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

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Abstract

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 firms' choice of where to relocate. 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 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. Furthermore, we find that the positive effect 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
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1. Introduction

Industrial activities are not distributed uniformly on a flat surface but spread very unevenly across locations. Location of firms are not an exception. To decide where to locate, firms take into account various factors, and amongst such factors, *agglomeration economies* have received considerable interest from 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 a related but more specific factor that could affect the firms' location choice: the presence of incumbent transaction partners. Firms often establish special and irreplaceable relationships with their transaction partners, such as suppliers, customers, and banks, through relation-specific (or differentiated) investments, products, or services (Williamson 1975, 1985). This relation-specificity might induce firms to locate closer to their transaction partners, in order to reduce transportation costs and to enhance mutual communication and information sharing, for example. However, the special relationships might work adversely, because too close a relationship

[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).

might invite hold-up problems (Klein et al. 1978), and so firms might prefer keeping distance from their transaction partners. Thus, whether or not firms locate to the areas where their transaction partners are located is an empirical question. Although the importance of input and/or output linkages in the firms' location choice has already been investigated in some studies using aggregate data (Holmes 1999, Head and Mayer 2004, Davis and Henderson 2008, Strauss-Kahn and Vives 2009), a few studies have investigated the importance of specific transaction partners using micro data (e.g., Head et al. 1995, Yamashita et al. 2014). In particular, this is the first study to compare the effect of the presence of incumbent suppliers, customers, and banks on the firms' relocation choice.

In this examination, we use unique data for the firms that were severely damaged by a massive natural disaster—the Tohoku Earthquake that hit eastern Japan on March 11, 2011. Firms damaged by the earthquake, especially those located in the areas affected by the massive tsunamis and the disastrous nuclear plant accident in Fukushima, were *forced* to relocate, which brings one methodological advantage to our analysis. In an ordinary environment, firms' relocation choices are endogenous decisions because only firms with specific characteristics, e.g., profitable firms that can cover the cost of relocation, can move. Our sample firms that were forced to relocate are less susceptible to this type of sample selection problem. Focusing on those firms that were located in the severely damaged areas before the earthquake and that actually changed their location after the earthquake, we use a conditional logit estimation framework to examine the determinants of their relocation choice.

The major findings of this paper are four-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 bank branches were present. Third, if we distinguish the firms' main and non-main customers/banks, we found gravity of these transaction partners were somewhat stronger for main customers/banks. Fourth, the effects of the incumbent customers and banks diminished if these partners were also severely damaged by the earthquake. Our findings suggest that the benefit of a relation-specific investment (relocation) surpasses its cost, as long as incumbent partners were not damaged.

The structure of the paper is as follows. Section 2 reviews the literature and explains our contribution. In section 3, we explain our data set and our sample selection. In Section 4 we descriptively confirm that the damage by the Tohoku Earthquake increased the firms' relocation. Section 5 describes our empirical framework to examine the determinants of the firms' relocation choice, and explains the variables to use. Our main results are reported in section 6, and Section 7 concludes the paper.

2. Literature review

In addition to the literature on agglomeration economies in the Introduction, this paper is closely related to the following three broad strands of the literature. First, our study is closely related to a number of studies that examine the location choice for new establishments, FDI and the relocation of headquarters. Among these studies, some examine the importance of input and/or output linkages in firms' (re)location choice by focusing on factors such as clustered intermediate goods producers (Holmes 1999), aggregate demand for the product often referred to as the "market potential" (Head and Mayer 2004), and the availability of financial services (Davis and Henderson 2008, Strauss-Kahn and Vives 2009). Unlike our paper, however, these studies use aggregate-level data and do not focus on the importance of the presence of specific transaction partners.

Among the literature on location choices for FDI, some studies focus on the agglomeration of *keiretsu* firms as a determinant of the location of FDI for Japanese manufacturing firms using micro data (Belderbos and Carree 2002, Head et al.1995, Head and Mayer 2004). However, these studies do not take into account the possible sample selection problem that may arise if only firms with specific characteristics can make FDI, and these studies also suffer from small sample containing only a handful of specific industries (e.g., autos and electronics). This small sample might raise another 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. Also, these studies on keiretsu firms do not distinguish suppliers and customers. There is one study that explicitly examines the effect of the presence of incumbent suppliers and customers on the choices of where Japanese manufacturing firms implemented FDI in China (Yamashita et al. 2014). However, this study does not take into account the possible sample selection bias of FDI either. Unlike these studies, we circumvent the sample selection problem by focusing on the relocation of firm headquarters that were severely damaged by the Tohoku earthquake. As far as we are aware of, there is one study (Strauss–Kahn and Vives 2009) that analyzes the location choice of headquarters in the U.S. taking into account of firms' decisions on whether and where to relocate simultaneously by employing a three-level nested logit model.

The second strand of the related literature is studies in the field of banking on the geographical proximity between lenders and borrowers. Theory predicts that a longer lender-borrower distance makes it difficult to transfer soft qualitative information on borrowers within banks' organization, and so decreases the incentives for the banks' loan officers to collect such information (e.g., Stein 2002 and Berger and Udell 2002).[3] This suggests that only local lenders can underwrite loans to opaque businesses. Consistent with this prediction, previous studies find that the geographical proximity matters in the pricing and availability of loans as well as the continuation 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). However, to the best of our knowledge no study has examined the effect of the banks' location on borrowers' relocation.[4]

Third, because of our focus on firms damaged by the earthquake, our paper is related to the broader literature on the impact of natural disasters on the firm's dynamics. Although we focus on firms' relocation, the disasters should affect other aspects of firm dynamics. Existing studies focus on such aspects, including the speed of the recovery (De Mel et al. 2012, Todo et al. 2014), employment, investment, and/or productivity (Cole et al. 2013, Hosono et al. 2015, Leiter el al. 2009, Tanaka 2013), export (Miyakawa et al. 2014), and exit (Cole et al. 2013, Uchida et al. 2014a, Uchida et al. 2014b). Some studies even examine whether the damage on their transaction partners hampered the recovery of the damaged firms (Carvalho et al. 2014, Todo et al. 2014). However, no studies have examined the impact of a natural disaster on the firms' relocation choice.[5]

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[3] Soft information is qualitative information that cannot be directly verified by the third party (Stein 2002). Examples of soft information include information on the morale or competence of borrower firms' CEOs.

[4] There are some studies that emphasize the availability of financial services as one of the key determinants for the relocation choice of firms' headquarters (Davis and Henderson 2008 and Strauss-Kahn and Vives 2009). However, their focus is on the agglomeration of financial services, not on a specific firm-bank relationship.

[5] Some studies ask a related question of whether or not the geographical distribution of economic activity changes after huge temporary shocks such as wartime bombing (Davis and Weinstein 2002, 2008) and natural disasters (Okazaki et al. 2011, Siodla 2013), but these studies do not focus on the relocation of individual firms.

3. Data

3.1. Data source

The main source of our data is the firm-level database compiled by Teikoku Databank Ltd. (hereafter TDB database), one of the leading business credit research companies in Japan. Because of its broad coverage, the majority of firms in the TDB database are small- and medium-sized enterprises (SMEs). 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. When a firm transacts with more than one transaction partner, the TDB ranks the partners in the order of importance to the firm.[6] Following a widely accepted convention, we assume that the top-listed firm or bank as the firm's main transaction partner (i.e., main supplier/customer/bank).

We supplement the TDB data with information on the addresses of the transacting banks' headquarters and branches, which is obtained from Nihon Kinyu Meikan (Almanac of Financial Institutions in Japan) complied by Nikkin Co., Ltd. We also use the Economic Census by the Statistics Bureau in the Ministry of Internal Affairs and Communications to construct proxies for agglomeration at the local level, e.g., the number of establishments and plants in a city. The Census data are available at the city/town/village level, and even at the ward level for large cities. But for the sake of brevity, we refer to these data the *city-level* data throughout this paper.

3.2. Sample selection

[6] The importance is evaluated based on subjective judgment by the researchers of the TDB, but the judgement reflects objective information, e.g., the dependence on the transaction partners in terms of the amount of sales/purchases.

The Tohoku Earthquake that occurred on March 11, 2011 caused serious damage to the area in the six prefectures in the Tohoku area of Japan: Aomori, Iwate, Miyagi, Akita, Yamagata, and Fukushima. From the TDB database, we first identify nonfinancial firms headquartered in these six prefectures that operated during the period from March 2010 to February 2011, i.e., one-year period before the earthquake. This selection results in 93,542 firms. We then 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] and on 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. We find that 39,138 out of our 93,542 sample firms are located in these 59 cities.

Among the 39,138 firms, we further eliminate those firms whose addresses cannot be identified after the earthquake (from March 2011 to February 2013), which results in 36,096 firms. Note that in a preliminary analysis on the fraction of relocated firms in section 4, we compare these 36,096 firms in the 59 cities (the affected area) with 52,035 firms that were located in the other (unaffected) areas in the six prefectures (with identified post-earthquake address).

Even among the affected area, there was a large variation regarding the severity of damages caused by the earthquake. To exclude any concern for possible endogeneity in our empirical analysis on the relocation choice, we identify firms that were forced to relocate by focusing on those that were

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

located in the most severely damaged area. More specifically, we focus on the firms that were located in the tsunami-flooded area or the area within a 30km radius of the Fukushima Daiichi Nuclear Power Station before the earthquake. In Figure 2, the locations of these firms are respectively indicated as x-marks and circles. Firms whose headquarters were located in the tsunami-flooded area are identified by the Geospatial Information Authority of Japan (GSI).[9] Then, we identify firms that actually relocated after the earthquake, for which the relocation is defined as the difference between firms' Euclidian (straight-line) geographical distance before and after the earthquake being more than 0.1km. To obtain the Euclidian distance of firm headquarters before and after the earthquake, we use the CSV Address Matching Service provided by the Center for Spatial Information Service at the University of Tokyo.[10] To be more precise, we first geocode the firms' headquarters addresses from "year" 2008 to 2012 to measure its latitude and longitude in each year.[11] 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. We find that there are 1,123 firms that relocated from the most severely affected area, among which 1,060 (94 percent) firms have moved to one of the 59 affected cities. Due to the availability of the explanatory variables described below, the number of observation for the conditional logit estimations slightly reduces to 1,041.

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[9] The GIS dataset of tsunami boundaries was downloaded from the webpage of the "Reaction project for the 2011 off the pacific coast of Tohoku earthquake" of University of Tokyo.

[10] In the later part of this study, the Euclidian distance between firm headquarters and the possible candidate cities for relocation and the distance between firms and their transaction partners are obtained using the same address matching service.

[11] 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.

4. Preliminary analysis on whether to relocate

Before proceeding to our main analysis on where to relocate, as a preliminary analysis we descriptively focus on whether or not firms relocated. This analysis also serves as an analysis to confirm whether our claim that our sample of relocated firms in the most severely affected area were those that were forced to relocate due to the earthquake.

Table 1 presents the number and the ratio of firms in different areas that relocated from 2008 to 2012. To classify firms based on the pre-earthquake location, we construct three variables: DISASTER, TSUNAMI, and NUCLEAR. First, DISASTER is a dummy variable that takes the value of one if a firm's headquarters was located in the 59 affected cities before the earthquake. 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. Lastly, NUCLEAR is a dummy variable that takes the value of one if a firm's headquarters before the earthquake was located within a 30km radius of the Fukushima Daiichi Nuclear Power Station. Note that our sample in the analysis on where to relocate (1,041 firms explained in subsection 3.2) are those with either TSUNAMI = 1 or NUCLEAR = 1.

Table 1 suggests that the ratio of relocated firms after the earthquake was positively associated with the damage. The ratio of relocated firms in the earthquake-affected area (DISASTER=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 during the two-year period after the earthquake (2011–2012), is 7.7 percent, which is much higher than that of the firms in the unaffected area (DISASTER=0), which is 3.1 percent.[12] Note that even before the

[12] To calculate this cumulative relocation ratio, we compare the location of the firms' headquarters before the

earthquake, the ratios of firms that relocated their headquarters were significantly higher for firms in the earthquake-affected area than those in the non-affected area. However, the difference between the two becomes larger after the earthquake.

If we focus on the most severely affected area, the ratios of relocating firms damaged by the tsunami (TSUNAMI=1) and by the nuclear accident (NUCLEAR=1) exhibit patterns similar to the case of DISASTER=1. However, the levels are much higher: the cumulative ratio of firms that relocated 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.[13] This observation lends support to our presumption that the earthquake-damaged firms' decision on whether to relocate is less susceptible to the sample selection problem. Thus, we restrict our sample for the analysis on the relocation choice of firm headquarters to either TSUNAMI or NUCLEAR firms.

5. Methodology and variables

5.1. Empirical framework

In this section, we set up our empirical framework using a conditional logit model. Following earlier studies on location choices, including the seminal study by Carlton (1983) which argued that logit choice probabilities can be derived from individual firms' profit maximization, we assume that each firm chooses 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

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.

[13] 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.

of locating in city c for firm i in industry j is represented as:

$$\pi_{ic} = \theta_c + \alpha_1\theta_{jc} + \sum_k \alpha_k TR_{ic}^k + \alpha_2\theta_{ic} + \varepsilon_{ic} \tag{1}$$

In equation (1), the vector θ_c indicates a set of variables defined at the city-level that captures the attractiveness of city c to the average firm in all industries. For example, θ_c reflects the characteristics of the city such as the infrastructure and the price of input factors e.g., labor and raw material.

The attractiveness of the city might also vary across industries, as exemplified by the concentration of firms in a particular industry in specific cities (industry localization). Thus, we also include a vector θ_{jc}, which indicates a set of the variables defined at the industry-city levels, to control for the industry-specific attractiveness of city c to firms in industry j. The variables included in θ_{jc} take different values across industries but take the same value across firms in the same industry.

The vector TR_{ic}^k represents our main independent variables that capture the effect of the presence of specific 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 among the firms that belong to the same industry. As explained in Section 2, most of the existing studies consider θ_c and θ_{jc}, but do not consider TR_{ic}^k. In addition to TR_{ic}^k, we also include a vector θ_{ic} which represent a set of the variables to control for the firm-specific attractiveness of city c.

Given (1), the conditional logit framework assumes 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 we assume that the choice is made from the choice set C that represents all of the possible candidate cities for relocation. Coefficients in equation (1) are estimated by maximum likelihood techniques.

In our estimation, we restrict our choice set C for the 59 earthquake-affected cities. As noted in section 3.2, 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 59 earthquake-affected cities, 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 relocated firms for the conditional logit estimation is 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 2.

5.2.1. Variables for transaction partners

The main independent variables in this paper are the presence of transaction partners, i.e., TR_{ic}^{k} in equation (1), where k represents suppliers, customers, and banks. From the TDB database, we construct two sets of variables for TR_{ic}^{k}.

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 respectively label them as SP_MAIN, CT_MAIN, and BK_MAIN. For example, for each of the 59 candidate cities, SP_MAIN takes the value of one if there are headquarters of the firm's main supplier in the city before the earthquake, and zero otherwise. If a firm's main supplier is not identified in the TDB database, or is located outside the 59 affected cities in our choice set, SP_MAIN takes the value of zero for all of the 59 candidate cities. Through this treatment, we may underestimate, if any, the effect of transaction partners on the firms' location choice because there is a possibility that the actual main transaction partners that are not identified by the TDB actually existed in one of the 59 cities. However, this concern for the underestimation also means that if we found a positive impact of the effect of the presence of transaction partners, it serves as a strong evidence for its effect.[14]

Second, in addition to the presence of the main transaction partners, we also take into account the presence of the other transaction partners as well. More specifically, we count for each candidate city the number of transaction partners, not only main but also non-main partners, which we respectively label as SP_NUM, CT_NUM, and BK_NUM for suppliers, customers, and banks.[15] We can consider that these variables represent the agglomeration of transaction partners.

Because there is a concern for multicollinearity, we use these two sets of key variables alternately in our estimations. We expect that the presence of the main partners and the number of

[14] 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 upon request to the authors.
[15] 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.

transaction partners have positive impacts on a firm's relocation choice.

5.2.2. Attractiveness of city to the average firm

In addition to the above main variables, we also control for the factors that have already been examined in prior studies (see Section 2). First, to capture the attractiveness of city c to the average firm irrespective of industries, θ_c, we take two alternative approaches.

First, following Head et al. (1995), we use city-specific constants (city dummies) 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. In return for this merit, however, we cannot estimate the effect of specific city-level variables that might be of interest to the firms' relocation choices.

The second approach is to explicitly take into account such variables of interests. We include the following three variables. First, lnAGG_ALL is the log of the number of establishments of all industries in the city that is constructed from the 2009 Economic Census. This variable controls for the general agglomeration (or urbanization) effect. Although the expected impact of such effect is positive (Davis and Henderson 2008, Strauss-Kahn and Vives 2009), to the extent that it capture the congestion of cities that might invite increases in input factor prices for example, the variable might have a negative impact on the choice of the relevant city. Thus, the overall impact of lnAGG_ALL is an empirical matter. Additionally, we use two variables to proxy for the damage inflicted by the earthquake. The first is TSUNAMI_R that measures the ratio of the firms that were located in the tsunami-flooded area to the total number of firms in the city in the TDB database. The second is NUCLEAR_R that 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.[16] We expect that both TSUNAMI_R and NUCLEAR_R have negative impacts on firms' relocation.

5.2.3. Industry-specific attractiveness of city

As for θ_{jc}, we use the log of the number of establishments in industry *j* to which a relocating firm belongs in each city. This variable, labeled as lnAGG_IND, is constructed from the 2009 Economic Census. We expect that this variable capture the effects of the factors that affect industry-specific agglomeration in each city, e.g., natural advantages and positive externalities caused by industry localization (Head et al. 1995). To the extent that the industry-specific agglomeration effect is prevalent, as indicated by many existing studies, we expect that lnAGG_IND has a positive impact on the firms' relocation choice.

5.2.4. Firm-specific attractiveness of city

To control for the firm-specific attractiveness of city c, θ_{ic}, we construct two variables: SAME and lnDISTANCE. The SAME is a dummy variable that takes the value of one if the relevant city *k* is the one where the relevant firm *i* was located before the earthquake, and zero otherwise. The lnDISTANCE

[16] Note that TSUNAMI_R and NUCLEAR_R differ from TSUNAMI and NUCLEAR variables in Table 1 (section 4) because they measure the ratio of TSUNAMI and NUCLEAR firms to total firms in each city.

is the natural logarithm of the Euclidian distance in kilometers between a firm's headquarters before the earthquake and 59 candidate cities.[17] These variables are to control for the gravity to the original location. If relocating firms have a preference for, and a social network at, the original (pre-earthquake) location or its neighborhood, it is unlikely that they will relocate to a remote city. Thus we expect that SAME and lnDISTANCE have respectively a positive and a negative effect on the firms' choice of the relevant city.

6. Estimation results

6.1. Baseline estimation results

Table 3 shows the average marginal effects of the covariates in the baseline estimations. Columns (i) and (ii) show the results for the specification with three regional variables (lnAGG_ALL, TSUNAMI_R, and NUCLEAR_R) as the attractiveness of city θ_c, while columns (iii) and (iv) show the results when we use the city fixed effects. In columns (i) and (iii), we focus on the presences of the main transaction partners (using SP_MAIN, CT_MAIN, BK_MAIN), while in columns (ii) and (iv) we focus on the number (agglomeration) of transaction partners (using SP_NUM, CT_NUM, BK_NUM).

With regard to the effect of customers, the four columns of Table 3 consistently show that the presence of the firms' customers matters. Specifically, both the presence of the 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.

[17] Because we cannot define the natural logarithm if the distance is zero, we add 0.001 when taking the logarithm.

In contrast, the presence of the suppliers does not matter because both SP_MAIN and SP_NUM do not have significant effects on the firms' relocation choice. Based on the results in columns (iii) and (iv), having a main customer in a city raises the probability of a firm's relocation by 0.4 percent point, and having an additional customer in a city raises the probability by 0.1 percent point. The results suggest that the presence of main customers has a larger impact on the firms' location choice than that of other customers. 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, which suggests that the presence of the main bank's branch is more important than the presence of other banks' branches in the firm's relocation choice. In sum, Table 3 supports our hypothesis that incumbent transaction relationships matter for the firms' relocation choice in the case of customers and banks.

The marginal effects of other covariates are also in line with the previous conjectures. First, regarding the effect of city-level variables (θ_c), the marginal effect of lnAGG_ALL is positive and significant, which suggests that the benefit of moving to larger cities (the positive agglomeration effects) surpass the cost of the congestions. The effects of the other city-level variables, TSUNAMI_R and NUCLEAR_R, are negative and significant, suggesting that firms had less tendency to move to more severely damaged cities.

Second, as for the city-industry level variables (θ_{jc}), lnAGG_IND has positive and significant impact on the firms' relocation in specifications (i) and (ii). This again suggests that the benefit of industry agglomeration outweighs the costs of congestion on average. However, in specifications (iii) and (iv), the marginal effects of lnAGG_IND are insignificant, presumably because some of the effects are absorbed in city-specific constants. Finally, with respect to the firm-specific characteristics of cities, SAME has a positive sign, which indicates that the firms were more likely to move to their hometowns. Consistently, we find a negative impact of lnDISTANCE which means that the firms were less likely to relocate to distant cities.

How can we evaluate the economic magnitudes of the effects of incumbent customers and banks? First, it should be noted that the average marginal effects of the incumbent customer-related variables and bank-related variables 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 2) is 0.0361(=0.024*1.506) using column (i), which is smaller than that of CT_MAIN (0.074) and BK_MAIN (0.073). The results are qualitatively the same when using column (iii), as the marginal effect of lnAGG_IND is insignificant in this specification. Based on our estimates, incumbent transaction relationships are quantitatively at least as important as agglomeration for the firms' relocation choice. Second, under the random choice among the potential 59 locations, the probability that a city is chosen is slightly less than 2 percent (1/59), while the presence of the main customer and main bank respectively raises this probability by 0.4 and 0.5 percent points (column (iii) of Table 3). This calculation implies that the economic impact of the presence of the main customer and banks are not negligible at all.

What about the economic impact of the damage inflicted by the earthquake on firms' relocation choice? To see this point, we 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, and 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 2). Given the estimated marginal effects in column (i) of Table 3, 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

In this subsection, we examine one concern that the analyses in the previous subsection may suffer from: The positive impacts of the presence of the incumbent transaction partners might just capture the tendency that firms move to the place where they have other undamaged establishments. This might be the case if firms own multiple establishments, and these establishments are close to the firms' customers and/or lender banks. To exclude such a possibility, we focus on the single-establishment firms and check the robustness of our prior findings.[18]

Table 4 shows the results for the single establishment firms. We can confirm that consistent with the results in Table 3, most bank- and customer-related variables have significantly positive effects on the relocation choice of the firms even when we exclude the firms with multiple establishments.

6.3. Effects of the earthquake damage to transaction partners

[18] Unfortunately, we do not know the location of establishments other than headquarters for the firms with multiple establishments.

In this subsection, we examine whether the “gravity” of the firm’s transaction partners that we found in the previous subsections differs depending on the damage to these partners. 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 identify damaged transaction partners as those located in the tsunami-flooded area (TSUNAMI=1) and/or within 30km radius of the Fukushima Daiichi Nuclear Power Station (NUCLEAR=1). Using this information we redefine the variables for the presence of the transaction partners. In the case of suppliers, for example, we replace SP_MAIN with SP_MAIN_UD (undamaged main supplier dummy) and SP_MAIN_D (damaged main supplier dummy).

Table 5 presents the estimation results. Consistent with the above conjecture, the marginal effects of the customer variables are positive and significant only when the customers were not damaged (CT_MAIN_UD, CT_NUM_UD). The marginal effects of the presence of undamaged bank are also positive and statistically significant, but we find that BK MAIN_D and BK_NUM_D are also significant, albeit weakly, in specifications (iii) and (iv) respectively. Note, however, that the marginal effects of these variables are quantitatively much smaller than those of the undamaged banks.

One notable result in Table 5 is that different from the previous results, a supplier variable SP_NUM_D, the number of damaged suppliers, has a negative and significant impact. This means that relocated firms tend not to head for the areas where many damaged suppliers were present.

6.4. Discussion

In this subsection, we discuss how we can interpret our findings. First, we find that the presence of the main customer and the agglomeration of the incumbent customers positively affect the relocation choice of the damaged firms. However, we do not find such an effect for suppliers. The finding of the customer effect is consistent with the previous finding of market potential as an important factor for firms' FDI decision (Head and Mayer 2004), but the no finding of the supplier effect is inconsistent with Yamashita et al. (2014) who find that first-tier suppliers and customers both generate positive effects on the choice of where to implement FDI. Note, however, that in terms of quantitative impacts, Yamashita et al. (2014) report much stronger impact for customers than that for suppliers, which is consistent with our finding. In short, our results suggest that the significant impact of suppliers' presence on firms' location choice found in studies on FDI might not be applicable to firms' domestic location choice. To see this point further, we calculate the geographical distance between firms and main transaction partners that were located in the 59 candidate cities before the earthquake. The mean distance between firms and their main suppliers is 47.7 km, while the mean distance between firms and their main customers is 26.9km. This finding also suggests that the location of suppliers matters less for the firms' activities than that of customers in our dataset.

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.[19] While it is difficult to identify the exact mechanism behind this effect, there are several possible explanations. First, as discussed in the literature on relationship lending (Boot 2000), banks invest in relation-specific capital 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

[19] The mean distance between firms and their main bank branches is 5.6km.

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, using data from a survey on Japanese SMEs, Yamori et al. (2013) report that more than 20 percent of the firms pointed out that "the advice with respect to the provision of information about real estate" is the most valuable information they obtained from their main banks.

7. Conclusion

By using a unique firm-level data set, we examine the relocation choice of firms that suffered severe damage from the Tohoku Earthquake. Our results suggest that the presence of incumbent transaction partners positively affects the firms' relocation choice after the earthquake. In particular, we find that the firms tended to relocate to the areas where their customers were present. Interestingly, we do not find such an effect in the case of the presence of their 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 the incumbent customers and banks were somewhat stronger for main transaction partners than for non-main partners, but the effects diminished if the customers and banks were also damaged by the earthquake.

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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 shaded areas in gray represent 59 affected cities. The circles represent the locations of the firms in our data set.

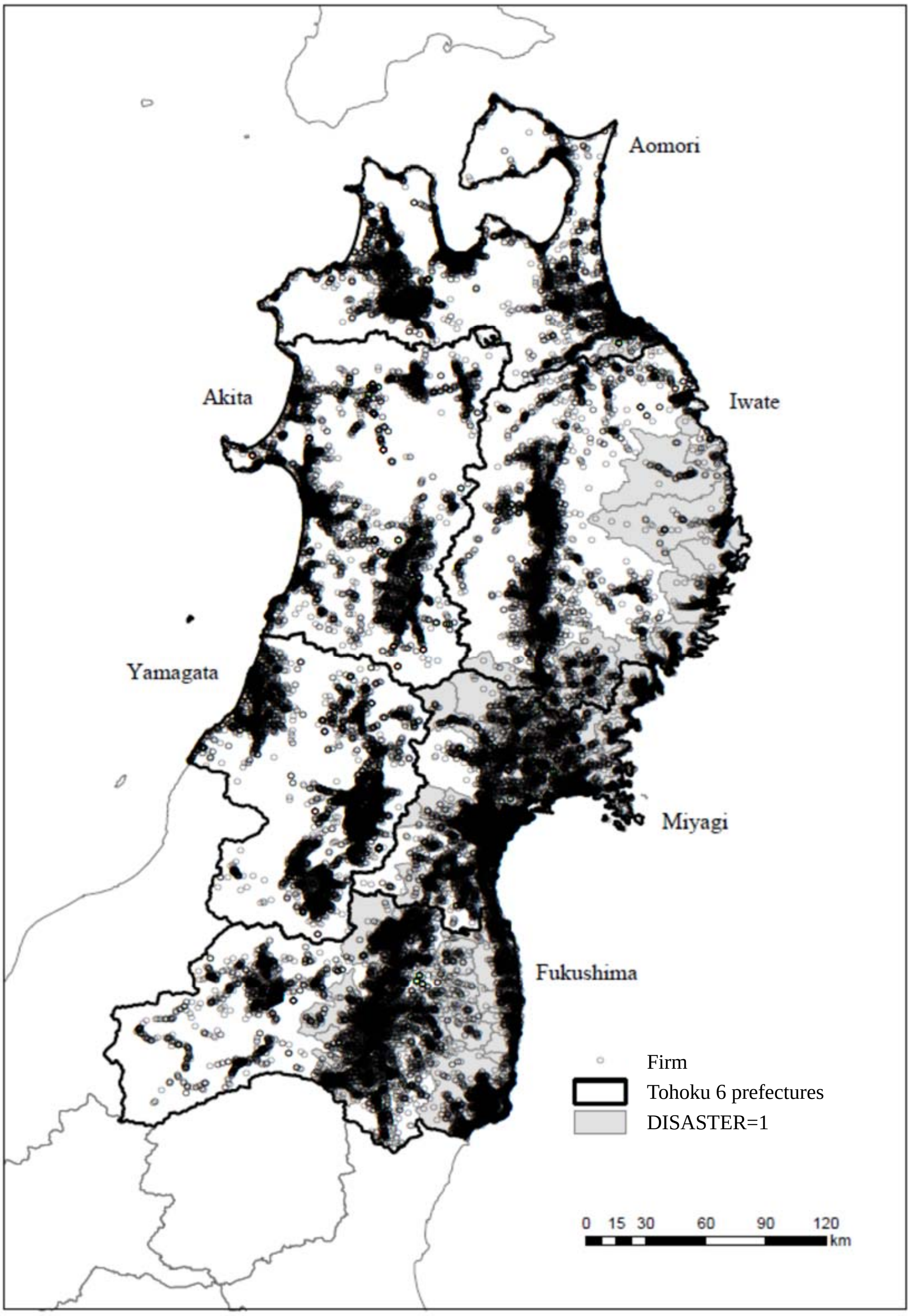

Figure 2 Firms suffering from the tsunami and the nuclear accident

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.

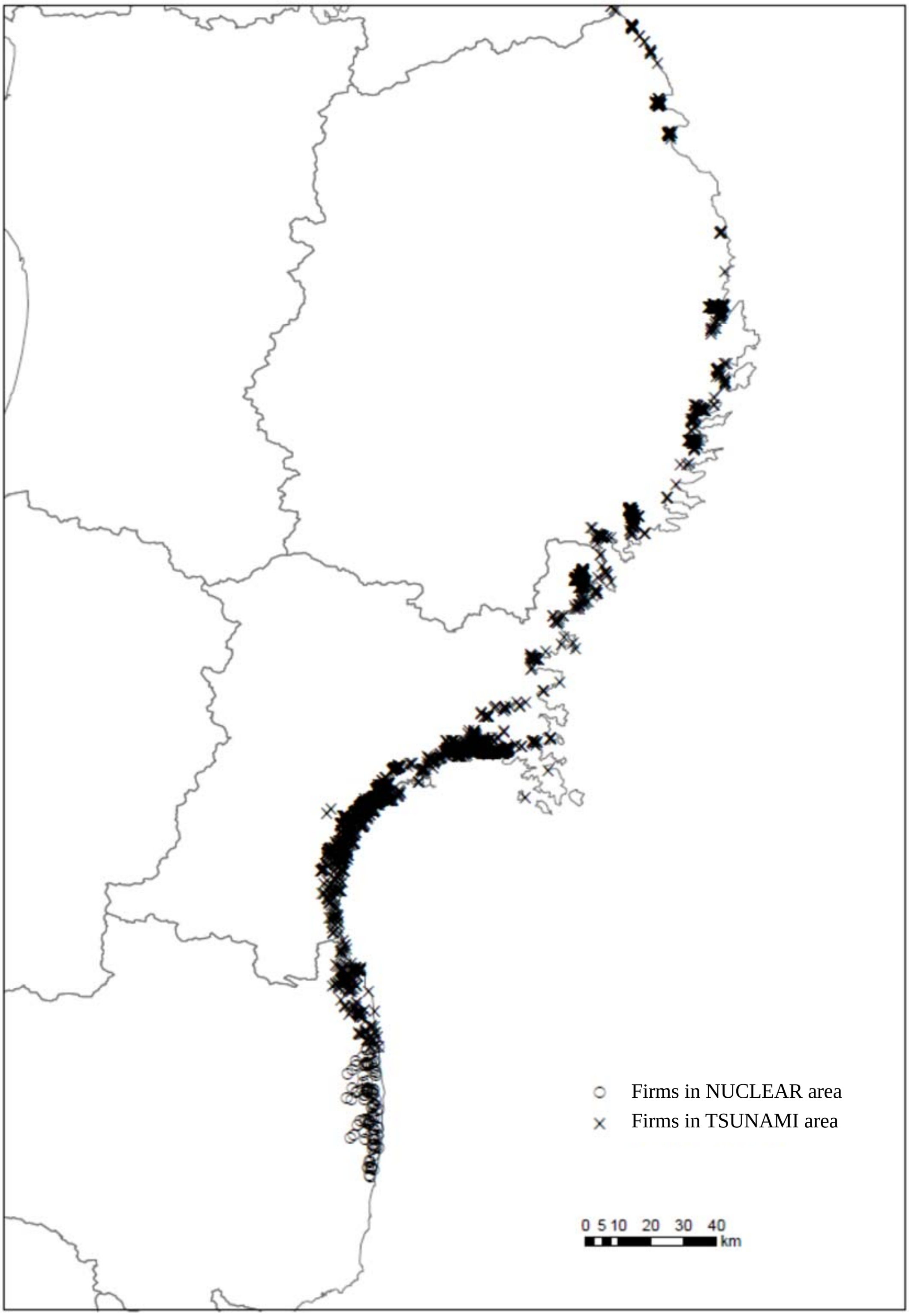

Table 1 Ratio of firms relocated after the earthquake

This table shows the ratio of firms that relocated their headquarters, depending on their locations before the earthquake Year X is defined as "March X - February X+1". The *** indicates significance at the 1% level.

	Damaged firms			**Undamaged firms**			**Difference**	
	Firms not relocated	Firms relocated	Ratio of firms relocated	Firms not relocated	Firms relocated	Ratio of firms relocated	Ratio of firms relocated	
	A	B	C=B/(A+B)	A	B	C=B/(A+B)	C=B/(A+B)	
	DISASTER=1			DISASTER=0			(DISASTER=1)-(DISASTER=0)	
2008	28,576	813	0.028	40,611	934	0.022	0.005	***
2009	28,899	1,087	0.036	40,321	887	0.022	0.015	***
2010	30,550	802	0.026	43,488	876	0.020	0.006	***
2011	28,245	1,276	0.043	45,166	790	0.017	0.026	***
2012	27,105	839	0.030	48,560	890	0.018	0.012	***
2011-2012	**33,303**	**2,793**	**0.077**	**50,422**	**1,613**	**0.031**	**0.046**	***
	TSUNAMI=1			TSUNAMI=0			(TSUNAMI=1)-(TSUNAMI=0)	
2008	4,261	173	0.039	64,926	1,574	0.024	0.015	***
2009	3,961	462	0.104	65,259	1,512	0.023	0.082	***
2010	4,186	133	0.031	69,852	1,545	0.022	0.009	***
2011	2,529	364	0.126	70,882	1,702	0.023	0.102	***
2012	1,893	145	0.071	73,772	1,584	0.021	0.050	***
2011-2012	**3,585**	**928**	**0.206**	**80,140**	**3,478**	**0.042**	**0.164**	***
	NUCLEAR=1			NUCLEAR=0			(NUCLEAR=1)-(NUCLEAR=0)	
2008	519	11	0.021	68,668	1,736	0.025	-0.004	***
2009	595	7	0.012	68,625	1,967	0.028	-0.016	***
2010	687	17	0.024	73,351	1,661	0.022	0.002	***
2011	38	69	0.645	73,373	1,997	0.026	0.618	***
2012	8	14	0.636	75,657	1,715	0.022	0.614	***
2011-2012	**34**	**195**	**0.852**	**83,691**	**4,211**	**0.048**	**0.804**	***
	TSUNAMI=1 or NUCLEAR=1			TSUNAMI=0 and NUCLEAR=0			(TSUNAMI=1 or NUCLEAR=1)-(TSUNAMI=0 and NUCLEAR=0)	
2008	4,779	184	0.037	64,408	1,563	0.024	0.013	***
2009	4,554	469	0.093	64,666	1,505	0.023	0.071	***
2010	4,872	150	0.030	69,166	1,528	0.022	0.008	***
2011	2,567	433	0.144	70,844	1,633	0.023	0.122	***
2012	1,900	159	0.077	73,765	1,570	0.021	0.056	***
2011-2012	**3,619**	**1,123**	**0.237**	**80,106**	**3,283**	**0.039**	**0.197**	***

Table 2 Summary statistics and definitions

This table shows the summary statistics and definitions of the variables used in the regression analyses (Tables 3–5).

(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 3 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 4 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 5 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	