Evacuation and Psychological Distress: New Evidence of Reference-Dependent Utility and Loss Aversion[*]

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Abstract

We test the canonical version of prospect theory using unique data from residents displaced by the Fukushima Daiichi Nuclear Disaster. To collect the data set, we designed and administered surveys to residents from Futaba (a town in Fukushima), who evacuated from the area because of high levels of radiation. As a result, all residents of Futaba lost their homes, land, and stable income sources. Using this incidence as a source of exogenous variations, our analysis reveals three significant empirical patterns. First, the displaced residents show unusually high levels of depression as captured by the Kessler 6 measure (K6), a widely-used measure of non-specific psychological distress. Second, we find that large losses of income, health, and home space are strongly associated with increased depression levels. Moreover, our empirical results show that psychological outcomes are more sensitive to losses than to gains, a finding which is largely consistent with the basic predictions of prospect theory.

Keywords: Prospect theory; Natural disaster; Depression
JEL Classification: D030

1. Introduction

While models of reference-dependent preferences and loss aversion have been tested in a variety of laboratory experiments, there is little real-world evidence that validates such models (Köbberling and Wakker, 2005; DellaVigna, 2009). In existing studies, there are a number of remaining issues such as the identification of the reference point and causal relationship and validity and generalizability of the empirical results as a real experienced welfare consequence of reference dependence and loss aversion. To bridge the gaps in the existing studies, we test the basic components of the canonical version of prospect theory by exploiting a natural experimental situation: the Fukushima Daiichi Nuclear Disaster. To carry out our study, we collected and employed data from the residents of Futaba town, who were unexpectedly displaced by the disaster in March 2011. Since Futaba town is located within a 2 to 10 km radius from the Fukushima Daiichi nuclear power plant, the government placed an indefinite evacuation order on all of the town's residents after the incident.

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Accordingly, all of the Futaba town residents were suddenly forced to evacuate from their homes and many of the residents lost stable income sources although the Tokyo Electric Power Company and the Japanese government have provided a variety of monetary and non-monetary compensations. Since the incident was unforeseen, the sudden evacuation provides researchers with a natural experiment similar to DiNardo (2008), in which individuals exogenously and unexpectedly lose their homes, assets, and income sources for an indefinite period.

2. Data

We conducted our survey in July 2013, two years and four months after the Great East Japan earthquake, subsequent tsunami and nuclear reactor disasters. We targeted residents from Futaba town, Fukushima, which is located within a 2 to 10 km from the Fukushima Daiichi nuclear power plant. Accordingly, most of the town is under a government-mandated evacuation order and all residents continue to live as refugees all over Japan for more than 4 years. We distributed our questionnaires by mail to all the displaced residents from Futaba town and received 585 answers by August 2013, giving us a response rate of about 20 %. As a part of the survey, we employ the K6, a widely used scale that measures nonspecific mental illnesses (Kessler 2002). K6 is a composite index of six questions on mental health that assigns a maximum of four points to each question for a total of 24 points. In existing studies the threshold for serious mental health problems is usually set at 13 points and above. To collect data on the determinants of the K6 measure, we asked home size, income, and subjective health status before and after the disaster in addition to basic characteristics such as age and gender.

3. Empirical Frameworks

We test the three basic components of the canonical version of prospect theory introduced by Kahneman and Tversky (1979) which are reference dependence, loss aversion and diminishing sensitivity. Pre-disaster home and asset ownership as well as income sources are likely to be a salient reference point for the evacuees' utility function. Hence, we apply pre-disaster wealth and income levels as reference points to test the theory. We can investigate the main characteristics of prospect theory by examining changes in psychosocial outcomes caused by the evacuation order. To test the three major characteristics of prospect theory, we postulate three regression models.

First, to test reference dependence, we follow Ferrer-i-Carbonell (2005) and Vendrik and Woltjer (2007) to adopt the regression model in equation (1):

$$V = \alpha + \beta_1 Y + \beta_2 (Y - Y_r) + X\gamma + u, \tag{1}$$

where V shows the utility level, Y is broad measurement of wealth that includes stable income sources, homestead, and health status, Y_r is a reference point, X is a set of control variables, and u is an error term. Within this model reference dependence can be tested examining the null hypothesis that β_2=0. In our empirical analysis, we define the utility level as V = 24 – K6, where V takes a value between zero and twenty-four. Note that V indicates a level of improved mental health condition. X is a set of control variables.

Second, to capture the shape of a value function with reference dependence and loss aversion, we employ the following piece-wise linear regression equation:

$$(2) \qquad V = \alpha + \beta_1 (Y\text{-}Y_r) + \beta_2 (Y\text{-}Y_r)*I[(Y\text{-}Y_r)<0] + \beta_3 I[(Y\text{-}Y_r)<0] + X\gamma + u,$$

where $I[.]$ is an indicator function which takes one if the argument is true. While reference dependence can be tested by the null hypothesis that H_0: $\beta_1=0$, loss aversion is tested by a null hypothesis that H_0: $\beta_2=0$. The loss aversion property indicates that the value function would be steeper for negative values than for positive values.

Finally, in order to examine the property of diminishing sensitivity, we postulate a non-linear regression equation as follows:

$$(3) \qquad V = \alpha + \beta_1^+ (Y\text{-}Y_r)*I[(Y\text{-}Y_r)<0] + \beta_2^+ g^+(Y\text{-}Y_r)*I[(Y\text{-}Y_r)>0]$$
$$+ \beta_1^- (Y\text{-}Y_r)*I[(Y\text{-}Y_r)>0] + \beta_2^- g^-(Y\text{-}Y_r)*I[(Y\text{-}Y_r)>0] + X\gamma + u.$$

To specify the non-linear parts, $g(Y\text{-}Y_r)$, we postulate three different forms. First, we simply assume a quadratic function, $g(Y\text{-}Y_r)=(Y\text{-}Y_r)^2$. Second, we follow Vendrik and Woltjer (2007) and assume a power function, $g(Y\text{-}Y_r)= [(Y\text{-}Y_r)^{1-\rho}-1]/(1-\rho)$ where $\rho>1$ and $\rho<0$, show concavity and convexity of the value function, respectively. Finally, we employ a semi-parametric regression approach to provide non-parametrical estimates of the non-linear parts, $g(Y\text{-}Y_r)$.

4. Empirical Results

High K6 Score among Futaba Residents

First, we find that the K6 score of Futaba residents is, on average, much higher than that of the entire population in Japan. Moreover, the residents of Futaba exhibit much higher K6 scores than individuals from other disaster-affected areas. Naturally, we may be able to attribute this pattern to the residents' reactions to the unexpected evacuation after the nuclear power plant fallout and their uncertainties about the future. Understanding the determinants of mental health would provide the disaster-affected residents with invaluable insights and allow them to ease their distress. To this aim, we adopt the prospect theory model and test the theory using the data from our original survey.

Reference Dependence

Table 1 presents the estimation results of equation (1). We can examine the reference dependence property by checking whether the reference level of wealth affects the utility level. Formally, we do this by testing a null hypothesis that $\beta_2=0$ in equation (1). Recall that we use income, house size, and health status as the wealth variables. Focusing on the income change variable, the estimated coefficient is positive and weakly significant. As for the house size and health status variables, the estimated coefficients are all positive and statistically significant. Hence, the estimation results reported in Table 1 are largely consistent with the implications of reference dependence.

Reference Dependence and Loss Aversion

Table 2 shows the estimation results of equation (2). Our target is to test the null hypothesis, H_0: $\beta_2=0$, by checking the coefficients on the interaction terms between the change in each wealth variable and the dummy variables for negative change in each wealth variable. As for the income variable, the estimated coefficient of the cross-terms are positive and statistically significant, indicating that the value function is steeper for losses than it is for gains. As for the house size variable, the coefficient, β_2, is not necessarily significant nor does it have a negative sign. A possible reason for this inconsistent finding may be attributed to a lack of sufficient data: there are only twenty-six respondents whose house size increased after the disaster. Finally, the estimated coefficients on the health status variable are all positive and statistically significant in Table 2, supporting the existence of reference dependence and loss aversion. To visualize our main findings, Figure 1, 2, and 3 exhibit the estimated value functions reported in Table 2.

Diminishing Sensitivity

We also tested for diminishing sensitivity using equation (3). In summary, income change shows concavity in negative values and convexity in positive values, a finding that is the opposite of the diminishing sensitivity property of the value function. House change shows concavity in both positive and negative values while health change shows concavity in positive values.

5. Concluding Remarks

Our analysis reveals three significant empirical patterns. First, the K6 levels among Futaba residents are substantially higher than the national average and are also higher than for residents from other areas affected by the March 2011 tsunami. Second, we find that large losses of income, health, and home size are strongly associated with increased levels of depression. Moreover, our empirical results show that the psychological outcomes of the evacuees are more sensitive to losses than to gains, a finding which is largely consistent with the basic predictions of prospect theory. Given the unusually high levels of psychological distress suffered by the evacuees, our findings have important policy implications. Since our results confirm that the evacuated residents substantially overweigh losses relative to gains, victims must be economically overcompensated for their losses in order to return to their original reference points. Furthermore, comprehensive support including health services and housing is required for their recovery since the impact of economical over- compensation is limited, a finding which can be derived from the multidimensional view point of the reference dependent model (Köszegi 2005).

References

DellaVigna, S. (2009). Psychology and Economics: Evidence from the Field. *Journal of Economic Literature*, 315-372.

DiNardo, J. (2008). Natural Experiments and Quasi-Natural Experiments. In S. Durlauf, & l. E. Blume, *The New Palgrave Dictionary of Economics, Second Edition.* Palgrave Macmillan.

Ferrer-i-Carbonell, A. (2005). Income and Well-being: An Empirical Analysis of the Comparison Income Effect. *Journal of Public Economics,* 997 – 1019.

Kahneman, D., Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 263-292.

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mrockzek, D. K., Normand, S.-L. T., . . . Zaslavsky, A. (2002). Short Screening Scales to Monitor Population Prevalences and Trends in Non-specifc Psychological Distress. *Psychological Medicine*, 959-976.

Kessler, R., Galea, S., Gruber, M., Sampson, N., Ursano, R., & Wessely, S. (2008). Trends in Mental Illness and Suicidality after Hurricane Katrina. *Molecular Psychiatry*, 374-384.

Köbberling, V., Wakker, P, P., (2006), "Preference Foundations for Difference Representations," *Economic Theory* 27, 375-391

Köszegi, B., & Rabin, M. (2005). Reference-Dependent Risk Preferences. *Department of Economics, University of California, Berkeley, Working Paper*.

Vendrik, M. C., & Woltjer, G. B. (2007). Happiness and Loss Aversion: Is Utility Concave or Convex in Relative Income? *Journal of Public Economics,* 1423-1448.

Table 1. Tests of Reference Dependence

	Income	House	Health	All
Dependent variable : V	(5)	(6)	(7)	(8)
Income after disaster (Y)	0.00526***			0.00394***
	(0.00130)			(0.000954)
Income change (Y-Yr)	0.00275*			0.00125
	(0.00138)			(0.00171)
House size after disaster (Y)		0.0520*		0.0471
		(0.0292)		(0.0345)
House size change (Y-Yr)		0.0116***		0.00738**
		(0.00378)		(0.00346)
Health change (Y-Yr)			3.890***	3.520***
			(0.301)	(0.521)
Controls				
Constant	19.46***	19.35***	19.71***	18.11***
	(2.153)	(2.266)	(2.157)	(2.606)
Number of observations	434	301	449	258
adj. R-sq	0.106	0.098	0.300	0.336

Cluster robust standard errors shown in parentheses * p<0.10 ** p<0.05 *** p<0.01

Table 2. Tests of Reference Dependence and Loss Aversion

	Income	House	Health	All
Dependent variable: V	(1)	(2)	(3)	(4)
Income change (Y-Yr)	-0.000392			-0.000692
	(0.00208)			(0.00195)
Income change decrease dummy # Income change	0.00849***			0.00539*
	(0.00233)			(0.00288)
House size change (Y-Yr)		-0.000326		0.213**
		(0.0603)		(0.0814)
House size decrease dummy # House size change		0.0119		-0.206**
		(0.0612)		(0.0805)
Health change (Y-Yr)			1.955***	2.262***
			(0.408)	(0.712)
Health change decreace dummy # Health change			2.362***	2.516
			(0.709)	(1.580)
Controls				
Constant	21.67***	22.38***	19.99***	19.24***
	(2.455)	(2.718)	(2.351)	(3.089)
Number of observations	434	301	449	258
adj. R-sq	0.089	0.088	0.304	0.322

Cluster robust standard errors shown in parentheses * p<0.10 ** p<0.05 *** p<0.01

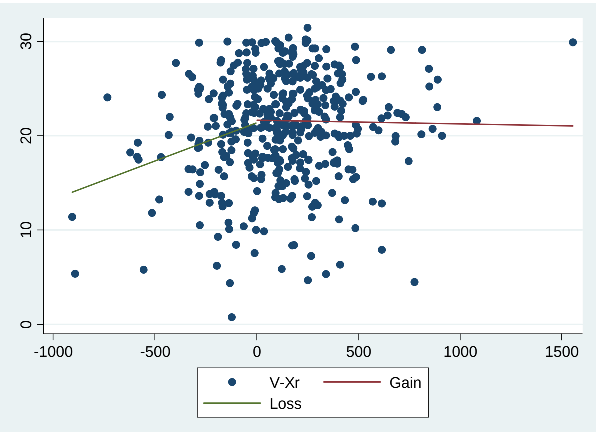

Figure 1. The Estimated Value Function over Income

Note) The values in the horizontal axis represent 10,000 yen

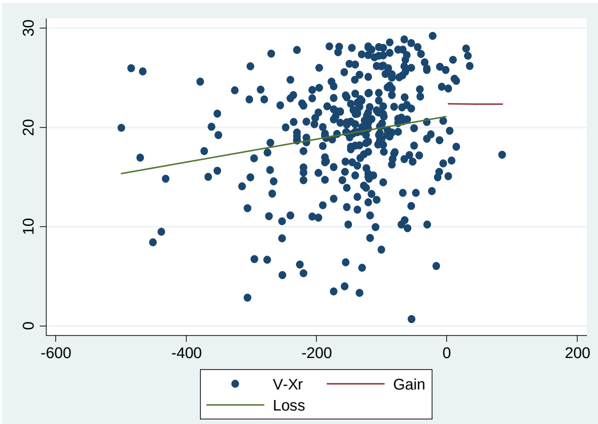

Figure 2. The Estimated Value Function over House Size

Note) The values in the horizontal axis represent squared meter.

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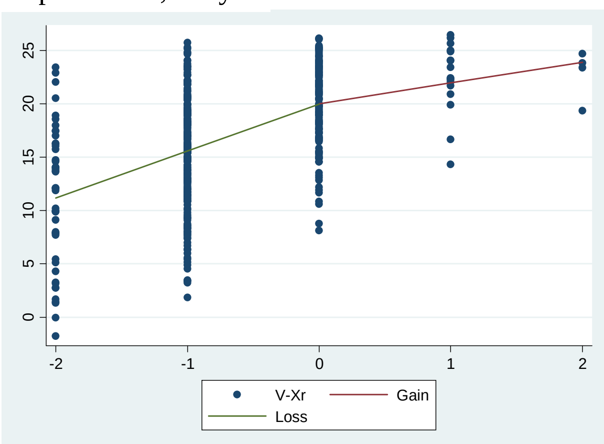

Figure 3. The Estimated Value Function over Health

Note) The values in the horizontal axis represent: 2=much better; 1=better; 0=no difference; -1=worse; and -2=much worse.