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Source: *The Journal of Finance*, Vol. 35, No. 1 (Mar., 1980), pp. 137-150
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2327186
Accessed: 27/11/2009 08:48

THE JOURNAL OF FINANCE • VOL. XXXV, NO. 1 • MARCH 1980

Establishing On-Site Bank Examination Priorities: An Early-Warning System Using Accounting and Market Information

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I. Introduction

THE ON-SITE EXAMINATION is and has been the backbone of bank supervision in the United States. Both federal and state banking agencies attempt to perform on-site inspections every twelve to twenty-four months for banks under their jurisdiction. Banks with known supervisory or financial problems are given top priority in the examination process, whereas small banks with satisfactory management, adequate capital, and acceptable earnings are given the lowest priority.[1]

At present, on-site inspection priorities are established using historical examination and accounting reports. The purposes of this paper are to suggest an early-warning technique using accounting and market information which may be useful in creating a more efficient method of scheduling bank examinations and to test the proposed dual-screening technique on a population of banks which have recently failed. If a bank is designated or flagged as a potential problem bank by both the market screen and the accounting screen, it is considered to be in immediate need of an on-site inspection. If a bank is flagged by only one system, the early-warning signal is considered to be less urgent. Banks not flagged by either screen and with "clean" histories are placed at the end of the examination queue.

The proposed dual-screening technique applies only to banks with actively-traded securities, such banks are the largest ones and present the greatest risk to the deposit-insurance fund and to the stability of the banking system.[2] For banks without active markets for their securities, a single screen based upon accounting data is recommended to establish examination priorities. Thus, the suggested early-warning system should be used to order the examination queue.

In establishing any early-warning system, the bank regulator's primary desire is to minimize the misclassification of problem banks as nonproblem banks (type-I error). To obtain classification information early, regulators should be willing to accept a higher type-II error (classifying nonproblem banks as problem banks) to gain a lower type-I error. Additionally, the type-II misclassification error only

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[1] For more detail on this topic see Le Maistre [9].

[2] As of December 31, 1976, there were only 130 commercial banks with total assets greater than \$1.0 billion. These giant banks, which represent less than one percent of the number of banks, control 25.5 percent of the total assets in the banking system. The 1,152 banks with total assets greater than \$100 million represent 7.8 percent of the number of banks, but control almost 72 percent of all banking assets. FDIC, *Annual Report,* (1976), Table 105.

would place healthy banks higher in the examination queue than normal. Of course, this type of misclassification would not be costless. However, as long as only a few nonproblem banks are scheduled for early examinations, the cost would be small compared to the benefits derived from early knowledge and early classification of potential problem banks.

The early-warning system developed in the fourth section of this paper is tested directly on a population of large failed banks to determine if the system provides earlier and useful information about the failed banks. The technique also is applied to a holdout sample of large nonfailed banks to assess the type-II error of the model. If the suggested system does provide early detection of banks which subsequently failed and if the misclassification errors are reasonable, the system may be helpful in scheduling bank examinations and providing earlier warning about the potential problems of commercial banks.

II. Information Available for Identifying Banks with Financial Difficulties

One of the ways the banking authorities attempt to carry out their safety-and-soundness mandate is to prevent existing banks from failing.[3] Since the failure path tends to be a decaying one rather than an explosive one, identifying banks with financial difficulties is a first step toward achieving the failure-prevention goal.

The major weapon in the banking authorities' identification arsenal has been and still is the on-site bank examination. This inspection technique primarily focuses upon evaluating the quality of bank's loan portfolio relative to its capital reserves. It results in a de facto definition of a "problem bank" as one with a large volume of "substandard loans" relative to its capital reserves. See Sinkey [22].

Four decades ago Secrist [17] suggested that bank accounting data be used to distinguish sound from unsound banking. However, only recently have the banking agencies attempted to make more efficient use of these data in the form of early-warning or surveillance systems. These systems can be used to assist in scheduling on-site bank examinations and allocating more efficiently the bank agencies' scarce resources.

Bank equity prices are another source of information for identifying banks with financial difficulties. If the market for actively-traded bank equities is reasonably efficient, information about potential problems at a bank will be translated into the bank's security prices. Although many bank regulators tend to reject the notion of efficient markets for bank equities, recent empirical evidence suggests that the market for large bank equities is efficient.[4] Therefore, market information may also provide an important component for an early-warning system designed to establish on-site examination priorities.

[3] Congressional oversight and recent hearings on problem and failed banks reinforce this interpretation of the safety-and-soundness mandate.

[4] Beighley [2], Fraser and McCormack [4], and Herzig-Marx [8], Murphy [13], Pettway [14, 15, 16], and Shick [20].

III. The Methodology of Early-Warning Systems

Two conditions must be present in a study of any proposed early-warning system to assure that the scheme can be implemented. First, the study must avoid sample selection bias associated by observing only failed banks. Second, the study must be *ex ante* rather than *ex post*. In other words, the methodology must not employ data or information available after some critical date (i.e., information about the financial condition of a failed bank after its classification as a "problem bank" and even information of the actual failure of the bank are not available to the regulator or the market before the critical date). To avoid these potential pitfalls, we employ control groups of nonfailed banks and we use only data available prior to the critical dates.

A. *An Early-Warning System Based Upon Accounting Data*

Hanweck [6, 7], Korobow, Stuhr, and Martin [10], Martin [12], Sinkey [21, 23, 24, 25, 26], and others have established the usefulness of accounting data in identifying potential problem and/or failed banks. The *modus operandi* employed in the studies are strikingly similar. A sample of distressed banks is compared with a paired or random sample of healthy banks. Data several years before some critical date (e.g., failure) are gathered and massaged. Financial characteristics are identified, the sample banks are reclassified, and predictions are made using holdout samples. Alternative but similar classification techniques such as discriminant, logit, or probit analysis are employed. To implement the models as early-warning systems, they are applied to the population of banks to identify those institutions with characteristics more similar to the failed- or problem-bank group. This information can be used to schedule on-site examinations and thereby direct scarce resources to those institutions that really need supervisory attention.

The accounting screens employed in this paper are Sinkey's [21] failure-prediction model. They are discriminant-analysis models with the same variables but different coefficients depending upon the year before failure. The specific models are presented below in the empirical-test selection.

B. *An Early-Warning System Based Upon Market Data*

The methodological approach using the market data centers on a portfolio of twenty-four large nonfailed banks prior to and contemporaneous with the classification of any potential failed bank.[5] To obtain estimating parameters based upon the market's required returns for these banks, which are judged to have only nominal potential for bankruptcy, the market model (1) developed by Sharpe [18] and later refined and expanded by Sharpe [19], Lintner [11], and others is applied to the portfolio return of these twenty-four banks. That is,

[5] The banks selected to represent the population of nonfailed banks with active security markets are the 24 banks in the Keefe Bank Stock Index (Keefe, Buryette and Woods, Inc.). These banks are chosen because of their market volume, prominence in the industry, and geographic dispersion. These banks serve as a control group and the required returns of other banks are compared with the returns of this control group to ascertain any significant differences in returns over time.

$$\tilde{R}_{p,t} = \hat{\alpha}_p + \hat{\beta}_p \tilde{R}_{m,t} + \tilde{u}_{p,t} \tag{1}$$

$\tilde{R}_{p,t}$ is the weekly holding period return on the portfolio of twenty-four banks based upon Thursday's closing prices for period t. A tilde indicates a random variable. $\tilde{R}_{m,t}$ is the return on a market factor common to all assets and is proxied by the weekly holding period return on Standard and Poor's 500 composite index based upon Thursday's closing prices. $\hat{\alpha}_p$ and $\hat{\beta}_p$ are the parameters to be estimated and $\tilde{u}_{p,t}$ is the error term associated with the linear model.

To obtain specific $\hat{\alpha}_p$ and $\hat{\beta}_p$ estimates which can be related contemporaneously with the data before the problem classification of a failed bank, equation (1) is estimated before the examination which led to the bank's classification on the FDIC's problem-bank list.[6] Thus, six estimates of $\hat{\alpha}_p$ and $\hat{\beta}_p$ are obtained prior to any adverse information about the actual failure of any of the sample banks.

To determine the estimated market return on the portfolio of nonfailed banks at any point in time during the critical test period, the $\hat{\alpha}_p$ and $\hat{\beta}_p$ derived from equation (1) for each bank's unique estimating period were employed with contemporary estimates of the market return in equation (2). That is, during the test period:

$$\hat{R}_{p,t} = \hat{\alpha}_p + \hat{\beta}_p R_{m,t} \tag{2}$$

where $\hat{R}_{p,t}$ is the estimated return on the portfolio of twenty-four nonfailed banks at time t and $R_{m,t}$ is the return on the S&P 500 index in time t. $\hat{\alpha}_p$ and $\hat{\beta}_p$ are the estimated parameters from the previous estimating time period for the portfolio of twenty-four banks.

Three residuals are developed for study. First, the total-error residual in (3) is equal to the difference of the weekly return on bank J and the estimated return on the portfolio of twenty-four nonfailed banks at time t in the test period.

$$E_{T,t} = R_{J,t} - \hat{R}_{p,t} \qquad \text{(Total Error)} \tag{3}$$

where $E_{T,t}$ is the total error at time t, $R_{J,t}$ is the actual return on the Jth bank at time t, and $\hat{R}_{p,t}$ is the estimated return on the portfolio of nonfailed banks from equation (2).

The second residual, the estimating-error residual, is the difference between the actual return on the portfolio of nonfailed banks ($R_{p,t}$) and the estimated return on the portfolio of twenty-four banks ($\hat{R}_{p,t}$) at time t subsequent to the estimated period.

$$E_{E,t} = R_{p,t} - \hat{R}_{p,t} \qquad \text{(Estimating Error)} \tag{4}$$

The most important residual error for this study is the difference between the total error ($E_{T,t}$) and the estimating error ($E_{E,t}$) at time t for each bank J as shown in equation (5).

$$E_{J,t} = E_{T,t} - E_{E,t} \qquad \text{(Firm-Specific Error)} \tag{5}$$

[6] The market model was applied with different lead times before the date of the examination which led to classification of an individual bank. The minimum lead time from the end of the estimating period to the beginning of the classifying exam was one year for both U.S. National and Franklin. The maximum lead time was three and one half years between the end of the estimating period and the exam of the Security National Bank.

$E_{J,t}$ is the error due to firm-specific variation of bank J after adjusting for any estimating error due to nonstationarity between the estimating and test periods. If there is stationarity, the estimating error will be zero and the estimated return on the nonfailed bank group will equal the actual return on the control group during the test period. Under these conditions the total residual error $E_{T,t}$ contains all the firm-specific differences between an actual return of bank J at time t and the actual return on the twenty-four bank portfolio. If the estimating error is nonzero, it must be removed from the total error to measure the firm-specific error without estimating bias. The firm-specific error captures any change in the market's perception of the potential bankruptcy of the Jth bank. If $E_{J,t}$ is zero at time t, there is no extra or nonnormal expectation about the potential failure of bank J at time t. Additionally, since $E_{J,t}$ is determined through time using only current and past information available at that point in time, it could be useful as an *ex ante* measure of the bankruptcy potential of bank J relative to the control group.

To measure the impact of new information and/or changes in market perceptions about the potential failure of bank J, the firm-specific error for bank J is accumulated over time until the actual failure of bank J. That is,

$$CE_{J,T} = \sum_{t=1}^{T} E_{J,t} \qquad \text{(Cumulative Firm-Specific Error)} \qquad (6)$$

where $CE_{J,T}$ is the accumulated error of bank J to T, and where $E_{J,t}$ is the firm-specific error of bank J at time t. Equation (6) is the market screen used and tested in this paper.

IV. A Suggested Screening Model

The screening model suggested in this paper has a dual-filtering mechanism: (1) a filter based upon an MDA classification model using accounting data and (2) a filter based upon the market model using market data. There are four possible outcomes for a bank analyzed by the dual-screening mechanism: (1) no flags, (2) an accounting flag, (3) a market flag, and (4) accounting and market flags. A "flag" refers to an adverse classification by the respective filtering mechanism.

A. *The Accounting Filter*

A bank receives an accounting flag if it has financial characteristics more similar to the average failed bank than the average nonfailed bank. The financial characteristics for the filter are derived from a paired sample of failed and nonfailed banks. The failure predictions are based upon a two-variable, linear discriminant function.[7] A bank is assigned to the failed group if its probability of membership in the failed group is greater than 0.50. Alternatively, if the bank's Z-score is greater than zero, it is assigned to the failed group.

[7] Both linear and quadratic classification equations were calculated. However, in the years more distant from failure, the variance-covariance matrices were not significantly different and hence quadratic equations were not required. Moreover, since in the first few years before failure the linear and quadratic findings were not substantially different and since the linear models outperformed the quadratic ones in holdout sample tests, we focus upon the linear models.

B. *The Market Filter*

The fundamental problem of implementing the market model scheme is that it is extremely difficult to detect significant trends in cumulative firm-specific error. That is, $CE_{J,T}$ may fluctuate about zero or its most recent value and it will be extremely difficult to determine when a downward trend is really a sign of changed perceptions or just another reversible part of the past cycles in $CE_{J,T}$. Two heuristic filters are suggested for implementation and testing:

1. A Runs Test. This system observes the cumulative residuals and tries to locate significant trends. The approach is similar to Fama, Fisher, Jensen and Roll [3] and is implemented here by locating a run of at least six successive negative residuals with each residual being less than the cumulative residual previously observed (i.e., during this type of run there are no reverses of the trend). This "unscientific" heuristic[8] is based upon the idea that net negative information in an efficient market requires a one-time downward adjustment in price or a one-time upward adjustment in the required return. Therefore, six weeks of successive reduced cumulative residuals can be interpreted as a succession of net negative information and/or a basic increase in the probability of the Jth bank's failure.

2. An appropriate t-test. A suggested t-test of the residuals of bank J has been proposed and the level of significance set at .05 so as to classify new trends quickly.[9] Since this test is affected by the number of observations and therefore by the starting point, it has been implemented by continuously updating over a twenty-six week period (i.e., at each t the residual of $E_{J,t=-27}$ is omitted and $E_{J,t}$ is added to form $CE_{J,T}$ where $T = 26$ at each t).

V. Empirical Tests

Since large banks present the greatest risk to the solvency of the deposit-insurance fund and to the safety and soundness of the U.S. commercial banking system, they should be the focal point for testing early-warning mechanisms. Accordingly, the findings presented in this section focus upon six of the nine largest U.S. bank failures, the ones marked with a triple asterisk in Table I, as they had sufficient daily trading of their common shares over the sample period for the market screen.[10] Failure is defined as a declaration of insolvency by the chartering agency or as a reorganization to avoid de jure failure.

[8] Although this is an "unscientific" technique, it should be noted that the probability of six successive negative residuals due to chance and not due to a trend is only 1.56 percent.

[9] Altman and Brenner [1] used a t-value calculated as the cumulative average residual (as of a particular period) divided by an estimate of the standard deviation of the cumulative average residual. This suggestion has been applied to each bank's cumulative residual in the following way. If $E_{J,t}$ is assumed normal, with mean 0, and variance σ^2 at time t, and if $CE_{J,T} = \sum E_{J,t}$, then $E(CE_{J,T}) = 0$ and $V(CE_{J,T}) = T\sigma^2$. Thus, the following t statistic was created $t = CE_{J,T}/[(\sqrt{T})(\sigma_{E_{J,T}})]$. Since the estimates come from regression equation (1), the degrees of freedom for the test are equal to $T - 2$.

[10] It should be noted that the date when each of the banks was assigned to the problem-bank list is not shown in Table I as this list and the classification dates are confidential documents only available to the bank regulatory authorities. This information was released to the authors only on these failed banks and only under the condition that the dates not be made public. But, it can be stated that all the banks listed in Table I becomes classified on the problem-bank list after the date of the beginning of the on-site exam stated in Table I.

Table I

Major Bank Failures and Reorganizations

Banks	Sufficient Trading	Total Deposits ($ millions)	Date of the Beginning of the Examination which Led to Classification	Failure or Reorganization Date
1. *Security National Bank*, Long Island, N.Y. Reorganization	***	$1,497	6/24/74	1/19/75
2. *Franklin National Bank*, N.Y. Failure	***	$1,445	11/14/73	10/8/74
3. *U.S. National Bank*, San Diego Failure	***	$ 932	6/26/72	10/18/73
4. *Hamilton National Bank*, Chattanooga Failure	***	$ 336	9/30/74	2/16/76
5. *American Bank & Trust*, N.Y. Failure		$ 199		9/15/76
6. *International City Bank & Trust*, New Orleans Failure	***	$ 160		12/3/76
7. *American City Bank & Trust*, Milwaukee Failure	***	$ 145	7/8/74	10/21/75
8. *American Bank & Trust*, Orangeburg Failure		$ 113		9/20/74
9. *Northern Ohio Bank*, Cleveland Failure		$ 95		2/14/75

A. *The Accounting Screen*

The accounting filter is a two-variable MDA classification model. The two variables are:

1. OEOI = Total operating expenses as a percentage of total operating income.
2. IA = Investments as a percentage of total assets, where investments include all securities plus federal funds sold.

OEOI is a measure of a bank's operating efficiency and IA is a measure of safety (or risk). Failed banks tend to be less efficient and make fewer investments (i.e., make more loans, especially bad ones) than nonfailed banks.[11]

The accounting model was developed using 33 banks that failed over the period 1970 to 1975. Each failed bank was matched with a nonfailed bank on the basis of deposite size, number of branches, and location (SMSA or county). It should

[11] For example, one year prior to failure the group means (standard deviations) for the failed group were OEOI = 102.4 (23.21 percent) and IA = 19.51 percent (10.27 percent). The values for the nonfailed group were OEOI = 78.56 percent (9.47 percent) and IA = 39.68 percent (14.46 percent).

Table II

Linear MDA Z-Scores for Six Failed Banks

Year Before Failure	Franklin National Bank (10/8/74)	U.S. National Bank (10/18/73)	Hamilton National Bank (2/16/76)	International City Bank & Trust (12/3/76)	American City Bank & Trust (10/21/75)	Security National Bank (1/19/75)
1	1.30*	0.49*	4.12*	1.52*	4.09*	4.39*
2	1.05*	0.48*	0.82*	2.54*	0.80*	2.24*
3	0.95*	1.23*	1.15*	1.78*	0.04*	0.10*
4	−0.48	1.21*	0.11*	0.40*	−0.08	−0.21

Notes: Figures in parentheses under each bank's name are its failure or reorganization date. The year-before-failure dates are the closest December 31 dates corresponding to the failure or reorganization date (e.g., for Security National one year prior (12/31/74) is only nineteen days and for International City one year prior (12/31/75) is roughly eleven months). If a bank's Z-score is greater than zero, it received an accounting flag, noted with an asterisk for each bank. Because of small sample sizes and the drop-off in predictive accuracy for the original models beyond four years prior to failure, accounting flags in the fifth and sixth year prior were not considered to be relevant and are not presented here.

be noted that three of the failed banks in this original sample (Franklin National, U. S. National, and American City Bank & Trust) are used to test the proposed dual-screening mechanism described below. However, when these three banks were dropped from the original sample, the findings were almost identical to the results from the original sample. Given the paucity of large bank failures, empirical findings based upon the full sample of thirty-three banks are reported.[12] In addition to the original sample, the accounting screen also was tested on a holdout sample of the 16 banks that failed in 1976. In this holdout-sample test, the linear model correctly identified 15 of the 16 banks as future failures one year prior to failure and 14 of the 16 two years prior. Two of the holdout sample banks (Hamilton National and International City Bank and Trust) are included in the test of the dual-screening mechanism. However, they are not a source of sample bias, since they were not members of the original sample of 33 failed banks.

The linear *Z*-scores of the OEOI-IA model for the six failed banks used to test the dual-screening mechanism are presented in Table II. If the *Z*-score is greater than zero, the bank receives an accounting flag, noted with an asterisk in Table II.

The critical dates for both the accounting screen and the market screen are the dates the on-site examination began which led to the banks being placed on the FDIC's problem-bank list. Based upon past history, a computer tape of year-end accounting data for all banks to test the accounting screen usually would be available around midyear. Since in the past the banking authorities have not

[12] In the reclassification of the original sample of 33 failed and 33 nonfailed banks, the Lachenbruch classification technique (described as an "almost" unbiased method) was employed. The Lachenbruch method requires the calculation of $N_1 + N_2$ different classification rules (where N_1 equals the number of observations in each group, 66 in this case) holding out a different observation (bank) each time. The observation which is held out then is classified. In contrast, a simple reclassification of the sample does not hold out the observation that is being classified, which is the source of the sample bias. The overall classification rates for the OEOI-IA linear model for years one to four prior to failure are 82%, 75%, 78%, and 76%.

attempted to analyze separately large banks' accounting data, we select July 1 as the information date corresponding to an accounting flag triggered by December 31 data.

As seen in Table III, the average lead time using the accounting screen over the actual beginning exam date is roughly 66 weeks. The lead times range from a maximum of 103 weeks for U.S. National to a minimum of 51 weeks for Security National. Franklin National, the largest U.S. bank failure and the FDIC's most troublesome deposit-assumption negotiation, has a lead time of 71 weeks.

To summarize, the accounting screen provides valuable lead time that regulators could have used to carry out more effectively their statutory responsibilities. For the six failed banks screened by the accounting model, the critical type-I error is zero.[13]

B. *The Market Screen*

Using the two proposed heuristic market filters, the critical dates of changing information or increased bankruptcy potential for the sample of failed banks also are shown in Table III. In all but one case, the twelve critical dates precede the beginning dates of the examination which led to the banks being classified as "problem institutions."

Using the suggested runs test, the lead times over the beginning date of the examination which led to classification of the bank on the problem bank list range from a maximum of 140 weeks for Security National to a minimum of seven weeks for Hamilton National. The average lead time of the runs test is 53 weeks. The lead times for the *t*-test range from 65 weeks for Franklin to a five-week lag for Hamilton with an average lead over the six banks of 33 weeks. Although there appears to be a twenty-week advantage (on average) of the runs test versus the *t*-test, most of this difference is accounted for by the large lead time for Security National. If Security National is excluded, the average advantage of the runs test over the *t*-test is only seven weeks. Additionally, it should be noted that both tests have the same critical date and lead time for Franklin National and only a week separates the critical dates for American City Bank and Trust.

To summarize, the market screen, like the accounting screen, produces early-warning signals that precede the start of the examinations which led to the sample banks being classified as problem institutions. The market-screen tests indicate that investor's perceptions, as reflected in bank equity prices contain useful information for early-warning purposes.

[13] It is the objective of an early-warning system to provide quick notification of disturbing changes in a bank's financial condition. The early-warning system proposed here should be used to schedule examination priorities, as on-site examinations are the backbone of bank supervision. Since these examinations usually are performed within twenty-four months without any assigned queueing priority, any error of incorrectly classifying a "good" bank as a potential "problem" bank and ordering an on-site examination sooner is not very costly compared to the substantial benefits of early detection of problem banks. The benefits of early detection of problem banks with the resulting ability of regulators to affect policies which may avoid bankruptcy, should be much more valuable than any cost of misclassifying banks when establishing on-site examination queue priorities.

Table III

Tests of the Dual-Screening Mechanism

		Accounting Flag		Market Flag			
				Runs Test		T-test for *CE* (*J*, *T*)	
Bank	Beginning Exam Date	Date	Lead Time Prior To Beginning of the Exam (weeks)	Date	Lead Time Prior To Beginning of the Exam (weeks)	Date	Lead Time Prior To Beginning of the Exam (weeks)
Franklin National	11/14/73	7/1/72	71	8/10/72	65	8/10/72	65
U.S. National	6/26/72	7/1/70	103	12/30/71	26	3/28/72	13
Hamilton National	9/30/74	7/1/73	64	8/8/74	7	11/7/74	−5
International City	6/31/74*	7/1/73	52	9/20/73	40	1/24/74	23
American City	7/8/74	7/1/73	53	10/18/73	37	10/11/73	38
Security National	6/24/74	7/1/73	51	10/14/71	140	4/12/73	62
Average			66		53		33

* Indicates an approximate date because International City was added to the FDIC's problem-bank list as a result of unfavorable developments that occurred between on-site examinations. The problem-bank list lead times for International City are: 64 weeks for the accouning flag; 52 weeks for the runs test; and 35 weeks for the t-test. We thank John J. Early, Director of the FDIC's Division of Bank Supervision, for providing the beginning examination dates.

C. *The Accounting and Market Screens*

As to the relationship between the accounting and market screens presented in Table III, the accounting flag generally leads the market flag. Since the accounting flag and the downturn in the cumulative firm-specific error are not very far from one another, we conclude that the market for equity shares of large banks is efficient in translating public information into current share prices.

The accounting screen has its greatest advantage in the U. S. National and Hamilton cases. This is interesting as the activities in these banks prior to failure are notorious for their abusive self-dealing and violations of law and regulations. In the Security National Bank case, the market screen outperforms the accounting screen. But more importantly and in all cases, the dual-screening technique provides an earlier warning than did the existing system of establishing examination priorities. The use of the suggested technique instead of the existing priority system would have provided at least an urgent call for an on-site inspection one year prior to the date on which the on-site classifying examination actually took place. Therefore, it must be concluded that there are substantial benefits to using accounting and market data to establish on-site bank examination priorities.

D. *The Type-II Error: A Validation Test*

Even though the suggested model works very well in classifying failed banks as problem banks, the potential misclassification of nonproblem banks as problem banks should be assessed. In the extreme case, if all banks were classified as problem banks by the dual-screening mechanism, it would not be very helpful or effective as an early-warning system. To assess the magnitude of the misclassification of nonproblem banks as problem banks, the dual-screening system was applied to a holdout sample of six nonfailed commerical banks. The banks chosen for study have actively traded securities and were selected at random, one from each of the six banking regions recognized by Keefe, Buryette, and Woods, Inc.[14]

To test the model on a difficult and unstable period for the banking system, the period of January 1, 1974 through December 31, 1976 was selected. It should be noted that, since the problem-bank list is a confidential document, we have no way of verifying the true accuracy of this holdout-sample test, only regulators with access to these confidential lists can actually validate our results. The misclassification error is measured against the presumption that the six banks were nonproblem institutions over the sample period.

Applying the dual-screening mechanism to this holdout sample, none of the six nonfailed banks were flagged by both techniques during the 156 week test period. Neither the runs test nor the t-test of the market screen flagged any of the six banks during the test period. However, using December 31, 1976 data, the accounting screen for one year prior to failure flagged 4 of the 6 banks as having OEOI-IA charactristics more similar to the average failed bank than the average

[14] The six banking companies selected as nonproblem banks were: J. P. Morgan and Company, First National Boston Corporation, National Detroit Corporation, Wachovia Corporation, First International Bankshares (Dallas), and Wells Fargo and Company.

nonfailed banks. For models using more distant dates prior to failure, the type-II error was even larger. While this test of the accounting screen was disappointing, it was not a complete surprise since the typical failed bank used in developing the accounting model is much different from the billion-dollar banks that comprise the holdout sample. Recall that only two members of the failed-bank group used to develop the accounting screen were billion-dollar institutions.[15]

When applied to large banks, it is clear that the accounting part of the dual-screening mechanism needs to be improved. Guttentag [5] contends that for large banks only basic "bottom-line" comparisons are likely to be meaningful when using accounting data. Testing Guttentag's contention with OEOI as the bottom-line variable, none of the six branches were flagged as of December 31, 1976.[16] Moreover, applying the same model to 1974 and 1975 annual income and expenses, only one bank was flagged in each year.

To summarize, this section has examined the type-II error of our classification scheme. The important result is that none of the six nonproblem banks were misclassified by both the accounting and market screens. This finding suggests that the dual-screening mechanism would work well as an early-warning system, since it does provide earlier detection of problem banks without misclassifying nonproblem banks. Finally, the results of the validation test support Guttentag's argument for basic bottom-line comparisons for large banks.

VI. Summary and Conclusions

The purposes of this paper have been (1) to suggest an early-warning technique using accounting and market information which may be useful in creating a more efficient system of establishing the priorities of banks to be examined and (2) to test the suggested dual-screening technique on a population of banks which have recently failed. The focal point of the proposed system is large banks with actively-traded securities, the ones presenting the greatest risk to the deposit-insurance fund and to the stability of the banking system. A dual-screening mechanism is developed using accounting and market information applied to recently failed banks and to a control group of nonfailed banks. The methodology employed uses only past and current information available to both the market and the regulator on or before the examination date which led to the bank being placed on the FDIC's problem-bank list.

It is concluded that the dual-screening system would have scheduled examinations for six of the largest banks which subsequently failed at least one full year before the beginning of the classifying examination. Although the primary test of the early-warning model focused upon classifying problem banks, an additional test of the system's potential type-II error was made. Based upon a

[15] The weak link in using the accounting screen on these large nonfailed banks was the IA variable. The six-bank average of IA was less than the value of IA for the average failed bank in the original sample, reflecting a basic difference in asset management between large and small banks.

[16] With OEOI as the bottom-line variable, the one year prior linear model has a cutoff value of OEOI = 90.88 percent. The original sample of 33 failed and 33 nonfailed banks was used to develop this single-variable model, which had a classification accuracy rate of 74.34 percent one year prior to failure.

sample of six nonfailed banks, the dual-screening technique did not flag any of these banks as problem banks during a three-year test period. Therefore, since the dual-screening system did provide an earlier classification of problem banks which subsequently failed and did not have an excessive type-II error, the dual-screening technique should be useful in scheduling bank examinations. The implementation of such a system is likely to give earlier warning about the potential problems of large banks and thus provide regulators with more time to prevent bank failure.

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