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Financial Constraints, Capital Allocation and Aggregate Productivity*

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Abstract

Using a dynamic general equilibrium model with external financial costs, this paper tries to quantify the degree to which high financial costs lower aggregate productivity through the misallocation of capital. Applying the model to the Japanese economy during the banking crisis, we find that aggregate TFP decreased by 0.7%, about one-third of the actual decline in the detrended TFP during the crisis period (1996-2002). We also show that the share of investment in output does not decline as financial cost rises, consistent with the Japanese economy. Our results suggest that differential impacts of financial costs between more and less productive firms or between entrants and incumbents are essential to understand the aggregate consequences of financial constraints.

Key Words: External Financial Costs, Firm Dynamics, TFP, Japan
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Financial Constraints, Capital Allocation, and Aggregate Productivity

1. Introduction

Financial crises have serious impacts on the real economy. However, their impacts on firms 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 financial crisis in the 1990s.

Japan's decade-long stagnation in the 1990s, the "lost-decade," has attracted many researches' attention. Though there have been long debates over the causes of the stagnation, most of the researches agree with the following "stylized facts" concerning the 1990s' Japanese economy.

1) Japanese banks incurred huge losses from non-performing loans until 2002 (Figure 1).

2) The firm turnover ratios, especially entry rate, decreased significantly (Figure 2).

3) Aggregate TFP slowed down (Figure 3).

4) Aggregate investment-to-output ratio did not decrease (Figure 4).

We try to explain these facts consistently. Our hypothesis is as follows. Huge losses from non-performing loans at banks raised firms' external financial costs, which affected seriously new entrants and productive firms, who were likely to invest, resulting in the misallocation of capital and low aggregate productivity. To quantitatively assess these effects, we use a dynamic general equilibrium model of firm dynamics with financial frictions and calibrate it to the Japanese economy during the banking crisis period.

Previous studies focus on one or some of the above facts but few studies account for all of them. For example, many researchers pointed out that the banking problems caused the stagnation in the 1990s. One strand of the literature stresses the credit crunches by banks and under-investment by profitable firms (Gibson 1995, 1997; Nagahata and Sekine, 2005; Fukuda, Kasuya and Nakajima, 2006, Hosono and Masuda, 2005; Ogawa, 2005). The others stress that the perverse incentives of banks led to the misallocation of credit and caused over-presence or over-investment by poorly-performing firms (Peek and Rosengren, 2005; Ahearne and Shinada, 2005; Caballero et al., 2006; Fukuda et al., 2007; Hosono and Sakuragawa, 2008; Nishimura et al., 2005).

On the other hand, Hayashi and Prescott (2002), among others, showed that the output stagnation in the 1990s could be accounted for mostly by the decline in the TFP growth rate.[1] Based on the fact that there was no significant decline in the investment share in output, Hayashi and Prescott (2002) suggested that banking problems played a limited role, if any, in the great stagnation.

Based on these two apparently opposing views, more recent studies try to link the relationship between the firm-level TFP and banking problems. Fukuda et al. (2007) find that the productivity of firms decreased if unhealthy banks increased long-term loans to the firms. Kobayashi and Akiyoshi (2006) also found a positive correlation between the bank equity value and the firm productivity for listed manufacturing firms during the severe financial crisis (FY 1997-99).[2] On the other hand, Miyagawa et al. (2008) attempt to estimate the effect of misallocation of capital and labor across industries on aggregate productivity using growth accountings. Though their interest is close to ours, they do not explore the sources of resource misallocations, while we focus on the role of external financial costs.

Caballero et al., (2006) and Tomura (2007) are closely related to this paper in that they link banking problems with aggregate productivity. Caballero et al. (2006) focus on the credit misallocation due to the bank's lending to almost insolvent borrowers ("zombies"). Tomura (2007) analyzes endogenous fluctuations of TFP in a collateral-constrained economy (Kiyotaki and Moore, 1997). Neither of them, however, assesses to what extent financial frictions can account for the TFP slowdown during the financial crisis period in Japan.

Though we calibrate the model to the Japanese economy, the impacts of financial constraints on capital allocation are not limited to Japan. For example, many empirical studies of the U.S. firm- or plant-level investment suggest that investment is constrained by external financial costs (Gilchrist and Himmelberg, 1995, among others)[3]. Based on these empirical evidences, the implications of financial constraints on the propagation mechanism of the business cycle has been

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[1] Most growth accounting studies report productivity slowdown in the 1990s, with one exception of Kawamoto (2004), who report that controlling for cyclical utilization and reallocations of inputs, there is little or no evidence of a decline in the pace of technological progress in Japan's lost decade.

[2] Kobayashi and Yanagawa (2008) presents a theoretical model in which a high probability of bank failure discourages ex ante investments (e.g., R&D investment) by firms that enhance their productivity. Ogawa (2007), however, reports that nonperforming loans at banks had no significant effects on firm investment in R&D.

[3] A typical empirical approach has been to examine the sensitivity of investment to cash flow as well as to Tobin's Q. However, recent studies point out that cash flow may not be a good proxy to financial constraints because measurement errors in Tobin's Q may cause a spurious correlation between cash flow and investment even without financial constraints (e.g., Erickson and Whited, 2000).

explored (e.g., Bernenke and Gertler 1989; Carlstrom and Furest, 1997). Another link between financial frictions and aggregate economy that is recognized in the literature is through firm dynamics, i.e., entry, aging and exit (Cooley and Quadrini ,2001; Cabral and Mata, 2003; Clementi and Hopenhayn, 2006). Some recent studies investigate the effects of financial development combined with occupational shifts on aggregate productivity through firm dynamics (Caselli and Gennaioli, 2003; Jeong and Townsend, 2007). This paper builds on those preceding studies to investigate the implications of a financial crisis on aggregate productivity.

Our results suggest that differential impacts of financial constraints on heterogeneous firms are essential to understand their aggregate consequences. Because high financial costs are harmful especially to entrants and highly productive firms, firm turnover and aggregate productivity is depressed. Our calibration shows that aggregate TFP decreased by about 0.7%, one-third of the actual decline in the detrended TFP during the banking crisis period. We also show that the output share of investment tells us little about the significance of financing constraints.

The rest of the paper is organized as follows. Section 2 presents a model with external financing costs. We calibrate the model to the pre-crisis period in Section 3 and show the results of the simulation in Section 4. We refer this model economy to the "benchmark economy". Section 5 compares the benchmark economy to the model economies with higher financial costs, which we refer to "financially constrained economies." Section 6 presents results from some alternative specifications. Section 7 concludes.

2. Model

To analyze the effects of external financing costs on investment and turnover, we present a dynamic general equilibrium model of firm dynamics based on Gomes (2001), which, in turn, is based on Brock and LeBaron (1990), Jovanovic (1982), and Hopenhayn (1992). Cooley and Quadrini (2001) also establish an industry dynamics model with financial frictions[4].

There are firms, households and financial intermediaries in the economy.

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[4] Though Cooley and Quadrinil (2001)'s model is somewhat richer in the structure of financial frictions, the entry/exit rate is exogenous in their basic model, which is not suitable to our analysis. They discuss the endogenous entry/exit decision only qualitatively.

Firms need the services of financial intermediaries to obtain outside funds. Financial intermediaries operate competitively and provide these services at some cost. 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 and households are described in details below.

Firms

A continuum of firms produce outputs that can be consumed or invested. Figure 5 depicts the timing of events. In every period, each incumbent firm observes productivity shocks, hires labor, produces output, finances and invests, pays dividends to consumers, and decides whether to stay or exit in the next period.

There is also a continuum of potential entrants that decide whether to enter or stay out. If an entrant decides to enter, it observe productivity shocks after entering the market, produces and invests just as an incumbent.

The production process is assumed to be required of a fixed cost and to be decreasing returns to scale. These assumptions imply a U-shaped average cost, which, in turn, implies a well defined distribution of firms and endogenous entry/exit decisions. Denoting the production function by

(1) $y_t = AF(k_t, l_t; z_t)$,

where y_t denotes output, k_t capital, l_t labor, and A a productivity measure that is common across firms and constant across periods, while z_t denotes an idiosyncratic productivity shock that is uncorrelated across firms. For incumbent firms, the idiosyncratic shocks have a common stationary and monotone Markov transition function $Q(z', z)$ over the support for the bounded interval $[\underline{z}, \bar{z}]$, where z' denotes the next period shock. For new entrants, the idiosyncratic productivity shock is drawn from a common distribution $\varphi(z)$ over the same interval $[\underline{z}, \bar{z}]$.

We first describe the firm's within-period decisions given the capital stock. The firm's problem is to maximize profit,

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

, where w denotes the wage rate and f a fixed cost of production that a firm must pay every period as long as it stays. We use profit and cash flow interchangeably hereafter. Specifying the production function to the Cobb-Douglas form:

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

we solve Equation (3) and get the following labor demand, supply of output, and profits.

(4) $l(k,z;w) = \left(\frac{1}{w} Ae^{z} \alpha_L k^{\alpha_K} \right)^{\frac{1}{1-\alpha_L}}$

(5) $y(k,z;w) = Ae^{z_t} k^{\alpha_K} l(k,z;w)^{\alpha_L}$

(6) $\pi(k,z;w) = y(k,l;z) - wl - f$

Next, we proceed to the firm's dynamic problem. The next-period capital stock, k', is accumulated as

(7) $i(k,k') = k' - (1-\delta)k$, $0 < \delta < 1$

, where i denotes investment and δ depreciation rate.

The firm incurs a financing cost of λ if it needs to raise funds from outside, i.e., if the profit falls short of investment.

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

The financing cost function is assumed to depend on the amount of external funds and to be positive and increasing for a positive range of external funds. We specify the financing cost function as

(9) $\lambda(k,k',z;w) = \begin{cases} \lambda_0 + \lambda_1(i(k,k') - \pi(k,z;w)) & \text{if} \quad i(k,k') - \pi(k,z;w) > 0 \\ 0 & \text{otherwise} \end{cases}$

, where λ_0 and λ_1 are positive constants. Figure 6 depicts the financing cost function. It seems natural to assume that significant economies of scale exist in the transaction costs of external finance; firms incur higher costs when they raise smaller amounts. Actually, based on the evidence on the floatation costs associated with issuing new equity provided by Smith (1977), Gomes (2001) finds that external funding costs can be well approximated by a linear function of Equation (9). In the case of bank loans, some fixed costs for screening and monitoring the borrowers will be necessary for banks to decide whether to accept or reject borrowers' applications. To adopt this functional form also enables us to compare our benchmark results with Gomes (2001). Introducing fixed financial costs induces some kind of lumpy investment as we see below.

The firm's dynamic problem is to maximize the expected value of the discounted profits, which can be expressed recursively as

(10)

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

where β is a discount factor. The first three terms represent the current dividends: profits minus investment spending and financing costs. The last term is the expected next-period value; if it decides to exit, it sells all its capital. We focus on the stationary equilibria, where all prices, aggregate quantities and the distribution of firms across states are constant. Thus we assume that the wage rate is constant: $w'=w$.

Gomes (2001) shows that there is a unique value function $v(k,z;w)$ and that it is continuous and increasing in (k,z) and continuous and decreasing in w. Solving for Equation (10) results in the policy functions of the next-period capital and stay/exit decision. The capital accumulation decision is described as

(11)

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

In case the maximizer on Equation (10) is not unique, the firm chooses the minimum value to avoid external financing costs if possible. The firm decides to exit if and only if

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

This exit decision implies a threshold value of the idiosyncratic shock z, below which the firm exits.

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

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

Finally, we describe the entry decision of potential entrants. They enter as long as the expected value of discounted profits is nonnegative. The free-entry condition is thus

(15) $\int v(0,z;w)\varphi(dz)\leq 0$,

with equality if entry is positive.

Aggregation

We now characterize aggregate variables. Let $\mu(k,z)$ denote the mass of firms in the state (k,z) and B denote the mass of new entrants. For any set $\Theta = (K, Z)$, the law of motion for μ is given by

(16) $\mu'(\Theta) = \int T(\Theta,(k,z))\mu(dk,dz) + B\int \mathrm{X}(K)\varphi(dz)Q(dz'|z)$,

where

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

and

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

The first term on the right hand side of Equation (16) represents the mass of incumbent firms that come from (k,z) to Θ. The last term represents the mass of new entrants, who have no capital at the time of entry. Equation (17) states that the transition must be conditional on the firm's staying in the market.

Given the mass of firms μ in each state (k,w) and the mass of new entrants, B, we can define the aggregate output, demand for labor, total profits, investment, financial costs, operating costs, and productivity respectively, as

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

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

cash flow: (21) $\Pi(\mu,B;w) = \int \pi(k,z;w)\mu(dk,dz) - Bf$,

investment: (22) $I(\mu,B;w) = \int (i(k(k,z;w),k)\mu(dk,dz) + B\int k(0,z;w)\varphi(dz)$,

financial costs: (23)

$$\Lambda(\mu,B;w) = \int (\lambda(k,k(k,z;w),z;w)\mu(dk,dz) + B\int \lambda(0,k(0,z;w),z;w)\varphi(dz)$$

fixed operating costs: (24) $\Phi(\mu,B;w) = \int f\mu(dk,dz) + Bf$

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

To derive Equations (19)-(25), we used the fact that new entrants who have no capital do not hire labor or produce anything, and hence incur the loss of f at the period of their entry.

Households

Households are represented by a single agent who maximizes lifetime utility from consumption c and leisure $1-l$. Household income consists of wages and dividends. Denoting the discount factor by $\tilde{\beta}$, the household problem can be written as

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

s.t.

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

where $\tilde{v}_t(k,z)$, $d_t(k,z)$, and $s_t(k,z)$ denote the price, dividends and the fraction of shares owned by the household, respectively. We assume that dividends are paid just after shares are bought. Because we focus on the stationary equilibrium described below, the assumption of a stationary equilibrium is implicit in this formulation. In the stationary equilibrium, the firm discount factor is equal to the household discount factor and the share price is equal to the firm value: $\tilde{\beta} = \beta$ and $\tilde{v}(k,z) = v(k,z)$ (Proposition 4 in Gomes, 2001). Since all the aggregate quantities and prices are constant in the stationary equilibrium, the consumer problem can be simplified into the following static problem,

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

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

In particular, we assume a momentary utility function following Hansen (1985):

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

where H is a positive constant. Then, solving for Equation (28), we get the optimal consumption and labor supply as

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

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

Stationary Competitive Equilibrium

In a 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. The labor market and goods market clearing conditions are

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

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

There exists a unique stationary competitive equilibrium with positive entry (Proposition 5 in Gomes 2001).

3. Calibration

We calibrate the model to the Japanese economy. Though bank non-performing loans had increased since the early 1990s when land prices dropped sharply, the banking crisis became severe after some regional and major banks failed in the middle of the 1990s (Hyogo Bank, Taiheiyo Bank and Hanwa Bank failed in 1995, 1996 and 1997, respectively.) The financial crisis culminated in the late 1997 and 1998 when a large security company named Sanyo Securities defaulted in the interbank market and one major bank (Hokkaido Takushoku Bank), one large security company (Yamauchi Securities) and two long-term credit banks (Nippon Credit Bank and Long-Term Credit Bank), as well as some regional banks, failed. The financial crisis continued until bank non-performing loans began to decrease in 2002.

Considering these changes in bank health, we divide the period into the pre-crisis period of 1980-1995 and the crisis period of 1996-2002. One may want to divide the sample period before and after 1990 or 1991, given that the stock and land prices fell sharply and the Japanese economy turned downward in the early 1990s. However, we choose our period division to focus on effects of the banking crisis on the aggregate economy. Then, we take the following procedures to evaluate the impacts of financial costs on the real economy.

First, we calibrate the model to the pre-crisis period. The calibrated economy is referred to as the benchmark economy.

Next, we change the financial cost parameters so as to be consistent with the micro evidence on the proportion of financially constrained firms during the crisis period or with the non-performing loan losses incurred by the banks during the crisis period.

Finally, calibrating the model with the high financial costs, we see whether the calibrated economy with high financial costs can match the post-crisis period economy and how different it is from the benchmark economy. The calibrated economy with high financial costs is referred to the constrained economy.

Preference

The marginal utility of leisure, H, is determined by the fraction of workers in the population. The share of labor force in working age (i.e., aged 15 and over) is 60% in Japan during the 1990s (*Labor Force Survey*), which we choose for H. The intertemporal discount factor, β, is set to $1/1.03$ so that the annual real interest rate is 0.03, roughly consistent with the Japanese economy during the 1990s and 2000s.

Technology

To determine the output elasticities to labor, α_L, and capital, α_K, we have to consider the returns to scale. Miyagawa et al (2005) estimates returns to scale for thirty-seven industries and found that a large number of industries show constant returns to scale. Considering their results, we set $\alpha_L + \alpha_K = 0.95$. The average capital share in the 1990s and 2000s is 30% (*JIP Database 2008*), which we use as the value of α_K. Consequently, we set $\alpha_L = 0.65$.

The fixed operating cost, f, mainly affects the firm turnover rate. Figure 2 shows that the share of entry firms decreased from 6.1% in the pre-crisis period to 4.4% in the crisis period. Therefore, we set f so that the turnover ratio becomes about 6% in the benchmark economy.

For incumbents, the stochastic process for the logarithm of the productivity, z, is assumed to follow

(33) $z' = \rho z + \varepsilon'$,

where ε' follows a truncated normal distribution with mean zero and standard deviation σ. In practice, we follow Tauchen and Hussey's (1991) method for optimal state space approximations to normal random variables. If appropriate data is available, the parameters ρ and σ could be calibrated to the serial correlation and standard error of the investment ratio, I/K. Unfortunately, we could not obtain micro evidence for the serial correlation of I/K that would cover a sufficiently long period and large sample firms to calibrate ρ. Therefore, we borrow the parameter that is consistent with the U.S. firm dataset of Compustat (Gomes, 2001). In particular, we set $\rho = 0.6$. We calibrate σ to match the standard deviation of I/K for listed firms, reported in Hosono and Watanabe (2002), setting $\sigma = 0.05$. For new entrants, the initial level of technology is assumed to follow a uniform distribution over the range that is the same with the incumbents.

Financing Costs

How to calibrate financing costs plays a key role in this model.

Figure 7 shows the interest rate margins between bank loans and deposits for Japanese banks. For the benchmark economy, we set the proportional financing cost (λ_1) to 2.2%, the average interest rate margin over the period of 1980-2006.

The fixed financing cost mainly affects the proportion of financial constrained firms. The investment literature has studied a number of indicators to identify a financially constrained firm, including dividend payment ratio (Fazzari et al., 1988), the existence of a bond rating (Whited 1992; Erickson and Whited, 2000), firm size and age, and a membership in a Japanese business group, *keiretsu* (Hoshi et al., 1991)[5]. However, most preceding studies classify firms into financially constrained firms and unconstrained firms a priori using those criteria and do not estimate the proportion of financial constrained firms. One important exception is Gomes (2001), who reports that among U.S. listed firms (in the Compustat universe), 63 percent is estimated to be financially constrained. Given no counterpart number for the Japanese firms, we set the value of λ_0 so that the proportion of financially constrained firms becomes about 60 percent in the benchmark economy. Later, we change the financial cost parameters to see how the economy is affected by high financial costs.

Table 1 summarizes our calibration procedure for the benchmark economy.

4. Benchmark Economy

We numerically compute the stationary competitive equilibrium given the parameters in Table 1, following the procedure described in Appendix 3. Before investigating the impacts of financially costs, we check the performance of our model by comparing the benchmark economy and the Japanese economy during the pre-crisis period of 1980-1995.

Aggregate Quantities

[5] For example, Erickson and Whited (2000) uses the criteria of a Standard & Poor's bond rating and find that among 737 manufacturing firms from the Compustat database covering the years 1992-95, 459 firms are identified as constrained firms and 278 firms as unconstrained. For Japanese listed firms, Nagahata and Sekine (2005) uses the criterion that a firm has ever issued a corporate bond and finds that about a quarter of total firms has never issued a corporate bond. It should be noted that those studies focus on publicly listed firms.

Table 2 provides some aggregate statistics of the benchmark economy. These are reasonably consistent with the Japanese economy during 1980-1995. The investment-to-capital ratio and the firm turnover ratio almost coincide, which is not surprising given our calibration of the parameters δ and f, respectively. The highly non-linear property of the model prevents us from exactly matching those quantities. In the benchmark economy, aggregate cash flow is larger than aggregate investment, just as the Japanese economy. The share of financing costs in the benchmark economy is lower than the Japanese economy, which is not surprising given that we do not consider any other financial services but financial intermediation. The average Tobin's Q in the Japanese economy is higher than in the benchmark economy, either because we do not consider any investment adjustment costs or intangible assets or because the stock market overpriced firm values.

Optimal Firm Behavior and Classification of Firm Types

Because we are interested in the differential impacts of financial costs among heterogeneous firms, we classify the firm types and see how their investment and exit decisions depend on firm types.

Without external financial costs, optimal firm behavior depends only on the current productivity shock, a signal of future profitability, and not on the current capital stock. However, with external financial costs, optimal firm behavior depends on both. Current capital stock matters because it affects current cash flow. Figure 8 depicts the optimal next-period capital stock. The upper lines show high levels of current productivity shocks and the lower lines show low levels of current productivity shocks. Depending on the optimal firm behavior, we can classify firms into four categories.

First, firms with sufficiently large current capital and with relatively low productivity shocks reduce their capital stocks (negative investment). We label them as "unconstrained" firms. It should be noted that even unconstrained firms are actually affected by the existence of external financing costs; they over-accumulate the capital as compared with the economy without financial costs in order to save the financial costs in the future.

Second, firms with less capital stock and with low productivity shocks do not borrow, but are severely affected by the financial costs. We call them "constrained." Most of them invest within their cash flow to replenish the depreciated capital.

Third, firms with less capital stock but with high productivity shocks finances from outside and invests to the optimal level of capital stock. We call them "external finance." Their investment is lumpy: A small positive shock to productivity induces a large jump of investment due to the fixed cost of external finance.[6]

Finally, firms with very low productivity shocks choose to exit, which we label as "exit" firms.

Financing, Size, and Productivity

Table 3 presents some key statistics by each of the four firm categories. It is a benefit of our model to see which firm is financially constrained. The share of financially constrained firms is just over 69%, slightly higher than our target in calibrating the fixed financial cost parameter to match the U.S. counterpart. Though the share of firms that raise external finds and make positive investment is as small as 0.7%, they account for a large proportion of aggregate investment. Many of the new entrants are classified into this category.[7]

One of the most interesting cross-sectional implications of this model is that firms that raise external finance is most productive, followed by financially constrained firms and unconstrained firms, in terms of the total factor productivity and Tobin's Q. The order of firm size is in the reverse direction: Unconstrained firms are the largest and financing firms and financially constrained firms are the smallest. The implication that small firms are more likely to be financially constrained is consistent with most of the empirical evidence for the Japanese economy.

The exit firms are least productive and their Tobin's Q is lower than unity. There are some competing studies concerning whether exit firms were actually the least productive or not during the 1990s in Japan.[8] While Nishimura et al, (2005) and Fukao and Kwon (2006) found that more productive firms were more likely to

[6] The U.S. plant-level evidences show the existence of lumpy investment (e.g., Cooper et al., 1999; Cooper and Hultiwanger, 2006). The Japanese firm-level evidences also show the existence of lumpy investment (e.g., Tokui et al, 2008).

[7] Financial Statistics of Corporations, the second quarter of 2008, published by Ministry of Finance, which covers corporations capitalized at 10 million yen and more, report the proportion of firms who did not increase fixed assets. According to this Statistics, the proportion of firms who did not increase their fixed asset during the second quarter of 2008 was 74.5%. Considering that this Statistics does not cover small firms capitalized at less than 10 million yens, our result of the small proportion of external financing firms seems to be reasonable.

[8] Griliches and Regev (1995) and Bellone et al. (2005) found that less productive firms were more likely to exit in Israel and France, respectively.

exit in some manufacturing industries in the 1990s[9], Matsuura and Motonishi (2005) found that less productive firms were more likely to exit in the retail industry in the 1990s. Kiyota and Takizawa (2008) also obtained similar results for all industries except for financial service industries. Our result is consistent with the latter evidences.

5. Constrained Economies

5.1 Setting Financial Cost Parameters

As we see in Figure 7, the interest rate margins did not increase during the banking distress in the 1990s and the early 2000s. The average interest margins were 2.23% and 2.05% for the pre-crisis and crisis period, respectively.[10]

Nonetheless, the proportion of financially constrained firms seems to have increased during the crisis period. Actually, firms whose applications for loans were rejected by banks increased. Small and Medium Enterprise Agency conducted a survey in December, 2001 (*Corporate Finance Survey*) and asked whether firms' applications for loans had been rejected by their main bank during the last three years. According to the Survey, among the 4,259 small- and medium-sized firms, 9.6 percent of firms had been rejected by their main bank on average during 1999-2001 (8.2%. 9.7%, and 14.1% in 1999, 2000 and 2001, respectively. See Hosono et al, 2004).

Of course, worsening financial conditions on the part of firms may have at least partly caused the increase in financially constrained firms as well as bank distress. Because we want to focus on the effects of the deterioration in bank balance sheets, not firm balance sheets, we estimated the determinants of the loan rejection and found that at least some part of the loan rejections were due to the deterioration of bank capital (Appendix B).

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9 Kim, Kwon and Fukao (2008) analyzes the exit of manufacturing firms and finds that more productive firms were more likely to exit both in the 1980s and 1990s. They point out that highly productive domestic establishments of electric industries were closed and transferred oversees in the 1990s.

10 The stable interest rate margin may reflect unchanging riskiness of borrowers. To consider this possibility, we constructed the proxy for the riskiness of the average Japanese firms, which is the total interest-bearing liability (short-term borrowings, long-term borrowings and corporate bonds) divided by operating cash flow. Using the Financial Statements Statistics of Corporations by Industry published by Ministry of Finance, we found that this proxy, or estimated repayment years, increased from 9.6 during the pre-crisis period to 12.5 during the crisis period, suggesting that the overall riskiness worsened during the crisis period. To calculate this proxy, we adjusted for the sample changes to keep consistency over time. See Hosono (2005) for details.

To account for the stable interest rate margins and the increase in the number of financially constrained firms, we adopt two alternative approaches.

In one way, using the Survey, we estimated the rate of increase in the number of firms who were financially constrained due to bank distress and found that the number of financially constrained firms increased by 18% due to bank distress (Appendix B). We increase *the fixed financial costs* so as to match this estimate. We label this economy as *the financially constrained economy A*.

The other way is to raise unit financial costs utilizing the non-performing loan losses incurred by the Japanese banks. This experiment is reasonable given that in our model financial intermediaries are competitive and do not incur losses, while actual banks reported huge losses from non-performing loans during the crisis period. For the fiscal year 1997-2001 period, when the aggregate data of loan losses is available, the Japanese banks incurred 1.7% of loan losses as a proportion of total loans on average. We raise λ_0 from 2.2% to 3.9%. This economy is referred to *the financially constrained economy B* below.

By comparing the financially constrained economies A and B with the benchmark economy, we can find the effects of banking distress on the aggregate productivity and other economic performance.

5.2 Comparison of Financially Constrained Economies and Benchmark Economy

Table 4 compares the financially constrained economies A and B with the benchmark economy. We first focus on the constrained economy A.

The share of financially constrained firms increases by 12.5 percentage points from 68.8% in the benchmark economy to 81.4%, with the rate of increase of 18.2% (=(81.4%-68.8%)/68.8%), consistent with our micro data evidence. On the other hand, the firm turnover ratio, which is equal to the share of entry firms or exit firms in the stationary equilibrium, decreases almost by half from 5.8% to 2.7%. This decrease is somewhat larger than the actual the actual decline in the entry rate from 6.1% to 4.4%.

Figure 9 compares the distribution of the firm-level investment-to-capital ratios of Japanese manufacturing SMEs during the crisis period[11] and that of the financial constrained economy A. Unfortunately, the data for the pre-crisis period

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[11] JADE, compiled by Bureau van Dijk from Teikoku Databank database, is used to construct firm-level investment ratios. Jade contains financial statements of unlisted firms only from 1998. The sample covers 27017 firm-year observations from 1999 to 2002. For the details of the construction of the investment-to-capital ratio, see Hosono and Masuda (2005).

was not available. The model economy captures a couple of distinguished features. First, investment is lumpy. A large proportion of firms are inactive and when a firm invests, it invests a lot. Second, the distribution is right-skewed.[12]

Looking at the aggregate variables, we see that neither the investment-to-capital ratio nor the investment-to-output ratio changes virtually from the benchmark economy. This result suggests that just by looking at the investment ratios, we cannot judge whether the economy is affected by the financial constraint or not. Looking at the actual data, we see that the investment ratios slightly decreased from the pre-crisis period to the crisis period. As we noted above, the share of entry firms decreases to 2.7%, which is a little smaller than the actual entry rate of 4.4% in the crisis period. The aggregate productivity (TFP) decreases by 0.7%. As a counterpart of the Japanese economy, we linearly detrended the logarithm of aggregate TFP and found that TFP dropped by 1.9 % from the 1980-95 period to the 1996-2002 period. High financial costs account for about one third of the actual decline in the detrended TFP. The aggregate labor productivity also decreases by 0.8% and accounts for about 45% of the actual decline in the detrended labor productivity.

Why is the aggregate productivity of the constrained economy lower than the benchmark economy? Entrants and productive firms incur losses from high external financial costs because they are more likely to raise external finance. As a result, the real wage decreases so as to make the entrant's firm value nonnegative (See the free-entry condition 15). The real wage is lower in the constrained economy A than in the benchmark economy by 0.4 %. On the other hand, less productive firms gain from the low real wage while they do not incur losses from high financial costs because they are less likely to raise external finance. Consequently, less productive firms are more likely to stay in the market. The survival of less productive firms lowers the aggregate productivity and the firm exit ratio. In sum, financial costs have differential impacts between more and less productive firms: They are harmful to more productive firms and beneficial to less productive firms.

The actual detrended real wage increased by 1.3% during the crisis period from the pre-crisis period. However, the real wage often deviates from marginal labor productivity. For example, Hosono et al., (2008) show that a rising trend of the proportion of middle-aged workers contributed to widen the gap between the real wage and marginal labor productivity.

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[12] The skewness of actual data is 27.3 for manufacturing SMEs, while that is 8.0 for the financially constrained economy A.

Having explained how financial constraints have negative impacts on aggregate productivity in our model, we can compare it with some relevant existing studies. Caballero et al. (2006) show that "zombie lending," or loans to almost insolvent firms, raised factor prices and lowered factor mobility, which was harmful to productive firms. Tomura (2007) analyzes a collateral-constrained economy and finds that a tightening of collateral constraints lowers the land (collateral and production factor) price and thus enables low-productive firms alive. Though exact mechanisms through which financial sector problems transmit to aggregate productivity are different among those two models and ours, all share a general equilibrium impact: financial market imperfections affect factor prices in such a way as high-productivity firms are affected negatively and low-productivity firms are benefited.

Next we compare the constrained economy B with the benchmark economy. The share of financially constrained firms increases by 18.1% and the firm turnover ratio decreases to 2.4%. These effects are somewhat larger than the constrained economy A. The other aggregate variables, including the investment ratio and the cash flow ratio are almost identical with the constrained economy A. In particular, the aggregate productivity (TFP) decreases by 0.7 percentage points from the benchmark economy. This coincidence may be surprising given that the increase in external financing costs are formulated differently (fixed costs vs. unit costs) based on the different evidence (micro evidence for firms and aggregate dataset for banks).

6. Alternative Specifications

We have made an assumption that in the benchmark economy the share of financially constrained firms is almost the same as that of the U.S. listed firms and set the fixed cost of external finance so as to match the evidence from Gomes (2001). In this section, we see to what extent our main results depend on this assumption. For this purpose, we make an alternative assumption that the fixed cost of external finance is zero. We find, however, that just eliminating the fixed cost of external finance makes the firm turnover ratio higher than 20% for a reasonable range of fixed operating cost, f. So, following Hopenhayn (1992), Cooley and Quadrini (2001) and others, we introduce a fixed cost of entry. We set this parameter to 0.03, so that the firm turnover ratio coincides with the pre-crisis period Japanese economy given the fixed operating cost of 0.01. Table 5 shows the calibration results.

First, we set the unit external financial cost, λ_1, to the interest rate margin, 0.022. In this alternative benchmark economy (labeled as "Benchmark Economy 2" below), lumpy investment by "external finance" firms is not as evident as Benchmark Economy with fixed financial costs (Figure 10) and the share of financially constrained firms decreases to 31%. However, the aggregate variables including I/K, I/Y and CF/Y do not change virtually from the Benchmark Economy.

Next, we raise λ_1 to 0.03 so as to increase the share of financially constrained firms by about 5 percentage points or about 18% rate of increase from 31%. Comparing this economy, labeled as "Constrained Economy A2", to "Benchmark Economy 2," we find that the firm turnover ratio decreases to 0.008, which is much smaller than Japanese economy during the crisis-period. Aggregate TFP decreases by 1 percentage point.

Finally, we raise λ_1 to 0.039 to take into consideration the losses from non-performing loans. Comparing this economy, labeled as "Constrained Economy B2" to "Benchmark Economy 2," we find that the share of financially constrained firms increase by 15.7%, much larger than what the *Corporate Finance Survey* suggests. The firm turnover ratio decreases to 0.008, again much smaller than the crisis-hit Japanese economy. Aggregate TFP decreases by 1 percentage point.

How can we interpret the results from these alternative specifications? Given the huge increases in the share of financially constrained firms and the low firm turnover ratio, 1% decrease in aggregate TFP may overestimate the impact of high external financing costs during the crisis-period. As such, it may be served as an upper bound.

7. Conclusion

Differential impacts of external financial costs between more and less productive firms or between entrants and incumbents are essential to understand their aggregate consequences. 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. Though we calibrate our model to a specific economy, Japan, the implications of our results are general: high financial costs significantly decrease aggregate productivity through depressed firm turnover and distorted investment decisions.

Appendix 1. Data

Aggregate Data

Aggregate output, investment, capital, labor and TFP are available at JIP Database 2008. All these variables exclude public and housing sectors (i.e., "market economy").

Y=Real Output –Real Intermediate Input,

K= Real Net Capital Stock,

I= Real Investment Flow, and

L=Divisia Index of Labor.

To derive the detrended ln(TFP) series, we first construct the TFP level series by consecutively multiplying the TFP growth rates from the 1980 level, which we normalize to be unity, to year 2005. Then we regressed the logarithm of TFP level by regressing it on time trend:

$$\ln(TFP) = 0.027 + 0.0102 * time\,trend\ .$$

We use the regression residuals as the detrended ln(TFP).

Similarly, we obtained the detrended ln(Y/L) by regressing the logarithm of labor productivity level (Y/L) on time trend.

The share of financial services is derived from JIP Database 2008 as

Λ/Y=The share of real value added of financial industries (*Industry 69*) in the market economy.

Cash flow is obtained from *Financial Statements Statistics of Corporations by Industry (FSSC)* published by Ministry of Finance. We adjusted the effects of sample changes and sample selection lag for the small-sized firms to keep consistency of time series data. See Hosono (2004) for details.

CF/Y=(Operating income+Depreciation) / Value added.

Firm turnover ratio of firms with employees is from "Employment Insurance Annuals," published by Ministry of Welfare and Labor.

Firm-level Data

For the descriptive statistics of the firm-level data of I/K and Q, we refer to Hosono and Watanabe (2002), whose sample consists of all the firms listed in the first and second sections of Tokyo Stock Exchange and other regional stock exchanges during 1971-99. Hosono and Masuda (2005) provide the SMEs' firm-level data of I/K for the period of 1999-2003. Because their sample covers only the crisis period, we do not use it for the calibration of the benchmark economy but only for the comparison of the distribution of I/K with the financially constrained economy.

Appendix 2. Estimation of the share of financially constrained firms

Data

To estimate the share of financially constrained firms, we use *Corporate Finance Survey* published by Small and Medium Enterprise Agency in December, 2001. This *Survey* is similar to NSSBF1993 (National Survey of Small Business Finance) for the U.S firms. The sample firms were randomly drawn from TSR (Tokyo Shoko Research) database. In the *Survey*, firms were asked whether their applications for loans had been rejected by their main bank over the last three years. We identify the firms' main banks as the first financial institutions in TSR database.

The *Survey* data is linked with the main banks' financial statements available at Nikkei Needs database and the bank stock prices from Toyo Keizai Stock Price CD-ROM.

Their sample consists of the firms that satisfy the following three conditions. First, they are small or medium-sized enterprises defined by Small and Medium-sized Firm Fundamental Law. Second, their main financial institutions are major banks, long-term credit banks, trust banks, first-tier regional banks, second-tier regional banks or credit banks (*shinkin*) whose data is available, and those firms who did not change their main banks during the three years of 1999-2001. The number of the firms left by satisfying these conditions is 4259.

Probit Estimation

We estimate the determinants of the rejections of loan applications using a Probit estimation following Hosono et al. (2004). We denote by R_{it} the dummy variable that takes the value of one if firm *i*'s loan application is rejected in year t and zero if accepted. R_{it} is determined by R^*_{it}, defined as

(A1) $$R^*_{it} = \beta_0 + \beta_1 Firm_{it} + \beta_2 Bank_{it} + \beta_3 \mathrm{Re}lationship_{it} + u_{it},$$

where $Firm_{it}$ denotes the vector of firm *i*'s operational performance and other firm characteristics, $Bank_{it}$ the vector of the main bank's capital conditions, and $\mathrm{Re}lationship_{it}$ the vector of the closeness between firm *i* and its main bank. u_{it} is a random variable drawn from a normal distribution with mean zero and variance σ^2. Whether the main bank rejects or accepts the firm's loan application is determined as

$$R_{it} = \begin{cases} 1 & if \;\; R_{it}^{*} \geq 0 \\ 0 & if \;\; R_{it}^{*} < 0 \end{cases} \quad \text{(A2)}$$

For the $Firm$ variables, we use 1) *reve*: the dummy variable that takes unity if firm *i*'s business conditions are better or unchanged and zero if they are worse, 2) *age*: firm age, and 3) *lnworler*: the logarithm of the number of employees. We use these variables to capture the creditworthiness of the firm. We can expect that the firm is more likely to be rejected if its business condition is worse, young, and small.

As for the $Bank$ variables, we adopt *stock*: rate of change in stock prices from March, 1993. Following Hosono et al, (2004) we also add 1) *cap*: the difference between the risk-weighted capital adequacy ratio and the minimum requirement level of the capital adequacy ratio, 2) *depo*: deposit growth rate, and 3) *npl*: non-performing loans outstanding as a share of total loans outstanding. A bank with a higher *stock* and *cap* and with a low *npl* is expected to be healthier, to extend more loans and hence to less frequently reject the client firm. We also include *depo* to capture the degree of the bank's liquidity constraints. A bank with a higher *depo* is expected to be less likely to be liquidity constrained and hence to less frequently reject the loan application.

For the $\mathrm{Re}\,lationship$ variables, we use 1) *relnumber*: the number of financial institutions that the firm deals with, and 2) *relyear*: the number of years for which the firm has been dealing with its main bank. A smaller *relnumber* and a longer *relyear* suggests a closer relationship between the firm and its main bank, and hence is supposed to result in a less frequency of the loan rejection.

The sample statistics of the variables we use are summarized in Table A1.

Results

Table A2 presents the estimation results for the marginal effect evaluated at the mean value of each dependent variable. The first column shows the result when we use only *stock* for $Bank$ variables, while the second column shows the result when we add *cap*, *depo* and *npl* for $Bank$ variables. All the coefficients have expected signs with high significance levels except for *npl*.

Our goal here is to estimate the share of firms that were financially constrained firms due to high external financial costs. For this aim, we extract those firms whose loan applications were rejected due to their main banks' unhealthy conditions. It is notable, however, that accounting measures of banks are not reliable and sometimes cause a perverse effect given the discretionary accounting practices prevalent among Japanese banks in the 1990s (Hosono and Sakuragawa, 2008). Thus, we focus on *stock* to estimate the share of financially constrained firms. By using the coefficient on *stock* (-0.0004) in the first column and multiplying it by the average value of *stock* (-36.017%), we find that among all sample firms, 1.469% of firms were rejected due to their main banks' financial conditions. Given that the rejected firms occupy 9.56% of all firms, we estimate that the number of rejected firms increased by 18.2% (=1.469%/(9.56%-1.469%)) due to the deterioration of bank equity value.[13]

Estimation of the proportion of financial constrained firms

Rejected firms can be safely regarded as financially constrained firms. But even among those who do not apply loans, there must be some firms who wanted to borrow but are discouraged due to high financial costs (just like discouraged workers, who do not search for jobs anticipating a low likelihood of finding a job). We assume that the proportion of "discouraged" firms in financially constrained firms is constant over time. Then, the number of financially constrained firms should increase at the same rate as the number of firms who were rejected due to the deterioration of bank health. Consequently, we estimate that the number of financially constrained firms increase by 18.2% due to higher financial costs during the crisis period.

[13] If we use coefficient on on *stock* in the second column, we find that the number of rejected firms increased by 16.3% due to the deterioration of bank equity value.

Appendix 3. Solution Methods

We adopt the following numerical solution methods based on Gomes (2002).

1. Given an arbitrary initial value of w, we solve the Bellman equation for the firm, (10), and compute the optimal decision rule, using the value function iteration method.

We divide the space for capital stock into 101 grid points between zero and the upper bound that is chosen so as to be non-binding. The space for productivity shocks are divided into 9 points.

2. Using the value function obtained in Step 1, we determine w that satisfies the free entry condition (15) for $B>0$.

3. Using the optimal decisions rules obtained in Step 1, we iterate the law of motion for μ, (16), to compute the stationary measure μ with $B=1$.

4. Using the market clearing conditions, (31) or (32), we determine the equilibrium level of entry B and the corresponding stationary measure μ.

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Table. 1 Calibration

Parameters	Benchmark Economy	Empirical Restrictions
Technology		
αk	0.3	Degree of returns to scale
αl	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		
$\lambda 0$	0.04	Share of financially constrained firms
$\lambda 1$	0.022	Interest rate margins between bank loans and deposits
Preferences		
β	1/1.03	Interest rate
H	0.6	Employment share

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	1.097
	(1.443)	

Notes.
1. The Tobin's Q value in the parentheses is the average over the period exculding the "bubble" period (1987–92
2. Firm turn over rate (Entry) is the average over 1981–1995.

Table 3. Cross-Sectional Results: 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

Note. CF and Λ dnote cash flow and financial costs, respectively.

Table 4. Financially Constrained Economies

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

B. 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

Note:
1. Log(TFP) and Log(Real Wage) for the Japanese economy are the detrended average levels.
2. Log(TFP) s for the model economies are for incumbernt firms.

Table 5. Alternative Specifications

Variable	Japanese economy 1980–1995	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	−0.009	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

Table A1. Variables in Coporate Finance Survey

Variable		No. of Obs.	Mean	Std. Dev.
Rejection of Loan Applications				
R	dummy that takes 1 if the loan application is rejected	12787	0.095566	0.294006
Firm				
reve	business condition: better or unchagned=1, worse =0	12777	0.613	0.487
age	firm age	12777	40.729	21.781
lnworker	logarithm of the number of workers	12777	3.685	1.040
Main Bank				
cap	risk-weighted cpital ratio - required minimu capital ratio	12777	4.403	2.163
stock	rate of change in stock prices from March, 1993	10689	-36.017	23.805
depo	deposit growth rate	12777	0.880	6.874
npl	non-performing loans / total loans	12777	3.815	1.868
Firm-Bank Relationship				
relnumber	number of financial institutions that the firm deals with	12777	4.323	3.288
relyear	number of years for which the firm deals with the main bank	12777	30.369	15.023

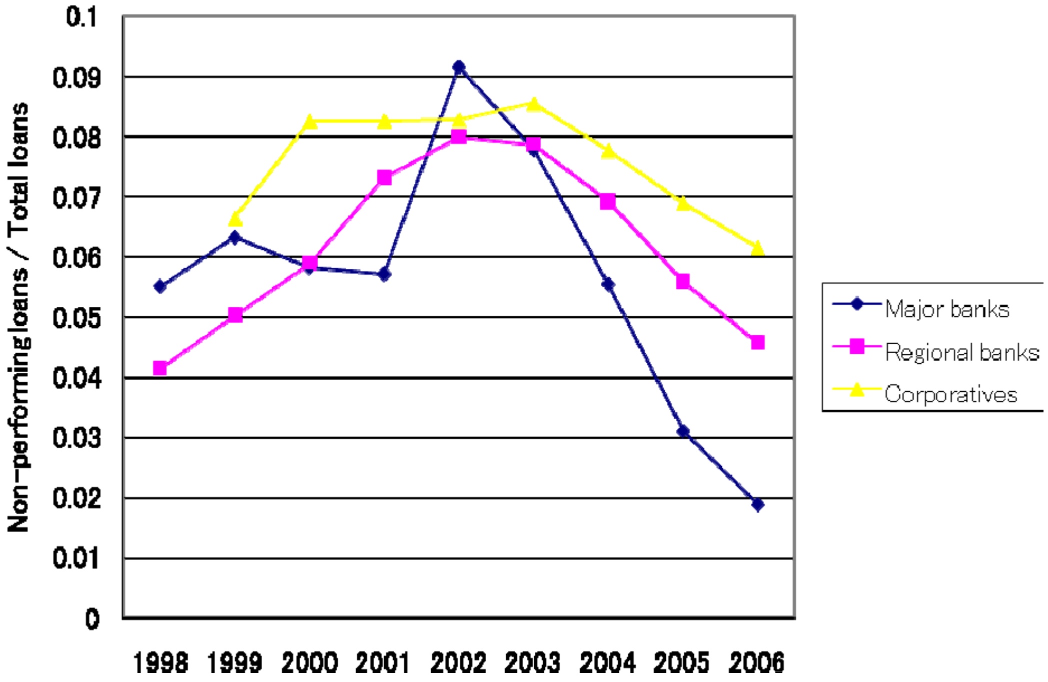
Source: Hosono et al. (2004).

Table A2. Probit estimates for loan rejection

Variable	dP/dX		dP/dX	
reve	−0.0742	***	−0.0743	***
	(0.0000)		(0.0059)	
stock	−0.0004	***	−0.0004	***
	(0.0001)		(0.0001)	
cap			−0.0033	**
			(0.0016)	
depo			−0.0013	***
			(0.0005)	
npl			−0.0031	*
			(0.0016)	
relnumber	0.0064	***	0.0063	***
	(0.0000)		(0.0007)	
relyear	−0.0014	***	−0.0014	***
	(0.0000)		(0.0002)	
age	0.0002	*	0.0002	*
	(0.0930)		(0.0001)	
lnwoker	−0.0322	***	−0.0327	***
	(0.0000)		(0.0028)	
Psudo R2	0.0845		0.0870	
No. of Obs.	10689		10689	

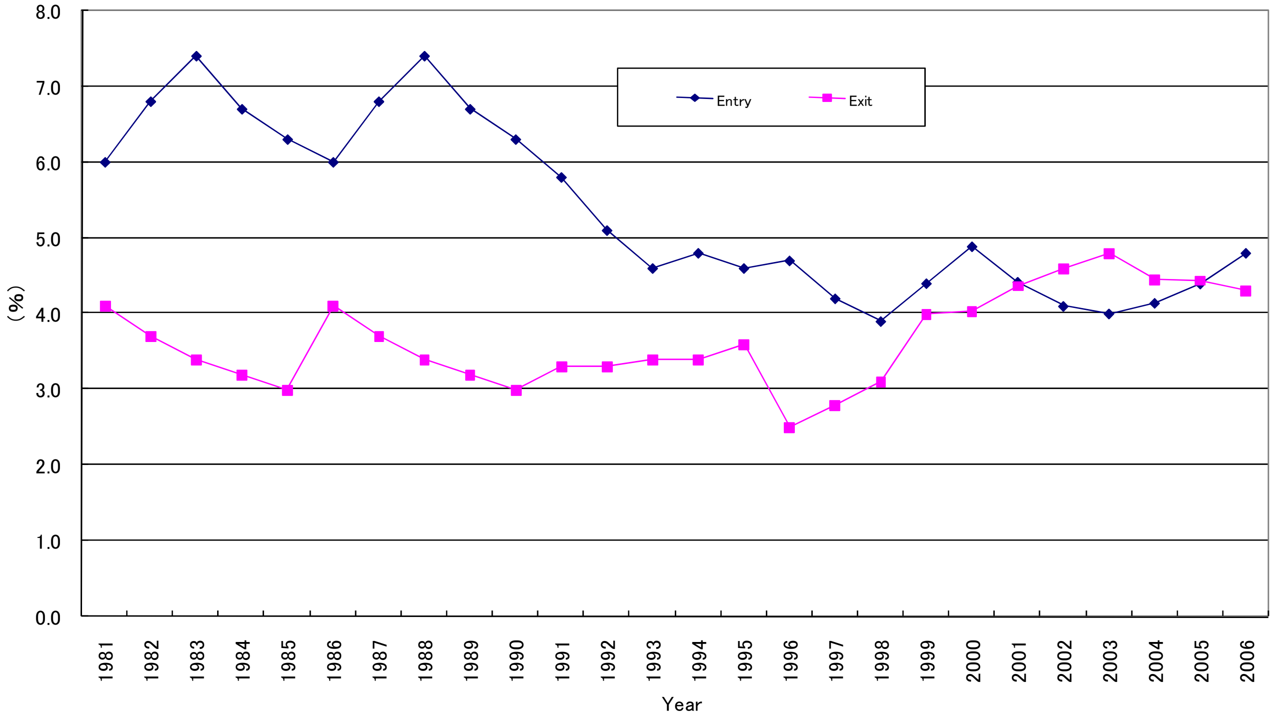
Note
1. The dependent variable is a dummy that takes unity if the firm's loan application is rejected and zero if it is accepted..
2. dP/dX notes the marginal probability evaluated at the mean value of the explanatory variables
For the reve dummy, it is for discrete change from 0 to 1.
3. Numbers in theparentheses are standard errors.
4. *** and * denote the significance levels at 1% and 10%, respectively.
5. Three industrial dummies and two year dummies are included in the explanatory variables.

Figure 1. Non-performing loans of Japanese banks



Source: Financial Service Agency. The non-performing loan ratios are as of March of each year.

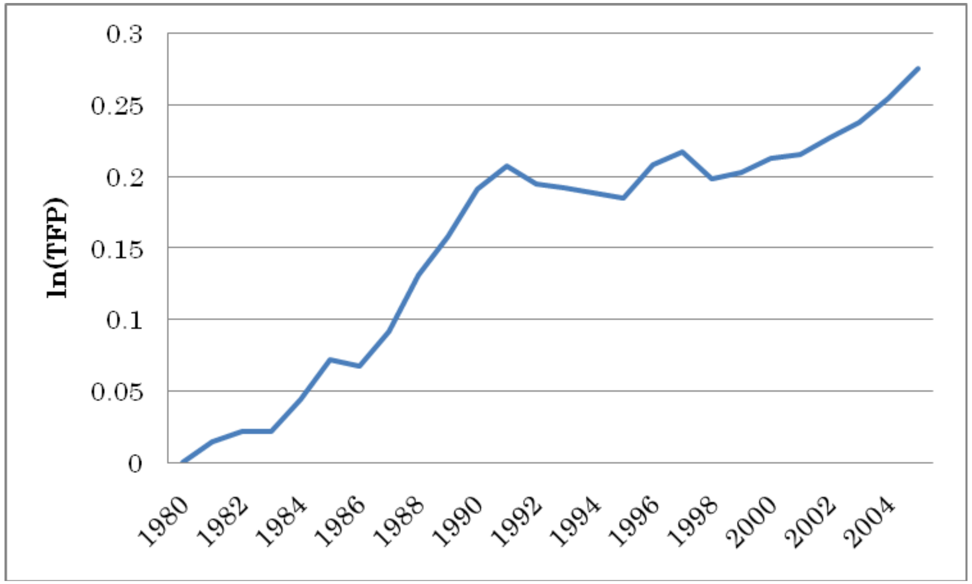
Figure 2. Turnover of Establishments



Note: Turnover ratio of establishments with emploees

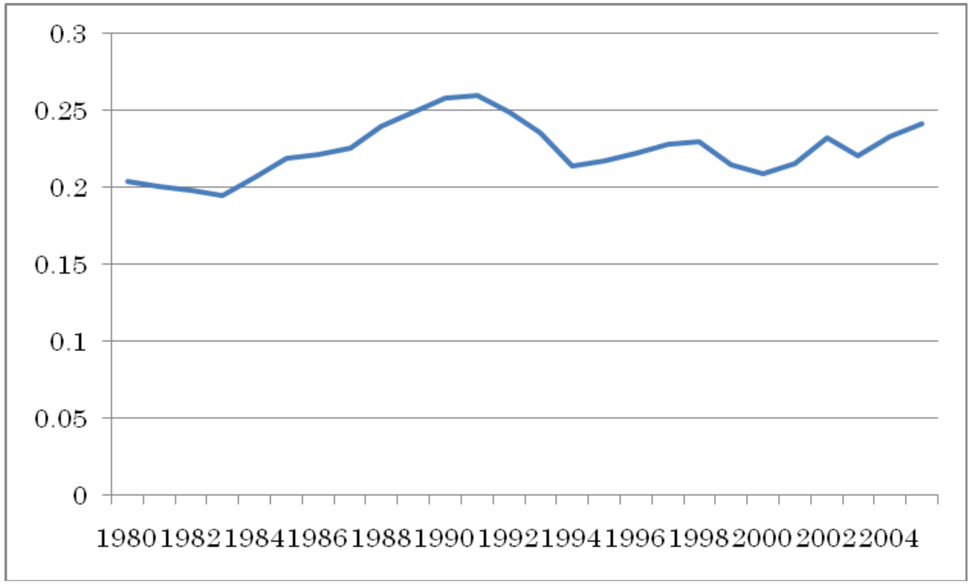
Source: Ministry of Welfare and Labor, “Employment Insurance Annuals.”

Figure 3. TFP in Japan



Note: The market economy sector in JIP Database 2008. The TFP level in 1980 is normalized to unity.

Figure 4. Share of Investment in GDP



Note: The market economy sector in JIP Database 2008.

Figure 5. Sequence of Events

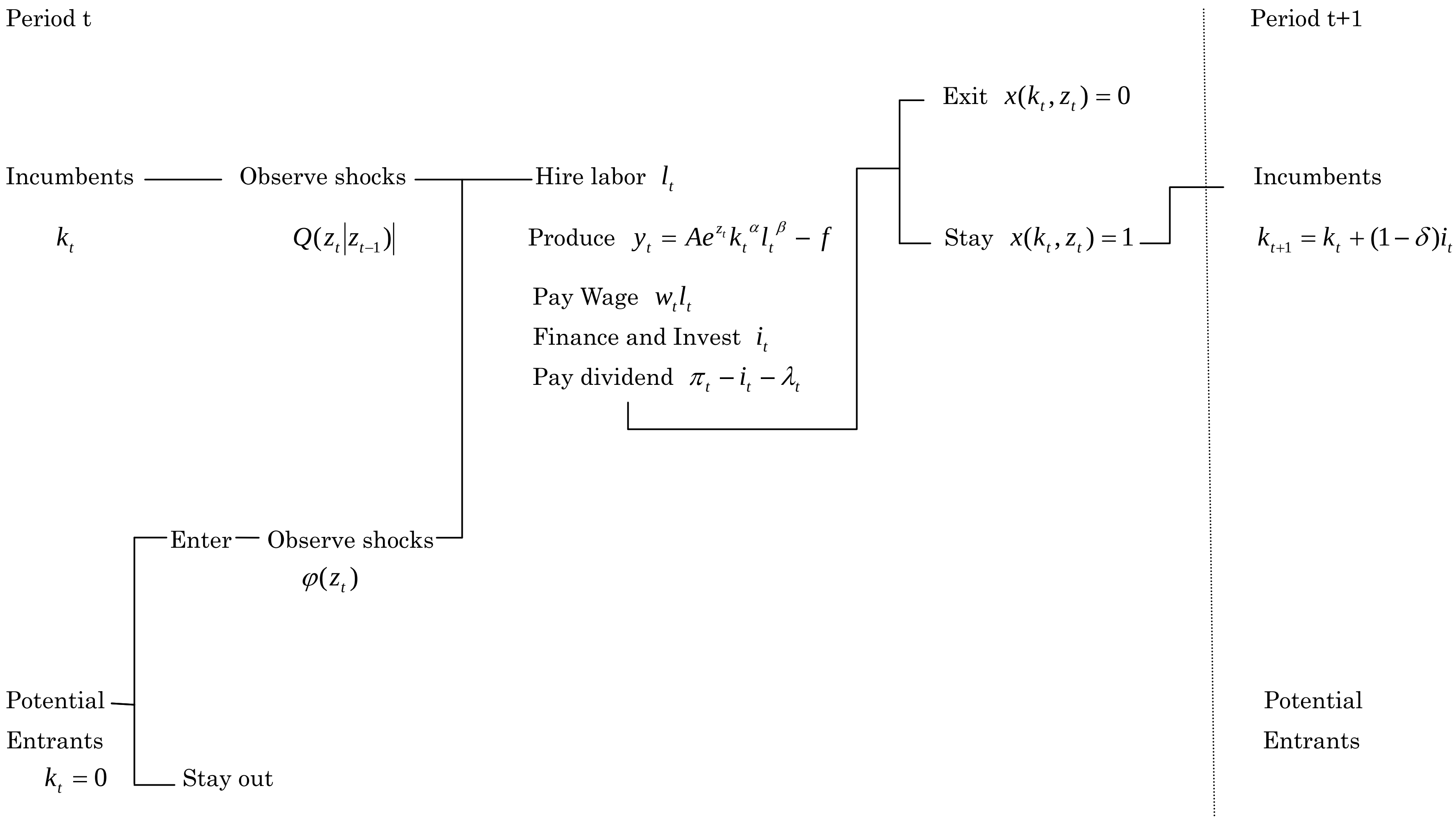


Figure 6. Financing Costs

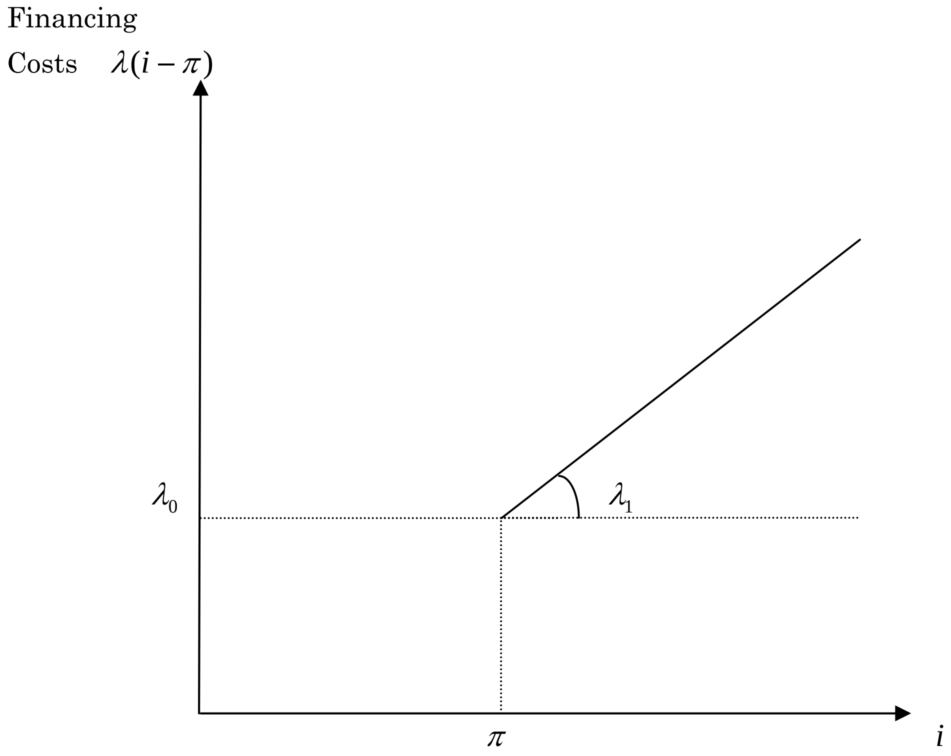
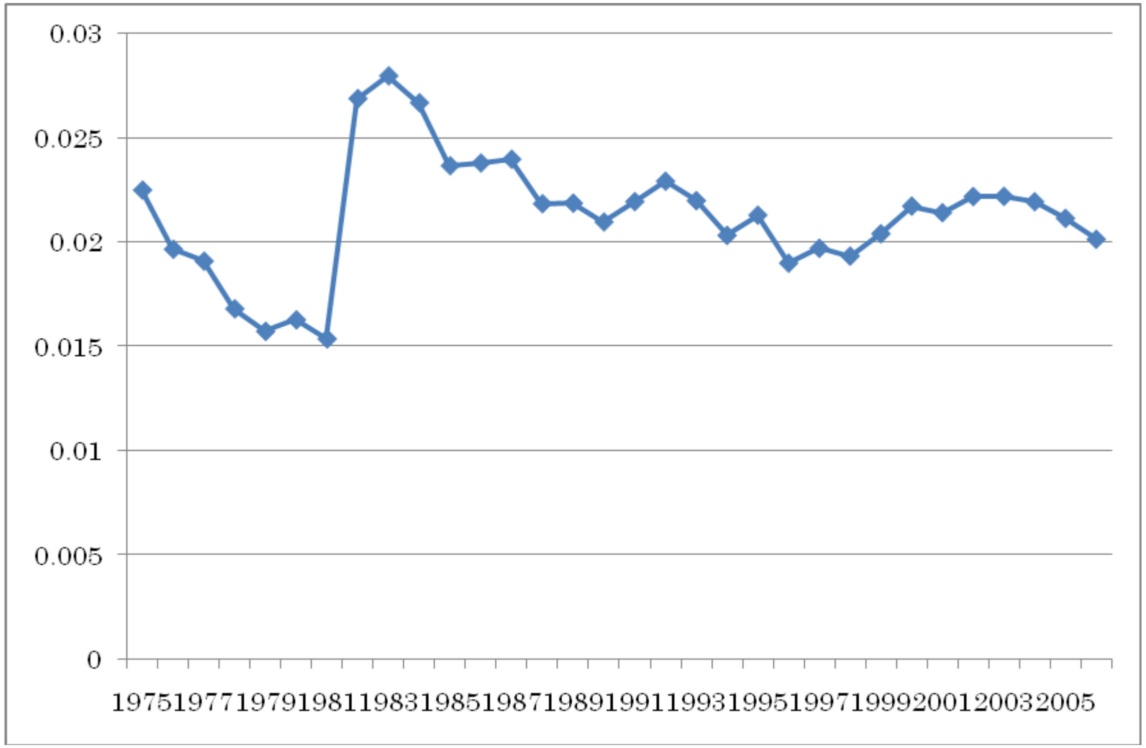


Figure 7. Interest Margins of Japanese Banks



Note: Interest margins = average loan interest rate – average deposit interest rate

Source: Sakuragawa and Hosono (2008)

Figure 8. Optimal Capital Accumulation in Benchmark Economy

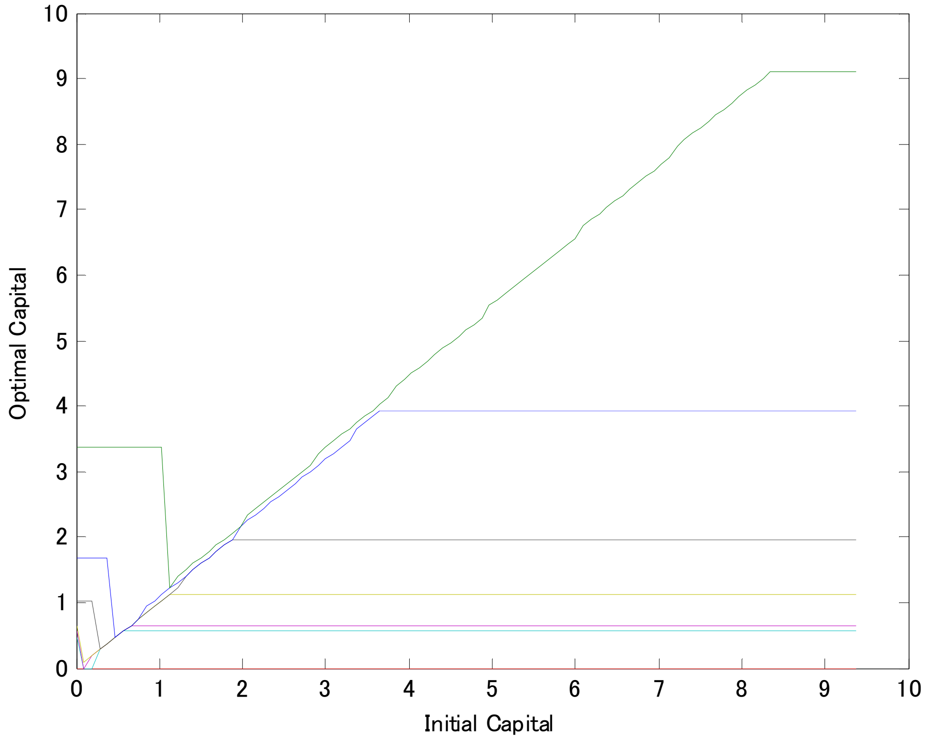
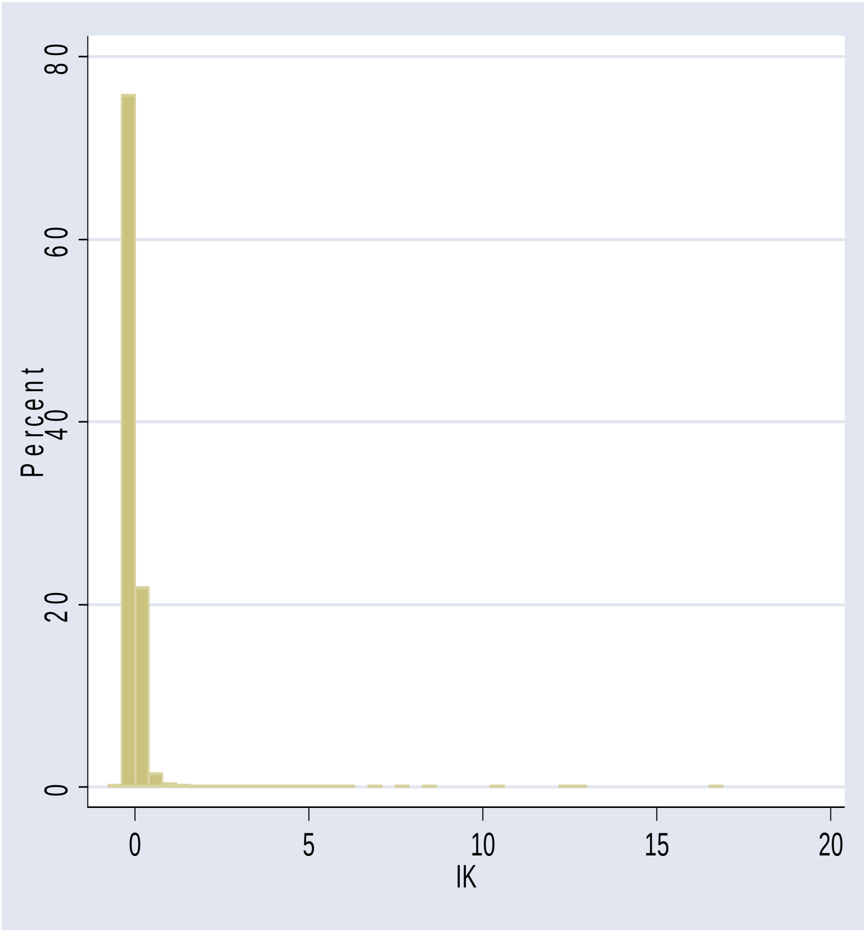
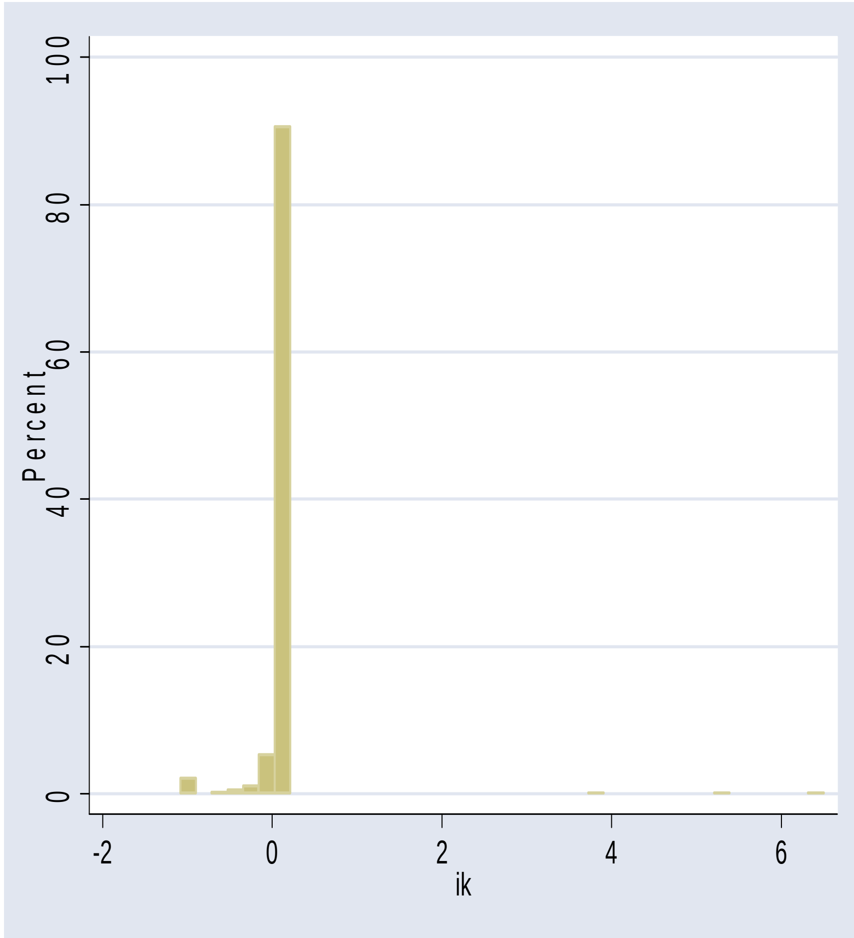


Figure 9. Distribution of Investment-to-Capital Ratio



A . SMEs in Japanese Manufacturing Industries: 1999-2002



B. Financially Constrained Economy A

Figure 10. Optimal Capital Accumulation in Benchmark Economy 2