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Abstract

This study investigates the determinants of transfer of waste between the affected areas and other municipalities that resulted from the Great East Japan Earthquake. In particular, we investigate to what extent economic factors, but also social factors such as reciprocity and pro-social concerns, affect municipalities' decision to accept disaster waste. We find some evidence that economic factors affect the decision, but the main factors that explain the decision are related to concerns about radiation and social concerns about the affected area. Our results suggest that it is primarily social concerns, both about the own municipality but also about the affected municipalities that explain behavior.

Keywords: Disaster waste; Social preferences; Wide area treatment

JEL-codes: Q53, R50

1. Introduction

On March 11, 2011, the Great East Japan Earthquake that occurred off the Pacific coast of Japan triggered a massive tsunami. It heavily impacted areas in the three prefectures of Iwate, Miyagi, and Fukushima, resulted in 15,884 fatalities and 2,633 missing persons. The tsunami destroyed many houses and buildings and a huge amount of disaster waste was generated. The tsunami also damaged the Fukushima Daiichi nuclear power plant, leading to a release of radioactive isotopes, and in turn to radioactive waste.

The amounts of waste generated by the tsunami were much larger than that of the annual municipal solid waste in these prefectures. Therefore, the Japanese Ministry of Environment inquired municipalities about the possibility of accepting the disaster waste from the Iwate and Miyagi prefectures. The disaster waste generated in Fukushima Prefecture was not included in the wide area treatment because of the radiation risk. When municipalities were asked about the possibility of acceptance just after the earthquake, 572 municipalities out of 1596 stated that they could accept disaster waste. Later on, as we will discuss, only 76 municipalities actually accepted disaster waste.

The tragic event of the tsunami provides us with an interesting case of movement of waste between regions/municipalities. There is an empirical literature that has investigated the determinants of the transfer of waste between states and countries. For example, Levinson (1999a, 1999b) investigated the influence of a waste disposal tax on the movement of hazardous waste between states in the United States. It was found that factors such as population size and density, land area, and capacity of the disposal site had a positive impact on the amount of wide area treatment while factors such as the

distance between states, and income had a negative impact. Baggs (2009) studied the international transfer of hazardous waste using data collected through the implementation of the Basel Convention. The results suggest that the movement of waste is better explained by the differences in capital per worker than by differences in income per capita. It means that more capital-intensive nations import more hazardous waste for disposal.

The focus of the previous studies has mainly been on the impact of economic factors. While they might be also of importance for disaster waste, it is likely that social factors such as pro-social and anti-social behavior, and reciprocity could play important roles in the time of crisis. Studies in psychology suggest that disasters can invoke both pro-social and anti-social behavior among individuals; see e.g. Gantt and Gantt (2012). Using economic experiments, Becchetti et al. (2012) find that there are long-run negative effects on altruism of being a victim of a natural disaster such as a Tsunami, while Li et al. (2013) find heterogeneous effects depending on the age of the victim. There is also an extensive literature on attitudes towards infrastructure development – such as landfills – that suggest that factors such as fear of objective and subjective risks are in important in determining local residents attitudes towards these types of projects (see e.g. Gallagher et al., 2008; Jenkins et al., 2004; Lober and Green, 1994; McClelland et al., 1990). Residents opposition to new development – that is collectively desirable - has given rise to the term NIMBY (Not In My Back Yard). As discussed by Frey et al. (1996), monetary compensation does not in many cases increase the level of support. On the contrary compensation could crowd-out intrinsic motivation (Frey and Oberholzer-Gee 1997; Titmus, 1970). This also suggests that intrinsic pro-social factors could be important for the attitudes towards these types of projects. There are actually

examples of counter-movements; often using the term YIMBY (Yes In My Backyard), that has more positive attitudes towards changes in the built environment.

In this paper, we investigate the characteristics of the municipalities that responded to the request for accepting the disaster waste of the Great East Japan Earthquake. In particular, we focus on the role of social factors such as altruistic reasons, measured as the amount of donations to the disaster victims, and reciprocity, i.e. if accepting municipalities themselves face the risks of similar situation.

The next section contains a description of the situation and the request for treatment of disaster waste. Section 3 introduces the data and the empirical strategy. Results are presented in Section 4 and Section 5 presents the conclusion.

2. Background

On March 11, 2011, the Great East Japan Earthquake that occurred off the Pacific coast of Japan triggered a massive tsunami. The most heavily impacted areas were in the three prefectures of Iwate, Miyagi, and Fukushima. The tsunami destroyed many houses and buildings and generated a huge amount of disaster waste. The amount of the disaster waste in Iwate prefecture was about 5.25 million tons, in Miyagi prefecture was 11.54 million tons, and in the Fukushima prefecture was 2 million tons. These are approximately 12 times, 14 times, and 3 times larger than that of the annual municipal solid waste in these prefectures, respectively. Iwate and Miyagi prefectures requested other municipalities to accept wide area treatment of the disaster waste through the Japanese Ministry of Environment. The disaster waste generated in Fukushima Prefecture has not been included in the wide area treatment so far because of the risk of radiation.

The Ministry of Environment inquired municipalities about the possibility of accepting the disaster waste in April 2011. As a result, 42 prefectures and 572 municipalities expressed intentions of accepting the disaster waste. The aggregate capacity of the incinerators in these municipalities amounted to about 2.93 million tons per year, suggesting that the wide area treatment could help a prompt response for disaster recovery. However, when the Ministry of Environment investigated the intentions again in October 2011, there were only 54 municipalities that had already accepted, or began actions towards acceptance. Compared to the investigation results of April 2011, it is clear that negative attitudes among the municipalities had increased.

The main reason was the anxiety over the possibility of radioactive contamination of the waste. In June 2011, it was detected that the radiation level in the incineration ashes of the municipal solid waste in Edogawa Ward, Tokyo was higher than the standard level.* Although the high radiation level found in the incineration waste of the Edogawa Ward does not relate to the wide area treatment, it invoked an anxiety over the radiation risks. The incident damaged the confidence of the government and created suspicion that sufficient information was not provided.

We use cross-sectional data from 1,592 municipalities that does not include the municipalities of Miyagi, Iwate, and Fukushima prefectures. The data on the acceptance of disaster waste is based on the reports from the municipalities, collected by the Ministry of the Environment as of June 26, 2012 and October 25, 2013. Table 1 shows the number of municipalities from 2011 to 2013 that were either positive or negative toward accepting the waste. For 2011, we only have information about the total number

*According to the guidelines of the Ministry of the Environment, radiation levels of the combustible waste must be less than 240Bq/kg for incineration and that of the incombustible waste must be less than 8,000Bq/kg for final disposal.

of municipalities that were positive, but not which these municipalities are.

On June 29, 2012, The Ministry of the Environment informed that there were enough expressed intentions of acceptance from municipalities to treat the existing tsunami waste and there was no need to examine further interest from other municipalities. As of June 2013, 76 municipalities have accepted the tsunami waste. Most of these municipalities are in the eastern part of Japan. Figure 1 shows the rate of municipalities that accepted the tsunami waste in each prefecture as of October 25, 2013.

The 2012 report by the Ministry of the Environment contains the list of municipalities that have been examining the possibility of acceptance, that expressed the intention of acceptance, or that have already accepted the disaster waste. We treat these municipalities as positive towards acceptance. The 2013 report contains a list of municipalities that have already accepted the disaster waste. Since the Ministry of the Environment sent a message on June 29, 2012 that there was no need to examine further acceptance, there are no municipalities examining the possibility of the acceptance or expressing any intention of acceptance in the 2013 report.

The role of the Ministry of the Environment in the wide area treatment of the tsunami waste was to coordinate the stakeholders. The Ministry facilitated the cooperation between the affected municipality and the accepting municipality and requests the acceptance of disaster waste for prefectures. The role of the prefecture was to investigate municipalities belonging to the prefecture about acceptance. Some prefectures that have their own incineration facilities or waste disposal, have accepted disaster waste. One example of this is Tokyo, which accepted about 25,000 tons of tsunami waste from several municipalities.

The role of the municipality is to accept the disaster waste and incinerate or dispose

of it in their facility for treatment of municipal solid waste. In addition, the accepting municipality measures the radiation level of the waste and announces the results to alleviate any anxiety the inhabitants may have. An affected municipality can receive a subsidy from the Ministry of the Environment to cover the entire cost of implementing the wide area treatment. Thus, in principle, the affected or accepting municipality does not need to bear any of the cost of disaster waste disposal.

The practice of wide area treatment is as follows. Table 2 describes the steps of the wide area treatment for the case of Osaka city, which accepted 15,000 tons of combustible disaster waste from the Miyako area in Iwate prefecture. The required disposal cost was at least 290 million yen. The tsunami waste contains many materials such as mud, concrete, plants, houses, cars, and various products. At the first temporary site in the Miyako area, the disaster waste was separated into combustibles and incombustibles, hazardous and non-hazardous, and recyclable and non-recyclable (by hand or machine). The separated waste was sent to a second temporary site and further separated by hand. After the separation process, the radiation level of the waste was measured at the second temporary site. The radiation level was measured again before loading it onto ships and trucks for transportation.

When the disaster waste arrived at a harbor and a transshipment facility near the accepting municipality, the radiation level was measured again. In the transshipment facility, machines removed hazardous waste and incombustibles found in the disaster waste. Lastly, the disaster waste was treated in an incineration plant and sent to a final disposal site, where it was disposed together with municipal solid waste after the measurement of concentration of radioactive material.

3. Data and empirical strategy

3.1 Factors affecting the acceptance of waste

As discussed in the introduction section, there is evidence that factors such as socio-economic and geographic characteristics of the municipalities and prefectures can affect the likelihood of accepting the disaster waste (see e.g. Levinson 1999a, 1999b). To begin with, we therefore include information on the population density, the rate of agricultural workers, and the population share under age 15 as explanatory variables. We include these four variables primarily to control for the importance of anxiety over the radioactive contamination. Reluctance to accept the waste may be stronger in municipalities with a higher population density since it is more likely that people live closer to the facility in a densely populated area. In municipalities with a large share of children, there may be stronger anxiety by parents over the health effects of radiation on their children. Similarly, in the municipalities with a higher number of agricultural workers, there may be more inhabitants who feel anxiety over the impact of radioactive material on the production of agricultural products.

The main economic factor that we will include is the slack capacity of the incinerator plants. The idea is that municipalities will try to manage their incinerators efficiently from the viewpoint of economic rationality. If there is a larger slack capacity in incinerators, they can bring the operation of the facility to a more efficient level by accepting additional waste from other municipalities. Data on the slack capacity of incineration plants and the slack capacity of final disposal sites in each prefecture were available from a survey by the Ministry of the Environment. The slack capacity of incineration plants is calculated as the difference between the annual capacity of the facility and the annual throughput.

We also investigate the effects of the pre-existing implementation of wide area treatment of municipal solid waste. While each municipality has responsibility to the treatment of its household waste in Japanese waste management policy, the Ministry of the Environment has, since late 1990s, promoted wide area treatment because of scale economy. Many municipalities form a coalition to treat household waste and share the incineration plants and final disposal sites that are operated based on the cooperation among municipalities. A municipality that is used to accepting the solid waste of other municipalities might have less reluctance to the wide area treatment of disaster waste.

Although each municipality determined the acceptance of the disaster waste independently, there might be an influence by the prefecture that the municipality belongs to. For example, the municipality can receive cooperation and support on the wide area treatment from the prefecture if the prefecture is also in favor of acceptance. We therefore include information on whether or not the prefecture was in favor of acceptance of the waste.

Reciprocity reasons could also be important for why a municipality accepts the disaster waste. Municipalities may willing to accept the disaster waste because they could be harmed by a disaster in the future, and thereby are able to ask other municipalities for help as well. Specifically, this motive would be strong if the municipality is located near the nuclear power plant as the risk of being denied the request is higher. Data on the location of nuclear power plants was sourced from the Japan Atomic Industrial Forum, Inc. This is a dummy variable that takes the value one if there is any nuclear power plant within the boundaries of the municipality. As of March 2, 2011, there were 54 nuclear power reactors located in 17 municipalities in 13 prefectures in Japan.

Finally, cooperation for emergency restoration between municipalities might be implemented from a humanitarian point of view. Then, the related question is if there are differences in the extent of pro-sociality among municipalities in general, and in particular with respect to altruistic concerns regarding the actual disaster in question. Furthermore, these potential differences might affect the likelihood of acceptance. In order to investigate this, we include two measures relating to the extent of pro-sociality among the municipalities and prefectures. The first one is a measure of the extent of volunteer activity in each prefecture. The data comes from the 2011 survey on Time Use and Leisure Activities by the Statistical Bureau of the Japanese Ministry of Internal Affairs and Communications. The data measures the percentage of people above 10 years old who participated in any volunteer activity in that year. Since the October 2011 survey was conducted after the disaster in March 2011, it also contains the volunteer activity for the Great East Japan Earthquake. The second measure is the amount of donations from the inhabitants of the prefecture to the victims of the Great East Japan Earthquake. The Japanese Red Cross Society, one of the biggest organizations that collected donations for victims of the Great East Japan Earthquake, provides data on the donations from each prefecture in Japan from March 2011 to March 2012. The data does not contain the money that was sent directly to the head office of the Japanese Red Cross Society. Thus, if the ratio between the donations to the prefectural office and those to the head office is significantly different among prefectures, it does not accurately represent the exact donations from each prefecture. While both our measures of pro-social preferences could explain the willingness to help the affected municipalities with handling their waste, the second measure is directly related to the disaster itself.

The relationship between donations and acceptance of waste is not clear. On the one hand the size of the donations could be a good measure of the extent of altruistic concerns. On the other hand, psychological studies suggest that there could be some sort of moral licensing (Monin and Miller, 2001), i.e. people who have undertaken a praiseworthy act, receive an implicit license for subsequently conducting a more selfish act. For example, Mazar and Zhong (2010) found that people become less altruistic after purchasing environmentally friendly products than after purchasing conventional products. In the case of the Great East Japan Earthquake, donations to help the victims might have lead to moral licensing.

The final variable that we include that is related to social concerns is the distance from Fukushima Daiichi. Social concern or social distance is potentially a function of spatial proximity (Akerlof 1997, Gleaser et al., 2002). Thus it is possible that people that live in municipalities close to the affected area have a closer social connection with the people in these areas, and are thus more concerned and more likely to support any help to the affected areas.

Summary statistics of all the variables are presented in Table 3.

3.2 Model

We estimate the determinants for the municipalities' acceptance of disaster waste using the logit model. The model is:

$$\text{Prob}(Y = 1|\mathbf{x}) = \Lambda(\mathbf{x}'\boldsymbol{\beta}) = \frac{e^{\mathbf{x}'\boldsymbol{\beta}}}{1 + e^{\mathbf{x}'\boldsymbol{\beta}}}$$

where Y is a dummy variable that takes the value of one when the municipality is positive toward the acceptance of the disaster waste and x represents explanatory variables. We estimate two models: one based on the 2012 data and one based on the 2013 data. Regarding the 2012 data, three kinds of municipalities are treated as positive toward the acceptance: municipalities that have been examining the possibility of acceptance; municipalities that have expressed the intention to acceptance; and those that have already accepted the disaster waste. With regard to estimations using the data of 2013, municipalities positive toward the acceptance are those have already accepted the disaster waste.

There are large differences in the acceptance rate between the regions, in particular between eastern and western parts of Japan. In particular, there are very few municipalities that finally accepted waste in 2013 in western Japan. We will therefore also estimate models focusing only on eastern part of Japan.

When a municipality already disposes municipal solid waste by wide area treatment with neighboring municipalities, it is necessary for the municipality to obtain permission from other municipalities to accept disaster waste. Hence, all of these municipalities belonging to the group of wide area treatment are counted as accepting municipalities because they actually agreed upon acceptance.

4. Results

Table 4 reports the results from the binary logit models with the acceptance of waste as the dependent variable. The first two models report the results from the 2012 and 2013 data respectively, and include all municipalities. The third and fourth model reports results focusing only on the municipalities in eastern Japan.

Most of the estimated marginal effects have signs that are in line with our hypotheses. The statistical significance varies somewhat between the 2012 and 2013 data. In municipalities with higher amount of donations, the likelihood of accepting waste is higher, and the effect is statistically significant in all models except the 2012 data of the full sample. The sizes of the marginal effects are non-negligible although not huge. For example, for the 2013 model if donations increase by one standard deviation, the probability that a municipality accepts waste increases by almost 0.02 units. The measure of volunteer activity is also positively correlated with the likelihood of accepting waste for all models at least in 10% level. In particular if we focus on the sample of municipalities in eastern Japan, the effect is robust. Thus, both our measures of pro-sociality are positively related to acceptance, and since the amount of donations is positively related, any type of moral licensing is not so strong so that it counteracts the effect of pro-sociality on the acceptance of waste.

The results related to the distance to the Fukushima Daiichi also point to the fact that social concerns were important when deciding whether to accept the waste or not. The estimated marginal effects with the data from all of Japan show that the distance from the Fukushima Daiichi is negative and statistically significant. This suggests that there is a stronger concern about the affected areas and a stronger willingness to help in municipalities that are close to the affected area. The size of the marginal effect is sizeable, for the 2013 model an increase in distance corresponding to a standard deviation increase, decrease the probability of acceptance by 0.061 units. On the other hand, the marginal effect is insignificant in estimation with the data of eastern Japan.

Results related to the factor of reciprocity show that proximity to a nuclear power plant has statistically significant and positive marginal effect. A municipality that has a

nuclear power plant within its boundaries may accept the disaster waste because they would expect other municipalities to help if a severe nuclear accident occurred in their own municipality. The results suggest that the concept of reciprocity motivation leads to a municipality's acceptance.

The impact of the prefecture's intention is negative and statistically significant in models that use the data from 2012. On the other hand, the effect is positive and statistically significant in models that use the data from 2013. Since the 2012 data contains municipalities that show intentions of accepting disaster waste and the 2013 data does not, this suggests that the intentions of the prefecture tend to be positive when the municipalities move to the actual stage of acceptance. While the negative coefficient in models with the data from 2012 is difficult to interpret, the influence of different levels of government might not be weak in coordinating the inter-municipal transfer of disaster waste.

While the above variables are mostly related to non-economic motivations for acceptance, the estimated results suggest that economic incentives to some extent influence the decision to accept disaster waste, at least in some cases. If we look at all municipalities in 2012, then the slack capacity of the incineration plant is positively correlated with the decision to accept waste or not. However, if we only look at the municipalities in eastern Japan, this is no longer true. Thus, the municipalities in eastern Japan may tend to accept the waste regardless of economic rationality.

The ratio of the population working in the agricultural sector as well as population density is statistically significant and negative. The agricultural workers might fear that accepting the tsunami waste could create a negative image of their products. Results on the variable suggest that the reluctance to accept disaster waste is strong in the

municipalities with a higher number of workers in agricultural sector. On the other hand, evidence is weak for the effect of population density and those under 15 years of age. While the sign of coefficients are in line with expectation, it does not have a strong statistically significant impact on the municipalities' decision to accept disaster waste.

5. Conclusions

This study investigated the determinants for the municipalities' acceptance of disaster waste resulting from the Great East Japan Earthquake. Our results indicate the social preferences were important for the decision to accept waste, more so than economic reasons. Previous studies have focused on economic reasons for transfer of waste between regions or municipalities. Thus, what we show is that other reasons could explain the decision as well.

Many news articles reported that inhabitants protested or opposed the acceptance of disaster waste while hoping for the revival of the stricken area. Our results confirm that the opposition to some extent comes from the inhabitants' anxiety over radiation contamination from the disaster. Information disclosure and communication about the radiation risks are important, especially for municipalities that are located far from the damaged area. The finding pertains to many NIMBY problem and the wide area treatment of other hazardous waste. On the other hand, variables related to pro-sociality positively affect the municipalities' acceptance of disaster waste. We could not find any evidence of moral licensing or negative relation between pro-social behaviors. Understanding how pro-social behaviors can positively affect cooperation is important for policy interventions for disaster recovery. It can create a feeling of YIMBY, i.e. Yes in my Backyard. It can be helpful for the ministry in the central government when it

comes to coordinating the decision making of municipalities in different areas and at different levels.

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Table 1: The number of municipalities and acceptance

	2011		2012		2013		
	Total	West	East	Total	West	East	Total
Positive	572	25	166	191	2	74	76
Negative	1030	678	723	1401	703	815	1516
Total	1596	703	889	1592	705	889	1592

Note: The number of municipalities changes over the years due to municipal mergers. As for the data in 2011, only the aggregated number of the municipalities is known.

Table 2: The flow of the wide area treatment

Miyako area	
1. Separation by machine and hand	First temporary site
2. Separation by hand	Second temporary site
3. Measurement of the radiation level	
4. Measurement of the radiation level	Harbor in Iwate
5. Loaded onto a ship	
Osaka city	
6. Unloading of containers	Harbor in Osaka
7. Measurement of the radiation level	
8. Separation by machine	Transshipment facility
9. Measurement of the radiation level	
10. Incineration with municipal solid waste	Incineration plant
11. Measurement of the radiation level	
12. Final disposal with municipal solid waste	Final disposal site
13. Measurement of the radiation level	

Table 3: Descriptive statistics

	Average	Min.	Max.	SD
Donation (yen/person)	0.81	0.14	2.69	0.52
Volunteer (%)	3.31	2.00	6.90	1.05
Proximity of nuclear plant (dummy)	0.01	0.00	1.00	0.10
Prefecture intention (dummy)	0.40	0.00	1.00	0.49
Slack capacity of incineration plant (10000 t/per year)	3.14	-0.21	120	5.91
Slack capacity of final disposal site (10000 t)	2.64	0.00	430	18.33
Distance from Fukushima Daiichi (100 km)	5.91	0.73	22.38	3.63
Population under age 15 (%)	12.70	4.25	21.81	2.28
Agricultural workers (%)	5.33	0	59.36	5.79
Density (100 person/km ²)	2.04	0.00	50.07	5.43
Wide area treatment of municipal solid waste (dummy)	0.58	0.00	1.00	0.49

Note: SD is standard deviation.

Table 4: Marginal effects, logit models on the decision to accept waste in 2012 and 2013.

	All of Japan		East Japan	
	2012 Data	2013 Data	2012 Data	2013 Data
Donations	0.015 (0.015)	0.039 *** (0.008)	0.106 *** (0.022)	0.067 *** (0.014)
Volunteers	0.040 *** (0.008)	0.008 * (0.005)	0.070 *** (0.011)	0.020 ** (0.009)
Proximity of nuclear plant	0.138 *** (0.050)	0.133 *** (0.025)	0.207 *** (0.066)	0.218 *** (0.045)
Prefecture intentions	-0.076 *** (0.018)	0.069 *** (0.016)	-0.063 ** (0.025)	0.127 *** (0.029)
Slack capacity of incineration plant	0.004 *** (0.001)	0.000 (0.001)	0.002 (0.002)	0.001 (0.001)
Slack capacity of final disposal site	0.000 (0.000)	0.001 *** (0.000)	0.001 * (0.001)	0.001 (0.001)
Distance from Fukushima nuclear plant	-0.014 *** (0.004)	-0.017 *** (0.005)	0.009 (0.010)	-0.013 (0.011)
Population under age 15 (*10 ²)	0.673 * (0.381)	0.090 (0.265)	0.931 (0.567)	0.201 (0.463)
Agricultural workers	-0.012 *** (0.003)	-0.004 ** (0.002)	-0.018 *** (0.004)	-0.006 ** (0.003)
Density	-0.002 (0.002)	-0.004 * (0.002)	-0.000 (0.000)	-0.000 * (0.000)
Wide area treatment of municipal solid waste	0.009 (0.016)	0.016 (0.010)	0.032 (0.025)	0.025 (0.019)
Observations	1592	1592	889	889

Note: Standard errors are given in parentheses. * p < 0.05; ** p < 0.01; *** p < 0.001.

Figure 1: The acceptance rate as of October 25, 2013

