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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 struck Japan in 1995, causing devastating damage to the economic landscape of south-central Japan. 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 investigated 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) the 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

Keywords: Natural disasters, social capital, volunteer activities

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 differs 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 very 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 fully protect one from such disasters; that is, natural disasters are indiscriminate and therefore affect people from all social classes. 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 or greater 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$200–300 billion (Sawada 2011, p. 46). In addition, in 1995, 16 years prior to this earthquake, a similar earthquake occurred in south-central Japan (the Hanshin-Awaji area), and the damage caused is comparable to that caused by the

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

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 areas 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.

Economic researchers have 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 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 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. Social capital is considered to enhance voluntary collective action, which is important when people encounter an emergency. For instance, social capital can lead neighbors to successfully rescue a community member trapped

[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).

under rubble. Prior works on this topic have assessed the impact of natural 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, with 1996 being 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 enables one to compare the impact of the earthquake across regions by comparing human behavior data from both before and after the earthquake[5].

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.

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

[5] Yamamura (2013) also investigated how volunteer activity changed between before and after the Hanshin-Awaji earthquake; it is noteworthy, however, that Yamamura (2013) did not consider the differences between the places where the respondents resided. The present paper thus differs from Yamamura (2013) in that individual behavior is explored from a spatial viewpoint.

2. Overview of the Great Hanshin-Awaji earthquake

On January 17, 1995, an earthquake hit the Hanshin-Awaji area of south-central Japan. The area damaged by the earthquake covered the prefectures of Hyogo, Osaka, Kyoto, and Tokushima[6]. 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 Meteorological Agency seismic intensity scale (JMA) 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 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[7], and Kobe, Osaka, and Kyoto are all such major cities. Furthermore, the Ministry has defined "metropolitan areas" as regions consisting of the major cities defined above as the core and their surrounding municipalities. By this definition, there are eight 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, with the death toll for Hyogo prefecture reaching 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 other Keihanshin areas.

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

[7] 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.)

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, 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 three homes destroyed. Hence, the damage was almost exclusively observed in Kobe[8]. 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.

A well-developed insurance market can help protect against asset and physical capital lows. However, the market cannot secure the safety of citizens against unforeseen events such as natural disasters. That is, the likelihood that a person trapped under rubble will be successfully rescued is not related to the function of the insurance market. Hence the government is expected to play a leading role in dealing with unforeseen events and the rescuing of victims. However, the Japanese government's initial response to the Hanshin-Awaji earthquake was regarded as slow[9]. In contrast with the government's slow response, however, 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 of coping 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[10].

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[8] 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).

[9] To take 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 approximately four months. After the March 2011 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).

[10] In Japan, homeownership and one's neighbors influence the degree of participation in community activities (Yamamura 2011a, 2011b).

3. Hypotheses

As a consequence of an unpredicted massive earthquake, a rise in the perceived subjective probability that a similar devastating disaster might strike a residential 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 [11]. 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 lived 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 any damage caused by future disasters striking their residence[12]. 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

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

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

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 Japanese social behavior in daily life. The survey, 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. The date of the 1996 survey was considered 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[13]. 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, it is assumed 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 Kobe residents. The sample sizes of Osaka and Kyoto were almost the same as that of Kobe. One additional definition was also used to categorize the victims as follows:

[13] 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 for the 2001 survey. Therefore, I cannot use the data from 2001 and 2006 to examine the long-term impact of the earthquake.

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, it was assumed that residents of these prefectures are victims.

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[14]. With regard to social position, respondents were divided into *Student*, *House* (stay-at-home workers)[15], *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)[16].

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[14] Annual earnings were grouped into 12 categories. It was assumed that everyone in each category earned the midpoint value. For the top category of "15 million yen and above," it was 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.

[15] 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.

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

The intensity of the Hanshin-Awaji earthquake in each prefecture was gathered from data from the Ministry of Land, Infrastructure, Transport and Tourism (1996)[17]. Information about the prefecture of residence of the respondents allowed for the integration of the distance and intensity of the earthquake 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 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. The Appendix 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 the 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 intensity of the earthquake in Japan differed according to geographical location. According to the Japan Meteorological Agency's (JMA) seven-level seismic intensity scale, the higher the value of the level, the more intense the shock of an earthquake is. The value of intensity in each prefecture is indicated in the table in the Appendix. As illustrated in Figures 2 and 3, the information in the Appendix was incorporated into a map of Japan to put it into a spatial context. In Figure 2, the darker a prefecture is shaded, the more intense the earthquake is. Figure 2 shows that the intensity of the earthquake is obviously related to the distance from the disaster-stricken area. In Figure 3, the darker a prefecture is shaded, the larger the increase in the investment for social capital is. Figure 3 thus shows that increases in social capital investment are not clearly related to the distance from the disaster-stricken area. Further, looking at Figures 2 and 3 together, it can be seen that increases in social capital investment are also not closely associated with the intensity of the earthquake. For example, increases in social capital investment were large in the north-eastern region, whereas they were small in Osaka and Kyoto prefectures, both of which border Hyogo prefecture. Osaka and Kyoto

[17] Land prices, Per capital income, and Population were collected from Index Corporation (2006). Gini coefficients of household income were gathered from the Statistics Bureau of the Ministry of Internal Affairs and Communications (1990 and 1995). Suicide rates were obtained from the Ministry of Health, Labor and Welfare (various years).

prefectures are considered to be urbanized and overpopulated areas. In contrast, the north-eastern region is considered to be less urbanized and depopulated. As discussed later with respect to Table 3, the population scale of a residential area seems to be related to the amount of investment in social capital. In Figure 3, this factor is not controlled for, which possibly attenuates the relationship between distance (or intensity) and social capital investment. Therefore, further analyses are conducted to control for various factors by using Probit estimation in Section 5.

The observed 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 individual behavior. 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 the increase in investment in social capital differs between areas, then macroeconomic shock can be considered as a determinant of social capital accumulation. To control for macro-level factors, prefecture-level variables should be taken into account. After controlling for such variables, this paper examines how the distance of one's residence from Kobe affects increases in social capital investments. 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 4 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 4 reveals a positive association between these values, implying that the greater the distance from the area hit by an earthquake, the lower the sense of crisis with respect to the damage caused by the earthquake. Apart from distance, the intensity of the earthquake is also thought to affect the investment in social capital. Figure 5 demonstrates the relationship between such investment and earthquake intensity, illustrating a positive relationship. This indicates that the greater the intensity, the higher the sense of crisis with respect to the damage caused by the earthquake. These relationships are considered to be reasonable. To examine these data closer, however, individual-level factors and changes in prefecture-level macro-economic conditions should be controlled for. For this purpose, regression estimation is conducted in the following section.

Table 3 presents the rates of community participation in 1991 and 1996 as well as the calculated difference between them, based on the 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[18]. From Table 3 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 the 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 the 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:

$$Social\ capital_{itp} = \alpha_0 + \alpha_1 IDistance_p\ (or\ Intensity_p) * 1996\ year\ dummy_t + \alpha_2 IDistance_p\ (or\ Intensity_p) + \alpha_3\ 1996\ year\ dummy_t + \alpha_4\ Intensity_p\ (or\ IDistance_p) + X'_{tp} A + Y'_{itp} B + u_{itp},$$

where $Social\ capital_{itp}$ represents the dependent variable in individual i, year t, and prefecture p. The regression parameters are denoted by α. A is the vector of the regression parameters for the prefecture level control variables that capture the influence of the various socio-economic conditions of a respondent's residential area. B is the vector of the regression parameters for the individual-level control variables that capture the influence of the various respondents' individual characteristics. The error term is denoted by u. *1996 year dummy* takes 1 when

[18] 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.

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[19]. The inverse of the distance is used to interpret the cross-term more easily. For the purpose of disentangling the influences of the intensity of and the distance from the earthquake, *Intensity* is incorporated as an independent variable.

In an alternative specification, instead of *IDistance* 1996 year dummy*, *Intensity * 1996 year dummy* is included as a key variable to examine how the intensity of the earthquake in each prefecture has an effect on changes in the investment of social capital. 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 their investment in social capital from 1991 to 1996. If the coefficient of *Intensity * 1996 year dummy* takes a positive sign, then the larger the influence of the earthquake, and therefore the more likely the respondents were to increase their investment in social capital from 1991 to 1996. In this specification, with the aim of disentangling the effect of distance from the earthquake from the effect of earthquake intensity, *IDistance* is incorporated as an independent variable.

As illustrated in Figure 3 and discussed previously, the increase in social capital investment is large in the North-Eastern region even though the region is relatively far from the Hanshin-Awaji area. Moreover, the region is not considered an urbanized or populated area. 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 *Mega city* is the reference group.

With respect to prefecture-level control variables, the vectors of the control variables are denoted by X, which includes land price, the Gini coefficients of household income, suicide rate, and population size. As previously mentioned, Japan experienced a long-term wave of prosperity from the mid-1980s to the

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[19] Information about a respondent's residential city, town, or village is not available from the STULA data because the questionnaire did not ask respondents about such information. The data provide information only about the prefecture and the size of the local government where the respondents resided. Prefecture consists of local governments, including cities, towns, and villages. In one prefecture there generally are many cities, towns, and villages. Hence, it is almost impossible to identify a respondent's specific residential city (or village). However, the case of Kobe city is unique. Kobe city is classified as a *Mega city*, as defined in Table 2. In Hyogo prefecture, such large cities did not exist in 1991 or 1996 apart from Kobe city. Accordingly, respondents who resided in Hyogo prefecture and in a *Mega city* as defined in Table 2 can be identified as Kobe residents. However, the specific residential city (or village) cannot be uniquely identified for most of the other respondents. Thus, this paper did not use the distance between Kobe city and one's place of residence at the level of local government.

beginning of the 1990s. However, following this period, land and stock prices have fallen drastically and the competitive power of Japanese firms has decreased. Inevitably, the demand for labor has also decreased and thus the unemployment rate has increased from 2.1% to 3.4 %[20]. If the unemployment rate increases, then the possibility of economic inequality increases among individuals. It was 1991 when Japan's "bubble economy" collapsed, but its influence has yet to be fully revealed. However, the economic downturn was actualized in 1996. Such a change in the macro-level economic condition is thought to influence individual behavior. Therefore, it is necessary to control for prefecture-level economic conditions whenever estimations are conducted. Thus, land prices, the Gini coefficients of household income, and per capita income levels in each prefecture are included as variables of changing economic conditions that respondent encountered[21]. After entering the 1990s, the suicide rate in Japan has risen remarkably (Andrés et al. 2011). This might be, in part, considered as one of the outcomes of the decline of the Japanese economy. In addition, the population size at the local government level as well as the size of each prefecture is controlled for. In this way, in addition to the abovementioned economic conditions, the suicide rate and population size of each prefecture are included to better capture the social condition of each area.

Turning to individual-level control variables, the vectors of the control variables are denoted by Y, 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 single individuals. 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, thereby reducing their investment in social capital. *Student*, *House*, and *No Work* are

[20] Data are available from the website of the Statistics Bureau of the Ministry of Internal Affairs and Communications: http://www.stat.go.jp/data/roudou/longtime/03roudou.htm (accessed on August 23, 2013). The values are calculated every year in December.

[21] The prefecture-level unemployment rate is not available before 1998. Because of the lack of available data, the unemployment rate cannot be incorporated as an independent variable although it should be taken into account.

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[22]. There are different categories of capital[23]. Here, focus is put on the relationship between social capital and human capital. There is an argument in the literature that social capital is complimentary to human capital (Coleman 1998). Indeed, social capital has been observed to reduce the long-term truancy of students (Yamamura 2011a). Contrary to this claim, however, the relationship can be inferred to be substituted as follows. 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:

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

$Kobe_c$, $Osaka_c$, and $Kyoto_c$ are dummies for residential area in city *c*. The vectors of the control variables are denoted by Z, which includes the same variable used in the model examining the distance effect as previously described. In addition, Z 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,* a differences-in-differences approach was employed to

[22] The correlation coefficient between *Household income* and *School* is 0.20. Hence there is the possibility of multicollinearity issues. However, as shown in Tables 4 and 5, the results are statistically significant in all columns, and further, these results do not change when an independent variable is deleted. Therefore, the results can be considered to be both robust and stable, suggesting that issues of multicollinearity are not a serious concern in these estimations.

[23] Capital can be classified roughly into physical and non-physical capital. The former type is defined as a measure of production, while the latter type can be further classified into social capital, human capital, or financial capital.

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 struck these mega-cities; the control group is thus the residents of other areas. As shown in Figure 2, the intensity of the earthquake varies among "other areas," although these areas have hardly suffered physical damage. Therefore, caution should be used when defining the treatment and control groups. 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 the 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, therefore, how and to what extent each individual's social capital investment was influenced by the degree of earthquake damage was investigated.

5. Estimation Results

Results of the probit estimations to examine Hypothesis 1 are shown in Tables 4 and 5. In Table 4 the effect of the distance is examined. In Table 5 the effect of earthquake intensity is explored. 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." In each Table, Columns (1)-(3) are based on the full data sample. To remove the effects of outlier data, the results of columns (4)-(6) were calculated based on a sample excluding the disaster-stricken area (Kobe city). Columns (1) and (4) report results of the full specification model. In addition, to check for robustness, alternative specifications are also exhibited. Results excluding individual-level variables are presented in columns (2) and (5), while results excluding prefectural-level variables are presented in columns (3) and (6). Furthermore, a marginal effect and the z-statistics for each variable are reported.

With respect to Table 4, the *Idistance* 1996 year* variable is considered to be the key variable in this study. Its sign takes a positive sign and is statistically significant in columns (1)-(6). In addition, its marginal effect is 0.01 in all results. These results suggest that the significant positive effect of *Idistance* 1996 year* is robust and, as such, is not influenced by the outliers and set of control variables. This is consistent with *Hypothesis 1.* As for the prefectural-level control variables, *Land price* and *Population* produce a negative sign, being statistically significant in all estimations. It follows from this result that social capital investment is low in urbanized and large-scale prefectures. Such evidence derived from prefectural-level variables is consistent with the previous observations made regarding Table 3. Other prefectural-level variables are not statistically significant in any of the columns.

Turning now to the results of the individual-level control variables in Table 4, the coefficients of *School*, *Household Income*, *Owner*, and *Car* have a positive sign and are statistically significant at the 1% (0.01) level. Furthermore, the coefficients of *Student* and *No Work* have a negative sign and are statistically significant at the 1% (0.01) 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 from a different perspective. The higher an individual's socioeconomic status, the more he or she is inclined to avert inequality partly to reduce the externality of envy from surrounding poorer 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 surrounding poorer individuals. It has been found in previous empirical work that home ownership is positively associated with investment in social capital (DiPasquale & Glaeser, 1999; Yamamura, 2011b), partly because long-term relationships with one's neighborhood as they relate to community stability lead people to invest in the maintenance of intimate relationships with their neighbors. Therefore, *Owner* can also be considered to capture the effect of residential immobility.

With regard to Table 5, the results of the control variables are almost the same as those in Table 4. Hence, here focus is concentrated on the results of *Intensity* 1996 year*. The *Intensity* 1996 year* takes a positive sign in all columns. However, it is not statistically significant in columns (2), (4), or (5). While its statistical significance is observed in column (1), its z-statistic is only 1.70, which is smaller than its z-statistic in columns (3) and (6). These results indicate that the significance of *Intensity* 1996 year* decreases when individual-level variables are included. Further, its z-statistic in columns (4)-(6) are smaller than those in columns (1)-(3), implying that the effect of *Intensity* 1996 year* is affected by the outliers. Taken together, the effect of intensity is not robust. Thus, considering these results together implies that the effect of distance is more robust than the effect of intensity.

With respect to Table 6, which relates to *Hypothesis 2*, the results of only the key variables are presented. The other control variables equivalent to those used in Table 4 are included as independent variables; however, their results are not reported in the table. The sign of the coefficient of *1996 year dummy* is positive and statistically significant at the 1% (0.01) 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 the Appendix. 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 do so. It follows from these dummy results that the levels of investment in social capital are 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% (0.01) 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 also not statistically significant but takes a negative sign. This implies that compared with the residents of other areas (i.e., those areas apart from Kobe, Osaka, and Kyoto), residents in Kobe city increased their investment in social capital after the earthquake. In contrast, increases in investment in social capital in the cities of Osaka and Kyoto did not differ from those of other 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% 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 actually increased. Hence, even if the long-term, tightly-knit social ties within a community are reduced, newly formed social networks are anticipated to function to cover such losses in modern society. A number of volunteer workers who came from other places in Japan to Kobe made critical contributions to the resilience of the area (Yamamura, 2013). It follows that such newly formed social capital can be considered open to non-community members, which is more effective than the formerly existing form of social capital, which was closed to non-community members (Fafchamps, 2006)[24]. 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 to 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.

[24] 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).

However, this conjecture has not been sufficiently assessed using detailed statistical analysis based on abundant individual-level data.

The current author had the great opportunity to use a mega-dataset comprising 488,223 individual observations to investigate statistically whether such earthquakes enhanced investment in social capital through participation in community activity. Through the differences-in-differences method the following results were found: (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 form new 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 an investigation of 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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Figure 1. Map of Japan showing Kobe's location and surrounding areas.

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

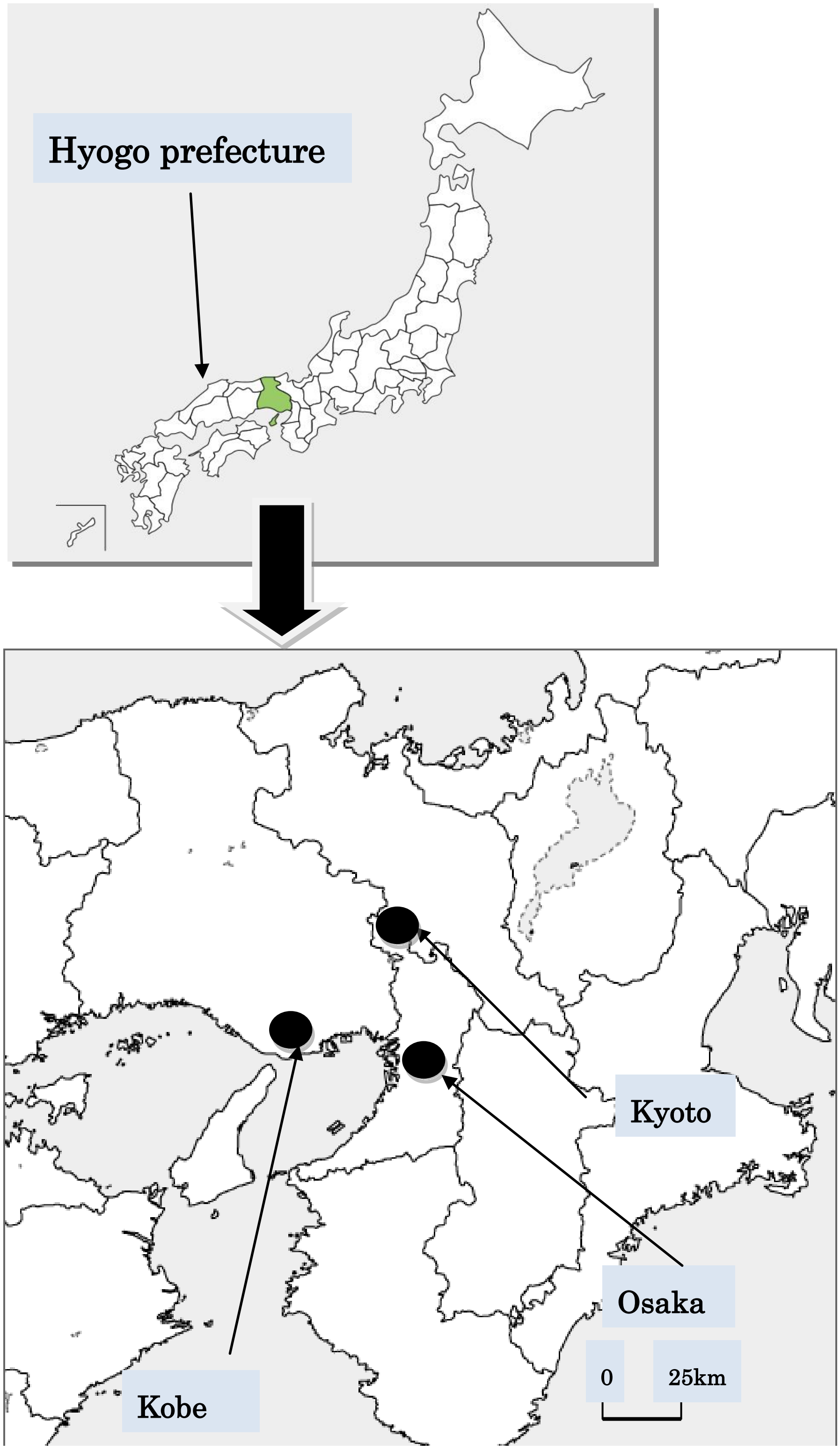
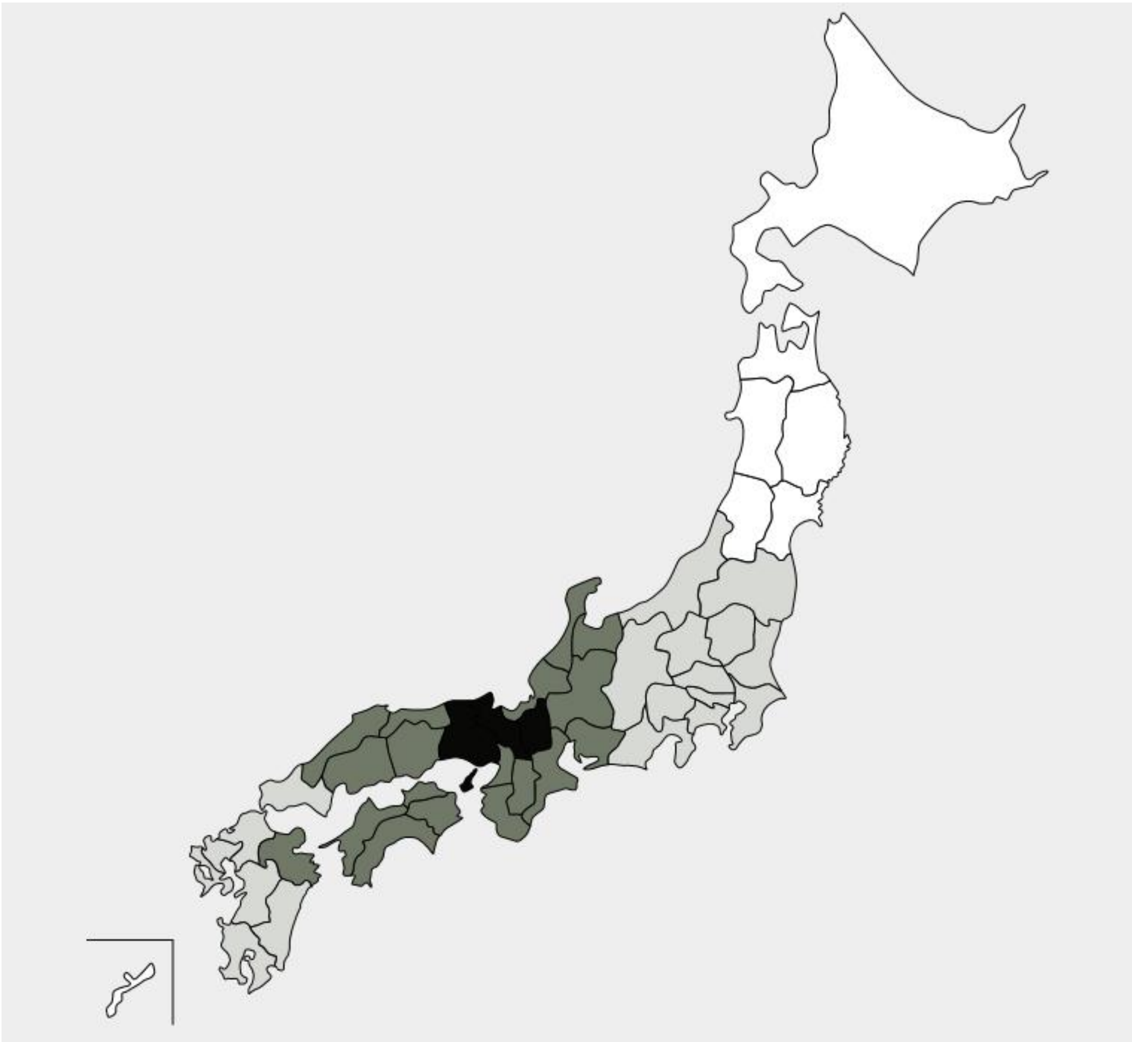


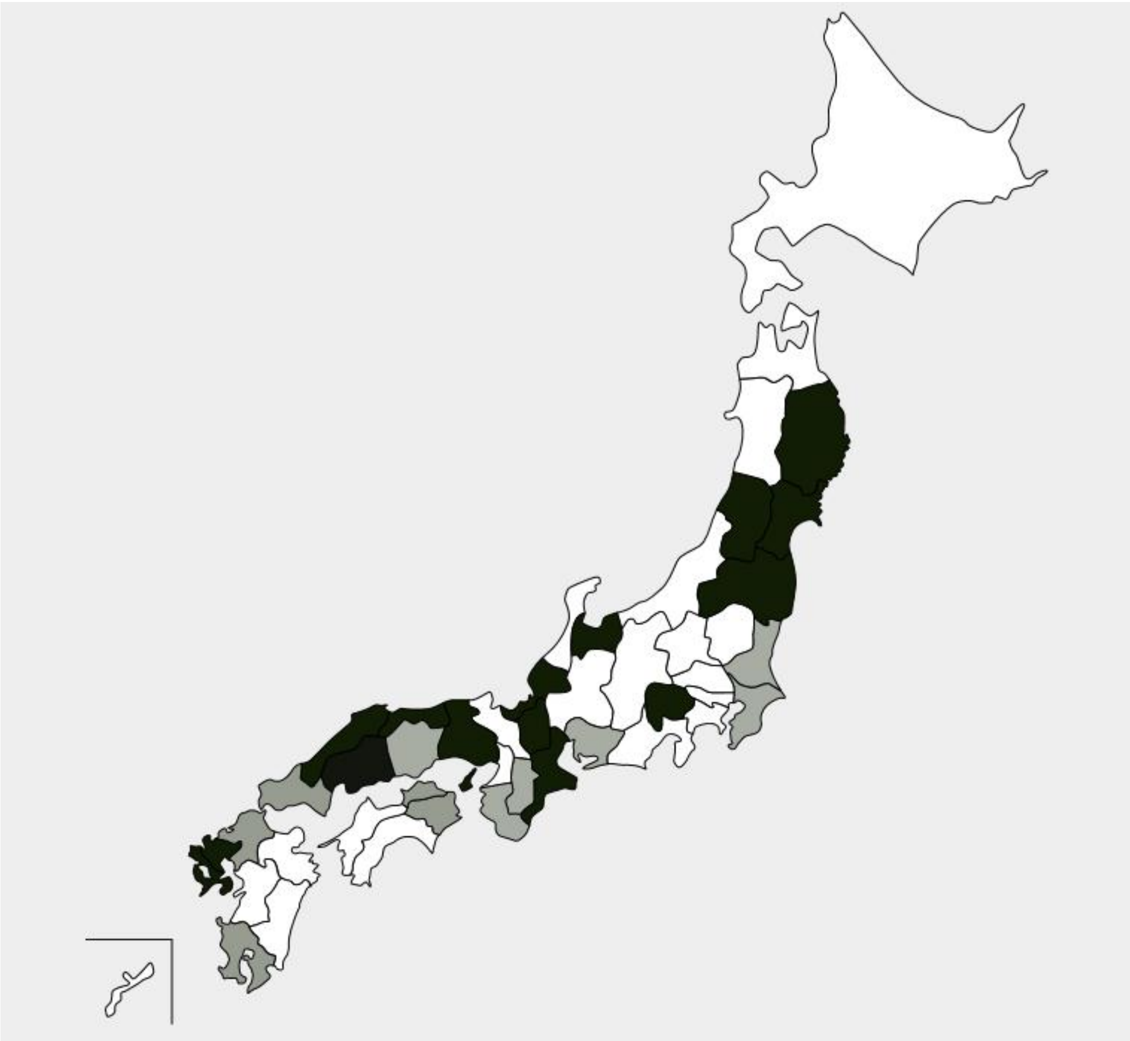
Figure 2. Map of Japan showing the intensity of the Hanshin-Awaji earthquake.



Note: Preferctures were deeply shaded if the earthquake registered intensity of 7(disastrous) and 5(strong) on the Japanese seven-stage seismic scale. Preferctures were moderately shaded if the earthquake registered intensity of 4(moderate)and 3(weak) on the Japanese seven-stage seismic scale. Preferctures were lightly shaded if the earthquake registered intensity of 2(slight) and 1(imperceptible) on the Japanese seven-stage seismic scale.

Source: Ministry of Land, Infrastructure, Transport and Tourism (1996), p.4.

Figure 3. Map of Japan showing difference in rate of social capital formation between 1991 and 1996.



Note: Prefectures were deeply shaded if difference in rate of social capital investment being euqal or larger than 0.08. Prefectures were lightly shaded if difference in rate of social capital investment being equal or larger than 0.07 but smaller than 0.08.

Figure 4. Association between distance from Kobe and the difference in the rate of social capital investment.

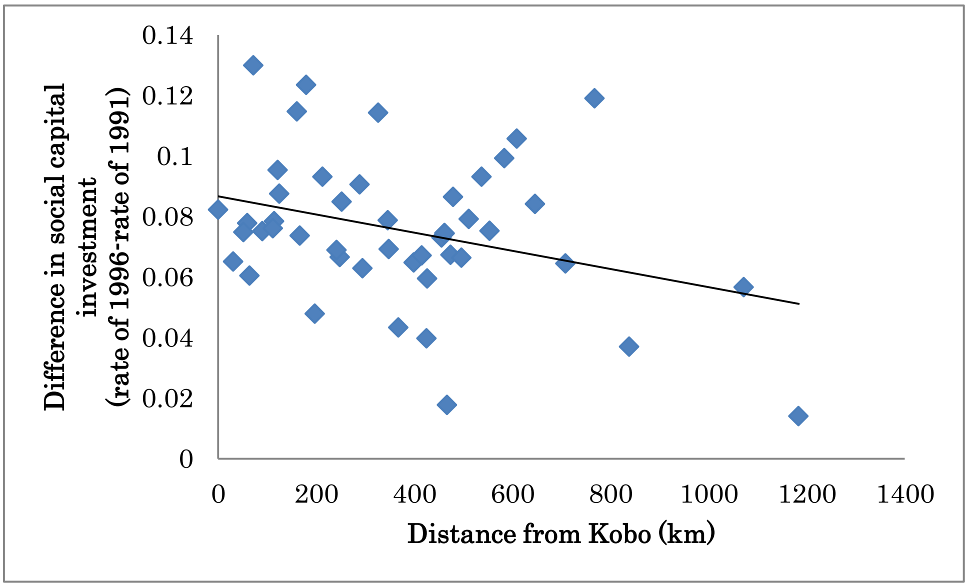
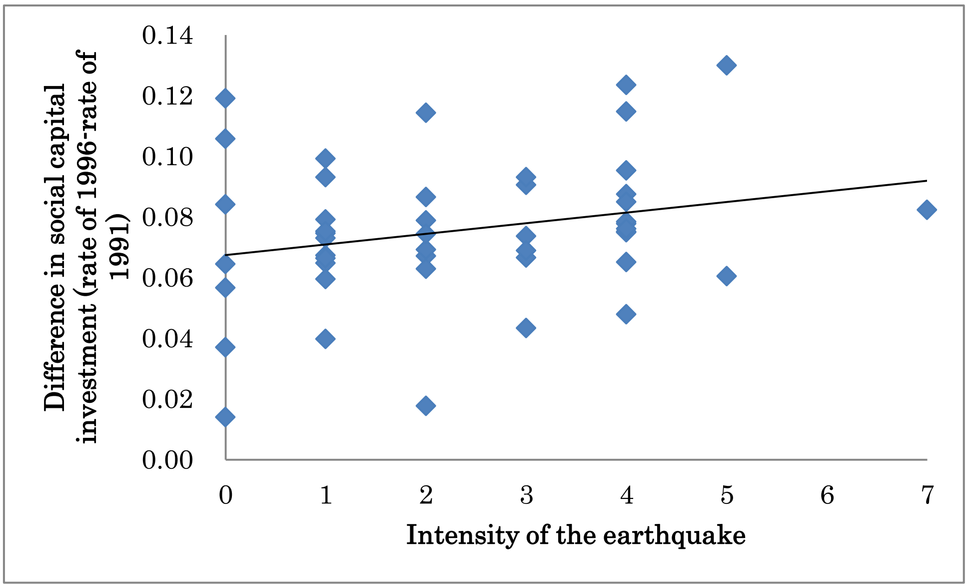


Figure 5. Association between intensity of the earthquake and the difference in the rate of social capital investment.



Note: The intensity ranges from 1(imperceptible) to 7(disastrous) on the Japanese seven-stage seismic scale.

Table 1. Structure of sample

Year	Category	Number of observations
1991 and 1996	Total	488,223
1991	Total	242,396
	Kobe city	2,446
	(Hyogo prefecture)	(6,076)
	Osaka city	2,737
	(Osaka prefecture)	(7,344)
	Kyoto city	2,276
	(Kyoto prefecture)	(4,717)
1996	Total	245,827
	Kobe city	2,386
	(Hyogo prefecture)	(5,866)
	Osaka city	2,864
	(Osaka prefecture)	(7,643)
	Kyoto city	2,354
	(Kyoto prefecture)	(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
Intensity	Intensity of the Hanshin-Awaji earthquake: 1(imperceptible) to 7(disastrous) on the Japanese seven-stage seismic scale	2.30	1.67
Land price	Land price per 3.3 m^2 (Million yen)	0.43	0.42
Gini	Gini coefficients of household income.	0.27	0.02
Income	Per capita real income (Million yen)	0.30	0.04
Suicide	Suicide rate (Number of suicide/1000 persons)	0.36	0.06
Population	Population size (Million)	1.55	1.35
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
Household 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 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 4. Probit analysis of effect of distance from Kobe on social capital investment

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Kobe city sample excluded		
Prefecture level variables						
*Idistance * 1996 year dummy*	0.01** (2.43)	0.01** (2.02)	0.01*** (4.87)	0.01** (2.22)	0.01** (2.27)	0.01*** (4.18)
Idistant	0.006 (0.42)	0.004 (0.31)	-0.003 (-0.63)	0.027* (1.87)	0.011 (0.80)	-0.012* (-1.88)
1996 year dummy	0.08*** (9.87)	0.08*** (9.79)	0.07*** (28.0)	0.08*** (9.78)	0.08*** (9.88)	0.07*** (28.2)
Intensity	0.001 (0.30)	0.001 (0.24)		0.001 (0.21)	0.001 (0.28)	
Land price	-0.02* (-1.75)	-0.02* (-1.91)		-0.02* (-1.91)	-0.02* (-1.75)	
Gini	-0.18 (-0.67)	-0.36 (-1.32)		-0.36 (-1.32)	-0.18 (-0.68)	
Income	0.06 (0.39)	0.01 (1.17)		0.01 (1.17)	0.06 (0.40)	
Suicide	-0.10 (-1.42)	-0.07 (-1.07)		-0.07 (-1.07)	-0.10 (-1.42)	
Population	-0.02*** (-4.40)	-0.02*** (-7.82)		-0.02*** (-7.83)	-0.02*** (-4.40)	
Individual level variables						
Mega city	<reference group>			<reference group>		
Large city	0.01* (1.79)		0.05*** (4.39)	0.01 (1.55)		0.05*** (4.32)
Medium city	0.04*** (4.31)		0.08*** (6.77)	0.04*** (3.92)		0.08*** (6.57)
Small city	0.05*** (5.13)		0.10*** (7.46)	0.05*** (4.72)		0.10*** (7.21)
Village	0.08*** (7.82)		0.12*** (9.95)	0.07*** (7.16)		0.12*** (9.57)
Age	0.001*** (8.78)		0.001*** (8.90)	0.001*** (8.82)		0.001*** (8.97)
Male	0.003 (1.11)		0.002 (0.69)	0.003 (1.19)		0.002 (0.77)
Married	0.08*** (38.9)		0.08*** (38.7)	0.08*** (38.7)		0.08*** (38.5)
School	0.003*** (8.02)		0.003*** (6.49)	0.003*** (8.32)		0.003*** (6.67)
Household Income	0.02*** (9.87)		0.02*** (4.58)	0.02*** (9.84)		0.02*** (4.55)

Full Work	<reference group>			<reference group>		
Student	-0.04*** (-10.9)		-0.04*** (-10.9)	-0.04*** (-10.7)		-0.04*** (-10.8)
House	0.01*** (5.16)		0.01*** (5.04)	0.01*** (5.12)		0.01*** (5.05)
No work	-0.06*** (-18.2)		-0.06*** (-18.2)	-0.06*** (-18.3)		-0.06*** (-18.3)
Owner	0.02*** (9.36)		0.03*** (8.96)	0.02*** (9.33)		0.02*** (8.82)
Car	0.02*** (8.88)		0.02*** (10.5)	0.02*** (8.83)		0.02*** (10.4)
Log Pseudo-likelihood	-225,965	-243,312	-226,802	-224,120	-241,290	-224,954
Observations	488,223	507,187	488,223	483,319	502,125	483,319

Note: 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. Numbers above the numbers in parentheses indicate marginal effects.

Table 5. Probit analysis of effect of distance from Kobe on social capital investment

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Kobe city sample excluded		
Prefecture level variables						
*Intensity*1996 year dummy*	0.002* (1.70)	0.002 (1.61)	0.003** (2.11)	0.002 (1.59)	0.002 (1.55)	0.003** (1.98)
Intensity	-0.001 (-0.30)	-0.001 (-0.31)	0.002 (0.94)	-0.001 (-0.32)	-0.001 (-0.35)	0.002 (0.87)
1996 year dummy	0.07*** (8.74)	0.07*** (8.63)	0.07*** (14.8)	0.07*** (8.77)	0.07*** (8.62)	0.07*** (14.5)
Idistant	0.01 (0.92)	0.01 (0.74)		0.01 (1.30)	0.03** (2.36)	
Land price	-0.02* (-1.79)	-0.02* (-1.94)		-0.02* (-1.78)	-0.02* (-1.94)	
Gini	-0.18 (-0.72)	-0.37 (-1.38)		-0.19 (-0.72)	-0.37 (-1.37)	
Income	0.06 (0.39)	0.01 (1.17)		0.06 (0.40)	0.01 (1.18)	
Suicide	-0.10 (-1.41)	-0.07 (-1.06)		-0.10 (-1.41)	-0.07 (-1.06)	
Population	-0.02*** (-4.42)	-0.02*** (-7.91)		-0.02*** (-4.42)	-0.02*** (-7.92)	
Individual level variables						
Mega city		<reference group>			<reference group>	
Large city	0.01* (1.80)		0.05*** (4.50)	0.01 (1.56)		0.05*** (4.22)
Medium city	0.04*** (4.32)		0.08*** (6.87)	0.04*** (3.93)		0.08*** (6.37)
Small city	0.05*** (5.14)		0.10*** (10.2)	0.05*** (4.73)		0.10*** (6.97)
Village	0.08*** (7.81)		0.08*** (7.81)	0.07*** (7.16)		0.12*** (9.44)
Age	0.001*** (8.78)		0.001*** (8.89)	0.001*** (8.82)		0.001*** (8.93)
Male	0.003 (1.11)		0.002 (0.68)	0.003 (1.20)		0.002 (0.76)
Married	0.08*** (38.8)		0.08*** (38.1)	0.08*** (38.7)		0.08*** (39.0)
School	0.003*** (8.02)		0.003*** (6.46)	0.003*** (8.33)		0.003*** (6.62)
Household Income	0.02*** (9.83)		0.02*** (4.70)	0.02*** (9.81)		0.02*** (4.66)

Full Work	<reference group>			<reference group>		
Student	-0.04*** (-10.9)		-0.04*** (-10.9)	-0.04*** (-10.7)		-0.04*** (-10.8)
House	0.01*** (5.17)		0.01*** (5.00)	0.01*** (5.14)		0.01*** (4.99)
No work	-0.06*** (-18.2)		-0.06*** (-18.1)	-0.06*** (-18.3)		-0.06*** (-18.2)
Owner	0.02*** (9.35)		0.03*** (9.22)	0.02*** (9.29)		0.03*** (9.13)
Car	0.02*** (8.85)		0.02*** (10.6)	0.02*** (8.79)		0.02*** (10.4)
Log Pseudo-likelihood	225,957	243,306	226,720	224,113	241,283	224,879
Observations	488,223	507,187	488,223	483,319	502,125	483,319

Note: 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. Numbers above the numbers in parentheses indicate marginal effects.

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. Numbers above the numbers in parentheses indicate marginal effects.

Appendix.

Table. Difference in rate of social capital formation between 1991 and 1996, and intensity of the Hanshin-Awaji earthquake.

Name of prefecture	1991 (a)	1996 (b)	Difference (b)-(a)	Intensity of earthquake
Hokkaido	0.120	0.177	0.057	0
Aomori	0.105	0.142	0.037	0
Iwate	0.184	0.303	0.119	0
Miyagi	0.163	0.247	0.084	0
Akita	0.153	0.217	0.064	0
Yamagata	0.163	0.268	0.106	0
Fukushima	0.178	0.277	0.099	1
Ibaraki	0.135	0.214	0.079	1
Tochigi	0.154	0.221	0.067	1
Gunma	0.181	0.245	0.065	1
Saitama	0.098	0.157	0.060	1
Chiba	0.103	0.177	0.075	1
Tokyo	0.081	0.120	0.040	1
Kanagawa	0.099	0.166	0.067	2
Niigata	0.116	0.183	0.066	1
Toyama	0.156	0.246	0.091	3
Ishikawa	0.177	0.244	0.067	3
Fukui	0.215	0.339	0.123	4
Yamanashi	0.191	0.305	0.114	2
Nagano	0.194	0.263	0.069	2
Gifu	0.162	0.277	0.115	4
Shizuoka	0.165	0.228	0.063	2
Aichi	0.107	0.180	0.074	3
Mie	0.151	0.247	0.095	4
Shiga	0.195	0.325	0.130	5
Kyoto	0.114	0.174	0.060	5

Osaka	0.082	0.147	0.065	4
Hyogo	0.129	0.211	0.082	7
Nara	0.143	0.221	0.078	4
Wakayama	0.137	0.212	0.075	4
Tottori	0.194	0.281	0.087	4
Shimane	0.189	0.282	0.093	3
Okayama	0.188	0.266	0.078	4
Hiroshima	0.164	0.249	0.085	4
Yamaguchi	0.201	0.280	0.079	2
Tokushima	0.147	0.222	0.075	4
Kagawa	0.160	0.236	0.076	4
Ehime	0.205	0.274	0.069	3
Kochi	0.153	0.201	0.048	4
Fukuoka	0.139	0.212	0.073	1
Saga	0.195	0.281	0.086	2
Nagasaki	0.172	0.266	0.093	1
Kumamoto	0.212	0.287	0.074	2
Oita	0.207	0.251	0.043	3
Miyazaki	0.217	0.234	0.018	2
Kagoshima	0.219	0.295	0.075	1
Okinawa	0.138	0.152	0.014	0

Note: The intensity ranges from 1(imperceptible) to 7(disastrous) on the Japanese seven-stage seismic scale.