Moral Hazard under the Japanese "Convoy" Banking System

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This paper examines a banking regime similar to the "convoy" scheme which prevailed in Japan through most of the 1990s. Insolvent banks are merged with solvent banks rather than closed, with the acquiring banks required to accept negative value banks at zero value. I demonstrate that a convoy scheme effectively taxes the acquiring bank and increases moral hazard by reducing bank effort towards enhancing its portfolio, even relative to a fixed-premium deposit insurance system, for negative value banks. However, for positive bank charter values, which are retained under the convoy scheme and lost under the deposit insurance program, these effects may be mitigated or even overturned.

I also find that the rules governing the convoy scheme can affect bank behavior. I compare two convoy regimes, one where acquiring banks are chosen at random and one where the weakest banks are paired with the strongest banks. Simulations reveal that the disparities in bank effort between the two convoy regimes are greater than those between the convoy regimes and the fixed-premium deposit insurance regime. I confirm the theoretical result above that the bank effort under either convoy program is increasing in bank charter value.

Perhaps the greatest puzzle in international finance over the previous decade has been the continued disappointing performance of the Japanese banking system. With the collapse of the "bubble economy" of the 1980s, Japan's banking sector experienced heavy losses, from which recovery has been extremely slow. As of September 1998, estimates of bad loans in Japan's banking sector still exceeded 7 percent of GDP (Hoshi and Kashyap 1999). In this paper, I examine whether the prevailing regulatory regime in Japan's banking sector through most of the 1990s may have played a role in the sector's slow movement towards recovery.

In particular, I examine the Japanese "convoy" system, under which the burden of maintaining the Japanese deposit safety net was to some extent placed on the banking industry as a whole. I first review the recent history of bank failures in Japan and demonstrate that banks were called upon to assist with failures, particularly systemic failures and those which occurred after the funds of the Japanese Deposit Insurance Corporation (DIC) were effectively exhausted in the mid-1990s.

I then introduce a simple theoretical model of bank lending under such a convoy system and compare bank behavior under that model to a standard self-financing fixed-premium deposit insurance benchmark. Under the fixed-premium regime, a bank is closed and liquidated when it is found to be insolvent.

I consider two types of "convoy systems": one where acquiring banks are chosen at random from the set of solvent companies and one where regulators pursue a more activist policy, pairing the weakest failing banks with the strongest solvent banks. An important distinction between the two convoy regimes and the fixed-premium deposit insurance regime is that banks are not liquidated under the convoy regimes. Their charter values accrue to the acquiring bank. Under the fixed premium regime, in contrast, charter values are lost due to the bank's liquidation.

The theoretical model demonstrates that the relative level of moral hazard in bank lending among the various regimes is dependent on bank charter values. For banks with negative values inclusive of charter values, I demonstrate that the level of moral hazard is greater under either of the convoy banking regimes than under the fixed-premium deposit insurance scheme. Surprisingly, however, the relative moral hazard under the randomly paired convoy scheme and the "best-with-worst" paired convoy scheme is ambiguous.

I then turn to simulations to investigate the quantitative importance of these disparities. My results confirm that the relative dominance of the deposit insurance regime is negatively related to bank charter values. For the set of parameters for which I found an interior solution with positive but uncertain probabilities of bank solvency, I found that the best-with-worst paired convoy system had lower levels of equilibrium bank effort and higher probabilities of bankruptcy than the deposit insurance regime. For sufficiently large levels of bank charter value, this dominance was reversed. The randomly paired convoy system had lower levels of moral hazard for all charter values that yielded interior solutions with positive default probabilities.

I. Background on the Japanese Convoy System

Breakdown of the Deposit Insurance Corporation

The Japanese convoy approach to banking regulation was an outgrowth of its "main bank" system. Under this system, a set of informal practices, ensured through the guidance of both the Japanese Ministry of Finance (MOF) and the Bank of Japan, constituted Japan's system of corporate finance throughout the postwar period. Under the main bank system, a firm would have a special long-term relationship with a bank, usually one that acted as its primary source of financing. Interactions between both banks and firms under this system were often complex, creating a significant degree of systemic risk if any component of the financial system should fail.[1]

The regulatory response to this systemic risk was to restrict lending levels by any individual bank so that banks in the system, particularly the large banks, would grow at roughly the same pace, hence the name "convoy." In addition, the number of banks was restricted. This created monopoly rents within the banking industry, such that individual banks could increase their profits through expansion. The MOF was therefore placed in a strong regulatory position through its power to control bank branching and overall lending activities.

The convoy system also imposed responsibilities on commercial banks for the safety of their competitors. When banks found themselves experiencing extreme difficulties, the MOF typically intervened by merging the troubled smaller bank with a larger bank. It has been suggested that through this activity, the MOF compensated for the absence of effective stockholder control in the Japanese banking system.

It is unclear whether acquiring banks were damaged by the sporadic early merger activity. Aoki, et al. (1994) claim that the MOF used its discretion over branch licensing to compensate rescuing banks. Even if the acquired banks had negative asset value, the branching rights they brought to the acquiring bank may have provided adequate compensation.

The merger activity since the start of the 1990s, however, was distinct from the earlier mergers in at least two dimensions. First, the number of problem banks, and the severity of their problems, were much larger subsequent to the collapse of the "bubble" prices which prevailed in the 1980s. Second, financial liberalization, which had been taking place since the mid-1970s, eroded the pervasiveness of monopoly rents in the banking sector, particularly the shadow values of branching rights which accompanied acquisitions of problem banks.[2]

Table 1 identifies several notable mergers from the 1960s through the 1990s. Four examples from the 1995–1996 period illustrate the changes in the way mergers were handled. The merger between Tokyo Kyodo and Anzen Bank in 1995 included a 40 billion yen injection of capital from the deposit insurance corporation and a 20 billion yen contribution of new equity from private banks. In addition, the Tokyo metropolitan government contributed subsidized loans (Cargill, et al. 1997). The contribution of private banks represented a departure from previous mergers and probably reflected the deterioration in the financial condition of the DIC.

Also in 1995, the Cosmo Credit Corporation failed and was bailed out with funds primarily from Cosmo's largest creditor, Sanwa, but also from a number of other banks, the National Federation of Credit Cooperatives, the DIC, and the Tokyo metropolitan government. Of the total estimated bailout cost of 240 billion yen, the contribution of the DIC was only 100 billion (Cargill, et al. 1997).

Several weeks later, the MOF closed the larger Hyogo Bank and Kizu Credit Corporation. The Hyogo Bank was to be reopened as a new entity while the Kizu Credit Corporation was liquidated. However, the government's efforts to assist the Hyogo Bank were unsuccessful, and it was closed in 1995, marking the first bank liquidation in 70 years (Yamori 1999). The net cost to the DIC of resolving these two banks' positions was estimated at 100 billion yen, effectively exhausting DIC funds.

A number of other closures followed. Finally, when the government moved to close the Hanwa Bank in 1996, it changed its policy. It ordered the bank to close operations and did not attempt to find a rescuing bank. Instead, the as-

1. For an overview of general aspects of the Japanese main bank system, see Aoki, Patrick, and Sheard (1994).

2. See Hoshi and Kashyap (1999) for details.

sets of the Hanwa Bank were placed in the Resolution and Collection Bank to be liquidated and the government promised to guarantee bank deposits.

The "Jusen" Problem

The financial strains faced by the Japanese financial system's safety net took a turn for the worse when it became clear that the bank subsidiaries known as "jusen" companies were extremely troubled. These jusen banks were heavily exposed to the collapse in Japanese real estate prices, since they were exempted from the 1990 limits on real estate financing placed on banks by the MOF.[3]

The magnitudes of jusen losses were impressive. The MOF estimated that, of the 12.8 trillion yen in outstanding loans, nonperforming loans amounted to 9.6 trillion yen, of which loans worth 6.4 trillion were unrecoverable. These losses were so large that certain financial institutions, most notably the agricultural credit cooperatives, lacked an adequate capital base to survive a write-off of a proportionate loss in their outstanding loans to jusen companies.

The regulatory response to the jusen problem once again followed "all Japan" features, in the sense that institutions' contributions to the funding of the first stage of resolution costs of the jusen problem were not proportional to their initial exposure (see Table 2). One notable component of the jusen resolution plan was the limited value of the contribution by the agricultural credit cooperatives. The initial planned contribution of 1.1 trillion yen by the agricultural cooperatives was bargained down to 520 billion yen, with the MOF making up the 680 billion yen difference (Rosenbluth and Thies 1998).

The government plan was widely opposed, particularly the use of public funds. The government subsequently announced a modified plan under which banks would be required to streamline their operations, leaving them more profitable. The plan predicted that enhanced bank profits would yield 680 billion yen in additional corporate income

3. For extensive reviews of problems surrounding the resolution of the jusen problem, see Cargill, et al. (1997), Milhaupt and Miller (1997), and Rosenbluth and Thies (1998).

TABLE 1

NOTABLE JAPANESE ASSISTED BANK AND CREDIT UNION MERGERS

YEAR	FAILED BANK OR CREDIT UNION	ACQUIRING BANK
1965	Asahi	Dai-Ichi
1965	Kawachi	Sumitomo
1969	Toto	Mitsui
1986	Heiwa Sogo	Sumitomo
1991	Toho Sogo	Iyo
1992	Toyo Shinkin	Sanwa
1993	Kamaishi Shinkin	Iwate
1993	Osaka Fumin Credit Corp	Osaka Koyo Credit Corp
1994	Gifu Shogin Credit Corp	Kansai Kogin Credit Corp
1995	Tokyo Kyowa Credit Corp	Tokyo Kyodo
	Anzen Credit Corp	
1995	Yuai Credit Corp	Kanagawa Labor
1995	Cosmo Credit	Tokyo Kyodo
1995	Hyogo	Midori
1995	Kizu Credit Corp	Seiri Kaishu
1995	Osaka Credit Corp	Tokai
1995	Sanyo Credit Corp	Tanyo Credit Corp
1995	Kenmin Daiwa	Tanyo Credit Corp
1996	Taiheiyo	Wakashio
1996	Hanwa	Kii Yokinkanri
1997	Hokkaido Takushogu	Chuo Trust, Hokuyo
1997	Tokuyo City	Sendai
1998	Long-Term Credit	
1998	Nippon Credit	

Sources: Aoki, et al. (1994), Cargill, et al. (1997), OECD (1998), and Deposit Insurance Corporation (1999). Dates refer to failure dates and not necessarily to dates of acquisition.

TABLE 2

CONTRIBUTIONS TO FIRST-STAGE JUSEN RESOLUTION COSTS

	CONTRIBUTION (YEN)	OUTSTANDING LOANS (YEN)
"Founder banks"	Abandonment of claims: 3.5 trillion	3.5 trillion
"Other lender banks"	Abandonment of claims: 1.7 trillion	3.8 trillion
"Agricultural credit cooperatives"	"Donation" 520 billion	5.5 trillion
Public contribution	680 billion	

Source: Japan Ministry of Finance, 1996.

taxes and offset the cost of the government contribution. This plan was widely criticized as implausible, but the Diet passed a budget allocating the use of taxpayer funds to bail out the jusen after Prime Minister Hashimoto announced that he would pressure the financial sector to increase its contributions to the program. After rejecting an unsuccessful challenge to the plan by the opposition, the Diet passed a budget allocating the funds necessary to finance the resolution of the jusen companies at the old contribution rates in June of 1996.

However, it has been recognized that the initial funds may prove to be inadequate, particularly in the event of further real estate downturns. Here again, the burden is to be borne to some extent by the banking system as a whole. The government has announced an agreement with the parent banks of the jusen banks, commonly known as "founding banks," to establish a Financial Stabilization Fund, under which founding banks would contribute more than 1 trillion yen in additional funds to offset half of the future jusen losses. The remainder is to be covered by public money (Kitami 1998). The bulk of regional banks, second tier banks, and insurance companies agreed to increase their contributions as well (Rosenbluth and Thies 1998).

Summary

The Japanese "convoy" banking system clearly placed some share of the burden of the safety net provided to Japanese depositors on the banking industry. In the early days of the convoy system, the empirical importance of the burden was questionable. The number of mergers was small, and side payments, such as enhanced branching opportunities, appear to have mitigated the losses from acquiring a failed bank.

However, with the turbulence experienced by the banking system in the 1990s, the banking system clearly bore some of the burden of failures within the system. Moreover, as financial liberalization eroded the share of bank finance, the charter values, such as bank branching rights, diminished.

The burdens faced by banks had little correspondence to their lending practices. This was particularly true for the jusen resolution program. As Rosenbluth and Thies (1998, p. 22) point out, under the jusen resolution plan ". . . stronger banks and nonbank financial institutions were asked to contribute to a bailout of the failing institutions, in rough proportion not to their exposure to the problem, but to their ability to pay." This characterization was echoed by Milhaupt and Miller (1997), who describe the resolution plan as a "survival of the weakest" strategy, in that the smallest contributions were solicited from entities that were least equipped to bear losses. In the case of jusen problem, this was primarily the agricultural credit cooperatives.

II. A Simple Model of a Convoy Banking System

In this section, I examine the implications of systems of bank resolution in which the burden of resolution is placed on the banking system rather than on a government deposit insurance system. I assume a simple lending model where regimes differ by their procedures for resolution of failed banks. I first model a fixed premium deposit insurance regime which results in the liquidation of a failing bank as a benchmark, and then compare the results under that regime to a "convoy" banking regime, in which the failed bank is merged with a solvent bank. I find that within the class of "convoy" regimes, the results can differ based on the method used to allocate failing banks. I consider two possible types of convoy regimes below.

A Fixed-premium Deposit-insurance System Benchmark

In order to understand the moral hazard implications of the "convoy" system, I first construct a fixed-premium deposit insurance benchmark against which it can be compared. I model the problem in terms of a representative bank. I assume that there are an infinite number of homogeneous banks of measure zero. Banks make fixed amounts of loans, which are financed by issuing insured deposits. Because the deposits are insured, they earn the risk-free rate. I assume that the deposit insurance premium, defined as Ψ_d, is paid up front, and set this premium to make the system self-financing.

The model has one period. The timing of the model is as follows. First, the bank pays its deposit insurance premium, Ψ_d, which is determined below, and chooses its effort level, μ_i. The effort level represents the bank's investment in enhancing the quality of its loan portfolio.[4] The cost of supplying an amount of effort equal to μ is assumed to satisfy the function $V(\mu)$, where $V_\mu > 0$ and $V_{\mu\mu} > 0$. For simplicity, I also assume that effort costs are borne up front. This simplifies the analysis by making this cost independent of the probability of bankruptcy, but drives none of our results.

Banks are assumed to play Nash, taking the equilibrium effort decision of the rest of the banking system, $\bar{\mu}$, as given. We define the equilibrium solution for the system as a value for μ which satisfies the first-order condition for all of the banks in the system.

4. For similar approaches to modeling moral hazard, see Dewatripont and Tirole (1993), Giammarino, Lewis, and Sappington (1993), and Kasa and Spiegel (1999).

Second, each bank i is hit with an idiosyncratic shock, ε_i, which is assumed to be distributed on the interval $[-\infty, +\infty]$.

Finally, the bank is closed if it is insolvent. Define n_i as the net value of assets minus liabilities of bank i. I assume that n_i is a separable function of μ_i and ε_i which satisfies

$$n_i = n(\mu_i,\varepsilon_i), \tag{1}$$

where $n_x > 0$, $n_{xx} < 0$ $(x = \mu_i,\varepsilon_i)$ and $n_{\mu_i,\varepsilon_i} = 0$. I assume that the bank is insolvent and closed if $n_i < 0$.

As in Marcus (1984), I assume that if the bank is allowed to continue, it has a charter value of C, which is taken as exogenous. This represents the expected future profits from continued banking operations, perhaps due to branching rights, and is not incorporated in the regulator's closure rule.

Banks are assumed to have limited liability, having zero value under bankruptcy to their equity holders. Since bankruptcy leads to liquidation in the deposit insurance regime, I assume that the charter value of the failed bank is lost.

Define ε^*_{di} as the minimum realization of ε_i under which the regulator chooses to allow the bank to continue in operation under the fixed-premium deposit insurance system, which satisfies

$$n(\mu_i,\varepsilon^*_{di}) = 0. \tag{2}$$

In particular, define ε^*_d as the minimum realization of ε_i under which the regulator chooses to leave a bank with the average level of industry effort, μ, open. The "fair" bank deposit insurance premium, Ψ_d, will then be equal to the expected resolution cost of a representative bank. Ψ_d satisfies

$$\Psi_d = -\int_{-\infty}^{\varepsilon^*_d} n(\mu,\varepsilon_i) f(\varepsilon_i) d\varepsilon_i . \tag{3}$$

Note that since the representative bank is small relative to the entire banking system, Ψ_d is a function of μ but not a function of μ_i.

The representative bank's investment decision is to choose μ_i to maximize Π, expected bank value net of effort cost, which satisfies

$$\Pi = -\int_{\varepsilon^*_{di}}^{+\infty} (n(\mu_i,\varepsilon_i) + C) f(\varepsilon_i) d\varepsilon_i - \Psi_d - V(\mu_i) , \tag{4}$$

where $f(\cdot)$ is the density of ε_i.

The bank's first-order condition satisfies

$$\int_{\varepsilon^*_{di}}^{+\infty} \frac{\partial n}{\partial \mu_i} f(\varepsilon_i) d\varepsilon_i - \left(\frac{\partial \varepsilon^*_{di}}{\partial \mu_i}\right) C f(\varepsilon^*_{di}) = V_{\mu_i} \tag{5}$$

since $\partial\Psi_d/\partial\mu_i = 0$.

The two arguments on the left-hand side of equation (5) represent the marginal benefits of additional effort. The first term reflects the increased expected payoff in nonbankruptcy states, holding the probability of bankruptcy constant. The second term reflects the value of the change in the probability of bankruptcy which results from a marginal change in effort.

The well-known result that the combination of fixed-premium deposit insurance and limited liability can create moral hazard can be seen in equation (5). When making its effort decision, the bank considers only the improved payoff under solvency states. Because of limited liability and fixed-premium deposit insurance, expected bank value is independent of bank payoffs for realizations of ε_i below ε^*_{di}. Consequently, any potential improvements from increases in bank effort over this range do not enter into the bank's maximization decision.

The fixed-premium deposit insurance regime precludes any consideration of the impact of effort on firm value in insolvency states. The impact of payoffs below ε^*_{di} would be considered if depositors lost their assets in bankruptcy states, i.e., in the absence of deposit insurance. If there were no deposit insurance, depositors would require higher premia in solvency states to offset their losses in insolvency states. The same would be true if deposit insurance terms were risk-weighted.

However, the severity of the moral hazard problem is mitigated by the bank charter value C. To the extent that the bank values continuing into the next period, the marginal increase in the probability of avoiding bankruptcy from increased bank effort will have greater weight. The value of continuing is precisely measured by the charter value C by definition. The higher is C then, the less severe is the moral hazard problem.

A "Convoy" Banking System

I next turn to the severity of moral hazard in a convoy banking system. To facilitate comparison with the fixed-premium deposit insurance system, I keep the model as close to it as possible. I again examine a one-period lending problem where the bank chooses its level of effort in improving the quality of its lending portfolio. As above, banks are assumed to have limited liability, and I model the problem in terms of a representative bank.

Unlike the model above, however, I do not assume that there is an explicit deposit insurance system in place, which services bank liabilities following the liquidation of a failed bank. Instead, I assume that regulators pursue a "convoy" system, in which the assets and liabilities of a failed bank are given to a safe bank which is forced to acquire the balance sheet of the failed bank at par. However, since the failed bank is not liquidated, I assume that its charter value is gained by the acquiring bank. The net cost or benefit to a bank from acquiring a failed bank is then equal to the net balance sheet value of the failed bank plus its charter value.

I assume that all agents place zero weight on the probability of complete bankruptcy of the commercial banking system. The effect of this assumption is that a "convoy" banking system does much of the same work as the fixed premium deposit insurance system. First, it eliminates the possibility of banking panics, since depositors are left whole even in the wake of an individual bank failure. Second, since depositors face no possibility of losses due to individual bank failure, the interest terms faced by the bank are again invariant with respect to its effort decisions. In particular, depositors receive only the risk-free rate of interest.

An implication of this assumption is that there must be a minority of failed banks in the system, so that each failed bank has a solvent bank available for pairing with adequate funds. For the pairing schemes considered below, this is satisfied if ε_i^* is less than zero. This implies that given the equilibrium effort level, a realization of ε_i equal to its expected value leaves a bank solvent. I adopt this restriction, which seems to hold commonly.

I again assume that banks play Nash, in the sense that each bank takes the effort levels of the rest of the banking system, μ, as given when making its decision over μ_i.

So far, I have not discussed the method by which the acquiring bank is chosen. I consider two possibilities, each representing a different form of "convoy" system. First, I assume that the regulator randomizes over the set of solvent banks and pairs them one-to-one with the set of insolvent banks. Second, I assume that the regulator tries to merge the weakest banks with the strongest banks, under the logic that the strongest banks are best equipped to acquire the weakest banks without failing themselves. I show that the scheme by which banks are chosen to participate in the convoy program affects both bank incentives and bank behavior.

Randomly Paired Convoy Program

I begin with a "random" convoy program in which the set of failed banks is randomly paired with the set of solvent banks.

Define Ψ_r as the expected net change in bank asset value from the randomly paired convoy program. Ψ_r will be equal to the net asset plus charter value of a failed bank times the probability of being chosen as the acquirer of that failed bank. Given the average level of effort in the banking system, μ, we can write this formally as

$$(6)\qquad \Psi_r = \left(\int_{\varepsilon_r^*}^{+\infty} f(\varepsilon_i)d\varepsilon_i\right)^{-1} \int_{-\infty}^{\varepsilon_r^*} \left[n(\mu,\varepsilon_i)+C\right] f(\varepsilon_i)d\varepsilon_i ,$$

where ε_r^* represents the minimum realization of ε_i which leaves a bank with effort level μ solvent. ε_r^* satisfies

$$(7)\qquad n(\mu,\varepsilon_r^*) = 0.$$

Note that Ψ_r is negative and independent of the individual bank's choice of μ_i.

The expected value of bank *i* under a randomly paired convoy system is then equal to

$$(8)\qquad \int_{\varepsilon_{ri}^*}^{+\infty} \left[n(\mu_i,\varepsilon_i)+\Psi_r+C\right] f(\varepsilon_i)d\varepsilon_i - V(\mu_i) ,$$

where ε_{ri}^* represents the minimum realization of ε_i which leaves a bank with effort level μ_i solvent.

The bank's first-order condition satisfies

$$(9)\qquad \int_{\varepsilon_{ri}^*}^{+\infty} \frac{\partial n}{\partial \mu_i} f(\varepsilon_i)d\varepsilon_i - \left(\frac{\partial \varepsilon_{ri}^*}{\partial \mu_i}\right)(\Psi_r + C) f(\varepsilon_{ri}^*) = V_{\mu_i} .$$

In equilibrium, banks are homogeneous, so we substitute μ for μ_i. An equilibrium is then an effort choice μ consistent with equation (9).

It is illustrative to compare equation (9) with equation (5). The only difference in the two first-order conditions is in the term modifying the effect of a change in the probability of bankruptcy with a change in bank effort. In the benchmark fixed-premium deposit insurance system, the value of avoiding bankruptcy was equal to the charter value *C*. Under the convoy system, however, this value is affected by the expected loss from the possibility of being chosen as an acquiring bank, Ψ_r.

In principle, this value could be positive or negative, depending on the probability and expected magnitude of bank failures relative to the charter value picked up after acquisition. This leads to our first proposition.

PROPOSITION 1: *Given $\Psi_r < 0$, the equilibrium value of μ_i is lower under the randomly paired convoy system than under the fixed-premium deposit insurance system. However, the opposite result obtains for $\Psi_r > 0$.*

To prove Proposition 1, I totally differentiate equation (9) with respect to μ_i and Ψ. Recalling that $n(\mu_i,\varepsilon_{ri}^*) = 0$ by definition, I obtain

$$(10)\qquad \frac{d\mu_i}{d\Psi_r} = \frac{\left(\frac{\partial \varepsilon_{ri}^*}{\partial \mu_i}\right) f(\varepsilon^*)}{\int_{\varepsilon_{ri}^*}^{+\infty} \frac{\partial^2 n}{\partial \mu_i^2} f(\varepsilon_i)d\varepsilon_i - \left(\frac{\partial^2 \varepsilon_{ri}^*}{\partial \mu_i^2}\right)(\Psi_r + C) f(\varepsilon_i^*) - V_{\mu\mu}} > 0 .$$

Given that the expected payoff from the randomly paired convoy program, Ψ_r, is negative, the total change in effort moving from the fixed-premium deposit insurance system to the randomly paired convoy system satisfies

$$(11)\quad \mu_{cr}-\mu_{di}=\int_{\Psi_r}^{0}\frac{\left(\frac{\partial\varepsilon_{ri}^{*}}{\partial\mu_i}\right)f(\varepsilon_{ri}^{*})}{\int_{\varepsilon_{ri}^{*}}^{+\infty}\frac{\partial^2 n}{\partial\mu_i^2}f(\varepsilon_i)d\varepsilon_i-\left(\frac{\partial^2\varepsilon_{ri}^{*}}{\partial\mu_i^2}\right)(\Psi_r+C)f(\varepsilon_{ri}^{*})-V_{\mu\mu}}d\Psi_r<0\ .$$

By inspection, one can see that the opposite result obtains for $\Psi_r > 0$, which completes the proof.

Before moving on, I must note a problem with the random pairing scheme. Under the random pairing scheme, it is possible that an otherwise solvent bank can be pushed into insolvency by being forced to acquire a sufficiently insolvent bank. Above, I have abstracted from this problem by only allowing banks to be closed prior to the allocation of failed banks to their acquisitors. However, this raises serious questions about the feasibility of a truly random scheme. It seems that some kind of explicit pairing is required to avoid this implausible outcome.

"Best-with-worst" Pairing Scheme

Alternatively, we consider the strategy of pairing the weakest failed banks with the strongest solvent banks. The motivation for such a strategy might be that the strongest banks are best equipped to digest the losses associated with the acquisition of the weakest banks without risking failure themselves. In particular, since the best-with-worst scheme does not merge a marginally solvent bank with a sufficiently insolvent bank, it avoids the potential for forcing the acquiring bank into bankruptcy.

I assume a simple pairing strategy: The bank with the largest net asset value is paired with the most insolvent bank. As above, I assume that banks play Nash, taking the effort choices of the other banks, μ, as given.

Define ε_p^* as the minimum realization a bank making effort level μ would need to avoid closure. ε_p^* satisfies

$$(12)\qquad n(\mu,\varepsilon_p^*) = 0.$$

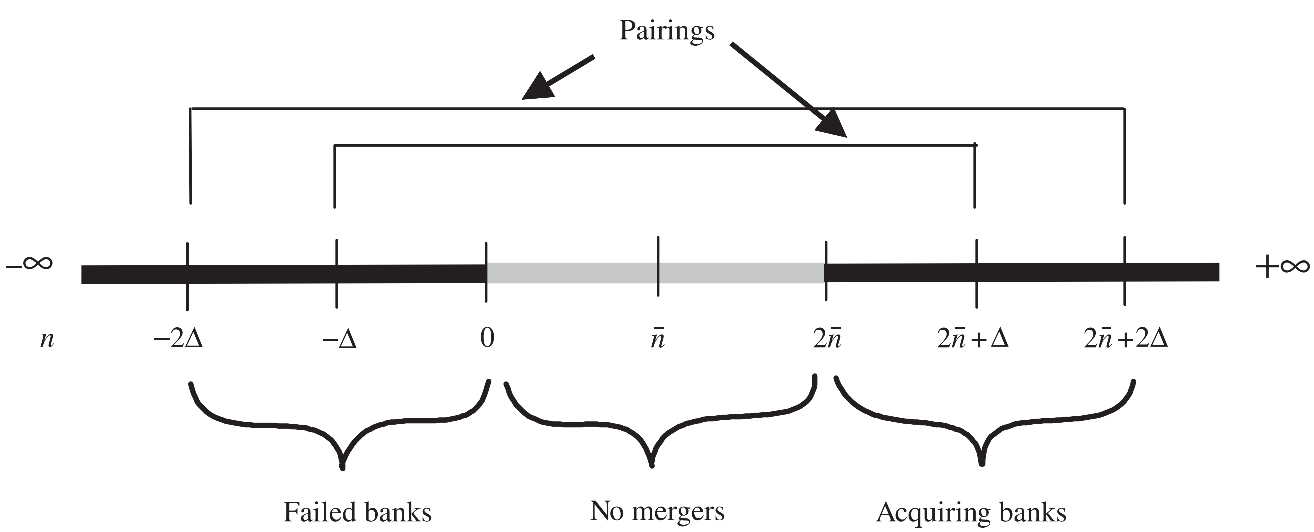
Figure 1 illustrates the best-with-worst pairing scheme. All banks with negative realizations of n will be insolvent. Each failed bank is paired with a corresponding solvent bank, starting by pairing the most insolvent banks with the most solvent banks. Let $\bar{n}$ represent the mean realization of the population of banks. We assume that the system as a whole is solvent, which implies that $\bar{n} > 0$. It can be seen that all banks with realizations of n greater than $2\bar{n}$ will be asked to acquire a failed bank under this scheme. For example, a bank with a realization of n equal to $2\bar{n} + \Delta$ will be paired with a bank with realization of n equal to $-\Delta$. Note that the weakest set of solvent banks, those with realizations of n in the range $0 \le n \le 2\bar{n}$, are not paired with any bank under this system.

Because all banks make effort level μ in equilibrium, the distribution is symmetric. A bank which receives a realization of ε_i which yields a value of n greater than $2\bar{n}$ will be paired with a bank with net value equal to $n(\mu,-\varepsilon_i)$.

We next turn to the decision problem faced by our representative bank, which again plays Nash and takes the above distribution of pairings with realizations of n as given.

FIGURE 1

Best-with-worst Paired Convoy System



The value of n for a representative bank is a function of its effort choice μ_i and its idiosyncratic shock realization ε_i. Let $\hat{n}$ represent the net asset value of the insolvent bank with which a bank with effort level μ_i and a realization of ε_i which yields a value of n above $2\bar{n}$ is paired. $\hat{n}$ will be a function of μ_i, ε_i, and μ

$$(13) \qquad \hat{n} = \hat{n}(\mu_i, \varepsilon_i, \mu),$$

where $\hat{n}_{\mu_i} < 0$, $\hat{n}_{\varepsilon_i} < 0$, and $\hat{n}_\mu > 0$.

The intuition for the sign on the partial derivatives stems from the best-with-worst pairing method. An increase in either μ_i or ε_i increases n. Holding the distribution of payoffs to the rest of the banking system constant, this raises a bank's relative performance standing. Under the best-with-worst pairing method, the bank is then asked to acquire a bank with a more negative asset position. An increase in μ, on the other hand, decreases the relative performance of a bank with net asset value n because the entire distribution of realizations of n is pushed upwards by an industry-wide increase in effort.

Finally, define $\hat{\varepsilon}$ as the realization of ε_i for a bank with effort level μ_i, which gives it a realization of n equal to $2\bar{n}$. $\hat{\varepsilon}$ satisfies

$$2\bar{n} = n(\mu_i, \hat{\varepsilon}).$$

Rearranging terms, we can write

$$(14) \qquad \hat{\varepsilon} = \hat{\varepsilon}(\mu_i, \mu),$$

where $\hat{\varepsilon}_{\mu_i} < 0$, and $\hat{\varepsilon}_\mu > 0$.

We can then define Ψ_p as the expected change in bank value stemming from the paired convoy program. Ψ_p satisfies

$$(15) \qquad \Psi_p = \int_{\hat{\varepsilon}}^{+\infty} \hat{n}(\mu_i, \varepsilon_i, \mu) f(\varepsilon_i) d\varepsilon_i \,.$$

Let ε^*_{pi} represent the minimum realization of ε_i which yields solvency for a bank with effort level μ_i. Note that $\hat{\varepsilon} > \varepsilon^*_{pi}$ since marginally solvent banks are not paired with failed banks under the paired convoy system. The expected value of bank i under the paired convoy system will then equal

$$(16) \qquad \int_{\varepsilon^*_{pi}}^{+\infty} [n(\mu_i, \varepsilon_i) + C] f(\varepsilon_i) d\varepsilon_i + \int_{\hat{\varepsilon}}^{+\infty} \hat{n}(\mu_i, \varepsilon_i, \mu) f(\varepsilon_i) d\varepsilon_i - V(\mu_i)\,.$$

The representative bank's first-order condition then satisfies

$$(17) \qquad \int_{\varepsilon^*_{pi}}^{+\infty} \frac{\partial n}{\partial \mu_i} f(\varepsilon_i) d\varepsilon_i - \left(\frac{\partial \varepsilon^*_{pi}}{\partial \mu_i}\right)(C) f(\varepsilon^*) + \int_{\hat{\varepsilon}}^{+\infty} \frac{\partial \hat{n}}{\partial \mu_i} f(\varepsilon_i) d\varepsilon_i = V_{\mu_i}\,,$$

since $\hat{n}(\hat{\varepsilon}) = 0$.

To solve for the equilibrium we note that since banks are homogeneous, $\mu_i = \mu$. The equilibrium is defined as a choice of μ for all banks in the system which satisfies (17).

As above, we first compare the paired convoy system with the fixed-premium deposit insurance system. Comparing (5) and (17), the paired convoy system has an additional term representing the change in the expected loss due to the convoy program with a change in μ_i. An increase in μ_i increases the bank's expected relative performance and therefore reduces the expected net value of the insolvent bank it will be forced to acquire under the convoy program. This leads to our second proposition.

PROPOSITION 2: *Given $\Psi_p < 0$, the equilibrium value of μ_i is lower under the best-with-worst paired convoy system than under the fixed-premium deposit insurance system. However, the result for $\Psi_p > 0$ is ambiguous.*

Proposition 2 can be proven by inspection. Given $\Psi_p < 0$, the additional term in equation (17) is negative. Since the second-order condition holds, μ_i needs to be reduced relative to the level that satisfies equation (5) to satisfy (17). However, the third term is unambiguously negative. This allows for the ambiguity when $\Psi_p > 0$.

However, comparison of equations (9) and (17) is more difficult because each has a unique term. The unique term in equation (9) reflects the reduction in the expected benefits of increasing the probability of solvency through an increase in μ_i due to the convoy program. This term does not appear in equation (17) because the best-with-worst convoy program is marginally costless for marginally solvent banks since they are not asked to acquire failing banks. The unique term in equation (17) reflects the marginal reduction in the expected quality of the acquired bank under the best-with-worst paired convoy system resulting from an increase in bank effort μ_i. This term does not appear in equation (9) because banks are randomly matched under that program. Our results therefore indicate an ambiguity in the relative severity of moral hazard under the two convoy programs.

III. Simulations

To evaluate the relative degrees of moral hazard under the various banking programs, I turn towards simulations. I first adopt some specific functional forms. I set the net asset position of bank i undertaking effort level μ_i as satisfying

$$(18) \qquad n_i = \alpha + (\mu_i)^\beta + \varepsilon_i,$$

where $\beta \varepsilon (0,1)$. Note that, as specified by the theory, $n_\mu > 0$, $n_{\mu\mu} < 0$, and $n_{\mu_i, \varepsilon_i} = 0$. We also assume that the cost of effort is quadratic in μ

$$(19) \qquad V(\mu) = v\mu^2.$$

Finally, I specify that ε_i is distributed uniform on the unit interval [0,1].

I will also have to place some parameter restrictions on C. In particular, the value of C must be set low enough to allow some positive probability of default, but high enough so that a minority of banks are expected to fail.

Fixed-premium Deposit Insurance

Let μ_F and ε_F^* represent the level of effort taken by the representative bank and the resulting level of ε^* under the fixed-premium deposit insurance system, respectively. By (18), this implies that the value of ε_F^* satisfies

(20) $$\varepsilon_F^* = -\alpha - (\mu_F)^\beta.$$

Substituting our functional forms into equation (5), the first-order condition for the fixed-premium deposit insurance regime satisfies

(21) $$\frac{2v}{\beta}\mu_F^{2-\beta} - \mu_F^\beta - (1+\alpha+C) = 0\,.$$

Randomly Paired Convoy System

Let μ_R represent the level of effort taken by the representative bank under the randomly paired convoy system. By (18), this implies that the value of ε_R^* satisfies

(22) $$\varepsilon_R^* = -\alpha - (\mu_R)^\beta.$$

Let μ represent the level of effort chosen by the rest of the banking system, which our representative Nash-playing banks take as given. By equation (6), the expected cost of the random convoy system, Ψ_r, is equal to

(23) $$\Psi_r = \frac{1}{2}\left(\alpha + \mu^\beta\right) + C\,.$$

Substituting these functional forms into (9) yields the first-order condition

(24) $$\frac{2v}{\beta}\mu_R^{2-\beta} - \frac{3}{2}\left(\alpha + \mu_P^\beta\right) - 1 - 2C = 0\,.$$

Best-with-worst Paired Convoy System

Finally, I turn to the best-with-worst paired convoy system. Let μ_P represent the level of effort taken by the representative bank. By (18), this implies that the value of ε_P^* satisfies

(25) $$\varepsilon_P^* = -\alpha - (\mu_P)^\beta.$$

Again, let μ represent the level of effort chosen by the rest of the banking system, taken as given by our representative bank. $\bar{n}$ will satisfy

(26) $$\bar{n} = \alpha + \mu^\beta + 1/2.$$

A bank with a realization of n which exceeds $2\bar{n}$ will be paired with a bank with net asset value plus charter value $\hat{n}$, which satisfies

(27) $$\hat{n} = 2(\alpha + \mu^\beta + 1/2) - n + C.$$

Substituting for n for the representative bank,

$$\hat{n} = \alpha + 2\mu^\beta - \mu_P^\beta + 1 - \varepsilon_i + C.$$

The value of $\hat{\varepsilon}$, the realization of ε_i for which a bank with effort level μ_P satisfies $n = 2\bar{n}$, satisfies

$$\hat{\varepsilon} = \alpha + 2\mu^\beta - \mu_P^\beta + 1.$$

Substituting these functional forms into (17) yields the first-order condition

(28) $$\frac{v}{\beta}\mu_P^{2-\beta} - \left(\alpha + \mu_P^\beta + \frac{1}{2} + C\right) = 0\,.$$

Simulation Results

Parameter values were chosen to yield interior solutions to the equations above with a positive probability of both bank failure and solvency, as well as some degree of moral hazard. The latter constraint operationally implies choosing parameters that yielded, $\mu_i < 1$ for all three regimes. In particular, I set $\alpha = -1.15$, $\beta = 0.5$, and $v = 1.7$. Under these values, convergence was achieved for values of $C \geq 0.5$.

The results of the simulation are summarized in Figures 2 and 3. A number of results emerge from the simulations: First, there is a significant difference between the effort levels and the probability of bankruptcy under the two convoy programs. The best-with-worst paired convoy system consistently yields lower effort levels and higher bankruptcy probabilities than the randomly paired system. For example, for the intermediate value of $C = 0.8$, the equilibrium value of μ under the best-with-worst paired convoy system is 0.37, yielding a 54 percent bankruptcy probability. These values are far closer to the 0.32 and 59 percent values obtained under the fixed-premium deposit insurance scheme than the 0.50 and 45 percent bankruptcy probability values obtained under the randomly paired convoy scheme.

Second, because of the high charter values necessary to obtain interior solutions under all three regimes, the randomly paired convoy program yielded higher effort levels over the entire range. However, I do find a change in the relative effort levels of the best-with-worst paired convoy system and the fixed-premium deposit insurance regime. As predicted by the theory, the relative effort is related to bank charter value levels. For low values of C, I find that the best-with-worst convoy scheme yields higher effort levels and lower bankruptcy probabilities than the deposit insurance regime. However, as C increases, this disparity is reduced

FIGURE 2

Bank Effort under Closure Regimes

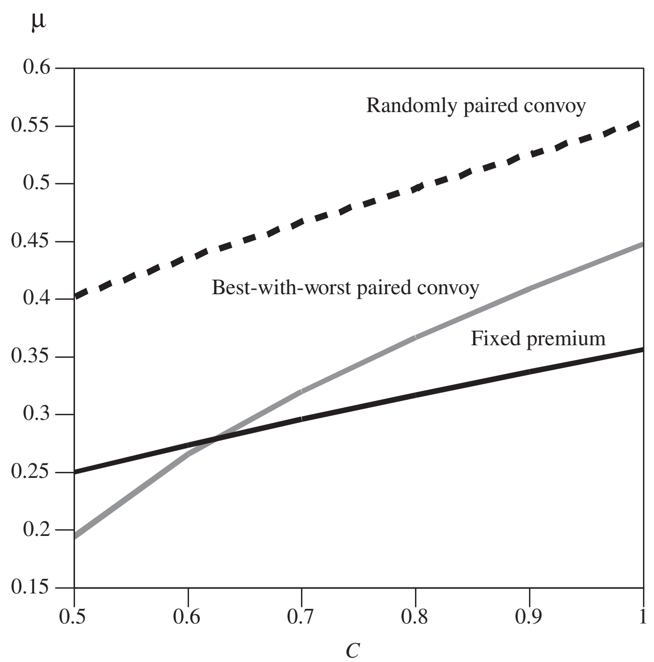
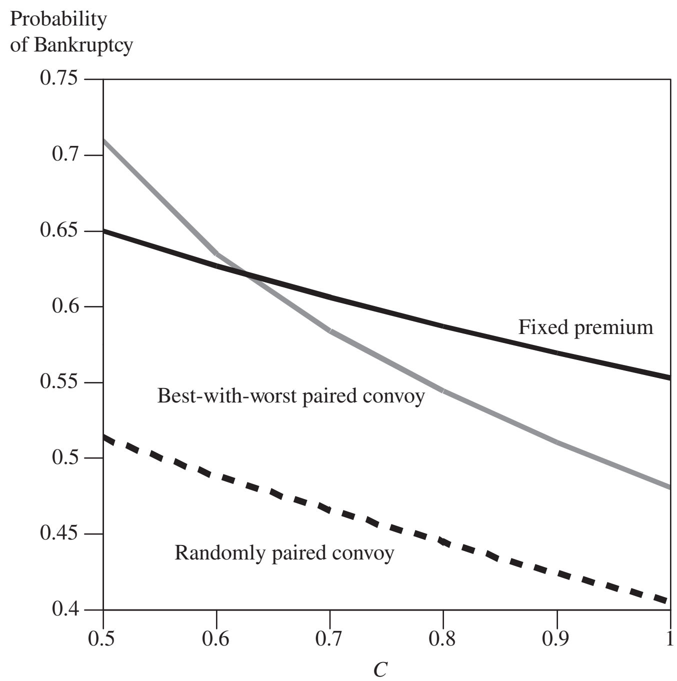


FIGURE 3

Probability of Bankruptcy under Closure Regimes



and is eventually reversed. As discussed above, raising C increases the relative attractiveness of the two convoy programs because the charter value of the bank is retained under them.

IV. Conclusion

This paper introduces a model of lending with a bank regulatory regime similar to the "convoy" regime which prevailed in Japan throughout the postwar era. In particular, the convoy regime is characterized as one in which the resolution costs of problem banks are shared among the members of the banking system rather than borne by an outside agency, as in a fixed-premium deposit insurance scheme. The theoretical results demonstrate that the relative prevalence of moral hazard distortions in bank effort decisions is dependent on the expected cost of acquiring failed banks relative to their positive charter values. In particular, the theoretical analysis demonstrates that if the expected return from participation in a convoy program is negative, bank effort levels will be lower, and the probability of bankruptcy in the banking system will be higher, under the convoy program than under the fixed-premium deposit insurance regime benchmark. However, increases in bank charter values can mitigate and eventually overturn this disparity. As charter values increase, effort levels under the fixed-premium deposit insurance scheme diminish relative to either convoy scheme because the acquisition of valuable bank charters mitigates the costs to a bank of acquiring a failed bank with negative asset value.

In a sense, this relationship between charter value and the relative desirability of the convoy program can help explain the eventual breakdown of the program in Japan. During the early years of the convoy program, the probability of bankruptcy was very small and branch rights were considered relatively valuable. As a result, the theory would predict little if any disadvantage for the convoy program relative to a fixed-premium deposit insurance scheme. However, as the probability of bankruptcy in the Japanese banking system rose and the perceived value of branching rights diminished, the severity of moral hazard under the convoy regime increased. This increased moral hazard added to the overall probability of bankruptcy in the system and contributed to the eventual collapse of the regime.

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