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Bank charter value and the viability of the Japanese convoy system*

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Abstract

This paper compares the performance of a convoy banking system, similar to that which prevailed in Japan, to a fixed-premium deposit insurance regime. Under this system, failed banks are merged with healthy banks, rather than closed, so that the banking system itself provides the safety net for guaranteed deposits. While neither regime is generally preferable over the other, the results show that the performance of the convoy system is more sensitive to changes in bank charter values and the overall health of the banking system. The recent breakdown of the convoy system may therefore be partly attributable to adverse changes in these characteristics in the Japanese banking system.

J.E.L. Classification: G21, G28

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1. Introduction

The performance of the Japanese banking system in the 1990s has been extremely disappointing. Banks suffered severe losses due to the collapse of asset prices at the close of the 1980s, resulting in a large increase in bank failures over the decade. The frequency of these failures eventually exhausted the funds of the Deposit Insurance Corporation (DIC). Moreover, the pace of recovery has been slow. As of September 1998, estimates of bad loans in Japan's banking sector still exceeded 7 percent of GDP [Hoshi and Kashyap ([6], 1999)].

This paper examines whether the system of resolving bank failures in Japan, commonly referred to as the "convoy system," may have played a role in the system's poor performance. Under this system, failing banks were merged with healthy banks rather than liquidated, such that the banking system itself provided the safety net for deposit guarantees. Below, I introduce a simple model of the convoy system. Failed banks are merged with healthy banks, with deposits carried at par values. Moral hazard arises in the model, as banks are faced with a choice of the magnitude of costly effort to extend towards enhancing the quality of their portfolios. Limited liability and deposit guarantees combine to reduce the incentive for individual banks to undertake increased effort.

The effort obtained under the convoy system is then compared to that under a fixed-premium deposit insurance regime with similar moral hazard issues introduced. Under the deposit insurance regime, failed banks are liquidated and deposits are paid through the deposit insurance fund. In contrast to the convoy regime, the liquidation of failed banks under the deposit insurance system is assumed to result in the loss in bank charter value.

To provide a fair comparison of the convoy and deposit insurance regimes, one would want to construct the most desirable convoy regime possible. The convoy system entertained here is an improvement over those considered in Spiegel (1999). Spiegel (1999) considered two potential convoy systems, a pure randomized system and a paired "best-with-worst" system. Each of these had difficulties. In the case of the random system, the system had the undesirable attribute that marginally solvent banks could be forced into bankruptcy by being paired with very insolvent failing banks. The feasibility of that system was therefore questionable. The paired "best-with-worst" system had the undesirable attribute of introducing excessive moral hazard into the system. Under the paired convoy system, each marginal increase in bank effort was penalized in expected value by an increase in the expected losses from being paired with a failed bank.

The system derived below combines pairing with randomizing to construct a feasible system with less moral hazard than the "best-with-worst" system. Under the convoy system derived in this paper, assignment of failed banks takes place in two steps: Subsequent to the realization of uncertainty, the regulator identifies a group of banks with sufficient asset positions to acquire individual insolvent banks. These banks form a "pool of potential applicants." Assignment of each bank within this pool is then done on a randomized basis. The convoy system here is to some extent "paired," in the sense that marginally-solvent banks are excused from the acquisition of insolvent banks. However, the randomization within the pool of potential acquiring banks reduces the marginal disincentive banks faced under the paired system for increased effort.

Neither the convoy regime nor the deposit insurance regime is universally dominant in terms of moral hazard. Instead, the relative performance of the convoy

system is dependent on the overall health of the banking system and the ability of bank regulators to adequately compensate acquiring banks. Through comparative static exercises, I demonstrate that the convoy regime is more sensitive to changes both bank charter values and the overall health of the banking system than the deposit insurance regime. As a result, reductions in either bank charter values or the overall health of the financial system deteriorates the relative performance of the convoy system. These theoretical results are confirmed in simulation exercises.

The remainder of the paper is divided into six sections. The next section discusses conditions leading to the breakdown of the convoy system. Section 3 introduces a simple model of the convoy system. Section 4 derives a simple model of a fixed-premium deposit insurance benchmark against which the performance of the convoy system can be compared. Section five conducts simulation exercises of the convoy and deposit insurance regimes. Section six concludes.

2. Breakdown of the convoy banking system

The convoy system has its origins in the "main bank" system, which prevailed in Japan throughout the post-war era.¹ Under this system, a firm would have a special long-term relationship with a bank, usually that which acted as its primary source of financing. In addition, the main banks usually held equity in their client firms. The complex interactions between firms and banks under this system left a large degree of systemic risk associated with the failure of any of its components.

Regulators responded to this systemic risk by limiting the growth and branch-

¹For background on the Japanese main bank system, see Aoki, Patrick and Sheard ([1], 1994).

ing of any individual bank in the system. All banks in the system were constrained to grow at roughly the same pace, similar to how ships in a convoy must move at the pace of their slowest members. These branching restrictions created monopoly rents within the banking system, as the right to open new branches carried value to banks.²

In addition, the convoy system placed the burden of resolution of bank failures on the banking system itself. In the event of a bank failure, regulators merged the failing bank with a healthy bank, rather than liquidating its assets. The acquiring bank received a failed bank with a negative value balance sheet, as well as the failed bank's branching rights. In addition, the cooperation of the acquiring bank probably brought some informal value in terms of expected future regulatory treatment by the Ministry of Finance.

This system endured for an extended period of time. However, a number of developments led to its decline. First, financial liberalization, which had been taking place since the 1970's, eroded the value of monopoly rents in the banking sector, including the value of branching rights obtained by acquiring failed banks [Hoshi and Kashyap, ([6], 1999)]. Hoshi ([5], 1999) demonstrates that Japanese bank profitability, which was positively correlated with branch numbers in the early period of the convoy program, was negatively related to the number of bank branches during the late 1980s and 1990s. These developments reduced the value of side payments banks received as a result of acquisition of a failed bank.

Second, the frequency of bank failures grew dramatically in the 1990s, as banks suffered severe losses stemming from the collapse of Japanese asset prices. These failures quickly eroded the funds of the DIC and hampered the ability of

²See Hoshi and Kashyap, ([6], 1999) for details.

regulators to negotiate mergers of failed banks. For example, the merger of Tokyo Kyozo and Anzen Bank in 1995 was partly financed by both the private banking system and subsidized loans from the Tokyo metropolitan government. Similarly, the DIC contributed only 100 billion of the estimated 240 billion yen needed to finance the resolution of the failed Cosmo Credit Corporation [Cargill, et al ([2], 1997)]. The public also responded negatively to government contributions to the resolution of the failed "jusen" bank subsidiaries.³

As the DIC funds were depleted, the government was forced to abandon the policy of rescuing failed banks. The Hyogo Bank's closure in 1995 represented the first Japanese bank liquidation in 70 years [Yamori, ([12], 1999)]. When the Hanwa bank closed in 1996, an attempt to find an acquiring bank was not even made. The assets of the bank were placed in the Resolution and Collection Bank to be liquidated and the government promised to guarantee bank deposits. The breakdown of the convoy scheme was complete.

The convoy scheme was viable as long as banks could be forced or adequately compensated for acquiring failed banks. However the liberalization of the Japanese financial system and the poor performance of the Japanese banking system over the 1990s threatened the capacity of regulators to adequately compensate banks for providing the safety net against bank failure.

³For details of the failures of the jusen banks, see Milhaupt and Miller [[9], (1997)] and Rosenbluth and Thies [[10],(1998)].

3. A simple model of a convoy banking system

This section develops a model of a convoy system similar to that described above in which the burden of resolution of failed banks is placed on the banking system. Failed banks are merged with adequately solvent banks rather than closed. Banks are considered adequately solvent to serve as acquiring banks if they can acquire the most insolvent banks without facing bankruptcy themselves.

Banks are assumed to be homogeneous. There are an infinite amount of homogeneous banks of fixed size which is set at measure zero for notational simplicity.

Banks choose a level of "effort," μ_i , to undertake to enhance the quality of their lending portfolios. Effort is assumed to have a cost function $V(\mu)$, where $V_\mu > 0$ and $V_{\mu\mu} > 0$. For simplicity, effort costs are assumed to be borne up front. This simplifies the analysis by making this cost independent of the probability of bankruptcy, but drives none of the results.⁴

As in Marcus ([8],1984), it is assumed that if the bank is allowed to continue, it has a charter value of C , which is taken as exogenous. Bank charter value is assumed to represent the expected future profits from continued banking operations, perhaps due to branching rights. It is assumed that bank charter values are not incorporated in the regulator's closure rule.

The model has one period. The timing of the model is as follows: First, each bank chooses its individual effort level, μ_i . Banks are assumed to play Nash, taking the effort choice of the rest of the banking system, μ , as given and moving simultaneously.

⁴For similar approaches to modelling moral hazard, see Dewatripont and Tirole ([3], 1993), Giammarino, Lewis and Sappington ([4], 1993) and Kasa and Spiegel ([7], 1999).

Second, each bank i is hit with an idiosyncratic shock, ε_i . ε_i is assumed to be symmetrically distributed on the interval $[\underline{\varepsilon}, \bar{\varepsilon}]$ with density function $f(\varepsilon_i)$ and expected value 0. Net asset value, A_i , is assumed to be a function of bank effort and the realization of the idiosyncratic shock according to the formula

$$A_i = A(\mu_i) + \varepsilon_i \quad (3.1)$$

where $A_\mu > 0$, $A_{\mu\mu} < 0$.

Third, the regulator makes its closure decision. Banks are closed if their net asset value falls below zero. Define ε^* as the minimum realization of ε which leaves a bank with effort level μ solvent. ε^* satisfies

$$\varepsilon^* = -A(\mu). \quad (3.2)$$

Note that ε^* is decreasing in μ , $\varepsilon_\mu^* < 0$, $\varepsilon_{\mu\mu}^* > 0$.

The regulator then pairs each failed bank with a solvent acquiring bank. Bank pairings are assumed to take place in two steps. First, the regulator identifies the set of "potential acquiring banks," defined as the set of banks which could acquire any of the failed banks in the system without becoming insolvent.

See Figure 1. All banks with negative realizations of A will be insolvent. Let \underline{A} represent the most insolvent failed bank. In equilibrium, \underline{A} will satisfy

$$\underline{A} = A(\mu) + \underline{\varepsilon}. \quad (3.3)$$

Define \tilde{A} as the "marginal acquiring bank," the bank with the lowest value of A which can acquire bank \underline{A} without being forced into bankruptcy itself. \tilde{A} satisfies

$$\tilde{A} = \bar{\varepsilon} - A(\mu) \quad (3.4)$$

All banks with realizations of A which exceed \tilde{A} are then in the "pool of potential acquiring banks." The regulator is assumed to pair the failed banks with banks within this pool randomly. A sufficient condition for the convoy system to be sustainable is that the number of banks within the potential pool exceed the number of failed banks.

I next turn to the decision problem faced by the representative bank. Define $\tilde{\varepsilon}_i$ as the realization of ε which leaves a bank with effort level μ_i with asset value \tilde{A} . By equation (3.4), $\tilde{\varepsilon}_i$ satisfies

$$\tilde{\varepsilon}_i = \bar{\varepsilon} - A(\mu) - A(\mu_i). \quad (3.5)$$

Note that $\tilde{\varepsilon}_i$ is decreasing in both μ and μ_i . An increase in μ increases the value of \underline{A} , reducing the value of \tilde{A} , and hence the realization of $\tilde{\varepsilon}_i$, which would leave a bank in the potential acquiring pool. An increase in μ_i raises the value of A_i given any realization of ε . as a result, it reduces the value of $\tilde{\varepsilon}_i$.

For realizations of ε above $\tilde{\varepsilon}_i$, the representative bank will be in the potential acquiring pool. Since the regulator randomizes over the set of banks in the pool when making its allocation decision, the probability of a bank in the pool actually being paired with a failed bank is equal to the number of failed banks divided by the number of banks in the acquiring pool. Define Ψ_r as the probability-weighted expected cost of falling into the potential acquiring pool. Ψ_r satisfies

$$\Psi_r = \left[\int_{\tilde{\varepsilon}_i}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon \right] \left[\int_{\underline{\varepsilon}}^{\varepsilon^*} (A(\mu) + C + \varepsilon) f(\varepsilon) d\varepsilon \right]. \quad (3.6)$$

The left term represents the probability of being paired with a failed bank contingent on being in the potential acquiring pool. The right term reflects the expected cost of acquiring a failed bank. Note that the cost of acquiring a failed

bank is reduced by the charter value of the acquired bank and is independent of the effort level chosen by the representative bank. The only impact of a change in the effort level of the representative bank, μ_i , is through its impact on $\tilde{\varepsilon}_i$ and hence the effect on the probability of landing in the pool of potential acquiring banks.

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

$$\begin{aligned} \Pi = & \int_{\varepsilon_i^*}^{\bar{\varepsilon}} (A(\mu_i) + \varepsilon + C) f(\varepsilon) d\varepsilon \\ & + \left[\int_{\tilde{\varepsilon}_i}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon \right] \left[\int_{\underline{\varepsilon}}^{\varepsilon^*} (A(\mu) + C + \varepsilon) f(\varepsilon) d\varepsilon \right] - V(\mu_i) \end{aligned} \quad (3.7)$$

where ε_i^* and $\tilde{\varepsilon}_i$ are the realizations of ε necessary to reach solvency and qualify for the acquiring bank pool given an effort level of μ_i . The bank's first-order condition satisfies

$$\int_{\varepsilon_i^*}^{\bar{\varepsilon}} \frac{\partial A}{\partial \mu_i} f(\varepsilon) d\varepsilon - \frac{\partial \varepsilon_i^*}{\partial \mu_i} C f(\varepsilon_i^*) - \frac{\partial \tilde{\varepsilon}_i}{\partial \mu_i} \int_{\underline{\varepsilon}}^{\varepsilon^*} (A(\mu) + C + \varepsilon) f(\varepsilon) d\varepsilon - \frac{\partial V}{\partial \mu_i} = 0 \quad (3.8)$$

The first term reflects the change in expected net asset value with increased effort over solvency states. The second term represents the value of the decrease in the probability of bankruptcy which stems from a marginal increase in effort. The third term reflects the change in the probability of being assigned a failed bank with a marginal increase in effort. The final term reflects the marginal cost of effort.

This solution represents a number of sources of moral hazard. First, because of limited liability, expected bank value is independent of bank payoffs for realizations of ε below ε_i^* . Consequently, any potential improvements from increases in bank effort over this range do not enter into the bank's maximization decision.

Second, the convoy system penalizes a bank for reaching a net asset value which qualifies as an acquiring bank. In this sense, the convoy system actually taxes marginal effort increases. An increase in μ_i raises the expected value of A_i , and therefore increases the probability that the bank will be asked to acquire a failed bank.

However, the equilibrium level of bank effort is increasing in C , bank charter values. Bank charter values affect effort through two distinct channels: The second argument shows that an increase in a banks own charter values raises the return from avoiding bankruptcy, while the third argument demonstrates that an increase in bank system charter values decreases the expected losses from acquiring a failed bank.

We next turn towards the equilibrium solution. In equilibrium, $\mu_i = \mu$ for all banks in the system. By equations (3.5) and (3.2), equation (3.8) simplifies to

$$\Lambda \equiv \frac{\partial A}{\partial \mu} \left[\int_{\underline{\varepsilon}^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + C f(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} (A(\mu) + C + \varepsilon) f(\varepsilon) d\varepsilon \right] - \frac{\partial V}{\partial \mu} = 0 \quad (3.9)$$

It is shown in the appendix that the second-order condition may not be satisfied in aggregate. This result stems from the spillover effect aggregate bank effort has on the burden faced by an individual bank under the convoy scheme. An increase in aggregate bank effort reduces the expected cost of acquiring a failed bank. Holding all else equal, this increases individual bank effort. If this spillover were sufficiently large, there would be increasing returns to scale in bank effort and banks would not have an interior solution for effort levels. The condition for an interior solution is derived in the appendix.

Assuming that the payoff to effort is concave, we can investigate the comparative static effects of a change in bank charter value. Differentiating equation (3.9)

with respect to C yields

$$\frac{\partial \Lambda}{\partial C} = \left(\frac{\partial A}{\partial \mu} \right) f(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} f(\varepsilon) d\varepsilon > 0 \quad (3.10)$$

This leads to Proposition 1:

PROPOSITION 1 : *With aggregate concavity, $d\mu/dC > 0$.*

The comparative static relationship satisfies

$$\frac{d\mu}{dC} = - \frac{\frac{\partial A}{\partial \mu} f(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} f(\varepsilon) d\varepsilon}{\frac{\partial \Lambda}{\partial \mu}} > 0 \quad (3.11)$$

The aggregate second order term, $\partial \Lambda / \partial \mu$, and the conditions for aggregate concavity are derived in the appendix.

There are two arguments in the numerator of equation (3.11) which drive the results in Proposition 1. The first term reflects the positive impact of increased charter values on a bank's own continuation value. As charter value increases, banks are willing to undergo more effort to avoid bankruptcy because their expected future earnings are higher. The second term reflects the decreases in expected losses from the convoy system with increased bank charter values. Holding bank asset values constant, an increase in bank charter values reduces the cost of acquiring an insolvent bank. This reduces the penalty that the convoy system places on banks that perform well.

The impact of a change in the overall health of the banking system can be seen by running a comparative static exercise on $A(\mu)$, holding μ constant. Holding all else equal, an increase in $A(\mu)$ raises the overall performance of the banking system for given effort levels. Differentiating Λ with respect to $A(\mu)$ yields

$$\frac{\partial \Lambda}{\partial A(\mu)} = \left(\frac{\partial A}{\partial \mu} \right) \left[f(\varepsilon^*) + C \frac{\partial f(\varepsilon^*)}{\partial A(\mu)} + \left[(C) f(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} f(\varepsilon) d\varepsilon \right] \right] \quad (3.12)$$

The first term is positive, reflecting the increased probability of solvency states with increased $A(\mu)$. The third term is also positive, reflecting the decreased probability of bankruptcy in the banking system, and hence a decrease in the expected burden of the convoy program, with increased $A(\mu)$. However, the second term is negative, reflecting a decrease in the density of the realization of ε^* .

The comparative static result satisfies

$$\frac{d\mu}{dA(\mu)} = - \frac{\left(\frac{\partial A}{\partial \mu}\right) \left[f(\varepsilon^*) + C \frac{\partial f(\varepsilon^*)}{\partial A(\mu)} + \left[(C) f(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} f(\varepsilon) d\varepsilon \right] \right]}{\frac{\partial \Delta}{\partial \mu}} \quad (3.13)$$

With aggregate concavity, $d\mu/dA(\mu)$ will be positive if the second term in equation (3.13) is not too large. In particular, the uniform distribution considered for ε in the simulations below are sufficient but not necessary to obtain this result. This implies that an increase in the overall health of the banking system induces increased bank effort.

4. Fixed-Premium deposit insurance benchmark

To examine the impact of the convoy regime on the severity of moral hazard in banking decisions, it is necessary to compare that regime to another system for resolving bank failure. In this section, I derive bank decisions under a standard fixed-premium deposit insurance regime and compare those decisions to the convoy program.

The set-up is similar to that above. The model has one period. The timing of the model is as follows: First, the bank pays its deposit insurance premium, which is determined below, and chooses its effort level, again taking the equilibrium effort

decision of the of the rest of the banking system as given. Second, each bank i is hit with its idiosyncratic shock, ε_i . Finally, the bank regulator is assumed to close the bank if it is insolvent. I assume that unlike the convoy system, closed banks are liquidated under the fixed-premium deposit insurance system. I also assume that bank charter values are lost to the banking system as a result of a bank closure.⁵

Define μ_d and ε_d^* as bank effort and minimum survival level respectively under the deposit-insurance system. The "fair" bank deposit insurance premium, Ψ_d , is then equal to the expected resolution cost of a representative bank

$$\Psi_d = - \int_{\underline{\varepsilon}}^{\varepsilon_d^*} (A(\mu_d) + \varepsilon) f(\varepsilon) d\varepsilon. \quad (4.1)$$

Note that since the representative bank is small relative to the entire banking system Ψ_d is a function of μ_d , but not a function of μ_{di} .

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

$$\Pi = \int_{\varepsilon_{di}^*}^{\bar{\varepsilon}} (A(\mu_{di}) + \varepsilon + C) f(\varepsilon) d\varepsilon + \int_{\underline{\varepsilon}}^{\varepsilon_{di}^*} (A(\mu_d) + \varepsilon) f(\varepsilon) d\varepsilon - V(\mu_{di}) \quad (4.2)$$

The bank's first-order condition satisfies

$$\int_{\varepsilon_{di}^*}^{\bar{\varepsilon}} \frac{\partial A}{\partial \mu_{di}} f(\varepsilon) d\varepsilon - \left(\frac{\partial \varepsilon_{di}^*}{\partial \mu_{di}} \right) C f(\varepsilon_{di}^*) = V_{\mu_{di}} \quad (4.3)$$

⁵One might argue that the banking system as a whole might be able to recover some of the liquidated bank's charter value. For example, the value of surviving banks' branching rights may be enhanced by the reduced number of branches subsequent to liquidation of the failed banks. However, these gains will not enter into the consideration of the representative Nash-playing bank.

since $\partial\Psi_d/\partial\mu_{di} = 0$.

The two arguments on the left-hand side of equation (4.3) represent the marginal benefits of additional effort. The first term reflects the increased expected payoff in non-bankruptcy 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.

Again, with homogeneity, $\mu_{di} = \mu_d$ for all banks in the system in equilibrium. Substituting into the first-order condition yields

$$\Lambda_d = \left(\frac{\partial A}{\partial \mu_d} \right) \left[\int_{\varepsilon_d^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + C f(\varepsilon_d^*) \right] - \frac{\partial V}{\partial \mu_d} = 0 \quad (4.4)$$

The appendix demonstrates that aggregate concavity holds under the fixed-premium deposit insurance regime if the individual bank second order condition is satisfied. Given aggregate concavity, we can again investigate the comparative static effects of a change in bank charter value. Differentiating equation (4.4) with respect to C yields

$$\frac{\partial \Lambda_d}{\partial C} = \left(\frac{\partial A}{\partial \mu_d} \right) f(\varepsilon_d^*) > 0 \quad (4.5)$$

The comparative static result then satisfies

$$\frac{d\mu_d}{dC} = -\frac{\frac{\partial A}{\partial \mu} f(\varepsilon_d^*)}{\frac{\partial \Lambda_d}{\partial \mu}} > 0. \quad (4.6)$$

As in the random convoy system, an increase in bank charter values increases bank effort under the fixed-premium deposit insurance system. A comparison of equations (3.11) and (4.6) leads to Proposition 2.

PROPOSITION 2: *With positive spillover effects, $d\mu/dC \geq d\mu_d/dC$.*

Proposition 2 states that bank effort levels are more sensitive to changes in bank charter values under the random convoy system than under the fixed-premium deposit insurance system for given levels of bank effort.

The positive spillover effect condition requires that the expected burden of acquiring a failed bank is decreasing in μ , the average effort level in the banking system. The conditions for this positive spillover effect, which would be expected to hold under normal circumstances, are shown in the appendix. This condition is a sufficient, but not necessary condition for Proposition 2 to hold.

Given that the spillover effect is positive, one can see from the concavity conditions in the appendix that $|\partial\Lambda/\partial\mu| \leq |\partial\Lambda_d/\partial\mu|$. Since an increase in bank charter value also reduces the expected cost of acquiring a failed bank, the numerator in equation (3.11) is greater than that in equation (4.6). It therefore follows that equilibrium bank effort levels will be more sensitive to bank charter values under the convoy program than under the fixed-premium deposit insurance program.

As in the case of the random convoy system, we can also investigate the impact of an increase in the overall health of the banking system by doing a comparative static exercise on a change in $A(\mu)$. Differentiating equation (4.4) with respect to $A(\mu)$ yields

$$\frac{\partial\Lambda_d}{\partial A(\mu)} = \left(\frac{\partial A}{\partial\mu}\right) \left[f(\varepsilon^*) + C \frac{\partial f(\varepsilon^*)}{\partial A(\mu)} \right] \quad (4.7)$$

The comparative static result satisfies

$$\frac{d\mu_d}{dA(\mu)} = - \frac{\left(\frac{\partial A}{\partial\mu_d}\right) \left[f(\varepsilon^*) + C \frac{\partial f(\varepsilon^*)}{\partial A(\mu_d)} \right]}{\frac{\partial\Lambda_d}{\partial\mu}} \quad (4.8)$$

Comparing equations (4.7) and (3.12), the numerator under the convoy system has an extra term reflecting the decreased expected burden under the convoy

program from an increase in the overall health of the banking system. This leads to Proposition 3.

PROPOSITION 3: *When spillover effects are positive and $d\mu/dA(\mu) \geq 0$, $d\mu/dA(\mu) \geq d\mu/dA(\mu)$.*

Proposition 3 states that bank effort levels are more sensitive to changes in banking system health under the random convoy system than under the fixed-premium deposit insurance system for given levels of bank effort. The positive spillover condition is again a sufficient, but not necessary condition for $|\partial\Lambda/\partial\mu| \leq |\partial\Lambda_d/\partial\mu|$. The condition that $d\mu/dA(\mu) \geq 0$ is again satisfied by the second term in equation (4.8) not being too large. Again, the uniform distribution assumption for ε below is sufficient, but not necessary, to satisfy this condition. Given these conditions, the proof follows directly from larger numerator in equation (4.8).

5. Simulations

5.1. Functional forms

The previous section identified two features which distinguish the fixed-premium deposit insurance system from the convoy system under fairly general conditions. The level of bank effort under the convoy system is predicted to be more sensitive to both changes in bank charter values and the overall health of the banking system. In this section, I turn towards simulations to investigate these predictions concerning the relative sensitivities of moral hazard under the two banking regimes.

I first adopt some specific functional forms. Let the net asset position of bank i undertaking effort level μ_i satisfy the linear relationship

$$n_i = \alpha + (\mu_i)^\beta + \varepsilon_i \quad (5.1)$$

where $\beta \in (0, 1)$. Note that, as specified by the theory $n_\mu > 0$, $n_{\mu\mu} < 0$ and $n_{\mu_i, \varepsilon_i} = 0$.

In addition, let the cost of effort be quadratic in μ

$$V(\mu) = \nu\mu^2. \quad (5.2)$$

Let ε be distributed uniform on the unit interval $[-1, 1]$.

Finally, only a certain range of values of C achieve an interior solution for the probability of default. I limit C to the range where the probability of default is positive, but less than one.

Substituting the functional forms into equations (5.1) and (5.2) into the convoy system equilibrium condition (3.9) yields

$$\frac{4\nu}{\beta} (\mu^{2-\beta}) - \mu^\beta - (1 + \alpha + 2C) - (1 - \alpha - \mu^\beta) \left(C - \frac{1}{2} (1 - \alpha - \mu^\beta) \right) = 0 \quad (5.3)$$

Let μ_d and ε_d^* represent the values of μ and ε^* under the fixed-premium deposit insurance system respectively. Substituting the functional forms in equations (5.1) and (5.2) into the equilibrium condition (4.4) yields

$$\frac{4\nu}{\beta} (\mu_d^{2-\beta}) - \mu_d^\beta - (1 + \alpha + 2C) = 0 \quad (5.4)$$

5.2. Results

Parameter values were chosen to yield interior solutions to equations (5.3) and (5.4) with a positive probability of both failure and solvency. I ran two sets of

simulations; one examines the impact of changes in C , bank charter values, and one examines the impact of changes in α , which reflects a shift in $A(\mu)$ and hence the overall health of the banking system for given values of μ . In both simulations I set $\beta = 0.5$ and $\nu = 1.7$. The first set of simulations sets $\alpha = -0.1$, while the second fixes $C = 0.1$.

Figures 2 and 3 demonstrate the impact of increases in bank charter values on bank effort and the probability of bankruptcy respectively. Bank effort is increasing in bank charter value for both the convoy and the deposit insurance regimes. However, consistent with the prediction of Proposition 1, the convoy regime is more sensitive to increases in bank charter values than the deposit insurance regime. At sufficiently high bank charter values, bank effort is actually higher (and bankruptcy probability lower) under the convoy regime than the deposit insurance regime.

Figures 4 and 5 demonstrate the impact of increases in the overall health of the banking system on bank effort and the probability of bankruptcy respectively. Increases in overall bank health raises effort under both the convoy and the deposit insurance system. However, consistent with the prediction of Proposition 2, the convoy regime is more sensitive to changes in the health of the banking system than the deposit insurance system. As in the case of bank charter values, sufficiently high banking system health can induce greater effort under the convoy system than the deposit insurance system.

6. Conclusion

This paper introduces a method of resolving bank failures within the banking system itself, similar to the convoy banking system which prevailed in Japan throughout the post-war era. The resolution method chosen combined attributes of selection and randomness. A pool of potential acquiring banks were selected on the basis of their capacity to acquire failed banks without experiencing financial difficulties themselves. Actual acquiring banks were then chosen at random from the pool.

The performance of the convoy system in the model above was not universally inferior to the deposit insurance benchmark. For certain conditions, particularly those with large values of branching rights and a healthy banking system, the convoy bank resolution system performed competitively relative to a fixed-premium deposit insurance system.

However, the convoy system was shown to be more sensitive to changes in bank charter values and the overall health of the banking system than its fixed-premium deposit insurance counterpart. As a result, when these conditions declined, we found the convoy system being outperformed by the deposit insurance system. The decline of the convoy system in Japan over the last decade may be related to such changes in these characteristics. First, bank charter values have declined markedly from the earlier heavily-regulated era. Second, the banking system has experienced severe difficulties, raising the cost of the burden borne by those providing resolution of bank failures. Our model predicts that banks would respond to these changes by decreasing their effort, resulting in increased default risk in the banking system. It can be seen that under the convoy system, this

moral hazard feeds on itself, as reduced effort of individual banks decreases the returns to effort of other banks. Eventually, moral hazard can be sufficiently pervasive that the convoy system is no longer viable.

A. Appendix: Aggregate concavity

A.1. Convoy system

By equation (3.8), the representative bank's second order condition satisfies

$$\left(\frac{\partial^2 A}{\partial \mu_i^2}\right) \left[\int_{\varepsilon_i^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + Cf(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} (A(\mu) + C + \varepsilon) f(\varepsilon) d\varepsilon \right] \quad (\text{A.1})$$

$$+ \left(\frac{\partial A}{\partial \mu_i}\right)^2 f(\varepsilon_i^*) + \left(\frac{\partial A}{\partial \mu_i}\right) C \left(\frac{\partial f(\varepsilon_i^*)}{\partial \mu_i}\right) - \frac{\partial^2 V}{\partial \mu_i^2} \quad (\text{A.2})$$

$$< 0 \quad (\text{A.3})$$

Differentiating equation (3.9) with respect to μ yields

$$\begin{aligned} \frac{\partial \Lambda}{\partial \mu} &= \left(\frac{\partial^2 A}{\partial \mu^2}\right) \left[\int_{\varepsilon^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + Cf(\varepsilon^*) + \int_{\underline{\varepsilon}}^{\varepsilon^*} (A(\mu) + C + \varepsilon) f(\varepsilon) d\varepsilon \right] \quad (\text{A.4}) \\ &+ \left(\frac{\partial A}{\partial \mu}\right)^2 f(\varepsilon^*) + \left(\frac{\partial A}{\partial \mu}\right) C \left(\frac{\partial f(\varepsilon^*)}{\partial \mu}\right) - \frac{\partial^2 V}{\partial \mu^2} \\ &+ \left(\frac{\partial A}{\partial \mu}\right) \left[\int_{\underline{\varepsilon}}^{\varepsilon^*} f(\varepsilon) d\varepsilon - Cf(\varepsilon^*) \right] \end{aligned}$$

The sign is ambiguous. While the first four terms can be signed as negative by the second-order condition of the individual representative bank's effort decision, there is an additional term, reflecting the spillover effects on a representative bank's value from a marginal increase in aggregate bank effort.

This term reflects the impact of an increase in μ on the expected burden of the convoy system. The first term is positive. Increased effort by the banking industry as a whole reduces the expected cost of acquiring failed banks as the expected net asset values of failed banks increase. However, the second term is negative, as an increase in overall bank effort reduces the probability of a bank

being asked to participate in the convoy system. At the margin, since banks have zero net value but positive charter value, acquisition of these banks has a positive impact on bank value. In net, the spillover effect is positive when the first term outweighs the second, i.e. when

$$\int_{\underline{\varepsilon}}^{\varepsilon^*} f(\varepsilon) d\varepsilon \geq Cf(\varepsilon^*) \quad (\text{A.5})$$

When (A.5) is positive, satisfaction of the individual bank second-order condition is insufficient to guarantee aggregate concavity. the aggregate concavity condition then is that $\partial\Lambda/\partial\mu < 0$ in equation (A.4).

A.2. Deposit Insurance

By equations (3.5), equation (3.8) simplifies to

$$\left(\frac{\partial A}{\partial\mu_{di}}\right) \left[\int_{\varepsilon_{di}^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + Cf(\varepsilon_{di}^*) \right] - \frac{\partial V}{\partial\mu_d} = 0 \quad (\text{A.6})$$

The representative bank's second order condition satisfies

$$\left(\frac{\partial^2 A}{\partial\mu_{di}^2}\right) \left[\int_{\varepsilon_{di}^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + Cf(\varepsilon_{di}^*) \right] + \left(\frac{\partial A}{\partial\mu_{di}}\right)^2 f(\varepsilon_{di}^*) + C\frac{\partial f(\varepsilon_{di}^*)}{\partial\mu_{di}} - \frac{\partial^2 V}{\partial\mu_{di}^2} < 0 \quad (\text{A.7})$$

Differentiating equation (4.3) with respect to μ yields

$$\frac{\partial\Lambda_d}{\partial\mu_d} = \left(\frac{\partial^2 A}{\partial\mu_d^2}\right) \left[\int_{\varepsilon_{di}^*}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + Cf(\varepsilon_{di}^*) \right] + \left(\frac{\partial A}{\partial\mu_d}\right)^2 f(\varepsilon_{di}^*) + C\frac{\partial f(\varepsilon_{di}^*)}{\partial\mu_{di}} - \frac{\partial^2 V}{\partial\mu_d^2} < 0 \quad (\text{A.8})$$

Unlike the convoy system, satisfaction of the individual bank second order condition guarantees aggregate concavity as well.

Finally, note that for a given value of μ , $|\partial\Lambda/\partial\mu| < |\partial\Lambda_d/\partial\mu|$ if the spillover effect in equation (A.4) is positive.

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Figure 1
Bank Pairing under the Convoy System

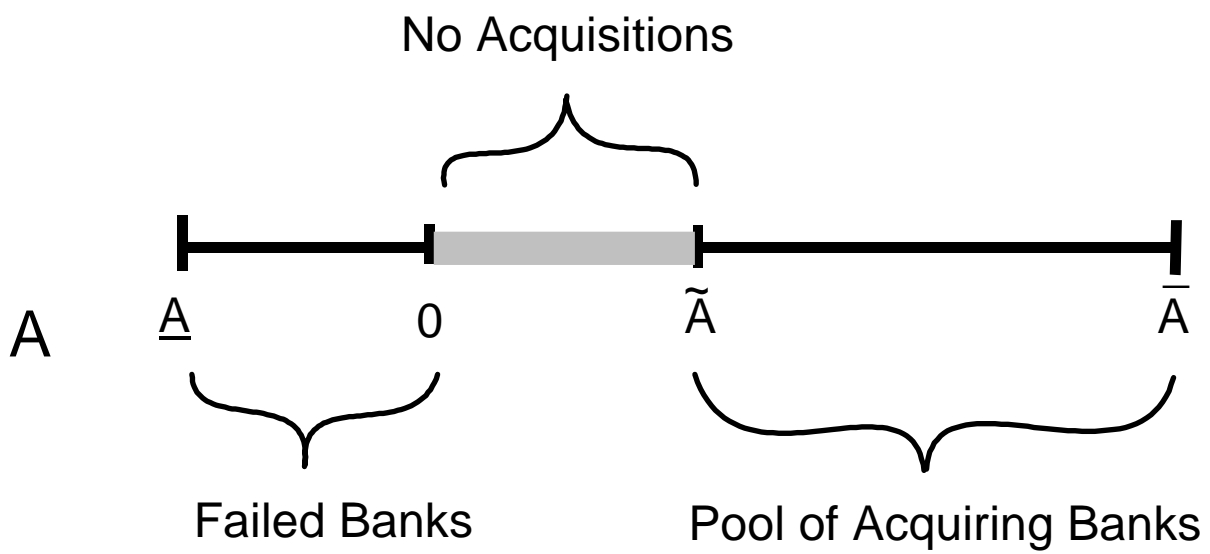


Figure 2: Charter Value and Bank Effort

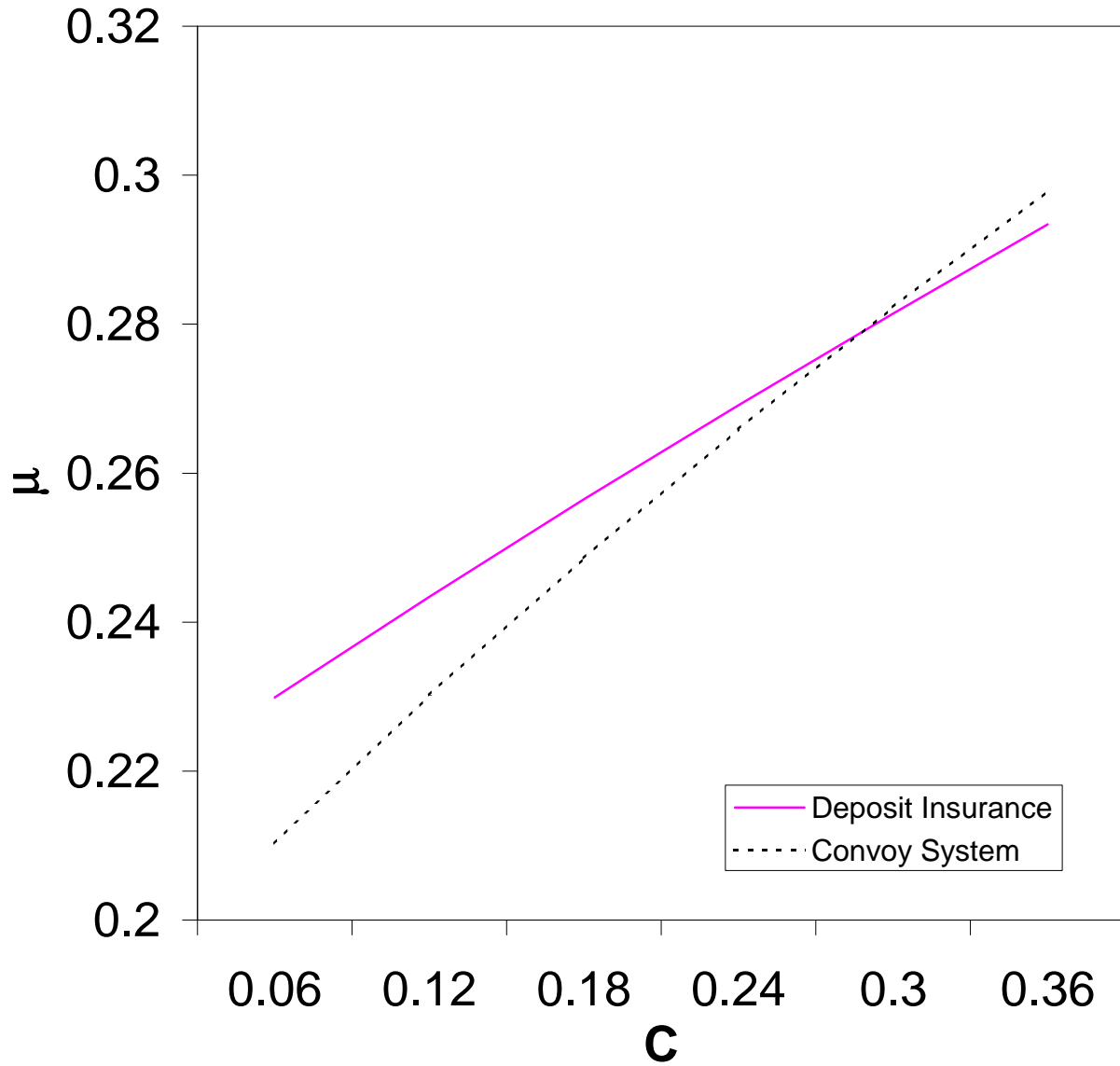


Figure 3: Charter Value and Prob. of Bankruptcy

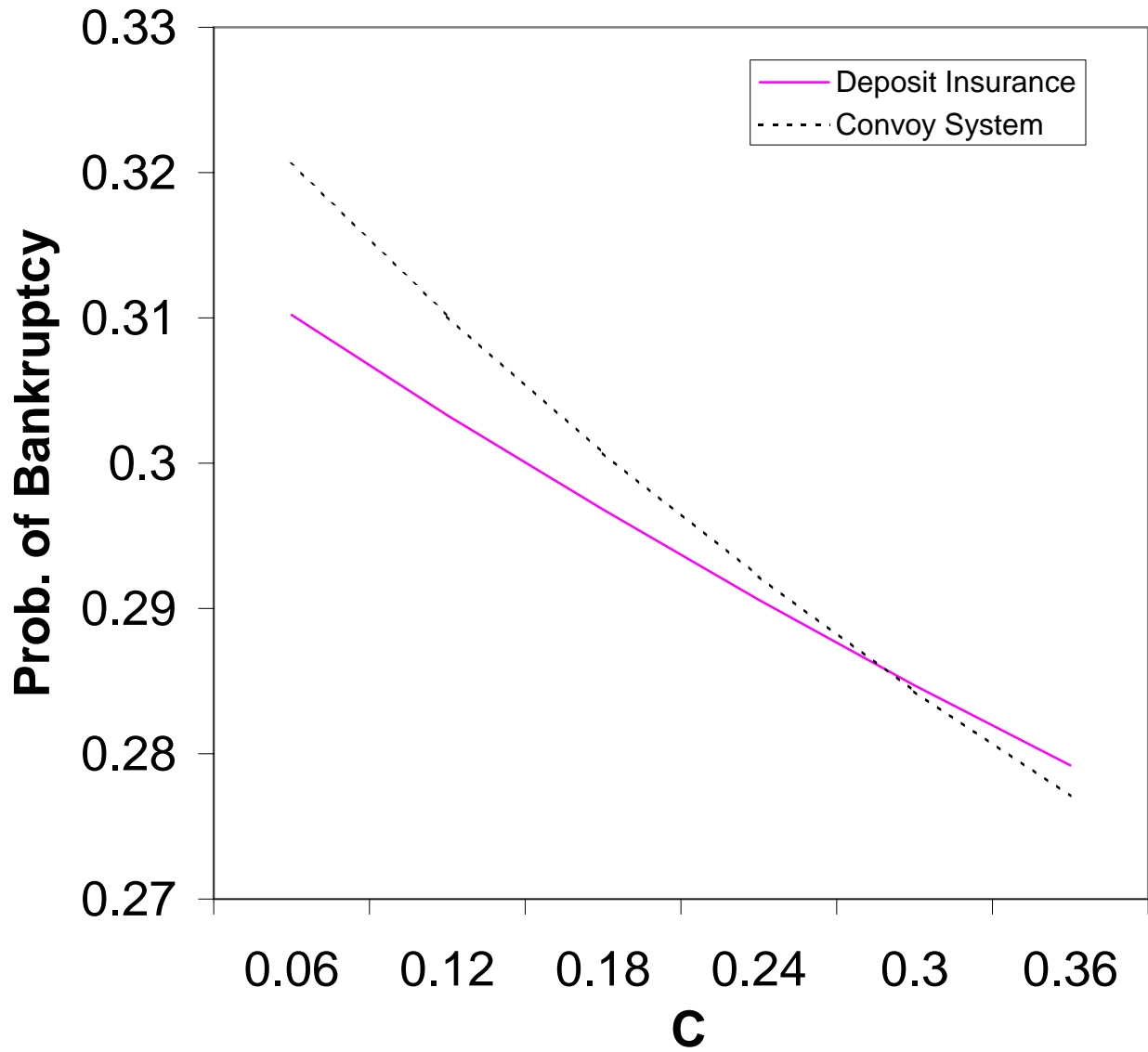


Figure 4: Banking System Health and Bank Effort

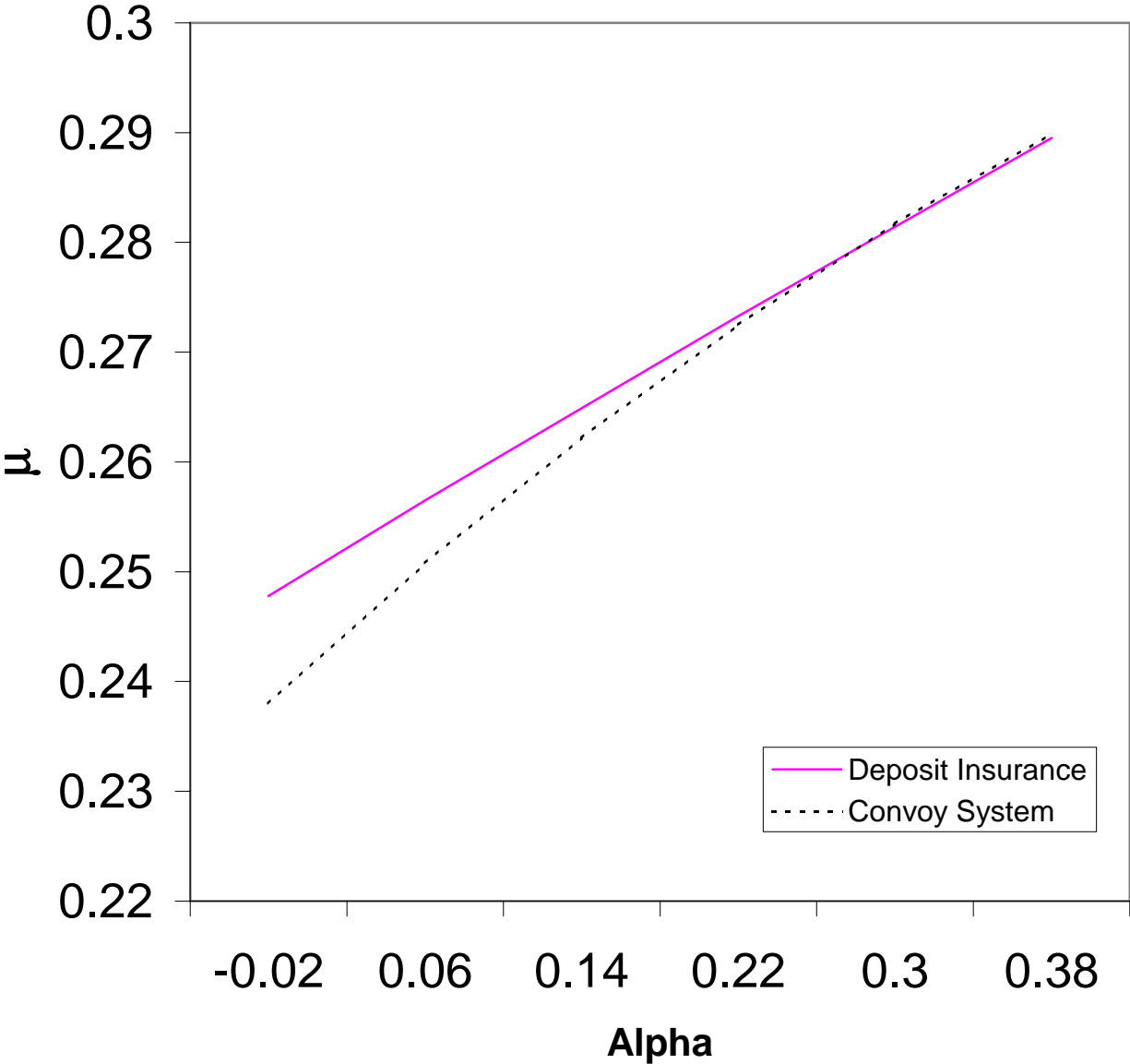


Figure 5: Banking System Health and Probability of Bankruptcy

