# “Natural Disasters, Damage to Banks, and Firm Investment”

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# 1. Introduction & Motivation

- Bank lending and firms' capital investment: Bernanke (1983)

- Identification problem: Peek & Rosengren (2000)

  ⇔ Better to employ separated exogenous shocks to banks and firms

- **This paper**

  - Natural disaster as an **experiment**: The Kobe earthquake in January 1995
  - Data of the firms located **inside (Fi) / outside (Fo)** the earthquake-affected area & the lender banks located **inside (Bi) / outside (Bo)** the earthquake-affected area
  - Study how the **financial friction** associated with earthquake-affected banks affects **capital investment** by client firms located outside the affected area.
  - **Two measures** for the damage of banks ( on "Headquarter" or "Branch network")

# 2. Key Findings

- **Firms located *outside*** the earthquake-affected area but associated with a **main bank located *inside*** the area **had a lower investment ratio** compared to the firms associated with a main bank located outside the are

Exogenously damaged banks' lending capacity has a significant effect on firm investment

- This finding above is robust to **two alternative measures** of bank damage

  — (i) Damage to the headquarter

    ☐ Deteriorated managerial capacity to process loan applications at the back office

  — (ii) Damage to the branch networks

    ☐ Deteriorated financial health and risk-taking capacity

- The impact of (i) emerges **immediately** while that of (ii) emerges with a **one-year lag**

# 3. Literature

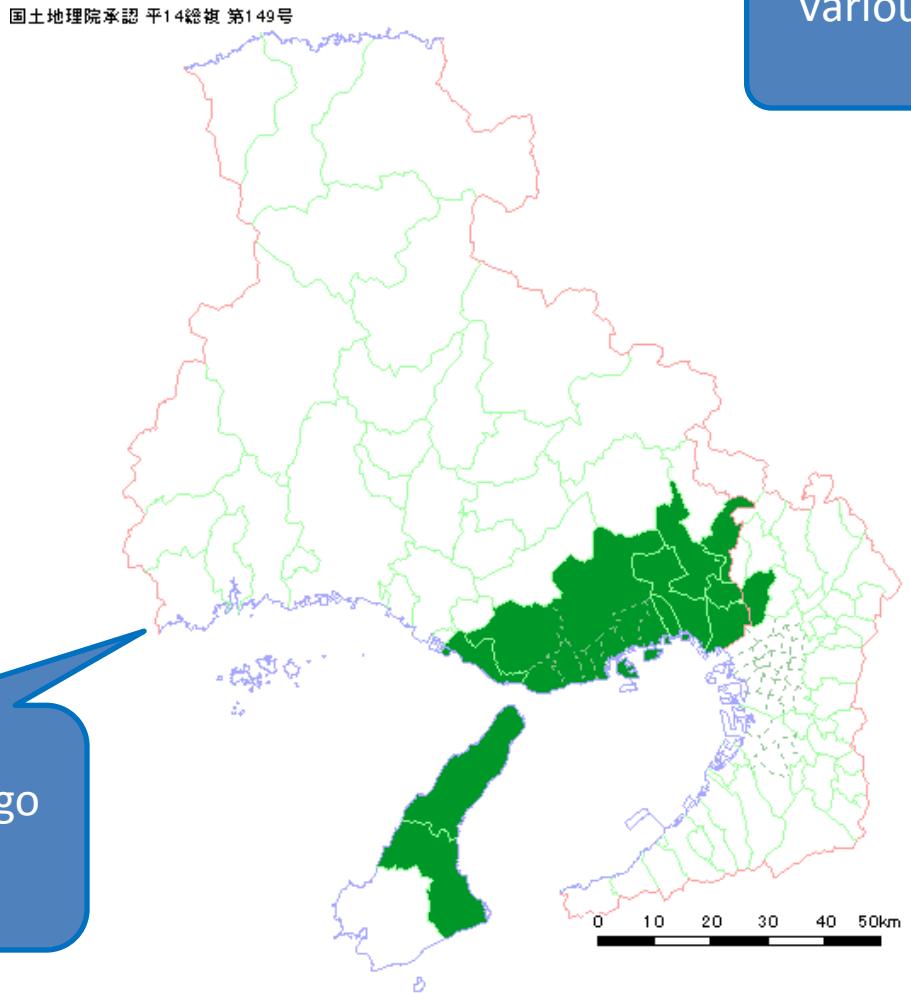
- **Bank loan and firm Activity**
  - **Aggregate data**: Berbanke (1983), Bernanke & Lown (1991)
  - **Event study**: Slovin et al. (1993), Yamori & Murakami (1999), Bae et al. (2002)
  - **Micro data**: Gibson (1995, 1997), Hori (2005), Minamihashi (2011)
  - **Identification strategy**: Peek & Rosengren (2000), Khwaja & Mian (2008), Berg and Shrader (2012)
  - **Int'l transmission**: Chava & Purnanandam (2011), Schnabl (2012), Popov & Udell (2010), Paravisini et al. (2011), Catorelli and Goldberg (2012)

- **Natural disaster and economic recovery**
  - **Country- or region-level data**: Skidmore & Toya (2002) and many…
  - **Firm-level data**: Leiter et al. (2009), De Mel et al. (2010)
  - **Household and financial constraint**: Sawada & Shimizutani (2008)

# 4. The Kobe Earthquake (1): Area

- **Earthquake-affected (treatment) area** = the targeted areas of *"the Act concerning Special Financial Support to Deal with the Designated Disaster of Extreme Severity by the Government of Japan"*
- **Control area** (the others in Hyogo and Osaka)

Various treatments for recovery become available




Osaka and Hyogo Prefectures

# 4. The Kobe Earthquake (2): Summary

- Occurred on January 17, 1995
- Estimated loss: 9.9 trillion yen, including 630 billion yen in business sector losses

| | | 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%** |

# 4. The Kobe Earthquake (3): Branch damages

- A quarter of bank branches in Hyogo Prefecture could not operate immediately after the earthquake.

| Type of banks | #(banks) | #(branches) | As of Jan 18, 1995 | |
|---|---|---|---|---|
| | | | Operated | Not Operated |
| City bank | 11 | 227 | 125 | 102 |
| Long-term | 2 | 2 | 0 | 2 |
| Trust | 6 | 17 | 10 | 7 |
| Regional | 13 | 122 | 72 | 50 |
| Regional2 | 12 | 254 | 106 | 148 |
| Shinkin bank | 15 | 422 | 325 | 97 |
| Credit Cooperatives | 15 | 111 | 77 | 34 |
| Total sum | 74 | 1155 | 715 | 440 |

(Source: BOJ)

# 4. The Kobe Earthquake (4): Headquarter damages

- 18 bank headquarters were affected by the disaster.

**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 shinkin banks (total) | | 19,752 | 192 |
| | 8 credit cooperatives (total) | | 4,381 | 66 |

# 5. Data (1): Sources

- **Basic Survey of Business Structure and Activities** (BSBSA: Kigyo Katsudou Kihon Chosa)
  ⇒ Ministry of Economy, Trade, and Industry in Japan
  ⇒ Covers the universe of enterprises in Japan with 50 or more employees whose paid-up capital or investment fund is greater than 30 million yen
  ⇒ "Firm-level" data storing capital investment and other basic financial statement info

- **Database provided by Teikoku Databank, Ltd (TDB).**
  ⇒ List of banks that each firm transacts with
  ⇒ Rank the banks in the order of the importance to the firm (⇒identify main bank)

- **Nikkei NEEDS Financial Quest** ⇒ Banks' financial information

- **Two more sources**
  ⇒ "Financial Statements of Shinkin Banks in Japan" and "Financial Statement of Credit Cooperatives in Japan" for the financial info of shinkin banks and credit cooperatives

- **Sample periods: 1995FY～1997FY** (i.e., mainly start from April and end in March)

# 5. Data (2): Sample selection

- **BSBSA**:
  - Number of sample firms 3897. Earthquake-hit area 641, non-hit area 3,256

- **Merge BSBSA & TDB**:
  - Number of sample firms 3,212, Earthquake-hit area 591, non-hit area 2621

- Construct **balanced panel data** over 1995FY to 1999FY by restricting our sample to firms that survived and whose main bank also survived over the three years.
  - Number of sample firms 2,086, Earthquake-hit area 390, non-hit area 1,696

- **Drop the outlier** (0.5% samples in each tail)
  - Number of sample firms **1,995**, Earthquake-hit area **351**, non-hit area **1,604**

# 5. Data (3): Selection bias?

- One may worry that we observe only healthy firms inside the affected area by restricting our sample to survivors.
- However, the drop-out rate was smaller for firms located inside the affected area than that for firms located outside the affected area in FY1996 and FY1996.

| | 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% |

# 6. Empirical Analysis (1): Model

- Year-by-year cross-section OLS
- All independent variables are one-period lagged

Proxy for Tobin's Q

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

Bank Size, ROA, and Equity Ratio

Firm Size, Leverage, ROA, and CASH (Liquidity asset to Total asset Ratio)

# 6. Empirical Analysis (2): Firm & Bank Damage Variables

- Firm:
  - —"**F_DAMAGED**": Dummy variable
    - ⇔ Taking the value of 1 if the firm is located in the earthquake-affected area

- Bank:
  - —"**B_HQDAMAGED**": Dummy variable
    - ⇔ Taking the value of 1 if the bank **HQ** is located in the earthquake-affected area
      - ☐ Deteriorated managerial capacity
      - ☐ Ability to process loan applications at the back office
  - —"**B_BRDAMAGED**": Continuously measured variable
    - ⇔ Ratio of **#(branches)** located in the earthquake-affected area to #(all branches)
      - ☐ Deteriorated financial health and risk-taking capacity

# 6. Empirical Analysis (3): Summary Statistics (Firm)

- Capital investment ratio (= I(t)/K(t-1)) of **Fi (inside)** > **Fo (outside)**

Recovery motive

- What about Fi-Bo, **Fo-Bi**, and Fi-Bi compared to **Fo-Bo**?

Financial friction

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 | *** |

# 6. Empirical Analysis (4): Baseline estimation

| 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_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* ×*B_DAMAGED* † | 0.3578 ** | 0.3473 * | 0.0721 | 0.1037 | -0.2114 *** | -0.0578 |
| | (0.1678) | (0.1893) | (0.0706) | (0.1001) | (0.0778) | (0.0866) |
| 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 |

Firms' financial condition variables have coefficients with expected signs with different significance levels, while banks' financial condition variables are not significant.

## 6. Empirical Analysis (5): Economic significance

- For specification (1) , with headquarter damage, I/K for undamaged firms with damaged main banks is smaller by 8.1 percentage points than I/K for undamaged firms with undamaged main banks in 1995. This is significant given that the average I/K for undamaged firms in 1995 was 13.1%.
- For specification (2), with branch network damage, I/K for undamaged firms with damaged main banks with average damages was lower by 1.0 percentage points than undamaged firms with undamaged main banks in 1996.

# 6. Empirical Analysis (6): Small Banks

Feature more vulnerable banks

| 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_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) |
| 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 |

# 8. Conclusion

- Use the Kobe Earthquake as a natural experiment, and find

  - ***The investment ratio*** of firms located ***outside*** the earthquake-hit but having a main bank ***inside*** the area was ***smaller*** than that of firms whose main bank was ***outside*** the affected area.
  - This is robust (with ***the difference in timing***) for the ***two alternative measures*** of bank damage: damage to headquarters or to its branch network.
  - Damage to banks affected client firms through the impairment of banks' ***managerial capacity*** to originate loans and through the impairment of ***risk-taking capacity***.
  - The effect of bank damage was ***short-lived***. It dissipated by three years after the earthquake.

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*Our research interests are in the effects of great earthquakes on

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