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Abstract

This paper evaluates a theoretical rescue package for Japanese banks. The package maximizes the profit of a bank in monopoly, in accordance with the Industrial Revitalization Corporation Law and the Deposit Insurance Law in Japan. The rescue package generates a maximum surplus for both depositors and borrowers under particular conditions.

Keywords: rescue package; theoretical framework; evaluation.

JEL Classification Number: D42;G21;G28

1. Introduction

Miyakoshi and Tsukuda (2003,table 1) show that the number of Japanese bank and credit cooperative failures has rapidly increased during the 1990s. Since 2000 the bank slump has continued and worsened. Many programs of supervision and policy for banks have been proposed and implemented. However, favourable results have not eventuated, and evaluation of the action programs is therefore necessary.[1]

There are many critiques of action programs, though there are few based on theoretical and empirical research. Among these, Ito and Sasaki (2002) found a close relationship between the Japanese bank slump and the 1993 adoption of the bank capital regulation based on the 1988 Basle agreement. Spiegel and Yamori (2003) empirically evaluated the effects of the 1998 Financial Reconstruction Act and the 1998 Rapid Recapitalization Act (RRA) on the bank slump, suggesting that the two Acts work against reform of the banking systems.

The Japanese government provided a total of 10 trillion yen to the 15 major banks and about 10 medium sized banks during the years 1998-2000. It did this by purchasing preferred stocks, based on the

[1] There is a strong relationship between the Japanese bank slump and the country's economic slump, as pointed out by Ito (2000), Ogawa and Kitasaka (2000) and Miyakoshi and Tsukuda (2003). The basic stance of government policy is found in Council on Economic and Fiscal Policy (2001), the Council being an advisory organ of the prime minister.

Deposit Insurance Law (DIL), incorporating the RRA, from April 2001. The government is now intending to reduce bad loans by purchasing them, based on the Industrial Revitalization Corporation Law (IRCL).[2] In this paper, we assume both policies in the rescue package for banks.

The purpose of this paper is to define the rescue package authorized by the IRCL and the DIL, and to evaluate it. This theoretical research is timely given that the package is to be implemented. The analytical results show that the package, which maximizes the profit of the bank, leads to a maximum surplus for depositors under any condition, but for both depositors and borrowers under particular conditions, subject to government budget constraint for the package. This study thus evaluates the outcomes of the package under particular conditions.

Research on bank capital regulation has concentrated mainly on the relationship between regulatory capital requirement and the probability of bank failures, or portfolio choice, in subjective equilibrium—see Blum (1999), Milne (2002), Kamoike (2003), Kopecky and VanHoose (2003), Chiuri, et al. (2002); see also Berger, Herring and Szegö (1995) for a review. However, to our knowledge, there is no theoretical framework with market equilibrium enabling analysis of

[2] See Deposit Insurance Corporation of Japan (2001) and the Industrial Revitalization Corporation Law (*Sangyo saisei kiko hou,* in Japanese).

the welfare effects on market participants. We provide such a framework in this paper.

Section 2 covers briefly the legal and institutional implications of the rescue package for Japanese banks. Section 3 sketches the basic model and defines the rescue package. Section 4 evaluates the rescue package. Section 5 sets out the conclusion.

2. The DIL, the IRCL and Japanese banks

The Japanese government enacted two laws aimed at rescuing troubled banks. The two laws associated with the legislation are the RRA (1998) and the IRCL (2003). The RRA provides government funds as capital to troubled but not insolvent banks by purchasing preferred stocks. The IRCL decreases the expected probability of bad loan ratios for banks by purchasing their bad loans.

Both Acts have the objective of rescuing banks while protecting depositors against low interest rates and borrowers against a lack of credit. The steps in policy implementation, based on both laws, are, first, to inject bank capital by purchasing preferred stocks, and second, to decrease the expected bad loan ratio by purchasing banks' bad loans. In our research, we suppose that the rescue package maximizes the profit of a bank. Our research question is: can a rescue package, which maximizes the profit of a bank, attain an optimum surplus for both borrowers and depositors?

The Japanese banking system is still characterized by restrictions on market entry and competition between banks and other financial institutions. Banks merge freely. As a result, the number of banks has decreased rapidly. Limited theoretical research suggests that Japanese banks are competitive in deposit and lending markets. However, Molyneux et al. (1996) conducted an empirical assessment of competitiveness in the Japanese banking market, by using the Panzar-Rosse methodology, and concluded they could not reject the hypothesis that bank revenues in 1986 behaved as if earned under monopoly. The assumption of monopoly seems to be plausible in the Japanese banking market, and we make that assumption. Since 1986, the institutional framework has changed, though we think that the bank behaviour changed so much.

The government perceives that bank capital is too scarce and the expected bad loan ratio is too high. We evaluate whether or not the policy package can attain the goal of the two laws, supposing that these factors are binding for bank behaviour. However, it is necessary to empirically check the validity of this assumption in future.

3. The Model

Bank behaviour: given exogenous parameters of bank capital K and *expected bad loan ratio* β

There is only one bank, with monopolistic power in a deposit market and a loan market. At the same time, there are many competitive depositors and borrowers in each market. The balance sheet of a bank is as follows:

$$D + K = L(1-b) + Lb = L \tag{1}$$

where D=Deposit, K=Capital, L=Loan, and b=the ratio of bad loan to Loan. For the sake of simplicity, we ignore the required reserve ratio and consider only that the bank capital ratio k is

$$k \equiv \frac{K}{\lambda_b bL + \lambda_{1-b}(1-b)L} \tag{2}$$

where the denominator is a risk-weighted asset and its weight is assumed to be $1 \geq \lambda_b > \lambda_{1-b} \geq 0$, reflecting the perception that the bad loan risk λ_b is the most serious threat to bank solvency. The regulatory required ratio $\bar{k}$ is less than one: $\bar{k}$ = 0.08 at present. The 1988 Basle agreement proposes that $k \geq \bar{k}$. Only a ratio b of bad loan is a random variable.

Considering the balance sheet of (1), the expected profit Π of a bank is

$$E(\Pi) = (1+r_L)(1-\beta)(D+K) - (1+r_D)D - (D+K)g \qquad (3)$$

where $1 \geq E(b) = \beta \geq 0$, the bad loan cannot acquire any gain, and r_L, r_D are the loan rate and the deposit rate. A cost function is linear i.e. $L\,g$ (: constant $g>0$) for the sake of simplicity. The loan demand and the deposit supply functions are respectively a linear function ($dr_L/dL<0$ and $dr_D/dD>0$) and then twice differential is zero.

We assume that bank capital is an exogenous and fixed parameter for a bank in the short run and that the expected bad loan ratio β is also exogenous. The maximizing problem of expected profit $E(\Pi)$ for a bank in the short run is as follows.[3]

$$\begin{aligned} &\underset{D\,\geq 0}{Max}\, E(\Pi) = (1+r_L)(1-\beta)(D+K) - (1+r_D)D - Lg \\ &\textit{subject to } \frac{K}{(\lambda_b \beta L + \lambda_{1-b}(1-\beta)L)} \geq \bar{k}, \quad L = D+K \end{aligned} \qquad (4)$$

As Milne (2002, p.2) pointed out, bank supervisors have only limited resources and are unable to monitor continuously the position of the banks. Even when they observe a breach of regulations, they are unable to control the operations of the bank concerned. In that

[3] Strictly, the balance sheet constraint must be presented by $L \leq D+K$. However, if there exists some D ($L<D+K$), a contradiction occurs since the deposit demanded by a bank is redundant and costly. Then, the balance sheet condition must be $L = D + K$ at a profit maximization point.

case, the expected bank capital ratio is as in (4)[4] and the assumption is that the bank behaves under the regulatory required ratio of (4). For the sake of simplicity, we suppose that the risk weight is independent of the expected ratio β of bad loans. While the risk weight may loosely depend on β, at least in the short run it will be independent.

Since an expected profit is a strict concave function of D and the feasible set of (4) is compact, an optimal solution must exist under exogenous parameters, bank capital K, expected bad loan ratio β and the regulatory required ratio $\bar{k}$. Then the Lagrange equation Ω and the Kuhn-Tucker conditions for the program hold (assuming that there is no corner solution for D). Also, since the Lagrange equation is the concave for D, the optimal solution is a maximum point.

$$\Omega(D,\mu : K, \beta, \bar{k}) \equiv E(\Pi) + \mu[K - \bar{k}\{\lambda_b \beta (D+K) + \lambda_{1-b}(1-\beta)(D+K)\} \tag{5}$$

$$\frac{\partial E(\Pi)}{\partial D} - \mu \bar{k}\{\lambda_b \beta + \lambda_{1-b}(1-\beta)\} = 0,\ D > 0 \tag{6}$$

$$\mu[K - \bar{k}\{\lambda_b \beta (D+K) + \lambda_{1-b}(1-\beta)(D+K)\}] = 0,\ \mu \geq 0, \text{ etc.} \tag{7}$$

where μ is the index of binding for bank capital K and for expected ratio β of bad loan, under the regulatory required ratio $\bar{k}$.

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[4] The detailed explanation is given here. The restriction of $k \geq \bar{k}$ and (2) are rearranged: $K \geq \bar{k}(\lambda_b bL + \lambda_{1-b}(1-b)L)$; and we assume: $K \geq \bar{k}(\lambda_b \beta L + \lambda_{1-b}(1-\beta)L)$.

Next, we consider the economic meaning of μ. At the optimal solution under the exogenous parameters K and β, we take partial derivatives of expected utility in terms of K and β, respectively.

$$\frac{\partial E[\Pi\{D(K,\beta;\bar{k})\}]}{\partial K} = \mu[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}] \quad (8)$$

$$\frac{\partial E[\Pi\{D(K,\beta;\bar{k})\}]}{\partial \beta} = \frac{-\mu K(\lambda_b-\lambda_{1-b})}{\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}} \quad (9)$$

where $1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}>0$ and $\lambda_b>\lambda_{1-b}$ are obvious since $1\geq\lambda_b>\lambda_{1-b}\geq 0$ and $1>\bar{k}>0$. (The derivation of (8) and (9) is given in the Appendix.) The economic meaning of μ is as follows. When $\mu>0$, the expected profit increases as the bank capital K increases since the optimal deposit is interrupted by the smaller K under the regulatory bank capital ratio $\bar{k}$. Also, when $\mu=0$, the expected profit does not change. On the other hand, when $\mu>0$, the expected profit increases as the expected ratio β decreases. Then, we define the following:

Definition 1: The bank capital K and the expected ratio β of bad loan are binding when $\mu>0$, and not binding when $\mu=0$.

We test only when bank capital and the expected ratio β of bad loans are binding, following government perception. We analyse an optimal solution when $\mu>0$. The optimal solution satisfies the following condition, considering (7).

$$K-\bar{k}\{\lambda_b\beta(D+K)+\lambda_{1-b}(1-\beta)(D+K)\}=0 \tag{10}$$

Then,

$$D=\frac{K[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}]}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}},\quad L=\frac{K}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}} \tag{11}$$

where D and K are positive. By differentiating this condition,

$$\frac{\partial L}{\partial K}=\frac{L}{K}>1,\quad \frac{\partial D}{\partial K}=\frac{D}{K}>0 \tag{12}$$

$$\frac{\partial L}{\partial \beta}=\frac{-K(\lambda_b-\lambda_{1-b})}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}^2}<0,\ \frac{\partial D}{\partial \beta}=\frac{\partial L}{\partial \beta}<0 \tag{13}$$

Thus, the increase of given bank capital increases the optimal loan and deposit, while the decrease of given expected bad loan ratio accelerates the optimal deposit and loan, increasing the profit, as seen in (8) and (9) with $\mu>0$. As a result, the bank, as a monopoly, decreases the loan rate and increases the deposit rate, which increases the surplus of both depositors and borrowers.

Next, we consider the iso-quant of the profit for a bank. The slope of iso-quant in a binding area is given, considering (8) and (9).

$$\begin{aligned}&\frac{dK}{d\beta}\Big|_{profit=const}=\frac{K(\lambda_b-\lambda_{1-b})}{[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}]\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}>0\\&\frac{d^2K}{d\beta^2}\Big|_{profit=const}>0\end{aligned} \tag{14}$$

The iso-quant is shown in Figure 1. Considering (8) and (9), it is obvious that the profit level is larger where there is smaller β and larger K. (The derivation is given in the Appendix.)

Government behaviour: changing exogenous parameters K and B given to a bank

The objective function of the rescue package is the expected profit of a bank. The content of the package is to increase bank capital K by purchasing preferred stocks, and to decrease expected bad loan ratio β by purchasing bad loans from the bank. However, the government has a budget constraint for the rescue package. The rescue package is the optimal solution (K, β) in the following optimization program:

$$\underset{K,\beta\ \geq 0}{Max}\ E[\Pi\{D(K,\beta)\}] \\ \textit{subject to } \bar{C} = \delta_1(K - K_a) + \delta_2(\beta_a - \beta), \beta \leq \beta_a \text{ and } K \geq K_a, \bar{C} > 0 \qquad (15)$$

where δ_1 and δ_2 are a unit price of increasing bank capital from the present value K_a and of decreasing the expected bad loan ratio from the present value β_a , respectively. The total expense for this package is constrained by $\bar{C}$. The policy implementation must increase β and K further than the present values of β_a and K_a , respectively. The unit price δ_2 is high, since β is the expected value and changing the value is costly.

Thus, the monopolistic bank maximizes the expected profit in the short run on the loan and deposit markets, subject to bank capital regulation. In the short run, the bank itself cannot change the bank capital K and the expected bad loan ratio β, therefore these parameters are given. The government controls K and β for the bank in order to maximize the bank's expected profit. That is, the government implements a rescue package.

Borrowers and depositors behave like competitors in monopolistic lending and deposit markets. The surplus accruing to borrowers and depositors defines their implicit welfare. The lower the lending rate and the higher the deposit rate, the more their surpluses increase. The evaluation aims to test whether both the DIL and the IRCL maximize surpluses.

4. Assessments of the rescue package

We suppose that the original condition of the bank lies at a point of A in a binding area in Figure 1. Moreover, the segment of the budget equation in (15), $(\bar{C} - \delta_2\beta_a)/\delta_1 + K_a$ is larger than K_a.

The rescue package is specified in (15). In Figure 1 the government budget equation slope, δ_2/δ_1, is equal to, larger than or less than that of the iso-quant for expected profit, $dK/d\beta\,|_{profit=const}$. Moreover, the package must be within the area surrounded by the dotted line, based on the budget equation in (15).

We consider possible cases depending on the magnitude of δ_2/δ_1 as a tangent of the government budget constraint. In case 1, $\delta_2/\delta_1>dK/d\beta\,|_{profit=const}$ for any $\beta(0<\beta<\beta_0)$, the rescue package is E_1, where $\beta=\beta_a$ and $K>K_a$. In case 2, $\delta_2/\delta_1<dK/d\beta\,|_{profit=const}$ for any $\beta(0<\beta<\beta_0)$, the package is E_2, where $\beta=0$ and $K>K_a$. In case 3, $\delta_2/\delta_1=dK/d\beta\,|_{profit=const}$, the package is E_3. Thus, the rescue package is profit-optimal for a bank, subject to a government budget constraint.

Next, we test how such a rescue package affects market equilibrium. As seen in E_1, E_2 and E_3, the package increases the capital K and decreases the expected ratio β or keeps it constant. As shown in (12) and (13), the loan rate decreases while the deposit rate increases. Borrowers' and depositors' surpluses increase and the welfare of both categories of market participants is enhanced.

The question arises whether the depositors' surplus can obtain a maximum point at E_1, E_2 and E_3, subject to a government budget constraint in (15). We change the β and K along a budget constraint and observe the change of an optimal deposit by using (12) and (13):

$$\begin{aligned}\frac{dD(K(\beta),\beta)}{d\beta}&=\frac{\partial D}{\partial\beta}+\frac{\partial D}{\partial K}\frac{dK}{d\beta}\\&=\frac{1}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}\left(\frac{\delta_2}{\delta_1}-\frac{K(\lambda_b-\lambda_{1-b})}{\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}\right)-\frac{\delta_2}{\delta_1}\end{aligned}\tag{16}$$

where $dK/d\beta=\delta_2/\delta_1$ since K and β depend on the government budget equation in (15). Then the increase of β decreases the deposit due to (13) as shown at the first term of the first equation in (16), while the increase of K (β) with β increases the deposit due to (12). We test both effects of β on deposits.

As shown in Figure 2, in case 3, by using the relation that δ_2/δ_1 as a tangent of a budget constraint is equal to $dK/d\beta \mid_{profit=const}$ on the iso-quant of profit shown in (14), $dD/d\beta$ in (16) is zero:

$$\frac{dD(K(\beta),\beta)}{d\beta}=\frac{1}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}\left(\frac{\delta_2}{\delta_1}-\frac{\delta_2}{\delta_1}[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}]\right)-\frac{\delta_2}{\delta_1}=0 \quad (17)$$

Moreover, $\delta_2/\delta_1<dK/d\beta \mid_{profit=const}$ in the right hand side of point E_3 on the government budget equation, and then $dD/d\beta<0$. Also, $\delta_2/\delta_1>dK/d\beta \mid_{profit=const}$ in the left hand side and then $dD/d\beta>0$. Then, at point E_3, the depositors' surplus obtains a maximum point subject to a government budget equation. Similar logic leads the depositors' surplus to a maximum point at E_2 for case 2 ($\delta_2/\delta_1<dK/d\beta \mid_{profit=const}$: $dD/d\beta<0$) and E_1 for case 1($\delta_2/\delta_1>dK/d\beta \mid_{profit=const}$: $dD/d\beta>0$), respectively. Thus, the direction of deposit movement coincides with the direction of profit.

We then ask if the borrowers' surplus can obtain a maximum point at E_1, E_2 and E_3, subject to a government budget constraint in (15). We change the β and K along a budget constraint and observe the change for an optimal loan by using (12) and (13):

$$\frac{dL}{d\beta}=\frac{dD}{d\beta}+\frac{dK}{d\beta}=\frac{dD}{d\beta}+\frac{\delta_2}{\delta_1}:L=K+D,\ \frac{dK}{d\beta}=\frac{\delta_2}{\delta_1} \tag{18}$$

where $dK/d\beta=\delta_2/\delta_1$ since K and β move on the government budget equation in (15). The sign of $dL/d\beta$ depends on the sign of $dD/d\beta$ and the positive δ_2/δ_1.

In case 3, by using the relation of $dD/d\beta=0$ in (17), $dL/d\beta$ in (18) is positive.

$$\frac{dL}{d\beta}=\frac{dD}{d\beta}+\frac{\delta_2}{\delta_1}>0 \text{ since } \frac{dD}{d\beta}=0 \tag{19}$$

Moreover, $\delta_2/\delta_1 \geq dK/d\beta \mid_{profit=const}$ in the left hand side of point E_3 on the government budget constraint and then $dD/d\beta \geq 0$, hence $dL/d\beta>0$. Also, $\delta_2/\delta_1<dK/d\beta \mid_{profit=const}$ in the right hand side and then $dD/d\beta<0$, hence

$$dL/d\beta \text{ is positive, zero and negative} \tag{20}$$

as the β increases along the budget constraint, as seen in Figure 3. (The derivation is given in Appendix.) At point E_3, the borrowers' surplus cannot obtain a maximum point subject to a government budget equation. Application of this logic can lead the borrowers' surplus to an ambiguous point at E_2 in case 2 ($\delta_2/\delta_1<dK/d\beta \mid_{profit=const},$

$dD/d\beta<0$: $dL/d\beta>0$, $dL/d\beta=0$, $dL/d\beta<0$) as the difference of both tangents increases. However, when $dK/d\beta\mid_{profit=const}$ is much larger than δ_2/δ_1, $dL/d\beta<0$ then the surplus of borrowers is a maximum at E_2. On the other hand, at E_1 in case 1 ($\delta_2/\delta_1>dK/d\beta\mid_{profit=const}$, $dD/d\beta>0$, $dL/d\beta>0$) the borrowers' surplus is a maximum point, as shown in Figure 4.

The results are summarized in Table 1. The rescue package, which maximizes the profit of a bank, generates a maximum surplus to depositors and borrowers, under case 1 ($\delta_2/\delta_1>dK/d\beta\mid_{profit=const}$) and case 2 ($\delta_2/\delta_1\ll dK/d\beta\mid_{profit=const}$), the latter being much larger. These occur when the unit price δ_2 of decreasing the expected bad loan ratio is much higher than δ_1 of bank capital and when the unit price δ_2 of decreasing the expected bad loan ratio is much lower than δ_1 of bank capital, respectively. For case 3, the package is optimal only for depositors. Whether or not cases 1 and 2 are plausible in Japan needs further research. Nevertheless, we can give a brief theoretical explanation for the result in each case. At case 3 (at E_3), $dD/d\beta=0$, while $dL/d\beta= dD/d\beta+\delta_2/\delta_1>0$ shown in (19). When the β and K increase along the budget constraint, D decreases in order to maximize profit, since D, with positive deposit rate increases, is costly. However, the increase of L(=K+D) is not costly. At case 2 (at E_2), D decreases when β and K increase along the budget constraint, while L (=K+D) decreases to satisfy the bank capital regulation only when β and K increase enough or D decreases with the decreases of K.

5. Conclusions

This paper defines the rescue package authorized by the IRCL and the DIL and evaluates the welfare effects of the package on borrowers' and depositors' surpluses.

The policy instruments of the rescue package are devised to increase bank capital by the government purchasing preferred stocks and to reduce banks' bad loans by purchasing them. The optimal bank capital and expected bad loan ratio to maximize the expected profit of a bank are subject to a government budget constraint. The package generates a maximum surplus for depositors and borrowers under the condition that the unit price δ_2 of decreasing the expected bad loan ratio is much higher than δ_1 of bank capital, or much lower. The package gives a maximum surplus for depositors only under the other conditions.

The rescue package is evaluated here under the restricted theoretical framework. Then, the results depend on whether a bank behaves like a competitor or a monopoly and on the specifications of the rescue package. Nevertheless, it is a starting point. Validity under other theoretical frameworks is a subject for further research.

Appendix

Derivation of (8)

We derive equation (8), considering (6).

$$\frac{\partial E[\Pi\{D(K,\beta,\bar{k})\}]}{\partial K}=\frac{dE(\Pi)}{dD}\frac{\partial D(K,\beta,\bar{k})}{\partial K}$$
$$=\left[\frac{dr_L}{dL}(1-\beta)L+(1+r_L)(1-\beta)-\frac{dr_D}{dD}D-(1+r_D)-g\right]\frac{\partial D}{\partial K} \qquad \text{(a.1)}$$
$$=\mu\,\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}\frac{\partial D}{\partial K}$$

If μ>0, we insert equation (12) to $\partial D/\partial K$ of equation (a.1).

$$\frac{\partial E[\Pi\{D(K,\beta,\bar{k})\}]}{\partial K}=\mu[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}] \qquad \text{(a.2)}$$

If μ=0, $\partial E(\Pi)/\partial K=0$ in equation (a.1). Then, the expression of equation (a.2) is available even if μ=0. The derivation of (9) is the same.

Derivation of (14)

We derive equation (14), considering equation (8) and (9).

$$\frac{\partial E[\Pi\{D(K,\beta:\bar{k})\}]}{\partial K}\frac{dK}{d\beta}+\frac{\partial E[\Pi]}{\partial\beta}=0$$
$$\frac{dK}{d\beta}=\frac{-\partial E(\Pi)/\partial\beta}{\partial E(\Pi)/\partial K}=\frac{K(\lambda_b-\lambda_{1-b})}{[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}]\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}>0 \qquad \text{(a.3)}$$

Next, we derive a second derivative for (a.3).

$$\frac{d^2K}{d\beta^2}=\frac{2K\bar{k}(\lambda_b-\lambda_{1-b})^2}{[1-\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}]^2\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}>0 \tag{a.4}$$

Derivation of (20)

We define (20) which satisfies

$$\delta_2/\delta_1 + A = dK/d\beta \mid_{profit=const} \text{ in (14),} \tag{a.5}$$

where

$$\delta_2/\delta_1 < dK/d\beta \mid_{profit=const} \text{ if and only if } A>0. \tag{a.6}$$

By using (16) and (18), we get the following equation.

$$\frac{dL}{d\beta}=\frac{1}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}\left(\frac{\delta_2}{\delta_1}-\frac{K(\lambda_b-\lambda_{1-b})}{\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}\right) \tag{a.7}$$

We insert (a.5) into (a.7).

$$\begin{aligned}\frac{dL}{d\beta}&=\frac{1}{\bar{k}\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}\left(\frac{\delta_2}{\delta_1}-(A+\frac{\delta_2}{\delta_1})\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}\right)\\&=\frac{1}{\bar{k}}\left(\frac{\delta_2}{\delta_1\{\lambda_b\beta+\lambda_{1-b}(1-\beta)\}}-(A+\frac{\delta_2}{\delta_1})\right)\end{aligned} \tag{a.8}$$

$$\text{If}\frac{\delta_2}{\delta_1}\left(\frac{1}{\lambda_b\beta+\lambda_{1-b}(1-\beta)}-1\right)>A\text{, then } dL/d\beta>0. \tag{a.9}$$

$$\text{If}\frac{\delta_2}{\delta_1}\left(\frac{1}{\lambda_b\beta+\lambda_{1-b}(1-\beta)}-1\right)=A\text{, then } dL/d\beta=0. \tag{a.10}$$

$$\text{If}\ \frac{\delta_2}{\delta_1}\left(\frac{1}{\lambda_b\beta+\lambda_{1-b}(1-\beta)}-1\right)<\text{A, then } dL/d\beta<0. \tag{a.11}$$

When the $\beta\in[0,1]$ increases, the $\lambda_b\beta+\lambda_{1-b}(1-\beta)\in[0,1]$ increases to $\lambda_b(1\geq\lambda_b>\lambda_{1-b}\geq 0)$ and the $\left(\frac{1}{\lambda_b\beta+\lambda_{1-b}(1-\beta)}-1\right)$ decreases to zero. On the other hand, the A increases when the $\beta\in[0,1]$ increases. Then, (a.9) to (a.11) will occur.

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Table 1. Profit and welfare maximization by the rescue package

Equilibrium	Bank's profit	Borrowers' surplus	Depositors' surplus
E1	Max	Max	Max
E2	Max	Max*	Max
E3	Max	X	Max

Notes: Max and X and Max* in Borrower's surplus column means that the maximum is attained at an equilibrium, not attained and undecided, respectively; Max* means the possibility of max.

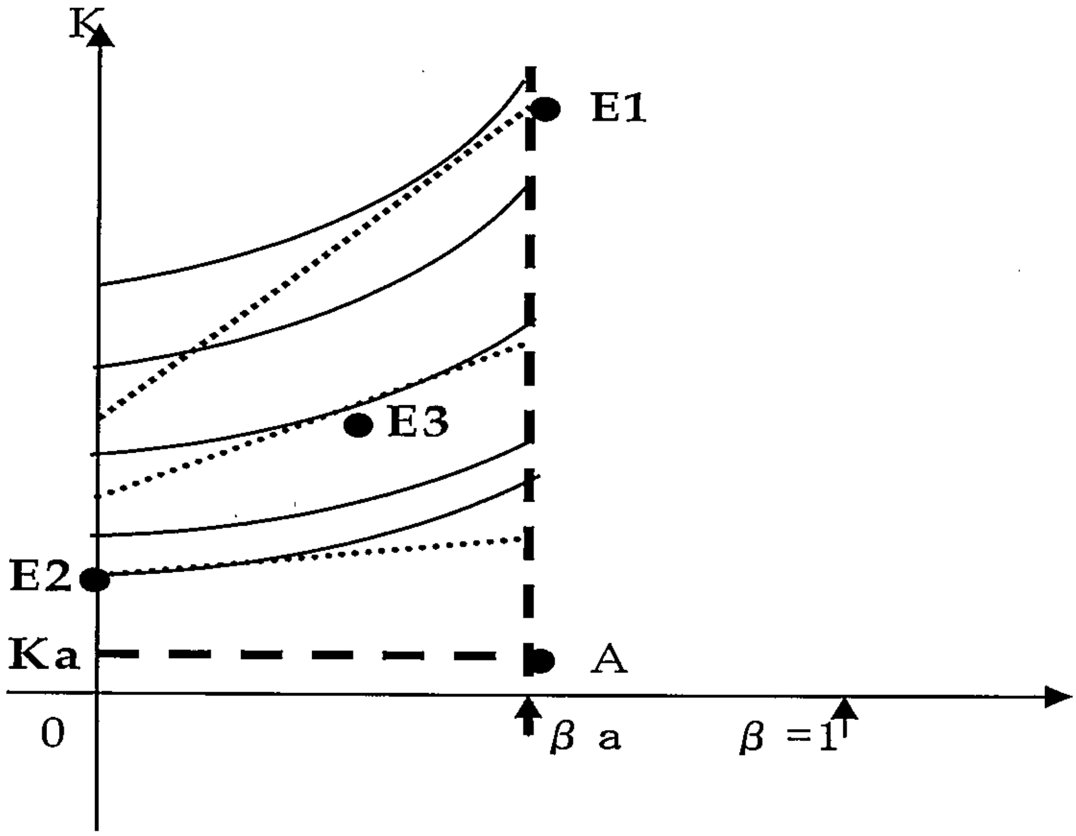

Figure 1

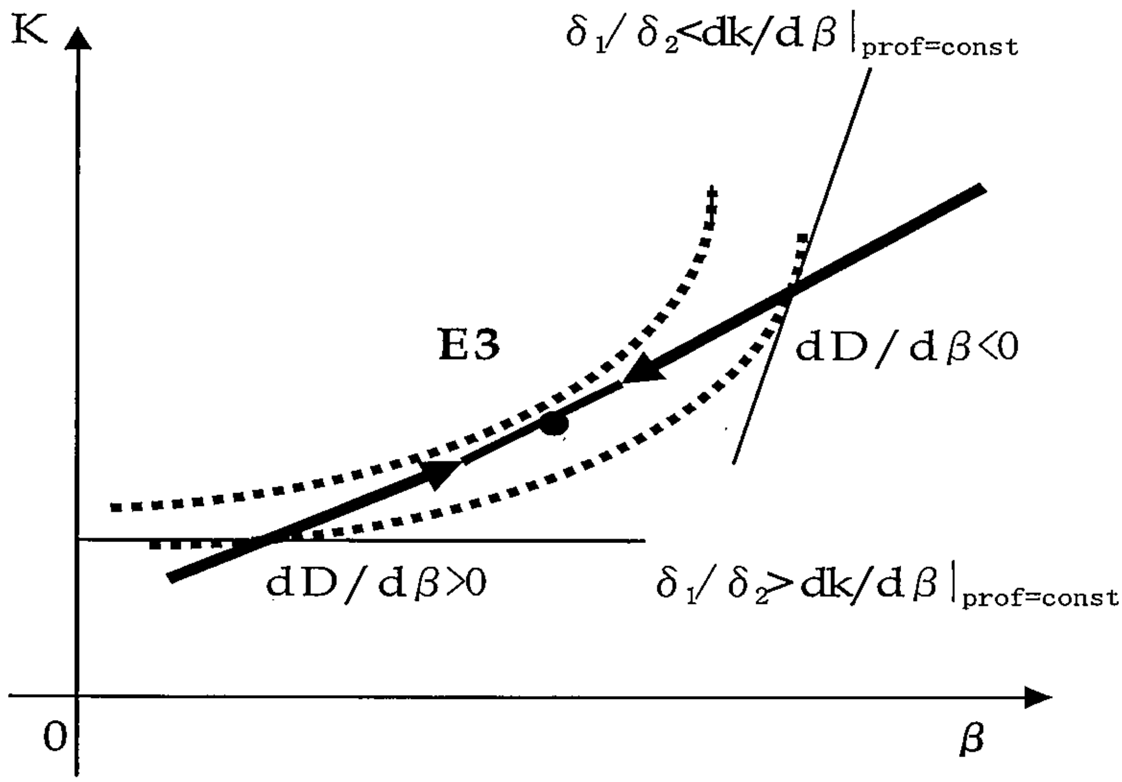

Figure 2

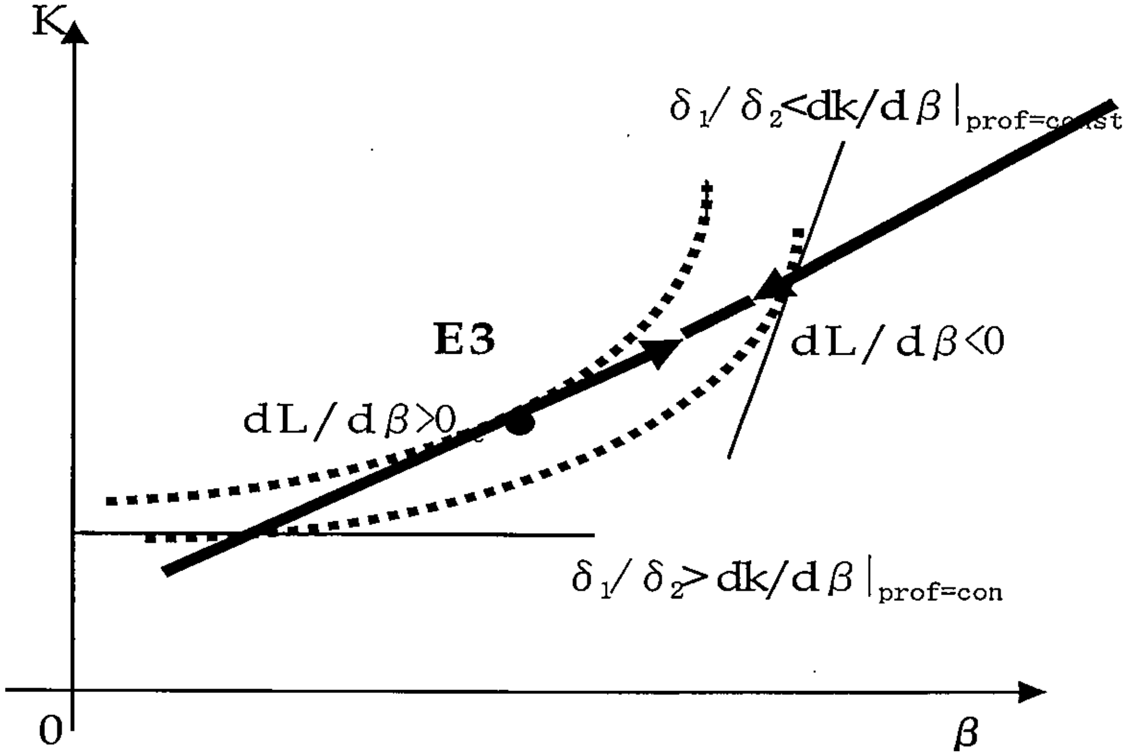

Figure 3

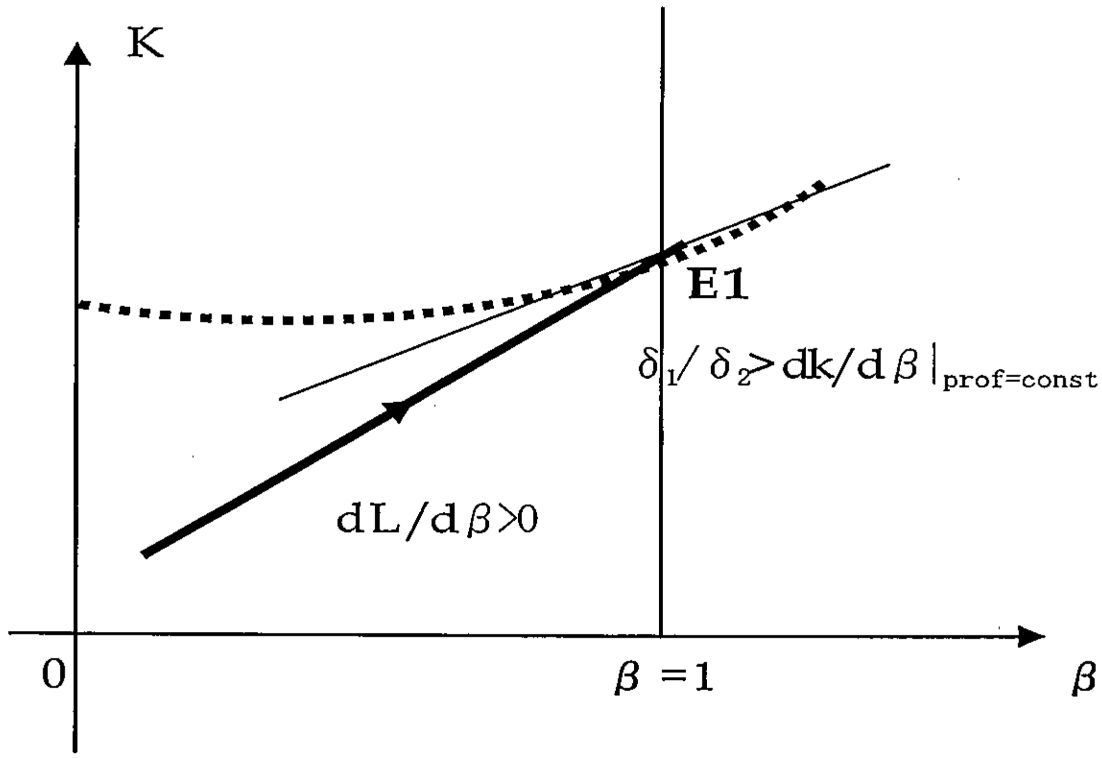

Figure 4