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Chapter Author(s): W. F. Sharpe

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8 Bank Capital Adequacy, Deposit Insurance, and Security Values

W. F. Sharpe

8.1 Introduction

Since the first owner of a gold depository discovered that profits could be made by lending some of the gold deposited for safekeeping, there has been concern for the "capital adequacy" of depository institutions. The idea is simple enough. If the value of an institution's assets may decline in the future, its deposits will generally be safer, the larger the current value of assets in relation to the value of deposits. Defining capital as the difference between assets and deposits, the larger the ratio of capital to assets (or the ratio of capital to deposits) the safer the deposits. At some level capital will be "adequate"—that is, the deposits will be "safe enough."

In most countries depository institutions are regulated and examined periodically by regulatory authorities, and much of this effort is directed toward ensuring capital adequacy, broadly construed. However, the concept of capital adequacy is generally left undefined, making it impossible to specify an explicit criterion by which one can judge whether capital is adequate.

This chapter provides a formal setting for the analysis of the capital adequacy of an institution with deposits insured by a third party. We emphasize the case in which the insurer charges a fixed premium per dollar of deposits, since this is the policy of federal insurance agencies in the United States. However, most of the analysis is applicable to cases in

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W. F. Sharpe is Timken Professor of Finance, Stanford University Graduate School of Business. Comments and suggestions from Paul Cootner, Laurie Goodman, Robert Litzenberger, Sherman Maisel, Huston McCulloch, James Pierce, David Pyle, Krishna Ramaswamy, Barr Rosenberg, Kenneth Scott and Robert Willis are gratefully acknowledged.

which insurance premiums vary with deposit risk, and much of it is also relevant for cases in which deposits are uninsured.

To avoid circumlocution, we will refer to the depository institution as a *bank*, but most of the analysis also applies to savings and loan companies and other depository institutions. Similarly, we will refer to the insurer as the *FDIC* (Federal Deposit Insurance Corporation), although the analysis applies as well to the Federal Savings and Loan Insurance Corporations and similar agencies.

8.2 The Value of the Insurer's Liability

A highly simplified view of the balance sheet at time t is the following:

bank

Assets = A_t	Deposits = D_t
	Capital = C_t

All amounts are *economic values*—the prices for which the assets (A_t) or claims on assets (D_t, C_t) would sell in a free market. Throughout, we assume that values are calculated in this manner and that we are dealing with *economic balance sheets*, not traditional (accounting) balance sheets.

If there is any risk that the bank might not pay its depositors' claims in full and on time, the economic value of such claims will be less than it would be if there were no such risk. Define DF_t as the amount the deposit claims would be worth at time t if they were *default-free*. An insured depositor has, in effect, two claims: one on the bank and another on the FDIC. One way to portray the situation is shown in figure 8.1.

The depositors consider their claims default-free, with a corresponding value of DF_t. Since the bank may in fact default, its liability to the depositors is only worth D_t. The difference, $L_t(= DF_t - D_t)$, is the *present value of the FDIC's liability*.

Another way to portray the situation is the following:

bank		FDIC		depositors	
A_t	D_t ←- - - - -	D_t	DF_t ←- - - -	DF_t	net worth = DF_t
	C_t	reserves	net worth		

To avoid a negative net worth, ex ante, the FDIC should charge a premium that will bring in reserves equal to the present value of its liability. Conversely, if the premium is predetermined, the FDIC should require that the value of the deposit claims (D_t) differ from the default-free value (DF_t) by no more than the premium.

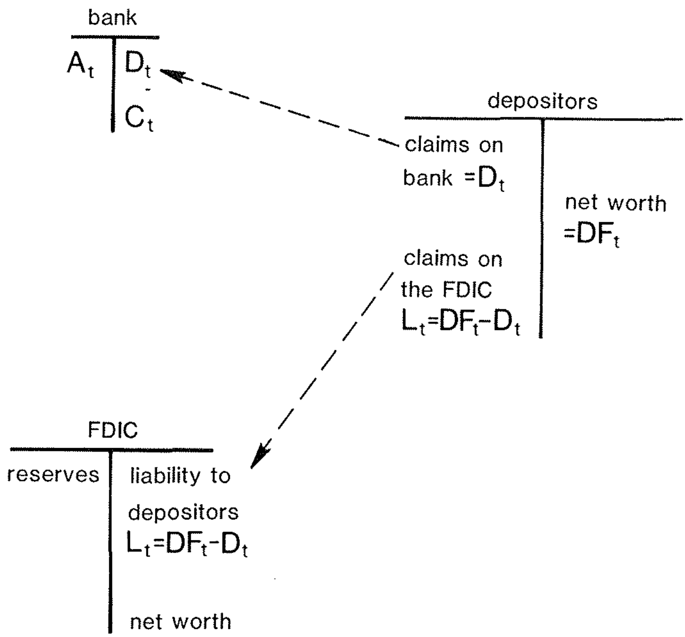

Fig. 8.1

Assume that for the relevant period the insurance premium is ρDF_t. Then the required condition is

$$\rho DF_t + D_t \geq DF_t$$

or

$$\frac{DF_t - D_t}{DF_t} \geq \rho.$$

If this condition is met, capital is adequate; if not, capital is inadequate. As we will see, the ratio on the left is a function of capital coverage and risk. The determination of a bank's capital adequacy thus requires both an assessment of the economic values of all assets and liabilities (including intangible assets such as the value of a charter, monopoly power or superior management, and options such as acceptances and lines of credit) and the estimation of all relevant risks.

The second depiction of the relationships among the three parties is particularly useful in one respect: it highlights the fact that the FDIC has the major interest in monitoring and policing the behavior of the bank, since it must bear the consequences of any default.

In the United States there is both explicit and implicit deposit insurance. The FDIC insures only some deposit claims; excluded are foreign deposits, claims owned by other banks (most of the "federal funds"), and portions of deposits above \$40,000 per private account and above \$100,000 per government account. However, the Federal Reserve system often provides de facto insurance for its member banks by furnishing liquidity to a troubled bank so that uninsured depositors can be paid off before the bank is actually closed. Moreover, the FDIC tries, whenever possible, to avoid actually closing a bank; arranging instead for another bank to assume all the deposit claims. One way or another, almost all deposits are insured.

The cost of such insurance is the explicit FDIC premium—a percentage of (virtually) all deposits, including those nominally uninsured—plus at least part of the interest forgone on reserves required to be held at a Federal Reserve bank by members of the Federal Reserve system.

We will ignore these complexities, assuming that all deposits are insured. In fact, this is quite an accurate characterization of the actual situation in the United States.

8.3 Capital Coverage and the Value of the FDIC's Liability

We assume that the FDIC insures a bank for one period. At the end of the period the bank is *reviewed.* At that time, if the economic value of assets is less than the default-free value of deposits, the FDIC must cover the shortfall in some manner; otherwise it bears no cost. The FDIC's problem is to ensure that ex ante, the economic value of its liability is no larger than the premium charged to insure the bank during the period.

Assume that the bank issues certificates of deposit (CDs) that promise total payments of $[P_1, P_2, \ldots, P_N]$ at times $1, 2, \ldots, N$ (the current time is denoted 0 and the bank is reviewed at time 1).[1]

At the beginning of the period depositors pay DF_0, the current value of default-free CDs paying $[P_1, P_2, \ldots, P_N]$, to the bank, since the CDs are insured. However, the bank receives a smaller amount, since it must pay ρDF_0 to the FDIC for insuring the deposits. In addition, the bank issues common stock for which it receives C_0' dollars. The net amount received is invested in an asset mix with a current value of $A_0 = (1 - \rho)DF_0 + C_0'$. If the insurance premium is set correctly, the economic value of the deposits (D_0) is equal to $(1 - \rho)DF_0$ and C_0, the economic value of the capital, is equal to C_0'. In any event, at time zero the economic balance sheet is:

assets $= A_0$	deposits $= D_0$
	capital $= C_0$

1. Demand deposits can be considered one-period deposits, since services are provided during the period and the existence of insurance gives depositors little incentive to withdraw funds before the FDIC review. Under this interpretation the value of services provided during the period could be assumed to be included in P_1 or to be placed in escrow at the beginning of the period.

At the end of one year, the assets will have a value of $\tilde{A}_1 = (1 + \tilde{r}^a)A_0$, where $\tilde{r}^a$ is the rate of return on the asset mix between time zero and time 1 and tildes indicate variables whose actual values are uncertain ex ante.

At time 1, the value of a set of default-free CDs promising payments $[P_1, P_2, \ldots, P_N]$ will be $\tilde{DF}_1$, a value that is uncertain ex ante, since the term structure of default-free interest rates that will prevail at time 1 is not known with certainty at time zero.

At time 1 the bank is reviewed. In effect the FDIC guarantees that the CDs will be paid as promised. To simplify the analysis, we assume that if A_1 exceeds DF_1 the depositors are paid in full and the stockholders retain the difference $(A_1 - DF_1)$. Otherwise the depositors receive all that is available (A_1), the FDIC makes up the difference $(DF_1 - A_1)$, and the stockholders receive nothing.

Our interest is in D_0, the economic value of the CDs at time zero, and its relationship to DF_0, the value of an otherwise similar set of default-free CDs. As we will see, the ratio $(DF_0 - D_0)/DF_0$ is a function of both the relative amounts of deposits and capital and the riskiness of the bank.

The issues that concern us can be analyzed using alternative paradigms, with roughly similar results.[2] We choose to employ a complete market, state-preference approach because it is both simple and powerful. This may seem an unusual choice, since in such a market the existence of financial intermediaries, though possible, is not essential. Of course such institutions do exist, and few would argue that they are redundant. Transaction processing and information gathering and transmittal do cost money, and financial institutions provide locational economies and economies of scale as well. However, our goal is to describe relationships among the values of financial institutions' assets and claims on those assets, not the choice of the assets and claims or the nature of the operation of such institutions. We hope that many of the qualitative conclusions obtained by analyzing these issues in a market free of transaction costs and information costs apply as well to institutions operating in real financial markets.

Assume that there are S possible states of the world at time 1. A *state* has the following attributes:

r_s^a: the return on the bank's assets from time zero to time 1 if state s obtains (i.e., $A_{1s} = (1 + r_s^a)A_0$

$\pi_{11s}, \pi_{12s}, \ldots, \pi_{1Ns}$: where π_{1ts} is the present value at time 1 if state s obtains of a default-free promise to pay \$1 at time t ($\pi_{11s} = 1$ for all s).

2. For a partial analysis using stochastic dominance, see Sharpe (1977); for analyses using option valuation theory, see Merton (1977*a*, *b*) and Ramaswamy (1978).

Given $[\pi_{11s}, \pi_{12s}, \ldots, \pi_{1Ns}]$, the default-free value of deposits at time 1 can be determined directly:

$$DF_{1s} = \sum_{t=1}^{S} \pi_{1ts} P_t .$$

Define r_s^ℓ as the "default-free" return on the bank's deposits in state s; that is, $(1 + r_s^\ell)\, DF_0 = DF_1$. Then the payment to depositors in state s will be

$$D_{1s} = \min\,[A_0\,(1 + r_s^a),\, DF_0\,(1 + r_s^\ell)],$$

and the payment to stockholders will be

$$C_{1s} = A_0(1 + r_s^a) - \min\,[A_0\,(1 + r_s^a),\, DF_0\,(1 + r_s^\ell)].$$

If, by buying and selling existing securities, an investor can obtain any desired proportions of payments in different states, the financial market is said to be *complete*. Equilibrium in such a market is characterized by a series of implicit or explicit prices for state-contingent claims—prices that are the same whether one wishes to purchase or to sell such claims (since transaction costs are assumed to be zero).

Now, let:

p_s = the price in time zero certain dollars of a default-free promise to receive \$1 if and only if state s occurs one year hence.

Then the present value of a dollar certain to be paid at time 1 is

$$\pi = \sum_{s=1}^{S} p_s \,. \tag{1}$$

Note also that:

$$A_0 = \sum_{s=1}^{S} p_s\,(1 + r_s^a)\,A_0$$

and

$$\sum_{s=1}^{S} p_s\,(1 + r_s^a) = 1 \,. \tag{2}$$

In such a market the value of the bank's CD would be

$$D_0 = \sum_{s=1}^{S} p_s\,\{\min\,[A_0\,(1 + r_s^a),\, DF_0\,(1 + r_s^\ell)]\} \,, \tag{3}$$

and the value of its common stock would be

$$C_0 = \sum_{s=1}^{S} p_s\,\{A_0\,(1 + r_s^a) - \min\,[A_0\,(1 + r_s^a),\, DF_0\,(1 + r_s^\ell)]\} \,. \tag{4}$$

Clearly,

$$C_0 + D_0 = \sum_{s=1}^{S} p_s\,\{A_0\,(1 + r_s^a)\} = A_0 \,. \tag{5}$$

Thus an uninsured bank could raise just enough capital to pay the market value for its assets, no matter what mix of deposits and stock it elected to employ. Moreover, each source of capital would be priced appropriately. While this is almost tautological, it serves to emphasize the well-known point that in a complete financial market there is no "optimal" financing mix.[3]

Given our formulation, the relationship between relevant values and capital coverage can be derived. Note that

$$DF_0 + \sum_{s=1}^{S} [p_s \, DF_0 \, (1 + r_s^{\ell})] \tag{6}$$

and

$$\sum_{s=1}^{S} [p_s \, (1 + r_s^{\ell})] = 1 \, .$$

Thus:

$$D_0 = \sum_{s=1}^{S} p_s \, \{\min \, [A_0 \, (1 + r_s^{a}), \, DF_0 \, (1 + r_s^{\ell})]\} \leq DF_0 \, . \tag{7}$$

Now, define the net worth in state s as

$$NW_s = A_{1s} - DF_{1s} = A_0 \, (1 + r_s^{a}) - DF_0 \, (1 + r_s^{\ell}) \, .$$

Without loss of generality, we will assume that the S states are numbered in order of increasing net worth; that is:

$$[A_0 \, (1 + r_s^{a}) - DF_0 \, (1 + r_s^{\ell})] < [A_0 \, (1 + r_{s+1}^{a}) - DF_0 (1 + r_{s+1}^{\ell})] \, .$$

Given A_0 and DF_0, there will be a set of states $1, \ldots, K$ in which net worth will be negative and depositors will receive less than DF_1. In the remaining states, $K + 1, \ldots, S$, net worth will be positive and depositors will receive the full amount DF_1. Moreover, as A_0/DF_0 increases, K will decrease (but only at discrete points).

The definition of K ensures that

$$\begin{aligned} (1 + r_s^{a})A_0 &< (1 + r_s^{\ell}) \, DF_0 \qquad & s &= 1, \ldots, K \\ (1 + r_s^{a})A_0 &> (1 + r_s^{\ell})DF_0. \qquad & s &= K + 1, \ldots, S \end{aligned}$$

Thus:

$$D_0 = \sum_{s=1}^{K} [p_s(1 + r_s^{a})A_0] + \sum_{s=K+1}^{S} [p_s \, (1 + r_s^{\ell})DF_0]$$

and

$$\frac{D_0}{DF_0} = \sum_{s=1}^{K} [p_s(1 + r_s^{a})] \frac{A_0}{DF_0} + \sum_{s=K+1}^{S} [p_s(1 + r_s^{\ell})] \tag{8}$$

3. This assumes that no resources are lost in the event of bankruptcy. If this assumption is dropped, with all others maintained, *any* situation that could lead to bankruptcy in *any* state would be suboptimal, as shown in Karaken and Wallace (1977).

Now, define

$$\frac{d(D_0/DF_0)}{d(A/DF_0)} \equiv m_k$$

as the slope of the curve relating D_0/DF_0 to A_0/DF_0 when default occurs in states 1, . . . , K. Then

$$m_K = \sum_{s=1}^{K} [p_s(1 + r_s^a)] \tag{9}$$

and

(1) m_K is constant for ranges of asset values over which K is unchanged
(2) $m_K \leq 1$
(3) m_K is smaller, the smaller is K
(4) $m_S = 1$
(5) $m_O = 0$.

These relationships imply that the curve relating D_0/DF_0 to A_0/DF_0 is piecewise linear, concave, and bounded by both the 45° line from the origin and the horizontal line for which $D_0/DF_0 = 1$, as illustrated in figure 8.2.

The larger the number of states, the larger the number of linear segments and the closer the piecewise linear curve in figure 8.2 will approach a smooth concave curve such as that shown in figure 8.3. As in

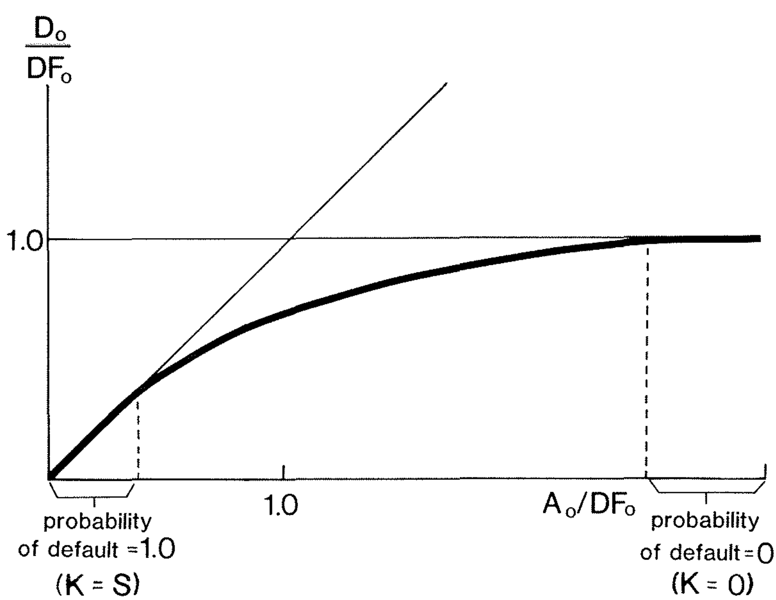

Fig. 8.2

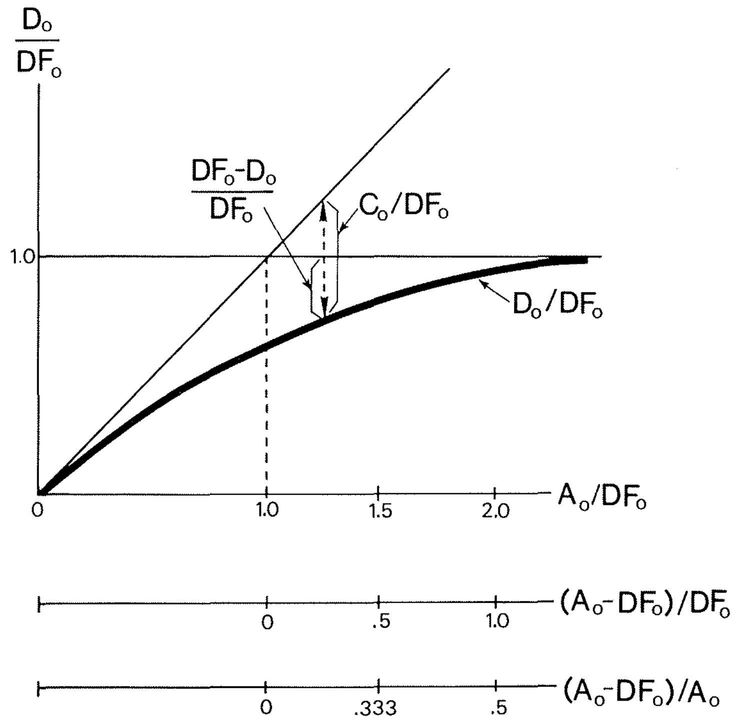

Fig. 8.3

figure 8.2, the primary scale for the horizontal axis is the ratio of assets to the default-free value of deposits, but monotonic transformations can be used to obtain scales for capital/deposit and capital/asset ratios, if the present value of net worth—the amount obtained by subtracting the *default-free* value of deposits from the economic value of assets—is utilized.

$$\frac{A_0 - DF_0}{DF_0} = \frac{A_0}{DF_0} - 1$$

$$\frac{A_0 - DF_0}{A_0} = 1 - \frac{1}{A_0/DF_0} .$$

As shown in figure 8.3, ceteris paribus, the greater the amount of assets covering deposits, the smaller will be the difference between the actual value of the deposits and the default-free value. Of course the balance sheet must balance, since the sum of the claims on a set of assets is worth neither more nor less than the assets. Thus C_0 must equal $A_0 - D_0$, and C_0/DF_0 must equal $(A_0 - D_0)/DF_0$, as shown. The distance between the curve and the horizontal line is of particular interest—it is the value of the FDIC liability per unit of deposits $\left(\frac{DF_0 - D_0}{DF_0}\right)$. For emphasis it has been plotted separately in figure 8.4. As shown there, given the relevant risks (i.e., the values of r_s^a and r_s^ℓ), an increase in the ratio of assets to the default-free value of deposits will reduce the per-unit value of the FDIC liability; however, this value will decrease at a decreasing rate. For any amount of risk, there will be some amount of capital that will make the per-unit liability equal to any preselected premium (e.g., in fig. 8.4, given a per-unit premium of ρ^*, the appropriate amount of capital is that which provides an asset-to-default free deposit ratio of $(A_0/DF_0)^*$). Given our definition, this is (precisely) an adequate amount of capital.

8.4 The Effects of Changes in Risk

Having considered the effects of changes in capital, holding risk constant, we now turn to the effects of changes in risk, holding capital constant.

8.4.1 Value-Preserving Spreads

In a complete market the risks associated with states of the world are reflected in the prices of state-contingent claims $[p_1, p_2, \ldots, p_S]$. Any economywide change in risk is likely to affect these prices. In this chapter we take a partial rather than a general equilibrium view, assuming that such prices do not change as the risks relevant for a bank change. Instead, we deal only with changes in the returns associated with various states.

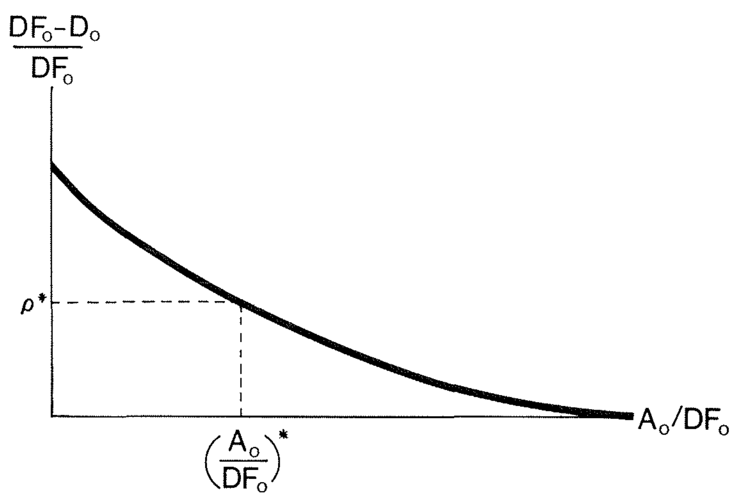

Fig. 8.4

Risk is generally considered to have increased when a set of returns becomes more "spread out." This can be given a precise meaning in the present context. Assume that states have been numbered in order of increasing magnitudes of return; that is:

$$r_s < r_{s+1}.$$

Let primes denote the set of returns after a change. Then we can say that risk has increased unambiguously if state-contingent claim prices do not change and

$$r_s' = r_s + R\Delta_s\,, \tag{10}$$

where

$$\begin{array}{ll} \Delta_s \leq 0 & s = 1, \ldots, s^* \\ \Delta_s \geq 0 & s = s^* + 1, \ldots, S \end{array}$$

and

$$R = \text{a positive constant.}$$

We wish, however, to consider only a subset of such changes in risk. Probabilistic approaches often consider *mean-preserving spreads*, in which expected return is held constant.[4] This type of increase in risk will usually lead to a change in value. In the present context this is an inappropriate ceteris paribus condition. Moreover, the concept of expected return requires the addition of some notion of (consensus) probability assessments to our set of assumptions. For both reasons we will hold *value* constant instead. Thus we require:

$$\sum_{s=1}^{S} [p_s R\Delta_s] = 0. \tag{11}$$

Equations (10) and (11) define a concept we will term a *value-preserving spread*. Note also that they imply:

$$R\sum_{s=1}^{K} [p_s\Delta_s] \leq 0 \text{ for all } K. \tag{12}$$

Any change conforming to (10) and (11) will be considered an increase in risk. Moreover, given a vector $[\Delta_1, \Delta_2, \ldots, \Delta_5]$ the magnitude of the change in risk will be proportional to R.

8.4.2 The Effects of a Value-Preserving Spread in Return on Net Worth

As before, assume that states have been numbered in order of increasing net worth at the end of the review period, with

$$\begin{array}{rl} NW_s < 0 & s = 1, \ldots, K \\ \text{and } NW_s > 0 & s = K + 1, \ldots, S. \end{array}$$

4. See, for example, Rothschild and Stiglitz (1970).

Let L_s be the liability of the FDIC at the end of the review period if state s obtains. Then:

$$L_s = \begin{Bmatrix} -NW_s & \text{for } s = 1, \ldots, K \\ 0 & \text{for } s = K+1, \ldots, S+1, \ldots, S \end{Bmatrix}$$

Similarly, let C_s be the value of the claim of capital-holders at the end of the review period if state s obtains. Then:

$$C_s = \begin{Bmatrix} 0 & \text{for } s = 1, \ldots, K \\ NW_s & \text{for } s = K+1, \ldots, S \end{Bmatrix}$$

The present values of net worth, the FDIC liability and capital are, respectively:[5]

$$NW_0 = \sum_{s=1}^{S} [p_s NW_s]$$

$$L_0 = -\sum_{s=1}^{K} [p_s NW_s]$$

$$C_0 = \sum_{s=K+1}^{S} [p_s NW_s] .$$

And

(13) $$NW_0 = C_0 - L_0.$$

Now, define r_s^n, the return on net worth in state s by

$$1 + r_s^n \equiv \frac{NW_s}{NW_0} .$$

Then the states are also ordered on the basis of r_s^n.

Assume that there is a value-preserving spread in net worth, and that the spread is small enough to leave unchanged the number of states in which default occurs. Letting primes denote values after the change:

$$L_0' = -\sum_{s=1}^{K} [p_s(1 + r_s^{n'})NW_0]$$

$$= -\sum_{s=1}^{K} [p_s\, s(1 + r_s^n + R\Delta_s)]\, NW_0$$

(14) $$= L_0 + \left\{ -NW_0 \left(R_s \sum_{s=1}^{K} [p_s \Delta_s] \right) \right\} .$$

Note, from (12) that the expression in braces is negative. Thus $L_0' \geq L_0$, and a value-preserving spread in net worth will either increase the value of the FDIC liability or leave it unchanged. Moreover, the magnitude of the change in L_0 will generally be greater, the greater the increase in risk (R).

5. Note also that $L_0 = DF_0 - D_0$.

Formula (14) can also be used to derive an empirically useful relationship between the effect of a shift in risk and the initial riskiness of deposits.

The change in the value of the FDIC liability is

$$\Delta L = L_0' - L_0 = -R\left[\sum_{s=1}^{K} (p_s \Delta_s)\right] NW_0 .$$

But we are considering only spreads that leave the total value of net worth unchanged. Thus, from (13):

$$\Delta C = \Delta L$$

$$\Delta C = -R\left[\sum_{s=1}^{K} (p_s \Delta_s)\right] NW_0$$

and

$$\frac{\Delta C}{NW_0} = -\left[\sum_{s=1}^{K} (p_s \Delta_s)\right] R . \tag{15}$$

Figure 8.5 plots the relationship between $[(\Delta C/NW_0)/R]$ and K. As implied by (10) and (12), the function is nonnegative throughout, nondecreasing over the range for which $K<s^*$, and nonincreasing over the range for which $K>s^*$.

Recall that K represents the number of states in which default occurs. As long as this is not large (i.e., $K<s^*$), the following relationship holds:

> The larger the number of states in which default occurs, the greater the increase in capital value per dollar of net worth induced by a given increase in risk, ceteris paribus.

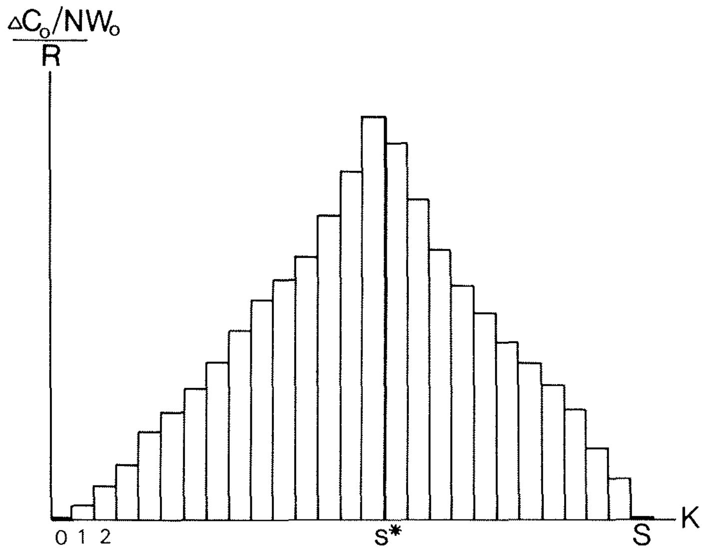

Fig. 8.5

As established earlier, $[(DF_0 - D_0)/DF_0]$ is positively related to K. We have now shown that for $K < s^*$, $[(\Delta C/NW_0)/R]$ is positively related to K. Thus, unless a bank's deposits are extremely risky:

> The larger the initial value of the FDIC liability per dollar of deposits, the greater the increase in capital value per dollar of net worth due to a *ceteris paribus* increase in risk, and vice-versa.[6]

This suggests that the response of the economic value of a bank's equity to a shift in risk may provide some information about deposit risk and hence the value of the associated FDIC liability. Ceteris paribus, the greater the effect of such a "risk shift" on capital value, the less adequate the bank's capital.

8.4.3 The Effects of a Value-Preserving Spread in Return on Assets

The uncertainty associated with a bank's net worth at the end of the review period derives from uncertainty about both the value of its assets and the default-free value of its liabilities at that time. To assess "net worth risk," one must in general consider asset risk, default-free liability risk (i.e., "interest rate risk"), and the relationship between the two.

For a financial institution with deposit liabilities extending beyond the review period, it is difficult to make general statements about the effects of changes in risk. For example, a value-preserving spread in asset returns unaccompanied by a change in default-free liability returns may not cause a value-preserving spread in return on net worth. The value of net worth will remain the same, but unless the ordering of states on the basis of NW_s conforms to the ordering on the basis of r_s^a, the changes in NW_s will not satisfy (10). Moreover, for such an institution, changes in asset returns may be accompanied by changes in default-free liability returns. In the extreme case in which a bank's assets consist of default-free bonds providing payments greater than or equal to the promised deposit payments in each period, the bank will be completely immunized, and L_0 will equal zero no matter what happens to the set of possible asset (and liability) returns.

Loosely speaking, the smaller the correlation between asset and default-free liability returns, the greater the effect of an increase in asset risk on the value of the FDIC liability. And the shorter the duration of the bank's deposits, the smaller will be this correlation.

The effects of a change in asset risk can be assessed unambiguously in one case. Assume that a bank has only deposits maturing at the end of the review period; then only asset risk is relevant. Moreover, ordering of the states in terms of NW_s is equivalent to ordering in terms of r_s^a, and a value-preserving spread in asset returns will make both r_s^n and r_s^a smaller

6. Except that changes in the value of the FDIC liability over a range in which K is unchanged do not affect $(\Delta C/NW_0)/R$).

or unchanged in states $1, \ldots, s^*$ and larger or unchanged in states $s^* + 1, \ldots, S$.

As before, let Δ_s be the spread in state s stated in terms of return on net worth. If Δ_s^a is the spread stated in terms of return on assets, then

$$\Delta_s^a A_0 = \Delta_s NW_0 .$$

Substituting in (15):

$$\frac{\Delta C}{NW_0} = \left[-\sum_{s=1}^{K} \left(p_s \Delta_s^a \frac{A_0}{NW_0} \right) \right] R$$

or

$$(16) \qquad \frac{\Delta_C}{A_0} = \left[= \sum_{s=1}^{K} \left(p_s \Delta_s^a \right) \right] R.$$

Given a value-preserving spread in asset returns, the expression in braces will, by (10), (11), and (12), be positive, nondecreasing for $K < s^*$ and nonincreasing for $K > s^*$. Since K is inversely related to the FDIC liability per dollar of deposits, we can conclude that unless deposits are extremely risky ($K > s^*$):

> For a bank with deposit liabilities that do not extend beyond the review period, the greater the increase in capital value per dollar of assets owing to a ceteris paribus increase in asset risk, the larger the initial value of the FDIC liability per dollar of deposits, and vice-versa.

8.5 Conclusions

Any agency insuring a bank's deposits should be concerned about the present value of the associated contingent liability. Ex ante, this value should be no larger than the premium charged for the insurance. In general, the present value of the insurer's liability depends on (*a*) the risk of the bank's assets, (*b*) the interest rate risk associated with the deposits, (*c*) the relationship between the two, and (*d*) the ratio of the economic value of the bank's assets to the default-free value of its deposits. Given the relevant risks, the present value of the insurer's liability can be reduced by increasing the value of assets by an infusion of new capital. When the value of the insurer's liability is no larger than the insurance premium, the bank can be said to have "adequate capital."

Our analysis emphasizes the importance of estimating *economic* values. It also emphasizes the importance of estimating all relevant components of risk. While these are difficult tasks, substantial progress could be made if bank regulatory authorities were to devote more effort to such goals.

Although the effects of changes in risk are complex, our discussion suggests a potentially useful new way to gain information about capital adequacy. An econometric model could be developed with the change in the market value of a bank's equity as the dependent variable (since this provides a good estimate of the change in the economic value of capital). Independent variables could include (*a*) surrogates for changes in asset values, (*b*) surrogates for changes in default-free values of liabilities, and (*c*) a surrogate for changes in asset risk multiplied by the value of assets. The coefficient associated with the latter variable would provide an estimate of the expression in braces in formula (16)—that is, the sensitivity of capital to a value-preserving spread in asset risk. It is plausible to assume that the larger the magnitude of this "risk shift sensitivity," the less adequate the bank's capital (i.e., the larger the FDIC's liability per dollar of deposits).

Unfortunately this magnitude cannot be readily translated into a numeric estimate of the FDIC's liability. However, a major increase over time in the sensitivity of a bank's equity to changes in risk might suggest a deterioration in capital adequacy. And, within a group of banks, those displaying a high sensitivity of capital to changes in risk might be considered worthy of special concern.

A procedure of this type would, at best, be simply an additional tool in the bank examiner's kit. But it might well be a desirable one.