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Financial Constraints, Capital Allocation and Aggregate Productivity

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Motivation

Financial crises have serious impacts on the real economy.

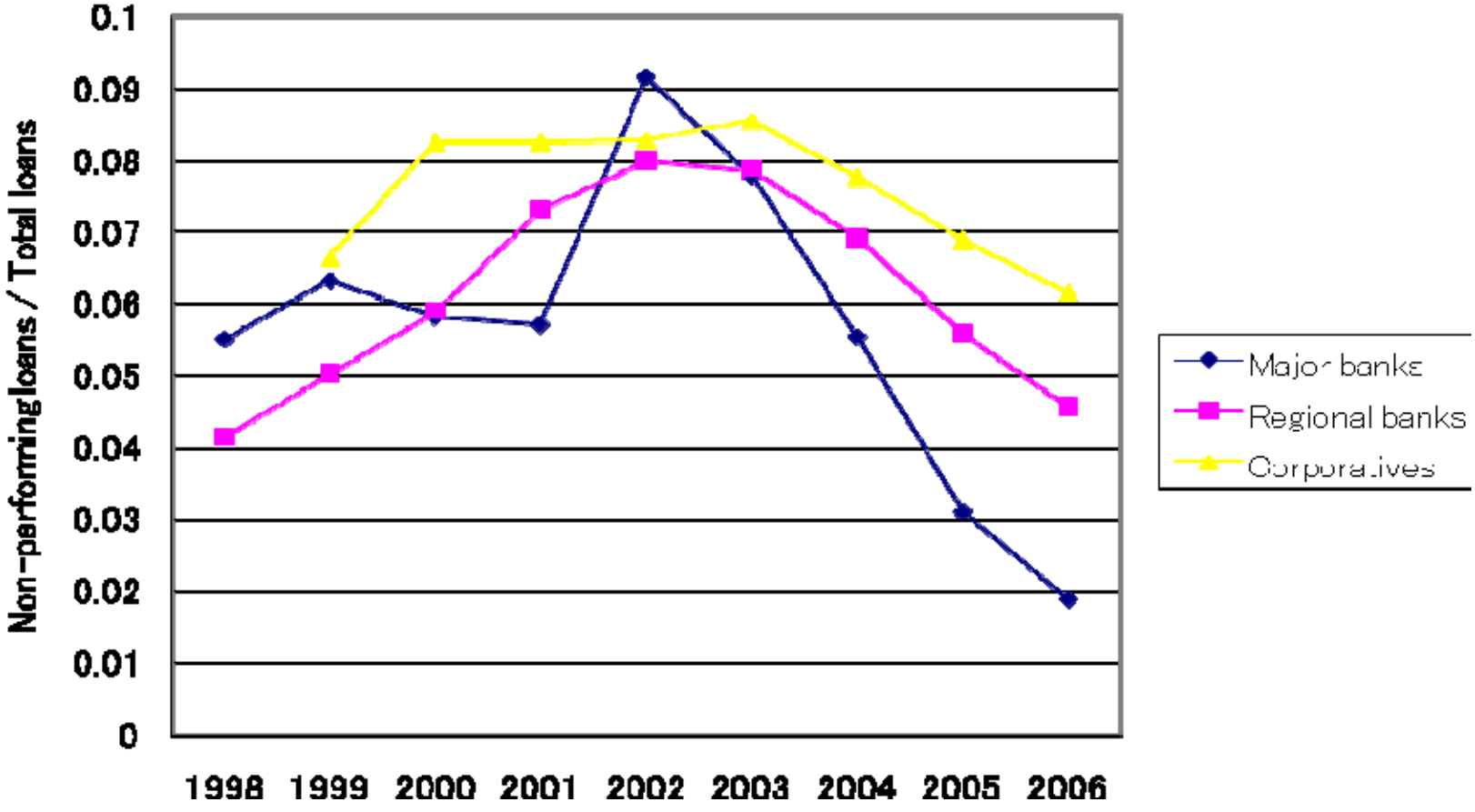
The impacts are differential between more and less productive firms or between entrants and incumbents.

We investigate the impacts of financial constraints on heterogeneous firms and their aggregate consequences based on the Japanese experience.

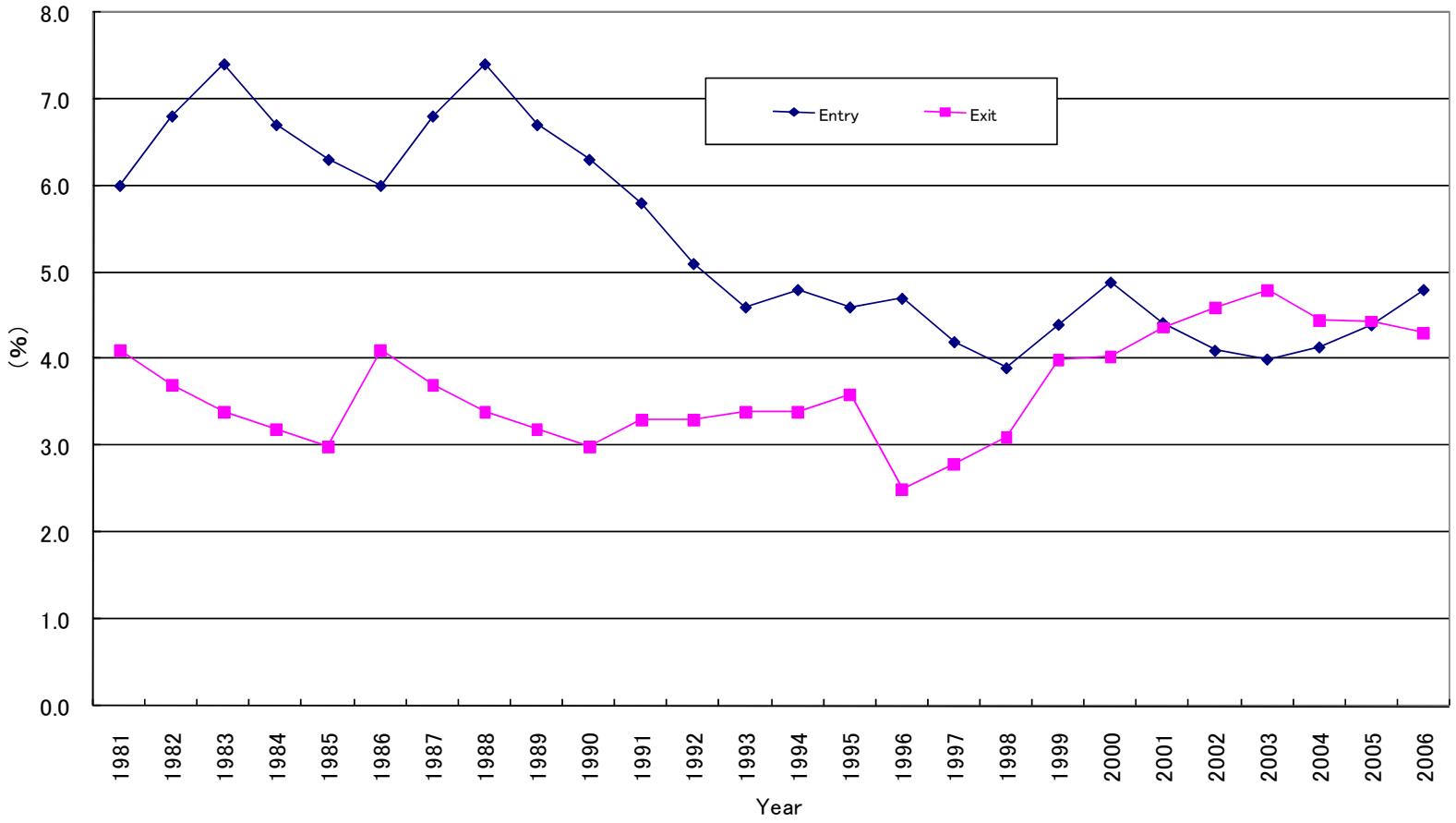
“Stylized Facts” about the “Lost Decade.”

1. Huge losses from NPLs at banks
2. Firm turnover ratio, esp. entry rate, decreased.
3. Aggregate TFP slowed down.
4. Aggregate investment-to-GDP ratio did not decrease.

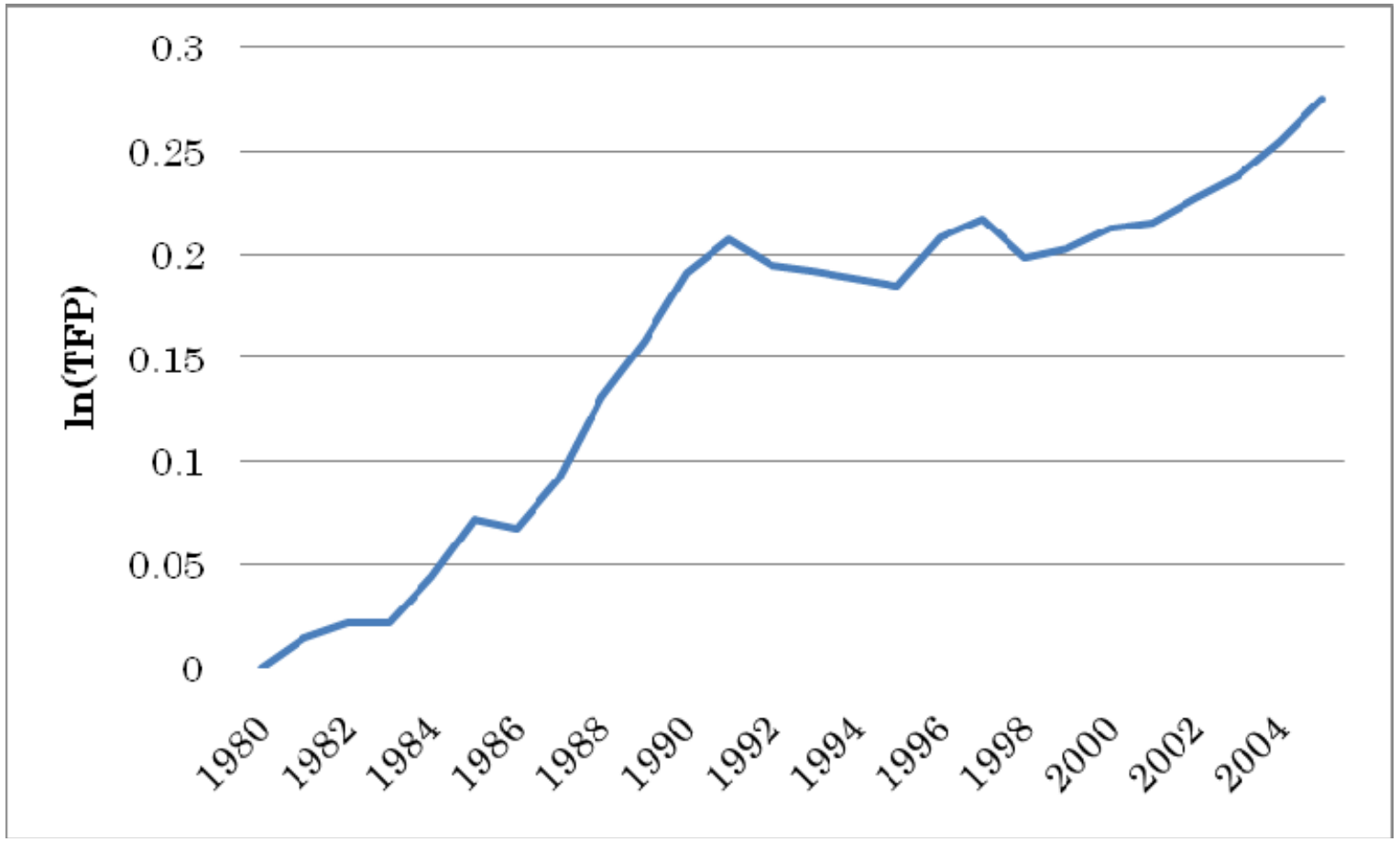
Fact 1. Non-performing loan ratio at banks



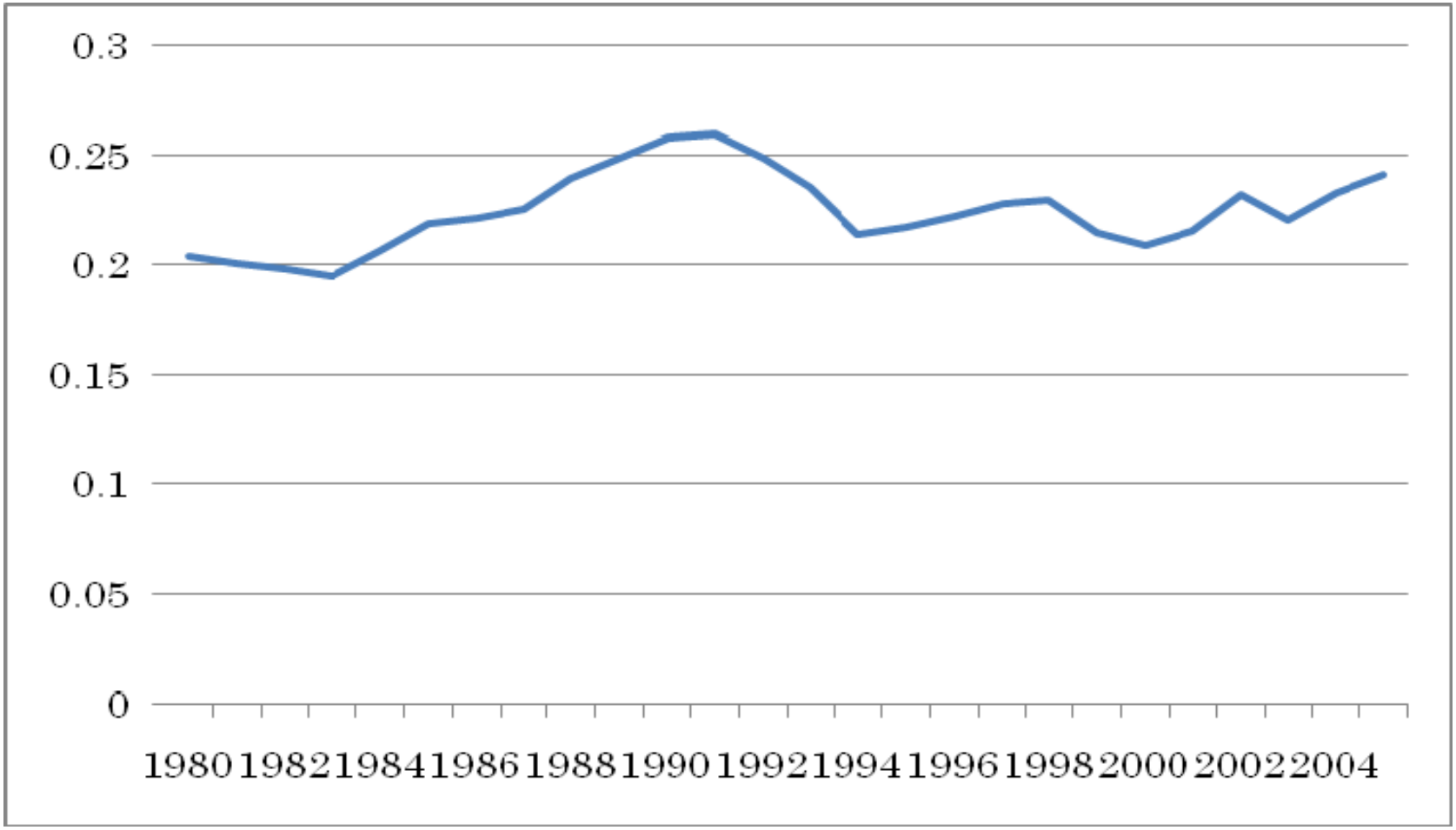
Fact 2. Turnover of Establishments



Fact 3. Aggregate TFP



Fact 4. Investment/GDP



We try to explain these facts consistently.

Our hypothesis

[Huge losses from NPLs at banks.→]

Higher external financial costs at firms.

→ Entrants and productive firms are hit hard.

→ Entry is depressed. Capital allocation becomes inefficient.

→ Aggregate TFP slowed down.

The aim of this paper

We quantitatively investigate the effect of financial constraints on the aggregate productivity through the allocation of capital by calibrating a dynamic general equilibrium model to the Japanese economy.

Literature on the "Lost Decade"

1. Bank distress: Credit crunch Gibson 1995, 1997; Nagahata and Sekine, 2005; Fukuda, Kasuya and Nakajima, 2006, Hosono and Masuda, 2005; Ogawa, 2005.

2. Bank distress: Soft budget Peek and Rosengren, 2005; Ahearne and Shinada, 2005; Fukuda et al., 2007; Hosono and Sakuragawa, 2008; Nishimura et al., 2005.

3. TFP slowdown Hayashi and Prescott, 2002

4. Impacts of bank distress on productivity Fukuda et al, 2007; Kobayashi and Akiyoshi, 2006; Miyagawa et al., 2008; Caballero et al., 2006; Tomura 2007

All focus on only one or some of the stylized facts!

Literature on the impacts of financial constraints on the real economy

Firm investment (Gilchrist and Himmelberg, 1995, among others)

→*Business Cycle* (Bernanke and Gertler, 1989; Carlstrom and Furest, 1997)

Firm dynamics (Cooley and Quadrini ,2001; Cabral and Mata, 2003; Clementi and Hopenhayn, 2006)

→*Long-Run Economic Performance* (Caselli and Gennaioli, 2003; Jeong and Townsend, 2007, This paper)

Summary of Results

Our results suggest that high financial costs decreased aggregate productivity through depressed firm turnover and distorted investment decision by about 0.7%, one-third of the actual decline in the detrended TFP during the banking crisis period.

Model

A dynamic general equilibrium model of firm dynamics (based on Gomes (2001), Brock and LeBaron (1990), Jovanovic (1982), and Hopenhayn (1992)).

Firms, households and financial intermediaries.

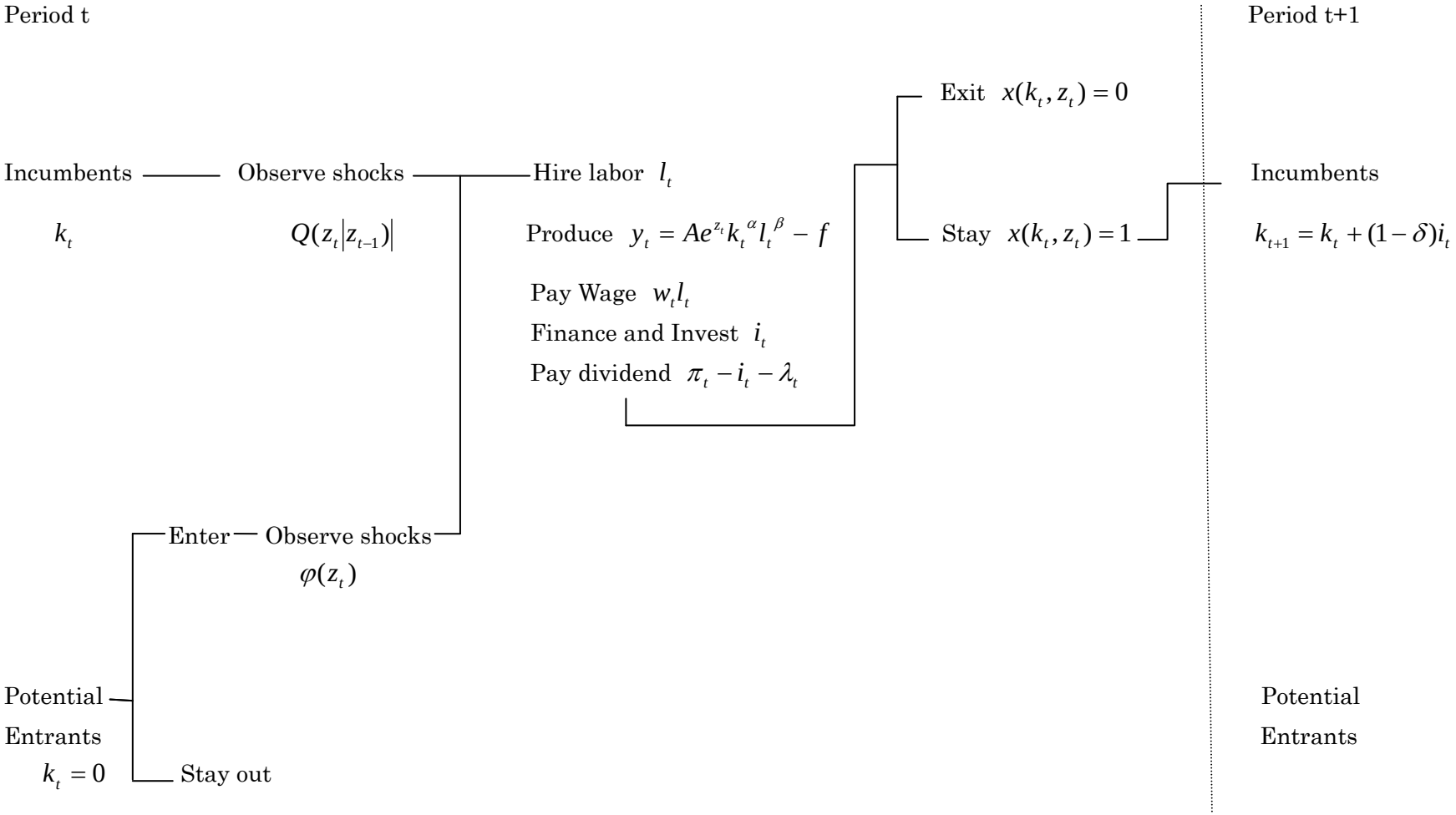
Firms need the services of financial intermediaries to obtain outside funds. Financial intermediaries operate competitively and provide these services at some cost.

Model (continued)

To allow for *differential impacts* of financial costs between more and less productive firms or between new entrants and incumbents, we assume that firms are hit by idiosyncratic productivity shocks. Thus we can analyze the impacts of financial costs on capital allocation and firm turnover.

Firms

Figure 5. Sequence of Events



Production

(1) $y_t = AF(k_t, l_t; z_t)$, decreasing returns to scale

Transition of productivity shocks:

For incumbents, $Q(z', z)$.

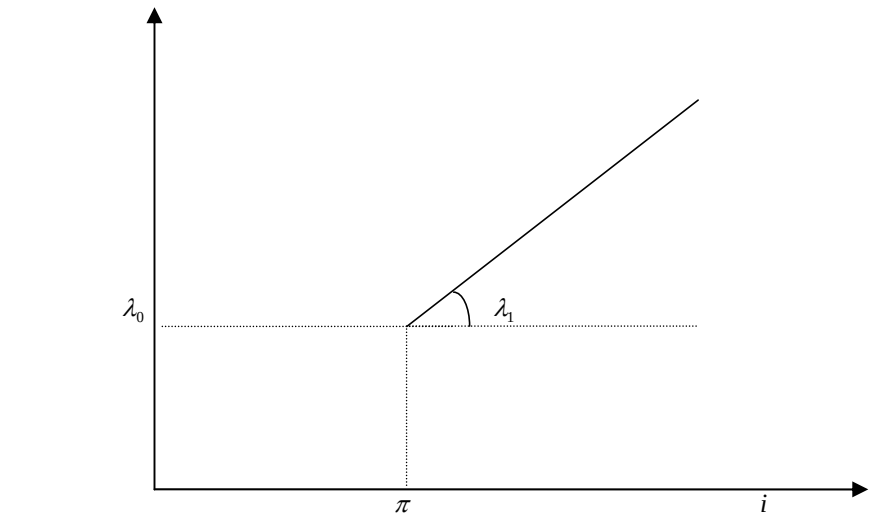
For entrants, $\varphi(z)$

(2) $\pi(k, z; w) = \max_{l \geq 0} \{F(k, l; z) - wl - f\}$, f: fixed cost

(3) $y_t = Ae^{z_t} k_t^{\alpha_K} l_t^{\alpha_L}$, $\alpha_K + \alpha_L < 1$,

Financing costs

(8) $\lambda(k,k',z;w) = \lambda(i(k,k') - \pi(k,z;w))$



Fixed financial costs include screening and monitoring costs. They imply lumpy investment.

The firm's dynamic problem

$$(10)\quad v(k,z;w)=\max_{k'\geq 0}\left\{\begin{array}{l}\pi(k,z;w)-i(k,k')-\lambda(k,k',z,w)\\ +\beta\max\left(k',\int v(k',z';w)\times Q(dz'|z)\right)\end{array}\right\},$$

Capital accumulation

(11)

$$k(k,z;w)=\min\left\{\arg\max_{k'\geq 0}\left\{\begin{array}{l}\pi(k,z;w)-i(k,k')-\lambda(k,k',z,w)\\ +\beta\max\left(k',\int v(k',z';w)\times Q(dz'|z)\right)\end{array}\right\}\right\}.$$

Exit decision

Exit $\Leftrightarrow$ (12) $\int v(k', z'; w) Q(dz' | z) < k'$.

(13) $$x(k, z; w) = \begin{cases} 1 \ \ (stay) \ \ if \ \ z > z^* \\ 0 \ \ (exit) \ \ if \ \ z \le z^* \end{cases}$$

(14) $$z^*(k, z; w) = \min\left\{\inf\left\{z : \int v(k', z'; w) \times Q(dz' | z) \ge k'\right\}, \ \bar{z}\right\}$$

Entry decision

(15) $\int v(0, z; w) \varphi(dz) \le 0$, with equality if entry is positive.

Aggregation

$\mu(k,z)$: mass of firms in the state (k,z)

B: mass of new entrants.

For any set $\Theta=(K,Z)$, the law of motion of μ is

$$(16)\quad \mu'(\Theta)=\underbrace{\int T(\Theta,(k,z))\mu(dk,dz)}_{\text{mass of incumbents moving from } (k,z) \text{ to } \Theta, \text{ conditional on the firm's staying in the market.}}+\underbrace{B\int \mathrm{X}(K)\varphi(dz)Q(dz'|z)}_{\text{mass of new entrants.}},$$

$$(17)\quad T(\Theta,(k,z))=\int \mathrm{X}(K)x(k,z;w)Q(dz'|z)$$

$$(18)\quad \mathrm{X}(K)=\begin{cases}1 & \text{if } k(k,z;w)\in K\\ 0 & \text{otherwise}\end{cases}$$

Aggregation (ctn'd)

Given μ and B,

output: (19) $Y(\mu, B; w) = \int (y(k, z; w) - f)\mu(dk, dz) - Bf$,

labor: (20) $L(\mu, B; w) = \int l(k, z; w)\mu(dk, dz)$

productivity: (25) $\Omega(\mu, B; w) = \int Ae^{z}\mu(dk, dz) / \int \mu(dk, dz)$

Households

$$(26)\quad \max_{c_t, l_t, s_t(k_t, z_t)} E_0\left[\sum_{t=0}^{\infty} \tilde{\beta}^t U(c_t, 1-l_t)\right]$$

s.t.

$$c_t + \int \{\tilde{v}(k,z) - d_t(k,z)s_t(k,z)\}\mu(dk,dz)$$

$$= \int \max\{\tilde{v}(k,z), k\}s_{t-1}(k,z)\mu(dk,dz) + w_t l_t$$

Note that in the stationary equilibrium, the discount factor of firms (β) is identical with that of the households ($\tilde{\beta}$) and the firm value ($v(k,z)$) is equal to the share price ($\tilde{v}(k,z)$).

In the stationary equilibrium,

(27) $\max_{c,l\geq 0} U(c,1-l)$

s.t. $c = wl + \Pi(\mu, B; w) - I(\mu, B; w) - \Lambda(\mu, B; w)$

Momentary utility function (Hansen, 1985)

(28) $U(c,1-l) = \log(c) + H(1-l)$,

(29) $C(\mu, B, w) = \frac{1}{H} w$

(30) $L^S(\mu, B, w) = \frac{1}{H} - \frac{\Pi(\mu, B; w) - I(\mu, B; w) - \Lambda(\mu, B; w)}{w}$

Stationary Competitive Equilibrium

All the markets clear, the free-entry condition (15) is satisfied, and all prices, aggregate quantities and the distribution of firms across states are constant.

(31) $L^S(\mu, B, w) = L(\mu, B; w)$,

(32) $C(\mu, B; w) + I(\mu, B; w) + \Lambda(\mu, B; w) = Y(\mu, B; w)$.

Consumption + Investment + Financial costs = Output

There is a unique stationary competitive equilibrium with positive entry.

Calibration: Methodology

Step 1. We calibrate the model to the pre-crisis period: 1980-95. ("*Benchmark economy*")

Step 2. We change the financial cost parameters so as to be consistent with the micro data evidence during the crisis period: 1996-2002. ("*Constrained Economies*)

Step 3. We compare the *stationary equilibria of financially constrained economies* with the stationary equilibrium of *benchmark economy*.

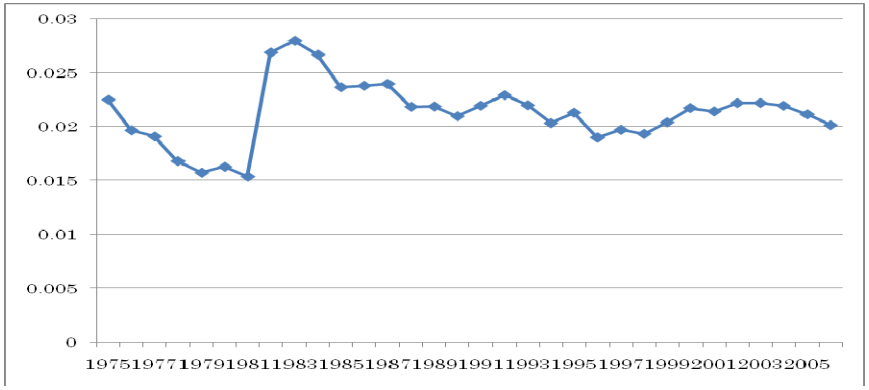
Calibration (*Benchmark economy*)

Table. 1 Calibration

Parameters	Benchmark Economy	Empirical Restrictions
Technology		
α k	0.3	Degree of returns to scale
α l	0.65	Labor share
δ	0.1	Investment to capital ratio
f	0.01	Turnover ratio
Technology Shock		
ρ	0.6	Serial correlation of I/K
σ	0.05	Std. dev of I/K
Financing Costs		
λ 0	0.04	Share of financially constrained firms
λ 1	0.022	Interest rate margins between bank loans and deposits
Preferences		
β	1/1.03	Interest rate
H	0.6	Employment share

Financing Costs (Benchmark Economy)

1) Unit financing cost is set to 2.2%, the average interest rate margins of Japanese banks during the pre-crisis period.



2) Fixed financial cost is set so as to match the U.S. evidence of the share of financially constrained firms (Gomes, 2001) in the *benchmark economy*.

Aggregate results: Benchmark Economy

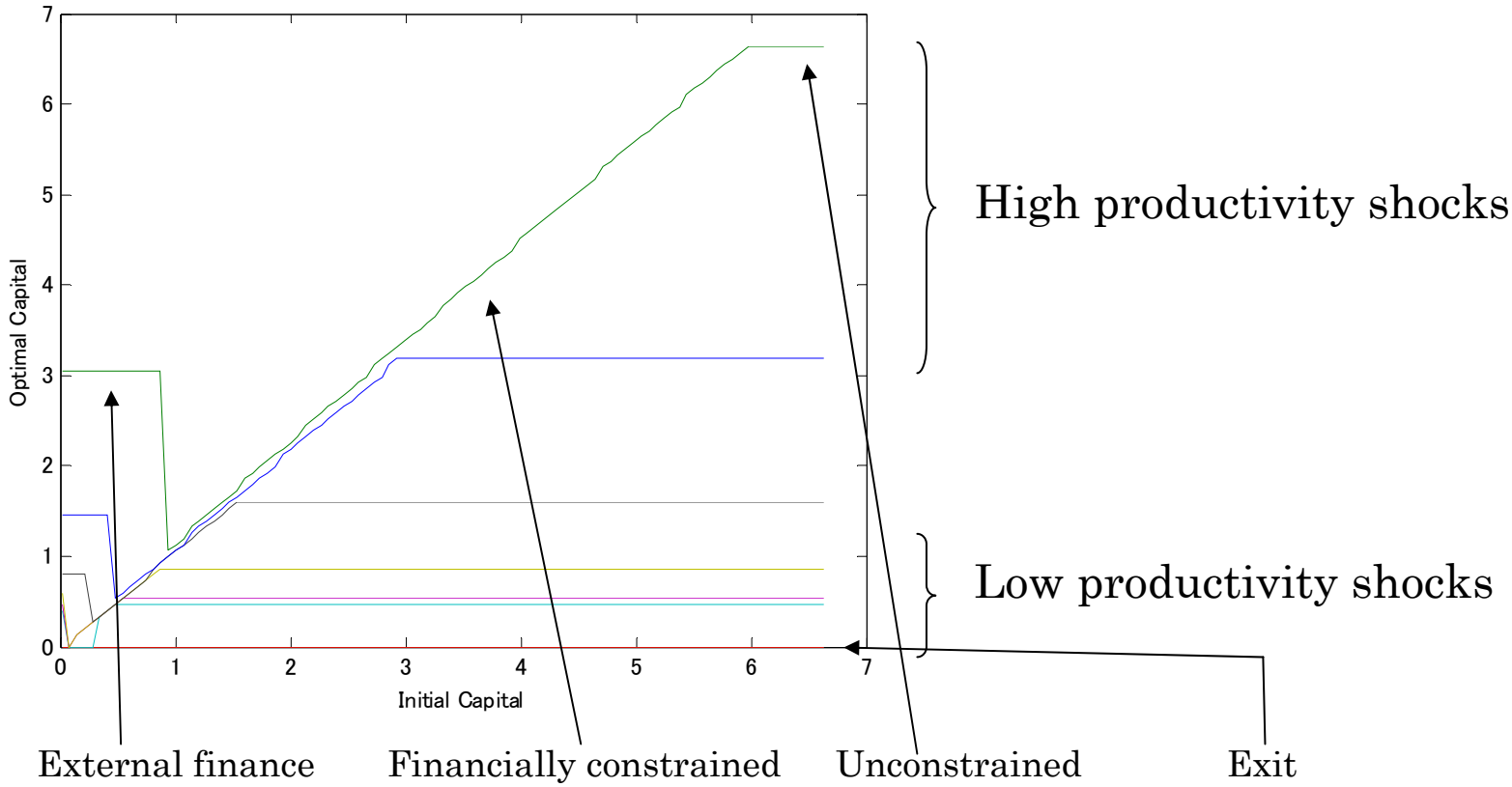
Table 2. Aggregate Results: Benchmark Economy

Variable	Japanese economy: 1980–95	Benchmark Economy
Matched quantities		
Investment rate I/K	0.113	0.095
Firm turnover rate (Entry)	0.061	0.058
Other quantities		
Investment share I/Y	0.225	0.223
Cash flow / Y	0.341	0.325
Share of financing costs Λ/Y	0.039	0.013
Tobin's Q	2.058 (1.443)	1.097

Well fitted! (Except for Tobin's Q)

CF>Investment

Optimal Firm Behavior and Classification of Firm Types



Investment by firms that raise external finance is *lumpy!*

Financing, Size, and Productivity: Benchmark Economy

	All firms			Incumbent firms							
	Share	Inv. Share	K Share	I/K	I/Y	CF/Y	Λ/Y	Y/L	Q	Ln(TFP)	K
External Finance	0.007	0.851	0.000	4.840	5.897	0.337	0.205	1.635	1.485	0.245	0.588
Financially Constrained	0.688	0.708	0.638	0.105	0.230	0.326	0.000	1.609	1.121	0.036	0.586
Unconstrained	0.247	−0.184	0.322	−0.054	−0.143	0.329	0.000	1.617	1.048	−0.024	0.825
Exit	0.058	−0.375	0.039	−0.900	−3.174	0.308	0.000	1.568	0.987	−0.116	0.547

1) The proportion of firms that raise external finance and make positive investment is very small but accounts for most of aggregate investment, consistent with the data.

2) Firms that raise external finance and invest are most productive, followed by financially constrained firms and unconstrained firms, in terms of the total factor productivity and Tobin's Q.

3) Firms that raise external finance or financially constrained are smaller than financially unconstrained firms.

4) Exit firms are least productive, consistent with some empirical evidences (, though other evidences show that productive firms were likely to exit.)

Constrained Economies

The interest rate margin did not increase in the crisis period.

Nonetheless, the proportion of financially constrained firms seemed to increase during the crisis period. (The proportion of firms whose applications for loans were rejected by their main banks increased, according to the *Corporate Finance Survey)*.

Constrained Economies (continued)

We change the financial costs in the following two ways.

1) *Constrained Economy A*

Using the Survey, we estimate the rate of increase in the number of firms who were financially constrained due to bank distress. We increase *the fixed financial costs* so as to match this estimate.

2) Constrained Economy B

We increase *the unit financial costs* by the loan losses as a proportion of total loans.

A: Higher fixed cost of external finance

B: Higher unit cost of external finance

Share of firm types

A. Share of Firm Types

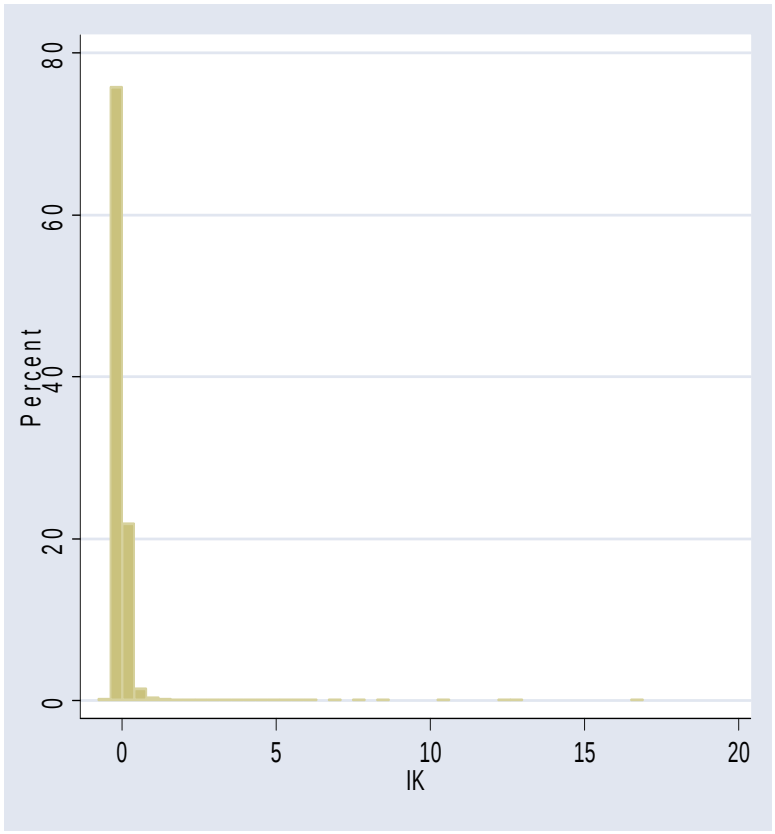
	Benchmark Economy	Constrained Economy A	Change from Benchmark	Constrained Economy B	Change from Benchmark
External Finance	0.007	0.005	−0.002	0.004	−0.003
Financially Constrained	0.688	0.814	0.125	0.870	0.181
Unconstrained	0.247	0.155	−0.092	0.102	−0.145
Exit	0.058	0.027	−0.031	0.024	−0.034

The proportion of financially constrained firms increased by 13-18%.

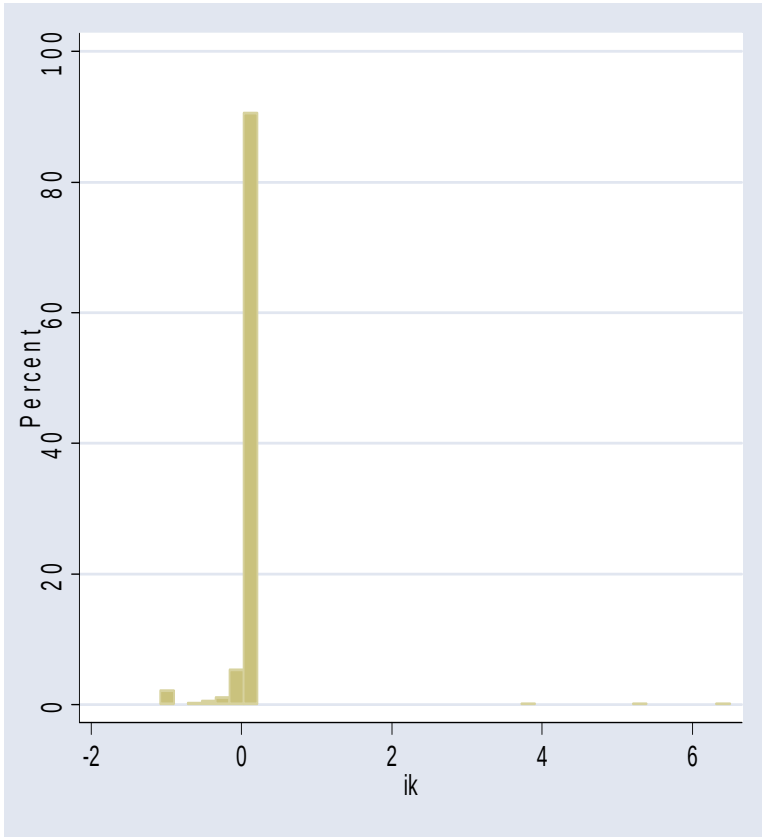
The firm turnover ratio decreases by half.

Investment is lumpy and its distribution is right-skewed.

Figure 9. Distribution of Investment-to-Capital Ratio



A . SMEs in Japanese Manufacturing Industries: 1999-2002



B. Financially Constrained Economy A

Aggregate results

Variable	Benchmark Economy	Constrained Economy A	Change from Benchmark	Constrained Economy B	Change from Benchmark	Japanese economy 1980–1995	1996–2002
Fixed cost of external finance (λ_0)	0.040	0.048	0.008	0.040	0.000		
Unit cost of external finance (λ_1)	0.022	0.022	0.000	0.039	0.017		
Investmetn Ratio (*I/K*)	0.095	0.097	0.002	0.097	0.003	0.113	0.092
Investment share (*I/Y*)	0.223	0.229	0.005	0.230	0.007	0.225	0.222
Cashflow share (*CF/Y*)	0.325	0.322	−0.003	0.322	−0.003	0.341	0.295
Log (*Y/L*)	0.474	0.466	−0.008	0.464	−0.010		
Firm turnover rate (Entry)	0.058	0.027	−0.031	0.024	−0.034	0.061	0.044
Log(Real Wage) (log(*W*))	0.082	0.078	−0.004	0.075	−0.006	0.010	0.023
Log(*TFP*)	0.015	0.008	−0.007	0.008	−0.007	0.007	−0.012

1. I/K or I/Y does not decrease.

2. The aggregate productivities of the constrained economies decreas by 0.7%, about one-third of the decline in detrended TFP from the pre-crisis period to the crisis period (1.9 %).

3. The labor productivity also decreases by 0.8%-1.0%.

Why does the aggregate productivity decline?

High financial costs

→Entrants and productive firms incur losses because they tend to raise external finance.

→Real wage decreases so as to make the entrant's value zero (free entry condition).

→Less productive firms gain from low real wage while they do not incur losses from high financial costs because they are less likely to raise external finance.

→Less productive firms are more likely to stay in the market.

Differential impacts between productive and less productive firms!

Is this story plausible?

1. The actual detrended real wage *increased* by 1.3% during the crisis period.

2. However, real wage deviates from marginal labor productivity due to the aging of workers and some other reasons (Hosono et al., 2008).

Alternative Specifications

Fixed cost for entry.

No fixed cost for external finance.

Table 5. Alternative Specifications

Variable	Japanese economy 1980–1995	Japanese economy 1996–2002	Benchmark Economy 2	Constrained Economy A2	Change from Benchmark	Constrained Economy B2	Change from Benchmark
Fixed cost of external finance (λ_0)			0.000	0.000	0.000	0.000	0.000
Unit cost of external finance (λ_1)			0.022	0.030	0.008	0.039	0.017
Fixed cost of entry			0.030	0.030	0.000	0.030	0.000
Share of external finance firms			0.210	0.248	0.038	0.228	0.018
Share of financially constrained firms			0.310	0.362	0.053	0.467	0.157
Investmetn Ratio (I/K)	0.113	0.092	0.098	0.101	0.003	0.101	0.003
Investment share (I/Y)	0.225	0.222	0.232	0.239	0.008	0.240	0.009
Cashflow share (CF/Y)	0.341	0.295	0.319	0.318	0.000	0.320	0.001
Firm turnover rate (Entry)	0.061	0.044	0.058	0.008	−0.050	0.008	−0.050
Log (Y/L)	0.009	−0.015	0.474	0.470	−0.004	0.469	−0.005
Log(TFP)	0.007	−0.012	0.015	0.004	−0.010	0.004	−0.010

The turnover ratio declines to 0.8% (too much).

Aggregate productivity declines by 1.0 %.

Conclusion

1. Differential impacts of external financial costs between more and less productive firms or entrants and incumbents are essential to understand their aggregate consequences.

2. Because high financial costs are harmful to entrants and highly productive firms while they are beneficial to relatively unproductive incumbents, firm turnover and aggregate productivity decrease.

3. Our results suggest that high financial costs significantly decrease aggregate productivity through depressed firm turnover and distorted investment decision though they do not decrease aggregate investment share.

Appendix. Solution Methods

1. Given an arbitrary value of w, we solve the Bellman equation for the firm, (9), and compute the optimal decision rule, using the value function iteration method.

2. We determine w that satisfies the free entry condition (14) for $B>0$.

3. We iterate the law of motion for μ, (15), to compute the stationary measure μ with $B=1$.

4. Using the market clearing conditions, (30) or (31), we determine the equilibrium level of entry B and the corresponding stationary measure μ.