The Effect of Bank Recapitalization Policy on Corporate Investment: Evidence from a Banking Crisis in Japan

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Common Challenges in Asia and Europe

Issues:

- Did capital injection promote investment in Japan during the 1997-1999 banking crisis?
- If so, how much?
- We look at specific mechanism:

Capital injection $\Rightarrow$ Bank capital ratio $\uparrow$

$\Rightarrow$ Financial friction $\downarrow$

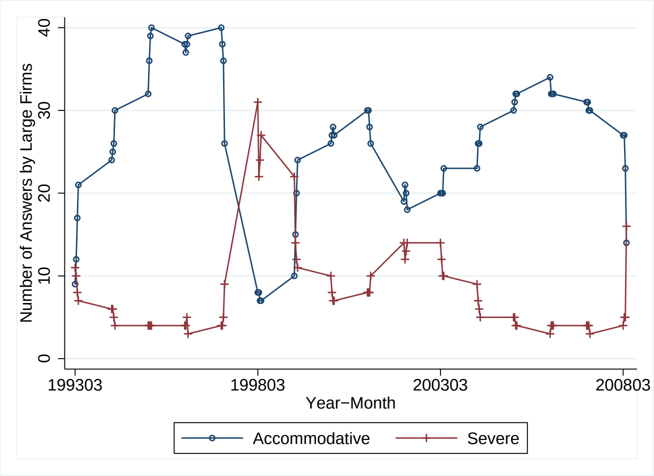
$\Rightarrow$ Investment $\uparrow$

Banking Crisis in Japan for 1997–1998

- 1997/7: Finance Ministry Ordinance: Threshold 4 or 8 %; Relaxing Accounting Standards
- 1997/11: Bank Failures — Sanyo Securities, Hokkaido Takushoku Bank, Yamaichi Securities, Tokuyo City Bank.
- 1998/3: **Capital injection (1.8 trillion yen/12.7 bn euro)**
- 1998/4: **"Law to Ensure the Soundness of Financial Institutions"**
- 1998/10-12: Nationalization of Long-Term Credit Bank of Japan and Nippon Credit Bank.
- 1999/3: **Capital injection (7.5 trillion yen/52.9 bn euro)**

TANKAN Survey (Large Firms, Manufacturing)

'Severe lending attitude' ↑ in 1997 and ↓ in 1999.



What We Do:

- Connect investment data with bank's balance sheet data
  - Japanese firms listed on the Tokyo Stock Exchange
- Estimate dynamic structural model of firm's investment with financial frictions
  - Variations across bank's Basel I capital ratios
- Conduct counter-factual policy experiments
  - Capital injection policies: March of 1998 and 1999

Related Literature:

Bank Capital ⇒ Lending

- Peek and Rosengren (2000), Woo (2003), Watanabe (2007)

Bank Capital ⇒ Corporate Investment

- Nagahata and Sekine (2005)

Bank Capital & Capital Injection ⇒ Lending

- Montgomery and Shimizutani (2009), Allen, Chakraborty, and Watanabe (2011), Giannetti and Simonov (2013)

Bank Capital & Capital Injection ⇒ Borrower Performance

- Giannetti and Simonov (2013)

Investment Rate and **Basel I Capital Ratio** (1997-1998)

	Low Machine Capital Stock			
	Low TFP		High TFP	
	$Basel1 \leq 0.02$	$Basel1 > 0.02$	$Basel1 \leq 0.02$	$Basel1 > 0.02$
Mean I_m/K_m				
1997	0.098	0.082	0.107	0.340
	(0.010)	(0.022)	(0.013)	(0.102)
1998	0.078	0.066	0.058	0.120
	(0.015)	(0.012)	(0.01)	(0.042)
# of Obs.				
1997	144	28	121	20
1998	125	97	59	46

$Basel1$ = Basel I capital ratio - 0.08 (or 0.04)

Dependent Variable: I_m/K_m

TFP	0.0205**	0.0242**	0.0229**	0.0182
	[0.009]	[0.010]	[0.010]	[0.011]
$\ln K_m$	0.0009	0.0010	0.0010	0.0025
	[0.003]	[0.003]	[0.003]	[0.004]
D_{Basel1}	0.0159	0.0180	0.0300**	0.0276*
	[0.012]	[0.012]	[0.014]	[0.015]
$D_{Basel1} \times TFP$		0.0412**	0.0441**	0.0393**
		[0.016]	[0.018]	[0.019]
$\frac{Debt}{Land}$	-0.0016	-0.0016	0.0007	0.0018
	[0.002]	[0.002]	[0.003]	[0.003]
$\frac{Debt}{Land} \times TFP$		-0.0071**	-0.0069	-0.0069
		[0.003]	[0.004]	[0.005]
$D_{Basel1} \times \frac{Debt}{Land}$			-0.0101**	-0.0095*
			[0.005]	[0.005]
$D_{Basel1} \times \frac{Debt}{Land} \times TFP$			-0.0037	-0.0006
			[0.007]	[0.008]
Lagged Investment				0.1896***
				[0.064]

Year dummy/Year dummy$\times$ TFP are included.

Model of Investment with Financial Friction

Notation: v (TFP), K (capital), b (net debt), N (land).

- N and *Basel*1 are firm-specific.

Profit Function

$$\pi(v, K) = \exp(\alpha_0 + \alpha_K \ln K + v).$$

Capital Adjustment Cost

$$\psi(K', K, \epsilon^k) = \begin{cases} \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K + e^{\epsilon^k} I & \text{if } I \geq 0 \\ \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K + e^{\epsilon^k} p_s I & \text{if } I < 0 \end{cases}$$

Value of Collateral

$$\Phi(K', N, \epsilon^b) = e^{\epsilon^b}(\lambda_K K' + \lambda_N N),$$

Model Cont'd

Dividend or new equity issuance

$$d = \pi(v, K) - \psi(K', K, \epsilon^k) - c_f - b + q^b(v, K', b', N, Basel1)b'.$$

where

- q^b: state-dependent bond price
- $Basel1$: weighted average of banks' Basel I capital ratios.

Equity issuance cost

$$\kappa(d) = \begin{cases} 0 & \text{if } d \geq 0 \\ \lambda_d |d| & \text{if } d < 0, \end{cases}$$

Timing within a Period

1. Enter period with $s = (v, K, b, N, Basel1)$.
2. Choose stay/exit/default (χ).
   - $\chi \in \{1 \text{ (stay)}, 2 \text{ (exit)}, 3 \text{ (default)}\}$.
   - Exiting cost shocks $\epsilon^{\chi} = (\epsilon^{\chi}(1), \epsilon^{\chi}(2), \epsilon^{\chi}(3))$ drawn independently from standard Type-I exterme-value distribution.
3. Choose K', and b'.
   - Collateral shock: $\epsilon^b \sim N(-0.5\sigma_b^2, \sigma_b^2)$
   - Investment price shock: $\epsilon^k \sim N(-0.5\sigma_k^2, \sigma_k^2)$
   - TFP shock:

   $$v' = \rho_v v + \epsilon^v$$

   with $\epsilon^v \sim N(0, \sigma_v^2)$

Firm's Problem

$$V(s, \epsilon^{\chi}) = \max\{\underbrace{W(z, s, \epsilon^k, \epsilon^b) + \rho\epsilon^{\chi}(1)}_{\text{stay}}, \underbrace{J(s) + \rho\epsilon^{\chi}(2)}_{\text{exit}}, \underbrace{\rho\epsilon^{\chi}(3)}_{\text{default}}\}$$

- Stay:

$$W(s, \epsilon^k, \epsilon^b) = \max_{b', K'} \quad d - \kappa(d) + \beta E[V(s', \epsilon^{\chi'})|s]$$
$$s.t. \;\; d = \pi(v, K, N, I) - \psi(K', K, \epsilon^k) - c_f - b + q^b b'.$$

- Exit value: $J(s) = (1 - \delta)K + N - b$
- Default value is zero.

State-Dependent Bond Price

- $q^b \equiv q^b(v, K', b', N, Basel1)$: state-dependent bond price
- $q(Basel1) \equiv 1/(1 + r + r(Basel1))$: bank's fund raising cost
- $r(Basel1)$: bank's interest premium depends on Basel I ratio.

$$\frac{q^b b'}{q(Basel1)} = \underbrace{(1 - E[\Pr(\chi' = 3|s')])}_{\text{no default}} b' + \underbrace{E[\Pr(\chi' = 3|s')]}_{\text{default}} \underbrace{\Phi(K', N, \epsilon^b)}_{\text{collateral}},$$

$$q^b = \begin{cases} q(Basel1) \left\{ E[\Pr(\chi' = 3|s')] \left(\frac{\Phi(K', N, \epsilon^b)}{b'} - 1 \right) + 1 \right\} & \text{if } b' > \Phi, \\ q(Basel1) & \text{if } \Phi \geq b' > 0, \\ 1/(1 + r) & \text{if } b' \leq 0. \end{cases}$$

Estimation: Parametric Specification of Bond Price

$$q^b(v, K', b', N, Basel1) =$$
$$q(Basel1)\left\{E[\Pr(\chi' = 3|s')]\left(\frac{\Phi(K', N, \epsilon^b)}{b'} - 1\right) + 1\right\},$$

Bank's Interest Premium

$$q(Basel1) = 0.6 + 0.4\frac{\exp(\beta_0^b + \beta_1^b Basel1)}{1 + \exp(\beta_0^b + \beta_1^b Basel1)}.$$

Approximation of Expected Default Probability

$$E[\Pr(\chi' = 3|s')] =$$
$$\frac{\exp(\beta_0^d + \beta_1^d v + \beta_2^d \ln K' + \beta_3^d (b'/K') + \beta_4^d \ln N)}{1 + \exp(\beta_0^d + \beta_1^d v + \beta_2^d \ln K' + \beta_3^d (b'/K') + \beta_4^d \ln N)}.$$

Estimation

Data:
$\{K_{i,1998}, b_{i,1998}, v_{i,1998}, N_{i,1998}, Basel1_{i,1998}, K_{i,1999}, b_{i,1999}\}_{i=1}^{N}$

Maximum Likelihood Estimation

- For each candidate parameter, given q^b, solve dynamic programming.
- Maximize log-likelihood of joint distribution of investment & debt.

Externally Set Parameters

Parameter	Description	Value
β	Discount factor	0.9000
ρ_v	Autocorrelation of v	0.8391
α_K	Curvature of profit function	0.5970
r	(saving) interest rate	0.0019
δ	Depreciation rate	0.0954
λ_K	Resale value of capital	0.1537
λ_N	Resale value of land	0.6777

Estimation Results

Bank's Interest Premium

$$q(Basel1) = 0.6 + 0.4\left(\frac{\exp(\beta_0^b + \beta_1^b \times Basel1)}{1 + \exp(\beta_0^b + \beta_1^b \times Basel1)}\right).$$

Expected Default Probability

$$\frac{\exp(\beta_0^d + \beta_1^d v + \beta_2^d \ln K' + \beta_3^d (b'/K') + \beta_4^d \ln N)}{1 + \exp(\beta_0^d + \beta_1^d v + \beta_2^d \ln K' + \beta_3^d (b'/K') + \beta_4^d \ln N)}.$$

$\hat{\beta}_0^b$	$\hat{\beta}_1^b$	$\hat{\beta}_0^d$	$\hat{\beta}_1^d$	$\hat{\beta}_2^d$	$\hat{\beta}_3^d$	$\hat{\beta}_4^d$
-1.40	39.97	-0.39	-1.13	-0.02	0.65	-0.18
(0.03)	(0.80)	(0.48)	(0.10)	(0.02)	(0.06)	(0.02)

Estimates of Real Interest Rate: $\hat{r}^b = 1/\hat{q}^b - 1$

	Real Interest Rate: $\hat{r}^b = 1/\hat{q}^b - 1$						
*Basel*1	Low b'	High b'	Low N	High N	Low K'	High K'	Median
0.00	0.47	0.85	0.53	0.47	0.52	0.47	0.48
0.02	0.35	0.70	0.40	0.35	0.39	0.35	0.35
0.04	0.22	0.54	0.26	0.22	0.26	0.22	0.22
0.06	0.12	0.41	0.16	0.12	0.15	0.12	0.12
0.08	0.06	0.33	0.10	0.06	0.09	0.06	0.06

"*Basel*1" = Basel I capital ratio - 0.08 (or 0.04)

"Low b'" = evaluating b' at 25 percentile value while other variables at their median values

"High b'" = evaluating b' at 75 percentile value

Investment Rates by Basel I Capital Ratio, Debt/Collateral, Capital and TFP: Data vs Model Prediction

	Low Machine Capital Stock			
	Low TFP		High TFP	
	$Basel1 \leq 0.02$	$Basel1 > 0.02$	$Basel1 \leq 0.02$	$Basel1 > 0.02$
Low b'/Φ				
Data (1998)	0.102	0.072	0.063	0.126
	(0.029)	(0.020)	(0.012)	(0.041)
Model	0.061	0.051	0.051	0.105
High b'/Φ				
Data (1998)	0.057	0.057	0.052	0.114
	(0.010)	(0.009)	(0.015)	(0.079)
Model	0.053	0.043	0.061	0.076

Investment Rates by Basel I Capital Ratio, Debt/Collateral, Capital and TFP: Data vs Model Prediction

	High Machine Capital Stock			
	Low TFP		High TFP	
	$Basel1 \leq 0.02$	$Basel1 > 0.02$	$Basel1 \leq 0.02$	$Basel1 > 0.02$
Low b'/Φ				
Data (1998)	0.137	0.105	0.104	0.117
	(0.019)	(0.010)	(0.012)	(0.009)
Model	0.065	0.067	0.135	0.141
High b'/Φ				
Data (1998)	0.102	0.082	0.122	0.099
	(0.025)	(0.014)	(0.015)	(0.011)
Model	0.062	0.071	0.125	0.131

Counterfactual Experiments

- What if there had been no capital injection of 1.8 trillion yen in March 1998?
- What if the 1999 capital injection (7.5 trillion yen) had taken place in March 1998 on the top of 1.8 trillion yen?

Counterfactual Aggregate Investment in 1998

	All Sample	Low K_m and High TFP
No injection in 1998	-1.34%	-3.31%
1999 injection	8.32%	16.46%

Counterfactual Average Investment Rate in 1998

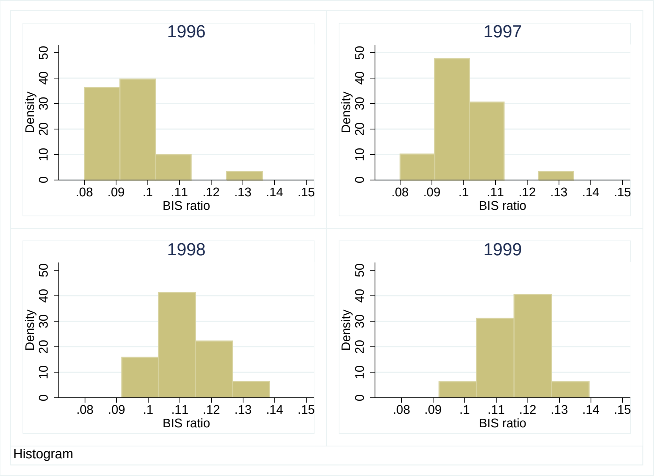
	Low TFP		High TFP	
	$Basel1 \leq 0.02$	$Basel1 > 0.02$	$Basel1 \leq 0.02$	$Basel1 > 0.02$
Low K_m				
Actual	0.056	0.047	0.056	0.092
No injection.	0.056	0.047	0.052	0.084
1999 injection	0.058	0.049	0.080	0.103
High K_m				
Actual	0.063	0.070	0.129	0.135
No injection	0.062	0.068	0.127	0.132
1999 injection	0.072	0.081	0.145	0.154

Tentative Conclusion

- Estimated investment model with financial frictions using Japanese firm-bank data for 1997–1999.
- Bank's Basel I ratio has significant effects on investment.
- Counterfactual experiment on capital injection policies
  - No injection in 1998: Aggregate investment $\downarrow$ by 1.34%.
  - 1999 injection: Aggregate investment $\uparrow$ by 8.32%.
  - Effects larger for smaller and more productive firms.

Back-up Slides

Basel I Capital Adequacy Ratio (1996-1999)



Investment Rate (I/K)

- Median I/K falls from 1997 to 1999.

Figure: Median I/K (DBJ)

Sources: Development Bank of Japan (DBJ).

Data Sources

Development Bank of Japan (DBJ) Data

- Manufacturing firms listed on Japanese equity markets.
  - Firms in financial sector not included in DBJ data.
- Data on balance sheets and income statements.

Nikkei NEEDS Data

- City and regional banks.
- Data on balance sheets and income statements.
  - Basel I capital ratio and non-performing loan ratio.

Combining DBJ and Nikkei NEEDS data

- For each firm, compute weighted average of Basel I ratios.
  - Use outstanding amount of long-term loans as weights.

Sample Selection

	Observations deleted	Remaining observations
Initial data for 1994-1999		11956
Missing data (I_m/K_m, Basel I ratio)	6321	5635
$I_m/K_m > 2$ or $I_m/K_m < -2$	4	5631
Large long-term loan with missing Basel I ratio	388	5243
More loans from 'other banks'	931	4312
Benchmark sample		**4312**

Summary Statistics (1997–1998)

		Mean	Median	Std. Dev.	Min	Max
*Basel*1	1997	0.015	0.128	0.007	0.001	0.056
	1998	0.021	0.020	0.008	0.005	0.069
TFP	1997	7.626	7.599	0.592	5.828	9.831
	1998	7.476	7.462	0.607	5.476	9.636
$\ln K_m$	1997	15.331	15.333	1.637	7.828	20.423
	1998	15.206	15.265	1.625	7.805	20.528
Debt	1997	243	623	651	-9960	8600
	1998	214	605	606	-1140	8960
ln *Land*	1997	16.079	15.998	1.368	9.754	20.618
	1998	15.926	15.864	1.358	9.679	20.401

Correlation Coefficient with *Basel*1 (1997–1998)

Corr. with *Basel*1	ln *TFP*	ln K_m	*Debt*	ln *Land*
1997	-0.0536	-0.0046	-0.0607	-0.0171
	(0.1777)	(0.9081)	(0.1267)	(0.6681)
1998	-0.0370	0.0906	-0.0032	-0.0028
	(0.3482)	(0.0213)	(0.9361)	(0.9436)

Notes. p-values for testing the null hypothesis of no correlation are in parentheses. (Sources: DBJ Corporate Finance Data, Nikkei NEEDS)

ln K_m by Basel I Ratio, Debt/Collateral, Capital and TFP (1997–1998)

	Low Machine Capital Stock			
	Low TFP		High TFP	
	$Basel1 \leq 0.02$	$Basel1 > 0.02$	$Basel1 \leq 0.02$	$Basel1 > 0.02$
Low b'/Φ				
1998	13.65	14.09	13.86	14.25
	(0.18)	(0.128)	(0.17)	(0.18)
High b'/Φ				
1998	13.80	14.18	14.02	14.22
	(0.15)	(0.12)	(0.21)	(0.21)

Linear Investment Model: Dependent Variable I_m/K_m

	(1)	(2)	(3)	(4)	(5)	(6)
z_{it}	0.0256**	0.0069	0.0042	0.0266**	0.0220	0.0182
	[0.012]	[0.011]	[0.011]	[0.013]	[0.015]	[0.015]
$k_{m,it}$	0.0035	0.0035	0.0041	0.0033	0.0032	0.0039
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
$BASEL1$	0.0274*	0.1851**	0.1671*	0.0271*	0.1814**	0.1642*
	[0.016]	[0.093]	[0.093]	[0.015]	[0.092]	[0.092]
$BASEL1 * z_{it}$		0.0726*	0.0661*		0.0710*	0.0647*
		[0.038]	[0.038]		[0.038]	[0.037]
$\frac{Debt}{Land}$	-0.0017*	-0.0058	-0.0035			
	[0.001]	[0.006]	[0.006]			
$\frac{Debt}{Land} * z_{it}$		-0.0020	-0.0011			
		[0.003]	[0.003]			
$\frac{Debt}{Collat.}$				-0.0046	-0.0265	-0.0217
				[0.003]	[0.018]	[0.017]
$\frac{Debt}{Collat.} * z_{it}$					-0.0107	-0.0093
					[0.009]	[0.008]
$\frac{I_{m,it-1}}{K_{m,it-1}}$			0.0954*			0.0930*
			[0.050]			[0.051]

Data for 1997-1998 used. Year dummy included.

Estimates

Capital Adjustment Cost

$$\psi(K', K, \epsilon^k) = \begin{cases} \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K + e^{\epsilon^k} I & \text{if } I \geq 0 \\ \frac{\gamma}{2}\left(\frac{I}{K}\right)^2 K + e^{\epsilon^k} p_s I & \text{if } I < 0 \end{cases}$$

Collateral Value

$$\Phi(K', N, \epsilon^b) = e^{\epsilon^b}(\lambda_K K' + \lambda_N N),$$

Equity Issuing Cost

$$\kappa(d) = \begin{cases} 0 & \text{if } d \geq 0 \\ \lambda_d |d| & \text{if } d < 0, \end{cases}$$

$\hat{\gamma}$	$\hat{p}_s$	$\hat{\sigma}^b$	$\hat{\sigma}^k$	$\hat{\lambda}_d$
31.81	0.005	0.21	1.60	1.81
(0.76)	(0.785)	(0.0003)	(0.04)	(0.001)

Counterfactual Experiments

Procedures for Counterfactual Experiments

1. Construct the counterfactual value of Basel I capital ratio for each bank.
2. Evaluate the counterfactual investment rate for each firm based on the counterfactual Basel I ratio using the estimated model.