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Early Warning Systems

Bank regulators and others have developed analytical models that serve as "early warning systems." The aim of these models is to identify the banks that are likely to experience financial problems. By using the information contained in the periodic reports of financial condition that banks are required to file, these models enable regulators to conduct "off-site" surveillance.

To the extent early warning models accurately identify potential problem institutions before any problems actually develop, regulators can target on-site examination efforts more effectively and take steps to minimize the drain on the deposit insurance system should a targeted institution become insolvent. This *Letter* discusses the foundation of typical early warning models, their effectiveness, and some possible improvements.

Identifying problem banks

Bank regulators attempt to identify banks that are not operating in a safe and sound manner in order to induce such banks to change their behavior or, if a given bank is in danger of failing, to minimize losses by taking action to close or reorganize it. In identifying potential problems, the best information available to regulators comes from on-site examinations. These examinations, however, are costly.

Consequently, regulators also attempt to identify potential problems by developing early warning models to analyze the information provided in the periodic reports of condition that banks file. An early warning model is useful if it reduces the total costs of bank supervision by allowing regulators to allocate examination resources more efficiently and enabling them to identify and resolve problems more quickly.

In practice, most early warning models aim to identify the banks that are most likely to become insolvent over the next interval of time (usually one or two years). A bank becomes insolvent when its net worth—the difference between the values of its assets and liabilities—is completely exhausted. The rationale for focusing on insol-

veny is that an insolvent bank most likely will require expenditures by the deposit insurer to cover the shortfall.

Early warning models

Since the level of a bank's net worth is one of the most important determinants of the probability of insolvency, all early warning models include some measure of the current level of net worth. The other major factor affecting the likelihood of insolvency is the variability of net worth. A bank that typically experiences large changes in net worth from one period to the next is more likely to fail than a bank with lower variability, given the same level of net worth. The variability of net worth, in turn, mainly depends on the variability of returns on the bank's assets. Most early warning models gauge this "asset risk" by evaluating the extent to which a given bank holds a concentration of its assets in the riskier asset categories.

Many different empirical models have been developed and tested by regulators and academics over the past twenty years. In an effort to characterize the level and variability of net worth, each model relies on a few key variables from among the many items banks are required to report. Statistical tests are used to see if the model would have done an acceptable job of identifying or ranking the banks that actually were problem institutions during some recent time period.

The general findings of these models are fairly consistent. As one would expect, they have found that the banks that experience problems during a given time period tend to begin that period with relatively low net worth. The models also have found that problem banks have a higher proportion of assets in the form of loans and a smaller proportion in the form of more liquid assets, which seems reasonable since the return on loans is generally more volatile than the return on liquid assets. In addition to having a concentration of their portfolio in loans, banks that become problems tend to have riskier loans within the portfolio, as indicated by a higher

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level of provisions for bad loans or a higher rate of loan charge-offs (bad loans actually written off as losses).

At the same time, most research on early warning models has found that more detailed information on the types of loans is not very useful for distinguishing problem banks from healthy banks, even though all loans clearly are not equally risky. Two notable exceptions are a relatively early model by Paul Meyer and Howard Pifer, which found that greater concentration in real estate lending increased the chances of a bank becoming insolvent, and a more recent model developed by William Lane and others that indicates that banks concentrating in commercial lending are more prone to insolvency.

False signals?

Inaccuracy in early warning models arises in two ways, referred to as "false positives" and "false negatives." The difference between the two can best be illustrated by another type of early warning system, a household smoke detector. If the smoke detector is too sensitive, frequent false alarms result in needless panic and concern, and may cause a family to give less credence to the alarm when there actually is a fire; these false alarms are false positives. On the other hand, an insensitive smoke detector may fail to sound an alarm when it should, resulting in serious damage and loss; this type of failure is an especially costly false negative.

False positives occur in a bank early warning model when healthy banks are incorrectly identified as problems by the model; false negatives occur when banks become insolvent without previously having been identified as problems. False negatives are clearly expensive, and are the primary motivation for the development of early warning models. False positives probably are less expensive, but still waste resources, since devoting resources to closer supervision and examination of banks that are actually healthy either raises total supervision costs or leaves less to be spent on real problems.

Ideally, both kinds of inaccuracy should be minimized, but in practice there often is a tradeoff between the two. Consequently, bank supervisors must weigh the costs imposed by each type of false signal, and decide on the tradeoff that is least costly. The rate of false nega-

tives in existing models ranges from 10 percent to 40 percent; that is, early warning systems may fail to spot as many as 40 percent of the banks that become problems during any given time period. A relatively high rate of false positives generally must be tolerated in order to get the rate of false negatives down to the 10 percent range.

Room for improvement

The high rate of false signals in early warning models suggests substantial room for improvement. There are a number of possible reasons for the mediocre performance. First, most models look at the characteristics of banks that actually became problems during some sample period chosen by the modeler, and hence focus on the record of actual losses rather than on their inherent riskiness "ex ante." If some banks are gambling by taking risky positions, they are more likely to encounter losses. But the nature of gambles is such that at the end of any time period, some of the gamblers will have lost, while others will have won. Focusing only on the losers misses half of the story; an early warning model should identify *all* of the gamblers, not just those who turned out to be unlucky. Using data from a longer time period would help, but makes it more likely that other fundamental features of the banking business will have changed during the sample period.

Another potential problem is that existing models commonly gauge asset risk by the types of assets held by banks. But asset composition alone is not sufficient to distinguish healthy from unhealthy banks. The riskiness of various categories of assets changes over time, as does the extent to which the risks might offset one another. For example, models may look at how heavily a bank invests in a category such as commercial loans, but not at whether commercial lending has become more or less risky, or whether commercial loans have become more or less useful for offsetting the risk from other activities in which banks engage.

A third weakness of most early warning models is that they are concerned only with predicting the development of problems or actual insolvency, implicitly assuming that all problem banks are equally costly. Yet two banks with identical chances of becoming insolvent during the next year may impose very different expected costs on the deposit insurance fund and on the broader

regulatory and financial systems. As a result, these models may be quite accurate in identifying likely insolvencies but actually end up saving little money. Not much is known about the true cost-effectiveness of existing early warning systems.

More useful warning systems would result from addressing these three major areas of deficiency. Better models would identify *all* of the gamblers, not just the gamblers that lost. Better models also would take into account any changes in the contribution various asset categories make to overall risk. Finally, better models would focus more explicitly on the objective of regulatory cost savings by incorporating costs directly.

Using market information

One possible route to such improvements is to incorporate new and fundamentally different types of data, such as information derived from financial market prices or interest rates. Market prices reflect the consensus views of a very large group of profit-motivated investors using diverse approaches to analysis. Bank regulators may be able to piggy-back on the efforts of these investors. Like regulators, investors try to evaluate the condition of banks, and their beliefs are reflected in the prices at which they are willing to buy and sell bank-issued securities. Regulators gather superior information when they examine banks, but examinations are costly and occur relatively infrequently; between examinations, the information obtained and used by market participants may be as good as, or better than, the information possessed by the regulatory agencies.

For example, declining stock prices at a given bank may signal that investors perceive problems at that bank. In one test, Richard Pettway found that investors began bidding down the stock of failed banks about two years before the actual failure, although he did not develop or test a complete early warning model based on this result.

An approach based on market-determined prices therefore is appealing, but a potential drawback is that the loss in net worth already may be irre-

versible by the time stock prices decline. Useful early warning models must indicate which banks are most likely to have problems *before* the losses actually occur.

Another possible way to improve early warning models would be to focus on the *variability* of bank stock prices, in addition to their level and/or trend. A number of the deficiencies of early warning models noted above could be addressed in this way. In theory, the variability of stock prices should be closely related to the variability of net worth. Variability thus should reflect the extent to which various banks are gambling in their operations, and can be estimated without reference to the historical record of which banks actually became problems.

Furthermore, the perceptions that cause stock prices to vary incorporate not only the composition of bank portfolios, but the market's current assessment of the contribution of each asset category to overall risk at the bank. Finally, combining stock variability with information on the current level of net worth should enable regulators to estimate the probability that a given bank's net worth will fall to zero or below, and the expected cost if net worth does decline. This would permit a more explicit focus on regulatory cost savings. A model based on these concepts is being developed at the Federal Reserve Bank of San Francisco.

Cost savings

Early warning models in bank supervision should continue to improve over time. More accurate models will reduce the extent to which deposit insurance funds must be used to deal with insolvencies, and hence may help alleviate concerns about the adequacy of the insurance fund and the premiums that banks pay. More generally, better early warning models enhance the overall effectiveness and efficiency of bank regulation and supervision, providing greater benefits at lower cost.

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