# Insuring Well-being: Psychological Adaptation to Disasters

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## Abstract

We examine the impact of life and health insurance spending on subjective well-being. Taking advantage of insurance spending and subjective well-being data on more than 700,000 individuals in Japan, we examine whether insurance spending can buffer declines in subjective well-being due to exposure to mass disaster. We find that insurance spending can buffer drops in subjective well-being by approximately 3-6% among those who experienced the mass disaster of the great East Japan earthquake. Subjective health increases the most, followed by life satisfaction and happiness. On the other hand, insurance spending decreases the subjective well-being of those who did not experience the earthquake by approximately 3-7%. We conclude by monetizing the subjective well-being loss and calculating the extent to which insurance spending can compensate for it. The monetary value of subjective well-being buffered through insurance spending is approximately 33,128 USD for happiness, 33,287 USD for life satisfaction, and 19,597 USD for subjective health for a person in one year. Therefore, we confirm that life/health insurance serves as an ideal option for disaster adaptation. Our findings indicate the importance of considering subjective well-being, which is often neglected when assessing disaster losses.

**Keywords:** Risk; Insurance; Great East Japan Earthquake; Subjective Well-being;

## 1. Introduction

Direct economic losses or the monetary value of damage to physical assets is commonly used as a metric for assessing mass disaster damages. Calculating damages to physical assets as disaster loss provides essential insights into disaster risks and informs policy guidelines to mitigate such risks. However, one limitation of assessing disaster risks through physical assets is that it can overlook other dimensions of loss. For example, declines in subjective well-being (SWB), which includes happiness, life satisfaction, and subjective health, and psychological effects such as fear, anxiety, or mental illness due to interruptions to educational and health services can be neglected but should be evaluated to fully understand disaster loss. The current approach, which focuses on damages to physical assets in evaluating damages, neglects SWB; therefore, the assessed loss might be underestimated.

Thus, mitigating disaster losses requires consideration of damage to SWB as well as to physical assets. However, in this process, individuals who adopt precautionary behavior, which can compensate for/prevent SWB losses in times of risk, need to be discussed. Life and health insurance spending usually represents precautionary behavior, as insurance can compensate for potential losses (Fillpiski et al., 2019) and allows households to prepare for shocks. Following a massive shock, such as a natural disaster, such behavior may become more noticeable. However, there is little evidence on whether precautionary behavior after a massive shock makes victims better off. This research gap is due mainly to the challenge of tracking individual-level data on SWB and precautionary behavior. Our analysis allows us to address this research gaps, as we rely on individual-level SWB and insurance spending data for more than 1,000,000 individuals. Simultaneously, because SWB is partially correlated with physical assets such as income (Luechinger and Raschky, 2008), an investigation of SWB cannot neglect damages to physical assets.

To this end, we investigate whether spending on life and health insurance can buffer drops in people's SWB after a massive shock, focusing on the great East Japan earthquake (hereinafter, the earthquake). We also quantify the monetary value of the buffer. We exploit two features of the earthquake. First, approximately 20,000 people died or went missing in the context of this event (National Police Agency of Japan). This massive earthquake represented an unexpected exogenous shock causing both destruction of physical capital and psychological damage in Japan. Second, the earthquake and its aftermath were massive yet local regional shocks that directly affected only a small fraction of the Japanese economy and population. The four affected prefectures accounted for only 4.6% of total Japanese output, despite their large impact on coastal areas (Carvalho et al. 2020). These characteristics, along

with the exogenous nature of earthquakes, provide us with a natural experiment in which a small subset of people were exposed to a massive shock.

Taking advantage of these two features, we answer the following research questions:

**Question 1)** Does increasing insurance spending increase SWB (happiness, life satisfaction, and subjective health)?

**Question 2)** If the answer to Question 1 is "yes", then is there a threshold or constraint on this effect of insurance spending? Does higher insurance spending monotonically and unconditionally increase subjective well-being? If this isthe case, would richer households be better off by increasing their insurance spending? Markhvida et al. (2020) note that losses of well-being were more substantial among the low-income group than among the high-income group in the aftermath of the Japanese earthquake. We also examine whether this is the case in our data.

**Question 3)** What is the SWB loss in monetary terms? Furthermore, how much of this loss can be compensated thanks to insurance spending?

To answer the research questions above, we merge two datasets. In total, our dataset contains more than 700,000 observations. The first dataset contains information on life insurance spending and the enrollee's socioeconomic characteristics such as income, gender, age, occupation, and city of residence. The second dataset is a survey on SWB, which contains questions on SWB and individual socioeconomic characteristics such as income, gender, and age. The second dataset is matched to the first based on respondents' region of residence, which our data report to the city level, and socioeconomic data on gender, income, and age.

Our study contributes by being the first to empirically connect the impact of disaster risk to economic behaviors and SWB and provide implications on how disaster losses should be assessed. Most previous works focus on either one or the other; for example, numerous previous works imply that people become more risk averse after exposure to risks, with a specific focus on individual (or household) economic behaviors. Filipski et al. (2019) mention that disasters make households save less. Filipski et al. (2019) and Fortson (2011) show that education spending decreases after negative shocks, which can effect declines in SWB. Fillipski et al. (2019) and Fortson (2011) show that insurance spending increases immediately after disasters, while the effect fades after 3 years. At the same time, other strands of literature examine the impact of risks, most often natural disasters, on subjective well-being. For example, studies such as Cohen etal. (2019) and Yule et al. (2000) show that natural disasters can drive the persistence of depression or posttraumatic stress disorder

(PTSD). Rehdanz et al. (2015), Almond, Edlund, and Palme (2007) and Berger (2010) show that while the SWB of victims of the Chernobyl and Japanese earthquake disasters did not change, their concerns about the environment increased. Focusing on this earthquake, Rehdanz et al. (2015) note that SWB decreased in its aftermath. We extend the literature on natural disasters and SWB, providing evidence of the former's effect on the latter by examining whether life insurance spending can increase the SWB of people whose SWB has fallen due to risk exposure. Furthermore, we also estimate the boundary of the proportion of insurance spending in income that can increase SWB and compute how much of the negative shock can be mitigated.

Another contribution of our study is that we examine the indirect effect of risk-averse behaviors, represented as insurance spending, on SWB. Currie et al. (2008) point to the direct effects of health insurance; that is, eligibility for health insurance shows substantial effects on children's health. While Currie et al. (2008) examine the direct impact of health insurance on health, our study shows an indirect impact by assessing whether risk-averse behaviors, represented as insurance spending, can improve SWB. In this vein, our study answers the following question: Given that natural disasters are exogenous and that such massive natural disasters rarely happen in a probabilistic sense, why would people pay insurance premiums at a price that exceeds the estimated direct cost of the disaster? If insurance spending enhances the SWB of risk-averse insurance purchasers, then the costs and benefits of insurance should be reconsidered. Therefore, while according to Kahneman et al. (1977) and Thaler et al. (1997), people commonly neglect disaster risk due to the small probability of such events, we argue that individuals should not ignore this risk. Our study enables this analysis because we have two groups of respondents: those who experienced the natural disaster and those who did not. As that those who experienced disaster would naturally be more willing to pay higher insurance premiums, comparing the two groups allows us to examine whether precautionary spending increases SWB and whether this impact is higher for those with disaster experience. Our analysis reveals that people who did not experience the earthquake regard insurance spending as mere consumption. Therefore, insurance spending is negatively correlated with their subjective well-being.

We find that insurance spending is positively correlated with SWB after experience of a shock, with significant and robust correlations. This positive correlation persists for increases in household insurance spending of up to 7.5% of income. Compared to those that do not pay for insurance, households that spend on insurance can mitigate postdisaster declines in their subjective well-being by approximately 90% for happiness and 40-50% for

life satisfaction and subjective health. We then calculate the monetary value of such a buffer. We find that a 1% increase in insurance spending can buffer happiness by the equivalent of approximately 3.63 million JPY, life satisfaction by the equivalent of 3.65 million JPY, and subjective health by the equivalent of 2.15 million JPY. Our results indicate that life/health insurance works as a disaster adaptation method and therefore can compensate for physical asset losses, given that the number of disasters is increasing.

The remainder of this paper is structured as follows. Section 2 provides a background. The data and model are presented in Section 3. Section 4 shows the empirical results. Section 5 shows additional simulation results. Section 6 discusses our findings and provides policy implications. Section 7 concludes.

## 2. Backgrounds

### 2.1. Motivating Facts

Over the past five decades, while mortality from disasters has decreased, the number of people affected by disasters and the number of disasters have continuously increased. According to the Emergency Event Based Dataset (EMDAT) (2020) and World Health Organization (WHO), the number of natural disasters has been continuously increasing since the 1950s.However, as people have adapted to disasters over time, mortality from natural disasters has decreased even as their number has increased. According to EMDAT (2020), mortality from natural disasters has decreased significantly over time; today, annual physical losses due to disasters range from 0.15% to 0.5% of global GDP. However, when we consider economic development over this period, there has been no substantial rising trend in damages in recent decades. These observations point to two motivating facts for our research. First, the fall in mortality indicates that a certain level of disaster loss mitigation has been achieved, with decreasing losses of tangible assets due to natural disasters. Second, as the number of natural disasters is increasing, if insurance spending can mitigate SWB losses, the aggregate benefits of insurance spending would increase, as it can cover more disasters and costs. Suppose that disaster damages to intangible assets, represented as SWB in this study, do not show a decreasing trend. In this case, policymakers should look for ways to mitigate them along with physical asset losses. These observations, therefore, motivate us to examine whether the current life and health insurance systems in Japan can compensate for declines in intangible assets, given that the number of disasters has increased steadily. As we examine people's precautionary behavior in times of disaster, even though we focus on the Japanese

case, the implications that we derive can contribute to policymaking more broadly by showing that the mitigation of intangible asset losses is also necessary.

### 2.2. Japanese Life/Health Insurance System

We focus on life and health insurance rather than disaster insurance because those who contract with a private insurance company are likely to be risk averse due to the characteristics of Japanese national and private insurance systems. First, disaster insurance is common, and it is natural for Japanese (and non-Japanese) citizens to have disaster insurance plans. Due to the high number of earthquakes, most Japanese housing, car, and private property insurance systems—and even bank loans—automatically incorporate disaster insurance, which covers damages from disasters such as earthquakes, fires, floods, and tsunamis. Each type of disaster is covered based on the damages and damaged property[1].

Furthermore, starting in January 2007, existing tax deductions for general insurance premiums were amended, and a deduction for earthquake insurance premiums was created to help people's efforts to compensate for damage caused by earthquake disasters. For example, a maximum of 50,000 JPY for the income tax (national tax) and of 25,000 JPY for the inhabitants tax (local tax) can be deducted from gross income (Ministry of Finance, Japan)[2]. Such benefits and coverage along with the frequent occurrence of disasters allow people to easily enter disaster insurance plans. Therefore, we simply cannot argue that an insurance enrollee is risk averse because he or she has a disaster insurance plan.

Second, focusing on private life and health insurance allows us to examine risk-averse enrollees and those who engage in precautionary spending. While the Japanese government provides a mandatory national insurance system to both Japanese and non-Japanese citizens that covers hospital care, outpatient care, mental health care, prescription drugs, home health care, and dental care (Arai and Ikegami 1998), private insurance is growing, as it additionally covers chronic conditions and hospitalizations, offering cash payments to the insured in times of cancer or long-term hospitalization. Private health insurance plans are classified into three types: medical insurance obtained separately from life insurance, medical riders attached to a new or current life insurance policy, and supplementary medical insurance that covers copays for services rendered by the public health insurance system (The Life insurance association,

[1] Earthquake insurance is bundled with fire insurance. To be precise, having fire insurance is necessary in order to have earthquake insurance. Fire insurance policyholders who do not have earthquake insurance may incorporate it at any point during the policy duration.

[2] https://www.mof.go.jp/english/financial_system/earthquake_insurance/outline_of_earthquake_insurance.html.

Japan). To be included in one of Japan's private insurance plans, one needs to choose an insurance company and plan and pay insurance premiums in addition to those for national insurance. Such efforts take time and require individuals to assume extra costs to prepare for unknown future events. Thus, in this study, we treat those who pay such additional premiums as engaging in precautionary spending.

### 2.3. The Great East Japan Earthquake

On March 11, 2011, at 14:46:23 local time, a 9.0 magnitude earthquake occurred, causing widespread damage to Japan's eastern coastal area. The earthquake lasted approximately six minutes and occurred at a relatively shallow depth of 24.4 kilometers (km), or 15.2 miles, with its epicenter approximately 130 kilometers (80 miles) east of the city of Sendai in the Tohoku region. The earthquake magnitude was so massive that it displaced Honshu, Japan's largest island, 2.4 meters east and shifted the Earth's axis by 10 to 25 centimeters. After the earthquake, 647 aftershocks occurred (up to August 4, 2011), and most of them were associated with tsunami alerts; following the earthquake, tsunamis destroyed Tohoku and the coast of southern Hokkaido, killing 15,848 people (the officially recorded death toll as of February 10, 2012). The extensive damage caused to eastern Japan led this natural disaster to come to be regarded as the worst in the world's history. In Tohoku, whole cities were swept away by the tsunami, and some towns were reduced to less than half of their pre-tsunami populations.

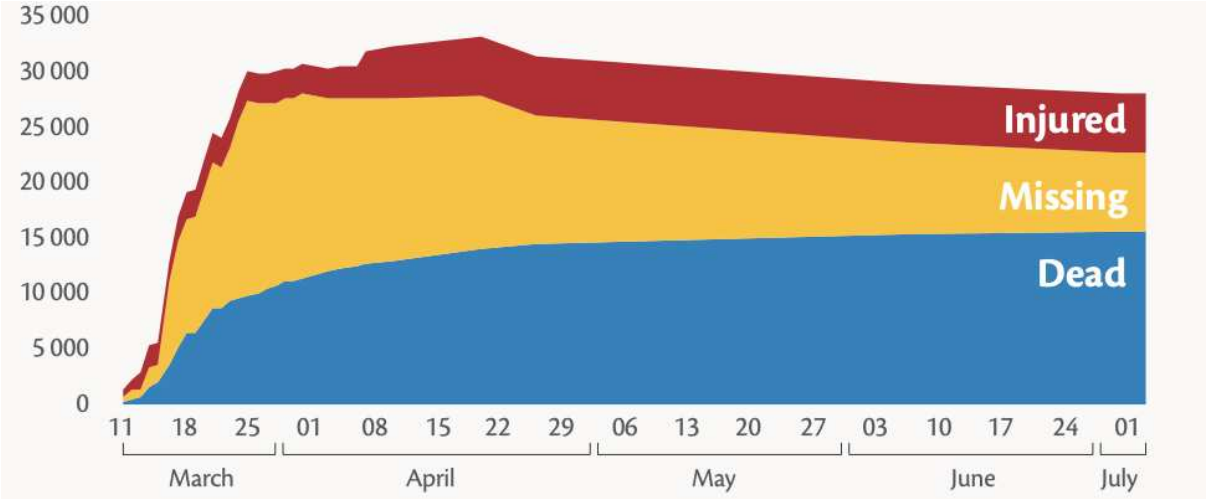


**Figure 1**: The number of the injured, missing, and dead people during 2011 March 11 to 2011 July 01. (Source: World Health Organization)

**Figure 1** depicts the number of injured, missing, and dead earthquake victims. The number of missing people continued to grow two weeks after the incident, peaking at 17,541 on March 25, 2011 (Figure 1). Drownings due to the tsunami caused more than 90% of the deaths, with the elderly bearing the brunt of the toll. In terms of long-term damages, the earthquake completely displaced communities; basic infrastructures for human well-being, such as schools and hospitals, were destroyed, and medical services were not able to operate due to the lack of capacity.

Alongside these direct damages, shortly after hitting Tohoku, the earthquake and a tsunami 14 meters (46 feet) high arrived and swept over the Fukushima nuclear powerplant's seawall, flooding the lower sections of reactors. This resulted in the failure of emergency generators and the loss of control of circulating pumps. Around March 12 and 15, three nuclear meltdowns, three hydrogen explosions, and the release of radioactive radiation occurred due to the failure of reactor core cooling in the so-called Fukushima nuclear energy plant accident. The Fukushima nuclear energy plant accident was identified as a possible global emergency of public safety following the massive earthquake and tsunami, with the International Nuclear Event Scale triggered to its highest level (level 7).

While damages from mass disasters can reduce people's SWB, current evaluations of disaster loss are unlikely to consider such falls in SWB. Moreover, those who experience mass disasters are more likely than those who have not to start seeking preventive measures to adapt to or mitigate another mass disaster should one occur again. Thus, taking advantage of our insurance spending and SWB dataset, we first examine whether insurance spending increases the SWB of those who experienced the earthquake and then estimate its monetary value to account for the disaster loss.

### 2.4. Literature Review

As mentioned in Section 2.2, experiencing massive natural disasters can impact people's well-being through various types of damage. These damages can be categorized into tangible and intangible disaster losses (Hudson, Pham, and Bubeck 2019; Hudson et al. 2019). Tangible losses include monetary losses, housing and infrastructure losses, injuries, deaths, and other physical damages. Intangible losses, in turn, include psychological losses that manifest in fear, anxiety, and other mental health problems.

Intangible losses are often ignored despite their long-lasting characteristics, which may cause an underestimation of overall damages from a natural hazard. Oishi et al. (2015) clarify that housing damages caused by the great Hanshin-Awaji earthquake of 1995 had

effects on sufferers' SWB that persisted even 16 years after the earthquake. Lamond, Joseph, and Proverbs (2015) find long-term psychological losses, such as distress and mental damage, from flooding. These effects are especially severe for low-income people and for households that experience relocation.

Recent studies have focused on the intangible losses caused by the great East Japan earthquake by investigating its effects on well-being ("Well-Being Effects of a Major Natural Disaster: The Case of Fukushima" 2015; Ohtake, Yamada, and Yamane 2016). These studies have shown that people living in the affected areas experienced significant SWB losses due to the disaster itself and disaster-related news broadcasts, unlike people not living in the affected areas.

Moreover, previous studies have explored the characteristics of the impacts of disasters on well-being by focusing on several types of natural disasters such as earthquakes (Sibley and Bulbulia 2012; Valenti et al. 2013), flooding (Valentiet al. 2013; Luechinger and Raschky 2009) and hurricane risk (Berlemann 2016). The effects of disasters on SWB differ by socioeconomic characteristics such as gender (Hudson, Pham, and Bubeck 2019; Valenti et al. 2013) and income (Berlemann 2016, Markhvida et al. 2020). In general, low-income people are found to suffer more serious SWB losses from disaster experiences. Carter et al. (2007) discuss the reason for such long-term impacts, particularly on low-income groups. They note that while theoretically, poorer households can cover their losses by utilizing loans and insurance, in reality, the poorest people tend to lack sufficient resources to recover and cannot easily escape the "poverty trap", making them suffer longer negative impacts and well-being losses.

Despite the serious and long-term impacts of natural disasters, earlier studies have clarified that people who incur damages from disasters can mitigate or recover from well-being losses in certain ways. One is an adaptation to disaster damages. It has been found that some coping strategies, such as purchasing flood protection, can reduce mental health effects (Lamond, Joseph, and Proverbs 2015). In addition to such behavioral adaptation, studies focusing on SWB have clarified the tendency of individuals to adapt to negative events over time, showing that SWB returns to levels close to the reference point approximately 1 year after the event (Frijters, Johnston, and Shields 2011). On the other hand, some researchers are skeptical about complete adaptation to severe damage from negative events (Oswald and Powdthavee, n.d., 2008). Religiosity is also related to the mitigation of the SWB impacts of disasters. Sibley and Bulbulia (2012)describe that espousing religious beliefs after a natural disaster does not improve subjective health.

Nevertheless, a loss of faith after a natural disaster leads to an additional loss of subjective health.

An insurance contract is another effective way to mitigate the damage caused by a disaster. Luechinger andRaschky (2009) show that mandatory insurance has mitigating effects that can almost fully compensate for losses from a flooding experience.

Moreover, the disaster risk itself has a negative influence on well-being even among people who did not experience the disaster (Hudson, Pham, and Bubeck 2019). This finding indicates that risk-avoiding behavior should lead to an increase in SWB for an individual who dislikes being exposed to disaster risk.

SWB measures can also be used to monetize the benefits obtained from intangibles. This method is called the life satisfaction approach and has been used in recent research to measure values that cannot be measured in the market (Frey, Luechinger, and Stutzer 2010). The general procedure of this method is as follows: (1) surveying life satisfaction, a targeted variable, income, and other sociodemographic characteristics among a target sample; (2) regressing the life satisfaction measure on the targeted variable, income, and other control variables; and (3) calculating the change in income that could compensate for the life satisfaction gains or losses caused by a change in the targeted variable.

Utilizing this method, previous studies have investigated the monetary value of intangible goods such as air quality (Welsch 2006; Luechinger 2009), airport noise (Welsch 2006), extreme weather events (Möllendorff, vonMöllendorff, and Hirschfeld 2016), green spaces (Tsurumi and Managi 2015), healthy behaviors (Shi et al. 2019) and the cost of terrorism (Frey, Luechinger, and Stutzer 2009). The life satisfaction approach is also useful for valuing the gains and losses from experiencing a disaster and purchasing insurance if such gains and losses include intangible aspects that cannot be revealed by market prices.

## 3. Methodology

### 3.1. Data

We construct our dataset by matching two datasets into one. The first is a survey on subjective well-being, an individual-level dataset from 2015 covering 246,642 respondents and containing our main variables related to SWB: happiness, life satisfaction, and subjective health. Happiness measures the overall happiness level that individuals experience throughout life. Life satisfaction shows individuals' satisfaction level with their life circumstances (living environment, financial circumstances and so on). Subjective health indicates how healthy individuals perceive themselves to be. All the variables are categorical

responses to the following question: "On the whole, how happy/satisfied with your life circumstances/healthy do you feel?" Respondents answered on the following scale: [5] totally agree, [4] agree to a fair extent, [3] not sure, [2] do not agree, and [1] do not agree at all. The question was asked in 2015. The mean reported happiness level is 3.60 (std. dev. 0.95), life satisfaction is 3.40 (std. dev. 1.03), and subjective health is 3.41 (std. dev. 1.07). Our first dataset also contains information on respondents' income, age, and gender.

This first dataset contains information on the reason that households moved into a new home. Respondents were asked the question, "What was the reason for your latest move?" The answer options include "fear of disasters" and "fear related to the great East earthquake", "family issues", "Career", and so on. We also asked about the importance of family and disaster prevention, as we anticipated these factors to be correlated with people's moving choice. The questions are as follows: "How important is family/disaster prevention to you?" The scale of responses is as follows: (0) no awareness/interest at all, (1) very unimportant, (2) unimportant, (3) neither important nor unimportant, (4) important, and (5) very important. Next, we surveyed the distance of their most recent residence from their current one. Respondents were asked to choose from among (1) the same town, (2) the same municipality, (3) the same prefecture, (4) a different prefecture, and (5) abroad. The proportions of respondents choosing each option are listed in Table 1. We take Move_4 as the baseline.

Our second dataset from 2015 was acquired from Daiichi-Seimei Life/Health Insurance Company, a famous Japanese insurance company holding 60 billion JPY in capital and ranking as the country's fifth largest insurer. Our second dataset has 1,435,412 observations of individuals and consists of insurance enrollees' sociodemographicinformation and data on their annual insurance spending and the insurance subscription fees paid at the time of policy purchase. We calculate the total insurance fee by summing the annual premium and the subscription fees[3].

We then match the first and second datasets; first, we match the dataset based on respondents' postal code, which shows respondents' addresses up to the municipality level. Then, we match the dataset according to income level, age, and gender in a given postal code. Since we match the data by geographic and socioeconomic features, not at the individual level, there is no guarantee that the same individuals are counted in the two data sources.

[3] Separating the subscription fee and annual premium in the model may be possible and interesting from the viewpoint of behavioral economics. However, in other fields, it is common to treat all price-related variables together, as consumers are believed to be rational enough to care only about the final prices that they must pay. Therefore, we use subscription fees and annual premiums together in our empirical analysis.

However, our merged dataset shows correlations between the first and the second dataset; for example, the first dataset's income and age levels were correlated at rates of 99.21% and 94.13%, respectively, with those in the second dataset. Given that the gender information and location of residence match perfectly, we anticipate respondents with the same socioeconomic characteristics in the same municipalities to have similar insurance plans and SWB, referring to previous works that show that insurance spending (A. C. Cameron et al. 1988, Koijen, Van Nieuwerburgh, and Yogo 2011) and SWB (Cummins 2000, Diener and Diener, 2002) hinge on the socioeconomic features of the individuals. Consequently, after merging the two datasets, we have 764,891 observations—a sizable number.

This study specifically examines those who moved out of their homes due to the earthquake or fear of other disasters such as floods and who pay private life/health insurance fees (hereafter, life/health insurance), considering this group risk averse. We make this designation because Japanese people tend not to move away from their hometowns (Higa et al., 2019) or across prefectures. Given this cultural norm, those who decide to move out and also pay for life and health insurance are likely to be risk averse, as they can afford the price of moving as well as insurance premiums even though a catastrophic event like the great earthquake is unlikely to happen frequently. Having said that, in our analysis, we divide our sample into three groups:

1. **Fear Group:** Risk averse due to fear of overall disasters (i.e., earthquakes, floods, and tsunamis). Those who belong to this group did not experience the great East Japan earthquake; rather, they fear natural disasters overall.
2. **Risk Group:** Risk averse due to fear experienced in the great East Japan earthquake[4].
3. **Other:** Those who belong to neither the first nor the second group.

The difference between the fear and risk groups lies in whether the person experienced the great East Japan earthquake. We conjecture that the amount of information on the earthquake should vary between the two groups, that such differences in information should affect household economic behaviors and that such economic behaviors should be expressed through the amount of precautionary spending (Gao et al., 2020; L. Cameron and Shah 2015). Comparing the two groups should show whether actual exposure to the earthquake or the mere fear of disasters changes households' precautionary spending and SWB.

[4] Group 1 and Group 2 are mutually exclusive.

Table 2 shows descriptive statistics. Panel (A) in Table 2 displays the descriptive statistics for everyone in our dataset, Panel (B) shows the descriptive statistics of the fear group, and Panel (C) indicates the descriptive statistics of people who belong to the risk group. While we do not find significant differences across the groups, we find that people in the risk group tend to spend 20.21% more on insurance while having an income 10.86% higher than that in Panel (A).

**Table 1: Variables on the Respondent's Latest Move**

| Variable | Explanation | Proportion (%) |
|---|---|---|
| Move_1 | Move within the town | 9.93 |
| Move_2 | Move within the municipality | 13.18 |
| Move_3 | Move within the prefecture | 8.56 |
| Move_4 | Move outside to the prefecture (Baseline) | 10.25 |
| Move_5 | Move outside from the country | 0.57 |

**Table 2: Descriptive Statistics**

| Variable | Mean | Std.dv | Min | Max |
|---|---|---|---|---|
| *Panel (A) Overall (N=764,891)* | | | | |
| Female Dummy (=1 if female) | .36 | .48 | 0 | 1 |
| Age (Contract) | 53.41 | 12.65 | 8 | 100 |
| Annual Income (10,000 JPY) | 369.49 | 324.50 | 75 | 2250 |
| Total Insurance Fee (10,000 JPY) | 13.41 | 12.72 | .018 | 1200 |
| Happiness | 3.60 | 0.95 | 1 | 5 |
| Life Satisfaction | 3.40 | 1.03 | 1 | 5 |
| Subjective Health | 3.41 | 1.07 | 1 | 5 |

| | | | | |
|---|---|---|---|---|
| *Panel (B) Fear Group (N=6,951)* | | | | |
| Female Dummy (=1 if female) | .64 | .48 | 0 | 1 |
| Age (Contract) | 53.82 | 12.97 | 22 | 91 |
| Annual Income (10,000 JPY) | 370.91 | 325.15 | 75 | 2250 |
| Total Insurance Fee | 13.84 | 13.86 | .061 | 300.22 |
| Happiness | 3.23 | 0.95 | 1 | 5 |
| Life Satisfaction | 3.29 | 0.98 | 1 | 5 |
| Subjective Health | 3.07 | 1.09 | 1 | 5 |
| *Panel (C) Risk Group (N=3,389)* | | | | |
| Female Dummy (=1 if female) | 0.37 | 0.48 | 0 | 1 |
| Age (Contract) | 52.96 | 12.38 | 27 | 87 |
| Annual Income (10,000 JPY) | 409.62 | 328.95 | 75 | 2250 |
| Total Insurance Fee | 16.12 | 13.91 | .080 | 150.11 |
| Happiness | 2.88 | 1.40 | 1 | 5 |
| Life Satisfaction | 2.68 | 1.36 | 1 | 5 |
| Subjective Health | 2.75 | 1.41 | 1 | 5 |

**3.2. Empirical Strategy**

As we are interested in whether the insurance spending of people in the fear and risk groups is positively associated with individual SWB, we estimate equation (1) through ordinary least squares (OLS)

$$SWB_i = \beta_0 + \beta_1 \ln Total_i + \beta_2 \ln Total_i * Risk_i + \beta_3 \ln Total_i * Fear_i + \beta_4 Risk_i + \beta_5 Fear_i + \boldsymbol{X_i \beta_6'} + RegionDummy \quad (1)$$

where $SWB_i$ is SWB (happiness, life satisfaction and subjective health) of individual $i$, ln ln $Total_i$ is the log total insurance fee, $Risk_i$ is a dummy variable equal to 1 if individual $i$ belongs to the risk group, and $Fear_i$ is a dummy variable equal to 1 if individual i belongs to the fear group. $X_i$ is a vector of control variables. The coefficients of interest in our study are $\beta_2$ and $\beta_3$, which show the difference in the correlation of SWB with insurance spending for the risk and fear Groups in comparison with the correlation for the baseline group. For the control variables, we include 1) individual socioeconomic characteristics, which are income, gender and age, 2) the answers to the question on the importance of family and disaster prevention, and 3) the answers to the question on how far they moved. Region dummies control for the 47 prefectures of Japan.

## 4. Result

### 4.1. Main Result

Table 3 shows the estimation results. Model (1) shows the results for happiness, Model (2) for life satisfaction, and Model (3) for subjective health. First, we find that insurance spending is positively correlated with happiness, life satisfaction, and subjective health by 1%, 0.7%, and 0.6%, respectively.

The correlation between the insurance spending of the risk and fear groups and SWB can be examined by summing up the coefficients of ln $Total$ and insurance spending for each group. For example, happiness plus insurance spending for those who belong to the fear group is 0.01+(-0.064)=-0.063. We focus on interpreting the results on SWB and insurance spending and then proceed to the socioeconomic and control variables. Overall, we find that exposure to the earthquake is negatively correlated with SWB, as the coefficient on the risk variable shows negative coefficients. On the other hand, those who belong to the fear group show positive coefficients on SWB, and increasing insurance spending decreases their SWB.

**Happiness.** Our results indicate that insurance spending is positively correlated with happiness for the risk group. On the other hand, insurance spending is negatively correlated with happiness for the fear group. According to Model (1), we find that the total insurance fee of people who experienced the great East Japan earthquake (Risk*ln $Total$) shows a positive correlation of 0.035 with happiness. Risk presents a negative but statistically nonsignificant

coefficient. On the other hand, the fear variable has a positive coefficient of 0.672, and Fear* ln $Total$ presents a negative and statistically significant coefficient of -0.064.

**Life Satisfaction.** According to Model (2), the risk variable shows a negative correlation of -0.667 with life satisfaction, but this decrease in life satisfaction is buffered through insurance spending, as Risk*ln $Total$ shows a positive relationship with life satisfaction, with a coefficient of 0.061. Fear shows a positive relationship with life satisfaction, with a coefficient of 0.896, while Fear*ln $Total$ shows a negative coefficient of -0.079 for life satisfaction.

**Subjective Health.** Based on Model (3), we confirm that Risk*ln $Total$ shows a positive relationship with subjective health, with a coefficient of 0.050, while the earthquake variable alone shows a negative relationship of -0.532. Furthermore, Fear*ln $Total$ shows a negative correlation with subjective health, with a coefficient of -0.031, while the fear variable alone does not show statistically significant results.

**Other Variables.** Other sociodemographic variables also show statistically significant correlations: Income level shows a positive correlation with happiness, life satisfaction, and subjective health. The female dummy also shows a positive correlation with SWB. While happiness and life satisfaction increase with the age of respondents, subjective health decreases. The variable measuring the importance of/satisfaction with family shows a positive correlation with SWB. While a concern with disaster prevention is positively correlated with SWB, the variable for the importance of disaster prevention shows a negative correlation with life satisfaction and health.

With Move_4 taken as the baseline, our results show that moving within the same town (Move_1) or municipality (Move_2) is negatively correlated with SWB. Our results indicate that happiness increases when a respondent moves from within the same prefecture (Move_3). Life satisfaction and subjective health, in turn, increase when a respondent moves outside of the prefecture (Move_4). The variable for moving abroad (Move_5) does not show any statistically significant results.

**Table 3: Relationship between SWB and Insurance Spendings of Risk and Fear Group**

| | Model (1)<br>Happiness | Model (2)<br>Life Satisfaction | Model (3)<br>Subjective Health |
|---|---|---|---|
| ln $Total$ | 0.010*** | 0.007*** | 0.006*** |
| | (.001) | (.001) | (.001) |

| | | | |
|---|---|---|---|
| Fear | 0.672*** | 0.896*** | 0.234 |
| | (.133) | (.146) | (.176) |
| Fear* ln $Total$ | -0.064*** | -0.079*** | -0.031* |
| | (.012) | (.013) | (.015) |
| Risk | -0.254 | -0.667*** | -0.532* |
| | (.199) | (.219) | (.264) |
| Risk*ln $Total$ | 0.035* | 0.061** | 0.050* |
| | (.017) | (.019) | (.023) |
| ln(Income) | 0.117*** | 0.156*** | 0.133*** |
| | (.001) | (.001) | (.002) |
| Female | 0.211*** | 0.217*** | 0.262*** |
| | (.002) | (.002) | (.003) |
| ln(Age) | 0.258*** | 0.445*** | -0.089*** |
| | (.004) | (.005) | (.005) |
| Satisfaction (Family) | 0.457*** | 0.484*** | 0.284*** |
| | (.001) | (.001) | (.001) |
| Importance (Family) | 0.069*** | 0.001*** | 0.009*** |
| | (.001) | (.001) | (.002) |
| Satisfaction (Disaster Prevention) | 0.113*** | 0.173*** | 0.163*** |
| | (.001) | (.001) | (.002) |
| Importance (Disaster Prevention) | 0.036*** | -0.004*** | -0.011*** |
| | (.001) | (.001) | (.002) |
| Move | 0.036*** | 0.006*** | 0.004*** |
| | (.002) | (.002) | (.003) |
| Move_1 | -0.308*** | -0.100*** | -0.368*** |
| | (.037) | (.041) | (.049) |
| Move_2 | -0.349*** | -0.116* | -0.232*** |
| | (.049) | (.054) | (.065) |
| Move_3 | -0.230*** | 0.144** | 0.644*** |

| | | | |
|---|---|---|---|
| | (.045) | (.049) | (.059) |
| Move_5 | -0.518 | -0.654 | -0.225 |
| | (.543) | (.597) | (.721) |
| Region Fixed Effects | Yes | Yes | Yes |
| Constant | -0.744*** | -1.626*** | 1.320*** |
| | (.022) | (.024) | (.029) |
| N | 764,891 | 764,891 | 764,891 |
| R-sq | 0.300 | 0.278 | 0.106 |

Standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

### 4.2. Additional Results on Insurance Spending

Our results in Table 3 show that insurance spending can buffer the drop in SWB of those who experienced the earthquake. However, do our results indicate that increasing insurance spending up to a level one cannot financially afford would increase SWB? To answer this question, therefore, in this subsection, we examine the threshold of the proportion of insurance spending in income up to which people are better off.

To this end, in view of our estimated results, we first run a series of regression models of Equation (1) for 5 subsamples based on the proportion of insurance spending in income (for simplicity, we refer to this as "the proportion" from now on): the proportion spent by those in income percentiles 0~10 (Group 1), the proportion spent by those in percentiles 10~25 (Group 2), the proportion spent by those in percentiles 25~50 (Group 3), the proportion spent by those in percentiles 50~75 (Group 4), and the proportion spent by those in percentiles 75~95% (Group 5). If the estimated coefficients are statistically significant and positive for all groups, the result would indicate that insurance spending is positively correlated with SWB regardless of the proportion of insurance spending. Thus, if this were the case, theoretically speaking, increasing spending on insurance regardless of its affordability would make the people in the risk group better off.

Table 4 shows our results. In the first column, "Group" refers to the groups' placement in the income distribution (percentile), and "Proportion of Income" shows the range of the groups' spending proportions. The results on happiness, life satisfaction, and subjective health show the estimated coefficients of beta_1 + beta_2 for the risk groups and beta_1+ beta_3 for the fear group from Equation 1 by spending group. We mark the column

in blue if the coefficient is statistically significant and negative. On the other hand, we mark the column in red if the estimated coefficient is statistically significant and positive. For the statistically nonsignificant coefficients, we treat them as zero (marked "Nonsignificant").

Interestingly, we find that SWB shows higher correlations with insurance spending in Group 4 and negative correlations with Group 1. We do not observe substantial differences across Groups 2 and 3. The insurance spending of Group 5 is not correlated with SWB, implying that excessive insurance spending is no longer positively correlated with SWB. In conclusion, a proportion ranging from 3.86 to 7.50% shows the highest correlations with SWB for the risk groups. [5]

**Table 4: Estimated coefficients of SWB buffers (Risk group)**

| Group | Percentile | Portion to Income | Happiness | Life satisfaction | Subjective Health |
|---|---|---|---|---|---|
| 1 | 0%~10% | 0.2~1.17% | -0.019*** | -0.028*** | -0.036*** |
| 2 | 10%~25% | 1.17~2.09% | Insignificant | 0.096** | Insignificant |
| 3 | 25%~50% | 2.09~3.86% | Insignificant | Insignificant | 0.028* |
| 4 | 50%~75% | 3.86~7.50% | 0.112** | 0.191** | 0.227*** |
| 5 | 75%~95% | 7.50~14.41% | Insignificant | Insignificant | Insignificant |

Next, as our results in Table 5 show, insurance spending decreases the well-being of the fear group. We also confirm that these results become stronger as the proportion of insurance spending to income increases. Greater insurance spending is negatively correlated with SWB, except for the subjective health of Group 3, indicating that people in the fear group perceive insurance spending as mere consumption.

**Table 5: Relationship between insurance spending SWBs (Fear Group)**

| Group | Percentile | Portion to Income | Happiness | Life satisfaction | Subjective Health |
|---|---|---|---|---|---|
| 1 | 0%~10% | 0.2~1.17% | -0.019*** | -0.028*** | -0.036*** |

[5] Proportions that range from 3.86% to 7.50% show the same estimated coefficients; therefore, our results focusing on the 7.50% proportion show the upper bound of the relationship between insurance spending and SWB.

| | | | | | |
|---|---|---|---|---|---|
| 2 | 10%~25% | 1.17~2.09% | -0.089** | -0.102** | -0.093* |
| 3 | 25%~50% | 2.09~3.86% | -0.137*** | -0.132*** | 0.028* |
| 4 | 50%~75% | 3.86~7.50% | -0.230*** | -0.263*** | -0.165*** |
| 5 | 75%~90% | 7.50~14.41% | Insignificant | -0.210*** | -0.217*** |

We graphically summarize our results in Figure 2. In the first column, "Marginal Increase" shows the correlation with SWB of a 1% increase in the spending proportion. "Overall Increase" shows how much SWB increases with an increase in insurance spending to 7.5% in comparison with the SWB of people who do not pay for insurance, and "Marginal Buffer" presents the proportion of a marginal increase to the overall decline in SWB (that is, "Marginal Increase"/"Fall in SWB"). "Overall Buffer" shows the portion of an overall increase to the overall fall in SWB (that is, "Overall Increase"/"Overall Fall in SWB").

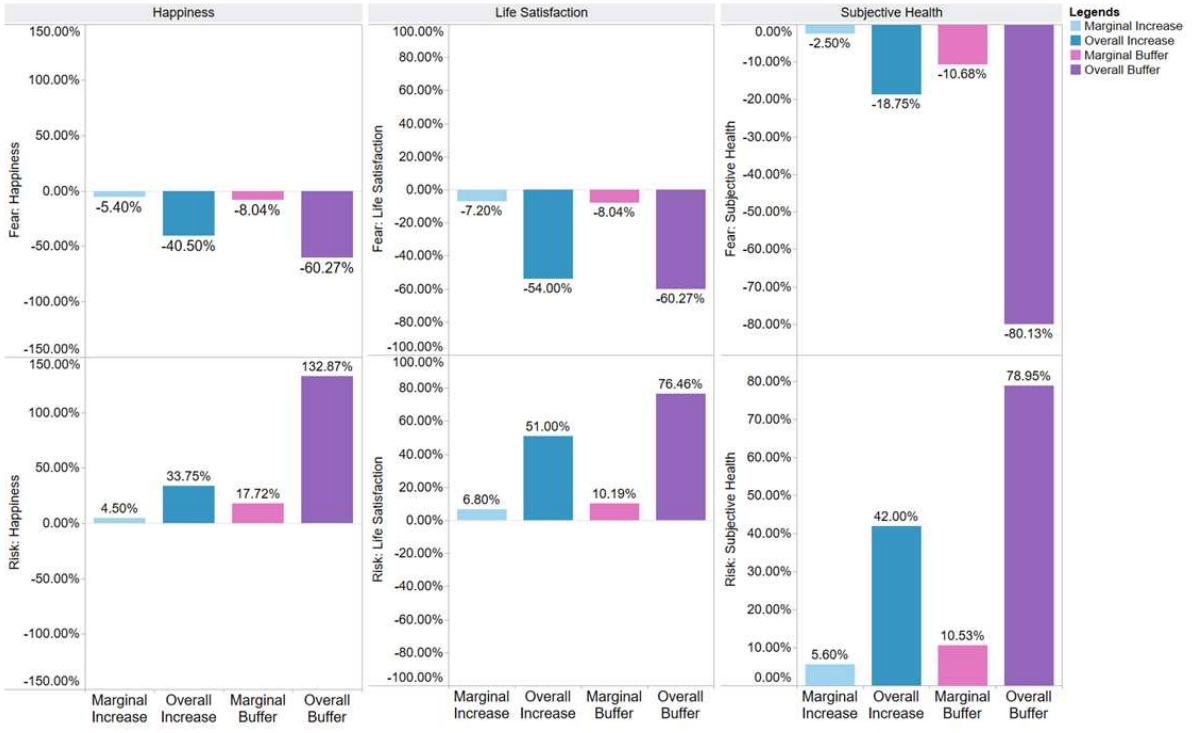


**Figure 2: Graphical Illustration on Estimation Results**

The results indicate that a 1% increase in the spending proportion increases SWB by 4-6% for the risk group. Life satisfaction increases the most, followed by happiness and subjective health. Compared to those who do not pay for insurance, those who pay up to

7.5% of their income for insurance show positive impacts on SWB of 33-51%. We see the most significant increase for life satisfaction, followed by subjective health and happiness. For the buffers, a unit increase in the insurance spending proportion buffers the fall in SWB by approximately 10-20%. The fall in happiness is compensated the most, at approximately 132.87%, followed by subjective health at 78.95% and life satisfaction at 76.46%.

In contrast, an increase of 1% in the spending proportion of the fear group is negatively correlated with SWB, with falls of 2.5~5.4%. This reduction becomes substantial (ranging from -60~-80%) if a person increases insurance spending to 7.5% of income, resulting in negative effects for all types of SWB.

**5. Quantifying SWB gains from Insurance**

Finally, using the estimation results from Table 3, we quantify the monetary value of the SWB buffers provided by both the risk and fear groups' insurance spending when people in both groups pay up to 7.5%. The monetized SWB buffer value shows how much intangible disaster losses can be mitigated by insurance spending. To this end, we use a life satisfaction approach, referring to Frey et al. (2010), to calculate the monetary value for each group as follows:

$$\text{Risk group: } Monetized\,Value = \overline{Income} - e^{ln(\overline{Income}) - \frac{\beta_2}{\beta_{Income}}} \quad (2)$$

$$\text{Fear group: } Monetized\,Value = \overline{Income} - e^{ln(\overline{Income}) - \frac{\beta_3}{\beta_{Income}}} \quad (3)$$

where $\beta_2$ and $\beta_3$ are the regression coefficients from Equation (1). By subtracting the monetized value of the fear group from that of the risk group, we can calculate the gains from insurance for each type of SWB and total SWB. The calculated monetized benefits are presented in Table 6. Our results show that the annual total per capita gains from insurance (for 2015) are 86,010.73 USD and are largest for happiness (33,127.71 USD), followed by life satisfaction (33,286.74 USD) and subjective health (19,596.59 USD). Figure 3 shows the graphical results of the monetized gains from insurance, divided across the risk and fear groups.[6]

[6] While the fear group shows a loss, subtracting its result from that of the risk group produces positive estimates. For simplicity, in Figure 4, we mark the positive value for the fear group.

**Table 6: Monetized Buffers and Gains from Insurance**

| Group | Happiness | Life Satisfaction | Subjective Health | Total |
|---|---|---|---|---|
| Risk Group | 8,654.01 USD | 10,962.04 USD) | 10,658.55 USD | 30,274 USD |
| Fear Group | -24,473.7 USD | -22,324.7 USD | -8,938.04 USD | -55,736.73 USD |
| Gains from Insurance | 33,127.71 USD | 33,286.74 USD | 19,596.59 USD | 86,010.73 USD |

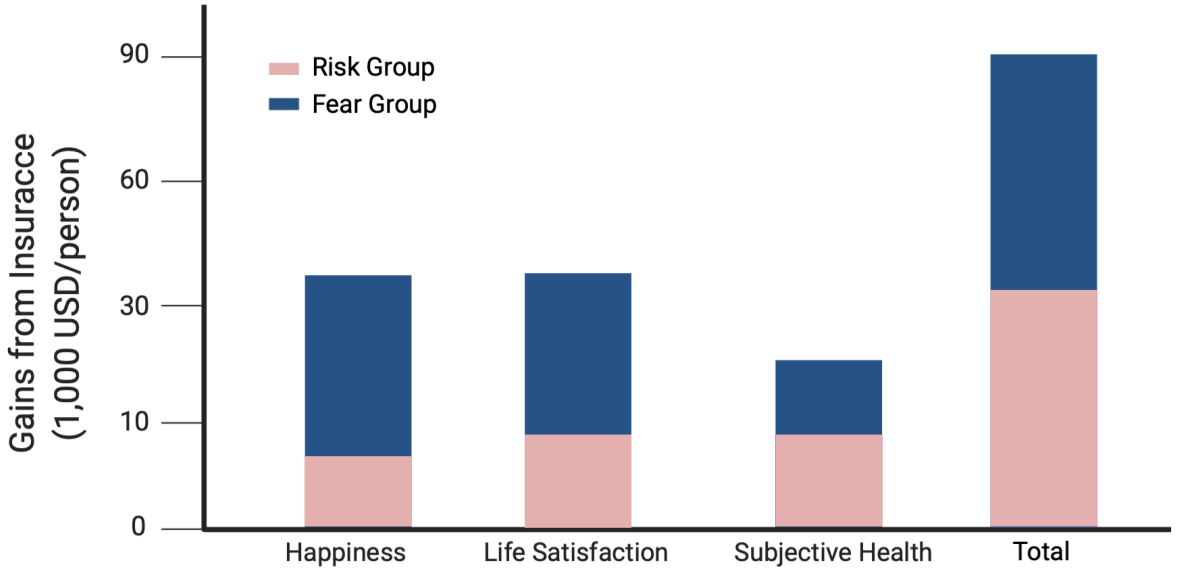


**Figure 3: Graphical Evidence on the Gains from Insurance**

## 6. Discussion

The results of the analyses conducted in this study provide some insightful implications and emphasize the important role of life/health insurance in buffering declines in subjective well-being, especially for those who have been exposed to mass disasters. We have observed the difference in the impact of life/health insurance on different types of SWB, namely, happiness, life satisfaction, and subjective health. The analyses have also shown that the magnitude of the impact differs significantly between those who have been physically exposed to mass disaster and those who have not but still fear mass disaster: a 1% increase in the life/health insurance spending proportion is correlated with a rise in SWB by 4-6% for those who were exposed to the great East Japan earthquake, while a 1% increase among those

not been physically exposed to that mass disaster but who express a strong fear of disasters in general is correlated with a decline in SWB by 2.5~5.4%.

As briefly discussed in Section 2, we have seen a continuous increase in the number of natural disasters in the past few decades, but with the enhancement of disaster risk management capacity, mortality from natural disasters has shown a decreasing trend (EMDAT, 2020). These trends underscore the importance of disaster adaptation measures to cope with the drop in SWB after exposure to mass disasters. In this light, this study implies that life/health insurance could be considered an important disaster adaptation measure.

Another notable point of discussion is the negative impact of an increase in life/health insurance on SWB for those not physically exposed to a mass disaster but who express strong fear. As presented in Section 2, despite the substantial literature investigating the impacts of disasters on people's SWB and the increasing number of studies investigating the relationship between life/health insurance and SWB, very few studies examine the relationships between disaster exposure, life/health insurance, and SWB, which are addressed in this study. For example, analyzing large survey datasets collected in the US, Tran et al. (2016) provide valuable evidence that health insurance coverage increases SWB, but this conclusion may differ when we consider the impact of disaster exposure. In this sense, this study contributes to research on the relationship between life/health insurance and SWB by shedding light on the importance of considering disaster exposure and presents empirical evidence on the effectiveness of life/health insurance as a disaster adaptation measure.

## 7. Conclusion

This study shows that life and health insurance can serve as an adaptation measure by preventing intangible losses related to disaster outbreaks. While the increasing number of natural disasters calls for urgent adaptation measures, the decreased losses of physical assets due to natural disasters imply that a certain level of disaster mitigation is already built into the status quo. Taking advantage of insurance spending data from Japan, we analyze whether insurance spending can buffer declines in SWB due to a massive natural disaster, the great East Japan earthquake. Our results show that declines in SWB can be buffered through life and health insurance spending, with the largest gains from insurance in life satisfaction, followed by happiness and subjective health.

Our results contribute to the literature by showing that spending up to 7.5% of income on insurance has the greatest effect in buffering SWB declines. By monetizing the buffer

effect of insurance spending, this study provides a new way to reshape natural disaster policy. Furthermore, our findings imply that considering damage to intangible assets and adaptation methods in times of disaster is necessary. Regardless of the low probability of a disaster, the increasing number of disasters indicates the necessity of preventive measures, and our results illuminate that life/health insurance can operate as one such measure. Unfortunately, we had access to only two separate datasets. Having access to one dataset with details on insurance spending and SWB as well as socioeconomic factors would not require a data-merging process, thus alleviating the assumptions required for that process.

This study provides several pathways for future research. First, future work could examine whether different types and combinations of life and health insurance provide different results for SWB. For example, some types of insurance include life-long policies, while other types are based on 5-year policies. Examining the factors affecting selections across these types and whether such factors mediate the buffer effect against disaster losses would be interesting. Second, another possible extension could be made by evaluating variation in the timing of insurance subscriptions. For example, does an insurance policy taken out a year before a disaster compensate for declines in SWB in equal measure to a policy taken out ten years before? Comparing estimates across groups according to the timing of insurance subscriptions is worth discussing. Third, evaluating the gains from insurance with reference to those who have never had insurance would show whether people who purchase insurance are still better off than those who never do. Unfortunately, our data do not allow us to make such a comparison, as it requires data on those who do not have insurance, and our data cover only people with insurance. Studying these issues is left for future research.

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