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Defining, Measuring, and Predicting Soundness

Bank soundness is a concept commonly used to denote, for example, an ability to withstand adverse events. Nevertheless, its usage is typically imprecise and gives rise to questions regarding its definition, measurement, and prediction.

Defining a Sound Banking System

A sound banking system may be defined as one in which most banks (those accounting for most of the system's assets and liabilities) are solvent and are likely to remain so. Solvency is reflected in the positive net worth of a bank, as measured by the difference between the assets and liabilities (excluding capital and reserves) in its balance sheet. In other words, the distance between soundness and insolvency can be gauged in terms of capitalization, since net worth is equivalent to capital plus reserves. The likelihood of remaining solvent will depend, *inter alia*, on banks' being profitable, well managed, and sufficiently well capitalized to withstand adverse events. In a dynamic and competitive market economy, efficiency and profitability are linked, and their interaction will indicate the prospects for future solvency. Inefficient banks will make losses and eventually will become insolvent and illiquid.⁶ Undercapitalized banks, that is, those with low net worth, will be fragile in the sense of being more prone to collapse when faced with a destabilizing shock, such as a major policy change, a sharp asset price adjustment, financial sector liberalization, or a natural disaster.

⁶ Although problems may first become public through illiquidity, insolvency normally precedes illiquidity. Banks can conceal losses and fund them by attracting new deposits or other liabilities. When problems become severe enough, which is usually well after insolvency, net flows of funds turn negative and illiquidity results.

It is difficult to precisely classify a banking system as “sound” or “unsound,” because there is no benchmark measure of systemic insolvency that determines when a banking system is unsound or when a crisis will occur. Banking systems may exhibit different degrees of vulnerability over time. They may be functioning poorly, or may be working relatively well now but exhibit signs (e.g., low earnings or capitalization) of probable future problems or potential crises. Nonetheless, having no precise classification does not detract from the usefulness of the concept of soundness, proxied by solvency, any more than the difficulty of precisely defining concepts like a realistic exchange rate or a sustainable balance of payments has barred the application of those useful notions.

Measuring Unsoundness

Accepting the usefulness of a definition is one thing; practical application from a macroeconomic policy perspective is another. Using current solvency as a proxy for the soundness of a banking system abstracts from important measurement and projection issues.

While solvency is straightforward to define, it is difficult to measure. Bank loans, which represent the bulk of bank assets in most countries, are extremely difficult to value; that is one reason why even in countries with well-developed capital markets bank loans are not readily traded or securitized.⁷ From an economic standpoint, insolvency results when the present value of the expected stream of future net cash flows becomes negative and exceeds capital. Obviously, a high reported level of nonperforming loans would indicate fragility. However, there is always an element of judgment in projecting and valuing uncertain future receipts. In addition, owners and managers of unsound banks have incentives to accrue unearned income and show loans as performing in order not to lose their bank. Thus, balance sheet figures on asset value and on nonperforming loans may not represent a bank’s actual circumstances. Assessing insolvency is further complicated by off-balance-sheet items and problems of consolidating the balance sheets of bank subsidiaries and other related financial units.

These weaknesses in information explain why banking problems emerge with little apparent warning even in the most advanced countries. Even the combined resources of external auditors, credit rating agencies, stock market analysts, and supervisors may not spot banking problems in time.

To the extent that it can be measured, solvency can be aggregated across banks; clearly a banking system in which a large portion of banks are insolvent at current valuation would be unsound. Aggregation across

⁷ Valuation is discussed further in Appendix I.

banks, however, may mask problems. For example, a key payments center bank whose net worth is slightly negative might have more significant systemic implications than a savings bank with a highly negative net worth.

Predicting Unsoundness

Apart from the difficulties in measuring current solvency is the additional complexity that the concept of a sound banking system should encompass its dynamic development and its susceptibility to shocks. Solvency is essentially a static concept: it characterizes a bank (or a banking system) at a point in time. A forward-looking measure of banking system health should capture the determinants of bank insolvency, which include poor asset quality and earnings, as well as less quantifiable factors such as management weaknesses, failures of internal and external control, and the potential impact of exogenous events. Thus, if a significant portion of bank profits derives from speculative activities, or if bank governance structures are such that they facilitate high-risk transactions, such as related-party lending, the probability of future insolvency will be higher.

Predicting Unsoundness at Individual Banks

Supervisors in some countries have constructed sets of indicators to provide an early warning that a particular bank is likely to experience difficulties. These indicators consist principally of bank-specific information provided by the reports banks make to the supervisory authority ("call reports"). Early warning indicators are usually used to determine where scarce supervisory resources would best be deployed in on-site examination.

Bank-reported data are often used in conjunction with complementary statistics from other sources and qualitative indicators, many of which are based on supervisory inspections. To the extent that bank data are inaccurate, the quality of such indicators and models is impaired. Even in such circumstances, though, the data may contain significant information: for example, an increase in loans past due provides a warning, even if such loans are systematically underestimated. Thus, specific indicators and trends derived from bank statistics, along with complementary data and judgment, can help to predict bank unsoundness.

Where data are available, some supervisors have constructed more complex econometric models to identify where severe problems are likely to develop. These empirical models identify factors that raise or reduce the probability of bank insolvency in any period. The characteristics of an individual bank can then be fed into the estimated equation to gauge the bank's soundness. The relevant characteristics are mostly bank specific,

but may also incorporate sectoral information (such as the concentration of the local banking market) and macroeconomic information (such as the regional unemployment rate). Supervisors then use the results of these models to identify banks that warrant greater supervisory attention, for example, in the form of more frequent on-site inspections.

There has been considerable published academic work in this area as well.⁸ Again, models try to predict whether a particular bank is likely to experience difficulties, often defined as insolvency. Published work has focused on the additional question of predicting failure, which is distinct from insolvency. Insolvency is determined by events in the banking market; a bank either is insolvent or is not. Failure in most cases hinges upon a supervisory decision, which may or may not be taken, and may be taken before or after insolvency. Failure usually depends on the same variables that determine insolvency, but as a regulatory decision, failure is subject to misincentives, forbearance, and political interference. Thus, the likelihood of insolvency and the timing of failure may hinge on different factors.

Insolvency should be the dependent variable in empirical exercises, but because banks are difficult to value, market value insolvency may not be observed or measured except after failure. Nevertheless, since regulators and other analysts all define an unsound bank in a similar fashion (focusing principally on insolvency), comparable sets of variables are used in most approaches. One key difference is that models used by regulators have access to a bank's prior supervisory ratings. For example, the U.S. Federal Reserve's Financial Institutions Monitoring System (FIMS) uses prior composite supervisory ratings as one of the predictors of future ratings and risk of failure.⁹ Such information is not normally available to outside investigators. While they do have access to some of the data underlying supervisory ratings, such as capital and earnings data, they would not normally have access to information on management and asset quality derived from on-site examinations. Research by supervisors has shown that using data from on-site inspections and from reports submitted by banks results in more accurate forecasts than relying on either alone; FIMS provides one example. In practice, however, supervisors tend to watch a larger number of variables than those identified by researchers.¹⁰ Despite the difficulties, models using publicly available data have been successfully formulated and applied.

Research has generally concluded that a small number of variables can accurately identify at an early stage those individual banks that will ulti-

⁸ Demirgüç-Kunt (1989) provides a survey. See also Cole and Gunther (1995), Gilbert and Park (1994), Thomson (1992), and Whalen (1991).

⁹ See Cole, Cornyn, and Gunther (1995).

¹⁰ For example, see U.S. Office of the Comptroller of the Currency (1989).

mately become insolvent (while avoiding incorrectly flagging banks that will survive). A summary of some of the variables used is provided in Table 1, along with the expected direction of the effect of each variable on the probability of insolvency.

These variables include traditional measures of capital adequacy, asset quality, management, earnings, and liquidity. The impact of macroeconomic conditions on banks is captured in some of the variables used. Recognizing that a bank will not remain well capitalized unless it operates efficiently, some models also include measures of operating efficiency. Assessing efficiency through financial performance indicators, such as earnings relative to assets or relative to employees, requires some control for market structure; a monopolist may be inefficient but still show high earnings. Thus some studies have included market structure variables as well.

Most of the anticipated effects are straightforward, but some are complex. In general, supervisors should be concerned about banks with unusually high or low financial ratios. For example, a high capital-to-asset ratio, which will cause a low rate of return on equity (ROE), may lead to hostile takeover activity that can have positive or negative implications for bank soundness, while a low capital ratio implies a high probability of failure. A low loan-to-asset ratio implies that banks are not carrying out their intermediation role and may be involved in other, possibly speculative, activities, whereas a high ratio indicates high exposure to credit risk.

Much of the published work in this area has focused on the United States, whose large banking sector, extensive recent experience with bank failures, and well-developed statistical reporting systems have provided abundant data. Translating this work to other banking environments will require further research. Since the basic financial operations of banking are the same across countries, the sets of relevant variables would be expected to be similar. It must be recognized, however, that in many countries individual bank data do not exist, or are inaccurate and outdated, presenting such a large errors-in-variables problem as to call into question the validity of any empirical estimates of the probability of insolvency for those economies.

A different approach to gauging insolvency has recently been adopted by a number of researchers. If financial markets can assess a bank's value, and the market price for equity reflects it, then an asset pricing model can be used to infer the risk of insolvency that the market has assigned to each bank. The capital asset pricing model was applied by Hall and Miles (1990) to assess bankruptcy risk for several U.K. banks and for a set of U.S. banks, including a subset that subsequently did fail. Clare (1995) used an arbitrage pricing model based principally on macroeconomic variables to estimate the probabilities of failure among individual U.K.

Table 1. Early Warning Indicators of the Probability of Bank Insolvency

Variables ¹	Expected Effect ²	Federal Reserve FIMS ³	Bank Balance Sheet Models ⁴	Asset-Pricing Models	Macro Studies
Capital					
Capital adequacy	–	×			
Loan-loss reserves/assets	–	×			
Bank size (ability to raise capital)	–		×		
Asset quality					
Loans past due 30–89 days/assets	+	×			
Loans past due 90 plus days/assets	+	×			
Nonaccrual loans/assets	+	×			
Foreclosed real estate/assets	+	×			
Safe investment securities/assets	–	×			
Rate of asset growth	+	×		×	×
Loans/capital	+		×		
Loans/assets	+/-		×		
Sectoral loans/assets (various sectors)	+/-		×		
Management					
Examiners' on-site rating of management	–	×			
Previous overall on-site rating	–	×			
Corporate structure	+/-		×		
Expenses/total revenue	+		×		
Earnings					
Net income/assets	–	×			
Loan revenue/total revenue	+/-		×		
Revenue from secure assets/total revenue	–		×		
Change in interest and fee income/assets	–		×		
Change in interest expenses/assets	+		×		
Liquidity					
Large certificates of deposit/assets	+	×			
Liquid assets/total assets	–		×		
Interest-sensitive funds/total funds	+		×		
Market structure					
Local banking market concentration	+/-		×		
State of the economy					
Deposit growth rate	+/-		×		
Price of oil	+/-		×	×	
Corporate default risk	+			×	×
Current account imbalance	+			×	

Table 1 (concluded)

Variables ¹	Expected Effect ²	Federal Reserve FIMS ³	Bank Balance Sheet Models ⁴	Asset-Pricing Models	Macro Studies
Inflation/deflation	+			×	×
Market interest rates/bond yields	+/-			×	×
Equity prices/yields	+/-			×	×
Terms of trade	-				×
Real GDP	-				×
International capital flows	+/-				×
Exchange rate changes	+				×
Government deficit, banking sector claims on government	+				×
Policy shocks	+				×

¹ Similar variables have been grouped together; for example, for capital adequacy, studies use various versions of capital/assets. These are not shown separately.

² This column indicates the direction of effect that an increase in each explanatory variable is expected to have on the probability of bank insolvency. Thus, for example, a better on-site rating of management would be expected to correlate with a lower probability of insolvency. The direction of effect of some individual variables will depend also on other factors; these variables are indicated as +/-.

³ Financial Institutions Monitoring System. See Cole, Cornyn, and Gunther (1995).

⁴ As surveyed in Demirgüç-Kunt (1989).

merchant banks. Fischer and Gueyie (1995) applied an option pricing model to estimate the implied variance of bank assets in a number of countries that had liberalized their financial systems. The asset pricing approach has the advantages of using data that are publicly available, principally market prices for bank securities, and of incorporating the information inherent in financial market prices (see Table 1). However, to the extent that financial markets are less than fully informed and efficient, the inferences drawn from these models may be insufficient as an early warning of bank unsoundness (for a critical view, see Simons and Cross (1991)).

Predicting Systemic Unsoundness

Relatively little empirical work has been done on predicting systemic unsoundness. In part this is because supervisors use a bottom-up approach; they are concerned initially with individual banks, and the system is then viewed as the sum of all banks. Most early warning models focus on predicting problems at individual banks and require access to bank-specific data. There is potential, however, to measure or project systemic banking problems from aggregate economic data as well. Three

possible approaches to predicting systemic unsoundness are summarized here, followed by a brief review of some recent literature.

Bottom-Up Approach

A bottom-up approach to systemic soundness estimates the probability of insolvency developing for each individual bank in the economy, based, for example, on a balance sheet model. These data then provide the basis for constructing a distribution of bank assets by probability of insolvency. A concern for systemic stability would be warranted when the probability of insolvency becomes significant for a large proportion of the country's banking assets, or when that probability increases substantially in any period of time. The critical range is a matter of judgment and will depend in part on the risk-aversion of the supervisor or policymaker undertaking the evaluation.

While a full distribution provides a more complete picture, a single measure of the condition of the banking system might be constructed as an asset-weighted probability of insolvency based on the probability of insolvency for each bank. The sum of asset-weighted probabilities will range between zero (when all banking assets are housed in banks with no probability of insolvency) and 100 (when all the nation's banking assets are in banks with a probability of insolvency equal to 1).

The principal drawback to applying this methodology is that sufficient bank-specific data to estimate the underlying model are not readily available for most countries. A secondary drawback is that it does not systematically take into account the different functions that banks may play in a market, and the degree of interaction between banks. Banks with certain functions, such as key payments centers, may be more important to the functioning of the system than simple asset weighting shows. The degree of interaction between banks, for example, interbank market exposure or overlapping exposure to certain sectors, will determine the extent of potential domino or contagion effects.

Aggregative Approach

Given the difficulty in obtaining bank-by-bank data, it might be useful to estimate the probability of systemic insolvency using aggregate banking sector data, which are often published by central banks or other official statistical sources. The approach here would be to apply a model based on single bank characteristics similar to those summarized in Table 1 to a synthetic aggregate bank. In this case, the model would have to be developed using cross-sectional data from countries with similar financial systems, since time-series data for a single country might not provide sufficient instances of systemic insolvency to establish the necessary econometric relationships. The model could then be applied to the aggregate

bank data to determine the probability of systemic insolvency for that system.

One significant drawback to this approach is that aggregation may hide problems. For example, while the capital-to-asset ratio is used as an indicator of individual bank condition, it is not possible to adequately assess the strength of the banking sector as a whole by looking at an average, even an asset-weighted average of the capital-to-asset ratio. Two banking systems each with ten equally sized banks might have an average capital-to-asset ratio of zero percent. In one system, each bank could have zero capital and so offer the public no sound banking options. The other might consist of half the banks with capital ratios of 10 percent and the other half with minus 10 percent. This system offers sound options to the public. Thus a distribution of bank assets by capital ratio is needed to assess the vulnerability of the banking system to systemic crisis. When a significant proportion of banking assets is held by undercapitalized or insolvent banks, the banking system would be considered unsound. An aggregate measure, however, would not always provide this information.

Another drawback would be the difficulty in estimating the model from cross-country data. First, as noted, defining systemic insolvency presents a number of challenges, although one might alternatively focus on predicting the extent of likely undercapitalization. Second, legal, regulatory, financial infrastructure, political and even cultural factors come into play in determining the degree to which a bank may be subject to losses, runs, and failure. Direct comparability across countries will be difficult to establish, but analysis using countries with similar economic structures or at similar stages of development might yield worthwhile insights.

Macroeconomic Approach

Banks are derivative institutions in that their health reflects the health of their customers, which in turn reflects the health of the economy as a whole. Instead of looking at bank balance sheet data for internal sources of unsoundness, it should be possible to establish systematic relationships between economywide variables and an indicator of bank soundness, such as capitalization. A number of macroeconomic variables would be expected to affect the banking system or reflect its condition. Indeed, some of the models summarized in the first columns of Table 1 employ macroeconomic variables to predict problems at specific banks. One would expect these same variables to be significant for the soundness of the system as a whole.

Broadly speaking, these macroeconomic factors can be grouped as indicators of macroeconomic conditions and indicators of financial fragility. The former group would include GDP and sectoral growth rates, indices of industrial activity, and indicators of macroeconomic balance, such as

capital account, current account, and fiscal balances. For example, if an economy or certain important sectors are in a prolonged recession, there is cause for concern about the soundness of the banking system; indicators of macroeconomic conditions would be relevant in these cases.

Indicators of financial fragility would include data on money and credit, interest rates, asset price indices, consumer credit, corporate indebtedness, and bankruptcy rates. For example, excessive credit growth relative to GDP and rapid rises in asset prices have been associated with a weakening of the quality of bank portfolios and an increase in risk exposure. Indicators of systemic distress would include frequent requests by banks for liquidity support and a tiered interbank market. Qualitative variables reflecting the political situation, legal and financial infrastructure, and regulatory environment might also be useful barometers in that the resilience of banking systems will depend to a significant degree on the framework in which they operate, as discussed in Part III.

Data availability for most of these variables should be high. Some researchers have looked at the history of banking crises in a particular country over time; an example is Gorton (1988), who studied the national banking era in the United States (1865–1914), during which there were numerous panics. Under current institutional structures in most countries, estimation of an insolvency probability model at the systemic level would again require cross-country data. Such an approach might provide a means of estimating the impact of particular events, such as a fall in asset prices, on the banking system as a whole. Where bank-specific data are available, macroeconomic factors could be applied to individual banks to derive their sensitivities to particular factors. Even where bank-specific data are not available, some insight into the sensitivity of the banking system as a whole to these factors could be derived from aggregate data, as described (and subject to the caveats noted) above.

Recent Literature

Recent literature has begun to look systematically at banking crises across countries with a view to better understanding the contributing factors. The methodology applied has been a case study approach: examples of countries that have experienced crises are selected, and common macroeconomic trends surrounding the crises are analyzed. The papers in Sundararajan and Baliño (1991) and the studies of Baer and Klingebiel (1995), Caprio and Klingebiel (1996), and Garcia (1994 and 1995) identify a number of the macroeconomic and financial fragility variables listed above as contributors to banking sector crises. The analysis of these studies is largely retrospective, focusing on explanation rather than prediction.

A few recent works have taken a more forward-looking view. Mishkin (1994) attempts to outline signals that a financial crisis is in prospect.

These include declines in stock prices, increases in interest rates and corporate indebtedness, and unanticipated declines in inflation. Hausmann and Gavin (1995) note that loan delinquencies are lagging indicators, and focus instead on macroeconomic shocks to asset quality and bank funding, and the role of credit booms in fostering financial fragility. Kaminsky and Reinhart (1996) focus on the links between balance of payments and banking crises and conclude that financial liberalization helps to predict banking crises across a range of countries, although this may be due to selection bias. As precursors, they identify recessionary conditions, declining economic activity, export sector weakening, sinking asset prices, rapid credit expansion, reversals of capital inflows, increases in the money multiplier, and high real interest rates. Fischer and Gueyie (1995) use a combination of bank balance sheet, macroeconomic, and policy variables to explain changes in bankruptcy probability (as gauged by an option pricing model).

Some of the variables that have been characterized by these studies as contributing to the emergence of a crisis are listed in Table 1. The studies are largely qualitative; no formal model to predict the onset of a crisis or the emergence of an unsound system has been estimated. An appropriate set of early warning signals will vary across countries, depending on the quality and availability of banking and macroeconomic data, and the specific institutional setting. However, as guides to policy these studies are important contributions. The logic underlying the importance of the identified macroeconomic factors is explored further in the next chapters.