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Transaction Partners and Firm Relocation Choice: Evidence from the Tohoku Earthquake[*]

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Abstract

A firm’s choice of location is very important because it reveals the firm’s dynamics. Using a unique firm-level data set, we examine whether and how the presence of incumbent transaction partners (i.e., suppliers, customers, and lender banks) affects this choice. To this end, we focus on those firms that were forced to relocate their headquarters because of the severe damage inflicted by the Tohoku Earthquake. We find that after the earthquake, firms tended to move to areas where their customers were located, but not to areas where their suppliers were located. We also find that firms tended to move to areas where the bank branches that they had transacted with were located. Further, we find that the sizable impact of the presence of incumbent customers and banks on the probability of the firms’ relocations diminished if the customers and the bank branches were also damaged by the earthquake. On balance, these results suggest that the presence of healthy transaction partners is an important factor in the firms’ choice of location.

Keywords: relocation choice; agglomeration; transaction partners; Tohoku Earthquake
JEL classification: R30, L14, G20

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1. Introduction

A firm's choice of location is very important because it reveals the firm's dynamics. To decide where to locate, firms take into account various factors; and amongst such factors, *agglomeration economies* have received considerable interest from the researchers in the fields of regional and urban economics. Agglomeration economies are the geographical concentration of economic activities that might yield positive externalities through knowledge spillovers, pooled labors with specialized skills, and the clustered producers of intermediate inputs (Marshall, 1920).[2] The literature focuses on the geographic concentration of firms as a key driver in the choice of locating new establishments (e.g., Carlton 1983) and/or implementing new foreign direct investments (FDI) (e.g., Head et al. 1995). In addition to agglomeration, the literature also studies the relevance of other factors such as input costs (Carlton 1983, Liu et al. 2010), taxes and other government incentive programs (Carlton 1983, Holmes 1998, Strauss-Kahn and Vives 2009), and transportation infrastructure.

In this paper, we focus on yet another factor that could affect the firms' location choice: the presence of specific incumbent transaction partners. Firms often establish special relationships with their transaction partners, such as suppliers, customers, and banks, through relation-specific (or differentiated) investments, products, or services and establishing each other as irreplaceable transaction partners (Williamson 1975, 1985). This relation-specificity might be reflected in firms wanting to locate closer to their transaction partners, for example, to reduce transportation costs and to enhance mutual communication and information sharing. In one sense, a shorter distance to the

[2] Regarding a vast theoretical and empirical literature on agglomeration economies, see, for example, surveys by Duranton and Puga (2004), Puga (2010), and Rosenthal and Strange (2004).

transaction partners could itself be considered a form of relationship-specific investment. However, the special relationships might work adversely, because too close a relationship might invite hold-up problems (Klein et al. 1978). Therefore, firms might prefer keeping their distance from their transaction partners. Whether or not firms locate to the areas where their transaction partners are located is therefore an empirical question. However, to the best of our knowledge, few studies investigate this question.

The importance of input and output linkages such as clustered intermediate goods producers (Holmes 1999), aggregate demand of the product that is often referred to as "market potential" (Head and Mayer 2004), and the availability of financial services (Davis and Henderson 2008, Strauss-Kahn and Vives 2009) in firms' (re)location choice have been well acknowledged in the literature. But these studies use aggregate-level data that does not allow them to directly identify the importance of the presence of specific transaction partners. In this paper, we pay explicit attention to a specific supplier/customer/bank that a firm transacts with. While the use of a firm-level data set of transaction partners is not entirely new (e.g., Head et al. 1995, Yamashita et al. 2014), our uniqueness rests on the comparison of suppliers, customers, and banks in terms of their relative importance to the firms' relocation choice.[3]

In doing so, we use a unique firm-level data set. Our data set comprises detailed firm-level information on the firms' locations, their characteristics, and the information on their transaction partners (suppliers, customers, and banks). Using this data set, we focus on those firms that actually change the location of their headquarters.

[3] See section 2 for details.

Ordinarily, a relocation choice is a two-stage decision: whether to move and then where to move (see, e.g., Strauss-Kahn and Vives 2009). That is, only those firms who decide to move choose where to move. However, not all firms can make a decision to move. For example, to change locations, firms incur fixed costs (Siodla 2013), so only large (and profitable) firms can afford to move. Also, to move to agglomerated regions, firms need to be productive enough to overcome the local competition in crowded markets (Baldwin and Okubo 2006). Thus, firms that can make a decision to relocate might have special characteristics. Therefore, this study accounts for the heterogeneity between the firms that decide to relocate and the firms that do not in order to avoid a sample selection bias.

Our data comes from the firms that were severely damaged by a massive natural disaster—the Tohoku Earthquake that hit eastern Japan on March 11, 2011. By the nature of the damage it caused, the earthquake *forced* firms to relocate, especially when they were located in the areas affected by the massive tsunamis and the disastrous nuclear plant accident in Fukushima. Thus, examining the relocation of these damaged firms is less susceptible to the sample selection bias described above. In fact, we confirm that the damages inflicted by the Tohoku Earthquake increased the likelihood of firm relocation.

For this sample of firms, we use a conditional logit estimation framework to examine the determinants of the firms' relocation choice. The major findings of this paper are three-fold. First, after the earthquake, firms tended to relocate their headquarters to areas where their incumbent customers were present. In contrast, we do not find similar effects for their suppliers. Second, firms tended to move to areas where their lending banks were present. Furthermore, if we differentiate the firms' main and non-main partners, we find that the effects of the incumbent customers and the banks were somewhat stronger for their main partners. Third, the effects of the incumbent customers and banks diminished if these partners were also severely damaged by the earthquake. Our findings show that the benefit of a relation-specific investment (relocation) surpasses the cost of the investment for firms in our data set on average, as long as incumbent partners were not damaged.

The structure of the paper is as follows. Section 2 is a review of the literature and a detailed explanation of this paper's contribution. In section 3, we explain the data set and sample selection. Section 4 is an examination of whether the damage by the Tohoku Earthquake affected the firms' decision on whether to relocate. We describe the empirical framework that examines the determinants of the firms' relocation choice and the variables used in section 5. The presentation of conditional logit estimation results follows in section 6. In section 7, we summarize the paper's main findings and discuss possible extensions.

2. Literature review

This paper is closely related to the following three strands of literature.

First, there are a number of studies that examine the location choice associated with new establishments within a country (e.g., Carlton 1983) and with FDI. In these studies, a conditional logit estimation framework is usually used to study the relevant determinants of the new location. In this respect, our study follows the empirical strategy of those studies that focus on the agglomeration of the firms from the same vertical industrial group, *keiretsu*, as the key determinant of where Japanese manufacturing firms implement FDI (Belderbos and Carree 2002, Head et al.1995, Head and Mayer 2004). In these studies, the agglomeration of establishments in the same industry as well as that of Japanese establishments in the same industry are included in covariates in order to properly control for the characteristics of the region that attracts the firms in the same industry and the firms that share the same nationality. Because keiretsu relationships usually entail the subcontracting of components and relation-specific investments, the positive effect of the agglomeration of keiretsu firms on the firms' FDI suggests the importance of an irreplaceable supplier or customer as the determinant of the firms' choice of where they implement FDI.

One caveat of these studies is that the sample of the analyses is limited to only a handful of Japanese industries and firms because keiretsu groups only apply to some specific industries (e.g., autos and electronics). This small sample might raise a sample selection bias because the importance of particular suppliers and customers might be greater for firms that belong to a keiretsu group than for non-keiretsu firms. That is, the effect of incumbent suppliers or customers might be overestimated. In addition, the effect of keiretsu firms on the firms' choice of where they implement FDI might vary depending on whether the existing keiretsu firms in the region are suppliers or customers of the firm. But, these studies on keiretsu firms do not pay close attention to the distinction between suppliers and customers.[4] But, we compare the roles that suppliers and customers play in the relocation choice and find that they are indeed different. Other than keiretsu studies, the study that is most closely related to this paper in this respect is Yamashita et al. (2014) who examine the agglomeration effect of interfirm backward (i.e., supplier) and forward (customer) linkages on the choices of where Japanese manufacturing firms implemented FDI in China. This

[4] Belderbos and Carree (2002) find that the agglomeration effect of a keiretsu firm is larger for follower member firms than for the leader core firms of the keiretsu. However, they do not identify whether firms are suppliers or customers.

paper differs from Yamashita et al. (2014) in that we focus on the relocations of firms that were severely damaged by the earthquake in order to mitigate the problem of a sample selection bias. Another difference is that we investigate the relocation of firms within the Tohoku area, and thus the average size of our sample firms is much smaller than those in Yamashita et al. (2014).

Second, our analysis on the role of lender banks as a determinant of relocation is closely related to the literature on banking and finance that emphasizes the importance of geographical proximity between lenders and borrowers. Because a longer physical distance between banks and firms decreases the precision of information about borrower firms and increases the transaction costs that banks and firms incur, loans to businesses have traditionally been extended by a local lender (headquarters and branches). This “tyranny of distance” is especially acute for loans to small businesses that are informationally opaque. This opaqueness requires lenders to produce “soft” information for the loans to be extended.[5] Consistent with these conjectures, previous studies find that the geographical proximity between lenders and borrowers affects the price and availability of loans as well as the continuation or breakup of bank-firm relationships (Agarwal and Hauswald 2010, Bellucci et al. 2013, Degryse and Ongena 2005, DeYoung et al. 2008, Knyazeva and Knyazeva 2012, Ono et al. 2013).

In spite of the importance of geographical proximity on firm-bank relationships, there are only a few studies that examine the effect of the banks’ location on that of firms. Exceptions are Davis and Henderson (2008) and Strauss-Kahn and Vives (2009) who emphasize the existence of diverse business services including financial services as one of the key determinants for the

[5] In the banking literature, soft information is usually defined as that which cannot be directly verified by anyone other than the agent who produces it, such as morale of the small business owner (Stein 2002).

relocation choice of the firms' headquarters. However, these papers are concerned about the agglomeration of financial services in general and do not pay attention to a firm-specific relationship with a particular bank. Thus, to the best of our knowledge, our paper is the first attempt to investigate the importance of incumbent banks on the firms' relocation choice.

Third, the impact of natural disasters on the firm's dynamics itself is an important research topic (see, e.g., Crespo-Cuaresma et al. 2008, Skidmore and Toya 2002). Since natural disasters inflict serious damages to the firms' physical and human capital, and thereby their productivity, it should affect the firms' activities including investment, export, entry, and exit. There are some studies that use firm-level data to examine various aspects of the firms' dynamics (De Mel et al. 2011, Hosono et al. 2012, Leiter el al. 2009, Miyakawa et al. 2014, Uchida et al. 2013). However, while investigating the relocation of firms that were damaged by the earthquake is of particular interest to researchers and policy-makers that are concerned with the recovery of disaster areas, to the best of our knowledge, no studies examine the impact of a natural disaster on the firms' relocation choice. There are some studies that ask a related question of whether or not the geographical distribution of economic activity is affected by huge temporary shocks including wartime bombing (Davis and Weinstein 2002, 2008) and natural disasters (Okazaki et al. 2011, Siodla 2013), but none of them focus on the relocation choice of individual firms.[6] In this respect, it is also important to examine whether the damages inflicted on the relocating firms' transaction partners affect their choice.

[6] Siodla (2013) examines the impact of the 1906 San Francisco earthquake and fire on the likelihood of the firms' relocations. Consistent with the result of this paper, he finds that the likelihood of relocating is larger for damaged firms than for undamaged firms.

3. Data

3.1. Data source

The data we use are taken from the following three sources. First, the data on firms' attributes are obtained from the database compiled by Teikoku Databank Ltd. (hereafter TDB database), one of the leading business credit research companies in Japan. The TDB database covers a variety of firms' attributes including the address of the firms' headquarters, the identity and the addresses of their suppliers and customers, and the identity of the bank branches that the firms transact with. In cases where a firm transacts with more than one transaction partner, these transaction partners are ranked in the order of importance to the firm. Following a widely accepted procedure, we assume that the firm or bank listed at the top as the firm's main partner (e.g., main bank). The majority of firms in the TDB database are small- and medium-sized enterprises (SMEs).

Second, information on the addresses of the transacting banks' headquarters and branches is obtained from Nihon Kinyu Meikan (Almanac of Financial Institutions in Japan) that is provided by Nikkin Co., Ltd. To calculate geographical distances, for example, between a firm and the city where the firm's main supplier is located, we geocode the address data using the CSV Address Matching Service of the Center for Spatial Information Science at the University of Tokyo.

Third, we use the Economic Census by the Statistics Bureau in the Ministry of Internal Affairs and Communications to construct proxy variables for agglomeration, for example, the number of establishments and plants in a city.

3.2. Sample selection

An earthquake hit the Tohoku area of Japan on March 11, 2011. This area comprises six prefectures: Aomori, Iwate, Miyagi, Akita, Yamagata, and Fukushima. The earthquake's epicenter was in the Miyagi prefecture. From the TDB database, we first identify nonfinancial firms headquartered in these six prefectures during March 2010‐February 2011, one year before the earthquake. As a result, we find 93,542 firms. Among these firms, 39,138 firms were headquartered in the 59 cities, towns, and wards (for the sake of brevity, we refer to "city" hereinafter) that were affected by the earthquake. To be more precise, we identify 59 earthquake-affected cities based on the Japanese Government's Act Concerning Special Financial Support to Deal with a Designated Disaster or Extreme Severity as of February 22, 2012,[7] as well as the Planned Evacuation Zones / Emergency Evacuation Preparation Zones for the severe accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Company, as of April 22, 2011.[8] As shown in the shaded area of Figure 1, the earthquake-affected cities are mostly located on the Pacific coasts of Aomori, Iwate, Miyagi, and Fukushima prefectures.

Of the 39,138 firms, there are several firms whose addresses could not be identified in the TDB database from March 2011 to February 2013. As a result, the number of firms with identified post-earthquake addresses is 36,096. The number of firms located in the unaffected areas in the six prefectures before the earthquake is 54,404, and that with identified post-earthquake address is 52,035. The firms whose post-earthquake addresses are identified constitute the sample for the univariate analysis on the effect of the earthquake on the firms' relocation.

Even among the firms located inside the affected area before the earthquake, there was a

[7] https://www.mlit.go.jp/report/press/house03_hh_000070.html
[8] http://www.kantei.go.jp/saigai/20110411keikakuhinan.html

large variation regarding the severity of damages caused by the earthquake. To take this fact into consideration, we limit the sample for the empirical analysis on where to relocate to those firms that were located in the tsunami-flooded area or within a 30km radius of the Fukushima Daiichi Nuclear Power Station before the earthquake, and that actually relocated to one of the 59 affected cities after the earthquake. Among 1,123 relocating firms that were affected by the tsunami-flood or the nuclear accident, 1,060 (94 percent) of them moved to one of the 59 cities. Due to the availability of the explanatory variables described below, the number of firms used for the conditional logit estimations reduces to 1,041.

4. The effect of the earthquake on whether to relocate

This section examines whether the damage inflicted by the Tohoku Earthquake affected the firms' decision on whether to relocate.

To identify relocation, we first geocode the firms' headquarters addresses from "year" 2008 to 2012 to measure its latitude and longitude in each year.[9] Then, we identify a firm as "relocating" in a particular year if there is more than a 0.1km difference in the Euclidian (straight-line) geographical distance between the firm's headquarters in that year and in the previous year.

Table 1 presents the number and the ratio of firms that relocated from years 2008 to 2012. In order to classify damaged firms and undamaged firms, we construct three variables: TREATMENT, TSUNAMI, and NUCLEAR. First, TREATMENT is a dummy variable that takes the

[9] In order to compare the firms' relocation before and after the earthquake that occurred in March 2011, we define a "year" as one that starts in March of the same calendar year and ends in February of the next calendar year. For example, year 2011 corresponds to March 2011 – February 2012, and is classified as "after" the earthquake.

value of one if a firm's headquarters was located in the 59 affected cities before the earthquake as defined in the previous section. Second, TSUNAMI is a dummy variable that takes the value of one if a firm's headquarters was located in the tsunami-flooded area before the earthquake as identified by the Geospatial Information Authority of Japan (GSI). Lastly, NUCLEAR is a dummy variable that takes the value of one if a firm's headquarters before the earthquake was located within 30km radius of the Fukushima Daiichi Nuclear Power Station. In Figure 2, the locations of the firms of TSUNAMI=1 and NUCLEAR=1 are respectively indicated as x-marks and circles.

Table 1 shows that the firms' relocation after the earthquake was positively associated with the damage. The ratio of relocating firms in the earthquake-affected area (TREATMENT=1) increased from 2.6 percent in year 2010 (before the earthquake) to 4.3 percent in year 2011 (after the earthquake). In addition, the cumulative ratio of the firms that relocated in the two years after the earthquake, 2011–2012, is 7.7 percent, which is much higher than that of the firms in the unaffected area (TREATMENT=0), 3.1 percent.[10] The ratios of relocating firms damaged by the tsunami (TSUNAMI=1) and by the nuclear accident (NUCLEAR=1) exhibit similar patterns, but the absolute values are much higher than the TREATMENT firms: the cumulative ratio of relocating firms is 20.6 percent for TSUNAMI and 85.2 percent for NUCLEAR. In sum, the severe damage inflicted by the earthquake seems to promote the firms' relocations.[11] This observation lends support to our assumption that the earthquake-damaged firms' decision on whether to relocate is less susceptible to the sample selection problem.

[10] To calculate this cumulative relocation ratio, we compare the location of the firms' headquarters before the earthquake (year 2010) and the firms' latest location during 2011–2012. As a result, the number of observations for 2011–2012 period is larger than for single years of 2011 and 2012.

[11] Uesugi et al. (2013) and Siodla (2013) obtained similar findings for the firms' relocations after the Kobe Earthquake in 1995 and the San Francisco Earthquake in 1906 respectively.

Focusing on firms that actually relocated, Table 2 shows the means and medians of the relocating distances for damaged and undamaged firms. While the average relocating distance did not change much after the earthquake for undamaged firms, it became longer for damaged firms. For example, the mean and median of the relocating distance for TREATMENT firms after the earthquake is respectively 15.4 km and 3.1 km, which is larger than those in year 2010 (5.6 km and 2.0km). The increase in the relocating distance after the earthquake is more substantial for NUCLEAR firms; for example, the mean and median distance increased from 29.8km and 19.4km in year 2010 to 55.6km and 40.9km in years 2011–2012 respectively.

Table 3 shows the number of firms that relocated within the 59 earthquake-affected cities. In total, of the 2,793 firms that relocated, 72 percent of the firms relocated within the areas of the city they had resided in before the earthquake (Table 3). This suggests that the firms tended to stick to their hometowns, albeit the incidence of relocation was higher for damaged firms than for undamaged firms and the average relocation distance of damaged firms became longer after the earthquake. Exceptions to this are the firms that were located in the cities that were severely damaged by the nuclear accident before the earthquake (e.g., firms in Namie-machi); the ratio of firms that relocated within their hometown is zero in most cases.

In sum, Tables 2 and 3 suggest that the relocation of firms in TSUNAMI and NUCLEAR areas was largely caused by the earthquake damages. This finding lends support to our assumption that relocation decisions for damaged firms are more or less exogenous because the areas of their headquarters were likely to be severely damaged.

5. The effect of transaction partners on where to relocate: Methodology and variables

5.1. Empirical framework

To examine the relocation decision of firms that were damaged by the Tohoku Earthquake, we use a conditional logit model where the dependent variable is the city chosen by each firm. Following earlier studies on location choices, including Carlton (1983) who argued that logit choice probabilities can be derived from individual firms' profit maximization decision, we assume that each firm chose the city that would yield the highest profit among the possible alternative choices. More specifically, following the reduced form equation of Head et al. (1995), we assume that the profitability of city *c* for firm *i* in industry *j* is represented as:

$$\pi_{ic} = \theta_c + \alpha_1 \theta_{jc} + \sum \alpha_k TR_{ic}^k + \varepsilon_{ic} \tag{1}$$

where θ_c captures the attractiveness of city *c* to the average firm in all industries, and θ_{jc} captures the industry-specific attractiveness of city *c* to firms in industry *j*. The θ_c reflects the characteristics of the city that are important for the firms' relocation choice such as the infrastructure and the price of input factors such as labor and raw material. However, the attractiveness of the city might vary across industries, which likely results in the concentration of firms in a particular industry (industry localization). This effect is captured by θ_{jc}. The variables contained in θ_{jc} take different values across firms in different industries but take the same value across firms in the same industry. Further, TR_{ic}^k represents the presence and agglomeration of transaction partners *k* (suppliers, customers, or banks) in city *c* for firm *i*. Because each firm has different transaction partners that reside in different cities, TR_{ic}^k takes a different value across firms even if firms belong to the same industry.

Given (1), the probability that firm i relocates to city c is given by the following logit expression:

$$\Pr(ic) = \frac{\exp(\pi_{ic})}{\sum_{x \in C} \exp(\pi_{ix})},$$

where the choice set C represents all of the possible candidate cities for relocation. Coefficients in equation (1) are estimated by maximum likelihood techniques.

We restrict the choice set C for relocating firms to the 59 earthquake-affected cities for which we could obtain the industry agglomeration variable described below from the Ministry of Internal Affairs and Communications. Among 1,123 firms that suffered from the tsunami and nuclear accident and relocated after the earthquake, only 63 firms relocated to cities outside the earthquake-affected area (Table 3), so the drop-out of these firms is unlikely to affect the estimation results.

Due to the availability of the explanatory variables, the number of relocating firms for the conditional logit estimation reduces further to 1,041. Because the unit of conditional logit estimations is firm-city pairs, the actual number of observations is the product of the number of firms and that of cities.

5.2. Variables

The dependent variable in the conditional logit estimation is the dummy variable CHOICE, which takes the value of one if firm i relocated to city c and zero otherwise. Definitions and summary statistics of the independent variables are presented in Table 4.

5.2.1. Variables for transaction partners

The main variables of interest in this paper are the presence and agglomeration of transaction partners TR_{ic}^{k} where k represents suppliers, customers, and banks. From the TDB database, we construct two sets of variables.

First, we construct dummy variables that indicate the presences of the headquarters of main suppliers and customers and the transacting branch of the main banks. We label them as SP_MAIN, CT_MAIN, and BK_MAIN respectively. For example, for each of the 59 candidate cities, SP_MAIN takes the value of one if the headquarters of a firm's main supplier existed before the earthquake and zero otherwise. If a firm's main supplier is not identified in the TDB database or is located in a city other than the 59 affected cities in our choice set, SP_MAIN takes the value of zero for all 59 candidate cities. This procedure could underestimate, if any, the effect of transaction partners on the firms' location choice because there is a possibility that the unobserved main suppliers actually existed in one of the 59 cities. Thus, our estimates are likely to yield the lower bound.[12]

Second, we count the number of transaction partners in each city, including both main and non-main partners, and construct SP_NUM, CT_NUM, and BK_NUM.[13] These variables represent the agglomeration of transaction partners.

We use these two sets of key variables alternately in the baseline estimations. We expect

[12] Baseline estimation results reported in the next section are qualitatively the same even if we drop firms whose main transaction partners are not identified, but some explanatory variables become statistically insignificant presumably because of smaller number of observations. The result (not reported) can be obtained on request from the authors.

[13] For the number of banks in transactions, BK_NUM, we count the number of bank branches that a firm transacted with before the earthquake in each city.

that the presence of the main partners and the agglomeration of transaction partners have positive impacts on a firm's relocation choice.

5.2.2. Attractiveness of city to the average firm

To capture the attractiveness of city *c* to the average firm irrespective of industries, θ_c , we take two approaches.

First, following Head et al. (1995), we use city-specific constants to control for city fixed effects. Head et al. (1995) argue that this approach is superior to the one taken by many previous studies that explicitly include region-specific characteristics such as input factor prices (wages and energy prices), unionization rates, and access to a major port. While the latter approach inherently causes the omitted variable bias problem that might induce a correlation between covariates and error terms, city-specific constant terms can circumvent such a problem. On the other hand, we cannot estimate the effect of region-specific variables that might be of interest to the firms' relocation choices.

Second, in order to capture the effect of variables of interests, we include the following variables: lnAGG_ALL, TSUNAMI_R, and NUCLEAR_R. The variable lnAGG_ALL is the log of the number of establishments of all industries in the city and represents the general agglomeration (or urbanization) effect that is likely to have a positive impact on a firm's relocation choice (Davis and Henderson 2008, Strauss-Kahn and Vives 2009). On the other hand, the congestion of cities might also increase the input factor prices that, ceteris paribus, deter firms from relocating. Thus, the overall impact of lnAGG_ALL on the firms' relocation is ambiguous and is an empirical matter. The variable lnAGG_ALL is constructed from the 2009 Economic Census. Next, to represent the damage inflicted by the earthquake, we construct TSUNAMI_R and NUCLEAR_R from the TDB database. For each city, TSUNAMI_R measures the ratio of firms that were located in the tsunami-flooded area to the total number of firms in the city. Similarly, NUCLEAR_R measures the ratio of firms located within a 30km radius of the Fukushima Daiichi Nuclear Power Station to the total number of firms in each city.

5.2.3. Industry-specific attractiveness of city

To capture the attractiveness of city c for a specific industry j, θ_{jc}, we count the log of the number of establishments in industry j to which a relocating firm belongs, lnAGG_IND, from the 2009 Economic Census. This variable should contain all of the relevant factors that affect industry-specific agglomeration in cities, such as natural advantages and positive externalities caused by industry localization (Head et al. 1995). If the industry-specific agglomeration effect is indeed prevalent as indicated by many existing studies, we expect that lnAGG_IND has a positive impact on the firms' relocation choice. On the other hand, if lnAGG_IND has an insignificant effect, the result might suggest that the positive impact of industry agglomeration in previous studies is at least partially due to a sample selection bias.

5.2.4. Firm-specific attractiveness of city

To control for the firm-specific attractiveness of city c, we construct two variables: SAME and lnDISTANCE. The SAME is a dummy variable that takes the value of one for the city that a firm was located in before the earthquake and zero for the other cities. We measure the Euclidian distance in kilometers between a firm's headquarters before the earthquake and 59 candidate cities (DISTANCE), and lnDISTANCE is the log of the sum of the DISTANCE and 0.001. If relocating firms have a preference for, and a social network in, their hometowns or in the neighborhood of the headquarters before the relocation, it is unlikely that they will relocate to a remote city. Thus we expect that SAME and lnDISTANCE respectively have a positive and a negative effect on the firms' relocation.

6. The effect of transaction partners on where to relocate: Estimation results

6.1. Baseline estimation

Table 5 shows the average marginal effect of the covariates in the baseline estimations. Columns (i) and (ii) show those covariates that employ three regional variables (lnAGG_ALL, TSUNAMI_R, and NUCLEAR_R) to capture the attractiveness of city θ_c, while columns (iii) and (iv) present those covariates that use city-specific constants that control for the city fixed effects. In columns (i) and (iii), the presences of transaction partners are represented by the main partner dummy variables (SP_MAIN, CT_MAIN, BK_MAIN), while in columns (ii) and (iv) they are represented by the number of transaction partners (SP_NUM, CT_NUM, BK_NUM).

With regard to the effect of suppliers and customers, columns (i)−(iv) of Table 5 consistently show that the existence of the firms' main customers (CT_MAIN) and the agglomeration of incumbent customers (CT_NUM) positively affected the firms' relocation choice, which implies that the firms headed for the areas where their customers were present. However, the average marginal effect is smaller for columns (iii) and (iv) than for columns (i) and (ii), presumably because the former is more immune to the omitted variable bias problem. Based on columns (iii) and (iv), having a main customer in a region raises the probability of a firm's relocation by 0.4 percent, whereas having an additional customer in a region raises the probability of a firm's relocation by 0.2 percent. The results suggest that the presence of main customers has a larger impact on the firms' location choice than that of other customers. In contrast, SP_MAIN and SP_NUM do not have significant effects on the firms' relocation choice.

Turning to the effect of incumbent banks, we find that BK_MAIN and BK_NUM positively affected the firms' relocation choice. The average marginal effect of BK_MAIN is larger than that of BK_NUM that suggests the importance of the main bank's status on the firm's location choice. Further, the marginal effect of the main bank branch (e.g., 0.008 in column (iii)) is larger than that of the main customer (0.004 in column (iii)).

In sum, Table 5 supports our hypothesis that incumbent transaction relationships matter for the firms' location choice in the case of customers and banks. The marginal effects of other covariates are also in line with our conjecture in the previous section. First, regarding the effect of city characteristics that might affect the firms' relocation choice, the marginal effect of lnAGG_ALL is positively significant that indicates the benefit of moving to larger cities that might have positive agglomeration (urbanization) effects is larger than the cost of the congestions of those cities on average. The effects of TSUNAMI_R and NUCLEAR_R are negatively significant and indicate that firms tended not to move to cities that were severely damaged by the earthquake. Second, the industry localization, lnAGG_IND, has significantly positive impacts on the firms' relocation in specifications (i) and (ii), which suggests that the benefit of industry agglomeration outweighs the costs of intensive competition and congestion on average. However, the marginal effects of lnAGG_IND are insignificant in (iii) and (iv). Finally, with respect to firm-specific characteristics of cities, SAME has positive signs that indicates the firms were more likely to stay in their hometowns. The negative signs of lnDISTANCE indicate that the firms were less likely to relocate to distant cities.

How can we evaluate the economic magnitudes of these estimated average marginal effects? First, it should be noted that the average marginal effects of the incumbent customer-related variables and bank-related variables in Table 5 are comparable to, or even larger than, those of the traditional industry agglomeration variable, lnAGG_IND. For example, the marginal effect of an increase in lnAGG_IND by one standard deviation (1.506 as tabulated in Table 4) is 0.0361(=0.024*1.506), which is smaller than that of CT_MAIN (0.074) and BK_MAIN (0.073). Based on our estimates, incumbent transaction relationships are quantitatively at least as important as agglomeration for the firms' relocation choice.

Second, suppose two cities are completely identical outside of the main customer's presence. Given the results in the column (iii) in Table 5, the difference from the presence of the main customer adds 0.4 percent to the probability of the city being chosen as a new location. Under random choice among the potential 59 locations, it is slightly less than 2 percent (1/59) for each city to be chosen. This calculation implies that the economic impact of the presence of the main customer is not negligible at all. Further, we also compute to what extent the earthquake damage to cities affects the firms' location choice. Suppose two cities are completely identical other than the damage measured by either TSUNAMI_R or NUCLEAR_R. One region shows a higher value of TSUNAMI_R or NUCLEAR_R by one standard deviation (i.e., 0.269 for TSUNAMI_R or 0.271 for NUCLEAR_R in Table 4). Given the estimated marginal effects in column (i) of Table 5, in this hypothetical circumstance, the probability for the city with greater damage to be chosen by a firm decreases 1.1 (=-0.040*0.269) percentage points in the case of TSUNAMI_R and 8.9 (=-0.328*0.271) percentage points in the case of NUCLEAR_R. The latter case particularly shows that the damage associated with the earthquake had an economically huge impact on the firms' relocation choice.

6.2. Robustness checks

Table 5 suggests that the incumbent customers and banks matter for the firms' relocation choice. To check the robustness of our main results, we implement the following two additional analyses.

First, there could be a concern that the positive impacts associated with the presence of the incumbent transaction partners might capture the tendency that firms move to their own extant undamaged establishments. This move could be the case if firms own multiple establishments and each establishment has transaction relationships with, for example, lender banks. Under this circumstance, the variables aiming at measuring the presence of lender banks might also measure the presence of the firms' own establishments.[14] To examine the possibility of this omitted variable bias associated with the firms' extant establishments, we focus on the firms with a single establishment

[14] Some of the literature (Ota and Fujita 1993, Duranton and Puga 2005) argues that the advancement of communication technology will lead firms to separate the location of headquarters (city center) from the location of plants and/or establishments for back office activities (suburbs). In such cases, we need not worry much about the omitted variable bias.

and see if the results associated with the transaction partners remain robust. Table 6 shows the results based on the firms with a single establishment and confirms that most bank- and customer-related variables have significantly positive effects on the relocation choice of firms with a single establishment. Thus, it is likely that our proxies for incumbent transaction partners are immune to an omitted variable bias.

Second, there could be a concern about the possible violation of the independence of irrelevant alternatives (IIA) assumption in the conditional logit estimation. However, as Yamashita et al. (2014) point out, the inclusion of the region-specific constants (specifications (iii) and (iv) in Table 5) provides a partial remedy, because they absorb the unobserved region-specific factors in a profit equation. In addition, we implement the subsample analysis in which the choice set (candidate cities to be relocated) is restricted to "big" cities that have ten or more incoming relocation firms after the earthquake (Table 7). The number of possible alternative cities in this estimation is 36, and the firms that relocated to other cities in the baseline estimation are dropped from the analysis. Table 7 presents the estimation results based on this subsample (998 firms). While the agglomeration of customers, CT_NUM, turns out to be statistically insignificant, the presence of the main customer, CT_MAIN, remains significantly positive. The effects of BK_MAIN and BK_NUM also remain positive as in the baseline estimation. In sum, Table 7 basically confirms the robustness of the baseline estimation results.

6.3. Effects of the earthquake damage to transaction partners

The "gravity" of a firm's transaction partners on its location choice could well depend on their healthiness. In our context, if a firm's transaction partners were also damaged by the earthquake, then the firm might not want to relocate to the nearby area. To examine this possibility, we distinguish suppliers, customers, and banks by whether they suffered from the earthquake. We identify damaged transaction partners if they were located in the tsunami-flooded area or within 30km radius of the Fukushima Daiichi Nuclear Power Station. Then we split the variables for transaction partners in two: one associated with damaged partners and the other associated with undamaged partners. For example, SP_MAIN is split into SP_MAIN_UD (undamaged main supplier dummy) and SP_MAIN_D (damaged main supplier dummy).

Table 8 presents the estimation results. Consistent with the conjecture above, the average marginal effects of the customer-related variables are significantly positive only when the customers were undamaged (CT_MAIN_UD, CT_NUM_UD). The marginal effects of bank-related variables also exhibit a similar pattern, but BK MAIN_D and BK_NUM_D are also significantly positive, albeit weakly, in specifications (iii) and (iv) respectively. However, their marginal effects are quantitatively much smaller than those of the undamaged banks.

Contrary to the results in the baseline estimation, the marginal effects of SP_NUM_D, the number of damaged suppliers, are significantly negative. That is, firms tended not to head for the areas where many damaged suppliers were present. Such negative effects cannot be found for SP_MAIN_D.

In sum, Table 8 shows that the effect of the transaction partners on the firms' relocation choice depends on whether the transaction partners were damaged or undamaged that indicates that the physical and financial soundness of the transaction partners matter.

6.4. Discussion

We find that the presence of the main customer and the agglomeration of the incumbent customers positively affect the relocation choice of the firms that were damaged by the earthquake. In contrast, such a positive effect on the firm's relocation is not found for suppliers. While some previous studies find that the input sharing that include clustered suppliers (Holmes 1999) and market potential (Head and Mayer 2004) are both important factors that affect where firms invest, the finding in this paper suggests that it is the customers that matter for the firms' location choice as far as specific transactional relationships are concerned. In this respect, our empirical result is inconsistent with Yamashita et al. (2014) who find that first-tier suppliers and customers both generate positive effects on the choice of where Japanese firms implemented FDI in China. However, in terms of quantitative impacts, Yamashita et al. (2014) find that the effect of customers is much stronger than that of suppliers, which is consistent with this paper's finding.

This paper also finds that the presence of the main banks and the agglomeration of lending banks have positive effects on the firms' location choice. While it is beyond the scope of this study to single out the reason behind this mechanism, there are several possible explanations. First, as discussed in the literature on relationship lending (Boot 2000), banks invest in relation-specific capital in order to accumulate soft information about their client firms. If the precision of such soft information is inversely proportional to the physical distance between firms and banks, then firms might want to relocate to areas near their banks in order to reduce the degree of information asymmetry and thereby increase the availability of credit. Second, because physical distance might also be inversely related to the transaction costs between firms and banks, firms might want to head for the areas where their banks are present for cost saving purposes. Further, banks might have rich information regarding the local real estate market, which is particularly useful for firms searching for new headquarters after the earthquake. Consistent with this conjecture, Yamori et al. (2013) report that more than 20 percent of the firms surveyed in their data set appreciated the advice from their main banks with respect to the provision of information about real estate.

Finally, we find that the impact of transaction partners on the firms' relocation choice is quantitatively larger for banks than for customers and is negligible for suppliers. This result implies that the geographical proximity between transaction partners is important for banks and customers, but not for suppliers, at least not for the relocating firms that this study focused on. To see this point further, we calculate the geographical distance between firms for the baseline estimation and main transaction partners that were located in the 59 candidate cities before the earthquake. The mean distance between the firms and their main suppliers, main customers, and main banks was 47.7km, 26.9km, and 5.6km, respectively. Such a fact that the original geographical distance between firms and their supplies are much longer than the other two relationships is consistent with our findings that the supplier location matters less for the firms' activities than that of customers and banks.

7. Conclusion

In this paper by using a unique firm-level data set, we examine the relocation choice of firms that suffered severe damage by the Tohoku Earthquake. In addition to the effect of industry agglomeration that many existing studies find, our estimation results suggest that the presence of incumbent transaction partners positively affects the firms' relocation choice. In particular, we find that the firms tended to relocate after the earthquake to the areas where their customers were present. Interestingly, we do not find such a positive effect on the firms' relocation choice for suppliers. We also find that firms tended to relocate to areas where the bank branches that they transacted with were present. The positive effects of incumbent customers and banks on the damaged firms' relocation choice were somewhat stronger for main transaction partners than for non-main partners, and they had economically sizable impacts. But such effects diminished if the customers and banks were also damaged by the earthquake.

The research presented in this study could be expanded in a number of directions. One might be to extend our analysis to examine whether the replaceability of interfirm transaction relationships matters for the firms' relocation choices. For example, it might well be the case that the impact of the presence of transaction partners on the firms' relocation choice is smaller if those partners are producing homogeneous goods or services rather than differentiated ones. Another potentially interesting extension might be to examine quantitatively the costs and benefits of the firms' choice to locate closer to their partners. As mentioned in this paper, in choosing where to relocate, firms balance the tradeoff between the marginal cost (e.g., more severe hold-up by the partners) and the marginal benefit (e.g., lower transaction costs) of having more geographical proximity with their transaction partners. However, it is still far from clear how such a tradeoff works and how it differs depending on the firms and their transaction partners' characteristics.

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Figure 1 Earthquake affected areas

This figure shows the 59 “affected” cities designated by the Japanese Government’s Act Concerning Special Financial Support to Deal with a Designated Disaster or Extremely Severity as of February 22, 2012, and/or the Planned Evacuation Zones / Emergency Evacuation Preparation Zones for the severe accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Company as of April 22, 2011. The circles represent the locations of the firms in our data set.

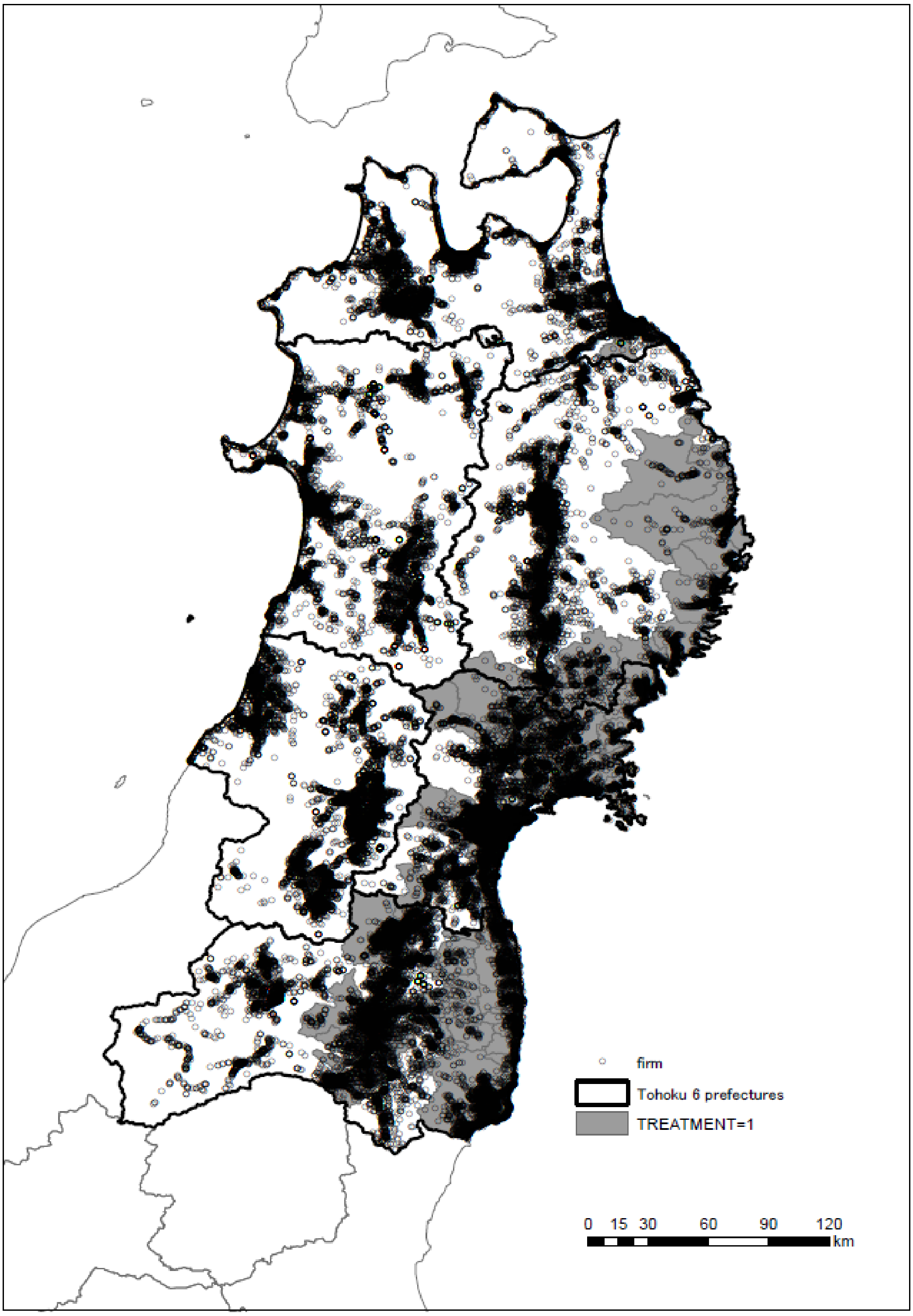

Table 1 Ratio of relocating firms

This table shows the ratio of firms relocating because of the damage inflicted by the earthquake. Year X is defined as "March X - February X+1"

	Damaged firms			**Undamaged firms**		
	Firms not relocated	Firms relocated	Ratio of firms relocated	Firms not relocated	Firms relocated	Ratio of firms relocated
	A	B	B/(A+B)	A	B	B/(A+B)
	TREATMENT=1			TREATMENT=0		
2008	28,576	813	0.028	40,611	934	0.022
2009	28,899	1,087	0.036	40,321	887	0.022
2010	30,550	802	0.026	43,488	876	0.020
2011	28,245	1,276	0.043	45,166	790	0.017
2012	27,105	839	0.030	48,560	890	0.018
2011-2012	**33,303**	**2,793**	**0.077**	**50,422**	**1,613**	**0.031**
	TSUNAMI=1			TSUNAMI=0		
2008	4,261	173	0.039	64,926	1,574	0.024
2009	3,961	462	0.104	65,259	1,512	0.023
2010	4,186	133	0.031	69,852	1,545	0.022
2011	2,529	364	0.126	70,882	1,702	0.023
2012	1,893	145	0.071	73,772	1,584	0.021
2011-2012	**3,585**	**928**	**0.206**	**80,140**	**3,478**	**0.042**
	NUCLEAR=1			NUCLEAR=0		
2008	519	11	0.021	68,668	1,736	0.025
2009	595	7	0.012	68,625	1,967	0.028
2010	687	17	0.024	73,351	1,661	0.022
2011	38	69	0.645	73,373	1,997	0.026
2012	8	14	0.636	75,657	1,715	0.022
2011-2012	**34**	**195**	**0.852**	**83,691**	**4,211**	**0.048**

Figure 2 Firms suffering from the tsunami and the nuclear accident

This figure shows the pre-earthquake locations of the firms that suffered from the tsunami-flood (TSUNAMI) and the nuclear accident (NUCLEAR). The X-marks and circles show the locations of the TSUNAMI and NUCLEAR firms respectively.

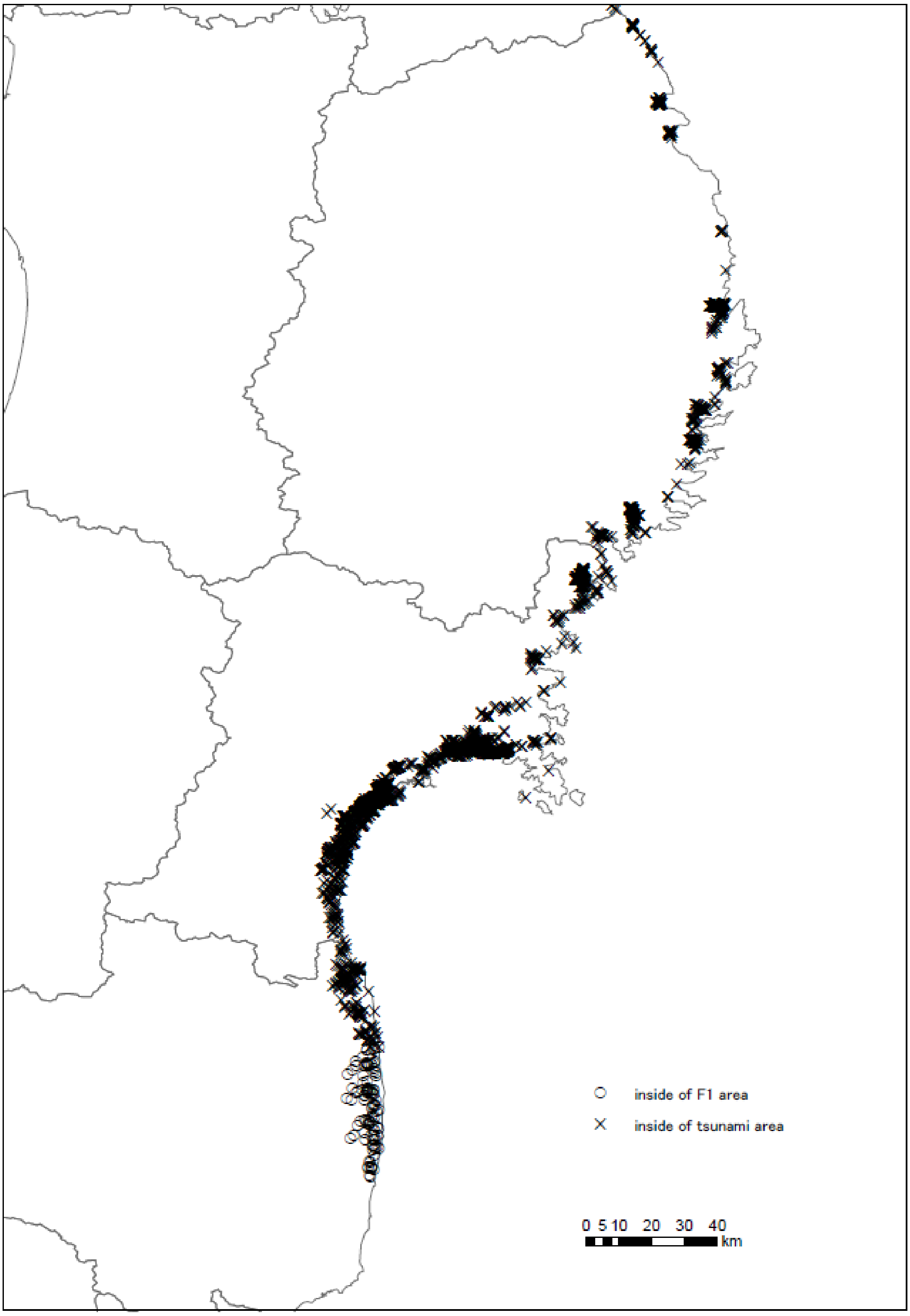

Table 2 Relocation distance

This table shows the mean and median of the relocating distance (kilometers) by the damage inflicted by the earthquake. Year X is defined as "March X - February X+1"

	Damaged firms			**Undamaged firms**		
	Firms relocated	Relocating distance in kilometers (mean)	Relocating distance in kilometers (median)	Firms relocated	Relocating distance in kilometers (mean)	Relocating distance in kilometers (median)
	TREATMENT=1			TREATMENT=0		
2008	813	4.946	2.003	934	15.993	2.019
2009	1,087	4.552	1.812	887	31.821	2.333
2010	802	5.615	2.041	876	20.477	2.268
2011	1,276	17.598	3.423	790	23.540	2.053
2012	839	9.988	2.481	890	27.368	2.030
2011-2012	**2,793**	**15.397**	**3.140**	**1,613**	**27.706**	**2.012**
	TSUNAMI=1			TSUNAMI=0		
2008	173	7.207	1.747	1,574	11.253	2.061
2009	462	5.570	1.692	1,512	20.238	2.223
2010	133	7.405	1.840	1,545	13.888	2.238
2011	364	16.456	3.900	1,702	20.600	2.538
2012	145	5.602	2.319	1,584	20.155	2.268
2011-2012	**928**	**11.411**	**3.085**	**3,478**	**22.169**	**2.501**
	NUCLEAR=1			NUCLEAR=0		
2008	11	2.680	0.622	1,736	10.904	2.019
2009	7	8.330	2.381	1,967	16.835	1.900
2010	17	29.792	19.438	1,661	13.206	2.150
2011	69	61.811	40.841	1,997	18.421	2.643
2012	14	48.137	46.097	1,715	18.696	2.222
2011-2012	**195**	**55.578**	**40.911**	**4,211**	**18.251**	**2.449**

Table 3 Number of relocating firms in the earthquake-affected cities

This table shows the number of firms that relocated to (gross inflows) and from (gross outflows) the 59 cities that were damaged by the earthquake.

	Gross inflows (a)	Gross outflows (b)	Net inflows (a)-(b)	Relocation within city (c)	Share of within-city relocation (c)/(b)	Share of firms located in tsunami-flooded area	Share of firms loated within 30km radius of nuclear accident
01 Iwate Ichinoseki-shi	33	35	-2	29	82.9%	0.0%	0.0%
02 Iwate Shimohei-gun Iwaizumi-cho	2	1	1	1	100.0%	6.4%	0.0%
03 Iwate Shimohei-gun Yamada-machi	29	30	-1	29	96.7%	57.5%	0.0%
04 Iwate Shimohei-gun Tanohata-mura	3	4	-1	3	75.0%	0.0%	0.0%
05 Iwate Kamaishi-shi	68	67	1	63	94.0%	39.9%	0.0%
06 Iwate Miyako-shi	47	46	1	46	100.0%	54.7%	0.0%
07 Iwate Kunohe-gun Noda-mura	6	6	0	6	100.0%	83.3%	0.0%
08 Iwate Kamihei-gun Otsuchi-cho	34	38	-4	33	86.8%	72.0%	0.0%
09 Iwate Ofunato-shi	81	80	1	75	93.8%	62.2%	0.0%
10 Iwate Rikuzentakata-shi	47	61	-14	46	75.4%	64.3%	0.0%
11 Miyagi Toda-gun Misato-machi	5	4	1	2	50.0%	0.0%	0.0%
12 Miyagi Toda-gun Wakuya-cho	6	5	1	4	80.0%	0.0%	0.0%
13 Miyagi Shiogama-shi	33	20	13	18	90.0%	59.2%	0.0%
14 Miyagi Oshika-gun Onagawa-cho	35	50	-15	34	68.0%	37.9%	0.0%
15 Miyagi Iwanuma-shi	26	31	-5	20	64.5%	39.7%	0.0%
16 Miyagi Kesennuma-shi	166	167	-1	163	97.6%	57.3%	0.0%
17 Miyagi Miyagi-gun Shichigahama-machi	14	17	-3	8	47.1%	55.8%	0.0%
18 Miyagi Miyagi-gun Matushima-machi	4	4	0	2	50.0%	32.1%	0.0%
19 Miyagi Miyagi-gun Rifu-cho	16	13	3	6	46.2%	2.2%	0.0%
20 Miyagi Kurihara-shi	9	10	-1	8	80.0%	0.0%	0.0%
21 Miyagi Ishinomaki-shi	223	229	-6	199	86.9%	66.4%	0.0%
22 Miyagi Sendai-shi Miyagino-ku	156	205	-49	92	44.9%	19.4%	0.0%
23 Miyagi Sendai-shi Wakabayashi-ku	125	144	-19	63	43.8%	11.3%	0.0%
24 Miyagi Sendai-shi Aoba-ku	287	272	15	199	73.2%	0.0%	0.0%
25 Miyagi Sendai-shi Izumi-ku	95	92	3	54	58.7%	0.0%	0.0%
26 Miyagi Sendai-shi Taihaku-ku	96	72	24	46	63.9%	0.5%	0.0%
27 Miyagi Tagajo-shi	29	46	-17	18	39.1%	61.0%	0.0%
28 Miyagi Osaki-shi	38	29	9	26	89.7%	0.0%	0.0%
29 Miyagi Tome-shi	31	16	15	15	93.8%	0.0%	0.0%
30 Miyagi Higashimatsushima-shi	24	30	-6	18	60.0%	84.8%	0.0%
31 Miyagi Shiroishi-shi	6	4	2	4	100.0%	0.0%	0.0%
32 Miyagi Motoyoshi-gun Minamisanriku-cho	43	52	-9	41	78.8%	64.4%	0.0%
33 Miyagi Natori-shi	57	53	4	40	75.5%	23.1%	0.0%
34 Miyagi Watari-gun Yamamoto-cho	13	16	-3	12	75.0%	38.9%	0.0%
35 Miyagi Watari-gun Watari-cho	14	14	0	12	85.7%	35.8%	0.0%
36 Aomori Hachinohe-shi	106	112	-6	103	92.0%	3.9%	0.0%
37 Fukushima Iwaki-shi	201	141	60	137	97.2%	0.0%	0.0%
38 Fukushima Date-gun Kori-machi	2	3	-1	1	33.3%	0.0%	0.0%
39 Fukushima Date-gun Kunimi-machi	2	2	0	1	50.0%	0.0%	0.0%
40 Fukushima Date-gun Kawamata-machi	9	6	3	4	66.7%	0.0%	0.0%
41 Fukushima Iwase-gun Kagamiishi-machi	4	3	1	2	66.7%	0.0%	0.0%
42 Fukushima Koriyama-shi	167	163	4	148	90.8%	0.0%	0.0%
43 Fukushima Sukagawa-shi	29	27	2	22	81.5%	0.0%	0.0%
44 Fukushima Nishishirakawa-gun Yabuki-machi	3	6	-3	3	50.0%	0.0%	0.0%
45 Fukushima Futaba-gun Katsurao-mura	0	2	-2	0	0.0%	0.0%	0.0%
46 Fukushima Futaba-gun Hirono-machi	7	5	2	2	40.0%	0.0%	0.0%
47 Fukushima Futaba-gun Kawauchi-mura	1	2	-1	1	50.0%	0.0%	4.0%
48 Fukushima Futaba-gun Futaba-machi	0	17	-17	0	0.0%	0.0%	100.0%
49 Fukushima Futaba-gun Okuma-machi	1	25	-24	0	0.0%	0.0%	100.0%
50 Fukushima Futaba-gun Naraha-machi	0	23	-23	0	0.0%	0.0%	89.9%
51 Fukushima Futaba-gun Tomioka-machi	0	31	-31	0	0.0%	0.0%	100.0%
52 Fukushima Futaba-gun Namie-machi	0	59	-59	0	0.0%	0.0%	96.4%
53 Fukushima Soma-gun Shinchi-machi	4	3	1	3	100.0%	28.4%	0.0%
54 Fukushima Soma-gun Iitate-mura	0	12	-12	0	0.0%	0.0%	0.0%
55 Fukushima Soma-shi	28	15	13	14	93.3%	38.3%	0.0%
56 Fukushima Tamura-shi	15	10	5	9	90.0%	0.0%	1.1%
57 Fukushima Minamisoma-shi	52	56	-4	36	64.3%	13.9%	19.2%
58 Fukushima Shirakawa-shi	10	10	0	8	80.0%	0.0%	0.0%
59 Fukushima Fukushima-shi	109	97	12	88	90.7%	0.0%	0.0%
99 Others	142						
Total	2,793	2,793	-142	2,017	72.2%	13.2%	2.3%

Table 4 Summary statistics and definitions

This table shows the summary statistics and definitions of the variables used in the regression analyses (Tables 5−8).

(1) Summary statistics - Unit of observations: Firm-city pair

Variable	No. Obs.	Mean	Std. Dev.	Min	Max
lnDISTANCE	58,493	4.448	0.922	-6.908	6.009
cf. DISTANCE	58,493	115.045	74.765	0.000	407.103
SAME	58,493	0.018	0.132	0	1
TSUNAMI_R	58,493	0.209	0.269	0	0.848
NUCLEAR_R	58,493	0.086	0.271	0	1
SP_MAIN	58,493	0.002	0.043	0	1
SP_MAIN_UD	58,493	0.001	0.032	0	1
SP_MAIN_D	58,493	0.001	0.028	0	1
CT_MAIN	58,493	0.002	0.040	0	1
CT_MAIN_UD	58,493	0.001	0.028	0	1
CT_MAIN_D	58,493	0.001	0.028	0	1
BK_MAIN	58,493	0.017	0.129	0	1
BK_MAIN_UD	58,493	0.008	0.090	0	1
BK_MAIN_D	58,493	0.009	0.093	0	1
SP_NUM	58,493	0.011	0.148	0	5
SP_NUM_UD	58,493	0.006	0.094	0	5
SP_NUM_D	58,493	0.005	0.104	0	5
CT_NUM	58,493	0.010	0.151	0	7
CT_NUM_UD	58,493	0.005	0.079	0	5
CT_NUM_D	58,493	0.005	0.112	0	7
BK_NUM	58,493	0.033	0.256	0	5
BK_NUM_UD	58,493	0.017	0.176	0	4
BK_UNM_D	58,493	0.016	0.166	0	5
lnAGG_IND	58,493	3.481	1.506	0.693	7.987
cf. AGG_IND	58,493	91.761	158.387	2	2,942
lnAGG_ALL	58,493	7.367	1.286	3.989	9.834
cf. AGG_ALL	58,493	3,376.378	4,381.750	54	18,658

(2) Summary statistics - Unit of observations: Firm

Variable	No. Obs.	Mean	Std. Dev.	Min	Max
lnDISTANCE	1,041	1.586	1.265	-6.908	5.453
cf. DISTANCE	1,041	10.921	17.493	0.000	233.343
SAME	1,041	0.748	0.434	0	1
SP_MAIN	1,041	0.102	0.303	0	1
SP_MAIN_UD	1,041	0.059	0.235	0	1
SP_MAIN_D	1,041	0.043	0.203	0	1
CT_MAIN	1,041	0.089	0.285	0	1
CT_MAIN_UD	1,041	0.045	0.208	0	1
CT_MAIN_D	1,041	0.044	0.206	0	1
BK_MAIN	1,041	1	0	0	1
BK_MAIN_UD	1,041	0.467	0.499	0	1
BK_MAIN_D	1,041	0.494	0.500	0	1
SP_NUM	1,041	0.235	0.777	0	5
SP_NUM_UD	1,041	0.076	0.389	0	5
SP_NUM_D	1,041	0.159	0.603	0	5
CT_NUM	1,041	0.251	0.900	0	7
CT_NUM_UD	1,041	0.077	0.361	0	5
CT_NUM_D	1,041	0.174	0.714	0	7
BK_NUM	1,041	1.246	1.060	0	5
BK_NUM_UD	1,041	0.670	0.885	0	4
BK_UNM_D	1,041	0.576	0.850	0	5
lnAGG_IND	1,041	4.255	1.315	0.693	7.416
cf. AGG_IND	1,041	145.746	182.948	2	1,662

(3) Summary statistics - Unit of observations: City

Variable	No. Obs.	Mean	Std. Dev.	Min	Max
TSUNAMI_R	59	0.206	0.272	0	0.848
NUCLEAR_R	59	0.087	0.273	0	1
lnAGG_ALL	59	7.297	1.334	4	9.834
cf. AGG_ALL	59	3263.458	4373.676	54	18658

(4) Definitions

Variable	Definition
lnDISTANCE	Log of Euclidian distance between a firm's headquarters and a city plus 0.001
SAME	Home town (city) dummy
TSUNAMI_R	The share of firms located in tsunami-affected area to total firms
NUCLEAR_R	The share of firms located in nucrear-affected area to total firms
SP_MAIN	Main supplier (headquarters) location dummy. "_UD" represents an undamaged supplier while "_D" represents a damaged supplier
CT_MAIN	Main customer (headqurters) location dummy. "_UD" represents an undamaged customer while "_D" represents a damaged customer
BK_MAIN	Main bank (transacting branch) location dummy. "_UD" represents an undamaged bank while "_D" represents a damaged bank
SP_NUM	Number of suppliers. "_UD" represents an undamaged supplier while "_D" represents a damaged supplier
CT_NUM	Number of customers. "_UD" represents an undamaged customer while "_D" represents a damaged customer
BK_NUM	Number of banks in trasactions. "_UD" represents an undamaged bank while "_D" represents a damaged bank
lnAGG_IND	Log of number of enterprises in own industry in the Economic Census
lnAGG_ALL	Log of number of all enterprises in the Economic Census

Table 5 Baseline estimation

These are the baseline results of the conditional logit estimation for the firms' relocation choice. Standard errors are estimated using delta method. The ***, **, and * indicate significance at the 1, 5, and 10% levels respectively. The dependent variable (CHOICE) is the dummy variable that takes the value of one if the city is chosen by firms among the possible alternative locations.

Dependent Variable: CHOICE	Firms damaged by the tsunami-flood and the nuclear accident: Average marginal effects							
	Without region-specific constant				With region-specific constant			
	(i)		(ii)		(iii)		(iv)	
(post-EQ)	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
lnDISTANCE	-0.111	0.033 ***	-0.107	0.032 ***	-0.007	0.002 ***	-0.007	0.002 ***
SAME	0.086	0.032 ***	0.090	0.033 ***	0.003	0.001 **	0.004	0.002 **
TSUNAMI_R	-0.040	0.018 **	-0.036	0.017 **				
NUCLEAR_R	-0.328	0.095 ***	-0.321	0.094 ***				
SP_MAIN	-0.026	0.035			-0.002	0.002		
CT_MAIN	0.074	0.037 **			0.004	0.002 *		
BK_MAIN	0.073	0.025 ***			0.005	0.002 ***		
SP_NUM			-0.005	0.010			-0.001	0.001
CT_NUM			0.027	0.014 *			0.001	0.001 *
BK_NUM			0.031	0.011 ***			0.003	0.001 ***
lnAGG_IND	0.024	0.007 ***	0.024	0.007 ***	0.001	0.001	0.001	0.001
lnAGG_ALL	0.030	0.016 *	0.028	0.016 *				
Region-Specific Constant	No		No		Yes		Yes	
No. Obs	58,493		58,493		58,493		58,493	
LR chi2	6287.1		6257.04		6518.37		6498.79	
Prob > chi2	0.0000		0.0000		0.0000		0.0000	
Pseudo R2	0.7515		0.7479		0.7791		0.7768	
Log liklihood	-1039.7392		-1054.7674		-924.10229		-933.89416	

Table 6 Subsample estimation: Single establishment firms

These are the results of the conditional logit estimation for the firms' relocation choice by using a subsample of firms with single establishment. Standard errors are estimated using the delta method. The ***, **, and * indicate significance at the 1, 5, and 10% levels respectively. The dependent variable (CHOICE) is the dummy variable that takes the value of one if the city is chosen by firms among the possible alternative locations.

Dependent Variable: CHOICE	Single establishment firms damaged by the tsunami-flood and the nuclear accident: Average marginal effects							
	Without region-specific constant				With region-specific constant			
	(i)		(ii)		(iii)		(iv)	
(post-EQ)	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
lnDISTANCE	-0.093	0.031 ***	-0.092	0.030 ***	-0.007	0.002 ***	-0.007	0.002 ***
SAME	0.064	0.026 **	0.067	0.027 **	0.002	0.001 **	0.003	0.001 **
TSUNAMI_R	-0.036	0.016 **	-0.033	0.015 **				
NUCLEAR_R	-0.474	0.162 ***	-0.461	0.156 ***				
SP_MAIN	-0.057	0.037			-0.004	0.002 *		
CT_MAIN	0.088	0.040 **			0.006	0.003 **		
BK_MAIN	0.059	0.022 ***			0.005	0.002 ***		
SP_NUM			-0.013	0.011			-0.001	0.001
CT_NUM			0.025	0.014 *			0.001	0.001
BK_NUM			0.028	0.011 **			0.003	0.001 ***
lnAGG_IND	0.017	0.006 ***	0.017	0.006 ***	0.001	0.001	0.000	0.000 ***
lnAGG_ALL	0.025	0.015 *	0.024	0.014 *				
Region-Specific Constant	No		No		Yes		Yes	
No. Obs	52,929		52,929		52,929		52,929	
LR chi2	5770.14		5736.15		6011.92		5983.51	
Prob > chi2	0.0000		0.0000		0.0000		0.0000	
Pseudo R2	0.7627		0.7582		0.7947		0.7909	
Log liklihood	-897.46316		-914.45441		-776.5722		-790.77413	

Table 7 Subsample estimation: Firms that relocated to “big” cities

These are the results of the conditional logit estimation for the firms' relocation choice by using a subsample of firms that relocated to "big" cities. Big cities are defined as those having equal to or more than ten inward relocating firms. Standard errors are estimated using the delta method. The ***, **, and * indicate significance at the 1, 5, and 10% levels respectively. The dependent variable (CHOICE) is the dummy variable that takes the value of one if the city is chosen by firms among the possible alternative locations.

Dependent Variable: CHOICE (post-EQ)	Firms relocating to "big" cities; damaged by the tsunami-flood and the nuclear accident: Average marginal effects							
	Without region-specific constant				With region-specific constant			
	(i)		(ii)		(iii)		(iv)	
	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
lnDISTANCE	-0.045	0.021 **	-0.046	0.021 **	-0.011	0.003 ***	-0.011	0.003 ***
SAME	0.027	0.014 *	0.031	0.016 *	0.004	0.002 **	0.004	0.002 **
TSUNAMI_R	-0.030	0.012 **	-0.030	0.012 **				
NUCLEAR_R	-0.111	0.056 **	-0.108	0.055 **				
SP_MAIN	-0.015	0.016			-0.004	0.003		
CT_MAIN	0.034	0.020 *			0.008	0.004 **		
BK_MAIN	0.029	0.014 **			0.008	0.003 ***		
SP_NUM			-0.002	0.004			-0.001	0.001
CT_NUM			0.009	0.006			0.002	0.001
BK_NUM			0.013	0.006 **			0.004	0.001 ***
lnAGG_IND	0.011	0.005 **	0.011	0.005 **	0.002	0.001	0.002	0.001
lnAGG_ALL	0.005	0.006	0.005	0.006				
Region-Specific Constant	No		No		Yes		Yes	
No. Obs	35,268		35,268		35,268		35,268	
LR chi2	5351.97		5314.96		5540.94		5510.37	
Prob > chi2	0.0000		0.0000		0.0000		0.0000	
Pseudo R2	0.7531		0.7479		0.7797		0.7754	
Log liklihood	-877.34039		-895.84561		-782.85447		-798.13996	

Table 8 Extension: Effect of undamaged and damaged transaction partners

These are the extensional results of the conditional logit estimation for the firms' relocation choice. Standard errors are estimated using the delta method. The ***, **, and * indicate significance at the 1, 5, and 10% levels respectively. The dependent variable (CHOICE) is the dummy variable that takes the value of one if the city is chosen by firms among the possible alternative locations.

Dependent Variable: CHOICE	Firms damaged by the tsunami-flood and the nuclear accident: Average marginal effects							
	Without region-specific constant				With region-specific constant			
	(i)		(ii)		(iii)		(iv)	
(post-EQ)	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
lnDISTANCE	-0.124	0.036 ***	-0.103	0.032 ***	-0.007	0.002 ***	-0.008	0.003 ***
SAME	0.097	0.035 ***	0.083	0.031 ***	0.004	0.001 ***	0.004	0.002 **
TSUNAMI_R	-0.025	0.019	-0.016	0.016				
NUCLEAR_R	-0.315	0.086 ***	-0.263	0.077 ***				
SP_MAIN_UD	-0.032	0.049			-0.002	0.003		
SP_MAIN_D	-0.034	0.059			-0.002	0.003		
CT_MAIN_UD	0.120	0.053 **			0.006	0.003 **		
CT_MAIN_D	0.006	0.049			0.001	0.003		
BK_MAIN_UD	0.110	0.036 ***			0.007	0.002 ***		
BK_MAIN_D	0.013	0.016			0.002	0.001 *		
SP_NUM_UD			0.014	0.012			0.000	0.001
SP_NUM_D			-0.029	0.014 **			-0.002	0.001 *
CT_NUM_UD			0.049	0.022 **			0.003	0.002 **
CT_NUM_D			0.004	0.012			0.000	0.001
BK_NUM_UD			0.051	0.018 ***			0.004	0.002 ***
BK_NUM_D			0.001	0.008			0.002	0.001 *
lnAGG_IND	0.026	0.008 ***	0.024	0.007 ***	0.001	0.001	0.001	0.001
lnAGG_ALL	0.036	0.019 *	0.025	0.014 *				
Region-Specific Constant	No		No		Yes		Yes	
No. Obs	58,493		58,493		58,493		58,493	
LR chi2	6317.63		6303.42		6537.88		6527.34	
Prob > chi2	0.0000		0.0000		0.0000		0.0000	
Pseudo R2	0.7551		0.7534		0.7814		0.7802	
Log liklihood	-1024.4701		-1031.5784		-914.34877		-919.61489	