# Online Appendix

For "Do Risk Preferences Change? Evidence from the Great East Japan Earthquake"

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## Appendix A: Variable lists and source of data

1. *Risk preferences, gamgling, drinking, and smoking*

Data on risk preferences, gamgling, drinking, and smoking are from Japan Household Panel Survey on Consumer Preferences and Satisfaction (JHPS-CPS). The following are survey questions used in the study.

a) *Risk Preferences*: Suppose there is a "speed lottery" with a 50% chance of winning JPY 100,000. If you win, you get the prize right away. If you lose, you get nothing. How much would you spend to buy a ticket for this lottery? Choose Option A if you would buy it at that price or choose Option B if you would not buy at that price. **(X ONE Box For EACH Row)**

| Price of the "speed lottery" ticket | | Which ONE do you prefer? **(X ONE Box For EACH Row)** Option A (buy the "speed lottery" ticket) | Option B (DO NOT buy the "speed lottery" ticket) |
|---|---|---|---|
| JPY 10 | (USD 0.1) | 1 □ | 2 □ |
| JPY 2,000 | (USD 20) | 1 □ | 2 □ |
| JPY 4,000 | (USD 40) | 1 □ | 2 □ |
| JPY 8,000 | (USD 80) | 1 □ | 2 □ |
| JPY 15,000 | (USD 150) | 1 □ | 2 □ |
| JPY 25,000 | (USD 250) | 1 □ | 2 □ |
| JPY 35,000 | (USD 350) | 1 □ | 2 □ |
| JPY 50,000 | (USD 500) | 1 □ | 2 □ |

Note: An exchange rate of JPY 100 = USD 1 is used.

b) *Gambling*: Do you bet on lotteries, casinos, sporting events, or horse races? **(X ONE Box)**

1 □ Don't gamble at all
2 □ Used to gamble but quit gambling now
3 □ Hardly gamble
4 □ Several times a year or so
5 □ Once a month or so
6 □ Once a week or so
7 □ Almost everyday

c) *Drinking*: Do you drink alcoholic beverages? **(X ONE Box)**

1 □ Don't drink at all
2 □ Hardly drink (a few times a month or less)
3 □ Drink sometimes (a few times a week)
4 □ A can of beer (12 oz.) or its equivalent a day, almost every day
5 □ 3 cans of beer (12 oz. x 3) or its equivalent a day, almost every day
6 □ 5 or more cans of beer (12 oz. x 5) or its equivalent a day, almost every day

d) Smoking: Do you smoke? **(X ONE Box)**

1 □ Never smoked
2 □ Hardly smoke
3 □ Occasionally smoke
4 □ I smoke about 1 to 5 cigarettes a day
5 □ I smoke about 6 to 10 cigarettes a day
6 □ I smoke about 11 to 20 cigarettes a day
7 □ I smoke about 21 to 30 cigarettes a day
8 □ I smoke about 31 to 40 cigarettes a day
9 □ I smoke 41 cigarettes or more a day
10 □ I used to smoke but I quit

2. *Intensity of the Earthquake*

Detail: http://www.kyoshin.bosai.go.jp/kyoshin/quake/

Accessed: 12:32pm CST, Sep 13, 2013

Data on seismic intensity of the Earthquake is obtained from the Earthquake and Volcano Data Center, National Research Institute for Earth Science and Disaster Prevention (NIED), Japan. The Center maintains a strong-motion seismograph network (K-NET, Kik-net) that includes more than 1,700 observation stations distributed uniformly every 20 km, covering Japan. The seismic intensity data as well as the geocode information of each observation station are collected for all major earthquakes in Japan.

3. *Radiation*

Detail: https://mapdb.jaea.go.jp/mapdb/portals/60/

Accessed: 3:55pm CST, March 11, 2014

Data on radiation are collected by the Airborne Monitoring Survey of the Ministry of Education, Culture, Sports, Science and Technology in Japan. The data are collected by airplane flight with altitudes between 150 and 300 m. The flight paths had a width of at most 5 km and cover almost all municipalities in Japan. The air dose rate of radiation (μSv/h) is adjusted to reflect the number at a height of 1 m above the ground. This is the only radiation survey that covered all municipalities across Japan after the Earthquake and accident at the Fukushima Daiichi Nuclear Power Plant. The survey was conducted between June 22, 2011 and May 31, 2012. Most of the affected municipalities were surveyed in 2011 while some of the less or almost non-affected areas, such as Hokkaido, Hyogo, Kyoto, Mie, Shiga, Shimane, and Tottori, are measured after March 2012.

4. *Pre-Earthquake Hazard Prediction*

Detail: http://www.j-shis.bosai.go.jp/download

Accessed: 12:54pm CST, March 12, 2014

This earthquake prediction is based on a 2010 report of the National Seismic Hazard Maps for Japan by the Headquarters for Earthquake Research Promotion of the Ministry of Education, Culture, Sports, Science and Technology, Japan. The report presents a detailed prediction on the probability of earthquake occurrence at a 250 m mesh code level. The prediction combines earthquake occurrence models, seismic source models, and subsurface structure models to calculate the predicted probability of different intensity levels at each mesh code level.

5. *Fatality Rate*

Detail: http://www.stat.go.jp/info/shinsai/zuhyou/data0422.xls

Accessed: 12:30pm CST, Sep 13, 2013

Fatality rate is created from the number of fatalities collected by the Fire and Disaster Management Agency (*Shobo-cho*, *Saiagi Taisaku Honbu* in Japanese) of the Ministry of Internal Affairs and Communications in Japan. The number is as of March 11, 2013, two years after the Earthquake. The numbers of deaths and missing people are reported at the municipality level for each affected municipality. We use the natural logarithm of one plus the numbers of deaths and missing people per million at the municipality level.

6. *Property value*

Detail: http://nlftp.mlit.go.jp/ksj/jpgis/datalist/KsjTmplt-L01-v1_1.html

Accessed: 11:28am, CST, June 26, 2014

Property value data are constructed by the Ministry of Land, Infrastructure, Transport and Tourism for the purpose of property tax evaluation based on the transaction price of nearby properties and other related factors. Property values as of January 1 for each year are published and the original data include more than 26,000 properties. We use the change of property values for the same property between 2011 and 2012 and take a simple average of all properties located in each municipality.

## Appendix B. Robustness of results on risk preferences

Table 3 in the main text presents our key results for short-term changes in risk preferences. We also perform a series of robustness checks as summarized in Subsection 5.1 in the main text. Here, we describe the details of these results. The following analysis focuses on men in the short-term because we find changes in risk preferences only for men (the long-term results between 2011–2016 are available upon request). In sum, our main results on men's risk preferences are robust to additional controls, different specifications, and alternative ways of constructing both explanatory and outcome variables.

### B1. Income and wealth

We investigate whether our results are robust to control for changes in income and wealth. Appendix Table B1 summarizes these results.[1] To facilitate the comparison, Column (1) replicates the estimate from our baseline in Table 3 in the main text. Column (2) adds interaction of a dummy variable of the intensity measure above four and a dummy variable that takes the value of 1 for men who work in the agriculture and fishery industries in order to capture the differential impact of the Earthquake by most affected industries. The estimates for both intensity and its interaction terms barely change, which is not surprising given that the proportion of workers in these two industries is very low. Column (3) controls for self-reported income but the estimate is again hardly affected. We need to view this result with caution because income is reported in brackets of JPY 2 million (roughly USD 20,000 in 2012), and thus, it is possible that income does indeed change within each bracket.

Column (4) shows that our results are also robust to changes in *expected* future income. We control for two survey measures for the percentage change in expected income 1 year or 5 years after the survey, instead of the reported change in current income, as shown in Column (3). The results remain unchanged.

In addition, we control for assets in Columns (5) and (6). Column (5) controls for assets measured in brackets of JPY 2.5 million (roughly USD 25,000) and the estimates are hardly affected. Column (6) adds a dummy that takes the value of 1 if the person owns a house but the estimates on intensity measure and its interaction are once again unaffected.[2] The result is in accordance with previous literature that finds no wealth effects on elicited risk tolerance or risk-

[1] We also conduct the robustness checks for income and assets using the alternative measure of risk preference (absolute risk aversion) and the different intensity thresholds. We find that the results are very similar (the results are available upon request).

[2] For Columns (5) and (6), we replace the missing value for assets and housing ownership with 0, and add a dummy for such observations in the estimation. In addition, we drop these observations and perform a re-estimation, but the estimates are essentially identical (the results are available upon request).

taking behavior (e.g., Sahm, 2012; Brunnermeier and Nagel, 2008). Finally, we control for the ratio of property values before and after the Earthquake at the municipality level. Column (7) shows that estimates are unchanged.[3]

We also find that the coefficients of the changes in income or wealth are not statistically significant (the results are available upon request). While these results are consistent with the previous literature (e.g., Sahm, 2012; Brunnermeier and Nagel, 2008), that is, wealth does not affect risk preferences, this is possibly because the variation in changes in income and assets in our sample are relatively small, as we discuss below.

Broadly speaking, there are two types of income windfall for households that are hit by the Earthquake.[4] One source comprises income transfers from donations by the Japanese Red Cross, and other organizations, channeled through local governments to affected households. Requirements for eligibility for these transfers include either the loss of a family member or the damage (half or complete) of housing. In fact, our sample of 227 municipalities includes only 25 municipalities that channeled these transfers. In addition, the possibility that the surveyed individuals in the municipality happened to be eligible for the transfer is extremely small for the municipalities in our data set because the number of surveyed individuals in each municipality is less than 15 on average. Furthermore, the amount of payment is rather small.[5]

The second channel of income transfer is compensation from the Tokyo Electric Power Company (TEPCO) to households and organizations directly affected by the accident at the Fukushima Daiichi Nuclear Power Plant. The total cumulative payment was roughly JPY 2 trillion (about US$ 20 billion) at the end of March 2013, which is about 6 times larger than payments via the first channel. Compensation to households is limited to those located in 11 municipalities within a 30-kilometer radius from the power plant or those specified by the government. None of these 11 municipalities is included in our data set. Thus, the only way TEPCO compensation could matter systematically to the individuals in our data set is through compensation to organizations, such as agricultural and fishing cooperatives. Compensation to organizations accounts for 21 percent of total compensation and payment to agricultural and fishing cooperatives (87 percent) dominates

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[3] Data on property values are not available for five municipalities. We replace the missing value with zero and add a dummy for such observations in the estimation. We also drop these observations and perform a re-estimation but the estimates are essentially identical (the results are available upon request).

[4] Specifically, income is the total income before taxes of all earnings of a respondent's entire household, including bonus payments and transfers. In addition, assets comprise financial assets and house ownership; financial assets are the balance of financial assets (savings, stocks, bonds, insurance, and so on) of a respondent's entire household and house ownership is determined by whether any household member is the owner of the residence.

[5] For example, a family that lost one family member receives JPY 350,000 (about USD 3,500) as compensation.

payment to organizations. However, the proportion of workers in these two industries is very small in the municipalities in our dataset. In fact, among 1,566 men in our sample, only 44 individuals (2.8 percent) work in the agriculture and fishery industries. Even if we limit the sample to individuals who live in locations hit by an intensity level of more than 4, only 20 individuals (1.3 percent) work in these two industries.

Finally, another simple way to test whether income and wealth are not driving our results is that we directly estimate where the LHS variable of the main specification (5) in Table 3 in the main text is replaced by employment, income, and expected income at the municpality-year level. We report the results from this specification in Appendix Table B2. It is reassuaring that none of the estimates are statistically significant at the conventional level.

**B2. Radiation and fatalities**

Throughout the study, we use the intensity of the Earthquake as the measure of the severity of the Earthquake. However, one may argue that radiation due to the accident at the Fukushima Daiichi Nuclear Power Station may be another factor that affects people's risk preferences (Goodwin et al., 2012).[6] Another possible intensity measure, which is often used in the literature (especially in violent conflicts), is the fatality rate.

As mentioned in Subsection 2.1 in the main text, we do not use radiation level or fatality rate as our intensity measure in the main specification because both measures are too concentrated in a small number of municipalities and little variation exists for the municipalities covered in our sample. In fact, while the nuclear accident forced thousands of residents in the vicinity of the plant to evacuate, none of these municipalities is included in our data. In addition, a very large proportion of fatalities is due to the tsunami following the Earthquake, and again, very few municipalities in our data set have a coastline facing the Pacific Ocean, as seen in Figure 1 in the main text. In fact, only 6 of 227 municipalities (2.6 percent) report non-zero population who lived in flooded areas.

Nonetheless, to assess whether radiation and fatalities are driving our results on changes in men's risk preferences, we add the level of radiation and the fatality rate for each municipality to our baseline specification (5) as controls.[7] The results are summarized in Appendix Table B3.

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[6] Using the data collected 11–13 weeks after the Earthquake, Goodwin et al. (2012) show that anxiety about future earthquakes and nuclear threats is correlated with changes in both preventive actions (keeping an earthquake kit and modifying living quarters) and avoidance behavior (avoiding certain foods or going outside, wearing masks, and contemplating emigration).

[7] Alternatively, as a further robustness check, we exclude subjects who lived in locations hit hardest by the Earthquake from the estimation sample and re-estimate equation (5). As for radiation, we exclude subjects who lived in locations exposed to 0.23 $\mu$Sv/h or more, which is the level adopted as a standard for planned evacuation zones after the accident at the Fukushima Daiichi Nuclear Power Plant (20 of 227 municipalities, or 8.8 percent of the sample). As for fatalities, we exclude subjects who lived in locations that reported non-

Column (1) in Appendix Table B3 replicates the baseline estimate from Table 3 in the main text for ease of comparison across specifications. Columns (2) and (3) add the level of radiation and fatality rate, respectively, while Column (4) adds both measures simultaneously. The estimates on the interaction term are quantitatively similar to the baseline in Column (1). In addition, the estimates on radiation and fatalities are not statistically significant. Note that we do not claim that radiation and fatalities do not affect risk preferences; we simply do not have enough variation to precisely estimate their effects.

Also, some studies show that fear of or risk perception about nuclear power plants increased after the Fukushima Daiichi Nuclear Plant accident in countries far from Japan, specifically in Germany (Goebel et al., 2015) and China (Huang et al., 2013). Therefore, one may argue that our intensity measure captures the effect of fear among those who live close to nuclear power plants *other* than the Fukushima Daiichi Nuclear Plant. In fact, there are 52 nuclear power plants in 18 locations across Japan. To address this concern, we control for the log distance from nearby nuclear power plants interacted with the Earthquake intensity measure. Appendix Table B4 shows that the estimates hardly change with this control. In addition, the estimate on the distance interacted with the intensity measure is not statistically significant at the conventional level.

### B3. Outliers and mean reversion

A potential concern for the results is that they may be driven by outliers. One way to address this concern is to use M-estimation (Huber, 1964), which puts less weight on residuals that are more likely to be outliers. In addition, we reestimate the model by excluding some observations that look like outliers. The results are not different, as shown in Appendix Table B5.

Another potential concern for the result is whether we may simply capture the mean reversion of people with high-risk aversion. However, mean reversion is not likely to drive our results. We are not aware of any event that occurred during the survey before the Earthquake for those who lived in high-intensity regions. In addition, from our data, we can show that such a concern may not be valid. We reestimate the same specification (5) in Table 3 in the main text by excluding the individuals whose risk categories are highest and second highest (categories 8 and 9 in Appendix Table C1) before the Earthquake. Our estimates remain unchanged, as shown in Appendix Table B6.

### B4. Alternative measures of risk preference

To examine whether our results are driven by a particular form of risk preference measure, we

zero population who lived in flooded areas (6 of 227 municipalities, or 2.6 percent of the sample). The results are very similar (the results are available upon request).

consider two alternative ways to measure risk preferences. First, we construct another cardinal measure of risk preference defined by Equation (2) in Subsection 2.2 in the main text, absolute risk aversion. We estimate our baseline specification (Equation (5)) using this alternative risk aversion measure in Appendix Table B7. The results show similar patterns to the corresponding columns in Table 3 in the main text, though the estimate on square of intensity measure in Column (4) is marginally statistically insignificant. Using the estimates from Column (1) in Appendix Table B7, as the intensity of the Earthquake increases by 2 above the threshold of 4, absolute risk aversion decreases by 0.100 [= $2 \times (-0.060 + 0.010)$], which corresponds to 5.7 percent reduction off the mean of 1.759 before the Earthquake. Note that since the relative risk aversion is approximately the product of absolute risk aversion and wealth (Cramer et al., 2002; Hartog et al., 2002), the change in the relative risk aversion is also 5.7 percent, which is the same as that of the absolute risk aversion. Put another way, the size of reduction (0.100) is 56 percent of the mean difference in risk aversion between men and women (0.177 = 1.936–1.759) before the Earthquake.

Second, as an alternative to the cardinal measure of risk preferences that we use so far, we consider an ordinal risk aversion measure. A potential concern we would like to address is that our results could be driven by the cardinal nature of the risk aversion measure as well as potential dependence on the particular way we construct these cardinal measures. To mitigate this concern, we construct an ordinal measure that takes 1 if the choice of risk category after the Earthquake is higher (i.e., more risk-averse) than that before the Earthquake, –1 if the opposite is the case, and 0 if there is no change between the two surveys. We estimate the main equation (5) by OLS using this ordinal measure as an outcome. Appendix Table B8 shows that the patterns of results are similar to those in Table 3, where the outcomes are cardinal risk preference measures.

### B5. Alternative measures of intensity

Finally, Appendix Table B9 demonstrates the robustness of our results to different ways of constructing the intensity measure. Column (1) replicates our baseline estimates; we use the weighted average of the three closest monitoring stations. As noted in subsection 2.1 in the main text, the weight is the inverse of the distance from the city hall of each municipality to each monitoring station. Columns (2)–(4) construct the intensity measure using only the two closest monitoring stations, the simple average of intensity at the three closest stations, and the only closest station. The estimates are quantitatively similar to those in Table 3 in the main text.

Also, one may be concerned also with measurement error in the intensity measure. We use the location of residence to assign the severity of the Earthquake. However, the Earthquake took place on a weekday (Friday) afternoon, so some adult men were probably at work. Thus, their assigned value of earthquake severity is possibly measured with an error. To mitigate this concern, we exclude men whose commute to work takes 15 minutes or longer (remaining N = 584), and 30 minutes or longer (remaining N = 778). The results are quantitatively similar (the results are available upon request). In any case, measurement error in the intensity measure causes our estimates to be at the lower bound because of attenuation bias.

**Table B1. Control for Income and Wealth Effects (Men Only)**

Outcome: Risk Aversion Measure 1 (Transformed Price)

| Additional Control Variables | Baseline | Industry dummy | Income | Expected Income | Asset | House Ownership | Property Price |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| X | 0.008* | 0.008* | 0.008* | 0.008 | 0.008* | 0.008* | 0.008* |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| (X – 4) * 1[X ≥ 4] | -0.038** | -0.036** | -0.038** | -0.038** | -0.038** | -0.038** | -0.038** |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| Constant | 0.007 | 0.007 | 0.007 | 0.008 | 0.007 | 0.007 | 0.015 |
| | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.016) |
| Individual FE | × | × | × | × | × | × | × |
| Industry dummy * 1[X ≥ 4] | | × | | | | | |
| Income | | | × | | | | |
| Expected Income | | | | × | | | |
| Asset | | | | | × | | |
| House ownership Dummy | | | | | | × | |
| Property price | | | | | | | × |
| Mean of outcome (before) | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 |
| No. of individuals | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 |
| R-squared | 0.003 | 0.005 | 0.004 | 0.006 | 0.004 | 0.005 | 0.003 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. For Columns (4)–(7), we replace the missing value for expected income, asset, house ownership, and property price with 0, and add a dummy for such observations in the estimation. We also drop these observations, but the estimates are essentially identical. Results for specifications with (X – 4.5) * 1[X ≥ 4.5], (X – 5) * 1[X ≥ 5], and X-squared are very similar (the results are available upon request). Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B2. Effects on Employment, and Income using Municipality-level Data**

| Outcomes | Employment rate | Personal Income | Personal Income Growth |
|---|---|---|---|
| X | -0.001 | 0.001 | -0.002 |
| | (0.005) | (0.035) | (0.006) |
| (X – 4) * 1[X ≥ 4] | -0.006 | 0.102 | 0.032 |
| | (0.020) | (0.135) | (0.028) |
| Constant | -0.001 | -0.151* | -0.016 |
| | (0.012) | (0.087) | (0.016) |
| Mean of outcome (before) | 0.710 | 6.314 | 6.314 |
| Municipality FE | × | × | × |
| N of municipalities | 227 | 227 | 227 |
| R-squared | 0.005 | 0.008 | 0.017 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. Results for specifications with (X – 4.5) * 1[X ≥ 4.5], (X – 5) * 1[X ≥ 5], and X-squared are very similar (the results are available upon request). Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01. Standard errors clustered at the municipality are reported in parentheses.

**Table B3. Control for Radiation and Fatality Rate (Men Only)**

Outcome: Risk Preference Measure 1 (Transformed Price)

| Additional Control Variables | Baseline | Radiation | Fatality rate | Radiation & Fatality rate |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| X | 0.008* | 0.008* | 0.008* | 0.008* |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| (X – 4) * 1[X ≥ 4] | -0.038** | -0.041** | -0.037** | -0.040** |
| | (0.017) | (0.018) | (0.018) | (0.019) |
| Radiation | | 0.015 | | 0.015 |
| | | (0.024) | | (0.025) |
| Fatality rate | | | -0.001 | -0.001 |
| | | | (0.003) | (0.003) |
| Constant | 0.007 | 0.005 | 0.004 | 0.003 |
| | (0.011) | (0.011) | (0.013) | (0.013) |
| Individual FE | × | × | × | × |
| Income | × | × | × | × |
| No. of individuals | 1,566 | 1,566 | 1,566 | 1,566 |
| R-squared | 0.003 | 0.004 | 0.004 | 0.004 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. Radiation is measured in μSv/h. Fatality rate is the log of the number of deaths plus 1 per 1,000,000 persons. See Appendix Section A for details of these variables. Results for specifications with (X – 4.5) * 1[X ≥ 4.5], (X – 5) * 1[X ≥ 5], and X-squared are very similar (the results are available upon request). Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B4. Control for Distance from Nuclear Power Plants (Men Only)**

Outcome: Risk Aversion Measure 1 (Transformed Price)

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | (a) | (b) | (a) | (b) | (a) | (b) | (a) | (b) |
| X | 0.008* | -0.020 | 0.006 | -0.014 | 0.004 | -0.007 | 0.018* | -0.015 |
| | (0.005) | (0.020) | (0.004) | (0.021) | (0.003) | (0.021) | (0.010) | (0.023) |
| (X – 4) * 1[X ≥ 4] | -0.038** | -0.034* | | | | | | |
| | (0.017) | (0.018) | | | | | | |
| (X – 4.5) * 1[X ≥ 4.5] | | | -0.056*** | -0.052** | | | | |
| | | | (0.021) | (0.025) | | | | |
| (X – 5) * 1[X ≥ 5] | | | | | -0.090*** | -0.091** | | |
| | | | | | (0.031) | (0.040) | | |
| X-squared | | | | | | | -0.003* | -0.003 |
| | | | | | | | (0.002) | (0.002) |
| X * log (distance from the nearest nuclear power plant) | | 0.006 | | 0.004 | | 0.002 | | 0.007* |
| | | (0.004) | | (0.004) | | (0.004) | | (0.004) |
| log (distance from the nearest nuclear power plant) | | -0.019 | | -0.018 | | -0.016 | | -0.020 |
| | | (0.014) | | (0.014) | | (0.013) | | (0.014) |
| Constant | 0.007 | 0.093 | 0.008 | 0.089 | 0.011 | 0.083 | 0.006 | 0.098 |
| | (0.011) | (0.063) | (0.010) | (0.062) | (0.010) | (0.061) | (0.011) | (0.065) |
| Individual FE | × | × | × | × | × | × | × | × |
| Mean of outcome (before) | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 |
| N of individuals | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 |
| R-squared | 0.003 | 0.004 | 0.004 | 0.005 | 0.005 | 0.005 | 0.002 | 0.003 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. Columns (b) add log of the distance from the nearest nuclear power and its interaction with the intensity measure to Columns (a). There are 52 nuclear power plants in 18 locations across Japan and we take the distance between the city hall of the municipality and the nearest nuclear power plant. Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B5. Outlier Analysis (Men Only)**

Outcome: Risk Aversion Measure 1 (Transformed Price)

| | Baseline | | | | M-estimation (Huber, 1964) | | | | Exclude four municipalities at X = 5.5 (N = 26) in Figure 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| X | 0.008* | 0.006 | 0.004 | 0.018* | 0.005 | 0.004 | 0.003 | 0.014* | 0.007 | 0.006 | 0.004 | 0.014 |
| | (0.005) | (0.004) | (0.003) | (0.010) | (0.003) | (0.003) | (0.002) | (0.007) | (0.005) | (0.004) | (0.003) | (0.010) |
| (X – 4) * 1[X ≥ 4] | -0.038** | | | | -0.027** | | | | -0.027* | | | |
| | (0.017) | | | | (0.012) | | | | (0.016) | | | |
| (X – 4.5) * 1[X ≥ 4.5] | | -0.056*** | | | | -0.040*** | | | | -0.039** | | |
| | | (0.021) | | | | (0.015) | | | | (0.019) | | |
| (X – 5) * 1[X ≥ 5] | | | -0.090*** | | | | -0.068*** | | | | -0.066*** | |
| | | | (0.031) | | | | (0.023) | | | | (0.025) | |
| X-squared | | | | -0.003* | | | | -0.003** | | | | -0.002 |
| | | | | (0.002) | | | | (0.001) | | | | (0.002) |
| Constant | 0.007 | 0.008 | 0.011 | 0.006 | 0.003 | 0.004 | 0.006 | 0.002 | 0.008 | 0.009 | 0.011 | 0.007 |
| | (0.011) | (0.010) | (0.010) | (0.011) | (0.008) | (0.008) | (0.008) | (0.009) | (0.011) | (0.010) | (0.010) | (0.011) |
| Individual FE | × | × | × | × | × | × | × | × | × | × | × | × |
| Mean of outcome (before) | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.737 | 0.736 | 0.736 | 0.736 | 0.736 |
| N of individuals | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,566 | 1,540 | 1,540 | 1,540 | 1,540 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. M-estimation (Huber, 1964) minimizes the residual function which puts less weight on residuals that are more likely to be outliers. M-estimation is run using the "robreg" user-provided package in Stata software (Jann, 2010). Standard errors for OLS are clustered at the municipality and those for M-estimation are robust standard errors as suggested by Croux et al. (2003). Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B6. Mean Reversion (Men Only)**

Outcome: Risk Aversion Measure 1 (Transformed Price)

| | Baseline | | | | Excluding subjects with risk aversion (category 9) before the Earthquake | | | | Excluding subjects with risk aversion (categories 8 and 9) before the Earthquake | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| X | 0.008* | 0.006 | 0.004 | 0.018* | 0.007 | 0.005 | 0.003 | 0.017* | 0.007 | 0.006 | 0.004 | 0.017 |
| | (0.005) | (0.004) | (0.003) | (0.010) | (0.005) | (0.004) | (0.003) | (0.010) | (0.005) | (0.004) | (0.003) | (0.011) |
| (X – 4) * 1[X ≥ 4] | -0.038** | | | | -0.038** | | | | -0.038** | | | |
| | (0.017) | | | | (0.017) | | | | (0.019) | | | |
| (X – 4.5) * 1[X ≥ 4.5] | | -0.056*** | | | | -0.057** | | | | -0.060** | | |
| | | (0.021) | | | | (0.022) | | | | (0.025) | | |
| (X – 5) * 1[X ≥ 5] | | | -0.090*** | | | | -0.095*** | | | | -0.100*** | |
| | | | (0.031) | | | | (0.032) | | | | (0.038) | |
| X-squared | | | | -0.003* | | | | -0.003* | | | | -0.003 |
| | | | | (0.002) | | | | (0.002) | | | | (0.002) |
| Constant | 0.007 | 0.008 | 0.011 | 0.006 | 0.014 | 0.015 | 0.018* | 0.013 | 0.021* | 0.021* | 0.025** | 0.020* |
| | (0.011) | (0.010) | (0.010) | (0.011) | (0.011) | (0.011) | (0.010) | (0.012) | (0.011) | (0.011) | (0.011) | (0.012) |
| Individual FE | × | × | × | × | × | × | × | × | × | × | × | × |
| Mean of outcome (before) | 0.737 | 0.737 | 0.737 | 0.737 | 0.727 | 0.727 | 0.727 | 0.727 | 0.706 | 0.706 | 0.706 | 0.706 |
| N of individuals | 1,566 | 1,566 | 1,566 | 1,566 | 1,506 | 1,506 | 1,506 | 1,506 | 1,392 | 1,392 | 1,392 | 1,392 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. See Appendix Table C2 for distribution of sample in each category. Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B7. Alternative Measure of Risk Preference (Men Only)**

Outcome: Risk Aversion Measure 2 (Absolute Risk Aversion)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| X | 0.010 | 0.008 | 0.004 | 0.024 |
| | (0.009) | (0.008) | (0.007) | (0.019) |
| (X – 4) * 1[X ≥ 4] | -0.060* | | | |
| | (0.031) | | | |
| (X – 4.5) * 1[X ≥ 4.5] | | -0.093** | | |
| | | (0.039) | | |
| (X – 5) * 1[X ≥ 5] | | | -0.138** | |
| | | | (0.053) | |
| X-squared | | | | -0.005 |
| | | | | (0.003) |
| Constant | 0.018 | 0.020 | 0.026 | 0.018 |
| | (0.022) | (0.021) | (0.020) | (0.023) |
| Individual FE | × | × | × | × |
| Mean of outcome (before) | 1.759 | 1.759 | 1.759 | 1.759 |
| No. of individuals | 1,566 | 1,566 | 1,566 | 1,566 |
| R-squared | 0.002 | 0.003 | 0.003 | 0.001 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. Note that the values of absolute risk aversion are multiplied by 1000. Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B8. Changes in the Choice of Risk Aversion Category (Men Only)**

Outcome: Ordinal Outcome of Risk Aversion Measure

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| X | 0.032* | 0.026* | 0.017 | 0.077** |
| | (0.017) | (0.014) | (0.011) | (0.037) |
| (X – 4) * 1[X ≥ 4] | -0.148** | | | |
| | (0.063) | | | |
| (X – 4.5) * 1[X ≥ 4.5] | | -0.216*** | | |
| | | (0.080) | | |
| (X – 5) * 1[X ≥ 5] | | | -0.374*** | |
| | | | (0.126) | |
| X-squared | | | | -0.014** |
| | | | | (0.007) |
| Constant | 0.001 | 0.006 | 0.016 | -0.007 |
| | (0.039) | (0.037) | (0.036) | (0.041) |
| Individual FE | × | × | × | × |
| Mean of outcome (before) | 5.349 | 5.349 | 5.349 | 5.349 |
| No. of individuals | 1,566 | 1,566 | 1,566 | 1,566 |
| R-squared | 0.004 | 0.005 | 0.006 | 0.003 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. Outcome is the ordinal outcome of risk aversion measure, which takes 1 if the person chose a higher risk aversion category after the Earthquake (i.e., is more risk averse) than that before the Earthquake; takes −1 if the person chose a lower risk aversion category after the Earthquake (i.e., is less risk averse) than that before the Earthquake; and 0 if the person chose the same category before and after the Earthquake. Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table B9. Alternative Intensity Measures of the Earthquake (Men Only)**

Outcome: Risk Preference Measure 1 (Transformed Price)

| | *Intensity Measure* | | | |
|---|---|---|---|---|
| | Baseline | Alternative Measure 1 | Alternative Measure 2 | Alternative Measure 3 |
| Method of constructing an *Intensity Measure* | Weighted Average of Three Closest Stations | Weighted Average of Two Closest Stations | Simple Average of Three Closest Stations | Closest Station Only |
| | (1) | (2) | (3) | (4) |
| *Intensity Measure* | 0.008* | 0.008 | 0.008* | 0.008* |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| (*Intensity Measure* – 4) * 1[*Intensity Measure* ≥ 4] | -0.038** | -0.035** | -0.040** | -0.033** |
| | (0.017) | (0.017) | (0.017) | (0.016) |
| Constant | 0.007 | 0.007 | 0.007 | 0.006 |
| | (0.011) | (0.011) | (0.011) | (0.011) |
| Individual FE | × | × | × | × |
| Mean of outcome (before) | 0.737 | 0.737 | 0.737 | 0.737 |
| No. of individuals | 1,566 | 1,566 | 1,566 | 1,566 |
| R-squared | 0.003 | 0.003 | 0.003 | 0.003 |

*Notes*: X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. Weight is the inverse of the distance between the city hall and each monitoring station. Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

## References


**Brunnermeier, Markus K., and Stefan Nagel.** 2008. "Do Wealth Fluctuations Generate Time-Varying Risk Aversion? Micro-Evidence on Individuals' Asset Allocation." *American Economic Review*, 98(3): 713–736.

**Cramer, Jan S., Joop Hartog, Nicole Jonker, and Mirjam van Praag.** 2002. "Low Risk Aversion Encourages the Choice for Entrepreneurship: An Empirical Test of a Truism." *Journal of Economic Behavior and Organization*, 48(1): 29–36.

**Croux, Christophe, Geert Dhaene, and Dirk Hoorelbeke.** 2003. "Robust standard errors for robust estimators." Discussions Paper Series (DPS) 03.16, Center for Economic Studies.

**Goebel, Jan, Christian Krekel, Tim Tiefenbach, and Nicolas R. Ziebarth.** 2015. "How natural disasters can affect environmental concerns, risk aversion, and even politics: evidence from Fukushima and three European countries." *Journal of Population Economics*, 28(4): 1137–1180.

**Goodwin, Robin, Masahito Takahashi, Shaojing Sun, and Stanley O. Gaines Jr.** 2012. "Modelling Psychological Responses to the Great East Japan Earthquake and Nuclear Incident." *PLoS One*, 7(5): e37690.

**Hartog, Joop, Ada Ferrer-i-Carbonell, and Nicole Jonker.** 2002. "Linking Measured Risk Aversion to Individual Characteristics." *Kyklos*, 55(1): 3–26.

**Huang, Lei, Ying Zhou, Yuting Han, James K. Hammitt, Jun Bi, and Yang Liu.** 2013. "Effect of the Fukushima Nuclear Accident on the Risk Perception of Residents near a Nuclear Power Plant in China." *Proceedings of the National Academy of Sciences*, 110: 19742–19747.

**Huber, Peter J.** 1964. "Robust estimation of a location parameter." *Annals of Mathematical Statistics*, 35: 73–101.

**Jann, Ben.** 2010. "ROBREG: Stata module providing robust regression estimators." Available at https://ideas.repec.org/c/boc/bocode/s457114.html [accessed September 22, 2015].

**Sahm, Claudia.** 2012. "How Much Does Risk Tolerance Change?" *Quarterly Journal of Finance*, 2(4).

## Appendix C. Additonal Figures and Tables

**Table C1. Risk Aversion Category, Price of the Lottery Tickets, and Risk Aversion Measures**

| | | <- Less risk averse | | | | | | More risk averse -> | |
|---|---|---|---|---|---|---|---|---|---|
| **Risk aversion category** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| Price of the lottery tickets (JPY) | ~50,000 | 50,000~35,000 | 35,000~25,000 | 25,000~15,000 | 15,000~8,000 | 8,000~4,000 | 4,000~2,000 | 2,000~10 | 10~ |
| Transformed Price | ~0 | 0~0.30 | 0.30~0.50 | 0.50~0.70 | 0.70~0.84 | 0.84~0.92 | 0.92~0.96 | 0.96~0.99 | 0.99~ |
| Absolute Risk Aversion | ~0 | 0~1.100 | 1.100~1.600 | 1.600~1.879 | 1.879~1.969 | 1.969~1.993 | 1.993~1.998 | 1.998~2.000 | 2.000~ |

*Notes*: The values of absolute risk aversion are multiplied by 1,000. See the main text for the construction of each risk aversion measure based on the price of the lottery tickets.

## Table C2. Transition Matrix of Risk Aversion Category
## Before (2011) and After (2012) the Earthquake (Men Only)

a) X ≥ 4

**After (2012)**

| | | <- Less risk averse | | | | | More risk averse | | -> | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Before (2011)** | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total |
| Less risk averse -> | 1 | 1 | 4 | 1 | 2 | 3 | 0 | 1 | 0 | 1 | 13 |
| | 2 | 5 | 14 | 6 | 2 | 4 | 2 | 1 | 1 | 0 | 35 |
| | 3 | 3 | 6 | 11 | 9 | 9 | 2 | 3 | 0 | 0 | 43 |
| | 4 | 2 | 2 | 9 | 16 | 19 | 13 | 2 | 1 | 1 | 65 |
| | 5 | 0 | 2 | 7 | 24 | 47 | 26 | 20 | 4 | 1 | 131 |
| | 6 | 1 | 1 | 2 | 11 | 26 | 15 | 31 | 8 | 1 | 96 |
| | 7 | 1 | 0 | 2 | 0 | 20 | 26 | 36 | 15 | 5 | 105 |
| | 8 | 1 | 0 | 1 | 1 | 6 | 4 | 17 | 14 | 3 | 47 |
| <- More risk | 9 | 0 | 0 | 0 | 0 | 1 | 5 | 3 | 1 | 11 | 21 |
| Total | | 14 | 29 | 39 | 65 | 135 | 93 | 114 | 44 | 23 | 556 |

b) X < 4

**After (2012)**

| | | <- Less risk averse | | | | | More risk averse | | -> | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Before (2011)** | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total |
| Less risk averse -> | 1 | 4 | 5 | 4 | 6 | 5 | 1 | 2 | 0 | 0 | 27 |
| | 2 | 9 | 11 | 10 | 11 | 7 | 3 | 2 | 1 | 1 | 55 |
| | 3 | 4 | 12 | 23 | 20 | 13 | 8 | 6 | 4 | 0 | 90 |
| | 4 | 2 | 5 | 18 | 33 | 38 | 24 | 5 | 3 | 0 | 128 |
| | 5 | 1 | 3 | 10 | 36 | 94 | 48 | 38 | 7 | 3 | 240 |
| | 6 | 1 | 6 | 4 | 7 | 51 | 56 | 42 | 7 | 6 | 180 |
| | 7 | 1 | 1 | 3 | 6 | 29 | 45 | 61 | 31 | 7 | 184 |
| | 8 | 0 | 0 | 1 | 3 | 9 | 8 | 16 | 25 | 5 | 67 |
| <- More risk | 9 | 0 | 1 | 1 | 3 | 3 | 6 | 0 | 8 | 17 | 39 |
| Total | | 22 | 44 | 74 | 125 | 249 | 199 | 172 | 86 | 39 | 1,010 |

**Table C3. Validity of Risk Aversion Measures**

a) Using the 2011 survey (a year before the Earthquake)

| Outcomes | Gambling | Drinking | Smoking |
|---|---|---|---|
| | (1) | (2) | (3) |
| Risk aversion measure 1 | -0.156*** | -0.032** | -0.031** |
| | (0.026) | (0.014) | (0.013) |
| Constant | 0.214*** | 0.040*** | 0.037*** |
| | (0.023) | (0.012) | (0.012) |
| No. of individuals | 3,352 | 3,352 | 3,352 |
| R-squared | 0.014 | 0.003 | 0.004 |

b) Using the 2012 survey (a year after the Earthquake)

| Outcomes | Gambling | Drinking | Smoking |
|---|---|---|---|
| | (1) | (2) | (3) |
| Risk aversion measure 1 | -0.198*** | -0.034** | -0.019 |
| | (0.031) | (0.014) | (0.013) |
| Constant | 0.257*** | 0.044*** | 0.033*** |
| | (0.026) | (0.012) | (0.011) |
| No. of individuals | 3,352 | 3,352 | 3,352 |
| R-squared | 0.019 | 0.003 | 0.001 |

*Notes*: Risk Aversion Measure 1 is the transformed price. See the main text for construction of the risk aversion measure. A gambling dummy takes one if the person is engaged in gambling once or more a week. A drinking dummy takes 1 if the person drinks 5 or more cans of beer (12 *oz*. per can) or its equivalent a day almost every day. A smoking dummy takes 1 if the person smokes more than 30 cigarettes per day. See Appendix Section A for the survey question for each outcome. Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.

**Table C4. Changes in Behavior (Women Only)**

| Outcomes | Gambling | Drinking | Smoking |
|---|---|---|---|
| | (1) | (2) | (3) |
| X | -0.004 | 0.002 | -0.000 |
| | (0.004) | (0.002) | (0.000) |
| (X – 4) * 1[X ≥ 4] | 0.014 | 0.000 | 0.000 |
| | (0.014) | (0.006) | (0.000) |
| Constant | 0.006 | -0.004 | 0.001 |
| | (0.009) | (0.004) | (0.001) |
| Individual FE | × | × | × |
| Income | × | × | × |
| Mean of outcome (before) | 0.039 | 0.004 | 0.002 |
| N of individuals | 1,786 | 1,786 | 1,786 |
| R-squared | 0.001 | 0.002 | 0.001 |

*Notes*: The data are from the JHPS-CPS in 2011 (a year before the Earthquake) and 2012 (a year after the Earthquake). X is the seismic intensity of the Earthquake (*Shindo* in Japanese), a metric of the strength of an earthquake at a specific location. A gambling dummy takes one if the person is engaged in gambling once or more a week. A drinking dummy takes 1 if the person drinks 5 or more cans of beer (12 *oz.* per can) or its equivalent a day almost every day. A smoking dummy takes 1 if the person smokes more than 30 cigarettes per day. See Appendix Section A for the survey question for each outcome. Results for specifications with (X – 4.5) * 1[X ≥ 4.5], (X – 5) * 1[X ≥ 5], and X-squared are very similar (the results are available upon request). Standard errors clustered at the municipality are reported in parentheses. Significance levels are *p < 0.10, **p < 0.05, and ***p < 0.01.