Natural disasters and social capital formation: The impact of the Great Hanshin-Awaji earthquake

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Abstract

The Great Hanshin-Awaji (Kobe) earthquake hit Japan in 1995, causing devastating damage to the economic landscape of southern-central Japan. However, the earthquake also caused people to realize the importance of social capital in Japan. Based on a large, individual-level database comprising 488,223 observations, this study investigates how and the extent to which the earthquake enhanced the investment in social capital through participation in community activity. The differences-in-differences method was used, and the following key findings were obtained: (1) In Japan, people were more likely to invest in social capital in 1996 than in 1991, (2) the effects of the earthquake decreased as the distance of one's place of residence increased from Kobe, and (3) he earthquake significantly increased the social capital investment rate of Kobe residents, whereas it had no significant influence on the investment rate of residents of large cities close to Kobe.

JEL classification: N35, Q54, Z13

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1. Introduction

In the real world it is impossible to precisely predict future accidents, and thus it is important to learn to cope with unforeseen events. For instance, an increasing number of research studies in the field of social science have investigated natural disasters (e.g., Albala-Bertrand, 1993; Tol & Leek, 1999; Congleton, 2006; Shughart, 2006; Skidmore & Toya, 2002; Toya & Skidmore, 2007, Cavallo et al., 2010). Moreover, a number of devastating disasters have occurred just since the year 2000, such as Hurricane Katrina in the United States in 2005, the tsunami in Indonesia in 2004, and the Sichuan earthquake in China in 2008. Some of these findings have indicated that the influence of disasters on society differ depending on the type of disaster (e.g., Skidmore & Toya 2002; Toya & Skidmore 2012). Italian seismologists had predicted that there was a very low probability that a devastating earthquake could occur in central Italy. Contrary to such predictions, however, in April 2009 a massive earthquake occurred in the city of Aquila located in central Italy, resulting in a large death toll. This tells us that forecasts about the likelihood of earthquakes are likely to be inaccurate. Thus, when we consider this fact that natural disasters such as earthquakes are unpredictable, we realize that economic status cannot protect one from such disasters; that is, natural disasters are indiscriminate and therefore independent of economic status. The occurrence of an earthquake can be considered an exogenous shock, and hence endogenous bias can be, to a certain extent, mitigated. This is one reason why this paper deals with earthquakes among the various types of natural disasters.

The Cabinet Office of the Government of Japan (2007) reported that 21% of the world's earthquakes of magnitude 6 and over have occurred in Japan, although Japan's landmass is relatively small, comprising only 0.25% of the world total[1]. Therefore, Japan can be regarded as the most appropriate country for exploring the impact of earthquakes on socioeconomic conditions, especially among developed countries. As is widely known, recently the East Japan earthquake occurred on March 11, 2011. It was a devastating disaster that caused approximately 15,200 deaths. The calculated total damage from this earthquake has been estimated to be between US$20,000–30,000 billion (Sawada 2011, p. 46). In addition, in 1995, 16 years prior to this earthquake, a similar earthquake occurred in southern-central Japan (the Hanshin-Awaji area), and the damage caused is comparable to that

[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).

caused by the more recent East Japan earthquake. During the summer, typhoons will often strike the southern parts of Japan, such as the Kyushu and Okinawa areas. Thus, the origins and area that will be hit by typhoons can be, to a certain extent, predicted in advance. Therefore, people living in the areas of Kyushu and Okinawa are able to take sufficient countermeasures against typhoons. In contrast to this situation with typhoons, however, prior to the Hanshin-Awaji earthquake, the probability that a massive earthquake would occur in the Hanshin-Awaji area was generally thought to be low. Therefore, the people of the Hanshin-Awaji area were not adequately prepared for the earthquake, resulting in devastating damage to the area.

Economic researchers analyzed the impact of the Hanshin-Awaji earthquake and suggested various policy implications (e.g., Horwich, 2000; Sawada, 2007; Sawada & Shimizutani, 2007, 2008). It is reasonable to argue that market functions and the role of the government should play critical roles in both disaster prevention and coping with disaster. However, 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, contribute 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 help mitigate the damage arising from natural disasters (Tierney & Goltz, 1997). The unpredicted Hanshin-Awaji earthquake is thought to have changed the subjective sense of probability about the occurrence of earthquakes among the Japanese people[3]. This, in turn, influences the behavior with respect to possible future disasters. The large amount of unpredicted damage caused by the Hanshin-Awaji earthquake seems to have triggered a new active approach toward disaster prevention measures throughout Japan. The Hanshin-Awaji earthquake can thus be regarded as a catalyst for accumulating social capital to prepare for unforeseen events.

Social capital is considered to be formed through the interactions among people. Natural disasters seem to provide an opportunity for individuals to adjust their interpersonal relationships and take collective action against unpredicted exogenous events. Prior works on this topic have assessed the impact of natural

[2] Social capital has thus far been vaguely defined, along with various related concepts (Putnam 2000), such as social trust, social networks, and degree of community participation.

[3] There are also studies that explore the impact of the great East Japan disaster on individual perceptions, such as happiness (Ishino et al., 2011, Uchida et al., 2011).

disasters on trust[4]. A field experiment in Thailand, for example, indicated that individuals influenced by disasters are more inclined to trust and be trustworthy than individuals in the same communities before the occurrence of disasters (Cassar et al., 2011). Owing to the experience of the Great East Japan earthquake, Uchida et al. (2011) used survey data to show that people recognized the importance of networks with friends, family, and community. Work based on cross-national data has shown that the number of thunderstorms has a positive influence on social trust within communities, whereas the number of floods has a negative effect (Toya & Skidmore, 2012). However, it has not been sufficiently scrutinized whether natural disasters have an influence on observable behavior, such as community participation.

To satisfy this requirement, this paper used the "Survey of Time Use and Leisure Activities" (STULA) to explore how and the extent to which the Hanshin-Awaji earthquake impacted individuals' voluntary community-building activities. The survey provided individual-level data and consisted of 488,223 observations. The STULA was conducted in 1991 and 1996, and 1996 was the year following the Hanshin-Awaji earthquake. The human behavior data recorded in 1996 are thus thought to reflect the impact of the earthquake, whereas the behavior data of 1991 do not. Hence, compared with prior studies (Whitt & Wilson 2007; Solnit 2008; Cassar et al., 2011), the advantage of the current study is that the mega-sample of data covering all of Japan enabled me to compare the impact of the earthquake across regions by comparing the human behavior data from both 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 Section 3. Section 4 explains the data set and the empirical method used. Section 5 provides the estimation results and their interpretation. The final section offers some conclusions while discussing remaining issues to be addressed in future studies.

2. Overview of the Great Hanshin-Awaji earthquake

On January 17, 1995, an earthquake hit the Hanshin-Awaji area of south-central

[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).

Japan. The area damaged by the earthquake covered the prefectures of Hyogo, Osaka, Kyoto, and Tokushima[5]. Hyogo prefecture includes Kobe city, a densely populated city and important hub port in western Japan. Kobe suffered the greatest damage compared with other affected areas in the Hanshin-Awaji region. Japan's earthquake scale ranges from level 1 (weak) to level 7 (devastation)—most of Kobe was categorized as level 7 (Ministry of Land, Infrastructure, Transport and Tourism, 1996, p. 3).

Figure 1 illustrates Kobe's location in the southeastern area of Hyogo prefecture. Furthermore, the Hanshin-Awaji region includes other large cities having populations of over one million, such as Osaka city (in Osaka prefecture) and Kyoto city (in Kyoto prefecture). While there are slight differences in the sociocultural features of Kobe, Osaka, and Kyoto, compared with other areas of Japan such as Kanto, which includes Tokyo, these three prefectures (Kobe, Osaka, and Kyoto) share similar characteristics. In terms of city scale, according to the 1995 Population Census conducted by the Ministry of Land, Infrastructure and Transport, there are 11 Japanese "major cities" with a population of at least one million[6], and Kobe, Osaka, and Kyoto are all such major cities. Furthermore, the Ministry of Land, Infrastructure and Transport has defined "major metropolitan areas" as areas where the core and surrounding municipalities are closely associated with a major city socially and economically. By this definition, there are eight major metropolitan areas in Japan. The core cities of the Keihanshin Metropolitan Area are Kobe, Osaka, and Kyoto. 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.

According to the Ministry of Land, Infrastructure, Transport and Tourism (1996, pp.10-14), the total death toll as a consequence of the earthquake reached 5,502. The death toll for Hyogo prefecture was 5,480. In total, 100,209 homes were completely destroyed. In Hyogo prefecture alone, 99,232 homes were destroyed. Thus, approximately 99% of the total human death toll and home destruction was concentrated in Hyogo prefecture; the earthquake damage was thus highly concentrated in Hyogo prefecture compared with the rest of the Keihanshin areas. Specifically, the death toll for Kobe city was 3,897, representing 71% of the total death toll for Hyogo prefecture. However, the death toll for Osaka city was only 14,

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

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

and there were no deaths in Kyoto city. The number of homes destroyed in Kobe city was 61,995, which represents about 62% of that in Hyogo prefecture. In Osaka city, the number was 189, while in Kyoto city there were only 3 homes destroyed. Hence, the damage was almost exclusively observed in Kobe[7]. Despite the socioeconomic similarities and geographic proximity between these areas, the damage experienced by Kobe was far greater than that in both Osaka and Kyoto.

The market cannot fully secure the safety of citizens against unforeseen events such as natural disasters despite a well-developed insurance market designed to cope with such disasters. Hence the government is expected to play a leading role in dealing with unforeseen events. However, the Japanese government's initial response to the Hanshin-Awaji earthquake was regarded as slow[8]. In contrast with the government's slow response, immediately after the earthquake many young people (mostly students) came to Kobe to participate in volunteer activities. This was the first time such a large number of people had served as volunteer workers in Japan. Hence, 1995 is now referred to as "the first year of volunteer activity" in Japan. The earthquake thus led Japanese residents to realize the importance of taking part in volunteer activities as a way to cope with unforeseen events (Waseda University Social Science Institute, 1996). It seems that disastrous events may influence citizens to take up critical roles in their community, thereby triggering community-based cooperation and collective action for disaster prevention and improving resilience.[9]

3. Hypothesis

As a consequence of an unpredicted massive earthquake, a rise in the perceived subjective probability that a similar devastating disaster might strike a residential

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

[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).

area in the future increases the potential for needing help from others in the future (Cassar et al., 2011). This causes individuals to acknowledge the importance of flexible and effective community roles in coping with disaster. Accordingly, individuals will become more inclined to invest in social capital by taking part in voluntary community-building projects[10]. Furthermore, in the case of the Hanshin-Awaji earthquake, the nearer one was to Kobe, the higher the perceived probability of a future disaster; those who live closer to Kobe city had a greater incentive to invest in social capital. I thus propose *Hypothesis 1*.

Hypothesis 1:

The shorter the distance between the area hit by a disaster and an individual's place of residence, the more likely that person is to invest in social capital.

As for individuals living within the boundaries of a disaster-stricken area, however, their perceived subjective probability of disaster occurrence does not vary even if *Hypothesis 1* holds true. The actual degree of damage they suffer, however, does vary, and thus their perceived subjective probability of disaster occurrence may differ. It seems appropriate to argue, therefore, that the greater the damage suffered by individuals, the greater their trauma, which thereby gives them a greater incentive to invest in social capital to reduce damage caused by future disasters striking their residence[11]. Hence, I also propose *Hypothesis 2.*

Hypothesis 2:

Within a disaster-stricken area, the greater the damage suffered by individuals, the more they are inclined to invest in social capital.

4. Data and Methods

4.1. Data

The Japanese Government (specifically, the Japanese Ministry of Internal Affairs and Communications, Statistical Bureau) began conducting the STULA in 1976 to provide information about the Japanese people's social behavior in daily life.

[10] According to the framework described by Glaeser et al. (2002), social capital can be accumulated through an individual's investment in social capital.

[11] It is also plausibly argued that massive disasters lead people to be more altruistic than they were before experiencing such disasters (Ishino et al., 2011). This, in turn, causes people to invest in social capital.

The survey, which is held every 5 years, includes observations randomly chosen from almost all regions of Japan. It is conducted in October of the survey year, and in 1996 the STULA was conducted approximately 18 months after the Hanshin-Awaji earthquake. I found the date of the 1996 survey to be appropriate for assessing the impact of the earthquake on individual behavior because people appear to have been influenced by the earthquake directly. This paper compares the likelihood that respondents participated in voluntary community activities before and after the Hanshin-Awaji earthquake. To assess the impact of the earthquake, the two surveys conducted in 1991 and 1996 were used[12]. Apart from issues regarding social activities, the STULA asks standard questions regarding individual characteristics, such as information about marital status, age, gender, annual household income, and education level. The combined data from 1991 and 1996 were gathered from approximately 507,187 respondents at least 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. Furthermore, the number of observations in 1991 was 242,396, while that in 1996 was 245,827. In the STULA, information about actually experiencing the earthquake is not included. Hence, I assume that any related experiences as well as the degree of suffering from the earthquake are determined by the respondents' place of residence; for example, respondents who resided in Kobe city were thought to be directly and most seriously affected by the earthquake. The number of observations of Kobe residents was 2,446 for 1991 and 2,386 for 1996. Residents in Osaka and Kyoto city were also assumed to have experienced the earthquake, although their degree of suffering was far less than that of the residents of Kobe. The sample sizes of Osaka and Kyoto were almost the same as that of Kobe. I also used one additional definition to categorize the victims as follows: Hyogo prefecture has borders with the four other prefectures of Osaka, Kyoto, Okayama, and Tottori. In addition, Tokushima prefecture faces Hyogo prefecture from across the sea. These prefectures are likely, to a certain extent, to have also been damaged by the earthquake. Hence, I also assume that residents of these prefectures are victims.

[12] In 2013, individual-level data could only be accessed for the 1991, 1996, 2001, and 2006 surveys. Among the list of questions asked to respondents, questions related to experiences participating in community-building activities only appear in the 1991 and 1996 surveys; the questions were changed from 2001. Therefore, I cannot use the data from 2001 and 2006 to examine the long-term impact of the earthquake.

The definitions and basic statistics of all the variables used in this paper are shown in Table 2. The respondents' areas of residence are available in the STULA data, and the scale of the size of each residential area can be divided into the following five categories: *Mega city, Large city, Medium city, Small city*, and *Village*. Kobe is classified as a *Mega city*. In total, 12.3% of the respondents lived in a *Mega city.* The percentage of male respondents was 47.8 %, suggesting that respondents were roughly equally divided according to sex. Married individuals comprised about 63.6% of the respondents. In the original data set, annual household income and education level were classified into a number of groups. The values shown in the table were calculated based on these categories.[13] With regard to social position, respondents were divided into *Student*, *House* (stay-at-home workers)[14], *Full Work* (those with full-time jobs), and *No Work* (those who were not included in *Student, House,* or *Full Work).* 56.1% of the respondents were regarded as having full-time jobs, while 8.4% did not have a job and were not students or stay-at-home workers. 73.5% of the respondents owned a home, and 82.6% owned car. In addition to the variables sourced from the STULA, the distance from Kobe city to each respondent's place of residence was collected from Geospatial Information Authority Japan (GSI)[15]. Information about the prefecture of residence of the respondents allowed for the integration of the distance data with the individual-level data.

The key variable for this study, i.e., 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-building work

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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," I assumed that everybody earned 15 million yen.

Education level was categorized into nine groups, including current students attending junior high school, high school, junior college, and university, and graduates from junior high school, high school, junior college, university, and other. In this paper, current students attending junior high school and high school are defined as having graduated from primary school and junior high school, respectively. Current junior college and university students are defined as having graduated from high school. In the education system of Japan, 6, 3, 3, and 4 (or 2) years are the typical lengths for primary school, junior high school, high school, and university (junior college), respectively. Hence the number of total years of schooling 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 six categories: workers (those who have full-time jobs), students (without a job), students (with a part-time job), home-workers (without a job), home-workers (with a part-time job), and others (without a job). Students consisted of both students without a job and students with a part-time job. House consists of stay-at-home workers currently without a job and stay-at-home workers currently with a part-time job.

15 See the GSI website: http://www.gsi.go.jp/KOKUJYOHO/kenchokan.html. (Accessed on January 28, 2013.)

within the past year?" The possible responses to this question were "Yes" and "No." Based on these data, the rate of participation was calculated for each prefecture. Table 3 shows these rates for both 1991 and 1996. Moreover, the difference between the 1991 and 1996 rates is also presented. It is interesting that the difference in rates is not negative for any prefecture, suggesting that participation rate increased from 1991 to 1996 for all prefectures; the positive impact of the Hanshin-Awaji earthquake on social capital accumulation does not seem to have been to the disaster-stricken area. Put another way, the Hanshin-Awaji earthquake enhanced investment in social capital throughout Japan.

The positive impact of the earthquake on social capital formation can be interpreted in various ways. It can be plausibly argued that macroeconomic shock and institutional change occurred between 1991 and 1996. This, in turn, affected the behavior of individuals. For instance, from the macroeconomic point of view, the Japanese people enjoyed a business boom, i.e., "the bubble economy," from the mid-1980s through the early 1990s. After the boom period, however, Japan entered a long-term economic recession, which is generally thought to have begun in 1991. Economic decline possibly increased the importance of the role of community in people's lives, rather than the functions of a market economy. Therefore, Japanese individuals during this time were more likely to invest in social capital than during the period of the "bubble economy." If this is true, then the earthquake can be said to have had almost the same impact on individual behavior across Japan. To put it differently, if the increase in investment in social capital differs between areas, then macroeconomic shock cannot be considered as a determinant of social capital accumulation. To better tackle this issue, therefore, this paper examines how the distance of one's residence from Kobe affects increases in investments in social capital. As derived from *Hypothesis 1*, individuals possibly have a greater incentive to invest in social capital when their place of residence is near Kobe. To preliminarily check this hypothesis, Figure 2 shows the relationship of the difference in the rate of investment in social capital and the distance of one's residence from Kobe. A cursory examination of Figure 2 reveals a positive association between these values, implying that the greater the distance from the area hit by the earthquake, the lower the sense of crisis was with respect to the damage caused by the earthquake. To examine these data closer, however, individual-level factors should be controlled. For this purpose, regression estimation is conducted in the following section.

Table 4 presents the rates of community participation in 1991 and 1996 as well as the calculated difference between them, according to residential area. Each prefecture consists of local governments, such as cities, villages, and towns. These local governments can be divided into various scales based on population size[16]. From Table 4 it can be seen that the larger the scale of the residential area, the lower the participation rate in both 1991 and 1996. Across all residential area scales, the rate difference takes a positive value, implying that participation rate increased from 1991 to 1996. It is interesting that the larger the residential area scale, the smaller the difference in participation rate, suggesting that while the residents of more urbanized areas tended to increase investment in social capital after the earthquake, their response to the earthquake was comparatively smaller than that of those who resided in less urbanized areas. Thus, in addition to geographical location, it is also necessary to control for the scale of residents to more accurately examine the impact of the earthquake on investment in social capital.

4.2. Econometric framework and estimation strategy

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

$$\text{Social capital}_{itp} = \alpha_0 + \alpha_1 \text{IDistance}_p * \text{1996 year dummy}_t + \alpha_2 \text{IDistance}_p + \alpha_3 \text{ 1996 year dummy}_t + X' B + u_{itp},$$

where $\text{Social capital}_{itp}$ 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 that capture the influence of the 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 the distance from Kobe city to the capital of the prefecture in which the individual resides. The reason why the inverse of the distance is used is to interpret the cross-term more easily. If the coefficient of IDistance_p ** 1996 year dummy* takes a positive sign, then the closer to Kobe the respondents resided, and hence the more likely they were to increase investment in social capital from 1991 to 1996. Furthermore, with the aim of capturing the scale of the area of residence, dummies for *Large city, Medium city, Small city,* and *Village* are incorporated when

[16] For instance, Hyogo prefecture consisted of 29 cities and 12 towns at the time of the survey. Kobe city is the largest local government when measured by population size.

Mega city is the reference group.

The vectors of the control variables are denoted by X, which includes the scale of the individual's residential area, age, male dummy, marital status, household income, job status dummy, schooling years dummy, home ownership dummy, and car ownership dummy. Married individuals are more likely to be involved in an interpersonal relationship because they tend to take part in not only their own social networks but also those of their spouse. Hence, social capital plays a greater role for married individuals than unmarried ones. I included *Married* in an attempt to capture such differences between married and unmarried respondents. The opportunity cost for full-time workers is considered to be higher than that for part-time workers or non-workers. Therefore, the cost for investment in social capital such as participating in community activities is higher for full-time workers, and thereby reducing their investment in social capital. *Student*, *House*, and *No Work* are incorporated to capture the difference in this opportunity cost, while *Full Work* is used as the reference group. *Student*, *House*, and *No Work* are expected to take a positive sign because those who are not full-time workers are more likely to invest in social capital because their opportunity cost is lower than that of full-time workers. *Household income* and *School* control for individual economic conditions. The higher the human capital as measured by years of schooling, the higher the wage. Hence, the opportunity cost for investment in social capital increases in proportion to years of schooling, and therefore educated individuals are relatively more discouraged from investing in social capital. Apart from household income, those who own a car or home are thought to have greater private assets than those who do not own such things. Hence, *Owner* and *Car* are included to capture this effect.

To assess *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 area in city c. The vectors of the control variables are denoted by Y, which includes the same variable used in the model examining the distance effect as previously described. In addition, 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 the increase in social capital between 1991 and 1996. In this paper, the treatment groups are the residents in Kobe, Osaka, and Kyoto cities because the earthquake hit these mega cities; the control group is thus the residents of other areas. The interaction term $Kobe_c$ ** 1996 year dummy* $_t$ is thus used to capture the difference in investment in social capital during the period spanning 1991-1996 between the residents of Kobe city and those of other areas. In addition, $Osaka_c$ ** 1996 year dummy* and $Kyoto_c$ ** 1996 year dummy* are included to examine how the earthquake affected the investment in social capital in those areas where the earthquake damage was far less than that in Kobe, despite their degree of urbanization and sociocultural characteristics being relatively similar to those of Kobe. Hence, the perceived subjective probability of future earthquake occurrence should be almost the same among the residents of Kobe, Osaka, and Kyoto. Moreover, their responses to the earthquake should be similar if the damage caused by the disaster is also similar. In this estimation, I thus investigate how and to what extent each individual's social capital investment was influenced by the degree of earthquake damage.

5. Estimation Results

Results of the probit estimations are shown in Tables 5 and 6. In Table 5, different samples are used for estimation although the specification of the estimated equation is the same. The behavior of residents in the disaster stricken area is distinctly different from that of other areas and thus the data can be regarded as falling into the "outlier" category. Therefore, the effect of the distance from the most seriously damaged area, Kobe, is possibly greatly influenced by such "outliers." Column (1) is based on the full sample. However, to remove the effects of outlier data, the results of columns (2)-(5) were calculated based on a sample excluding the disaster stricken areas variously defined. Furthermore, a marginal effect is reported. The coefficient of *Idistance* 1996 year*, considered to be the key variable in this study, takes a positive sign and is statistically significant in all columns. This suggests that the significant positive sign is robust and as such is not influenced by the outliers. This is consistent with *Hypothesis 1.*

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

Now I focus attention on Table 6, where the results of only the key variables are presented. The other control variables equivalent to those used in Table 5 are included as independent variables; however, their results are not reported. The sign of the coefficient of *1996 year dummy* is positive and statistically significant at the 1 percent level in all columns. The absolute value of the coefficient is 0.07. This implies that the probability that people invested in social capital in 1996 is 7 percent higher than the probability in 1991, which is consistent with the data in Table 3. As shown in columns (1)-(3), the coefficient of *Kobe city* is not statistically significant, despite showing a negative sign. Hence, the probability that residents of Kobe took part in community-building work does not differ from the probability of those who resided in other areas. The coefficient of *Osaka city* yields a significant positive sign, whereas that of *Kyoto city* yields a significant negative sign. That is, residents in Osaka city were more likely to participate in community-building activities while those in Kyoto city were less likely to. It follows from these dummy results that the level of investment in social capital is much different between the residents of the two cities. These results, however, capture the "level" of social capital rather than any "increase" in social capital. Let us now look at columns (4)-(6) to check for any actual "increase" in social capital during the survey period. With respect to the results of the cross terms, the results of *Kobe city* 1996 year*, *Osaka city* 1996 year*, and *Kyoto city* 1996 year* are reported. Only *Kobe city* 1996 year* yields a positive sign and is statistically significant at the 1 percent level in columns (4)-(6). However, *Osaka city* 1996 year* is not statistically significant although it take a positive sign. *Kyoto city* 1996 year* is not statistically significant and takes a negative sign. This implies that compared with the residents of non-damaged areas, residents in Kobe city increased their investment in social capital after the earthquake. In contrast, increase in investment in social capital in the cities of Osaka and Kyoto did not differ from that of the non-damaged areas. Therefore, the experience of undergoing an earthquake seems to have had a greater impact on the residents of Kobe than on those of Osaka and Kyoto, thereby affecting the community-building activities of Kobe residents more remarkably than those of Osaka and Kyoto residents. Furthermore, the absolute value of 0.01 for *Kobe city* 1996 year* can be interpreted as suggesting that the probability that residents of Kobe partook in community-building activities increased from 1991 to 1996 by 1 percent when compared with the residents of other areas.

A large number of residents died as a result of the earthquake, resulting in the destruction of existing social capital stock such as the interpersonal networks within communities. However, as observed in this paper, as a consequence of the earthquake, investments in social capital increased. Hence, the long-term tightly-knit social ties within a community are thought to have been replaced by newly formed social networks. A number of volunteer workers who came from other places in Japan to Kobe made a critical contribution to the resilience of the area (Yamamura, 2013). It follows that such newly formed social capital can be considered to be open to non-community members, which is more effective than the formerly existing social capital, which was closed to non-community members (Fafchamps, 2006)[17]. Enhancing participation in community activities seems to therefore change individual perceptions, such as trust in others. According to Uslaner (2002, 26-27), "the central idea distinguishing generalized from particularized trust is how inclusive your moral community is." Uslaner (2002) also argued that neighborhood trust is a mixture of generalized and particularized trust. The occurrence of an earthquake possibly triggered a transition from community-based, particularized trust limited to within a community to a

[17] Generalized trust is more important in generating large efficiency 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).

community based on a more generalized trust open to strangers (Uslaner, 2002). The positive relationship between natural disasters and generalized trust has also been described Toya and Skidmore (2012). "Receiving help from family and neighbors increases the belief that others are similarly trustworthy" (Cassar et al., 2011, p.9). Trustful relationships are thought to be formed through strangers' participation in volunteer work for the purpose of reconstructing communities. Put another way, not only do community members, but also non-community members take part in community-building activities, which may result in the observed positive relationship between earthquake occurrence and increased generalized trust. These findings suggest that unforeseen exogenous shocks can be considered catalysts for the creative destruction of social capital, triggering not only the quantitative accumulation of social capital but also its qualitative conversion.

6. Conclusions

Compared with climatic disasters such as storms, it is difficult to predict the precise location and date of future earthquakes. Hence, among natural disasters, earthquakes are regarded as unforeseen and uncontrolled exogenous events. Naturally, the following question arises: Does such an event change an individual's behavior and social relationships? In the wake of devastating disasters such as the Hanshin-Awaji earthquake in 1995 and the great East Japan earthquake in 2011, it was generally believed that the Japanese people found it critical to create social capital in the forms of social trust, social networks, and community participation. This, in turn, was thought to trigger individual investment in social capital. However, this conjecture has not been sufficiently assessed using detailed statistical analysis based on abundant individual-level data.

I had a great opportunity in using a mega-dataset comprising 488,223 individual observations to investigate statistically how such earthquakes did or did not enhance investment in social capital through participation in community activity. I found through the differences-in-differences method the following results: (1) In Japan, people were more likely to invest in social capital in 1996 than in 1991; (2) the effect of the earthquake declined as the area of one's residence became more distant from Kobe; and (3) the earthquake significantly increased the social capital investment rate of Kobe residents, whereas the earthquake did not influence the investment rate of residents of large cities close to Kobe. In addition to these findings, the large death toll numbers of Kobe residents led me to conclude that many of the previous social ties within communities had been destroyed. Here, I derive the argument that undergoing the experience of such a large disaster leads people to newly form social capital, which is necessary for collective action to cope with the effects of the disaster, although the damage of disaster has a detrimental effect on tangible capital stock and intangible existing social capital stock. That is, the disaster possibly triggers creative destruction not only by updating capital stock and increasing human capital (Skidmore & Toya, 2002), but also by converting particularized social capital into generalized social capital.

However, it seems plausible that the impact of the earthquake on individual behaviors may differ between the victims of the earthquake and the non-victims. Individuals who suffered serious loss or injury may have passed away or relocated their residence to other areas outside of Kobe if they had survived. Limitations in the data, however, prevented me from investigating the extent to which such unobservable selection biases may have influenced the outcome of this study. Furthermore, it is unknown whether the impact of such disasters depends on other disaster characteristics. Hence it is worth conducting comparable estimations in the cases of predictable climatic disasters. Moreover, because of other data limitations, this paper focused only on changes in human behavior immediately following the disaster. However, social capital cannot be sufficiently accumulated if investment in social capital decreases as time passes. It is thus necessary to explore the long-term impacts of the Kobe earthquake by using datasets covering more recent time periods, such as the 2000s. Furthermore, there is the question of whether social capital is formed from selfish or altruistic motivations because the actual individual motivations behind the formation of social capital cannot be assessed using the current data. These issues should be addressed in future studies.

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Table 1. Structure of sample

Year	Category	Number of observations
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 community-building activities within a year, otherwise 0 (%)	19.1	---
1996 year dummy	A value of 1 is given if data are 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 (Millions of yen)	0.63	0.41
Full Work	A value of 1 is given if respondent is a 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 stay-at-home worker, otherwise 0 (%)	26.6	---
No work	A value of 1 is given if respondent does not have work and is not a student or stay-at-home 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,* and *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
Aomori	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
Ibaraki	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 in 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

Table 5.

Probit analysis of effect of distance from Kobe on social capital investment.

	(1) Full sample	(2) Kobe city sample excluded	(3) Hyogo prefecture sample excluded	(4) Hyogo, Osaka, Kyoto prefecture samples excluded	(5) Prefectures surrounding Hyogo prefecture samples excluded
*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 indicate marginal effects. 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.

Table 6.

Probit analysis of the differences of the disaster effects between Kobe city and other areas (Full sample), excluding the samples of prefectures surrounding Hyogo prefecture.

	(1)	(2)	(3)	(4)	(5)	(6)
*Kobe city *1996 year dummy*				0.01*** (5.44)	0.01*** (5.41)	0.01*** (3.58)
*Osaka 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)
Osaka 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 here because of space limitations.

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

(Kobe is the area which suffered the most damage in the 1995 earthquake.)

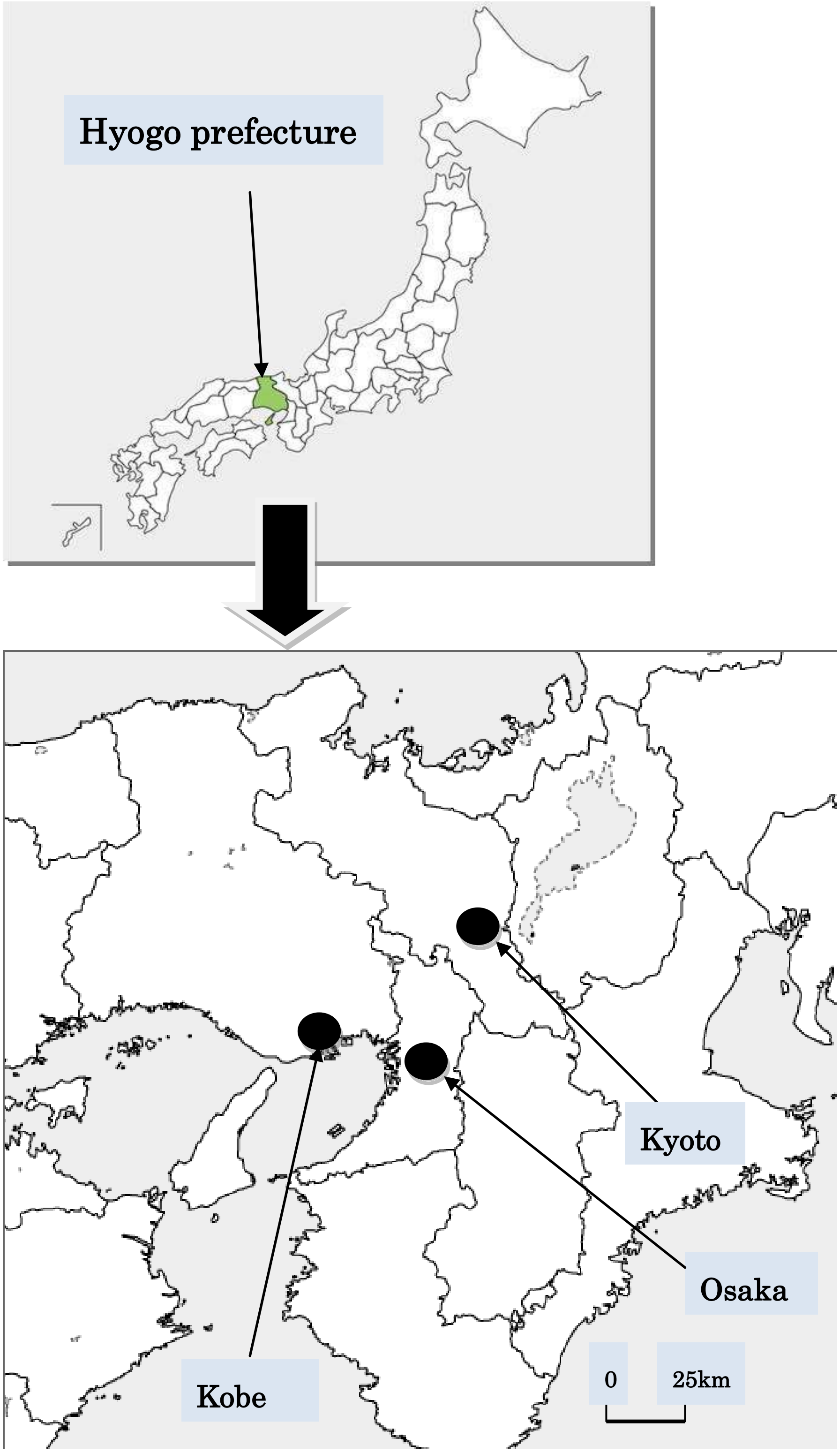

Figure 2. Association between distance from Kobe and the difference in the rate of social capital investment.