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Usefulness of Market Information and Accounting Information from the Perspective of Bank Supervisory Policy : An Empirical Study of Japanese Banks

Tatsuya YONETANI* and Nobuyuki ODA**

Abstract

This paper aims to explore the possibility of making effective use of market information and accounting information for identifying risk banks. In order to identify risk banks by their market-based information, we calculate stock market-based deposit insurance premiums and capital ratios using the option pricing method, used in a number of studies such as Merton's (1977) and those of Ronn and Verma (1986, 1989). Then we conduct empirical tests on the relationship between these items of market-based and accounting information of Japanese banks. We also conduct empirical tests using both market-based and accounting information to predict future bank performance.

We find : (1) Equity market measures are sensitive to the accounting information disclosed. (2) When bank performance is defined by whether or not banks fail, the risk-adjusted deposit insurance rate and net non-performing loans are both significant. In conclusion, our results suggest that market and accounting information may be useful in jointly identifying risk banks.

Key words: Market information, Accounting information, Option pricing theory, Bank performance predicting

JEL classification : G13, G14, G21, G28

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1. Introduction

This paper aims to explore the possibility of making effective use of market information and accounting information for identifying risk banks.

In order to maintain the safety and soundness of the financial system, it is indispensable to establish a system designed for the supervisory authorities to detect troubled banks at the early stages and conduct prompt corrective action with regard to them. In particular, the severe financial environment surrounding Japanese financial institutions makes it all the more important for the supervisory authorities to identify the future default risk of financial institutions.

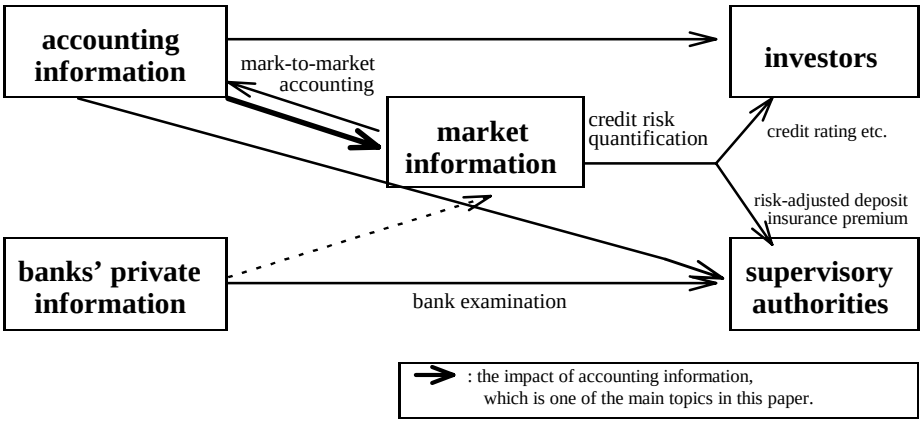
From the perspective of early detection of troubled banks, it has been considered that the most effective means is to collect accurate private information from each bank through bank examinations and then to examine this information. However, as the nation's financial markets grow increasingly complex and fast-paced, it becomes a crucial question whether policymakers should continue to rely so heavily on the supervisory model or whether governments might be aided by the discipline of the market to help police excessive risk taking. Timely disclosure of the financial condition of banks and market efficiency are improving, therefore providing more room for the supervisory authorities to use market information and accounting information as complementary[1] information to that collected through bank examinations.

In this regard, it is all the more important for supervisors to develop a methodology which uses the risk information available from various sources. For this purpose, to begin with, it is considered to be important to analyze the relationship between various perceived pieces of information and to examine their usefulness.

Figure 1 shows the relationships between accounting information, market information and banks' private information which can be collected through bank examinations. If accurate accounting information on banks' financial conditions is useful to investors and also the market is efficient, market information such as banks' share prices is considered to reflect

[1] With regard to this point, Flannery (1998) even asserted that greater access to regulatory information may also be necessary to enhance the ability of market forces to identify and control risk taking in banking firms.

Figure 1. Relationship among various information (ex. credit risk)



banks' financial conditions accurately. Market information might also reflect information from other sources than accounting documents.

With regard to the usefulness of information, each piece of information has its advantages and disadvantages. Private information through bank examinations is superior in accuracy, however, it has problems with frequency of information acquisition and acquisition cost. Timewise and moneywise, it costs both examiner and examinee a great deal to examine banks and therefore, in practice, we have to leave some intervals between bank examinations. Also, if we rely upon bank examination too heavily, such reliance might not be consistent with fostering market discipline. On the other hand, market information is superior in frequency of information acquisition, but it has much noise and sometimes contains overreaction. Accounting information is superior in acquisition cost, but its content depends on the disclosure system. If the disclosure system is insufficient, the content of accounting information is poor, misleading and not useful to investors.

This paper focuses on market information and accounting information and we conduct an empirical study on the relationship between them using Japanese data.

Specifically, in order to identify risk banks by their market-based information, we calculate market-based deposit insurance premiums and capital ratios using the option pricing method, as used in a number of studies such as those of Merton (1977 and 1978) and Ronn

and Verma (1986). Then we conduct empirical tests on the relationship between market-based information derived from this calculation and accounting information. We also conduct empirical tests using both market-based and accounting information to predict future bank performance.

In the case of market-based information, option methodology has been used to calculate banks' credit risk and to model deposit insurance value. In particular, in the USA, there has been strong interest in the potential use of a market-based, risk-adjusted approach to setting deposit insurance premiums and there have been a number of studies[2] on it in the past. Also, recently, major banks in developed countries have been involved in a process of upgrading their credit risk management capabilities. These studies and practices use an option methodology[3] calculating default probabilities from publicly-traded equity prices as an important model. Based on these backgrounds, this paper also aims to explore the possibility of the use of option pricing methodology for identifying banks by their riskiness in Japan.

Our results can be summarized as follows: (1) Equity market measures are sensitive to the accounting information disclosed. For example, the accounting information in three categories (capital, asset, earnings) of CAMEL ratings is significantly reflected in the market-based information calculated by using option pricing theory. (2) When bank performance is defined by whether or not a bank fails, the risk-adjusted deposit insurance rate and net non-performing loans are both significant. Our results suggest that market-based and accounting information are useful in jointly identifying risk banks.

The remainder of this paper is organized as follows: Section 2 presents the theoretical background for the calculation of stock market-based deposit insurance premiums using the option pricing method. Section 3 describes data and methodology for empirical analysis on the relationship between accounting information and market-based information. Section 4 presents the results, and Section 5 concludes the study.

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[2] For example, King and O'Brien (1991) conducted empirical studies on the use of option pricing methods to set market-based deposit insurance premiums using US data and gave some evaluations to it.

[3] Methodology used by KMV Corp. (credit scoring vendor) is one typical example. Banks purchase from KMV Corp. direct predictions of firms' default probabilities.

2. Methods for Calculating Market-based Deposit Insurance Premiums Using Option Pricing Theory

This section[4] reviews the option pricing theory that has been used to model deposit insurance rates. Specifically, we present a summary of three methods for calculating insurance rates which apply option pricing theory: (1) the Merton method (Merton [1977]); (2) the Marcus and Shaked method (Marcus and Shaked [1984]); and (3) the Ronn and Verma method (Ronn and Verma [1986, 1989]). Method (2) may be considered as an improved version of method (1), and method (3) may be considered as an improved version of method (2). The empirical analyses in this paper utilize method (3).

(1) Merton method

Merton (1977) adopts the Black-Scholes option pricing theory for the calculation of fair insurance rates, as follows. From the viewpoint of the body providing deposit insurance, the required cash flow G at the time of maturity (T) of the insured bank's liabilities (for simplification, a single type of discount bond is assumed) may be defined as follows.

$$G = \max(0, B-V) \qquad (1)$$

Here, V is the value of the bank's assets and B is the face value of the bank's liabilities. Consequently, G expresses the bank's net liabilities, and the deposit insurance is obligated to cover this. Considering that B is a constant and V is a stochastic variable, equation (1) may be interpreted as expressing the payoff on a European put option where the value of the bank's assets V is the underlying asset and the face value of the bank's liabilities B the exercise price. Therefore, in determining the value of insurance, assuming that the value of the bank's assets V follows a lognormal process (with a volatility of σ_v), the option theory pricing equation (the Black-Scholes formula) can be applied. In this case, the insurance premium P may be calculated as follows.

$$P = Be^{-rT}N(x+\sigma_V\sqrt{T}) - VN(x) \qquad (2)$$

$$\text{where } x \equiv \frac{\ln\frac{B}{V} - (r+\frac{1}{2}\sigma_V^2)T}{\sigma_V\sqrt{T}}$$

[4] The description of this section is entirely based on Oda (1999).

Here, r expresses the risk-free interest rate.[5] The function N (•) is the cumulative probability density function for a standard normal distribution. In equation (2), V and σ_v are unknowns, and the insurance premium can be determined by seeking their values.

(2) Marcus and Shaked method

Marcus and Shaked (1984) make certain revisions to the Merton method and conduct empirical analyses on U.S. bank stock price data.

As for the computational method, the Marcus and Shaked method differs from the Merton method in two main points. First, Marcus and Shaked note that the value of bank assets differs before and after a bank obtains deposit insurance. Specifically, they define V as the value of bank assets before the bank obtains deposit insurance. If P is the value of the deposit insurance, then the value of the bank assets after the bank obtains deposit insurance may be expressed as V + P. Marcus and Shaked assume that V is a stochastic variable that follows a lognormal process (with a volatility of σ_v), and using equation (1) as a starting point the value of the deposit insurance P can be derived by applying the Black-Scholes formula as follows.

$$P = Be^{-rT}N(x + \sigma_V\sqrt{T}) - Ve^{-\delta T}N(x) \qquad (3)$$

$$\text{where } x \equiv \frac{\ln\frac{B}{V} - (r - \delta + \frac{1}{2}\sigma_V^2)T}{\sigma_V\sqrt{T}}$$

Here, B is the face value of the bank's liabilities, r is the risk-free interest rate, and the function N (•) is the cumulative probability density function for a standard normal distribution. Equation (3) is basically equivalent to equation (2), but in as much as equation

[5] Under the Merton method, the result includes the risk-free interest rate but does not include the risk premium because in asset valuation theory with no arbitrage condition the return on a risk-free composite portfolio must equal the risk-free interest rate. In contrast, some analysts (such as Moridaira [1997]) argue that because there are no securities or markets for trading in the asset values V of banks (or more broadly, of corporations) themselves, it is inappropriate to further develop this line of reasoning, and that the expected growth rates of the assets or some other factor should be used in place of the risk-free interest rate. However, it should also be noted that in practice it is difficult to estimate risk premiums or the expected growth rates of assets.

(3) clearly incorporates the effect whereby internal reserves decrease through stock dividend distributions (the dividend rate is defined as δ), it is a generalized version of equation (2).

The second point in which the Marcus and Shaked method differs from the Merton method is as follows. Marcus and Shaked note that equation (2) includes two unknowns that cannot be directly observed (that is, the value of the bank's assets V and the volatility of this variable σ_v), and introduce the following two relations so that these unknowns can be estimated. The first equation is:

$$V + P = D + E \tag{4}$$

Here, D is the present value of the bank's liabilities, and E is the present value of the bank's capital (total equity). Equation (4) may be interpreted as a general relation showing the balance between assets, liabilities and capital. In the Merton method, for simplification, a single type of discount bond is assumed for the liabilities, but here general bonds are assumed and different variables are given for the face value B and the present value D. Of course, in actual computations some sort of relationship must be assumed between B and D. By assuming a bond that pays a risk-free interest rate r, Marcus and Shaked assume the case in which the present value of the bond is equal to the face value of the bond, as follows.

$$V + P = B + E \tag{4'}$$

The second relation is:

$$\sigma_E E = \sigma_V V \frac{\partial E}{\partial V} \tag{5}$$

This is the result of applying the Ito's lemma (known in stochastic calculus), noting that the present value of the bank's capital E is a stochastic variable dependent on the value of the bank's assets V and its volatility σ_v (that is, E = E (V, σ_v). Here σ_E indicates the volatility of the present value of the bank's capital E. To rearrange equation (5), first equation (3) is substituted into equation (4).

$$\begin{aligned} E &= V - D + P \\ &= V - D + Be^{-rT} N(x + \sigma_V \sqrt{T}) - Ve^{-\delta T} N(x) \end{aligned} \tag{6}$$

By substituting equation (6) and its differential form into equation (5), the result is:

$$\sigma_V = \sigma_E \cdot [1 - \frac{Be^{-rT}\{1 - N(x + \sigma_V \sqrt{T})\}}{Ve^{-\delta T}\{1 - N(x)\}}] \tag{7}$$

Then the three unknowns P, V, and σ_v can be calculated by simultaneously solving equations (3), (4'), and (7). In seeking a numerical solution to these simultaneous equations, the book value is used for the face value of the bank's liabilities B, and the present value of the bank's capital E is calculated by multiplying the stock price by the total number of outstanding ordinary shares. The volatility of E (σ_E) is estimated from past stock price data.

(3) Ronn and Verma method

Ronn and Verma (1986, 1989) use the framework of the Marcus and Shaked method with several modifications.

Specifically, the Ronn and Verma method has two points in common with the Marcus and Shaked method. First, Ronn and Verma express the insurance premium as the premium on a put option using the Black-Scholes formula. Second, because the bank's asset value and its volatility cannot be observed directly, they estimate these figures using data on stock prices and stock price volatility, which can be observed. On the other hand, the Ronn and Verma method differs from the Marcus and Shaked method in the following four points. First, they adopt the asset value after the bank obtains deposit insurance as the underlying asset for the option that determines the insurance premium (in this subsection 2 (3), this is referred to as V, and it should be noted that this definition differs from that adopted in subsection 2 (2), above), and assume that this V is a stochastic variable that follows a lognormal process. Second, in accordance with this expression, equation 4 in the Marcus and Shaked method can be rewritten as V = D + E, but Ronn and Verma do not adopt this relationship, and instead assume the following relationship.

$$E = VN(y) - \rho BN(y - \sigma_V\sqrt{T}) \qquad (8)$$

$$\text{where } y \equiv \frac{\ln\left[\frac{V}{\rho B}\right] + \frac{1}{2}\sigma_V^2 T}{\sigma_V\sqrt{T}}$$

This is consistent with Black and Scholes (1973), who demonstrated that a corporation's (here, a bank's) capital value can be estimated using the theoretical price of a call option (the underlying asset is the asset value V and the exercise price is the future value of the bank's

debt Be^{rT}, where B is the face value of the bank's debt). However, in equation (8), as the exercise price, Be^{rT} is multiplied by ρ ($0<\rho\leq 1$), and this is the third difference versus the Marcus and Shaked method. This takes account of the common understanding that when a bank falls into a net debt position, the supervisory authorities may sometimes provide financial assistance or otherwise exercise forbearance[6] rather than ordering an immediate bank closure. Under this model, a bank closure is not ordered at the moment when V equals B (when the bank falls into a net debt position). Rather, the bank closure is only ordered when V declines to ρB ($\leq B$). Consequently, the parameter ρ may be interpreted as expressing the market expectations of the possibility of financial assistance and/or forbearance by the supervisory authorities (hereinafter, these are referred to as "forbearance expectations"). Ronn and Verma conduct most of their numerical analyses at $\rho = 0.97$. Also, Ronn and Verma report that while changing the value of ρ naturally changes the absolute amount of each bank's deposit insurance rate, this results in virtually no change to the relative amounts of the insurance rates charged to different banks. Like Marcus and Shaked, Ronn and Verma also utilize the relation in equation (5), but by rearranging the equation, instead of the expression in equation (7), they derive the following equation.

$$\sigma_V = \frac{\sigma_E E}{VN(y)} \qquad (9)$$

This is the result of substituting $\frac{\partial E}{\partial V} = N(y)$, which is the result of a partial differentiation of equation (8), into equation (5).

Finally, the fourth difference versus the Marcus and Shaked method is that the framework of the Ronn and Verma method includes both insured liabilities (face value B_1) and uninsured liabilities (face value $B_2 \equiv B - B_1$). They use the situation in which all of the liabilities (face value B) are covered by the deposit insurance. At this point, the hypothetical deposit insurance premium P' is calculated in the same way used in the Marcus and Shaked method.

[6] Ronn and Verma (1986) use the phrase "a temporary reprieve from closure," but here the word "forbearance" – which is considered more familiar – is used.

$$P' = BN(x + \sigma_V\sqrt{T}) - Ve^{-\delta T}N(x) \tag{10}$$

$$\text{where } x \equiv \frac{\ln\frac{B}{V} + (\delta - \frac{1}{2}\sigma_V^2)T}{\sigma_V\sqrt{T}}$$

Because just B_1/B percent of the total liabilities are actually covered by the deposit insurance, assuming that the seniority of all the liabilities is equal, the deposit insurance premium P is calculated as follows.

$$\begin{aligned} P &= \frac{B_1}{B}P' \\ &= B_1 N(x + \sigma_V\sqrt{T}) - \frac{Ve^{-\delta T}B_1}{B}N(x) \end{aligned} \tag{11}$$

This can then be converted into the insurance rate d as follows.

$$\begin{aligned} d &\equiv \frac{P}{B_1} \\ &= N(x + \sigma_V\sqrt{T}) - \frac{Ve^{-\delta T}}{B}N(x) \end{aligned} \tag{12}$$

Using the above results, first the unknowns V and σ_v can be calculated by simultaneously solving equations (8) and (9).[7] The insurance rate can then be determined by substituting the results into equations (11) and (12).

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[7] Iteration is used to solve these simultaneous equations in accordance with the following procedure. First, two new variables are defined for convenience.

$$\begin{aligned} a &\equiv y \\ b &\equiv y - \sigma_V\sqrt{T} \end{aligned} \tag{FN-1}$$

The relationships between these new variables and the unknowns may be expressed as follows.

$$\sigma_V = \frac{a - b}{\sqrt{T}} \tag{FN-2}$$

$$V = \rho B \exp(\frac{a^2 - b^2}{2}) \tag{FN-3}$$

Then the binary simultaneous equations derived from equations (8) and (9) are rewritten using a and b as follows.

$$a = \frac{\sigma_E E\sqrt{T}}{\rho BN(b) + E} + b \tag{FN-4}$$

$$\frac{a - b}{\sqrt{T}}\rho BN(a)\exp(\frac{a^2 - b^2}{2}) - \sigma_E E = 0 \tag{FN-5}$$

If equation (FN-5) is solved for a and b using the Newtonian method with equation (FN-4) as a condition of constraint, by substituting the results into equations (FN-2) and (FN-3), the values of the unknowns can then be determined.

3. Data and Methodology

(1) Data

The objects of the analyses are, in principle, 116 banks whose shares are publicly-traded.[8] The data used is as follows. A represents data used for calculation of market-based information based on option pricing theory. B represents accounting information, and for empirical analysis we use market-based deposit insurance rates and capital ratios calculated by option pricing theory and accounting information.

A. Data for calculation of market-based information

- The stock prices at the end of March (the end of fiscal year) and September from 1996 through 1998.
- The outstanding number of issued shares
- Total liabilities
- The historical volatility calculated from the daily stock prices in the applicable fiscal year (the standard deviation of the daily rate of return).

B. Accounting information

As accounting information, we focus on the disclosed accounting data from March 1996 to September 1998 in the following categories (capital ratio, asset quality, earnings), to which great importance is attached in CAMEL ratings used in the United States.

B1. Capital ratio

We include securities' unrealized gains/losses in capital to calculate real capital-asset ratio. The following data is used.

- Total assets
- Total liabilities
- Securities' unrealized gains/losses

[8] However, banks which are virtually subsidiary firms of other banks are excluded.

B2. Asset quality

As asset quality variables, we use the amount of non-performing loans, loan-loss provisions and loan write-offs. We subtract the amount of loan-loss provisions and loan write-offs from the non-performing loans to calculate the amount of net non-performing loans. The scope of disclosure of non-performing loans has been expanded and it contributes to give more accounting information to the public. The expansion of the scope is as follows.

<From March 1996 to September 1996>

After March 1996 all banks[9] had started to disclose the amount of " bankrupt loans" [10], "past due loans"[11] and "restructured loans"[12]and we use the sum of these amounts as non-performing loans.

<From March 1997 to September 1997>

In addition to the above-mentioned categories, all banks[13] had disclosed "loans to borrowers under financial rehabilitation"[14] and we add the amount of this category to non-performing loans.

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[9] In accordance with the uniform disclosure standards of the Federation of Bankers Associations of Japan, banks of the Regional Banks Association of Japan were not required to disclose the amount of "restructured loans", and banks of the Second Association of Regional Banks (regional banks II) were not required to disclose the amount of "past due loans" and "restructured loans". However, these banks also had disclosed the amounts of all three categories on their own initiative.

[10] Bankrupt loans refer to loans to borrowers in legal bankruptcies (debtors that filed petitions for bankruptcy, corporate reorganization, composition, special liquidation and company arrangement etc.).

[11] These loans refer to loans on which banks are not required to register accrued interest, excluding "bankrupt loans" and "restructured loans" on which accrued interest has not been registered as earnings owing to temporary relief from interest payments. This category mostly comprises loans on which interest payments have been in arrears for more than six months.

[12] These loans refer to loans on which interest has been reduced or waived, or the sum of the following two items.

(1) Loans to help rehabilitate or support borrowers under either of the following conditions: (a) loans whose interest rates are reduced to a level below the official discount rate when contract terms are amended; and (b) spread lending on which interest margin is not secured (i.e., when the interest margin is zero or negative at the time of contract term amendment).

(2) Loans which, after application to the authorities (under the provisions of the above-mentioned corporate income tax), have been officially recognized as claims on which interest has been suspended.

[13] City banks , long-term credit banks and trust banks (also some regional banks and regional banks II) had disclosed "loans to borrowers under financial rehabilitation" since March 1996.

[14] These are claims which have been renounced and can be treated as deductible expenses, with the approval of the tax authorities, in order to provide rehabilitation or support.

<Since March 1998>

In March 1998 (fiscal 1997), the scope of disclosure expanded to cover loans under special risk review based on definitions similar to those set by the United States Securities and Exchange Commission (SEC). Concretely, the category "loans past due three months or more[15]" was introduced in addition to "past due loans", and "restructured loans" and "loans to borrowers under financial rehabilitation" was reclassified as newly defined "restructured loans[16]". We use the sum of "bankrupt loans", "past due loans", "loans past due three months or more" and new "restructured loans" as non-performing loans.

B3. Earnings

As the earnings' variable, we use return to asset ratio. Concretely, we calculate net operating profits (which signifies earnings from core operations) by dividing by assets.

(2) Handling of parameters for calculation of market-based information

In applying the Ronn and Verma method presented above (subsection 2 (3)), two parameters need to be set: the option period T when the stock prices are interpreted as options, and the market expectations of supervisors' forbearance ρ.

A. Setting of the option period

As for the option period T, taking the hypothetical case in which the liabilities of the banks being evaluated all have the same maturity, the equity value may be interpreted as the liquidation value following the period T, so T corresponds to the liability maturity. In actual practice, however, bank liabilities are composed of numerous liabilities with different

[15] These are loans for which payments on principal or interest are due more than three months, calculated from the day after the contract payment date. They exclude "past due loans" (past due more than six months) mentioned above. ("Loans past due three months or more" corresponds to "past-due loans" [past due more than 90 days] under the SEC standards).

[16] These are loans for which the contract conditions were amended to provide specific concessions that benefit borrowers. Such changes are made primarily to facilitate loan collectibility by providing financial assistance to borrowers in economic difficulties. These loans correspond to "restructured loans" under the SEC standards.

maturities, and it is difficult to set the value of T based on maturity information. In this paper, making reference to prior research, the value of T is set *a priori* at one year, and this value is used consistently throughout the analyses.

B. Setting of the forbearance expectations

The next issue is the setting of the forbearance expectations parameter ρ. This paper adopts an approach which uses new external information, and then estimates the implied value of ρ based on this. Specifically, the average spread on debentures measured by rating level is noted, and the value of ρ is estimated to minimize, overall, the gap between each bank's fair insurance rates and this spread. The details of this logic and the analysis results are presented in section 4 of Oda (1999).

4. Results

(1) Estimated relationship between market-based and accounting information

We conduct a regression analysis between market-based and accounting information. The dependent variable is the estimated market-based capital ratio calculated by the option pricing method (MCAP). The independent variables are variables relating to capital ratio, asset quality and earnings, which are derived from accounting information.

Concretely, we calculate the following figures.

- Real capital ratio, adjusted for securities' unrealized gains/losses (CAP)
- Net non-performing loans adjusted for loan-loss write-offs and provisions divided by the amount of asset (NETN)
- Asset return calculated by net operating profits divided by the amount of asset (OP)

The estimated regression equation is as follows.

$$MCAP = a + b\,CAP + c\,NETN + d\,OP \qquad (13)$$

Table 1 presents cross-section regression estimates using 116 banks[17] for each semi-annual statement and annual statement from 1996 to March 1998.

[17] Banks which have failed or whose shares have not yet publicly traded are excluded. Therefore, the sample size for each cross section analysis banks may vary from year to year.

We conduct two types of regression analysis, the regression analysis on the relationship between accounting information and contemporaneous market-based information, and between accounting information and half-year lagged market-based information. Banks' annual and semi-annual statements cannot be obtained at the end of the accounting period (in March and September). At that point market participants have no choice but to infer the current accounting figures by judging from forecast figures in the previous annual or semi-annual statements and other information sources such as rating firms. In this sense, from the viewpoint of the analysis on the relationship between accounting information and market-based information, the latter regression[18] would be more valid.

Table 1. Regression of market-based information on accounting information (t-statistics in parentheses)

Time of Accounting Information		Mar. 96	Sep. 96	Mar. 97	Sep. 97	Mar. 98
		(116 banks)	(114 banks)	(114 banks)	(114 banks)	(116 banks)
Regression of contemporaneous market-based information	**a**	1.27 (1.20)	-0.30 (-0.21)	-0.97 (-1.15)	-0.02 (-0.03)	1.86 (2.43)
	b	-0.001 (-0.02)	0.51 (1.47)	0.62 (3.09)	0.51 (3.74)	0.85 (4.75)
	c	-12.17 (-0.80)	-29.24 (-1.75)	-51.26 (-3.63)	-58.18 (-3.64)	-45.91 (-3.23)
	d	1.36 (0.98)	3.04 (3.16)	1.36 (2.75)	1.63 (0.83)	-1.31 (-1.64)
	R^2	0.01	0.15	0.30	0.20	0.35
		(115 banks)	(114 banks)	(114 banks)	(116 banks)	(115 banks)
Regression of half-year lagged market-based information	**a**	1.61 (1.66)	-0.97 (-0.96)	-0.85 (-0.81)	0.72 (0.81)	0.38 (0.59)
	b	-0.02 (-0.85)	0.66 (2.64)	0.49 (1.96)	0.71 (3.41)	1.07 (7.06)
	c	-26.34 (-1.81)	-49.09 (-4.08)	-72.37 (-4.10)	-64.84 (-4.30)	-44.33 (-3.67)
	d	1.61 (1.28)	2.39 (3.45)	2.20 (3.54)	1.30 (0.83)	-1.36 (-2.02)
	R^2	0.04	0.32	0.28	0.32	0.48

± : coefficients are significant at 5% level and these signs accord with expected ones.

Table 1 summarizes the result of the regression (13).

[18] We selected the point in time of half-year lagged market-based information for the following reasons: Banks' annual and semi-annual financial statements are published three months after the end of accounting period. Particularly, such detailed accounting figures as used in this regression analysis have become known to the general public quite a long time later (about five months later) after the end of the accounting period. Also, accounting figures (total liabilities) for the calculation of market-based information are available only at the end of March or September. Taking these factors into account, the analysis of regression between the accounting information and the market-based information with a six months lag, which are adopted in this paper, would be relevant for the relative impact of accounting information on the market information in different points in time.

The upper and lower half give the results of the regression analysis on the relationship between accounting information and contemporaneous market-based information, and between accounting information and half-year lagged market-based information, respectively.

First, during this period there is an increasing tendency in the explanatory power (R^2) of accounting information, which is represented by three categories (capital, assets and earnings) in the CAMEL rating used in the United States. This tendency is considered to be brought about by two factors[19], namely (1) the expansion of the scope of disclosure to the public and (2) heightened sensitivity to banks' financial conditions, in particular their credit risk, on the market. The details are as follows.

(i) As mentioned before, during this period, the scope of the accounting disclosure (non-performing loans) was expanded twice, namely March 1997 and March 1998. Judging from this table, the expansion of the scope of disclosure could strengthen the interconnectedness between accounting information and market information.

(ii) In the recent severe financial environment surrounding Japanese financial institutions, the market has come to be sensitive to banks' financial conditions.

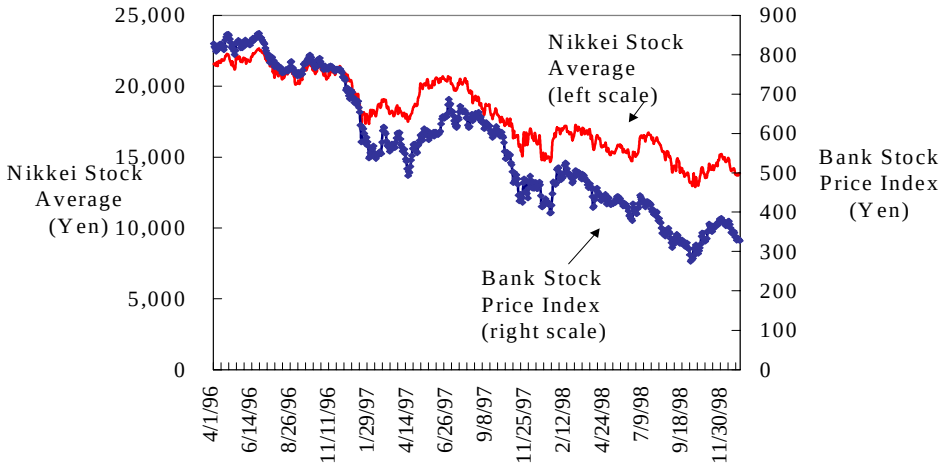
Particularly, a series of financial institution failures from autumn 1997 onwards heightened the sensitivity to the credit risk in the market. For example, on the domestic straight bond market, credit risk came to be dramatically incorporated in the bonds' spread (see, for example, Ieda and Ohba [1998]) after the fall of 1997. Also, the concern of possible financial crisis push down the stock prices, which became more sensitive to banks' accounting information.

Figure 2 presents the daily data of the Bank Stock Price Index (Tokyo Stock Exchange) and the Nikkei Stock Average from April 1, 1996 through December 30, 1998. Several of the conspicuous declines in the bank stock price index correspond to announcements of bank failures (These include the announcements concerning the failures of Hokkaido Takushoku Bank and Tokuyo City Bank in October-November, 1997 as well as failures of Long-Term

[19] Incidentally, during there also seemed to be changes in policy towards bank supervision, going from lenient to strict, which brought about the change in "Forbearance Expectations". In this study, we assume "Forbearance Expectations" have changed in calculating market-based capital ratio, as mentioned in subsection 3 (2). Therefore, this factor can be already considered to be removed in this regression analysis.

Credit Bank of Japan and Nippon Credit Bank in 1998). Through this period it is considered that market participants became more sensitive to banks' disclosed financial data.

Figure 2. Movements of the Bank Stock Price Index and the Nikkei Stock Average



Second, with regard to the sign and significance of the coefficients in regressions, we find the following.

(i) In both types of regression (the upper half and the lower half of Table 1), net non-performing loans is the most significant variable. Except for a few cases (in March 96 and contemporaneous case in September 96), its coefficients c are significantly different from the hypothesized value of null.

(ii) The coefficient b of accounting-based capital ratio (adjusted for securities' unrealized gains/losses) is small but tends to be more significant and larger as time passes. This might be mainly caused by the fact that the recent shrinkage of securities' unrealized gains came to be more strongly recognized by investors as contributing factors to increasing credit risk of banks concerned.

(iii) Profit variable (net operating profit) is not always significant. In particular, it is less significant in the regression using the recent data than the older ones. On the contrary, signs that they are valued negatively by investors are seen in the most recent year. This result is considered to be somewhat affected by the large-scale loan write-offs in the recent years. In this situation, high earnings are not necessarily positively valued, because banks, which have

huge non-performing loans, are sometimes forced to register high earnings for the large-scale loan write-offs by realizing unrealized gains of bonds[20] they hold more than average.

Results of subsection 4 (1) can be briefly summarized as follows:

(i) Market-based capital ratios calculated by using the option pricing method are sensitive to the accounting information disclosed. Particularly, they reflect credit risk accounting measures, which are represented by non-performing loans.

(ii) Expansion of disclosure and the recent severe financial environment have strengthened interconnectedness between market information and accounting information.

(2) Results of predicting bank failure

In this subsection, we conduct empirical tests using both market-based and accounting information to predict bank failure. In particular, one of the aims of this subsection is to explore the possibility of making effective use of market-based information for predicting future bank failure. To begin with, fair premium rates for deposit insurance are estimated by using option pricing theory for eight banks (all previously listed on Japan's stock exchanges) that have failed from 1995 to 1998.

The eight banks[21] are as follows.

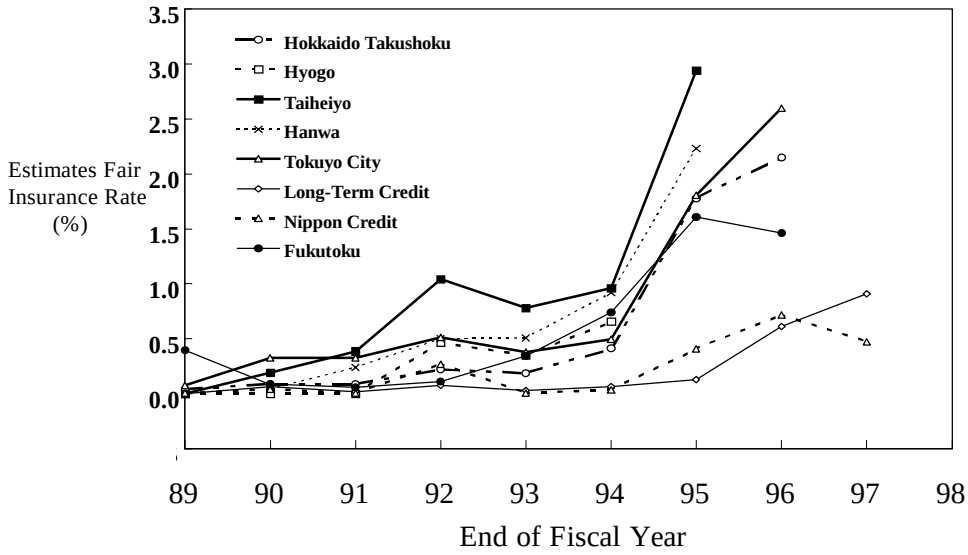
<banks>	<bank category>	<announcement time of failures>
Hyogo	Regional bank II	August, 1995
Taiheiyo	Regional bank II	March, 1996
Hanwa	Regional bank II	November, 1996
Fukutoku	Regional bank II	October, 1997
HokkaidoTakushoku	City bank	November, 1997
Tokuyo City	Regional bank II	November, 1997
Long-Term Credit Bank of Japan	Long-term credit bank	October, 1998
Nippon Credit	Long-term credit bank	December, 1998

[20] Bonds' realized gains/losses are included in operating profit, while equity's realized gains/losses are not included in this profit (they are included in ordinary income). In the most recent year, due to the declines of stock prices, there came to be less room to use equity's realized gains/losses for loan write-offs, which might lead to the increased realizing unrealized gains of bonds, instead.

[21] These listed banks fall under the "failing financial institutions" label which is stipulated in the Deposit Insurance Law. In the Law, "failing financial institutions" are defined as the financial institutions which suspend the repayment of deposits or are on the verge of doing so.

These rates are presented in Figure 3.

Figure 3. Movements of Estimated Fair Insurance Rates for Failed Banks



The last points on the lines for each bank correspond to the time just before the banks failed (the banks all failed within one year from this point in time). At these points, the estimated rates for six of the eight banks are over 1.4%, and the rates for the remaining two banks are also obviously higher than the average rates among non-failed banks (the average rates: 0.31 %(FY95) →0.28 % (FY96) → 0.15 % (FY97)). Moreover, unusually high rates are seen not only just before the banks failed, but also one or two years prior. Thus, Figure 3 demonstrates that there were warning signs regarding the stability of these banks at least two years before they were declared insolvent. In other words, although this is *ex post facto* analysis, in almost every case it was possible to discriminate the banks that failed from those that did not at least 1-2 years prior to the failures. Incidentally, the two banks whose estimated insurance rates at the last points on the lines were lower than the other six banks failed after the new framework for the disposal of failed financial institutions[22] was put into effect in Japan in October 1998. The results in Figure 3 seemed to show that the recent new framework enabled troubled banks to leave the financial system at the earlier stage than before.

[22] Two failed banks (Long-Term Credit Bank of Japan and Nippon Credit Bank) in 1998 were placed under special public management (temporary nationalization), which was one of the new financial revitalization measures introduced in October 1998.

Next, by using the same market-based deposit insurance rates as used above, along with accounting information, we conduct the regression analysis of probability models.

The results of Probit and Logit models predicting subsequent bank failure (through December 1998) are given in Table 2. The sample comprises 56 banks, which are categorized as city banks, long-term credit banks, trust banks and regional banks II[23]. Column (1) shows regressions of bank failures from October 1996 through December 1998 (FAILURE 1) on the accounting information at the end of September 1996 and the contemporaneous market-based information. Column (2) shows regressions of bank failures from April 1997 through December 1998 (FAILURE 2) on accounting information at the end of September 1996 and half-year lagged market-based information (i.e., at the end of March 1997). As accounting and market-based information, we use, respectively, net non-performing loans (adjusted for loan-loss write-offs and provisions <NETN>) and the market-based deposit insurance rate calculated by the option pricing method (DEPO). Among accounting information, NETN is considered to represent credit risk of banks. In fact, NETN have most significant explanatory power in the regression analysis between accounting and market-based information, as examined in Section 4 (1). FAILURE 1 and 2 are dummy variables, which take the value of one if the bank failed during the above period and zero otherwise.

Table 2. Regressions of bank failure on accounting and market-based information (t-statistics in parentheses)

Variable	FAILURE 1		FAILURE 2	
	Probit	Logit	Probit	Logit
NETN	32.12 (2.44)	60.98 (2.41)	32.96 (2.23)	62.18 (2.25)
DEPO	1.08 (2.65)	2.21 (2.59)	1.00 (2.08)	1.90 (2.04)

[23] This sample size was chosen, by taking into account the balance between the number of total observations and that of observations whose dummy variables are positive (failed institutions). In Japan, there are a small number of failed banks in comparison with the total number and for the efficiency of estimation we exclude regional banks' data from the data. Compared with banks in other categories, regional banks are relatively sound and there have been no failures during the sample period.

We find net non-performing loans (NETN) and market-based deposit insurance rate (DEPO) have significant explanatory power[24] both in column (1) and column (2) of the Table 2.

As examined in subsection 4 (1), market-based information reflects the previous disclosed accounting information. In order to confirm this relationship by using DEPO variable and NETN variable, we estimate the following equation.

$$DEPO = a' + b' CAP + c' NETN + d' OP \qquad (14)$$

The only difference from equation (13) is a dependent variable. DEPO represents, as it were, the likelihood of failures while MCAP in equation (13) represents robustness of banks. Therefore, expected coefficients' signs of equation (14) are the opposite to those of equation (13). The results of regression (14) are given as follows.

Table 3. Regression of market-based deposit insurance rate on accounting measure (t-statistics in parentheses)

	Explanatory variable				
	C	**CAP**	**NETN**	**OP**	**R^2**
< Mar.96 → Sep.96 >	0.70 (2.29)	0.01 (1.35)	11.36 (2.96)	-0.63 (-1.72)	0.19
< Sep.96 → Mar.97 >	0.72 (1.77)	-0.10 (-0.93)	16.02 (3.63)	-0.50 (-2.25)	0.30

The first half of Table 3 shows that the regression of market-based information in September 1996 on accounting information in March 1996, and the second half of the table shows that of March 1997 information on September 1996 information. In both columns net non-

[24] The number of value 1 in FAILURE dummy variable is small (6 in column (1) and 5 in column (2)), but the robustness of this regression is confirmed by the simulation using the same data.

Incidentally, marginal effects (slope) for probit and logit models show that changes of explanatory variables has the following impacts.

(1) 10% point change of NETN has the impact of 35%(probit) and 33% increase in the failure probability on average (Failure 1). Similarly, 10% point change of NETN has the impact of 27% increase in the failure probability on average (Failure 2).

(2) 1% point change of DEPO (deposit insurance rate) has the impact of 12% increase in the failure probability on average in Failure 1 and 8% increase on average in Failure 2.

performing loans (NETN) are significant and their coefficients' signs accord to theoretical expectations.

When combining Table 2 with Table 3, the results can be interpreted as follows:

(i) As column (1) of Table 2 shows, both accounting information (NETN) and market-based information (DEPO) have an explanatory power for predicting bank failures. By definition, the DEPO variable cannot reflect information in the other explanatory variable, contemporaneous NETN (which has not yet been disclosed at the time), but only the previous disclosed accounting information. Only seen from these results, FAILURE 1 regression might suggest that both current accounting information (as in NETN) and a proxy of the previous accounting information (as in DEPO) are useful in predicting bank failures.

(ii) In column (2) of Table 2, unlike column (1), the DEPO variable can reflect information in the other explanatory variable, half-year lagged NETN. This is empirically confirmed by Table 3. Nevertheless, both DEPO and NETN have an explanatory power for predicting bank failures. This result suggests that market-based information (as in DEPO) contains some useful information, such as analysts' evaluations or rumors, in identifying risk banks in addition to the disclosed accounting information.

To summarize, the results in subsection 4 (2) suggest that market-based information and accounting information are useful in jointly identifying risk banks.

5. Conclusions

This paper has investigated the effectiveness of accounting information and market information in identifying risk banks. Specifically, in order to identify risk banks by their market-based information, we have calculated market-based deposit insurance premiums and capital ratios using the option pricing method. Then we have conducted empirical tests on the relationship between market-based information derived from this calculation and accounting

information of Japanese banks. We have also conducted empirical tests using both market and accounting measures to predict future bank performance.

Our findings can be summarized as follows:

(1) Market-based capital ratios calculated by using the option pricing method are sensitive to the accounting information disclosed. Particularly, they reflect credit risk accounting measures, which are represented by non-performing loans.

(2) Expansion of disclosure and the recent severe financial environment have strengthened interconnectedness between market information and accounting information.

(3) Market-based information (risk-adjusted deposit insurance rate) and accounting information (net non-performing loans) are useful in jointly identifying risk banks.

In Japan, there has so far been a small number of empirical studies[25] on the use of accounting and market information for the prediction of bank performance, while there have been lots of studies in the USA and some other developed countries, especially on the early warning system of the bank failures or the option model for valuing deposit insurance. After World War II until the first half of 1990, the Japanese financial system had been protected by the so-called "convoy administration" by the government, where financial institutions had been heavily controlled and protected from hard free competition. Thus, this paternalistic financial structure along with the steady economic development had provided stability in the financial system. In these circumstances, where there were virtually no experiences of bankruptcies in financial institutions in the postwar period, there had seemed to been little need to predict bank failures.

In the first half of the 1990s, Japan's financial system experienced a disturbance of a magnitude that it had not experienced since the prewar financial crisis almost half a century ago. After the crash of an economic 'bubble' in the early 1990s, financial institutions came to be burdened with substantial non-performing loans, most of which were related to real estate,

[25] Among them, Tanaka and Moridaira (1998) and Yabushita (1995) focused the use of accounting information for the prediction of bank failure, whereas Ikeo(1991a, b) and Omura (1986) studied the option model for valuing deposit insurance by using Japanese equity prices.

Tanaka and Moridaira (1998) dealt with the prediction of failures of Credit Cooperatives (small financial institutions in a cooperative form) and Yabushita (1995) dealt with the prewar financial crisis.

and the resulting loss of interest income and write-off costs seriously impaired their financial condition. Since 1995, following the failures of large Credit Cooperatives, we have experienced some failures of regional banks II. Finally in 1997 and 1998 some banks, which were categorized as some of Japan's major banks, also failed.

However, on one hand, after the bitter experience of severe financial environment, there have also been positive changes in Japan's financial system. First, the scope of disclosed accounting information to the public has been expanded considerably in 1990s. Particularly, as discussed before, the scope of information pertaining to non-performing loans has been expanded[26]. Next, on the basis of the expansion of public disclosure, market mechanisms have come to work, which evaluate how financial institutions are managed and detect, at an early stage, excessive risk taking that might lead to problems.

Thus, timely disclosure of the financial condition of banks and market efficiency are improving, therefore providing more room for the supervisory authorities to use market information and accounting information as complementary information to that collected through bank examinations. This paper has explored this possibility and verifies empirically that accounting and market information are interconnected and they are useful in jointly identifying risk banks. In the future, there will be more need to analyze the accounting and market information for predicting bank performance.

[26] Besides non-performing loans, mark-to-market accounting has been applied to the trading accounts of banks and securities firms from fiscal 1997. Moreover, major financial institutions have started to disclose the market profile of their trading portfolios.

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