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Abstract

This paper investigates the effect of banks' lending capacity on firms' capital investment. To overcome the difficulties in identifying purely exogenous shocks to firms' bank financing, we utilize the natural experiment provided by the Great Hanshin-Awaji (Kobe) Earthquake in 1995. Using a unique firm-level dataset that allows us to identify firms and banks in the earthquake-affected area, together with information on bank-firm relationships, we find that the investment ratio of firms located outside of the earthquake-affected area but with their main banks inside the area was lower than that of firms that were both located and had their main banks outside of the area. This result implies that the weakened lending capacity of damaged banks exacerbated the borrowing constraints on the investment of their undamaged client firms. We also find that the negative impact is robust for two alternative measures of bank damage: that to the bank headquarters and that to the branch network. However, the impacts of the two are different in timing; while that of the former emerged immediately after the earthquake, the latter emerged with a one-year lag.

Keywords: Natural disasters; Bank damage; Lender bank; Capital investment.
JEL classification: E22, G21, G3

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1. Introduction

Does the lending capacity of banks affect the activities of firms that borrow from those banks? A vast literature has tried to answer this question since the seminal work by Bernanke (1983). However, researchers are faced with an identification problem: while lending behavior affects borrowing firms' performance, the performance of borrowing firms itself has a significant impact on the way lenders extend loans. This paper tackles this problem by taking advantage of the natural experiment provided by a natural disaster, which allows us to single out a purely exogenous shock to firms' bank financing.

A natural disaster may obliterate information on borrowers' creditworthiness accumulated by the disaster-hit banks, and thus destroy their managerial capacity to originate loans, including the ability to screen and process loan applications. A natural disaster may also cause damage to borrowing firms located in the neighborhood of such banks, leading to deterioration in the banks' loan portfolios and risk-taking capacity. In either case, a disaster reduces the damaged banks' lending capacity. Thus, for those firms that are not directly damaged by the disaster, damage to banks that they borrow from is an exogenous shock that may affect the availability and the cost of external funds they can access. A natural disaster thus provides us a good laboratory for studying the effect of banks' lending capacity on borrowing firms' investment.

To that end, this paper focuses on the Great Hanshin-Awaji (Kobe) Earthquake, which hit the area around Kobe City and Awaji Island in western Japan in January 1995. We examine whether damage to banks had an adverse impact on the investment of client firms that did not themselves suffer any damage. To do so, we construct and use a unique firm-level dataset compiled from various sources. The dataset includes information on firms' main banks,[1] on their investment levels, and on whether these banks and firms were located inside or outside the earthquake-affected area. The dataset also includes information from firms' and banks' financial statements. Thus, our sample consists of four groups of firm-bank pairs: damaged/undamaged firms, paired with damaged/undamaged banks. By comparing undamaged firm-damaged bank pairs with undamaged firm-undamaged bank pairs, we are able to single out the effect of damage to banks on the investment of undamaged firms.

Our main findings can be summarized as follows. First, firms located *outside* the earthquake-affected area but associated with a main bank located *inside* the area had a lower investment ratio than *outside* firms associated with a main bank located *outside* the area. This result implies that the exogenous damage to banks' lending capacity had a significant adverse effect on firm investment. Second,

[1] Our dataset includes information on the banks that firms transact with. Among those banks, we treat the bank that a firm regards as the "most important" as the firm's main bank. See Section 5 for more details.

the finding above is robust to two alternative measures of bank damage: A) damage to a bank's headquarters, which captures the decline in a bank's managerial capacity to process loan applications at the back office, and B) damage to a bank's branch network, which captures the decline in a bank's financial health and risk-taking capacity. Our results imply that both of these transmission mechanisms were important. However, we also find that the impact of headquarters damage emerged immediately after the earthquake, while the impact of branch damage appeared only with a one-year lag.

The contributions of this paper to the literature are twofold.[2] First, by using a natural experiment, we are able to circumvent the identification problem faced by many existing studies on the effects of bank lending on firm activities – namely, the difficulty in distinguishing between a loan supply shock and a loan demand shock. Our matched firm-bank data also allow us to identify the mechanism through which the lending capacity of banks affects the activities of borrowing firms in a more precise manner than many other studies that are based on aggregate data (e.g., Peek and Rosengren 2000). Second, this paper is closely related to the literature that investigates the effects of natural disasters on corporate activities. Many of these studies use country or regional level data and thus are unable to clarify the effects of disasters on individual firms. Leiter et al. (2009) and De Mel et al. (2010) examine the recovery of disaster-hit firms using a firm level dataset, but our uniqueness rests on the fact that we investigate the negative impact of damage to banks not only on earthquake-hit firms but also on undamaged firms as well.

The rest of the paper is structured as follows. Section 2 reviews the related literature and our contribution in greater detail. Section 3 provides a brief overview of the Kobe earthquake. Sections 4 and 5 describe our data and methodology, respectively, and Section 6 reports our results. Section 7 summarizes the results and concludes.

2. Literature Review

2.1 Bank Loans and Firm Activities

There is a vast literature that examines empirically the effects of bank lending on the real economy. In his seminal paper, Bernanke (1983), using aggregate data, purported to show that bank failures significantly reduced aggregate production in the US economy during the Great Depression. His study, however, has been challenged on the grounds that it does not identify loan supply shocks as distinct from shocks to loan demand. In other words, the observed relationship between bank failures and aggregate

[2] See Section 2 for more details.

production may simply capture the fact that the recession caused bank failures. In fact, using US state-level data for the 1990-91 recession, Bernanke and Lown (1991) find no significant relationship between bank lending and employment growth when the loan growth is instrumented for by the bank capital-asset ratio, suggesting that a credit crunch was not a major cause of the 1990-91 recession.

There are some event studies examining the effect of bank failures on the market values of their client firms. Slovin et al. (1993) are the first to analyze the stock prices of firms that had lending relationships with the Continental Illionis Bank during the period of its de facto failure. This study is followed by Yamori and Murakami (1999), Bae et al. (2002), and Brewer et al. (2003a), all of which find a significant effect of bank failures on the market values of firms that borrow from those banks.[3] Similarly, Yamori (1999) investigates the failure of a regional bank in Japan (Hyogo Bank), and finds that the subsequent returns on the stocks of the problem banks were significantly lower than those of solvent banks.[4] The advantage of these event studies is that they are able to clearly identify bank failure shocks using high-frequency (daily) data. However, they have limitations as well. First, event studies rely on the assumptions of market efficiency and rational investor behavior. Second, event studies cannot be applied to non-listed firms. In this paper we focus on a real activity of firms, i.e., investment behavior, and hence do not require any assumptions of market efficiency or rationality. In addition, we analyze unlisted firms, most of which are small and medium-sized and therefore likely to be severely affected by shocks from lending banks.

Several other studies use firms' financial statements to investigate the effects of bank failures or weak bank health on client firms.[5] For instance, Hori (2005) examines the profitability of firms that borrowed from a large failed Japanese bank (Hokkaido-Takushoku Bank), and finds adverse effects on firms with low credit ratings. Similarly, Minamihashi (2011) analyzes the failures of two long-term credit banks in Japan, and finds that the failures significantly decreased the investment of their client firms.[6] Finally, Gibson (1995, 1997) finds that client firms that were borrowing from Japanese banks with low credit ratings significantly reduced their investment during 1994-95.[7] However, these studies suffer from the aforementioned identification problem, because the direction of the causality between bank failure (or

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[3] Note, however, that Brewer et al. (2003a) also find that the magnitude of these negative effects on the values of borrower firms is not significantly different from that on all other firms in their sample.

[4] See also Brewer et al. (2003b).

[5] Using bank balance sheet data, Woo (2003) and Watanabe (2007) find that weakly capitalized Japanese banks reduced their lending in 1997, when the Ministry of Finance started to impose rigorous self-assessments of loan classifications.

[6] See also Fukuda and Koibuchi (2007).

[7] See also Nagahata and Sekine (2005). Using data of listed Japanese firms for the period 1993-1999, Peek and Rosengren (2005) find that banks expanded loans to unprofitable firms during this period. See also Caballero et al. (2008) for such "zombie" lending practices by Japanese banks in the 1990s.

weak bank health) and client firms' poor performance is unclear.

To resolve that identification problem, Peek and Rosengren (2000) examine whether state-level construction activities in the United States were affected by the deterioration in the health of Japanese banks, through reductions in those banks' lending at their US branches. They find that the firms were indeed affected, with clearly identified causality running from bank lending capacity to firm activities. The identification strategy employed in this paper is similar to the one employed in that paper, since we examine the effect of damage to banks on firms that are located outside the earthquake-hit area. However, Peek and Rosengren (2000) use state-level aggregate data, so they cannot control for firm and bank heterogeneity. We have the advantage of being able to more clearly capture the effects of the damage to lending banks, because we use firm- and bank-level data.

The papers most closely related to the present study are Khwaja and Mian (2008) and Berg and Schrader (2012). Khawaji and Mian (2008) examine the transmission of a bank liquidity shock to client firms' financial distress in an emerging market (Pakistan), while Berg and Schrader (2012) analyze the effects of volcanic eruptions on borrowing from a microfinance institution in a developing economy (Ecuador). In this paper we show that a shock to bank lending capacity affects client firms' activity even in an economy with well-developed financial markets and institutions.

Finally, there is also an emerging strand of literature that examines the international transmission of financial crises. Chava and Purnanandam (2011) and Schnabl (2012) use the 1998 Russian sovereign default as a bank liquidity shock, and examine its international transmission to both the US and to an emerging market (Peru). Popov and Udell (2010) examine the cross-border transmission of the 2008-09 financial crisis from West European and U.S. banks to firms in Central and Eastern Europe. Paravisini et al. (2011) study the impact of the capital flow reversals during the 2008 financial crisis on Peruvian firms. Cetorelli and Goldberg (2012) investigate lending by the U.S. branches of foreign banks during the Great Recession. We differ from these studies in that we focus on the domestic transmission of a shock from banks in disaster-hit areas to their client firms in other areas.

2.2 Natural Disasters and Economic Recovery

This paper is also related to the literature on the economic consequences of, and recovery from, major natural disaster events. Natural disasters cost lives and destroy infrastructure, buildings, and machinery, and thereby affect both labor and capital. They also not only disrupt the business operations of firms directly affected by the disaster, but also impact the operations of non-affected firms through upstream and downstream supply linkages. However, destroyed capital is typically replaced, and firms' output and productivity may eventually recover. Although the empirical findings are mixed, cross-country studies on the factors determining the extent of economic recovery following a major disaster generally suggest that updating of technology and/or of the composition of production factors, as well as factor accumulation, play a role (Skidmore and Toya 2002, Okuyama 2003, Kahn 2005, Stromberg 2007, Toya and Skidmore 2007, Crespo-Cuaresma et al. 2008, Sawada et al. 2011).

However, compared with the rich literature on the macroeconomic impact of natural disasters, studies exploring the firm-level impact of, and subsequent recovery from, natural disasters are relatively scarce. Notable exceptions are Leiter et al. (2009) and De Mel et al. (2010). Leiter et al. (2009) examine the capital accumulation, employment, and productivity growth of European firms affected by floods, and find that employment growth and accumulation of physical capital are significantly higher in regions experiencing major flood events. They also find that the positive effect is stronger for firms with a higher share of intangible assets. De Mel et al. (2010) conduct a series of surveys of enterprises in Sri Lanka following the 2004 tsunami and examine their recovery from the disaster. In their field experiments, they randomly provide grants to selected enterprises and investigate the impact of the grants on the firms' recovery. They find that direct aid had a significant positive impact on the profits of tsunami-affected enterprises in the retail industry, but not in the manufacturing industry. However, they do not investigate the role of borrowing from banks, which are major providers of funds. The uniqueness of our study lies in the fact that we investigate the impact that damage to banks has on non-affected as well as affected borrowers.[8]

3. Summary of the Kobe Earthquake

The Kobe earthquake occurred on January 17, 1995. The total loss from this major natural disaster is estimated to have been 9.9 trillion yen, including 630 billion yen in business sector losses.[9] Table 1 provides an overview of the estimated damage, including the number of casualties and the number of housing units destroyed. There were more than 6,000 casualties, and about 100,000 housing units were completely destroyed. There is considerable variation in the number of casualties and the extent of damage across municipalities in the earthquake-affected area.[10] The ratio of the number of casualties to the total population and the ratios of the number of completely and partly destroyed housing units to the

[8] Sawada and Shimizutani (2008) focus on financial constraints of households affected by the Kobe earthquake. Their findings suggest that borrowing constraints played an important role in the wake of the disaster.

[9] Data provided by Hyogo Prefecture (http://web.pref.hyogo.jp/wd33/wd33_000000010.html).

[10] For the exact definition of the "earthquake-affected area," see section 4.2.

total number of housing units are especially high in specific areas of Kobe City, including its wards of Higashinada, Nada, and Nagata.[11]

The Kobe earthquake had a serious impact on banks' operations as well. Table 2 shows that about a quarter of the bank branches located in Hyogo Prefecture were unable to operate immediately after the earthquake. Although information is not available regarding how long such disruption of banking operations continued, Table 3 provides an overview of banks headquartered in the earthquake-affected area at the time of the earthquake. It shows that 18 banks, including 2 relatively large regional banks, were directly affected by the disaster. We examine how such bank damage affected borrowing firms' investment below.

4. Data

4.1 Data sources

We rely primarily on two firm-level data sources. First, information on firms' capital investment and financial conditions is obtained from the *Basic Survey of Business Structure and Activities* (BSBSA; *Kigyo Katsudou Kihon Chosa* in Japanese) compiled by the Ministry of Economy, Trade and Industry. The main purpose of this survey is to gauge quantitatively the activities of Japanese enterprises, including capital investment, exports, foreign direct investment, and investment in research and development. To this end, the survey covers the universe of enterprises in Japan with more than 50 employees and with paid-up capital of over 30 million yen. From this data source, we obtain firm-level data on capital investment and capital stocks.

Second, we rely on the firm-level database provided by Teikoku Databank LTD. (TDB), a leading business credit bureau in Japan. In addition to information on firm characteristics, the TDB database provides a list of the banks with which each firm transacts, where firms rank the banks in the order of importance to them. We define the bank at the top of each firm's list as that firm's *main bank*. We further augment our dataset with data from the financial statements of all the main banks, obtained from the Nikkei NEEDS Financial Quest compiled by Nikkei, Inc. (Nihon Keizai Shimbunsha) and two other,

[11] The ratios of completely destroyed, partly destroyed, and completely or partly destroyed housing units in the table should be treated with a degree of caution, because the Fire Defense Agency and the Ministry of Construction (*Housing and Land Survey*) use slightly different definitions. For example, the ratio of completely or partly destroyed housing units in Nagata-ku is more than 90%, which seems excessively high. For a limited number of cities and towns, we can use alternative survey data collected by the Architectural Institute of Japan, which cover around 80% of the housing in Japan. If we use these data, the ratios of completely, partly, and completely or partly destroyed housing units for Nagata-ku are 25.6%, 22.0%, and 47.6%, respectively.[12] These two sources are the "Financial Statements of Shinkin Banks in Japan" and the "Financial Statements of Credit Cooperatives in Japan," edited by Financial Book Consultants, Ltd. (Kinyu Tosho Konsarutantosha).

paper-based sources.[12] This augmented dataset is then merged with the first data set from the BSBSA firm names and addresses.

4.2 Sample Selection

We treat firms whose headquarters are located in the earthquake-affected area as "damaged firms" (treatment group). The earthquake-affected area is defined as the nine cities and five towns in Hyogo and Osaka prefectures that were included in the Japanese Government's Act Concerning Special Financial Support to Deal with a Designated Disaster of Extreme Severity.[13] We choose firms located in Hyogo and Osaka prefectures as the control group in order to eliminate differences in unobserved characteristics stemming from region-specific factors. The BSBSA database contains the information of 3897 firms headquartered in Hyogo and Osaka prefectures, 641 of which were located in the affected area and 3256 in the non-affected area. However, when we merge the Teikoku Databank data with the BSBSA data the number of firms is reduced to 3,212, of which 591 firms were headquartered in the affected area and 2,621 firms in the non-affected area.

We aim to trace the changes over time in the effects of damages to banks and firms on firms' investment. To this end, we need a balanced panel dataset that contains the same firms over the observation period. Therefore, we restrict our sample to firms that do not exit from the sample over our observation period, i.e., the three years following the earthquake. Although this restriction may raise concerns about survivor bias, we argue that it does not cause serious problems. Somewhat surprisingly, the number of firms in the affected area that exited from the sample is not large compared with the equivalent number in the non-affected area. Table 4 shows the cumulative number of firms who dropped out of the TDB-BSBSA merged dataset as a proportion of the total number of firms that existed in the dataset in fiscal year (FY) 1994.[14] The drop-out rate in the affected area was actually lower than that in the non-affected area in FYs 1995 and 1996, though the former was slightly higher than the latter in FY 1997.

We also restrict our sample of firms to those whose main bank survived over the three years after

[12] These two sources are the "Financial Statements of Shinkin Banks in Japan" and the "Financial Statements of Credit Cooperatives in Japan," edited by Financial Book Consultants, Ltd. (Kinyu Tosho Konsarutantosha).

[13] The nine cities and five towns consist of Toyonaka City, Kobe City, Amagasaki City, Nishinomiya City, Ashiya City, Itami City, Takarazuka City, Kawanishi City, Akashi City, Tsuna Town, Hokutan Town, Ichinomiya Town, Goshiki Town, and Higashiura Town. Goshiki Town later merged with Sumoto City, and Tsuna, Hokutan, Ichinomiya, and Higashiura towns merged to form Awaji City.

[14] The financial year for most firms in Japan is the same as the fiscal year, starting in April and ending in March. For example, FY1995 starts in April 1995 and ends in March 1996. The Kobe Earthquake on January 17, 1995 is thus included in FY1994.

the earthquake. Among the banks headquartered in the affected area, we have one bank that failed during the three year window (Hyogo Bank, which failed in August 1995). A reported reason for the failure was the expansion of real estate-related loans during the 1980s, which became non-performing when the Japanese land price bubble burst in the early 1990s. Because we exclude those firms whose main bank was Hyogo Bank, we can rule out the possibility of a "sick bank" effect. With this exclusion, the number of firms falls to 2,086, of which 390 were headquartered in the affected area and 1,696 in the non-affected area.

Finally, to exclude outliers, we drop observations for which our dependent variable or one of the independent variables (explained below) falls in either of the 0.5% tails of its distribution for the observation years. The observation period is the three fiscal years following the earthquake (i.e., t = FY1995, FY1996, and FY1997). Our final dataset consists of 351 damaged firms and 1,604 undamaged firms. These 1955 firms make up our sample for the empirical analysis in the following sections.[15]

To see whether our choice of control group and sample selection cause any bias by shifting the industrial composition of the sample, we compare the industrial composition between damaged firms and undamaged firms in FY 1995 (Table 5). Though the share of wholesalers is smaller and the share of retailers and restaurants is larger in the affected area than in the unaffected area, the share of each of the other industries is almost the same. Importantly, the shares of construction firms, which may have a strong incentive to invest to meet the demand of public investment following the disaster, are almost the same between the affected and unaffected areas.

5. Methodology and Variables

5.1 Regression

We estimate the following equation:

$$\begin{aligned}\frac{I_{it}}{K_{it-1}} &= \beta_0 + \beta_1 F\_SALESGROWTH_{it-1} + \beta_2 F\_DAMAGED_i + \beta_3 B\_DAMAGED_i \\ &+ \beta_4 F\_DAMAGED_i * B\_DAMAGED_i + \beta_5 F\_CONSTRAINTS_{i,t-1} \\ &+ \beta_6 B\_CAPACITY_{it-1} + \beta_7 Industry_i + \varepsilon_{it}, \qquad for\ \ t = 1995, 1996, 1997. \qquad (1)\end{aligned}$$

This is a Tobin's Q-type investment equation, which is augmented by a dummy variable indicating whether the firm is located in the earthquake-affected area, a proxy for bank damage, and

15 The sample size slightly varies over the three year period since we drop outliers for each year.

proxies for the firm's financial constraints and the bank's lending capacity.

The dependent variable is the capital investment ratio, which is defined as the ratio of investment during period *t* to the capital stock at the end of period *t*-1. This ratio is widely used in existing empirical studies on investment based on the Q thoery. Taking into account the possibility that the effects of the earthquake on investment change over time, we run a separate cross-sectional regression for each fiscal year.

5.2 Explanatory Variables

As regressors, we use a proxy for Tobin's Q and a variety of additional variables that may affect investment. For all time-varying variables, we use a one-year lag to eliminate possible endogeneity problems.

5.2.1 Proxy for Tobin's Q

Since most of our sample firms are not listed on stock exchanges, we cannot use Tobin's Q (defined as the ratio of the market value to the replacement cost of capital) as a regressor to represent firm's degree of investment opportunity. We thus follow studies such as Shin and Stulz (1998), Whited (2006), and Acharya et al. (2007), and instead use the growth rate of firms' sales (*F_SALESGROWTH*) as a proxy for their investment opportunity. *F_SALESGROWTH* is hypothesized to have a positive coefficient.

5.2.2 Damaged firm dummy

Because we do not know whether and to what extent each firm actually suffered from the earthquake, we assume that firms in the affected area are all damaged firms. We use *F_DAMAGED*, which takes a value of one if the firm is located in the earthquake-affected area as defined above. Having probably lost part or all of their physical capital, damaged firms are likely to have a large marginal product of capital, so that such firms should have greater demand for capital than undamaged firms. We thus predict that this variable has a positive impact on the investment ratio.

5.2.3 Damaged bank variables

Our main interest lies in the effects of bank damage on borrowing firms' investment. *B_DAMAGED* indicates the damage to a firm's main bank. Because we have no precise information concerning whether and to what extent banks suffered from the earthquake, we use two alternative variables for *B_DAMAGED*. The first alternative is *B_HQDAMAGED*, a dummy variable that takes a value of one if the headquarters of the bank are located in the earthquake-affected area. This variable captures whether the managerial capacity to process loans is impaired; this managerial capacity includes back-office operations, such as the ability to process applications for large loans or to manage the total risk of the bank's loan portfolio.

The second alternative is *B_BRDAMAGED*, which is the share of the main bank's branches located in the earthquake-affected area as a fraction of the total number of branches. Compared to *B_HQDAMAGED*, this variable measures the extent of damage to the main bank's branch network. It represents the impairment of the main bank's ability to process applications for relatively small loans under the authority of branch managers. It also captures the extent of the main banks' exposure to damaged and possibly non-performing borrowers, which is likely to negatively affect their risk-taking capacity. We hypothesize that either of these measures of bank damage imposes borrowing constraints on client firms, and thus will take a negative coefficient in the regression.

Note that we use the main bank at the time the earthquake occurred (i.e. in FY 1994). This is done in order to properly identify an exogenous shock to the firm, i.e., whether the firm's main bank at the time of the earthquake sustained damage or not. If firms can easily switch their main banks, they might be able to escape collateral damage from the adverse effects suffered by their earthquake-affected main banks; this would reduce the size of the coefficients on *B_HQDAMAGED* and *B_BRDAMAGED*. However, we find that firms in our sample rarely changed their main banks. As shown in Table 6, only 5.9% of all firms, and only 7.7% of the firms in the affected area, switched their main banks during the three years following the earthquake.

5.2.4 Interaction of damaged firms and damaged banks

In addition to *F_DAMAGED* and *B_DAMAGED*, we also add a term interacting these two variables. This is done to differentiate the impact of bank damage on damaged firms from that on undamaged firms. As mentioned earlier, what we are most interested in is the effect of bank damage on undamaged borrowers, which is captured by the coefficient on *B_DAMAGED*. On the other hand, the effect of bank damage on damaged borrowers is captured by the sum of the coefficients on *B_DAMAGED* and on the interaction term of *B_DAMAGED* and *F_DAMAGED*. If bank damage has a negative impact on damaged borrowers, the sum of these coefficients will take a negative value.

5.2.5 Firms' financial constraints

We also include a vector of variables representing firms' financial constraints, *F_CONSTRAINTS*. Specifically, we use firms' size, which is represented by the natural logarithm of total assets (*F_LNASSETS*); their leverage, which is computed as the ratio of total liabilities to total assets (*F_LEV*); their profitability, which is represented by the ratio of current income to total assets (*F_ROA*); and their liquidity, which is proxied for by the ratio of liquid assets to total assets (*F_CASH*).

Recent studies, including Whited (2006), Bayer (2006), and Hennessy et al. (2007), consider financial frictions to be important factor generating variations in firm investment. Firms with higher profitability (*F_ROA*), more liquidity (*F_CASH*), and larger size (*F_LNASSET*) are less likely to be financially constrained. Note, however, that these firm characteristics could be also related to future profitability, as discussed by Abel and Eberly (2011) and Gomes (2001). But regardless of which interpretation is correct, we expect the coefficients on these variables to be positive. On the other hand, since firms with higher leverage *(F_LEV*) are more likely to be financially constrained, we expect *F_LEV* to have a negative coefficient.

5.2.6 Banks' lending capacity

Finally, we include a vector of variables representing the main bank's lending capacity, *B_CAPACITY*. More specifically, we control for the size, financial health, and profitability of each firm's main bank. For size, we use the natural logarithm of the bank's total assets (*B_LNASSETS*). As proxies for the financial health and profitability of the main bank, we use the bank's risk-unadjusted capital-asset ratio (*B_CAP*) and ratio of operating profit to total assets (*B_ROA*). Banks with higher profitability (*B_ROA*) and greater financial health (*B_CAP*) are less likely to be constrained by regulatory capital requirements or capital shortages, and are thus more likely to provide loans to their client firms, which should therefore be more likely to carry out investment. Moreover, larger banks (*B_LNASSETS*) are able to diversify their loan portfolios, and are hence less likely to be severely affected by the earthquake. These variables are therefore expected to have positive coefficients.

Note, however, that it has been widely recognized that during the 1990s, i.e., the period that we examine, Japanese banks manipulated their balance sheets and reported inflated profits and capital by, for example, underreporting loan loss reserves, double-gearing subordinated debt with affiliated life insurance companies, and rolling over loans to non-performing borrowers (see, e.g., Ito and Sasaki, 2002;

Shrieves and Dahl, 2003; Peek and Rosengren, 2005; Caballero et al., 2008). These studies suggest that such accounting manipulations are more likely to be observed for financially unhealthy banks. To the extent that these claims are valid, *B_ROA* and *B_CAP* may not capture true profits and capital, so that the coefficients on these regressors may turn out to be insignificant.

5.2.7 Industry dummy

To control for industry-level shocks that affect firm investment, we classify the firms into 5 industries (mining and construction; manufacturing; wholesale, retail and restaurant; finance, insurance, real estate, transportation, and communications; and others) and add four industry dummies accordingly.

5.3 Summary statistics and univariate analysis

Summary statistics for the above-listed variables for each firm and its main bank are shown in Table 7(a). The three panels in Table 7(a) correspond to the three fiscal years of our observation period. Each of the panels shows summary statistics for the whole sample; for the subsample of damaged firms (*F_DAMAGED*=1); and for the subsample of undamaged firms (*F_DAMAGED*=0).

As a preliminary analysis, Table 7(a) presents *t*-tests of the differences in means of some variables between the sample of damaged firms and sample of undamaged firms. For the investment ratio, the difference is positive and statistically significant in FY1995. This implies that damaged firms significantly increased their investment in FY1995, presumably to recover from damage after the earthquake. On the other hand, the financial characteristics of the main banks for damaged and undamaged firms do not systematically differ. For example, the capital-asset ratio of damaged firms' main banks in FY 1996 is lower, while the ROA is higher, compared with the main banks of undamaged firms. However, in FY1997, the differences are not statistically significant. In contrast, *B_HQDAMAGED* and *B_BRDAMAGED* are significantly higher for damaged firms. Whether and how the damage to firms and banks affects firms' capital investment is examined in the regression analysis below.

Table 7(b) shows the summary statistics of bank characteristics over the three years, taking each bank as one observation. In the upper three panels, the first column shows the statistics for all the main banks of our sample firms, and the second and third columns respectively show the statistics for the banks headquartered inside or outside the affected area (*B_HQDAMAGED*=1 or 0), in each of the three years. In the two columns in the lower three panels, we classify banks according to the extent of branch damage (i.e. whether *B_BRDAMAGED* is greater than the median value).[16] We find that the differences in means of the bank characteristic variables between banks above and below the median in terms of *B_BRDAMAGED* are mostly statistically significant. However, this does not necessarily mean that the financial conditions of damaged banks were worse than those of their undamaged peers. Although *B_CAP* is higher for banks with a smaller *B_BRDAMAGED* in all three years, *B_ROA* in FY 1995 is higher for banks with a greater *B_BRDAMAGED* than those with a smaller *B_BRDAMAGED*. Since the bank characteristic variables are potentially correlated with banks' capability to provide loans, we need to control properly for such characteristics in our empirical analysis. Finally, we check the correlation coefficients for firm and bank characteristics (not reported) and find that no significant correlation is observed between any pair of explanatory variables, implying that we do not need worry about multicollinearity.

6. Regression Results

6.1 Baseline results

The results for the baseline estimation are shown in Table 8. For each year, we report the results for two specifications: one using (1) *B_HQDAMAGED* and the other using (2) *B_BRDAMAGED* as the bank damage variable (referred to as *B_DAMAGED*). We find that *F_SALESGROWTH*, the proxy for Q, takes a positive coefficient in all years for both specifications, and is statistically significant in FY1995 and FY1997. *F_DAMAGED* has a positive and significant coefficient in all three years for specification (1), and in FY1997 for specification (2), implying that the capital investment ratio of affected firms increased after the earthquake as they recovered from the damage. For example, the results for specification (1) show that when associated with an undamaged main bank, the investment ratios of damaged firms were higher by 2.4, 2.3 and 2.8 percentage points respectively in FY1995, FY1996 and FY1997 than those of undamaged firms.

Turning to our variables of primary interest, we find that *B_DAMAGED* has a negative and significant coefficient in either FY1995 (for specification (1)) or FY1996 (for specification (2)), implying that the investment ratio of firms that were not hit by the earthquake was adversely affected if their main bank was hit. Since damage to banks is an exogenous financial shock for firms located outside the earthquake-hit area, this result strongly suggests that exogenous shocks to bank lending capacity generally affect client firm investment. The impact of bank damage on undamaged firms is economically significant as well. For specification (1), where bank damage is defined as headquarters damage, the

[16] The median is computed using only those banks with a positive value for *B_BRDAMAGE*. Banks with a zero value for *B_BRDAMAGE* are classified as being below the median.

investment ratio of undamaged firms associated with damaged main banks is smaller by 8.1 percentage points than that of undamaged firms associated with undamaged main banks. This impact is economically significant, given that the average investment ratio for undamaged firms in FY1995 was 13.1%. For specification (2), where bank damage is represented by branch damage, the investment ratio of undamaged firms associated with damaged main banks whose value of *B_BRDAMAGED* equals to its sample mean of the undamaged firms (i.e., 7 percentage points) in FY1996 had investment ratios that were lower by 1.0 percentage points compared with firms with undamaged main banks. The quantitative impact is again economically significant.

An interesting finding is that the timing of the impact of bank damage on firm investment differs between the two specifications. While the negative and significant impact of *B_HQDAMAGED* on client firms' investment manifested itself immediately after the earthquake, i.e., in FY1995, the significant impact of *B_BRDAMAGED* did so only one year later in FY1996. This difference might stem from what these variables represent. *B_HQDAMAGED* captures the impairment to a bank's back-office operations at the headquarters, such as making decisions on whether to accept or reject applications for large loans, while *B_BRDAMAGED* reflects the damage to a bank's ability to process applications for small loans, and/or loan portfolio losses caused by the deterioration in local borrowers' financial conditions due to the earthquake. Note that the effects of bank damage, either to headquarters or to branch networks, are short-lived. The coefficient of *B_HQDAMAGED* turns *positive* and significant in FY 1997, possibly reflecting a recovery from the low investment caused by bank damage in FY1995, while *B_BRDAMAGED* is not significant in FY 1997.

Turning to the interaction term of bank damage and firm damage, the sum of *B_DAMAGED* and the interaction term of *F_DAMAGED* and *B_DAMAGED* is positive and marginally significant at the 10% level in FY1995 (for specification (1)), suggesting that bank damage positively affected damaged firms' investment. This might imply that damaged banks shifted their loan portfolios from undamaged to damaged firms to assist the damaged firms' recovery, but the result is not strongly significant and is observed only in FY1995.

All the variables representing firms' financial constraints have coefficients with the expected signs, although the level of statistical significance varies across variables and years. *F_ROA* and *F_CASH* have significantly positive coefficients in all years in both specifications, while *F_ LNASSET* has significantly positive coefficients in FY1996 and FY1997, and *F_LEV* has a significantly negative coefficient in FY1995.

Finally, the coefficients on the variables for banks' lending capacity have inconsistent signs over time, and none of the coefficients are significant. These results are consistent with the view that banks' balance sheet variables at the time might not have reflected their true financial conditions.

6.2 Differences by bank size

In the baseline estimation, we did not distinguish between banks of different sizes. Compared with larger regional banks, Shinkin banks *(shinyo kinko* in Japanese) and credit cooperatives (*shinyo kumiai* in Japanese), both of which are small credit unions, tend to operate in more concentrated geographical areas.[17] Consequently, it may be more difficult for these banks to diversify their loan portfolios, so they might be more vulnerable than others if struck by an earthquake. To the extent that this is the case, firms associated with a damaged Shinkin bank or credit cooperative may have been affected more severely.

To take this possibility into account, we now introduce an interaction term interacting *B_HQDAMAGED* or *B_BRDAMAGED* with a small bank dummy, *SMALL*, which takes a value of one if a firm's main bank is either a Shinkin bank or a credit cooperative. The interaction term is expected to have a negative sign. Note that in this specification, we implicitly assume that damage to regional banks, which are relatively large, has no significant impact on their client firms' investment, because these banks are likely to have more diversified loan portfolios than Shinkin banks and credit cooperatives.

Table 9 shows the results. In specification (1), where *B_HQDAMAGE* is interacted with *SMALL*, the coefficient on the interaction term is negative and statistically significant both in FY1995 (as in the baseline case) and in FY1996 (unlike in the baseline case). In FY1995, the absolute value of the coefficient is larger than that of *B_HQDAMAGE* in the baseline result. That is, the investment ratio of undamaged firms associated with damaged Shinkin banks or credit cooperatives was lower by 10.0 percentage points than that of undamaged firms associated with undamaged (or damaged regional) main banks. These results are consistent with our prediction that firms associated with a damaged small bank are more severely affected than those associated with a damaged large bank. The interaction term of *B_HQDAMAGED* and *SMALL* has a positive and significant coefficient in FY1997, but its absolute value is smaller than the coefficient of *B_HQDAMAGED* in the baseline result, suggesting that the recovery from the period of depressed investment was weaker for firms associated with small banks. In specification (2) where we interact *B_BRDAMAGED* with *SMALL*, the coefficient of the interaction term is significant and negative for FY1996 (as in the baseline result).

[17] Regional banks are generally smaller than city banks but larger than Shinkin banks and credit cooperatives in Japan. A more detailed description of the various types of banks in Japan, including regional banks and Shinkin banks, can be found in Uchida and Udell (2010).

Note that the results for all the other explanatory variables are similar to those in the baseline estimation for both specifications, except that the sum of the coefficients on *B_DAMAGED* and on the interaction term of *F_DAMAGED* and *B_HQDAMAGED* (interacted with *SMALL*) is not statistically significant. The latter result suggests that the portfolio shift effect observed in the baseline estimation is not found when we focus on small banks only.

6.3 Controlling for firm fixed effects

Thus far we have conducted cross-sectional regressions, based on the assumption that before the earthquake, firms' investment was not significantly different between damaged and undamaged firms. This assumption is plausible, given that the earthquake was an exogenous shock to firms. However, for the sake of robustness, we attempt to ascertain whether controlling for the difference in the pre-earthquake investment ratio among firms changes our results. Here we explicitly control for the unobservable firm-level fixed effect by differencing the investment ratio as follows:

$$\begin{aligned}\frac{I_{it}}{K_{it}} - \frac{I_{i94}}{K_{i94}} &= \beta_0 + \beta_1 F\_SALESGROWTH_{it-1} + \beta_2 F\_DAMAGED_i + \beta_3 B\_DAMAGED_{it-1} \\ &+ \beta_4 F\_DAMAGED_i * B\_DAMAGED_{i,t-1} + \beta_5 F\_CONSTRAINTS_{i,t-1} \\ &+ \beta_6 B\_CAPACITY_{it-1} + \varepsilon_{it} \qquad for\ \ t = 1995, 1996, 1997. \qquad (2)\end{aligned}$$

The dependent variable now is the difference in investment ratio between the post-earthquake period (in FY1995, FY1996, and FY1997) and the pre-earthquake period (FY1994). Because the BSBSA database contains firm characteristic data only from FY1994, the information on capital stock as of FY1993 (K_{i93}) is not available. We therefore include a rather unconventional variable: the ratio of investment to the *contemporaneous* end-of-period capital stock (I_{it} / K_{it}) rather than the ratio of investment to the previous end-of-period capital stock (I_{it} / K_{it-1}). Because the information on firm characteristics as of FY1993 ($F\_CONSTRAINTS_{i93}$) is also unavailable, we do not difference the explanatory variables.[18]

The results are shown in Table 10. *F_SALESGROWTH* has a positive coefficient in all years and is significant in FY1997 for specification (2). More importantly, *B_HQDAMAGED* has a negative and significant coefficient in FY1995 (first column), while *B_BRDAMAGED* has a negative and significant

[18] We obtained the information on sales in FY1993 from the TDB database in order to construct the variable $F\_SALESGROWTH_{i,94}$.

coefficient in FY1996 (fourth column), both of which are consistent with our baseline results. On the other hand, when we test whether the sum of the coefficients on *B_DAMAGED* and on the interaction term of *F_DAMAGED* and *B_HQDAMAGED* is statistically different from zero, we find that the sum is not significant in any year, suggesting that the portfolio shift effect observed in the baseline estimation is not robust to an alternative estimation strategy. As for the control variables, *F_ROA* and *F_CASH* are positive and significant in all years for both specifications, and *B_ROA* has a positive and significant coefficient in FY1997. Overall, controlling for firm-level fixed effects yields reasonable results and does not substantially change the results concerning the effects of bank damage on the investment of undamaged firms.

7. Conclusion

In this paper we investigated whether the lending capacity of banks affects firm investment. To overcome the difficulties in identifying truly exogenous shocks to the lending capacity of banks, we utilized the natural experiment provided by the Kobe earthquake. Using a unique firm-level dataset that allows us to identify firms and banks in the affected area, and combining this dataset with information on bank-firm relationships and financial statements, we examined the impact that a transactional relationship with a bank in the affected area had on the post-earthquake investment of client firms that were not themselves directly affected by the earthquake.

We found that the investment ratio of firms located *outside* the earthquake-affected area but having a main bank *inside* the area was smaller than that of firms whose main bank was outside the affected area. This result implies that the weakened lending capacity of damaged banks exacerbated borrowing constraints on the investment of their client firms. In addition, we found that the negative impact is robust to whether bank damage is measured as damage to the bank's headquarters or damage to its branch network. However, while the impact of headquarters damage emerged immediately after the earthquake, the impact of branch damage appeared only with a one-year lag. This difference in the timing of the impacts suggests that there were two different channels through which damage to banks affected client firms: through the impairment of banks' managerial capacity to originate loans, and through the impairment of their risk-taking capacity. It is also noteworthy that bank damage, either to headquarters or branch networks, did not last for a long time; by three years after the earthquake, the effect had dissipated.

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Tables

Table 1. Estimated damage caused by the Kobe earthquake

		No. of deaths	No. of housing units completely destroyed	No. of housing units partly destroyed	Death rate	Rate of housing units completely destroyed	Rate of housing units partly destroyed	Rate of housing units completely or partly destroyed
Regions in designated disaster area		**6,405**	**104,455**	**140,681**	**0.17%**	**16.50%**	**22.23%**	**38.73%**
Kobe City	Higashinada-ku	1,470	12,832	5,085	0.77%	50.50%	20.01%	70.51%
	Nada-ku	931	11,795	5,325	0.72%	54.13%	24.44%	78.57%
	Hyogo-ku	553	8,148	7,317	0.45%	35.55%	31.92%	67.47%
	Nagata-ku	917	14,662	7,770	0.67%	60.21%	31.91%	92.12%
	Suma-ku	401	7,466	5,344	0.21%	27.68%	19.81%	47.50%
	Tarumi-ku	25	1,087	8,575	0.01%	2.78%	21.95%	24.73%
	Kita-ku	13	251	3,029	0.01%	0.63%	7.67%	8.31%
	Chuo-ku	243	5,156	5,533	0.21%	33.39%	35.84%	69.23%
	Nishi-ku	9	403	3,147	0.01%	1.19%	9.28%	10.46%
Amagasaki City		49	5,688	36,002	0.01%	7.60%	48.07%	55.67%
Nishinomiya City		1,126	20,667	14,597	0.26%	31.30%	22.11%	53.41%
Ashiya City		443	3,915	3,571	0.51%	31.67%	28.89%	60.57%
Itami City		22	1,395	7,499	0.01%	4.39%	23.57%	27.96%
Takarazuka City		117	3,559	9,313	0.06%	9.12%	23.86%	32.98%
Kawanishi City		4	554	2,728	0.00%	1.56%	7.70%	9.26%
Akashi City		11	2,941	6,673	0.00%	5.51%	12.51%	18.02%
Sumoto City		4	203	932	0.01%	1.71%	7.83%	9.54%
Awaji City		58	3,076	3,976	0.11%	NA	NA	NA
Toyonaka City		9	657	4,265	0.00%	1.12%	7.27%	8.39%
Regions outside designated area		**22**	**445**	**3,427**	**0.00%**	**0.04%**	**0.30%**	**0.33%**

Note: "Regions outside designated area" refers to regions that are in Hyogo and Osaka prefectures but were not included in the Act Concerning Special Financial Support to Deal with a Designated Disaster of Extreme Severity. All rates for these regions are the averages of all cities and towns in these regions. The Act Concerning Special Financial Support to Deal with a Designated Disaster of Extreme Severity covered nine cities and five towns. One of the towns has since been merged into Sumoto City, while the other four have been merged together to form Awaji City. The table here shows the casualties and housing damage for the merged entities. The number of deaths and the numbers of destroyed housing units were compiled by the Fire and Disaster Management Agency and are as of May 19, 2006. To calculate the rates, we used data from the 1990 *Population Census* and the 1993 *Housing and Land Survey*. The figures on the losses of housing units are taken from <http://web.pref.hyogo.jp/pa20/pa20_000000006.html>. The table covers all cities and towns in Hyogo Prefecture as well as some in Osaka Prefecture (for a total of nine cities and five towns in the two prefectures combined), which were included in the Act Concerning Special Financial Support to Deal with a Designated Disaster of Extreme Severity.To calculate the ratio of the number of casualties to the total population and the ratios of the numbers of completely and partly destroyed housing units to the total number of housing units, we used data from the 1990 Population Census (Ministry of Internal Affairs and Communications, Government of Japan) and the 1993 Housing and Land Survey (Ministry of Construction).

Table 2. Bank branch operations after the earthquake

Type of banks	No. of banks	No. of branches	As of Jan 18, 1995	
			Operated	Did Not Operate
City banks	11	227	125	102
Long-term banks	2	2	0	2
Trust banks	6	17	10	7
Regional banks	13	122	72	50
Regional banks 2	12	254	106	148
Shinkin banks	15	422	325	97
Credit Cooperatives	15	111	77	34
Total	74	1155	715	440

Note. The sample is limited to those financial institutions whose branches were located in Hyogo prefecture. "Regional banks 2" refers to member banks of the Second Association of Regional Banks. Shinkin banks (shinyo kinko in Japanese) and credit cooperatives (shinyo kumiai in Japanese) are small credit unions. The data source is the Bank of Japan.

Table 3. Banks headquartered in the earhtquake-affected area

Prefecture	Name and type of financial institution		Loans outstanding (100 million yen)	No. of branches
Osaka	Suito Shinkin	Shinkin bank	1,720	19
	Howa Shinso	Credit cooperative	377	8
Hyogo	Hyogo Bank	Regional bank 2	27,443	147
	Hanshin Bank	Regional bank 2	8,772	80
	6 Shinkins (total)		19,752	192
	8 credit unions (total)		4,381	66

Note: Regional bank 2 refers to a member bank of the Second Association of Regional Banks. Shinkin banks (shinyo kinko in Japanese) and credit cooperatives (shinyo kumiai in Japanese) are small credit unions.The earthquake-affected area comprises 8 cities and 5 towns (among them Kobe City itself) in Hyogo prefecture and 1 city (Toyonaka City) in Osaka prefecture. The data sources are Nikkei NEEDS Financial Quest, Financial Statements of Shinkin Banks in Japan, and Financial Statements of Credit Cooperatives in Japan.

Table 4. Share of firms dropped from the sample

	No. of firms observed in FY1994	No. of firms dropped out of the sample		
	FY1994	FY1995	FY1996	FY1997
Full sample	3,212	430	612	895
(Percentage)	100.0%	13.4%	19.1%	27.9%
F_DAMAGED = 0	2,621	364	513	727
(Percentage)	100.0%	13.9%	19.6%	27.7%
F_DAMAGED = 1	591	66	99	168
(Percentage)	100.0%	11.2%	16.8%	28.4%
B_DAMAGED = 0	3,157	421	597	876
(Percentage)	100.0%	13.3%	18.9%	27.7%
B_DAMAGED = 1	55	9	15	19
(Percentage)	100.0%	16.4%	27.3%	34.5%

Table 5. Industry composition

	F_DAMAGED = 1		F_DAMAGED = 0	
	No. of firms	Share	No. of firms	Share
Agriculture, forestry and fisheries	0	0.0	0	0.0
Mining	0	0.0	0	0.0
Construction	8	2.3	23	1.4
Manufacturing	220	62.7	910	56.7
Wholesale	80	22.8	552	34.4
Retail and restaurants	35	10.0	102	6.4
Services	8	2.3	17	1.1
Other	0	0.0	0	0.0
Total	351	100.0	1,604	100.0

Note. The observation period is FY1995.

Table 6. Fraction of firms that switched their main banks

	No. of firms in FY1994	No. of firms that switched their main banks		
	FY1994	FY1995	FY1996	FY1997
Full sample	2,094	57	81	124
(Percentage)	100.0%	2.7%	3.9%	5.9%
F_DAMAGED = 0	1,703	41	65	94
(Percentage)	100.0%	2.4%	3.8%	5.5%
F_DAMAGED = 1	391	16	16	30
(Percentage)	100.0%	4.1%	4.1%	7.7%

Table 7(a). Summary statistics for sample firms

FY1995

	Whole sample			*F_DAMAGED* =1			*F_DAMAGED* =0			t-test for (*F_DAMAGED* =1) = (*F_DAMAGED* =0)	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	difference	p-value
F_INVESTMENTRATIO	1,955	0.136	0.231	351	0.158	0.264	1,604	0.131	0.223	0.0268	**
F_SALESGROWTH	1,955	0.003	0.106	351	-0.011	0.126	1,604	0.007	0.101		
F_LNASSETS	1,955	8.659	1.269	351	8.516	1.306	1,604	8.690	1.259		
F_LEV	1,955	6.800	12.423	351	5.415	8.988	1,604	7.103	13.037		
F_ROA	1,955	0.028	0.043	351	0.023	0.050	1,604	0.029	0.041		
F_CASH	1,955	0.635	0.167	351	0.625	0.165	1,604	0.637	0.167		
F_DAMAGED	1,955	0.180	0.384	351	1.000	0.000	1,604	0.000	0.000		
B_LNASSETS	1,955	24.151	1.086	351	24.209	1.086	1,604	24.139	1.086	0.0700	
B_CAP	1,955	0.036	0.004	351	0.036	0.004	1,604	0.036	0.004	-0.0002	
B_ROA	1,955	0.003	0.004	351	0.003	0.003	1,604	0.004	0.004	-0.0002	
B_HQDAMAGED	1,955	0.008	0.087	351	0.031	0.174	1,604	0.002	0.050	0.0288	***
B_BRDAMAGED	1,955	0.077	0.089	351	0.113	0.138	1,604	0.070	0.072	0.0434	***

FY1996

	Whole sample			*F_DAMAGED* =1			*F_DAMAGED* =0			t-test for (*F_DAMAGED* =1) = (*F_DAMAGED* =0)	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	difference	p-value
F_INVESTMENTRATIO	1,990	0.140	0.228	362	0.156	0.229	1,628	0.136	0.228	0.0202	
F_SALESGROWTH	1,990	0.020	0.111	362	0.022	0.141	1,628	0.020	0.103		
F_LNASSETS	1,990	8.679	1.266	362	8.532	1.285	1,628	8.712	1.260		
F_LEV	1,990	6.761	12.626	362	6.151	11.375	1,628	6.897	12.887		
F_ROA	1,990	0.029	0.041	362	0.026	0.045	1,628	0.029	0.040		
F_CASH	1,990	0.635	0.168	362	0.623	0.173	1,628	0.638	0.167		
F_DAMAGED	1,990	0.182	0.386	362	1.000	0.000	1,628	0.000	0.000		
B_LNASSETS	1,990	24.175	1.100	362	24.216	1.097	1,628	24.166	1.100	0.0499	
B_CAP	1,990	0.031	0.005	362	0.031	0.006	1,628	0.032	0.005	-0.0007	**
B_ROA	1,990	0.007	0.008	362	0.009	0.010	1,628	0.007	0.008	0.0018	***

FY1997

	Whole sample			*F_DAMAGED* =1			*F_DAMAGED* =0			t-test for (*F_DAMAGED* =1) = (*F_DAMAGED* =0)	
Variable	Obs.	Std. dev.	Std. Dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	difference	p-value
F_INVESTMENTRATIO	1,997	0.135	0.205	366	0.151	0.219	1,631	0.131	0.202	0.0200	*
F_SALESGROWTH	1,997	0.032	0.098	366	0.024	0.123	1,631	0.033	0.091		
F_LNASSETS	1,997	8.702	1.278	366	8.540	1.289	1,631	8.739	1.273		
F_LEV	1,997	6.593	12.781	366	5.188	9.274	1,631	6.908	13.425		
F_ROA	1,997	0.033	0.039	366	0.030	0.041	1,631	0.033	0.039		
F_CASH	1,997	0.635	0.170	366	0.614	0.174	1,631	0.639	0.169		
F_DAMAGED	1,997	0.183	0.387	366	1.000	0.000	1,631	0.000	0.000		
B_LNASSETS	1,997	24.223	1.118	366	24.258	1.139	1,631	24.216	1.113	0.0421	
B_CAP	1,997	0.032	0.005	366	0.031	0.005	1,631	0.032	0.005	-0.0004	
B_ROA	1,997	0.003	0.005	366	0.003	0.003	1,631	0.003	0.005	0.0000	

Note: *F_INVESTMENTRATIO* is the ratio of firms' capital investment to one-period lagged fixed assets, *F_SALESGROWTH* is the growth rate of firms' sales, *F_LNASSETS* is the natural logarithm of firms' total assets, *F_LEV* is the ratio of firms' liabilities to equity, *F_ROA* is the ratio of firms' current profit to total assets, *F_CASH* is the ratio of firms' liquid assets to total assets, *F_DAMAGED* is a dummy variable taking a value of one if the firm is located in one of the cities or towns identified as affected by the earthquake in the Act on Special Financial Support to Deal with a Designated Disaster of Extreme Severity, *B_LNASSETS* is the natural logarithm of the total assets owned by a firm's main bank, *B_CAP* is the equity to assets ratio of a firm's main bank, *B_ROA* is the ratio of operating profit to total assets of a firm's main bank, *B_HQDAMAGED* is a dummy variable taking a value of one if the headquarters of a firm's main bank is located in the earthquake-affected area, and *B_BRDAMAGED* is the ratio of the number of branches of a firm's main bank located in the earthquake-affected area to the total number of branches of that bank.

Table 7(b). Summary statistics for sample banks

FY1995	Whole sample			*B_HQDAMAGED* =1			*B_HQDAMAGED* =0			t-test for (*B_HQDAMAGED* =1) = (*B_HQDAMAGED* =0)	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	difference	p-value
B_LNASSETS	70	21.755	1.554	4	21.024	0.700	66	21.799	1.583	-0.776	
B_CAP	70	0.041	0.014	4	0.033	0.022	66	0.041	0.014	-0.008	
B_ROA	70	0.007	0.015	4	0.001	0.001	66	0.008	0.015	-0.007	

FY1996	Whole sample			*B_HQDAMAGED* =1			*B_HQDAMAGED* =0			t-test for (*B_HQDAMAGED* =1) = (*B_HQDAMAGED* =0)	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	t-value	p-value
B_LNASSETS	70	21.769	1.565	4	21.020	0.677	66	21.814	1.594	-0.794	
B_CAP	70	0.040	0.016	4	0.027	0.033	66	0.041	0.014	-0.014	*
B_ROA	70	0.003	0.004	4	0.005	0.006	66	0.003	0.004	0.002	

FY1997	Whole sample			*B_HQDAMAGED* =1			*B_HQDAMAGED* =0			t-test for (*B_HQDAMAGED* =1) = (*B_HQDAMAGED* =0)	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	t-value	p-value
B_LNASSETS	70	21.770	1.556	4	20.998	0.666	66	21.817	1.585	-0.819	
B_CAP	70	0.035	0.023	4	0.008	0.071	66	0.037	0.017	-0.029	**
B_ROA	70	0.010	0.016	4	0.024	0.039	66	0.009	0.013	0.015	*

FY1995	*B_BRDAMAGED* >Med(+)			*B_BRDAMAGED* <Med(+)			t-test for (*B_BRDAMAGED* >Med(+)) = (*B_BRDAMAGED* <Med(+))	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	t-value	p-value
B_LNASSETS	22	22.704	1.388	48	21.320	1.438	1.384	***
B_CAP	22	0.035	0.007	48	0.044	0.016	-0.008	**
B_ROA	22	0.013	0.020	48	0.005	0.011	0.008	**

FY1996	*B_BRDAMAGED* >Med(+)			*B_BRDAMAGED* <Med(+)			t-test for (*B_BRDAMAGED* >Med(+)) = (*B_BRDAMAGED* <Med(+))	
Variable	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	t-value	p-value
B_LNASSETS	22	22.730	1.437	48	21.329	1.429	1.401	***
B_CAP	22	0.035	0.007	48	0.042	0.018	-0.007	*
B_ROA	22	0.003	0.003	48	0.003	0.005	0.001	

FY1997	*B_BRDAMAGE* >Med(+)			*B_BRDAMAGE* <Med(+)			t-test for (*B_BRDAMAGED* >Med(+)) = (*B_BRDAMAGED* <Med(+))	
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	t-value	p-value
B_LNASSETS	22	22.716	1.442	48	21.336	1.420	1.380	***
B_CAP	22	0.031	0.010	48	0.037	0.027	-0.006	
B_ROA	22	0.014	0.021	48	0.008	0.012	0.006	

Note: B_BRDAMAGED is the ratio of the number of branches of a bank that were located in the earthquake-affected area to that bank's total number of branches. Med(+) is the median of B_BRDAMAGED conditional on B_BRDAMAGED being positive. B_LNASSETS is the natural logarithm of the total assets owned by the bank, B_CAP is the equity to assets ratio of the bank, and B_ROA is the bank's ratio of operating profit to total assets.

Table 8. Year-by-year cross-sectional regressions for investment ratio

Dependent variable: *F_INVESTMENTRATIO* (t)	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*
	FY1995		FY1996		FY1997	
F_SALESGROWTH (t-1)	0.0960 *	0.1006 *	0.0452	0.0437	0.1712 ***	0.1741 ***
	(0.0529)	(0.0528)	(0.0479)	(0.0480)	(0.0490)	(0.0490)
F_DAMAGED	0.0244 *	-0.0042	0.0233 *	0.0182	0.0281 **	0.0327 **
	(0.0134)	(0.0205)	(0.0128)	(0.0171)	(0.0127)	(0.0144)
B_DAMAGED †	-0.0815 ***	-0.0396	-0.0290	-0.1273 **	0.1713 ***	0.0061
	(0.0230)	(0.0558)	(0.0297)	(0.0593)	(0.0666)	(0.0611)
F_DAMAGED	0.3578 **	0.3473 *	0.0721	0.1037	-0.2114 ***	-0.0578
×*B_DAMAGED* †	(0.1678)	(0.1893)	(0.0706)	(0.1001)	(0.0778)	(0.0866)
F_LNASSETS (t-1)	0.0056	0.0056	0.0167 ***	0.0165 ***	0.0067 *	0.0066 *
	(0.0039)	(0.0039)	(0.0041)	(0.0041)	(0.0035)	(0.0035)
F_LEV (t-1)	-0.0004 *	-0.0005 *	0.0000	0.0000	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0004)	(0.0004)	(0.0006)	(0.0006)
F_ROA (t-1)	1.1521 ***	1.1452 ***	0.8211 ***	0.8183 ***	0.8451 ***	0.8461 ***
	(0.1502)	(0.1504)	(0.1404)	(0.1402)	(0.1227)	(0.1227)
F_CASH (t-1)	0.1228 ***	0.1229 ***	0.1270 ***	0.1250 ***	0.0850 ***	0.0857 ***
	(0.0333)	(0.0332)	(0.0347)	(0.0348)	(0.0250)	(0.0250)
B_LNASSETS (t-1)	-0.0005	-0.0002	-0.0032	-0.0052	-0.0009	-0.0016
	(0.0061)	(0.0065)	(0.0062)	(0.0065)	(0.0043)	(0.0045)
B_CAP (t-1)	-0.9513	-0.5902	0.5575	0.2849	-0.7586	-0.8526
	(1.2277)	(1.2463)	(1.2171)	(1.2216)	(0.9377)	(0.9521)
B_ROA (t-1)	-1.6745	-1.3800	0.6028	0.6032	-0.6228	-0.6204
	(1.4629)	(1.4998)	(1.1214)	(1.1178)	(0.5936)	(0.5971)
Constant	0.1008	0.0825	-0.0309	0.0374	-0.0181	0.0028
	(0.1928)	(0.2017)	(0.2088)	(0.2196)	(0.1237)	(0.1303)
Sum of coefficients on *B_HQDAMAGED* and *F_DAMAGED*B_HQDAMAGED*	0.2764 *		0.0431		-0.0401	
	(0.1678)		(0.0668)		(0.0420)	
Obs	1,955	1,955	1,990	1,990	1,997	1,997
F-value	9.46	8.62	7.05	7.21	8.97	8.47
p-value	**	**			**	
R-squared	0.0811	0.0792	0.0462	0.0472	0.0581	0.0567
Root MSE	0.2223	0.2225	0.2239	0.2238	0.1996	0.1998
Industry dummies	yes	yes	yes	yes	yes	yes

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The significance level of the sum of the coefficients on *B_DAMAGED* and *F_DAMAGED×B_DAMAGED* is based on the F-values under the null hypotheses that the sum is zero.

† The *B_DAMAGED* variable is either *B_HQDAMAGED* or *B_BRDAMAGED* as indicated in the column heading.

Table 9. Year-by-year cross-sectional regressions for investment ratio with small bank dummy

Dependent variable: *F_INVESTMENTRATIO* (t)	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*
	FY1995		FY1996		FY1997	
F_SALESGROWTH (t-1)	0.0951 *	0.0994 *	0.0432	0.0422	0.1714 ***	0.1745 ***
	(0.0532)	(0.0532)	(0.0481)	(0.0480)	(0.0490)	(0.0490)
F_DAMAGED	0.0276 **	0.0069	0.0257 **	0.0306 *	0.0280 **	0.0316 **
	(0.0137)	(0.0221)	(0.0128)	(0.0168)	(0.0127)	(0.0142)
B_DAMAGED †×*SMALL*	-0.1000 ***	-0.0429	-0.0579 ***	-0.1425 **	0.1165 *	-0.0281
	(0.0212)	(0.0580)	(0.0212)	(0.0609)	(0.0618)	(0.0585)
F_DAMAGED	0.3351	0.2627	-0.0025	-0.0116	-0.1764 **	-0.0387
×*B_DAMAGED*†×*SMALL*	(0.2055)	(0.2126)	(0.0348)	(0.0860)	(0.0711)	(0.0872)
F_LNASSETS (t-1)	0.0058	0.0056	0.0166 ***	0.0163 ***	0.0066 *	0.0065 *
	(0.0039)	(0.0039)	(0.0041)	(0.0041)	(0.0035)	(0.0035)
F_LEV (t-1)	0.0002	-0.0005 *	0.0000	0.0000	0.0002	0.0002
	(0.0006)	(0.0002)	(0.0004)	(0.0004)	(0.0006)	(0.0006)
F_ROA (t-1)	1.1462 ***	1.1415 ***	0.8204 ***	0.8187 ***	0.8471 ***	0.8460 ***
	(0.1502)	(0.1500)	(0.1405)	(0.1401)	(0.1228)	(0.1225)
F_CASH (t-1)	0.1248 ***	0.1240 ***	0.1257 ***	0.1233 ***	0.0847 ***	0.0852 ***
	(0.0330)	(0.0330)	(0.0348)	(0.0348)	(0.0251)	(0.0251)
B_LNASSETS (t-1)	-0.0024	-0.0024	-0.0041	-0.0061	-0.0011	-0.0018
	(0.0063)	(0.0066)	(0.0061)	(0.0064)	(0.0043)	(0.0044)
B_CAP (t-1)	-1.0778	-0.8027	0.5806	0.1778	-0.7451	-0.8599
	(1.2306)	(1.2472)	(1.2194)	(1.2144)	(0.9479)	(0.9530)
B_ROA (t-1)	-1.7979	-1.5847	0.5885	0.6072	-0.6093	-0.6436
	(1.4634)	(1.4982)	(1.1210)	(1.1157)	(0.5951)	(0.5959)
Constant	0.1480	0.1422	-0.0079	0.0662	-0.0107	0.0107
	(0.1956)	(0.2051)	(0.2071)	(0.2162)	(0.1240)	(0.1291)
Sum of coefficients on *B_HQDAMAGED*SMALL* and *F_DAMAGED*B_HQDAMAGED *SMALL*	0.2352		-0.0605 *		-0.0599	
	(0.2060)		(0.0334)		(0.0367)	
Obs	1,955	1,955	1,990	1,990	1,997	1,997
F-value (1)	10.99	8.38	8.40	7.50	8.97	8.54
p-value				**		
R-squared	0.0777	0.0759	0.0464	0.0485	0.0573	0.0568
Root MSE	0.2227	0.2229	0.2239	0.2237	0.1997	0.1998
Industry dummies	yes	yes	yes	yes	yes	yes

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The significance level of the sum of the coefficients on *B_DAMAGED* and *F_DAMAGED*×*B_DAMAGED* is based on the F-values under the null hypotheses that the sum is zero.

† The *B_DAMAGED* variable is either *B_HQDAMAGED* or *B_BRDAMAGED* as indicated in the column heading.

Table 10. Year-by-year cross-sectional regressions controlling for firm-level fixed effects

Dependent variable: *F_INVESTMENTRATIO* (t) - *F_INVESTMENTRATIO* (1994)	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*	(1) *B_DAMAGED* = *B_HQDAMAGED*	(2) *B_DAMAGED* = *B_BRDAMAGED*
	FY1995		FY1996		FY1997	
F_SALESGROWTH (t-1)	0.0248	0.0265	0.0517	0.0504	0.0859	0.0892 *
	(0.0374)	(0.0374)	(0.0357)	(0.0356)	(0.0525)	(0.0525)
F_DAMAGED	0.0124	0.0014	0.0117	0.0070	0.0230 *	0.0268 *
	(0.0115)	(0.0154)	(0.0114)	(0.0138)	(0.0124)	(0.0143)
B_DAMAGED †	-0.0422 **	-0.0794	-0.0125	-0.1495 ***	0.1409 ***	-0.0425
	(0.0193)	(0.0536)	(0.0209)	(0.0580)	(0.0399)	(0.0722)
F_DAMAGED ×*B_DAMAGED* †	0.1562 **	0.1603	0.0124	0.0968	-0.2128 ***	-0.0405
	(0.0752)	(0.1041)	(0.0402)	(0.0805)	(0.0519)	(0.0916)
F_LNASSETS (t-1)	0.0012	0.0010	0.0057 *	0.0054	0.0010	0.0009
	(0.0033)	(0.0033)	(0.0034)	(0.0034)	(0.0035)	(0.0035)
F_LEV (t-1)	-0.0002	-0.0002	0.0001	0.0001	-0.0003	-0.0003
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
F_ROA (t-1)	0.2448 **	0.2415 **	0.2072 *	0.2033 *	0.2495 *	0.2516 *
	(0.1173)	(0.1172)	(0.1190)	(0.1190)	(0.1366)	(0.1364)
F_CASH (t-1)	0.0618 **	0.0609 **	0.0688 ***	0.0671 ***	0.0521 *	0.0524 **
	(0.0253)	(0.0254)	(0.0261)	(0.0261)	(0.0266)	(0.0266)
B_LNASSETS (t-1)	-0.0052	-0.0064	-0.0057	-0.0079 *	-0.0028	-0.0039
	(0.0047)	(0.0048)	(0.0047)	(0.0048)	(0.0040)	(0.0040)
B_CAP (t-1)	0.3456	0.3460	0.8485	0.5054	0.5087	0.3054
	(1.0447)	(1.0544)	(0.8939)	(0.8966)	(0.9133)	(0.9099)
B_ROA (t-1)	-1.0688	-1.0911	-0.0761	-0.0704	1.0520 *	1.0138 *
	(1.2010)	(1.2051)	(0.4994)	(0.4980)	(0.5688)	(0.5754)
Constant	0.1613	0.1965	0.0493	0.1271	0.0161	0.0543
	(0.1513)	(0.1556)	(0.1413)	(0.1443)	(0.1214)	(0.1225)
Sum of coefficients on *B_HQDAMAGED* and *F_DAMAGED*B_HQDAMAGED*	0.1140		-0.0001		-0.0719 **	
	(0.0744)		(0.0373)		(0.0343)	
Obs	1,946	1,946	1,971	1,971	1,980	1,980
F-value (1)	2.45	2.25	1.88	2.32	2.95	1.98
p-value	*					
Value (1)	0.1264		0.0116		-0.0489	
p-value	**				***	
Value (2)	0.1686		0.0241		-0.1898	
p-value					**	
Value (3)	0.1140		-0.0001		-0.0719	
p-value	***		***		***	
R-squared	0.0192	0.0185	0.0139	0.0164	0.0137	0.0126
Root MSE	0.1802	0.1802	0.1903	0.1901	0.1921	0.1922
Industry dummies	yes	yes	yes	yes	yes	yes

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The significance level of the sum of the coefficients on *B_DAMAGED* and *F_DAMAGED×B_DAMAGED* is based on the F-values under the null hypotheses that the sum is zero.

† The *B_DAMAGED* variable is either *B_HQDAMAGED* or *B_BRDAMAGED* as indicated in the column heading.