Effect of natural disasters on social capital formation: The case of the Great Hanshin-Awaji earthquake.

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Abstract

The Great Hanshin-Awaji (Kobe) earthquake hit Japan in 1995, caused a devastating damage on the economic conditions of southern-central Japan. However, the earthquake also led people to acknowledge the importance of social capital in Japan. Based on a large individual-level data comprised of 488,223 observations, this study investigates how and the extent to which the earthquake enhance investment for social capital through participating in community activity. The differences-in-differences method was used and the following key findings were obtained: (1) People are more likely to invest in social capita in 1996 than 1991 in Japan, (2) the effect of the earthquake declined as the residential place of place is more distant from Kobe and (3) The earthquake increase significantly the social capital investment rate of Kobe residents, whereas the earthquake does not influence the investment rate of residents of large cities close to Kobe.

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1. Introduction

In the real world, people cannot predict exactly the accident in the future and so it is important to cope with unforeseen events. For instance, an increasing number of works were concerned with issues of natural disaster in social science (e.g., Albala-Bertrand, 1993; Tol and Leek, 1999; Congleton, 2006; Shughart, 2006; Skidmore and Toya, 2002; Toya and Skidmore, 2007, Cavallo et al., 2010). There are devastating disasters occurring after 2000, such as Hurricane Katrina in United States in 2005, Tsunami in Intonesia in 2004 and Sichuan earthquake in China in 2008. Influence of disaster on society is found to differ according to types of disasters (e.g., Skidmore & Toya 2002; Toya & skidmore 2012). Italian seismologists predicted that there is very low probability that devastating earthquake occur in the middle part of Italy. Contrary to it, actually, in April 2009, massive earthquake hit the Aquila city located in the middle part of Italy, resulting in number of death toll. This tells that forecast about the likelihood of earthquake is difficult and inaccurate. So it is difficult for rich people to live in area where the earthquake is unlikely to occur. That is, the likelihood that people become victims of earthquake does not vary according to their economic status. Occurrence of earthquake can be considered as exogenous shock, and hence endogenous bias can be, to a certain extent, mitigated. This is one of reason why this paper deals with the earthquake among various types of disasters.

The Cabinet Office, Government of Japan (2007) reported that 21 % of earthquakes of magnitude 6 and over occurred in Japan in the world, although Japan landmass is relatively small which is only 0.25% of World's[1]. Therefore, Japan is regarded as the appropriate country to explore the impact of earthquake on socio-economic condition, especially among the developed countries. As widely known, recently, the East Japan Earthquake occurred on March 11, 2011, the devastating disaster in Japan caused approximately 15,200 deaths. In this earthquake, the calculated total damage was between US$20,000–30,000 billion (Sawada 2011, p. 46). 16 years prior to this earthquake, in 1995 an earthquake has occurred southern-central Japan (the Hanshin-Awaji area), which is comparable to the damage caused by the East Japan earthquake. In Japan, typhoons often struck and passed the southern part of Japan such as Kyushu-Okinawa area every year during summer. Thus, the root of typhoons and the area hit by typhoon can be, to a

[1] Japan incurred 13 % of the total amount of damage resulting from natural disasters worldwide during the past 30 years (Cabinet Office, Government Of Japan, 2007).

certain extent, predicted in advance. Therefore, people living in Kyushu-Okinawa area take a sufficient countermeasure for typhoon. On the other hand, prior to Hanshin-Awaji earthquake, probability that massive earthquake occur in the Hanshin-Awaji is in general thought to be low. Therefore, the Hanshin-Awaji people have not prepared for it, resulting in devastating damage in the area.

Concerning the earthquake, economic researchers analyzed the impact of the earthquake and suggested various policy implications (e.g., Horwich, 2000; Sawada, 2007; Sawada and Shimizutani, 2007; 2008). It is appropriate to argue that the function of the market and the role of government should play a critical role to disaster prevention and in coping with disaster. On the other hand, the level of damage caused by disasters appears to also depend on institutional conditions (Kahn, 2005). There are assertions that social capital such as social networks and community participation make a contribution to the prevention of and resilience to natural disasters (Chamlee-Wright, 2010; Yamamura, 2010)[2]. Informal cooperative activities, such as voluntary disaster control organizations, are thought to mitigate the damage arising from natural disasters (Tierney and Goltz, 1997). The unpredicted Hanshin-Awaji earthquake is thought to change individual's subjective probability about occurrence of earthquake[3]. This, in turn, influences their behavior against disaster. Unpredicted huge damage caused by the Hanshin-Awaji earthquake seems to trigger grappling with the disaster prevention measures throughout Japan. The Hanshin-Awaji earthquake can thus be regarded as catalyst for accumulating social capital to prepare for unforeseen invent.

Social capital is considered to be formed through interaction among people. Natural disaster seems to provide an opportunity for individual to change interpersonal relationship and to take collective action against the unpredicted exogenous event. The prior works assessed the impact of natural disaster on trust[4]. Field experiment in Thailand indicated that individuals influenced by the disaster are more inclined to trust and be trustworthy than subjects in the same communities before disaster (Cassar et al., 2011). Owing to the experience of the Great East Japan earthquake, Uchida et.al (2011) used the survey data to exhibit that people recognized importance of network with friends, family, and community.

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[2] Social capital has been vaguely defined and so has various facets (Putnam 2000), such as social trust, social network, and degree of community participation.

[3] There are works to explore the impact of the great East Japan disaster on individual's perception such as happiness (Ishino et al., 2011, Uchida et.al., 2011).

[4] Apart from trust, natural disaster was found to have a sizable impact on individual's perception such as subjective well-being or life satisfaction (Carroll et al., 2009; Luechinger and Raschky, 2009).

Work based on cross-countries data exhibited that number of storms has positive influence on social trust whereas number of floods has opposite negative effect (Toya and Skidmore 2012). However, it has not been sufficiently scrutinized whether natural disaster has an influence on observable behavior such as community participation based on abundant data.

To satisfy this requirement, this paper used a "Survey of Time Use and Leisure Activities" (STULA) to explore how and the extent to which the Hanshin-Awaji earthquake impacted on individuals' voluntary community creating activities. The survey provided individual-level data and consisted of 488,223 observations. STULA has been conducted in 1991 and 1996. Hence, 1996 is next year of the Hanshin-Awaji earthquake. The human behavior recorded in data of 1996 thus is thought to reflect the impact of the earthquake, whereas the behavior of 1991 has not been influenced by the earthquake. Hence, in compared with prior works (Whitt and Wilson 2007; Solnit 2008; Cassar et al., 2011), the advantage of this paper is that the mega sample covering throughout whole Japan enabled me to compare impact of earthquake among regions by comparing human behavior before and after the earthquake.

The remainder of this paper is organized as follows. Section 2 provides an overview of the Great Hanshin-Awaji earthquake. The testable hypotheses are proposed in Section3. Section 4 explains the data set and the empirical method used. Section 5 provides the estimation results and its interpretation. The final section offers some conclusions and remaining issues in the future studies.

2. Overview of the Great Hanshin-Awaji earthquake

On January 17, 1995 an earthquake has hit southern-central Japan (the Hanshin-Awaji area). The damaged area of Hanshin-Awaji earthquake covers Hyogo, Osaka, Kyoto, and Tokushima prefectures[5]. Hyogo prefecture includes Kobe city which is a densely populated city and an important hub port in western Japan. Kobe has suffered the greatest damage in compared with other parts of the Hanshin-Awaji area. Japan's earthquake scale ranges from level 1 (weak) to level 7 (devastation)—most of Kobe was categorized as level 7 in the Great Hanshin-Awaji earthquake (Ministry of Land, Infrastructure, Transport and Tourism 1996, p. 3).

Figure 1 illustrated Kobe's location in the south-eastern area of the Hyogo

[5] A Japanese prefecture is the equivalent to a state in the United States or a province in Canada. There are 47 prefectures in Japan.

Prefecture. Further, Hanshin-Awaji area covers other large cities having more than population of million, such as Osaka city belonging to Osaka prefecture and Kyoto city belonging to Kyoto prefecture. To put it precisely, there is slight difference of socio-cultural features between Kobe, Osaka and Kyoto. However, in compared with other areas such as Kanto which includes Tokyo, these prefecture (Kobe, Osaka and Kyoto) share the similar characteristics. In terms of scale of cities, according to 1995 Population Census conducted by Ministry of Land, Infrastructure and Transport, there are 11 major cities defined as cities with one million or more inhabitants[6]. Kobe, Osaka, and Kyoto were defined as the major cities. Further, the Ministry of Land, Infrastructure and Transport defined metropolitan areas as: Major metropolitan areas refer to the regions consisting of the "designated cities by the Cabinet Order" as the core and surrounding municipalities which are closely associated with the designated cities socially and economically. By this definition, there are 8 Major metropolitan areas. The core cities of Kei-hanshin Metropolitan Area were Kobe, Osaka, and Kyoto cities. As is demonstrated in Figure 1, the distance between Kobe and Osaka is only 30.9 km and that between Kobe and Kyoto is 63.9 km.

As a consequence of the earthquake, according to Ministry of Land, Infrastructure, Transport and Tourism., (1996, pp.10-14), the total death toll reached 5,502. The death toll of Hyogo prefecture was 5,480. Totally, 100,209 homes were destroyed completely. In Hyogo prefecture, 99,232 homes were destroyed. That is, approximately, 99% of death toll and destruction about home concentrated in Hyogo prefecture. This tells that damage of the earthquake is dominantly observed in Hyogo prefecture among Kei-hanshin areas. To put it more precisely, the death toll of Kobe city was 3,897, which covered 71% of death toll of Hyogo prefecture. On the other hand, The death toll of Osaka city is only 14, and there was no death in Kyoto city. Number of home destruction was 61,995 in Kobe city, which is about 62 % of that of Hyogo prefecture. That of home destruction was 189 in Osaka city, and only 3 in Kyoto city. Hence, it implies that the damage was remarkably observed in Kobe[7]. Despite the socio-economic similarity and geographical proximity, damage for Kobe was far larger than Osaka and Kyoto cities.

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[6] See web-site of Ministry of Land, Infrastructure and Transport(http://www.stat.go.jp/english/data/zensho/1999/6.htm). (accesed on February 2, 2013).

[7] The loss of housing was estimated at more than US$60 billion, and that of capital stock was larger than US$100 billion (Horwich, 2000; Sawada and Shimizutani, 2007, 2008)., Hurricane Katrina lead to approximately 5,336 deaths and US$26.5 billion in damage (Sawada 2011, p. 46).

Market cannot fully secure the safety of citizens against unforeseen events such as natural disasters even though insurance market has developed to cope with it. Hence, the government are anticipated to plays a leading role in dealing with unforeseen events. However, the government's initial response to the Hanshin-Awaji earthquake was slow[8]. Immediately after the Great Hanshin-Awaji earthquake, many young people (generally students), came to Kobe for the purpose of participating in volunteer activities. In Japan, this was the first time to observe that such a large number of people had served as volunteer workers. Hence, 1995 is called as "the first year of volunteer activity" in Japan. To cope with unforeseen event, the earthquake has lead Japanese residents to find it important to take part in volunteer workers (Waseda University Social Science Institute, 1996). Further, disastrous events have possibly urged people to critical role of community, triggering community-based cooperation and collective action for disaster-prevention and resilience.[9]

3. Hypothesis.

As a consequence of unpredicted massive earthquake, a rise in the perceived subjective probability that a similar devastating disaster might hit the residential place in the future increases the potential for needing help from others in the future (Cassar et al., 2011). This causes people to acknowledge importance of flexible and effective community role to cope with disaster. Accordingly, people become more inclined to invest for social capital by taking part in voluntary community creating works[10]. Further, the nearer to Kobe, the higher the perceived probability of the disaster. This gives people larger incentive to invest for social capital when their residential place is closer to Kobe. I thus proposed the hypothesis 1.

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8 To take an another example, in the East Japan Earthquake, "after March 11 it took the government more than three months to enact a basic law for rebuilding Tohoku's coastal communities, whereas a similar law came into force only a month after the massive 1995 Kobe earthquake…the most dismaying difference between the two catastrophes is the time it took to pass a supplementary budget to fund full-scale reconstruction work. After the Hanshin quake, a budget to rebuild Kobe was enacted in around four months. After last March's disasters, the ruling Democratic Party of Japan took twice as long—more than eight months—to enact a 12 trillion yen reconstruction budget for Tohoku" (Hongo 2012, p. 9).

9 In Japan, homeownership and neighbors influence the degree of participation in community activities (Yamamura 2011a, 2011b).

10 According to framework of Glaeser et al. (2002), social capital can be accumulated through individual's investment for social capital.

Hypothesis 1:

The smaller the distance between place hit by disaster and individuals' residential place, the more they likely to invest for social capital.

Assuming that individuals lived in the disaster stricken area, perceived subjective probability of disaster occurrence does not vary among them even if *Hypothesis 1* holds true. Even in this situation, the degree of damage they suffered varies and so their perceived subjective probability of disaster occurrence possibly differs. It is appropriate to argue that the larger the damage individuals suffered, the larger their trauma, which gives them a greater incentive to invest for social capita to reduce the damage when disaster hit their residential place[11]. Hence, I proposed *Hypothesis 2:*

Hypothesis 2:

Within a disaster stricken area, the larger the damage individuals suffered, the more they are inclined to invest for social capital.

4. Data and Methods

4.1. Data

The Japanese Government (Ministry of Internal Affairs and Communications, Statistical Bureau in Japan) began conducting STULA in 1976, in order to provide information about Japanese people's social behavior in the daily life. The survey includes observations randomly chosen from almost all regions throughout Japan. These surveys are scheduled to be held every 5 years. The survey is conducted in October of the survey year, and in 1996 STULA was conducted approximately 18 months after the earthquake. I found the date of 1996 survey appropriate for assessing the impact of the earthquake on individual behavior because people appear to be influenced by the earthquake directly. This paper compares likelihood that respondent participates in the voluntary community activities before and after the Great Hanshin-Awaji earthquake. For assessing the impact of the great Hanshin-Awaji earthquake, the Surveys conducted in 1991 and 1996 were used[12].

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[11] It is also plausibly argued that the massive disaster leads people to be more altruistic than before experiencing the disaster (Ishino et.al., 2011). This, in turn, change caused people to invest for social capital.

[12] In 2013, individual-level data could only be accessed for 1991, 1996, 2001, and 2006. In the list of questions about experience about participating community creating works is

Apart from issues regarding social activities, STULA asks standard questions regarding individuals' characteristics. The data includes information about marital status, age, gender, annual household income, and education level. Combined data from 1991 and 1996 were gathered from approximately 507,187 respondents aged over 15 years old. However, not all respondents answered all of the survey questions. Inevitably, data regarding some variables used in the estimations were not available. Consequently, as is shown in Table 1, the number of observations used in the regression estimations was reduced to 488,223. Further, number of observations in 1991 is 242,396, while that in 1996 is 245,827. In the STULA, information about the experience or suffering about the earthquake is not included. Hence, I assume that the experience and the degree of suffering are determined by respondent's residential place. Respondents who resided in Kobe city are thought to directly and most seriously experience the earthquake. Number of observations of Kobe residents is 2,446 in 1991 and 2,386 in 1996. Residents in Osaka and Kyoto city are also considered to experience the earthquake although their suffering is far smaller than those of Kobe. Sample size of Osaka and Kyoto city is almost the same as that of Kobe. I also used another definition about victims as follows: Hyogo prefecture has borders with four other prefectures such as Osaka, Kyoto, Okayama and Tottori. In addition to it, Tokushima prefecture faced the Hyogo prefecture beyond the sea. These prefectures are likely to be, to a certain extent, damaged by the earthquake. Hence, I also assume that residents of these prefectures are victims.

Definition and basic statistics of variables used in this paper is exhibited in Table 2. Respondent's residential place can be available in the STULA data. Scale of residential place can be divided into 5 such as *Mega city, Large city, Medium city, Small city* and *Village*. Kobe can be classified as *Mega city*. 12.3% of respondents lived in *Mega city.* Rate of male is 47.8 %, suggesting that respondents can be roughly equally divided into male and female. Married respondents are about 63.6 %. In the original data set, as for annual household income and education level were classified into a number of groups. Base on the categories, these values were calculated.[13] With regard to social position, respondents are divided into

asked only in 1991 and 1996 surveys. The question concerning it changed from 2001. Therefore, I cannot use data of 2001 and 2006 to examine the long-term impact of earthquake.

[13] Annual earnings were grouped into 12 categories. I assumed that everyone in each category earned the midpoint value. For the top category of "15 million yen and above," we assumed that everybody earned 15 million yen.

Education level was grouped into 9 groups, including current students at junior high school, high school, junior college, university, and graduates from junior high school, high school, *Student*, *House* (house-workers)[14], *Full Work* (those who have full-time jobs), and *No work*(those who are not *Student, House* and *Full Work)*. 56.1 % of respondents can be regarded as those who have full-time jobs, while 8.4 % respondents don't have job and are not student and house-workers. 73.5 % of respondents own home, whereas 82.6 % of respondents own car. In addition to variables sourced from the STULA, distance from Kobe city is collected from Geospatial Information Authority Japan (GSI) [15]. Information about residential prefecture of respondents allowed me to integrate the distance data to individual level data.

The key variable, the proxy for the degree of participation in voluntary community activities, is defined as follows: in the STULA questionnaire respondents were asked "Did you participate in voluntary community creating work within a year?" The possible responses to this question were "Yes" or "No". Based on the data, rate of participation was calculated in each prefecture. Table 3 reported the rate in 1991 and 1996. What is more, its difference between 1991 and 1996 was also presented. It is interesting to observe that difference of rate is not negative in any prefect, suggesting that participation rate increased from 1991 to 1996 for all prefectures. Positive impact of the Hanshin-Awaji earthquake on social capital accumulation has not been limited to the disaster stricken area. To put it in another way, the Hanshin-Awaji earthquake enhanced the investment for social capital throughout Japan.

The positive impact of the earthquake on social capital formation can be interpreted in various ways. It is plausibly argued that the macro-economic shock or institutional change between 1991 and 1996. This, in turn, changed the behavior of people. For instance, from the macro-economic point of view, Japanese people enjoyed a business boom, "the bubble economy" from the mid-1980s to the early 1990s. After the boom period, Japan entered a long-term economic recession, which

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junior college, university, and others. In this paper, current students at junior high school, high school are defined to to graduated from primary school, junior high school. Current junior college and university are defined to graduate from high school. In the education system of Japan, 6, 3,3, 4 (2) years for primary school, junior high school, high school, and university (junior college), respectively. Hence schooling years for those who graduate from primary school, junior high school, high school, and university (junior college) are 6, 9, 12, and 16 (14) years, respectively.

[14] The original data set showed 6 categories: workers (those who have full-time jobs), student (without job), student (with part-time job), house-workers (without jobs), house-workers (with part-time jobs), others (without jobs). Student consists of both student (without job) and student (with part-time job). House consists of house-workers (without jobs) and house-workers (with part-time jobs).

[15] See website of GSI. http://www.gsi.go.jp/KOKUJYOHO/kenchokan.html. (Accessed on Jan 28, 2013).

was generally thought to have begun in 1991. Economic decline possibly increased importance of role of community, rather than function of market economy. Therefore, Japanese people are more likely to invest for social capital than period of "the bubble economy". If this holds true, the earthquake has almost the same impact on individual's behavior across Japan. To put it differently, if the increase in investment for social capital differs between areas, macro-economic shock cannot be considered to be determinants of social capital accumulation. In order to tackle with this issue, this paper examines how the distance from Kobe affects the increase in investment for social capital. As derived from *Hypothesis 1*, individuals possibly have larger incentive to invest for social capital when their residential place is nearer to the Kobe. To preliminarily check it, Figure 2 demonstrated how difference of the rate is related to distance from Kobe. A cursory examination of Figure 2 reveals the positive association between them, implying that distance from the area hit by the earthquake lower the sense of crisis against the earthquake. For closer examination, various individual level factors should be controlled. For this purpose, regression estimation is conducted in the following section.

Table 4 presented the level of community participation rate in 1991 and 1996 and further difference between them, by scale of residential areas. Each prefecture is consisted of local governments such as city, village and towns. These local governments can be divided into various scales based on population size[16]. I see from Table 4 that the larger scale of residential area, the lower the participation rate in 1991 and 1996. In all scale of residential areas, difference of rate takes positive values and implying that participation rate increase from 1991 to 1996. It is interesting to observe that the larger scale of residential area, the smaller the difference, suggesting that residents of the more urbanized area tends to increase investment for social capital after the earthquake, however their response to the earthquake is smaller than those who resided in the less urbanized areas. In addition to geographical location as earlier discussed, it is necessary for control for scale of residents to examine the impact of earthquake on investment for social capital.

4.2. Econometric framework and estimation strategy

For the purpose of examining the *Hypothesis 1,* the estimated function takes the

[16] For instance, Hyogo prefecture was consisted of 29 cities and 12 towns. Kobe city is the largest local government measure by its population size.

following form:

$$Social\ capital_{itp} = \alpha_0 + \alpha_1 IDistance_p * 1996\ year\ dummy_t + \alpha_2 IDistance_p + \alpha_3\ 1996\ year\ dummy_t + X' B + u_{itp},$$

where *Social capital* $_{itp}$ represents the dependent variable in individual *i*, year *t,* and prefecture *p*. The regression parameters are denoted by α, and *B* is the vector of the regression parameters for the control variables which capture influence of various individual characteristics. The error term is denoted by *u*. *1996 year dummy* takes 1 when observations are collected in 1996, otherwise 0. *IDistance* is an inverse of distance from Kobe city to the prefectural capital where individual resides. The reason why the inverse of the distance is used is to interpret the cross-term more easily. If coefficient of $IDistance_p$ ** 1996 year dummy* takes the positive sign, the closer to Kobe respondents resided, the more they are likely to increase investment for social capital from 1991 to 1996. Furthermore, with the aim of capturing scale of residential place, dummies for *Large city, Medium city, Small city,* and *Village* are incorporated when *Mega city* is reference group.

The vectors of the control variables are denoted by X, which includes scale of individual's residential place, age, male dummy, marital status, household income, dummies for job status, schooling years, home owner dummy, car owner dummy. Married people are more likely to be embedded in the interpersonal relationship because they tend to take part in not only their own social network but also their spouse's ones. Hence, social capital plays a greater role for married people than unmarried ones. I included *Married* in an attempt to capture such difference between married and unmarried people. Opportunity cost for full-time workers is thought to be higher than part-time worker or non-worker. Therefore, the cost for investment for social capital such as participating in community activity is higher for full-time worker, reducing full-time worker's investment for social capital. *Student*, *House* and, *No Work* are incorporated to capture the difference of opportunity cost, while *Full Work* is reference group. *Student*, *House* and, *No Work* are expected to take the positive sign because those who are not full-time worker are more likely to invest for social capital because their opportunity cost is lower than full-time worker. *Household income* and *School* control for individual's economic condition. The larger the human capital measured by schooling years, the higher their wage. Hence, their opportunity cost for investment for social capital is higher than others, discouraging educated people to invest for social capital. Apart from household income, those who own car or home are thought to have larger private asset than those who do not own them. Hence, *Owner* and *Car* are included to capture this effect.

In order to assess the *Hypothesis 2,* the estimated function takes the following form:.

$$Social\ capital_{itc} = b_0 + b_1 Kobe_c * 1996\ year\ dummy_t + b_2 Osaka_c * 1996\ year\ dummy_t + b_3 Kyoto_c * 1996\ year\ dummy_t + b_4 Kobe_c + b_5 Osaka_c + b_6 Kyoto_c + b_7 1996\ year\ dummy_t + Y' C + u_{itp},$$

$Kobe_c$, $Osaka_c$, and $Kyoto_c$ are dummies for residential place in city *c.* The vectors of the control variables are denoted by Y, which includes the same variable as used in the model examining distance effect as previously suggested. In addition to it, Y also incorporates the prefecture dummies to control for various time invariant residential prefecture factors such as geographical location. With the aim of investigating *Hypothesis 2,* I employed a differences-in-differences approach to examine the impact of the earthquake in 1995 on increase of social capital between 1991 and 1996. In this paper, the treatment groups are residents in Kobe, Osaka and Kyoto cities because the Earthquake hit these mega size cities; the control group is residents in other places. The interaction term of $Kobe_c * 1996\ year\ dummy_t$ is to capture how difference of investment for social capital during the period 1991-1996 between residents of Kobe city and others. In addition, $Osaka_c * 1996\ year\ dummy$ and $Kyoto_c * 1996\ year\ dummy$ are included to examine how the earthquake affects the investment for social capital in the areas where its damage is far smaller than Kobe although degree of urbanization and socio-cultural condition are similar to Kobe. Hence, the perceived subjective probability of earthquake occurrence is almost the same among residents of Kobe, Osaka, and Kobe. What is more, their responses to earthquake are similar if the damage of disaster is the same for them. In this estimation, I can investigate how and the extent to which individual's social capital investment is influenced by the degree of earthquake damage.

5. Estimation Results

Results of the Probit estimations are set out in Table 5 and 6. In Table 5, different samples are used for estimation although the specification of estimated equation is same. The behavior of residents in the disaster stricken area is distinctly different from other place and so can be regarded as "outliers". Therefore, effect of distance from the most seriously damage area, Kobe, possibly influenced extremely by the "outliers". Column (1) is based on full sample. On the other hand, in order to removing outlier's effect, results of columns (2)-(5) are based on sample excluding disaster stricken area variously defined. Further, marginal effect is reported. Coefficient of *Idistance* 1996 year*, considered as key variable, take the positive sign and statistically significant in all columns. This suggests that significant positive sign is robust and so is not influenced by the outliers. This is consistent with the *Hypothesis 1.*

Coefficients of *School, Income, Owner* and *Car* have the positive sign and statistically significant at the 1 percent level. Further, coefficients of *Student* and *No work* have the negative sign and statistically significant at the 1 percent level. These results are contrary to the prediction inferred from opportunity cost, with the exception of the significant positive sign of *House.* That is, those who have opportunity to earn more are more likely to invest for social capital at the expense of larger opportunity cost. Instead of viewpoint of opportunity cost, it is necessary to interpret these results differently. The higher the socio-economic status, the more people are inclined to avert inequality partly because they would like to reduce externality of envy from surrounding poor people (Yamamura 2012). If this holds true, people with high social economic status possibly have a tendency to take part in community creating work to create good relationship with surrounding poorer people. It is found in the previous empirical works that home ownership is positively associated with investment for social capital (DiPasquale and Glaeser,, 1999; Yamamura 2011) partly because that long-term relationship with neighborhood stemming from population immobility leads people to invest for maintaining intimate relationship with neighbors. Therefore, *Owner* can be also considered to capture the effect of residential immobility.

Now I switch attention to Table 6 where only results of key variables are presented. Other control variables equivalent to those used in Table 5 are included as independent variables, however their results are not reported. The sign of coefficient of *1996 year dummy* is positive and statistically significant at the 1 percent level in all columns. Its absolute value of coefficient is 0.07. This implies that probability that people are invest for social capital in 1996 is by 7 percent higher than in 1991, which is consistent with Table 3. As shown in columns (1)-(3), coefficient of *Kobe city* is not statistically significant, despite showing negative sign.

Hence, the probability that residents of Kobe take part in community creating work does not differ from those who resided in other areas. Coefficient of *Osaka city* yields the significant positive sign whereas that of *Kyoto city* yields the significant negative sign. That is, residents in Osaka city are more likely to participate in community crating works while those in Kyoto city are less likely to do it. It follows from what is observed about these dummies that level of investment for social capital is much different between them. These results, however, capture the "level" of social capital, rather than "increase" of social capital. Let me see columns (4)-(6) to check the "increase" of social capital during the period. With respect to results of the cross terms, results of *Kobe city* 1996 year*, *Osaka city* 1996 year,* and *Kyoto city* 1996 year* are reported. Only *Kobe city* 1996 year* yields that positive sign and statistically significant at the 1 percent level in columns (4)-(6). On the other hand, *Osaka city* 1996 year* is not statistically significant although it take the positive sign. *Kyoto city* 1996 year* is not statistically significant and take the negative sign. This implies that, in compared with non-damaged areas, residents in Kobe city increase their investment for social capital after the earthquake. In contrast, increase in investment for social capital in Osaka and Kyoto cities did not differ from non-damaged areas. Therefore, experience of the earthquake has a greater impact on Kobe residents than Osaka and Kyoto residents, changing Kobe residents' community creating activities more remarkably than Osaka and Kyoto residents. Furthermore, absolute value of *Kobe city* 1996 year* is 0.01 can be interpreted as suggesting that the probability that residents of Kobe partakes in the community creating work increased from 1991 to 1996 by 1 percent in compared with residents in other place.

A large number of neighbors have passed away as a result of the earthquake, resulting in destruction of existing social capital stock such as interpersonal network within a community. On the other hand, as observed in this paper, as a consequence of the earthquake, investment for social capital increased. Hence, the long-term tightly knitted social ties within a community are thought to be replaced by newly formed social networks. A number of volunteer workers comes from other place to Kobe and make a critical contribution to resilience (Yamamura 2013). It follows from this that the newly formed social capital is considered to open to non-community members, which is more effective than former existing social capital which is close to non- community members (Fafchamps, 2006)[17]. Enhancing

[17] It is pointed out that generalized trust is more important in generating large efficiency

participation in community activity seems to change individual's perception such as trust for others. According to Uslaner (2002, 26-27), "the central idea distinguishing generalized from particularized trust is how inclusive your moral community is". Uslaner (2002) argued that neighborhood trust is a mixture of generalized and particularized trust. The occurrence of earthquake possibly transited from community based on the particularized trust limited within a community to community based on generalized trust open to strangers (Uslaner, 2002). The positive relationship between natural disaster and generalized trust is exhibited by Toya and Skidmore (2012). "Receiving help from family and neighbors increases that others are similarly trustworthy"(Cassar et al., 2011, p.9). The trustful relationship is thought to be formed through strangers' volunteer work for reconstructing community. To put it in another way, not only community member but also non-community member took part in community creating activity, which possibly results in positive relation between earthquake and generalized trust. These suggest that the unforeseen exogenous shock can be considered as catalyst of creative destruction of social capital, triggering not only quantitative accumulation of social capital but also qualitative conversion of social capital.

6. Conclusions

In compared with climatic disaster such as storm, it is difficult to predict the place and date when earthquake occur. Hence, among natural disasters, earthquake is regarded as unforeseen and uncontrolled exogenous event. Naturally, a question arises as follows: Does such an event change individuals' behavior and social relationship? In the wake of devastating disasters such as the Great Hanshin-Awaji earthquake in 1995 and the great East Japan earthquake in 2011, it was generally believed that Japanese people found it critical to form social capital such as social trust, social network, and community participation. This, in turn, was thought to trigger individual's investment for social capital. However, this conjecture has not been sufficiently assessed using detailed statistical analysis based on abundant individual-level data.

I have a great advantage of using mega dataset comprised of 488,223 observations to investigate statistically how the earthquake enhances investment for social capital through participating in community activity. I found through the

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gains than particularized trust (Fafchamps 2006). This is why generalized trust has attracted special attention (e.g., Leigh 2006a, 2006b, Bjørnskov 2006, Berggren and Jordahl 2006, Chan 2007, Gustavsson and Jordahl 2008).

differences-in-differences method as follows: (1) People are more likely to invest in social capita in 1996 than 1991 in Japan, (2) the effect of the earthquake declined as the residential place of place is more distant from Kobe and (3) The earthquake increase significantly the social capital investment rate of Kobe residents, whereas the earthquake does not influence the investment rate of residents of large cities close to Kobe. In addition to these findings, a large number of death tolls of Kobe residents lead me to conjecture that the existing social ties within a community have been destroyed. Here, I derive the argument that experience of disaster leads people to newly form social capital which is necessary for collective action to cope with disaster, although the damage of disaster has a detrimental effect on tangible capital stock and intangible existing social capital stock. That is, disaster possibly trigger the creative destruction not only by updating capital stock and increasing human capital (Skidmore and Toya 2002), but also by converting particularized social capital to generalized social capital.

However, it seems plausible that the impact of the earthquake on individuals' behavior differs between victims of the earthquake and non-victims. Serious suffered people possibly passed away or relocated their residential place from Kobe to other areas. The data limitation did not allow me to investigate how and the extent to which such unobservable selection bias influence the outcome. Further, it is unknown whether the impact of disaster depends on characteristics of disasters. Hence it is worth conducting comparable estimation in the case of predictable climatic disasters. What is more, because of data limitation, this paper focused on change of human behavior immediately after the disaster. However, social capital cannot be sufficiently accumulated if investment for social capital reduces as the time has passed. It is thus necessary to explore the long-term impact of Kobe earthquake by using dataset covering more recent 2000s. Further, there is question concerning whether the social capital is formed from selfish or altruistic motivation because the motivation for social capital cannot be assessed and so black-box. These issues should be addressed in future studies.

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Table 1, Structure of sample

Year	Categories	Number of observation
1991 and 1996	Total	488,223
1991	Total	242,396
	Kobe city (Hyogo prefecture)	2,446 (6,076)
	Osaka city (Osaka prefecture)	2,737 (7,344)
	Kyoto city (Kyoto prefecture)	2,276 (4,717)
1996	Total	245,827
	Kobe city (Hyogo prefecture)	2,386 (5,866)
	Osaka city (Osaka prefecture)	2,864 (7,643)
	Kyoto city (Kyoto prefecture)	2,354 (4,894)

Table 2. Definition of variables used for estimation and basic statistics

	Definitions	Mean	Standard deviation
Social capital	A value of 1 is given if respondent participating in voluntary creating community activities within a year, otherwise 0 (%)	19.1	---
1996 year dummy	A value of 1 is given if data is in 1996, otherwise 0 (%)	50.0	---
Distance	Distance from Kobe city (Km).	370.6	259.4
Idistance	1/ (*Distance+1)*	0.03	0.15
Mega city	Population >=1000 thousands	12.3	---
Large city	1000 thousands>Population >=150 thousands	38.8	---
Medium city	150 thousands>Population >=50 thousands	18.0	---
Small city	50 thousands>Population >=30 thousands	7.1	---
Village	30 thousands>Population	23.8	---
Age	Ages	44.0	19.0
Male	A value of 1 is given if respondent is male, otherwise 0 (%)	47.8	---
Married	A value of 1 is given if respondent is married, otherwise 0 (%)	63.6	---
School	Schooling years	11.7	2.35
Income	Household income (Million yens)	0.63	0.41
Full Work	A value of 1 is given if respondent is full-time worker, otherwise 0 (%)	56.1	---
Student	A value of 1 is given if respondent is a student, otherwise 0 (%)	8.9	---
House	A value of 1 is given if respondent is a house-worker, otherwise 0 (%)	26.6	---
No work	A value of 1 is given if respondent does not have work and is not student and hous-worker, otherwise 0 (%)	8.4	---
Owner	A value of 1 is given if respondent resides in own home, otherwise 0 (%)	73.5	---
Car	A value of 1 is given if respondent own car, otherwise 0 (%)	82.6	---

Note: Numbers are mean values for *Age, School, Income.* The percentage of respondents taking 1 is also reported.

Table 3. Difference of rate of social capital formation between 1991 and 1996

Name of prefecture	1991 (a)	1996 (b)	Difference (b)-(a)
Hokkaido	0.120	0.177	0.057
Aokmori	0.105	0.142	0.037
Iwate	0.184	0.303	0.119
Miyagi	0.163	0.247	0.084
Akita	0.153	0.217	0.064
Yamagata	0.163	0.268	0.106
Fukushima	0.178	0.277	0.099
Ibaragi	0.135	0.214	0.079
Tochigi	0.154	0.221	0.067
Gunma	0.181	0.245	0.065
Saitama	0.098	0.157	0.060
Chiba	0.103	0.177	0.075
Tokyo	0.081	0.120	0.040
Kanagawa	0.099	0.166	0.067
Niigata	0.116	0.183	0.066
Toyama	0.156	0.246	0.091
Ishikawa	0.177	0.244	0.067
Fukui	0.215	0.339	0.123
Yamanashi	0.191	0.305	0.114
Nagano	0.194	0.263	0.069
Gifu	0.162	0.277	0.115
Shizuoka	0.165	0.228	0.063
Aichi	0.107	0.180	0.074
Mie	0.151	0.247	0.095
Shiga	0.195	0.325	0.130
Kyoto	0.114	0.174	0.060
Osaka	0.082	0.147	0.065
Hyogo	0.129	0.211	0.082
Nara	0.143	0.221	0.078
Wakayama	0.137	0.212	0.075
Tottori	0.194	0.281	0.087
Shimane	0.189	0.282	0.093
Okayama	0.188	0.266	0.078

Hiroshima	0.164	0.249	0.085
Yamaguchi	0.201	0.280	0.079
Tokushima	0.147	0.222	0.075
Kagawa	0.160	0.236	0.076
Ehime	0.205	0.274	0.069
Kochi	0.153	0.201	0.048
Fukuoka	0.139	0.212	0.073
Saga	0.195	0.281	0.086
Nagasaki	0.172	0.266	0.093
Kumamoto	0.212	0.287	0.074
Oita	0.207	0.251	0.043
Miyazaki	0.217	0.234	0.018
Kagoshima	0.219	0.295	0.075
Okinawa	0.138	0.152	0.014

Table 4. Difference of rate of social capital formation between 1991 and 1996

Scale	1991 (a)	1996 (b)	Difference (b)-(a)
Mega city	0.092	0.146	0.054
Large city	0.138	0.207	0.069
Medium city	0.163	0.233	0.071
Small city	0.175	0.263	0.088
Village	0.198	0.291	0.093

Table5.

Probit Analysis about the effect of distance from Kobe on Social capital investment.

	(1) Full sample	(2) Excluding Kobe city sample	(3) Excluding Hyogo prefecture sample	(4) Excluding sample of Hyogo, Oska, Kyoto Prefectur.	(5) Excluding sample of Surrounding prefecture of Hyogo.
*Idistance * 1996 year dummy*	0.01*** (4.87)	0.01*** (4.18)	0.76*** (2.65)	1.25** (1.99)	1.40** (1.97)
1996 year dummy	0.07*** (28.7)	0.07*** (28.0)	0.07*** (20.7)	0.07*** (17.8)	0.07*** (16.8)
Idistant	-0.003 (-0.63)	-0.01* (-1.88)	-1.45** (-2.34)	-0.39 (-0.37)	-0.53 (-0.50)
Mega city			<reference group>		
Large city	0.05*** (4.39)	0.05*** (4.32)	0.05*** (4.17)	0.05*** (3.58)	0.05*** (3.58)
Medium city	0.08*** (6.77)	0.08*** (6.57)	0.08*** (6.49)	0.08*** (5.68)	0.08*** (5.46)
Small city	0.10*** (7.46)	0.10*** (7.21)	0.10*** (6.98)	0.10*** (5.96)	0.10*** (6.00)
Village	0.12*** (9.95)	0.12*** (9.57)	0.12*** (9.23)	0.12*** (7.85)	0.12*** (7.79)
Age	0.0007*** (8.90)	0.0007*** (8.97)	0.0007*** (8.87)	0.0007*** (8.51)	0.0006*** (7.94)
Male	0.002 (0.69)	0.002 (0.77)	0.002 (0.87)	0.003 (1.05)	0.004 (1.14)
Married	0.08*** (38.7)	0.08*** (38.5)	0.08*** (37.6)	0.08*** (36.2)	0.08*** (35.2)
School	0.003*** (6.49)	0.003 (6.67)	0.003*** (6.69)	0.003*** (6.34)	0.003*** (5.78)
Income	0.02*** (4.58)	0.02*** (4.55)	0.02*** (4.65)	0.02*** (4.49)	0.02*** (4.26)
Full Work			<reference group>		
Student	-0.04*** (-10.9)	-0.04*** (-10.8)	-0.04*** (-10.6)	-0.04*** (-10.8)	-0.04*** (-10.1)
House	0.01*** (5.04)	0.01*** (5.05)	0.01*** (5.10)	0.01*** (4.65)	0.01*** (4.60)
No work	-0.06*** (-18.2)	-0.06*** (-18.3)	-0.06*** (-18.1)	-0.06*** (-17.6)	-0.06*** (-17.1)
Owner	0.03*** (8.96)	0.03*** (8.82)	0.03*** (8.39)	0.03*** (8.13)	0.03*** (7.90)
Car	0.02*** (10.5)	0.02*** (10.4)	0.02*** (9.38)	0.02*** (9.05)	0.02*** (9.02)

Constant	-2.03*** (-46.3)	-2.04*** (-43.3)	-2.01*** (-39.0)	-2.01*** (-40.0)	-2.00*** (-39.3)
Log Pseudo-likelihood	-226,802	-224,954	-221,623	212,721	198,490
Observations	488,223	483,319	476,281	451,683	423,294

Note: Numbers are marginal effect. Numbers in parentheses are z-statistics calculated using robust standard errors adjusted for clusters in prefectures. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table6 .

Probit Analysis about difference of the disaster between Kobe city and other areas (Full sample). Excluding sample of Surrounding prefecture of Hyogo.

	(1)	(2)	(3)	(4)	(5)	(6)
*Kobe city *1996 year dummy*				0.01*** (5.44)	0.01*** (5.41)	0.01*** (3.58)
*Oska city *1996 year dummy*					0.003 (1.14)	0.004 (1.02)
*Kyoto city *1996 year dummy*						-0.001 (-0.29)
Kobe city	-0.07 (-1.30)	-0.003 (-0.72)	-0.003 (-0.72)	-0.01** (-2.57)	-0.01** (-2.11)	-0.01** (-2.24)
Oska city		0.03*** (6.19)	0.03*** (6.19)		0.03*** (5.53)	0.03*** (5.42)
Kyoto city			-0.05*** (-9.13)			-0.05*** (-8.68)
1996 year dummy	0.07*** (28.7)	0.07*** (28.7)	0.07*** (28.7)	0.07*** (28.5)	0.07*** (28.3)	0.07*** (28.1)
Log Pseudo-likelihood	-224,813	-224,803	-224,803	-224,813	-224,803	-224,803
Observations	488,223	488,223	488,223	488,223	488,223	488,223

Note: Numbers in parentheses are z-statistics calculated using robust standard errors adjusted for clusters in prefectures. ** and *** indicate significance at the 5% and 1% levels, respectively. In all estimations, the set of variables used in Table 5 is included as independent variables. In addition, 46 prefecture dummies are also included as independent variables. But they are not reported because of space limitations.

Figure 1. Map of Japan showing Kobe's location and surrounding area.

(Kobe is the area suffering the most damage in the 1995 earthquake)

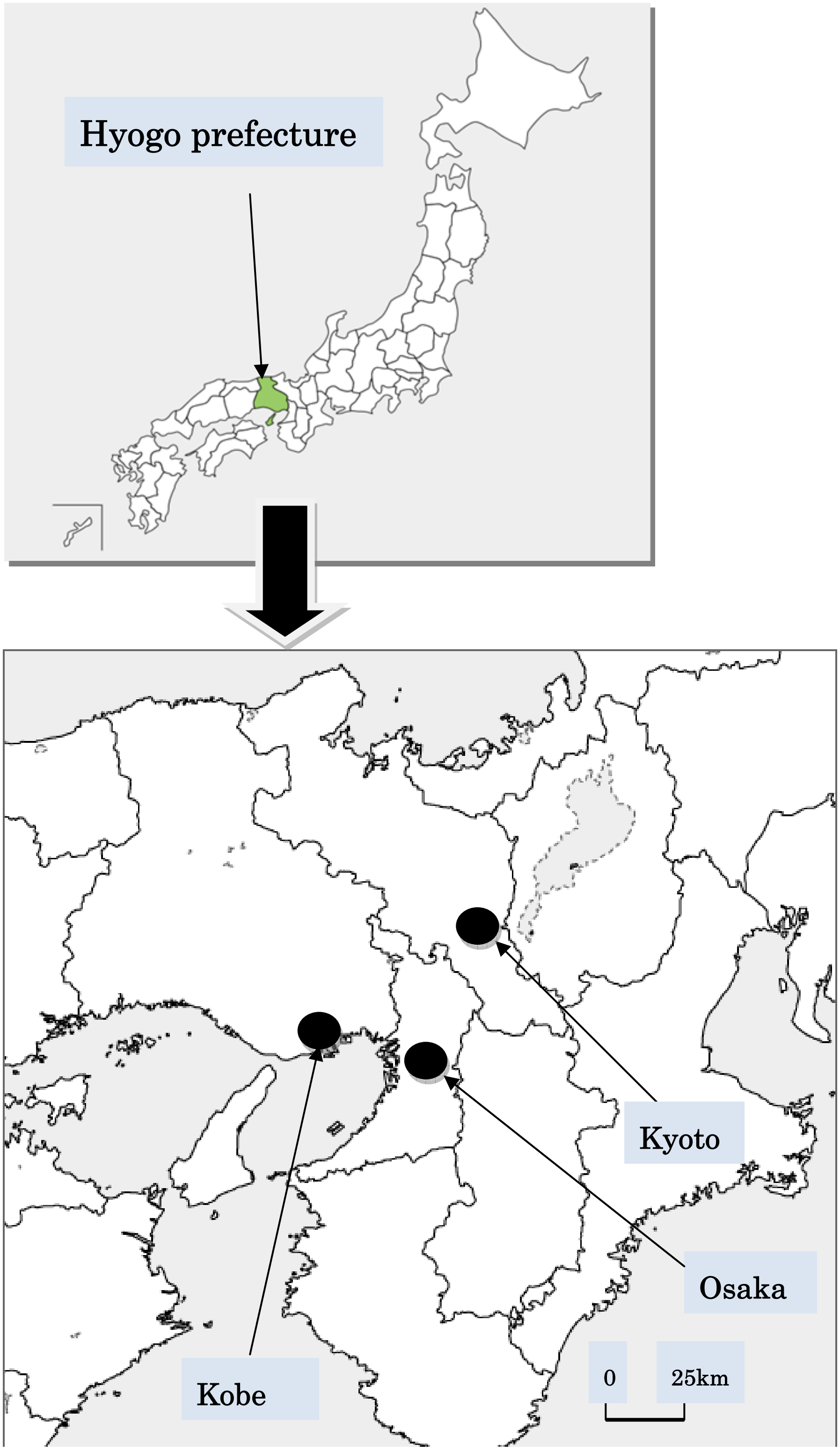

Figure 2. Association between distance from Kobe and difference of rate of social capital investment.