A note on the recent behaviour of Japanese banks

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1. Introduction

This note offers a brief analysis of Japanese banks' behaviour in recent years. Section 2 reviews the current situation at Japanese banks and Section 3 attempts to build a model which describes their behaviour. Although there is no single model that succeeds in explaining banks' behaviour consistently over the longer term, it is possible not only that their behaviour may be significantly affected by different factors in different periods but also that the same factor might have a different degree of impact depending on the period. In order to check the latter possibility, Section 4 focuses on the capital constraint and, making use of simulations within a dynamic model, reviews the influence of the capital constraint on banks' decision-making regarding the amount of write-offs.

2. Japanese banks in recent years

The Bank of Japan has been providing ample liquidity as part of its active pursuit of monetary easing and, as a result, overall financial market stability has been maintained (Figure 1). Within this environment, Japanese banks have been tackling management tasks such as the disposal of non-performing loans (NPLs).

The effects of the active monetary easing on banks' profitability, however, seem complicated. For example, the profitability of deposits, ie the margin between the deposit rate and the market rate, which had been narrowing since the beginning of the 1990s along with the deregulation of deposit rates, finally fell to zero with the introduction of the zero interest rate policy that forced short-term market rates up against the zero bound (Figure 2).

As for the disposal of NPLs, total credit costs at Japanese banks have exceeded operating profits from their core business since fiscal 1993 (Figure 3). In detail, write-offs of past NPLs have been accelerating (Figure 4) and the ratio of NPLs to total loans has started declining, albeit slowly (Figure 5). With regard to loan loss provisions, since fiscal 2002 major banks have adopted the discounted cash flow (DCF) method to calculate loan loss provisions for borrowers, with credit of ¥10 billion or more, classified as "special attention", and the loan loss provision ratio has risen (Figure 4). New NPLs, on the other hand, continue to arise, as Japan's economy is in the midst of structural changes. Under such circumstances, Japanese banks should assume, for the time being, comparatively high credit costs, say around 1% against their loans outstanding. It is, therefore, still very important for banks to earn sufficient profits to cover these credit costs.

Bank capital has become impaired not only because of these high credit costs but also because of stock market weakness. Since fiscal 2000 in particular, net unrealised stock-related gains have actually disappeared (Figure 6) and hence any losses that occur tend to impair capital. This tighter constraint on capital may have affected bank behaviour. For instance, during this process banks seem to have become more sensitive about the size of their loan assets, reducing overseas loans in the late 1990s and subsequently even domestic ones (Figure 7).

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3. Modelling banks' behaviour

This section attempts to build a theoretically grounded model to describe bank behaviour consistently. Considering the issues discussed in the previous section, it may be expected that building such a model would prove problematic, and in fact it proves not to be possible to build a model capable of providing a fully satisfactory explanation of the observed reality.

The model applied here is based on the assumption that the bank acts to maximise its present value and that its decision regarding the amount of loans to extend is dependent mainly on the loan margin. The following additional factors are also taken into account: (1) costs on loans, including losses from NPL disposal; (2) land prices, reflecting the value of collateral; (3) the constraint on capital; (4) net unrealised stock-related gains/losses; and (5) developments in the real economy. Appendix 1 explains the details of the model.

As bank behaviour may depend upon balance sheet size, the model was estimated for both major banks and regional banks. We also carried out estimations for four different periods: (a) the whole period, fiscal 1985-2001; (b) the bubble period, fiscal 1985-89; (c) the first half of the 1990s, ie fiscal 1990-96; and (d) the period from the second half of the 1990s onwards, ie fiscal 1997-2001.

The main results obtained may be summarised as follows (Figure 8):

- It is not possible to obtain a satisfactory explanation of the lending behaviour of both major and regional banks that holds true throughout the whole period.
- Changes in the price of land, which served as collateral for loans, affected the lending behaviour of both major and regional banks, in the sense that higher land prices acted to lower costs on loans and hence to increase them, in the bubble period.
- The constraint on banks' capital seems to have become binding, especially for major banks, since the second half of the 1990s. It was at this time that Japan experienced its banking crisis.

Thus it is difficult to describe the lending behaviour of Japanese banks precisely enough with a single optimisation model. However, the following possibilities can be pointed out. One is that bank behaviour might be crucially influenced by different factors in different periods. The other is that the same factor might have a different degree of impact depending on the period.

4. Simulations of bank write-offs

The second of the two possibilities introduced at the end of the previous section may apply to the capital constraint. When banks dispose of NPLs, they have to decide how much to write off. If they write off NPLs, they have to prepare for unexpected losses. However, future returns on loans should improve with the removal of unprofitable assets from their balance sheets. Capital constraints may affect this decision-making process. If the constraint is severely binding, banks may prefer to make provisions rather than to carry out write-offs since by doing so they would avoid unexpected losses and the resulting capital impairment. The extent to which the capital constraint is a binding factor in this decision-making process may vary depending on the period.

In order to check this point, we use a dynamic macro model to perform simulations. Figure 9 gives a brief description of the simulation algorithm. The bank's utility is assumed to be a function of its own expected future profits and the variance of this expectation. The bank is assumed to be facing uncertainty with regard to the macroeconomic condition in the future, about which it forms adaptive expectations. The bank goes bankrupt when its capital adequacy ratio falls below a certain minimum level.

Two time points, the beginning of fiscal 1997 and of fiscal 2001, are considered. The bank is assumed to have full information on the economic structure at the end of fiscal 1996 and fiscal 2000 respectively. Two hypothetical cases are considered: one where the bank is aggressive in carrying out write-offs, the other where it is not (Figure 10). The difference between the banks' respective utilities in these two cases can be obtained through simulations. Appendix 2 explains the details of the model and the way simulations are conducted.

The main simulation results can be summarised as follows:

- In fiscal 1997, the capital constraint proved a binding condition in determining the amount of write-offs carried out by the bank (Figure 11). According to the simulation, the probability at that time that the bank would go bankrupt was fairly high, especially in the "aggressive write-off" case. The bank was therefore cautious about being overly aggressive in its write-offs.
- This result is more or less the same even when the bank possesses perfect foresight about the future macroeconomic condition (Figure 12).
- In fiscal 2001, on the other hand, the incentive for the bank to be aggressive in its write-offs was stronger (Figure 13). This may reflect changes in the bank's situation, such as a gradual correction of the bank's once optimistic expectations about the future economic condition, as well as enhancement of the bank's capital via injections of public funds.

The above results coincide with the fact that banks have been more active in their writing-off of NPLs in recent years. In addition, major banks are trying to reduce their stock holdings, as stocks are regarded as assets which carry a relatively high price fluctuation risk given their current capital levels. Such a reduction allows them to ease their capital constraints and to achieve more effective use of their capital. The Bank of Japan launched a scheme to purchase stocks held by banks to support their efforts in this regard and to mitigate the negative effects of stock price fluctuations on their capital.

It is expected that the changes in the behaviour of Japanese banks reviewed in this note will become more firmly reinforced and this would contribute to improving their profitability over the coming years.

Appendix 1:
Derivation of the optimal condition for bank behaviour

Model[2]

Consider the following representative bank value function (V):

$$V_t = \beta E_t \left[\sum_{\tau=0}^{\infty} CF_{t+\tau} \right] \qquad \text{(A1-1)}$$

where β is the subjective discount factor, E_t is the expectations operator conditional on information available in period t, and CF denotes the cash flow earned in each period. We define the bank's cash flow as:

$$CF_t = r_{Lt}L_{t-1} + r_{St}S_{t-1} - r_{Ct}Call_{t-1} - r_{Dt}D_{t-1} - C_t \qquad \text{(A1-2)}$$

where r_{Lt}, r_{St}, r_{Ct}, and r_{Dt} represent, respectively, the rates of return in period t on loans (L), securities (S), call money ($Call$), and deposits including debentures (D) outstanding at the end of period $t-1$.[3] C describes a cost function on loans which we specify as:

$$C_t(FL_t, L_{t-1}, D_{t-1}) = a_1 FL_t + \frac{a_2}{2}\frac{FL_t^2}{D_{t-1}} + a_3 L_{t-1} \qquad \text{(A1-3)}$$

where FL_t is the net flow of loans in period t, assuming that, as new loans increase, credit exposure also increases to borrowers about whom available financial information is insufficient, resulting in higher monitoring costs for the bank ($a_2 > 0$).[4] The parameter a_3, on loans outstanding at the end of period $t-1$, is regarded as a proxy for the magnitude of non-performing loans (NPLs) generated in period t, and is thus supposed to enter positively in equation (A1-3) ($a_3 > 0$).[5] In short, costs on loans here include losses from NPL disposal as well as the implicit general and administrative expenses incurred in loan management. In the meantime, the larger the deposits, a proxy for bank scale, the more likely it is that loan portfolios will be diversified, and we therefore incorporate deposits as a scale variable acting to mitigate costs on loans.

We also give the impact of changes in land prices (P_L) on the parameter a_3, which is expressed as:

$$a_3 = a_4 - a_5 \frac{P_{Lt-1}}{P_{Lt-2}} \qquad \text{(A1-4)}$$

What equation (A1-4) implies is that appreciation in the value of land helps the bank to secure loans (ie its collateral role on loans), which is empirically found in the US bank data by Berger and Udell (1995).[6] If this implication is true, the sign condition will be that $a_5 > 0$.

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2 In building a model, we owe much to work by Elyasiani et al (1995) and Ogawa and Kitasaka (2000) aimed at capturing the bank's optimal behaviour.

3 When the bank takes out a net call loan, we interpret this to mean that it has a negative holding of call money. Since banks can generally control both holdings of and returns on negotiable certificates of deposits (NCDs) and straight bonds, they are not included in deposits.

4 Although FL_t should be new loans made in period t in this sense, we use the difference in loans outstanding from period $t-1$ to t due to the availability of such data.

5 If a_3 is properly estimated, it should not be substantially different from actual credit costs (the NPL ratio) at banks.

6 In Japan, movements in land values are almost perfectly negatively correlated with movements in the number of firm bankruptcies.

The balance sheet condition requires that the following identity holds:

$$L_t + S_t + R_t + OA_t = D_t + Call_t + K_t + OL_t \tag{A1-5}$$

where R is bank reserves defined such that $R_t > \rho D_t$ (ρ: required reserve ratio, assuming simply that $R_t = \rho D_t$ in the optimal representative bank case), K denotes capital, and OA_t and OL_t represent, respectively, other assets and liabilities at the end of period t.

Without restrictions on asset management and given *a* change in deposits that is exogenously determined via the consumer's optimal resource allocation, the bank's optimal strategy is to choose {*L*, *S*, *Call*} in each period in order to maximise the value function (A1-1) subject to equations (A1-2) to (A1-5). Solving this dynamic optimisation problem yields the following first-order condition:

$$\frac{\partial C_t}{\partial FL_t} = \beta E_t\left[r_{Lt+1} - r_{Ct+1} - \frac{\partial C_{t+1}}{\partial L_t} + \frac{\partial C_{t+1}}{\partial FL_{t+1}}\right] \tag{A1-6}$$

Decomposing conditional expectation terms into their certainty equivalent values and an expectation error under the assumption of rational expectations and rearranging them, we obtain the bank's optimal lending function:

$$\frac{FL_t}{D_{t-1}} - \beta\frac{FL_{t+1}}{D_t} = b_0 + b_1\left(r_{Lt+1} - r_{Ct+1}\right) + b_2\frac{P_{Lt}}{P_{Lt-1}} + u_{t+1} \tag{A1-7}$$

where:

$$b_0 = \frac{\beta\left(a_1 - a_4\right) - a_1}{a_2}$$

$$b_1 = \frac{\beta}{a_2} > 0$$

$$b_2 = \frac{\beta a_5}{a_2} > 0,$$

and u_{t+1} is an expectation error uncorrelated with any information in period t.

In fact, bank lending behaviour has been restricted by the Basel Accord formally introduced in 1993, which is defined simply:

$$K_t \geq \kappa L_t, \tag{A1-8}$$

where κ is the required capital adequacy ratio.[7, 8] Taking account of this restriction and applying the first-order Kuhn-Tucker condition to the optimisation problem, we obtain the Euler equation to be estimated as:

$$\frac{FL_t}{D_{t-1}} - \beta\frac{FL_{t+1}}{D_t} = b_0 + b_1\left(r_{Lt+1} - r_{Ct+1}\right) + b_2\frac{P_{Lt}}{P_{Lt-1}} - \frac{\kappa}{a_2}\lambda_t + u_{t+1} \tag{A1-9}$$

where λ_t is the non-negative Lagrange multiplier associated with the bank's capital requirement restriction.[9] Since λ_t is unobservable, the fourth term on the right-hand side of equation (A1-9) is set to be $b_3\kappa_t$ in later estimations, where $b_3 > 0$ and κ_t is the actual capital ratio.

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7 Note that, strictly speaking, L_t on the right-hand side of inequality (A1-8) should be the weighted risk assets derived from the BIS formula. Ito and Sasaki (1998) estimate the impact of the Basel capital standard on Japanese banks' behaviour, and confirm its significance empirically.

8 We do not account here for the existence of the bank lending channel, used to refer to the quantitative effect whereby deposits on the liability side affect loans on the asset side. Although this effect is empirically observed in the US bank data and documented in Kashyap and Stein (1997), we simply assume here perfect substitutability between deposits and money in the short-term financial market.

Data

In estimating the Euler equation (A1-9), we employ annual settlement data from the accounts of 10 major and 113 regional Japanese banks.[10] Our sample data run from fiscal 1982 to fiscal 2002. Due to data availability, the capital ratio (κ_t) is defined as core capital (Tier 1) divided by loans outstanding at the end of each period. For simplicity, the subjective discount factor (β) is set to be the average of the reciprocal of real gross returns on 10-year government bonds (deflator: GDP deflator) in the corresponding estimation period, and this is assumed to be common across all banks. Land prices (P_L) are obtained from the Japan Research Institute of Real Estate, and we assume that banks face different land prices, depending on the location of their head offices. If a bank is located in one of the six largest cities, we use the "six largest cities" land price index for that bank. Otherwise, we use the "other cities" land price index (which excludes the six largest cities).

Estimation method

Under the assumption of rational expectations, the error term, u_{t+1}, is uncorrelated with any variables known in period t. However, the Euler equation (A1-9) includes variables in period $t + 1$, and thus we use the iterative weighted two-stage least squares (2SLS) to estimate it as a system with the time-series, cross-sectional data.[11] Instrumental variables are the constant, twice-lagged dependent variables, the twice-lagged loan-call rate spread ($r_{Lt+1} – r_{Ct+1}$), once-lagged growth in stock values listed in the first section of the Tokyo Stock Exchange, and once-lagged growth in nominal GDP.[12] The purpose of including stock values and nominal GDP in the set of instruments is to consider the impacts of hidden profits from banks' stock holdings and of demand for bank loans by firms on the model.

In the estimation, the constant term b_0 in the system is often regarded as a factor that is idiosyncratic for each agent. There are two well known cases: the "fixed effects" and "random effects" cases. Since, even if estimated, these effects are not significant, we do not consider them in the estimation here. This is equivalent to carrying out a pooling estimation in which it is not only the parameters b_1 to b_3 in the Euler equation (A1-9) that are all common across all sample banks, but also the parameter b_0.

The estimation period is split into several subperiods: from fiscal 1985 to fiscal 1989 (the bubble period); from fiscal 1990 to fiscal 1996 (the first half of the 1990s); and from fiscal 1997 to fiscal 2001 (the second half of the 1990s onwards). We also consider the entire period from fiscal 1985 to fiscal 2001. All parameters reported in Figure 8 are estimated using a simultaneous weighting matrix and coefficient control, where the convergence criterion is 1.0E-07.

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9 A good example of deriving the Euler equation (A1-9) is found in Zeldes (1989), in which the impact of quantitative borrowing constraints on consumers' optimal resource allocation is evaluated.

10 Due to the fact that mergers and nationalisation cause non-adjustable data discontinuities during the sample period, Shinsei Bank and Aozora Bank are excluded from the major bank sample, while Tokyo Star Bank and Kansai Sawayaka Bank are excluded from the regional bank sample. Mizuho Bank and Mizuho Corporate Bank, likewise Risona Bank and Saitama Risona Bank, are regarded as single banking entities, thus yielding the samples of 10 major banks and 113 regional banks.

11 Estimation results using the 3SLS method are basically the same, and thus are not reported in this note. They are available from the authors on request.

12 Other candidates for instruments can be lagged values of other independent variables in the Euler equation (A1-9). Even if they are included in the set of instruments, however, we find no significant changes in the results.

Appendix 2:
Model for simulating the bank's decision regarding write-offs

Model

The bank utility is determined by the mean and standard deviation of the present value of future profits:

$$U(\mu(PV), \sigma(PV)) \qquad \text{(A2-1)}$$

The present value depends on expected profits $E_t(\pi_{t+j})$ over the next six half-year periods and is given by:

$$PV(\pi) = \sum_{j=1}^{6} \beta^j E_t(\pi_{t+j}) \qquad \text{(A2-2)}$$

where we assume a unit subjective discount factor and a zero discount factor for inflation in the nominal value of profits.

Bank capital, Cap_t, is the state variable, the path of which is determined by the transition equation:

$$Cap_t = Cap_{t-1} + \pi_t - Tax_t - Div_t - Others_t \qquad \text{(A2-3)}$$

where profits (π_t) reflect credit costs such as write-offs and loan loss provisions. The profit surplus, after deducting taxes (Tax_t), dividends (Div_t) and other factors ($Others_t$), determines the path of bank capital over time, as described in the transition equation (A2-3). Tax_t includes government capital injections into banks, and $Others_t$ covers other factors that affect bank capital, such as the introduction of deferred tax assets and any surplus from the revaluation of the bank's land holdings.

Profits π_t are defined by:

$$\pi_t = R_t^L \cdot Loans_t - R_t^D \cdot Deposits_t - AdCosts_t - CrCosts_t, \quad if \ Cap_t / Loans_t \geq AdequacyRatio$$

$$= 0, \quad \text{otherwise} \qquad \text{(A2-4)}$$

where R_t^L corresponds to the average rate of return on loans (obtained as total revenue divided by outstanding loans), R_t^D captures the average cost of funding (hereafter the "average funding rate", obtained by dividing total funding costs by outstanding deposits), and $AdCosts_t$ measures administrative costs including payroll costs.

The credit costs ($CrCosts_t$) reflected in NPL disposals comprise four parts: write-offs of new bad loans ($NewWO_t$); write-offs of existing bad loans not covered by loan loss provisions ($WO2_t$); loan loss provisions for new bad loans ($NewLLP_t$); and additional loan loss provisions for bad loans which have been partly covered by past loan loss provisions ($dLLP_t$). The total of $WO2_t$ and $dLLP_t$ corresponds to secondary losses, that is, unexpected losses which could not be predicted at the time the bank made its decision regarding disposals. Write-offs of bad loans with loan loss provisions ($WO1_t$) impair neither current profits nor bank capital, because these credit costs regarding $WO1_t$ were reflected in previous profits as either $NewLLP_{t-j}$ or $dLLP_{t-j}$ ($t - j < t$). Write-offs of $WO1_t$ reduce possible losses via $dLLP_{t+j}$, but this obliges the bank to give up the "real option" value inherent in bad loans, ie the possibility that these loans may become performing again.

The bank balance sheet constraint is:

$$Loans_t = Deposits_t + Cap_t \qquad \text{(A2-5)}$$

We assume that all assets take the form of loans and all liabilities are deposits. The average rate of return on loans R_t^L, therefore, represents a gross based ROA, covering revenue from securities, fees and commissions, in addition to income from lending. The average funding rate R_t^D also covers funding from money and bond markets in addition to deposits.

R_t^L and R_t^D are determined by imposing equilibrium on the bank loan and deposit markets. First, firms' demand for bank loans and the bank's supply of loans are assumed to be functions of the following variables:

$$Loans_t^D = f^{LD}(NGDP_t, R_t^L) \quad \text{and} \tag{A2-6}$$

$$Loans_t^S = f^{LS}(R_t^L, Deposits_t, BLratio_{t-i}, CapRatio_t), \quad i = 0,1 \tag{A2-7}$$

where $NGDP_t$ is nominal GDP, $BLratio_t$ is the ratio of bad loans to total loans, and $CapRatio_t$ is the capital adequacy ratio obtained simply by dividing bank capital by bank loans (total assets). A high $BLratio_t$ negatively affects the bank's supply of loans for a given R_t^L, because it requires a premium for taking on the higher credit risk. The equilibrium condition in the loan market provides a reduced form of R_t^L, which is estimated by:

$$R_t^L = l_0 + l_1 NGDPdot_t + l_2 Depodot_t + l_3 BLratio_t + l_4 BLratio_{t-1} + \varepsilon_{Lt} \tag{A2-8}$$

where $NGDPdot_t$ represents the growth rate of nominal GDP, and $Depodot_t$ the growth rate of deposits. The bank capital constraint on lending, $CapRatio_t$, is omitted from the regression because the term is insignificant.

Second, the bank's demand for deposits and households' supply of deposits are assumed to take the following shapes:

$$Deposits_t^D = f^{DD}(R_t^D, Loans_t, Call_t, ExR_t) \quad \text{and} \tag{A2-9}$$

$$Deposits_t^S = f^{DS}(R_t^D, NGDP_t) \tag{A2-10}$$

where $Call_t$ is the call rate and ExR_t is the bank's reserves in excess of requirements. A reduced form of R_t^D obtained from the deposit market equilibrium condition is estimated by:

$$R_t^D = d_0 + d_1 NGDPdot_t + d_2 Call_t + d_3 \ln(ExR_t) + \varepsilon_{Dt} \tag{A2-11}$$

$Loans_t$ is omitted due to its insignificance in the regression.

Bank loans comprise both bad loans and good loans: the former are given by the "Risk Management Loans" disclosed by government and the Japanese Bankers' Association, while the latter are made up of the remaining loans. This gives:

$$Loans_t = BadLoans_t + GoodLoans_t \tag{A2-12}$$

Bad loans are divided into two categories; bad loans fully covered by loan loss provisions and bad loans proving not to be covered. We denote the former as LLP_t and the latter as $Naked_t$. The transition of LLP_t is given by:

$$LLP_t = LLP_{t-1} + NewLLP_t + dLLP_t - WO1_t \tag{A2-13}$$

while the transition of $Naked_t$ is:

$$Naked_t = Naked_{t-1} + NewNaked_t - dLLP_t - WO2_t \tag{A2-14}$$

We find that the transition of bad loans:

$$LLP_t + Naked_t (= BadLoans_t) = LLP_{t-1} + NewLLP_t + Naked_{t-1} + NewNaked_t - WO1_t - WO2_t \tag{A2-15}$$

is independent of $dLLP_t$ and $NewWO_t$, and only $WO1_t$ and $WO2_t$ can effect reductions in the outstanding amount of bad loans. New bad loans during period t, $NewBL_t$, are assumed to depend on the nominal economic growth rate ($NGDPdot_t$):

$$NewBL_t = f^{NewBL}(NGDPdot_t, dummy_{t=i}) \quad i = \text{FY95:2, FY97:2, FY98:2} \tag{A2-16}$$

$NewBL_t$ is divided into three categories: $NewNaked_t$, $NewLLP_t$ and $NewWO_t$. The ratios among the two types of disposals ($NewLLP_t$ and $NewWO_t$) and the uncovered outstanding amount of bad loans ($NewNaked_t$) are determined by historical data on new bad loans and their disposal.

Equations (A2-3), (A2-5) and (A2-15) provide us with an expression describing the transition of good loans:

$$\begin{aligned} GoodLoans_t - GoodLoans_{t-1} = (Deposits_t - Deposits_{t-1}) + (NewWO_t + WO1_t + WO2_t) \\ - NewBL_t + (\pi_t - Tax_t - Div_t - Others_t) \end{aligned} \quad \text{(A2-17)}$$

What this equation implies is that, supposing deposits remain unchanged, the bank's balance sheet freedom to expand its good loans depends on (i) total write-offs, (ii) new bad loans, and (iii) profit surplus.

The decrease in bad loans through write-offs improves future profits via a recovery in the rate of return on loans, as described in equation (A2-8), and also via the freedom to extend new good loans. In contrast, the write-off impairs current capital and therefore increases the risk of coming up against the constraint imposed by capital adequacy regulation, as is seen in equation (A2-4). The trade-off between the improvement in future profits and the rise in the risk of bankruptcy determines the optimal choice of write-offs. This optimal choice is dependent on the different business conditions faced by the bank at each stage, for example: its capital adequacy, its expectations of future economic growth, and the extent of its bad loans.

Details of simulation

The bank we examined in the simulations is a representative agent endowed with the aggregate figures of the banking accounts of all banks in Japan. The data run from the second half of fiscal 1992 to fiscal 2002, because NPL-related data are available only for this period.

For the initial values of all simulation variables, we adopt the value observed at the end of fiscal 1996 and 2000 respectively. For the exogenous deterministic variables, we make use of static expectations (Figure 9). Taxes, dividends and other factors in equation (A2-3) are omitted from the simulation, because it is difficult to make use of static expectations for variables which fluctuated significantly as a result of government policies such as capital injections. The influence of these variables is reflected in the initial values for each simulation. For technical reasons, administrative costs, which we regard as a proxy of payroll costs, are added to profits in the simulation.

Since there is only one stochastic factor, the nominal GDP growth rate, the distributions of the present values depend on how the bank forms its expectations of the growth rate. We assume that the expectations are adaptive, that is, the bank expects the growth rate to follow an AR(1) process with the same mean and variance as in the last six half-year periods. The choice of six periods derives from a survey on firm expectations of the real economic growth rate that suggests it takes about three years for firms to correct mistaken expectations by observing actual growth rates. The AR coefficient is estimated to be 0.77 over the full sample period. The means and variances for the two simulations with different initial starting periods are shown in the appendix table.

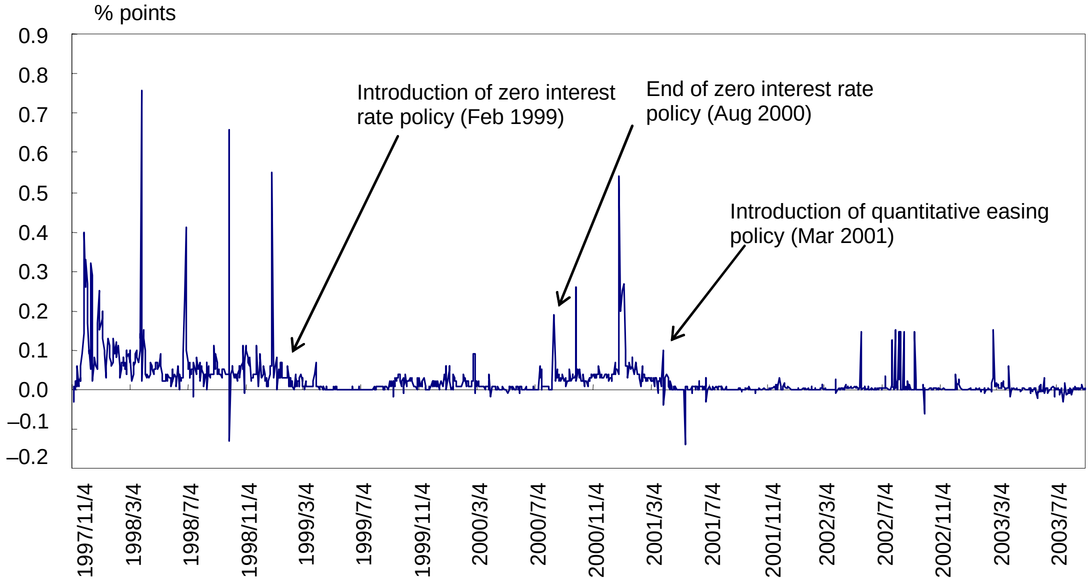
The simulation of "not aggressive" write-offs, starting in fiscal 1997, is based on actual figures for write-offs: the average of the first and second halves of fiscal 1996. The simulation of "aggressive" write-offs produces an amount some ¥2 trillion larger, almost the same as the average from fiscal 1997 to 1999 when the government adopted a strong initiative to push forward NPL disposal during and after the banking crisis. "Aggressive" write-offs in the simulation starting in fiscal 2001 are based on average write-offs in fiscal 2000. Write-offs in the "not aggressive" case are set to be ¥1 trillion less, almost the same as their average in fiscal 1996.

We carried out 100,000 simulations for each case. When a bank comes up against the minimum capital adequacy bound, this acts to terminate the loop in the updating process for the state variables: bank capital, and the bad loan components, LLP_t and $Naked_t$. Distributions of present values shown in Figures 11-13, where there are spikes at low levels of present values, suggest that some banks gain profits only at early stages of the simulation and then go bankrupt. Bell-shaped distributions at higher levels of present values in these figures correspond to the cases where banks are still alive at the end of the simulation period. These distributions show that banks can enjoy higher profits in the future through their aggressive write-offs only if they are able to survive the capital damages that accompany NPL write-offs. The appendix table illustrates how aggressive write-offs improve the average rate of return on loans (if banks remain alive with high probability), while at the same time impairing capital levels.

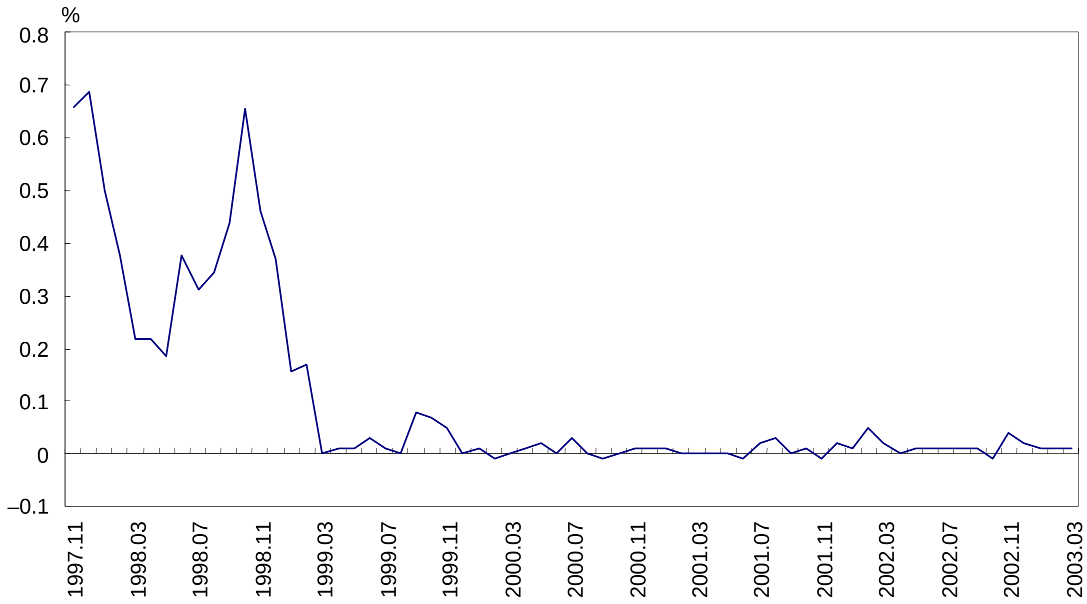
Figure 1

The liquidity premium and the Japan premium

(1) The liquidity premium (T/N call rate – O/N call rate, unsecured)



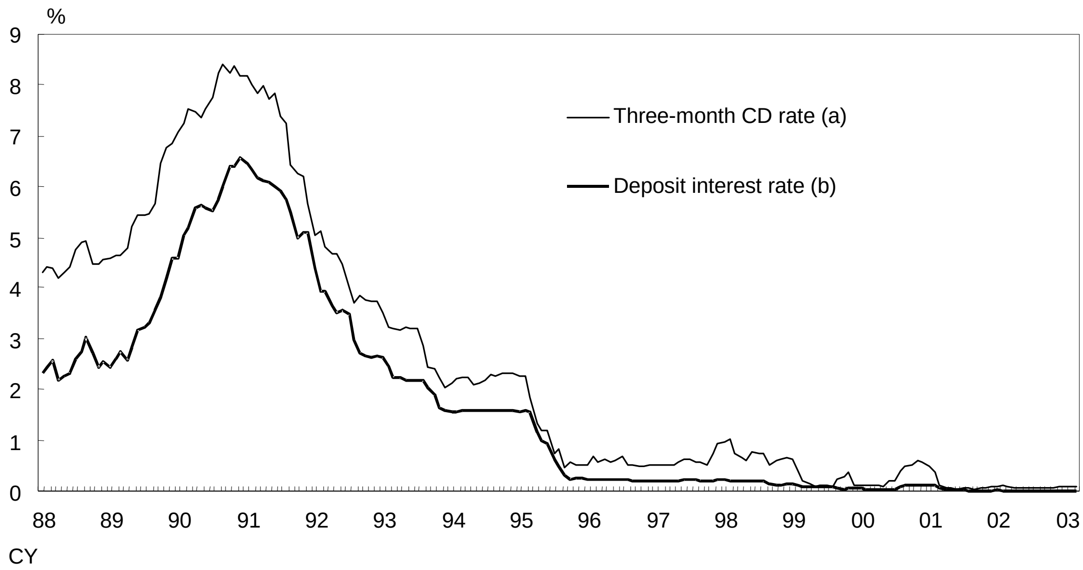
(2) The Japan premium



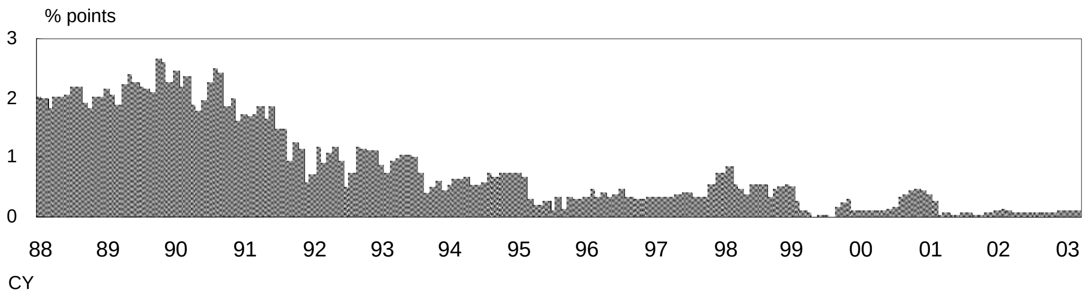
Note: The Japan premium is defined as the spread in Libor between Barclays and the Bank of Tokyo Mitsubishi.

Figure 2

Interest rates and deposit margin



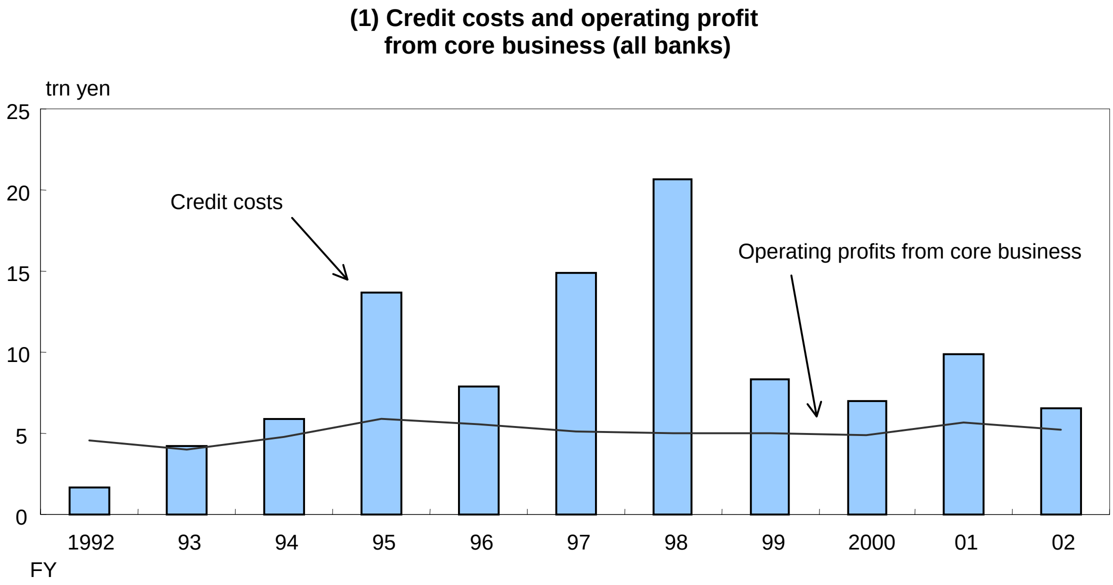
Spread

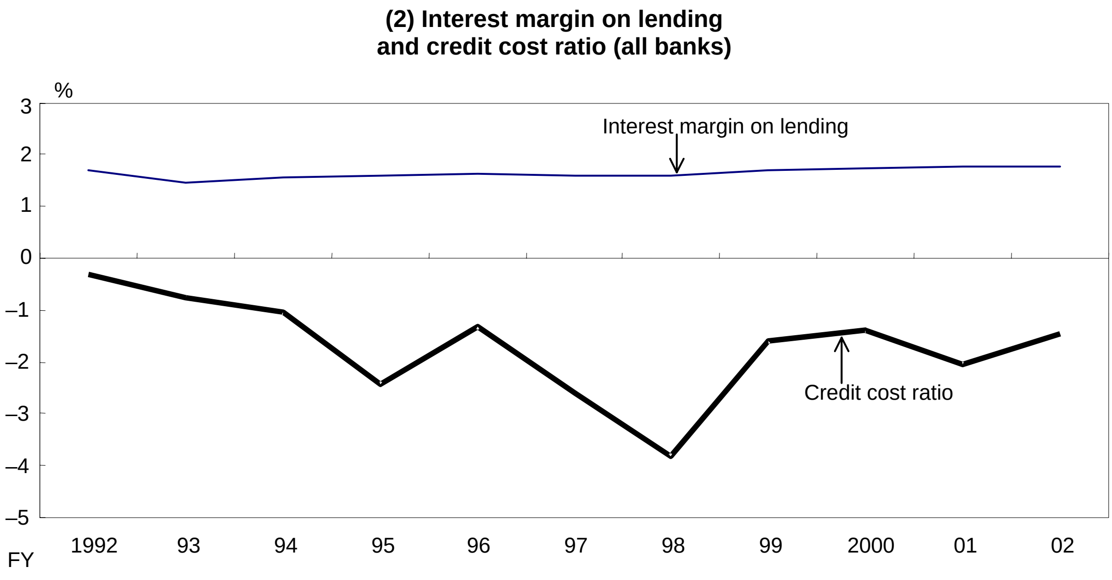


Note: Deposit interest rate = interest rate on three-month time deposits of less than ¥3 million.

Figure 3

Credit costs and profits



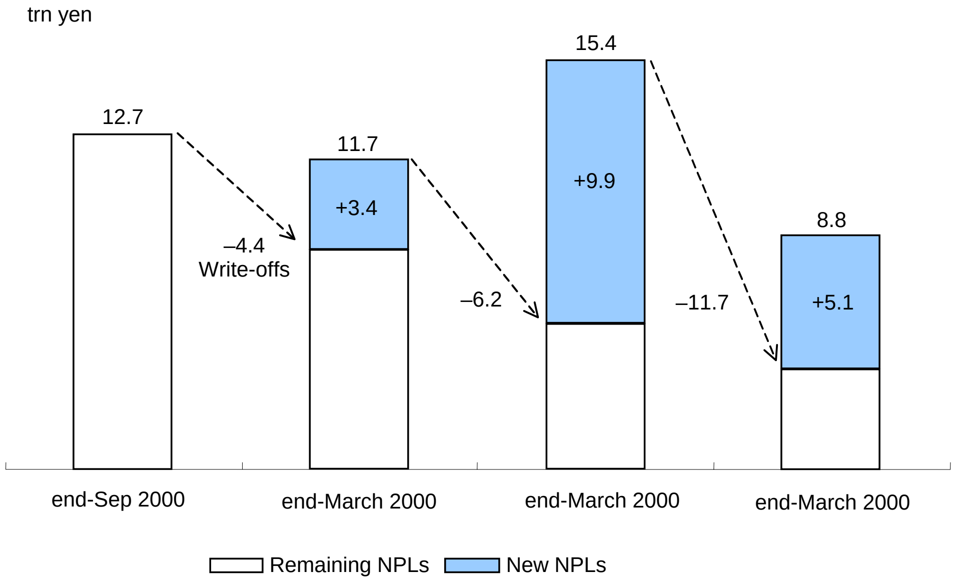


Note: Credit cost ratio = credit costs/total loans.

Figure 4

Progress in NPL disposal

(1) Removal of NPLs from balance sheets (major banks)



Notes: 1. NPLs here cover loans to borrowers classified as "bankrupt", "de facto bankrupt" and "in danger of bankruptcy". 2. Major banks here exclude Shinsei Bank and Aozora Bank.

(2) Loan loss provision ratio (provisions/total loans)

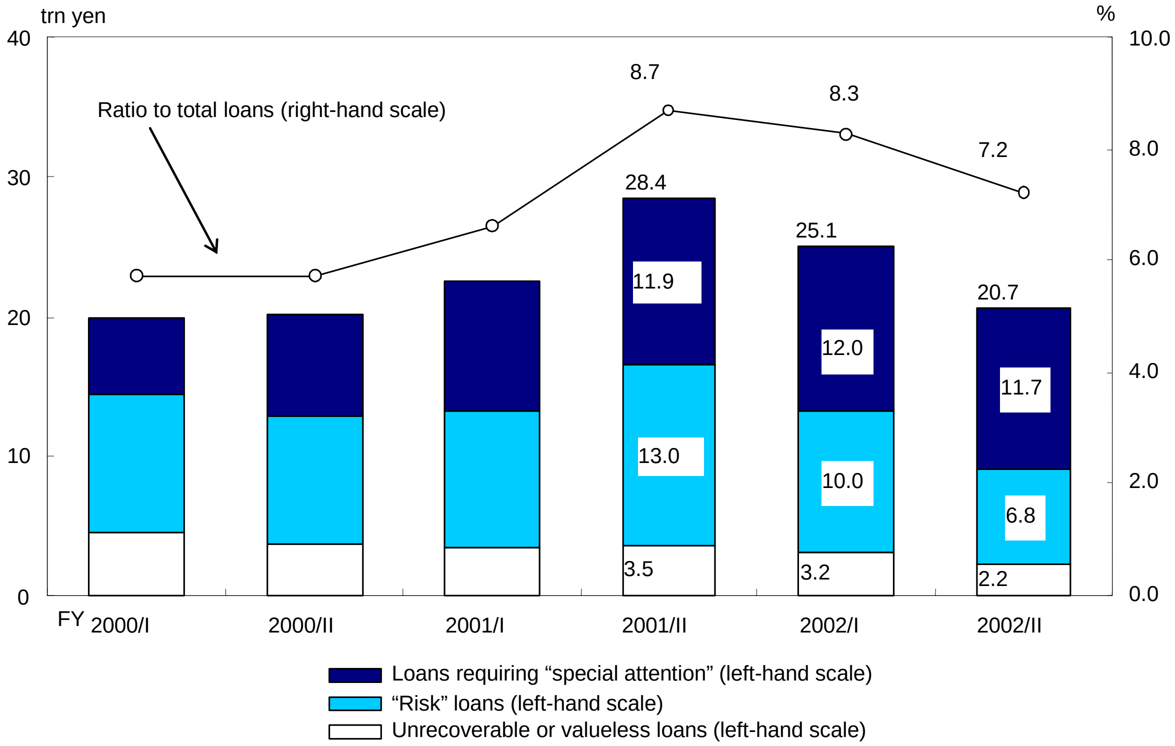
	All banks	**Major banks (excluding Shinsei Bank and Aozora Bank)**
Loans to "normal" borrowers and borrowers that "need attention"	1.4 (1.1)	1.7 (1.2)
Excluding loans requiring "special attention"	0.8 (na)	0.8 (0.7)
Loans requiring "special attention"	19.1 (na)	20.8 (14.2)
Loans to borrowers "in danger of bankruptcy"	33.6 (na)	39.4 (37.0)

Note: Percentage, at end-March 2003; figures in parentheses are at end-March 2002.

Figure 5

Non-performing loans

(1) Major banks



(2) Regional banks

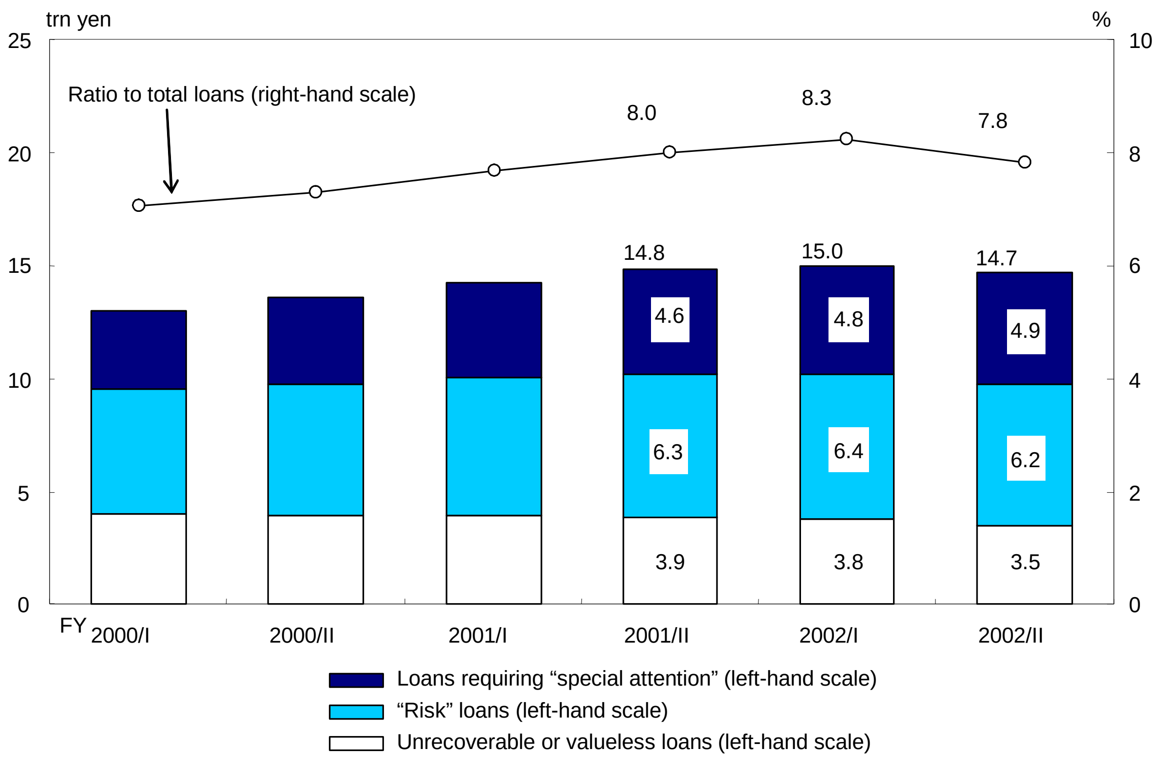


Figure 6

Stock-related gains/losses

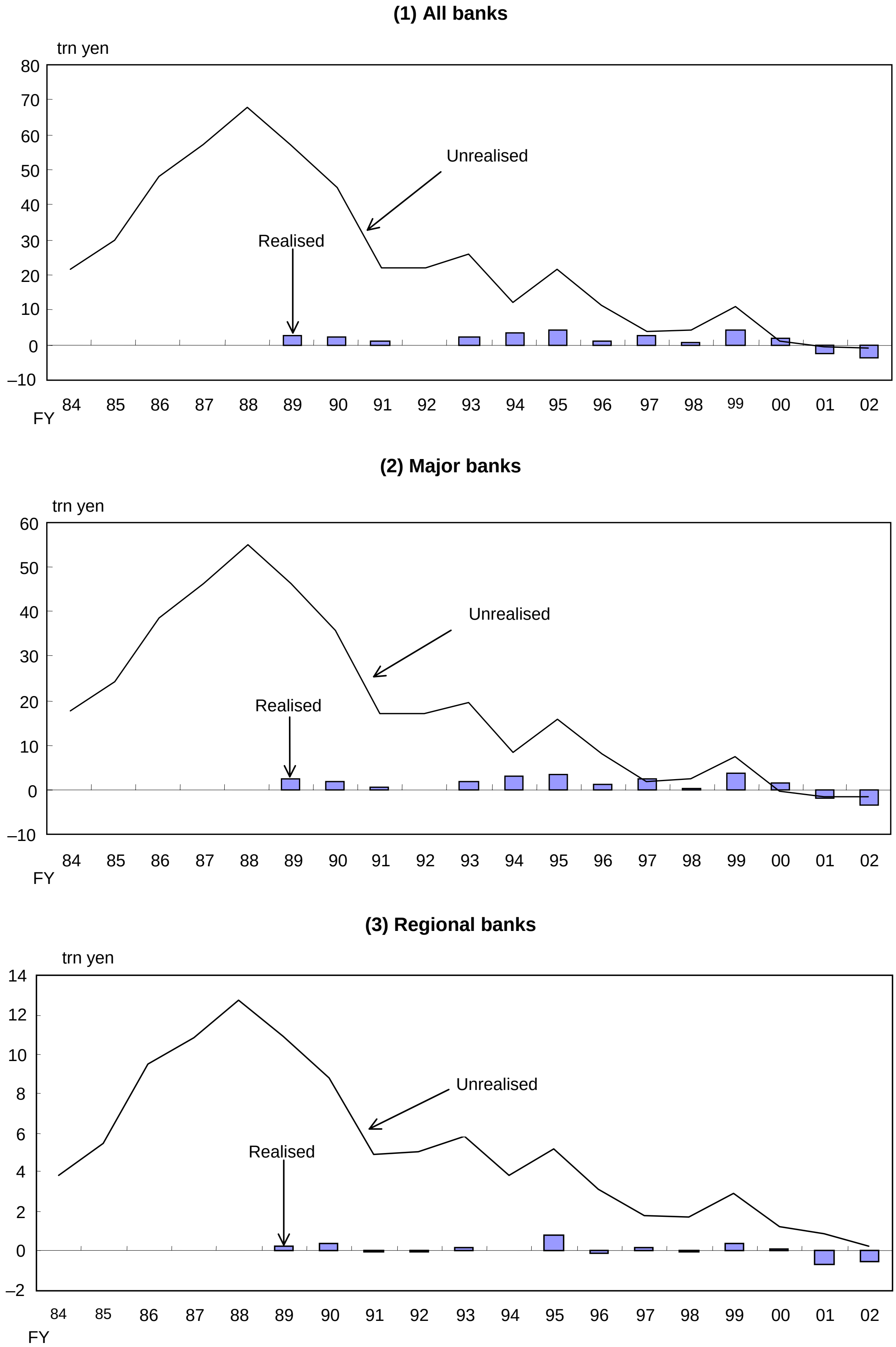


Figure 7

Changes in loans outstanding

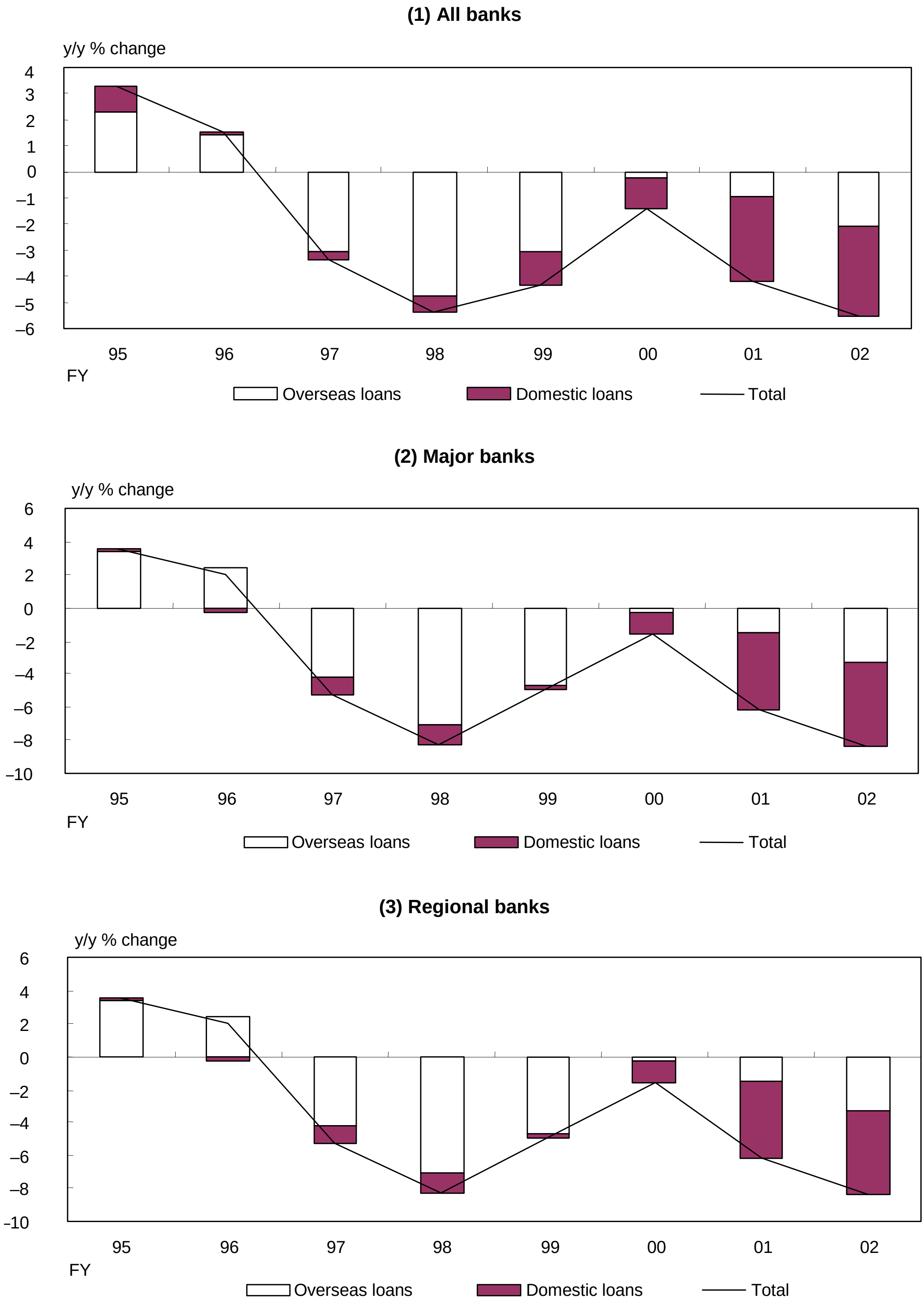


Figure 8-1

Estimation results for the optimisation model of bank behaviour

Equation: $$\frac{FL_t}{D_{t-1}} - \beta \frac{FL_{t+1}}{D_t} = b_0 + b_1(r_{Lt+1} - r_{Ct+1}) + b_2 \frac{P_{Lt}}{P_{Lt-1}} - b_3 \kappa_t + u_{t+1}$$

(1) Sample period: fiscal 1985-2001

Dependent variables	**Constant** b_0	**Loan-call rate spread** b_1	**Change in land prices** b_2	**Tier 1 ratio** b_3	**Discount factor (average** β**)**	**NPL ratio (average** α_3**)**	**Number of observations**
Major banks	–0.0122 (–0.602)	0.5173 (0.980)	0.0085 (0.198)	0.2306 (0.652)	0.9656	0.0062	170
Regional banks	–0.0106 (–0.807)	0.0302 (1.539)	0.0100 (0.989)	0.0520 (0.987)	0.9656	0.0045	1,921
(Reference) All banks	–0.0134 (–1.047)	0.0225 (1.193)	0.0127 (1.327)	0.0625 (1.203)	0.9656	0.0064	2,091

(2) Sample period: fiscal 1985-89

Dependent variables	**Constant** b_0	**Loan-call rate spread** b_1	**Change in land prices** b_2	**Tier 1 ratio** b_3	**Discount factor (average** β**)**	**NPL ratio (average** α_3**)**	**Number of observations**
Major banks	–0.5767 *** (–6.071)	0.1212 (0.940)	0.4482 *** (5.288)	0.8022 (1.539)	0.9601	0.0033	50
Regional banks	–0.1144 *** (–7.638)	0.0270 (1.252)	0.0889 *** (6.287)	0.1074 (1.180)	0.9601	0.0023	565
(Reference) All banks	–0.1285 *** (–8.675)	0.0224 (1.077)	0.0999 *** (7.295)	0.1193 (1.309)	0.9601	0.0019	615

Notes: *t*-values are in parentheses. *** 1% level. ** 5% level. * 10% level. NPL ratio (average α_3) is imputed with the estimated parameters, the average of discount factors and changes in land prices in the corresponding periods. See Appendix 1.

Figure 8-2

Estimation results for the optimisation model of bank behaviour (continued)

Equation: $\frac{FL_t}{D_{t-1}} - \beta \frac{FL_{t+1}}{D_t} = b_0 + b_1(r_{Lt+1} - r_{Ct+1}) + b_2 \frac{P_{Lt}}{P_{Lt-1}} - b_3 \kappa_t + u_{t+1}$

(3) Sample period: fiscal 1990-96

Dependent variables	Constant b_0	Loan-call rate spread b_1	Change in land prices b_2	Tier 1 ratio b_3	Discount factor (average β)	NPL ratio (average α_3)	Number of observations
Major banks	–0.0970	1.5682	0.0891	0.8463 **	0.9633	0.0081	70
	(–0.772)	(1.340)	(1.361)	(2.111)			
Regional banks	–0.0450 ***	0.0721 ***	0.0473 ***	0.0850	0.9633	0.0066	791
	(–3.017)	(3.304)	(3.978)	(1.606)			
(Reference) All banks	–0.0445 ***	0.0632 ***	0.0469 ***	0.0829	0.9633	0.0070	861
	(–2.927)	(2.940)	(4.025)	(1.578)			

(4) Sample period: fiscal 1997-2001

Dependent variables	Constant b_0	Loan-call rate spread b_1	Change in land prices b_2	Tier 1 ratio b_3	Discount factor (average β)	NPL ratio (average α_3)	Number of observations
Major banks	–0.6070	2.6463 **	0.5959	1.6230 ***	0.9743	0.0150	50
	(–1.278)	(2.499)	(1.069)	(3.386)			
Regional banks	–0.4203 ***	0.0804	0.4413 ***	0.1113 *	0.9743	0.0116	565
	(–6.872)	(1.540)	(7.026)	(1.849)			
(Reference) All banks	–0.4083 ***	0.0855	0.4284 ***	0.1190 **	0.9743	0.0130	615
	(–6.770)	(1.640)	(6.945)	(1.993)			

Notes: *t*-values are in parentheses. *** 1% level. ** 5% level. * 10% level. NPL ratio (average α_3) is imputed with the estimated parameters, the average of discount factors and changes in land prices in the corresponding periods. See Appendix 1.

Figure 9

Algorithm of simulation

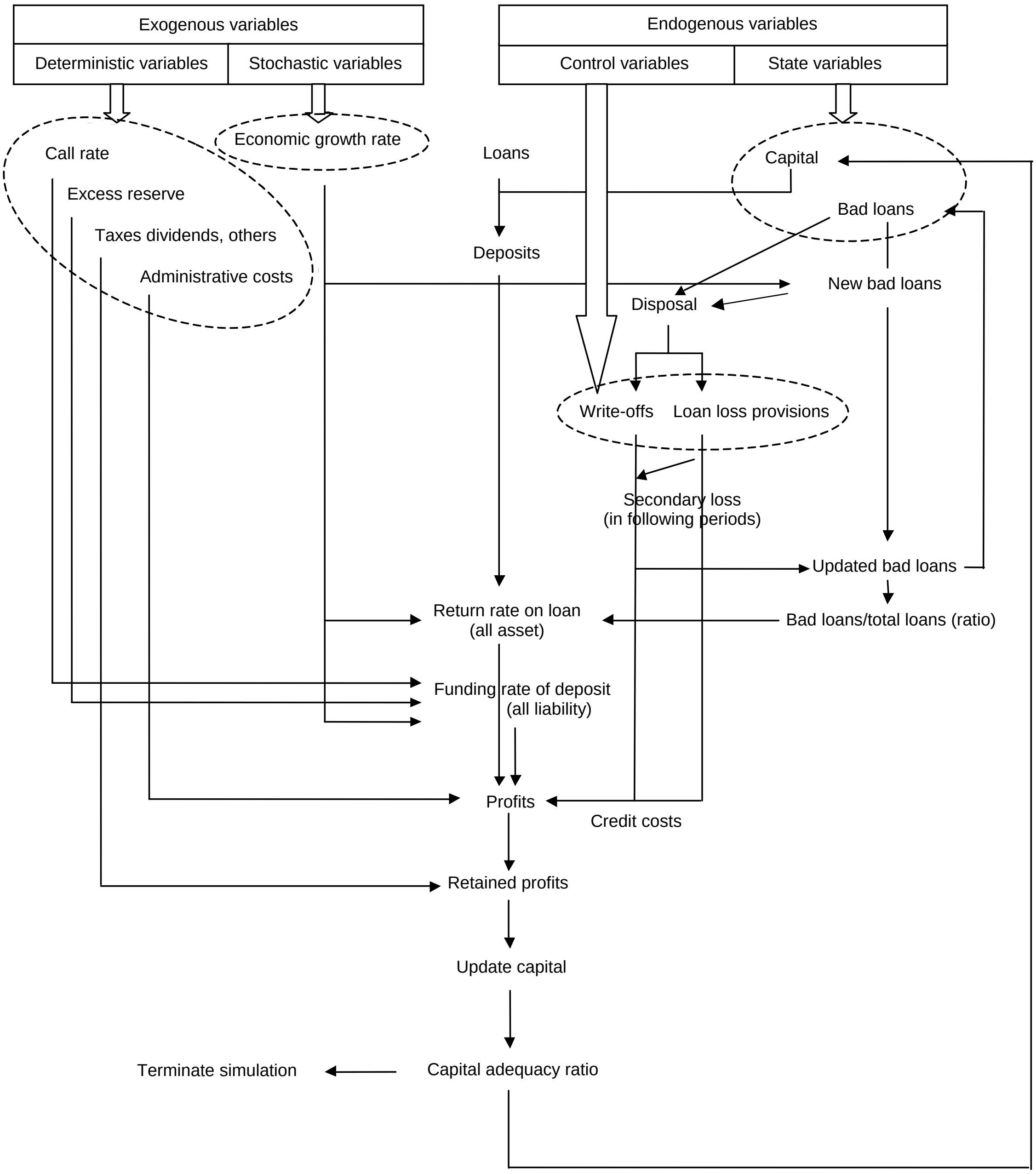


Figure 10

Four simulation cases

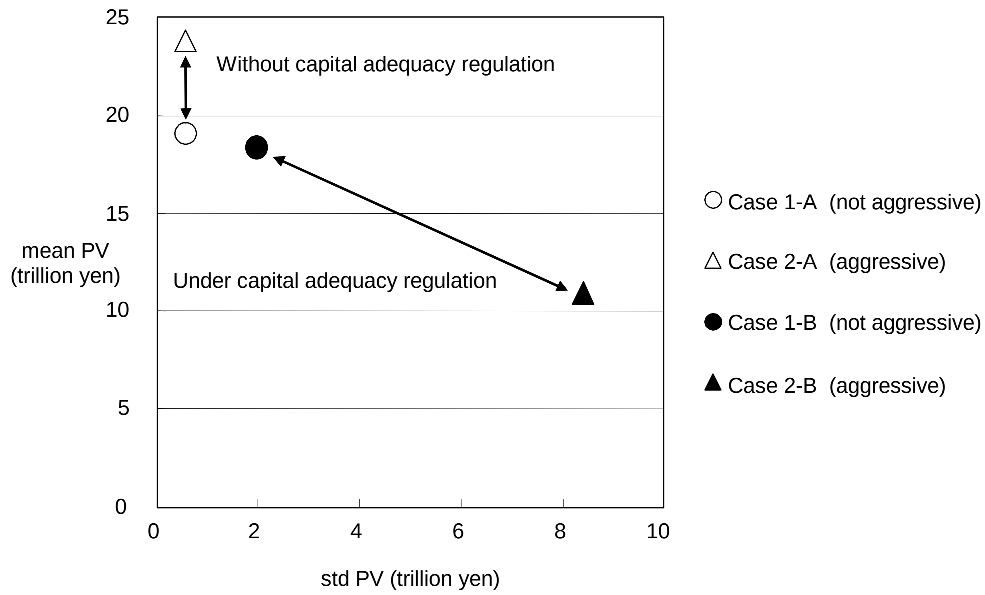
		Expectation of economic growth	
		Adaptive expectation	**Perfect forecast**
Aggressiveness in write-offs of bad loans	Not aggressive	Case 1	Case 3
	Aggressive	Case 2	Case 4

Note: Economic growth is measured by nominal GDP growth rate. Adaptive expectation is based on mean and standard deviation of the growth rates for the preceding six half-year periods. Perfect forecast case does not mean the bank's perfect forecast of the future *path* of the growth rate, but assumes that the bank can correctly predict its mean and standard deviation. See Appendix 2 for details on the amount of write-offs in the four cases.

Figure 11

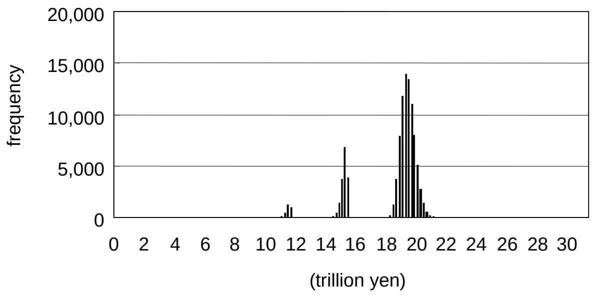
Mean and standard deviation of the bank's present value (1)

Beginning of fiscal 1997 as initial period

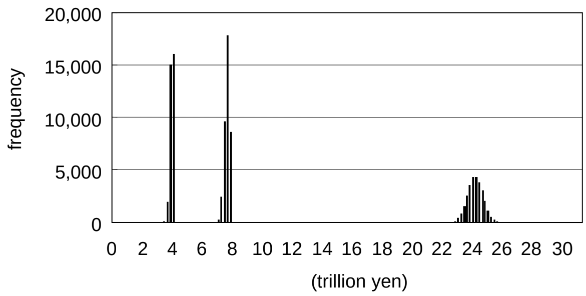


Distributions of present values

Case 1-B: ratio of termination = 49%



Case 2-B: ratio of termination = 72%

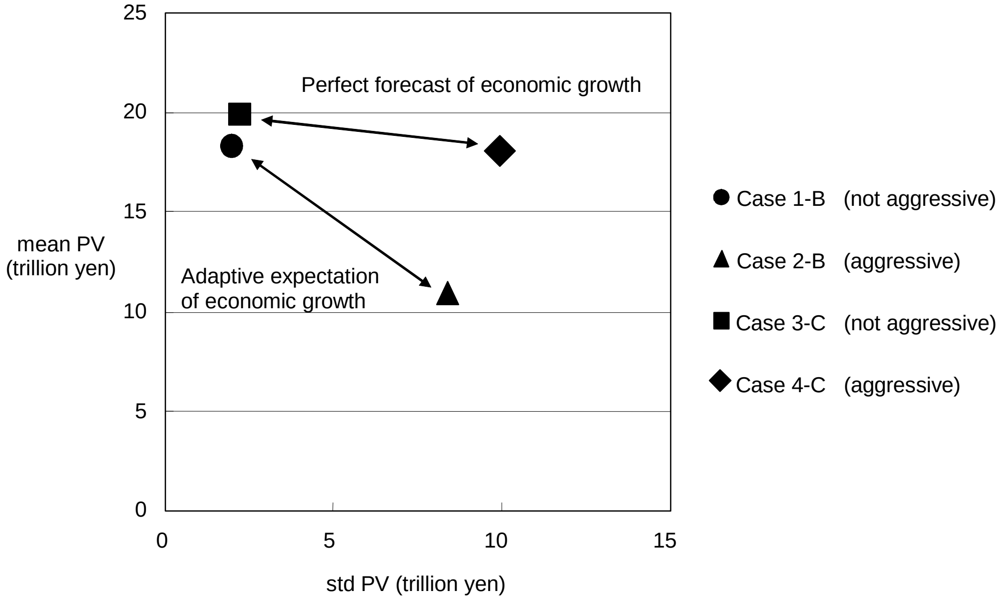


Note: Present values of profits are measured for next six half-year periods using unit subjective discount factor. See Appendix 2 for details.

Figure 12

Mean and standard deviation of the bank's present value (2)

Beginning of fiscal 1997 as initial period



Distributions of present values

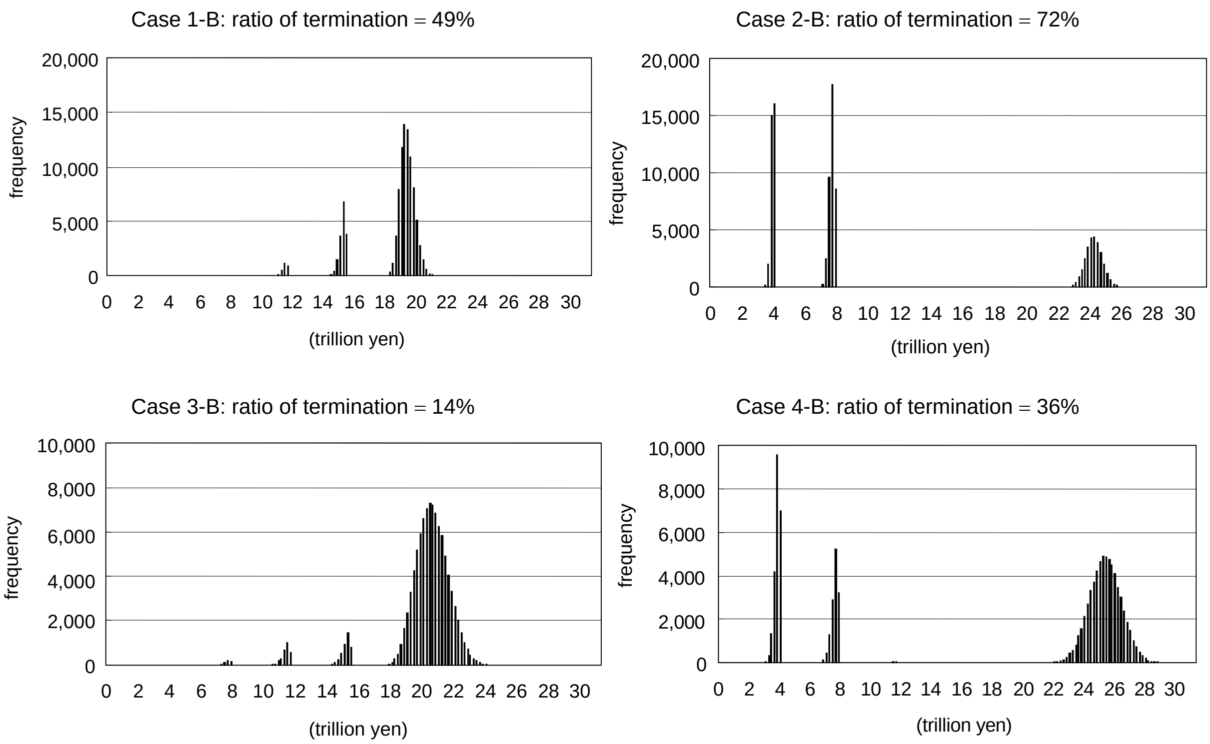
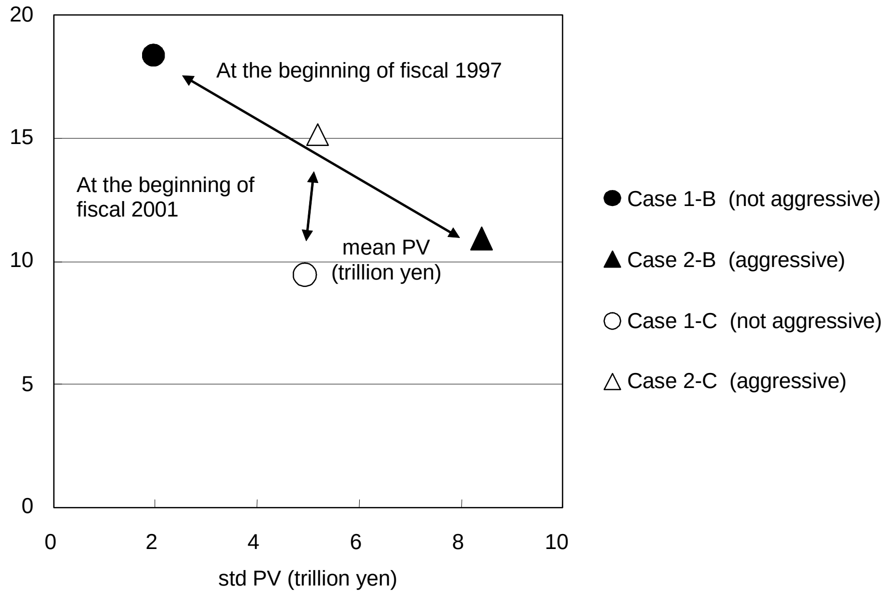
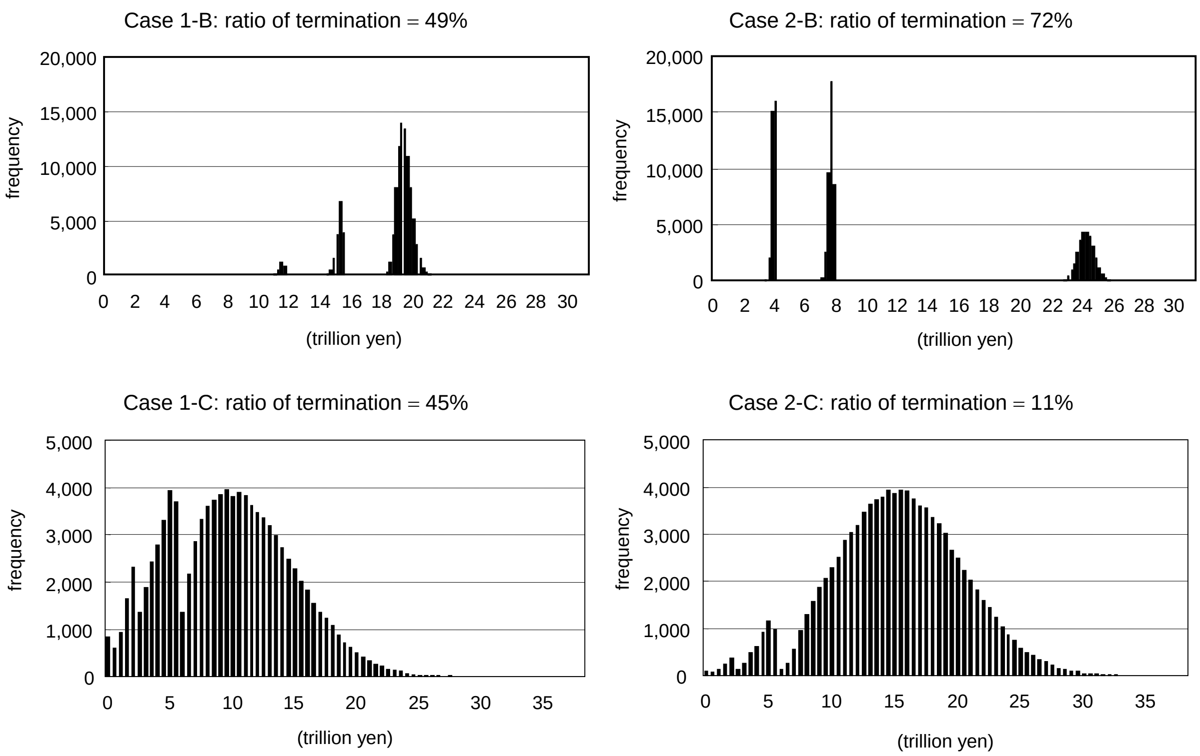


Figure 13

Mean and standard deviation of the bank's present value (3)



Distributions of present values



Appendix table

Simulation results: means through simulation periods (in trillions of yen)

(Termination ratio, %)	Growth rate (%) mean/std		Total return rate (%)	Total funding rate (%)	Capital	Credit cost	New bad loan	Bad loan	Out-standing LLP
Fiscal 1997, without capital adequacy regulation									
Case A1 (0)	1.0	0.5	1.9	1.1	27	3.5	4.1	24	11
Case A2 (0)	1.0	0.5	2.1	1.1	27	4.5	4.1	19	8
Fiscal 1997, under capital adequacy regulation									
Case B1 (49)	1.0	0.5	1.8	1.1	26	3.4	4.0	24	11
Case B2 (72)	1.0	0.5	1.2	0.7	16	2.7	2.4	13	6
Case B3 (14)	–0.1	1.0	1.7	0.9	27	3.6	4.5	25	11
Case B4 (36)	–0.1	1.0	1.5	0.7	22	0.4	3.6	16	7
Fiscal 2001, under capital adequacy regulation									
Case C1 (45)	–0.2	0.9	0.9	0.6	29	2.4	4.4	32	8
Case C2 (11)	–0.2	0.9	1.2	0.6	31	2.6	4.6	31	5

Note: Since “high termination ratio” cases produce zero values for all variables after termination, average values in the table tend to be lower than in “low termination ratio” cases.

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