnecessary to require the same level as the current house.

(A-2): It is necessary to require the same level as the current house.

(A-3): It is necessary to require a higher level than the current house.

(B-1): I have never thought about it.

Table 4
Policy expectations concerning earthquake-related repair expenses

Household Annual Income (millions of yen)	Policy Expected from Government				
	<3	3~5	5~7	7~10	10 ~15
A-1	31.8%	35.7%	27.0%	25.2%	8.8%
A-2	35.7%	32.4%	38.4%	43.5%	42.1%
A-3	28.7%	27.4%	27.0%	26.8%	41.2%
B-1	3.9%	4.5%	7.5%	4.5%	7.9%

(A-1): Government should provide a grant for repair expenses.

(A-2): Government should implement a tax reduction for repair expenses.

(A-3): Government should provide a lower interest loan than usual.

(B-1): Government does not need to get involved and we should manage our costs of repair ourselves.

However, in general, people tend to expect more or less assistance from their government after a severe disaster occurs irrelevant to their individual effort on managing such disaster. This tendency has also been observed in our survey. Table 4 provides details on the expectation of government assistance at the time of severe earthquakes. Regardless of household annual income, approximately 90% of respondent households expect some kind of government support. We can see that most respondents, irrespective of the income level, would prefer a policy of a tax reduction to direct funding from the government (Table 3, A-2). This preference for a tax reduction policy is particularly marked in the higher income class.

B. Simple Analysis of Earthquake Insurance Demand

The system of household earthquake insurance in Japan has several key characteristics. First, the government provides reinsurance⁶. Second, households are compelled to purchase earthquake insurance in conjunction with fire insurance. Third, there are limits on the level of coverage and the insured amount. For example, insurance covers only 30–50% of earthquake exposure and the maximum amounts insured for residential building and household belongings are 50 and 10 million yen, respectively⁷.

Outside Japan, Browne and Hoyt (2000) find that the decision of purchasing flood insurance is highly influenced by income and price besides the level of flood losses in the state during the previous year. Most recently, Kunreuther, Pauly, and McMorro (2013) shed light on the impact of behavioral factors on insurance demand. Thus, we also focus on several behavioral factors governing the purchase of earthquake insurance.

Respondents experienced in submitting insurance claims to insurers also tend to purchase insurance (Table 5). The difference in behavior between respondents who have (21.9%) and have not (13.4%) received payment for a prior insurance claim is statistically significant. This result is therefore consistent with similar work in Browne and Hoyt (2000). However, only about 7.0% and 6.2% of these same households respectively newly purchased new earthquake insurance after the earthquake. In general, some 6–7% of Japanese households newly purchased earthquake insurance after the Great East Japan Earthquake (Table 5).

Table 6 provides information on the relationship between the expectation of loss and insurance purchase. The result shown is rather surprising in that respondents who expected the complete destruction of their house tended not to purchase insurance unlike those who expected a partial destruction or losses to household belongings. Nevertheless, the earthquake insurance is still expected to play an important role in covering the loss resulted from the earthquake. Table 7 provides details on the relation between the purchase and loss coverage of earthquake insurance. All other things being equal, as the percentage of household losses covered by earthquake insurance increases, households become more likely to purchase an earthquake insurance policy. This indicates that the household loss coverage against severe earthquakes mainly results from the use of earthquake insurance⁸.

Table 5
Prior experience and the purchase of earthquake insurance

Experience of Claim Payment	Yes	No
Already Purchased	21.9%	13.4%
Newly Purchased	7.0%	6.2%

Table 6
Expected earthquake loss and the purchase of earthquake insurance

Damage Prediction	Percentage of All Households	Percentage of Insured Households
A-1	12.0%	11.8%
A-2	16.7%	18.2%
A-3	38.3%	16.6%
A-4	28.3%	20.7%
B-1	4.7%	3.3%

(A-1): My house may be destroyed.

(A-2): My house may be half-destroyed.

(A-3): My house may be damaged.

(A-4): Some damage may occur to my possessions, but not to the house.

(B-1): I do not think there will be any damage.

Table 7
Loss coverage and the purchase of earthquake insurance

Loss Coverage	Percentage of All Households	Percentage of Insured Households
0% ~10%	13.8%	3.4%
10% ~20%	15.6%	14.6%
20% ~30%	20.1%	16.3%
30% ~40%	16.1%	19.4%
40% ~50%	14.6%	29.0%
50% ~	19.9%	17.3%

Once a large earthquake and subsequent tsunami takes place, the lack of participation in insurance protection and loss mitigation by property owners prior to the disaster often creates major problems for both victims of the catastrophe and the government. The government is then likely to respond with costly, but poorly targeted, disaster assistance (Kunreuther, 1996, 2001; Kunreuther and Pauly, 2006; Michel-Kerjan and Kunreuther, 2011)⁹.

However, this does not exclude the possibility that persons who have anticipated the complete loss of a house may have already conducted loss-control activities such as seismic retrofitting and/or have saved funds to rebuild the house in the contingency of its damage or destruction. As results shown in Table 8, comparing to the respondents who do not expect government assistance, those who expect it are more likely to purchase earthquake insurance and/or conduct loss-control activities. This is a finding contrary to the prior studies such as Michel-Kerjan and Kunreuther (2011) and Botzen, Wouter and van den Bergh (2012) which suggest that the expectation of ex post public compensation on flood damage lowers the insurance demand and discourages the loss control activities.

Table 8
Government assistance and household risk-management activities

Expect Government Assistance	Purchased Earthquake Insurance	Conducted Loss-control Activities
Yes. (94.4%)	17.4%	28.8%
No. (5.6%)	6.9%	12.5%

In addition, we also found the loss control is consistently preferred to the insurance purchase regardless of the expectation of the government assistance. This is a plausible finding given that households face difficulties once a major earthquake takes place as it can cause serious damage and even loss of life. Nevertheless, we could not find the correlation between the loss-control activities and earthquake insurance purchase. The computed result of correlation coefficient is 0.256 which suggests that loss-control activities and insurance purchase are not complementary. In other words, loss-control activities and the purchase of insurance are substitute risk-management activities at the household level.

V. CONCLUDING REMARKS

In this paper, we attempt to investigate household insurance purchase and loss-control activities in the context of earthquake risk management by analyzing a survey of Japanese households conducted two years after the Great East Japan Earthquake. We also attempt to clarify whether government assistance influences household risk-management activities.

On balance, our empirical evidence is consistent with previous studies examining flood insurance behavior in the US. Specifically, insurance purchase and loss-control activities are both associated with the level of household income, though the relation between income and the latter is much stronger. This suggests that loss-control activities play a relatively more important role in household earthquake

risk management. Our evidence also indicates that as a method of risk management, the relation between loss control and insurance purchase is not complementary.

We believe the results obtained in this paper will be informative for other countries faced with the threat of earthquakes in designing disaster preparation and recovery policy. Some empirical challenges such as the application of regression analysis to the current or similar data sets are deferred to future work.

ENDNOTES

1. See company website, <http://www.myvoice.co.jp/>.
2. The few exceptions include Wang, Liao, Yang, Zhao, Liu, and Shi (2012) and Lee, Kwon, and Chung (2010).
3. Several studies have examined the Japanese insurance industry, including Lai and Piman (2003), Jeng and Lai (2005) and Pope and Ma (2005). For those interested in the Japanese earthquake insurance industry, see Yamori and Okada (2007).
4. Surprisingly, while some existing studies focus on household insurance demand using data from across a number of countries (Browne and Kim, 1993), few studies employ non-US data. This is probably because, unlike the US, detailed insurance data are not available in many countries and this makes it difficult to analyze insurance demand in a non-US environment. Put differently, there is likely to be significant bias in many previous studies. Our unique data set allows us to fill this gap in the literature by providing evidence on household insurance demand from a non-US context.
5. For more details, refer to <http://www.jishin.go.jp/main/index-e.html>. Also see Yamori and Kobayashi (2004) and Yamori and Okada (2007), for the recent situation of earthquake insurance market in Japan.
6. Private insurers in Japan exclusively provide earthquake insurance for the business enterprise sector.
7. For further information refer to the Web sites of the General Insurance Rating Organization of Japan or Japan Earthquake Reinsurance Co., Ltd.
8. As the maximum loss coverage of public earthquake insurance is 50%, 17.3% of respondents may have purchased private earthquake insurance in order to obtain better coverage.
9. Unlike our study, previous studies use data obtained through public disclosure. For instance, the data used in Kunreuther and Pauly (2006) and Michel-Kerjan and Kunreuther (2011) are from the US National Flood Insurance Program (NFIP), a government-funded disaster insurance program controlled by the US Federal Emergency Management Agency (FEMA).

APPENDIX

Q1. In what year was your house built?

- 1) Before 1950 2) 1951~1971 3) 1972~1981 4) 1982~1995
 5) 1996~2000 6) After 2001 7) I don't know or I don't remember

Q2. What do you know about the earthquake resistance of your current residential building?

- 1) Maybe it will collapse in an earthquake of M6.

- 2) Maybe it will not collapse in an earthquake of M6.
 - 3) Maybe it will not collapse in an earthquake of M7.
 - 4) I don't know about the earthquake resistance of my current residential building.
- Note: M6 and M7 are earthquakes with magnitudes of 6.0 and 7.0 on the Richter scale, respectively.

Q3. Are you currently living in an area with a high risk of natural disasters that could cause severe damage to your property?

- 1) Yes.
- 2) No.

Q4. Do you think there will be a major earthquake in your current residential area?

- 1) Yes, I think so.
- 2) Probably.
- 3) Probably not.
- 4) No, I don't think so.

Q5. Do you think an earthquake of M6 or greater will damage your house or belongings if it occurs?

- 1) Yes, my house will be destroyed.
- 2) Yes, my house will be half-destroyed.
- 3) Yes, my house will be damaged.
- 4) Yes, some damage may occur to household belongings, but not to the house.
- 5) No, I don't think so.

Note: M6 is an earthquake with a magnitude of 6.0 on the Richter scale.

Q6. What kind of damage did the Great East Japan Earthquake cause for you?

- 1) My house was severely damaged.
- 2) My house was slightly damaged.
- 3) My possessions were severely damaged.
- 4) My possessions were slightly damaged.
- 5) No damage at all.

Q7. Do you have other experiences of suffering damage from a natural disaster other than the Great East Japan Earthquake?

- 1) Yes, my house was severely damaged.
- 2) Yes, my house was slightly damaged.
- 3) Yes, my belongings were severely damaged.
- 4) Yes, my belongings were slightly damaged.
- 5) No, I have had no such experiences.

Q8. What specific measures for natural disaster prevention had you taken before the Great East Japan Earthquake?

- 1) Considered the foundations and topography when buying or moving to a new land or house.
- 2) Considered the building's structure and construction method when building, buying, or moving to a new house (excluding earthquake-resistant construction).
- 3) Conducted earthquake resistance checks.
- 4) Conducted earthquake reinforcement works including reconstruction.
- 5) Secured or relocated furniture to prevent it falling over.
- 6) Confirmed emergency contact address and evacuation route.
- 7) Prepared emergency takeout products.
- 8) Bought an earthquake insurance policy.

- 9) Others.
 - 10) Hadn't taken any specific measures.
- Q9. What specific measures for natural disaster prevention have you taken after the Great East Japan Earthquake?
- 1) Considered the foundations and topography when buying or moving to a new land or house.
 - 2) Considered the building's structure and construction method when building, buying, or moving to a new house (excluding earthquake-resistant construction).
 - 3) Conducted earthquake resistance checks.
 - 4) Conducted earthquake reinforcement works including a reconstruction.
 - 5) Secured or relocated furniture to prevent it falling over.
 - 6) Confirmed emergency contact address and evacuation route.
 - 7) Prepared emergency evacuation products.
 - 8) Bought an earthquake insurance policy.
 - 9) Others.
 - 10) Haven't taken any specific measures.
- Q10. How will you deal with the repair expenses for your residence caused by an earthquake?
- 1) Withdraw my savings.
 - 2) Insurance or mutual aid money (Kyosai).
 - 3) Expect support from central or municipal government.
 - 4) Expect donations for relief.
 - 5) Expect support from parents or siblings or other relatives.
 - 6) Borrow money from financial institutions.
 - 7) Others.
- Q11. What will you do if your current residential building is totally lost due to an earthquake?
- 1) Rebuild a house in the same area.
 - 2) Rebuild a house in another area.
 - 3) Move to a rental house in the same area instead of rebuilding.
 - 4) Move out to a rental house in another area instead of rebuilding.
 - 5) Move to temporary housing then think about it.
 - 6) Move to a relative's or friend's house.
 - 7) I don't know.
- Q12. What do you think about earthquake resistance when planning to buy or build a new house?
- 1) It is unnecessary to require the same level as the current house.
 - 2) It is necessary to require the same level as the current house.
 - 3) It is necessary to require a higher level than the current house.
 - 4) I have never thought about it.
- Q13. Have you checked the hazard map of your current residential area?
- 1) Yes, I have checked it and I'm aware of all risks for my current residence.
 - 2) Yes, I have checked it, but I don't exactly remember the risks of my current residence.
 - 3) No, I haven't.
 - 4) I don't even know what it is.

Q14. What percentage of loss is covered by earthquake insurance when your house and belongings are totally lost?

- 1) 0%~10%
- 2) 10%~20%
- 3) 20%~30%
- 4) 30%~40%
- 5) 40%~50%
- 6) More than 50%

Q15. What do you think about the earthquake insurance provided by private sector nonlife insurance companies?

- 1) I want to buy it even if the premium is higher than that of public earthquake insurance.
- 2) I want to buy it if its premium is the same as that of public earthquake insurance.
- 3) I don't want to buy it.
- 4) I don't know.

Note: Assume that the earthquake insurance provided by private companies will cover more than 50%, but less than 100% of the insured's loss, while public earthquake insurance will only cover less than 50%.

Q16. What do you expect your government to do with your property repair expenses from damage caused by earthquake?

- 1) Government should provide a grant for these repair expenses.
- 2) Government should implement a tax reduction on these repair expenses.
- 3) Government should provide a lower interest loan than usual.
- 4) Government doesn't have to get involved and we should manage repairs ourselves.

Q17. What do you think about the restart of nuclear power stations?

- 1) Should restart immediately after confirming their safety.
- 2) Should restart after confirming their safety and obtaining the approval of local residents.
- 3) Should immediately restart the minimum necessary stations for ensuring the electricity supply required after confirming their safety.
- 4) Should immediately restart the minimum necessary stations for electricity supply required after confirming their safety and after obtaining the approval of local residents.
- 5) Should not restart even after safety is confirmed.

Q18. What do you think about decontamination and the costs of decontamination?

- 1) Decontamination should continue until radiation levels return to a normal 1 mSv/year without considering its expense.
- 2) Decontamination should continue until radiation levels return to a normal 1 mSv/year while considering its expense.
- 3) Decontamination should continue until radiation levels return to 20 mSv/year while considering its expenses.
- 4) I don't care about radiation exposure, so decontamination not necessary.
- 5) I don't know.

Note: The 20 mSv/year standard is set by the Japanese government as the maximum tolerated radiation dose in an emergency.

- Q19. Were there any changes in your household income after the Great East Japan Earthquake?
- 1) Significantly decreased.
 - 2) Slightly decreased.
 - 3) No changes at all.
 - 4) Slightly increased.
 - 5) Significantly increased.
- Q20. What measures have you taken to deal with the decrease in household income?
- 1) Stopped putting money into savings or reduced the amount of savings.
 - 2) Withdrawing money from savings.
 - 3) I and/or my spouse started a side job or increased our workload.
 - 4) Reduced consumption.
 - 5) Others.
 - 6) No, I haven't taken any specific measures.
- Q21. Do you have experience of receiving insurance proceeds from the death or injury of an insured person?
- 1) Yes.
 - 2) No.
- Q22 Do you think the Japanese government will go bankrupt someday.
- 1) Probably in the near future.
 - 2) Probably, though not in the near future.
 - 3) I think the possibility is very low.
 - 4) I don't think it will happen.

REFERENCES

- Aiuppa, T., R.J. Carney, and T.M. Krueger, 1994, "An Examination of Insurance Stock Prices Following the 1989 Loma Prieta Earthquake," *Journal of Insurance Issues*, 16, 1-15.
- Aiuppa, Thomas A., and Thomas M. Krueger, 1995, "Insurance Stock Prices Following the 1994 Los Angeles Earthquake" *Journal of Insurance Issues* 18(1), 23-36.
- Asai, Yoshihiro, and Mahito Okura, 2011, "How Do Cost and Regulation Change Loss Control Activities and Insurers' Monitoring?," *Journal of Insurance Issues* 34(2), 172-188.
- Browne, Mark J., and Kihong Kim, 1993, "An International Analysis of Life Insurance Demand," *Journal of Risk and Insurance*, 60(4), 616-634.
- Browne, Mark J., and Robert E. Hoyt, 2000, "The Demand for Flood Insurance: Empirical Evidence", *Journal of Risk and Uncertainty*, 20(3), 291-306.
- Disaster Management in Japan*, 2011, Published by Cabinet Office, Government of Japan.
- Erwann O. Michel-Kerjan, and Carolyn Kousky, 2010, "Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida", *Journal of Risk and Insurance*, 77(2), 369-397.
- Grace, M.F., and R.W. Klein, and P.R. Kleindorfer, 2004, "Homeowners Insurance with Bundled Catastrophe Coverage", *Journal of Risk and Insurance*, 71(3), 351-379.
- Harrington, S.E., and G.R. Niehaus, 2007, *Risk Management and Insurance*, New York: McGraw-Hill.
- Hau, Arthur, 2000, "Liquidity, Estate Liquidation, Charitable Motives, and Life

- Insurance Demand by Retired Singles”, *Journal of Risk and Insurance*, 67(1), 123-141.
- Jeng, Vivian, and Gene C. Lai, 2005, “Ownership Structure, Agency Costs and Efficiency: Analysis of Keiretsu and Independent Insurers in Japanese Non-life Insurance Industry”, *Journal of Risk and Insurance*, 72(1), 105-158.
- Kunreuther, Howard, 1996, “Mitigating Disaster Losses through Insurance”, *Journal of Risk and Uncertainty*, 12, 171-187.
- Kunreuther, Howard, and Mark Pauly, 2006, “Rules Rather than Discretion: Lessons from Hurricane Katrina,” *Journal of Risk and Uncertainty*, 33(1-2), 101-116.
- Kunreuther, Howard, and Michel-Kerjan Erwann, 2011, “Redesigning Flood Insurance” *Science*, 333, 408-409.
- Kunreuther, Howard C., Mark Pauly, and Stacey McMorrow, 2013, *Behavioral Economics and Insurance: Improving Decisions in the Most Misunderstood Industry*, New York: Cambridge University Press.
- Kriesel, Warren, and Craig Landry, 2004, “Participation in the National Flood Insurance Program: An Empirical Analysis for Coastal Properties”, *Journal of Risk and Insurance*, 71(3), 405-420.
- Lai, Gene C., and Piman Limpaphayom, 2003, “Organization Structure and Firm Performance: Empirical Evidence from the Japanese Non-Life Insurance Industry”, *Journal of Risk and Insurance*, 70(4), 735-757.
- Lee, Soon-Jae Soon, Il Kwon, and Seok Young Chung, 2010, “Determinants of Household Demand for Case of Korea”, *The Geneva Papers on Practice and Issues*, 35, 82–91.
- Landry, Craig E., and Mohammad R. Jahan-Parvar, 2011, “Flood Insurance Coverage in the Coastal Zone”, *Journal of Risk and Insurance*, 78(2), 361-388,
- Naoi, Michio, Kazuto Sumita, and Miki Seko, 2010, “Estimating Consumer’s Valuation of Earthquake Risk: Evidence from Japanese Housing Markets”, *International Real Estate Review*, 13(2), 117-133.
- Naoi, Michio, Miki Seko, and Takuya Ishino, 2012, “Earthquake Risk in Japan: Consumers’ Risk Mitigation Responses after the Great East Japan Earthquake”, *Journal of Economic Issues*, 46(2), 519-530.
- Pope, Nat, and Yu-Luen Ma, 2005, “Market Deregulation and Insurer Pricing Strategies: The Japanese Experience,” *Geneva Papers on Risk and Insurance: Issues and Practice*, 30(2), 312-326.
- Shelor, Roger M., Dwight C. Anderson, and Mark L. Cross, 1992, “Gaining from Loss: Property-Liability Insurer Stock Values in the Aftermath of the 1989 California Earthquake”, *Journal of Risk and Insurance*, 59(3), 476-488.
- Skipper, Harold D., and Jean W. Kwon, 2007, *Risk Management and Insurance: Perspectives in a Global Economy*, Oxford, Wiley-Blackwell.
- Swiss Re, 2012, *World Insurance in 2011 shows Non-Life Insurance Premiums Continued to grow in 2011 Despite an Overall Decline in Premiums*, March 2012.
- Useem, Michael, and Howard Kunreuther, 2009, *Learning from Catastrophes: Strategies for Reaction and Response*, New Jersey: Pearson Prentice Hall.
- Wang, Ming, Chuan Liao, Saini Yang, Weiting Zhao, Min Liu, and Peijun Shi, 2012, “Are People Willing to Buy Natural Disaster Insurance in China? Risk Awareness, Insurance Acceptance, and Willingness to Pay”, *Risk Analysis*, 32(10), 1717-1740.
- Wouter Botzen, W.J., and Jeroen J.C.M. van den Bergh, 2012, “Monetary Valuation of

- Insurance against Flood Risk under Climate Change”, *International Economic Review*, 53(3), 1005-1025.
- Yamori, N., and T. Kobayashi, 2002, “Do Japanese Insurers Benefit from a Catastrophic Event? Market Reaction to the 1995 Hanshin–Awaji Earthquake”, *Journal of Japanese and International Economies*, 16(1), 92-108
- Yamori, N., and T. Okada, 2007, “Japanese Insurance Market and Companies: Recent Trends”, in J.D. Cummins and Bertrand Venard (eds.) *Handbook of International Insurance: Between Global Dynamics and Local Contingencies*, 147-204, New York, Springer Science.