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3 The Measurement of Capital Adequacy

In measuring capital adequacy and estimating the risk of insolvency, the first step is to establish the value of the economic balance sheet of a bank—that is, the present value of the expected cash flows from a firm's existing portfolio of assets and liabilities. Next the expected balance sheet of the bank at the end of a period must be projected. Finally, to measure risk one must assess the volatility or distribution function of this expected value. Many of the papers in this volume show techniques for estimating the probability of such changes. Some assume that future values will move in accordance with past distributions of movements of the values of similar assets, liabilities, or portfolios. Others make future distributions conditional on forecasts of events both within the bank and in the macroeconomy.

3.1 Applications of Modern Theories of Finance

In recent years, modern theories of finance have made major advances in improving the knowledge required to measure capital and portfolio risks. The papers in this volume are both contributions to and applications of these theories. The key factor in recent developments has been the application of rigorous mathematical analysis to simplified models of financial markets. When their assumptions apply, these theories demonstrate that the task of measuring risk and capital adequacy can be accomplished with a limited number of formulas and a manageable amount of information.

Most of the existing theories have been applied to large active markets, such as those for common stocks, bonds, or commodities. Applications to a specific problem, such as measuring bank capital, require additional theoretical developments. They also require empirical studies to see what

type of information is available for this use, how the theories can be applied, and how closely the markets conform to the theoretical assumptions.

Controversies persist with respect to the empirical verification of the theories. The studies that follow recognize many such problems. Although they are only a start toward a desired solution, they do indicate that the newer theoretical concepts can improve our techniques of analyzing bank capital needs. While not yet at a stage for complete solutions, the techniques can be applied in specific cases. The studies serve to increase knowledge of critical issues and of where to look for solutions.

The models from modern finance emphasize the likelihood that markets are efficient and utilize all available information. Financial markets act as tremendous machines or computers that are constantly driving rates of return into congruence with the underlying risks they contain. Modern theories contrast with much traditional analysis of financial institutions that has tended to emphasize special features of each market and institution. In this later literature, banks are pictured as specialized firms with monopoly powers. Government regulations are critical. Information is poor and expensive. Emphasis is on the analysis of specific markets and actions rather than on more general equilibrium solutions.

One of the purposes of our study was to see whether the modern models can be applied to the banking system. Even though the market does not agree in many respects with the assumptions of the theories, the results indicate that such prospects are good. It is true that not all monopoly profits are competed away. The market as a computer works more slowly and erratically than is generally assumed. Forecasts are poor, and many banks make far from optimum choices. They pick bad portfolios. Information and transaction costs are significant.

Because individual cases do diverge from theory, close analysis of each institution is necessary and worthwhile. By using knowledge derived from modern theories, individual bankers can make better decisions, and more logical and efficient regulations can be formulated.

3.2 The Steps in Measuring Capital Adequacy

The determination of risks in a bank and the adequacy of its capital can be handled through a procedure with five separate but closely related steps: (1) dividing into activities; (2) estimating net worth; (3) estimating expected values; (4) estimating distribution functions of expected returns; and (5) relating capital and risks.

3.2.1 Activities

The initial need is for a logical division of assets, liabilities, and other operations into pertinent activities. The purpose of combining functions

into a limited number of activities is to make use of existing information concerning differences in earnings and risks in analyzing the bank's current situation. A logical breakdown into activities increases the ability to use market and other knowledge to improve the estimates of current net worth and of portfolio risks. The number of activities studied in the individual papers ranges from three to ten. On the basis of a more complete analysis, it seems likely that an optimum division into activities might be between fifteen and twenty. When a class contains securities with a wide spread of maturities, it should be further subdivided by this factor. Since risk depends on the proportion of each activity in the total, the first step in measuring risk for a specific bank is to aggregate assets and liabilities into these desired classes.

3.2.2 Capital or Net Worth

The model of risk and capital adequacy starts with a measurement of net worth at the beginning of a period. This is one of the most difficult tasks in the entire process. In a way this seems surprising, since ascertaining the value of capital is a primary aim of accounting systems. In fact, however, as chapter 5 shows, finding the economic, as compared to the book, value of a bank is an extremely complex task. For a limited number of banks, valuations of capital are constantly performed by the stock and bond markets. However, this is not true for the vast majority of institutions, which are either privately held or have stocks that trade in narrow markets. For these banks, alternative methods are called for to find actual current capital.

Moreover, even for those banks for which market estimates of net worth are available, questions arise as to the accuracy of such valuations, particularly for the purposes of measuring the risks of insolvency. The degree to which stock market values reflect the facts of regulation compared with the values that would be set in free markets is unclear. Bankers claim that their net worth is reduced by restrictive regulations and capital requirements. Bank critics hold that net worth is inflated by the oligopolistic position of banks, by regulated interest rates, and by deposit insurance whose fees in specific cases may not cover the risks assumed by a bank.

Capital is required in relation to total or risk assets. Banks are among the most highly leveraged of all firms. Many of the arguments over bank capital arise from the banker's assumption that he will be better off if he can increase this leverage even more. The theory of capital structure and financial leverage indicates that this will be true only in special circumstances (Modigliani and Miller 1958; Stiglitz 1974). It will occur primarily when debt issues bring major tax advantages or when high information or transaction costs, including those of bankruptcy, make issuing stock or selling other assets expensive. To date, studies fail to show whether

increased leverage is more efficient either for banks or for the economy. This is especially so because of the situation analyzed by Sharpe (chap. 8), where the existence of insurance makes it possible for the firm to increase its value to its owners at the expense of the insurer.

The idea that investors will choose portfolios composed of optimum risk return relationships to their own utilities leads to concepts of markets in which individuals shift their investments and use arbitrage and hedging to obtain optimum portfolios. Because of their ability to hedge and arbitrage, investors value the debt and equity of each institution in accordance with the amount of systematic risks they include. Except for possible tax savings and information difficulties, a firm cannot change its value by leverage. It can, however, change the risk of a particular class of assets. It can therefore alter the price these assets will sell for to people looking for and willing to pay for particular risks. Thus leverage can alter the risk and the price of common stock.

While most banks have sought to increase their leverage to the maximum, it is not clear whether this results from the current regulatory system or from forces that would exist even in a free competitive market. Taxes, bankruptcy costs, and information deficiencies can influence optimum capital/asset ratios. On the other hand, because financial markets are fluid, to the degree they are not fettered by government action they tend toward efficiency and toward equalizing costs of capital.

3.2.3 Expected Values

A third task is to project the expected level of operations and capital to the time of next evaluation. The expected value of a bank depends both on its own operations and on future movements in cash flows and expected values. The studies by Jacobson (chap. 11) and by Craine and Pierce (chap. 12) attempted to model changes in the net worth of individual banks by use of econometric models whose inputs came from movements of variables forecast by large-scale models.

The forecasting ability of such econometric models was poor. The papers show that Box-Jenkins types of techniques using recent trends in a bank's activities plus projected changes in major macroeconomic forces do a better job of estimating end-of-period values. They assume that the information contained in market forecasts will be correct. The combination of time-series models with forecasts of interest rates, GNP, and dividend policy can produce acceptable expected values for a bank.

3.2.4 Risks in Particular Activities

The fourth task is to estimate the distribution function surrounding the expected value of the bank. The spread of the distribution function depends on the weights and the volatilities of the activities in the bank's portfolio. In theory, a complete risk estimate requires finding the covari-

ance matrix of returns for each of the bank's numerous activities. When it is recognized that what is desired are the risks arising from unanticipated events, their measurement becomes more tractable. In practice, useful estimates of risk can be made by applying a limited number of risk functions to a small group of activities.

The papers that follow estimate probability distributions of future returns for three main causes of variations. The first is interest rate risk or changes in the value of a portfolio arising from movements in the rate at which expected cash flows are discounted. Discount rates alter as spot interest rates move, as the time structure of interest rates shifts, and as the margin between rates on risk-free and risky assets alters. The second risk is that of default or losses on loans. The third is operating losses. These can occur when there are changes in interest margins, operating expenses, the sources of funds, and from income and losses in miscellaneous or non-balance-sheet operations.

Time-series and cross-sectional data of unanticipated shifts in each of these factors are used to estimate probability distributions and forecasting equations of potential losses in specific activities. With additional estimates or allowances for nondiversification and fraud or insider abuse, the knowledge of these probability distributions can be used to set outer bounds on risks in any particular bank. With more detailed data from individual banks, the reliability of these estimates could be rapidly improved.

The application of these techniques to prototype banks is illustrated in chapter 5. These examples show the degree to which risks may vary among banks. Dissimilarities are found to be economically significant. Variations appear more dependent on interest rate and maldiversification risks than on loan or operating losses.

3.2.5 Relating Capital and Risks

A final task is to combine the estimates of capital with the probability distribution of future values to obtain a measure of true portfolio risk. McCulloch shows (chap. 10) that the risk of insolvency is a nonlinear function of the amount of potential variance in a bank's portfolio and of level of capital. It decreases rapidly as the ratio of expected capital to assets increases. It also alters with the length of time between portfolio evaluations. Thus McCulloch shows that raising the capital/asset ratio from 1 percent to 10 percent decreases the risk of insolvency more than thirty-three times.

The methods of calculating probability distributions differ depending upon the techniques used to model risks. Some of the projections in the papers assume that future events follow a random process. Others predict risks conditional upon forecast changes in the macroeconomy. While use of past random movements may suffice for regulatory or insurance pur-

poses, within a bank, analysis and projections based upon risks conditional upon forecasts of the economy may be preferable. It may be particularly useful to estimate the risks of insolvency under a graduated list of possible events. Banks may desire to cut off their risks when the probabilities of failure are at low levels (say .001) for events thought to be extremely unlikely (a major war and freezing of all assets by foreign nations).

The following discussion first considers some of the factors involved in estimating expected values, as well as the factors that can alter the expected returns. It then discusses problems in determining net worth and methods of relating capital and risks.

3.3 Activities, Expected Values, and Risks

When a bank selects its portfolio and activities, it simultaneously determines its expected future net worth and its risks of insolvency. Both of these factors must be estimated.

1. The expected future net worth can be projected from the type of activities the bank chooses, its earning record, how it handles dividends and capital investment, and its current balance sheet.

2. The distribution function around such expected values, which determines its possible losses of net worth, is also a function of the particular activities selected. In addition, however, distribution functions depend on the way such activities are likely to react to unanticipated events. Each activity will respond differently to the events that occur, according to how its values are affected by economic change.

3.3.1 Expected Values

The expected change in net worth of an individual institution can best be projected from what has been happening within the bank. Its expected level of losses and operating income depends on the loans it has made and its operating procedures. Recent data can be used to estimate expected earnings, losses, and growth. If they indicate a low expected net worth, risks can be reduced by increasing capital.

Risk analysis for the individual bank, whether for the manager, creditor, investor, or regulator, begins with the proper calculation of expected income by applying valuations based on current market data to operations. In addition to assets with market prices, such values must be applied to assets and liabilities not quoted in the market and to intangibles. In this sphere, arguments over the validity of market, as compared to nonmarket, valuations are hottest. The paper by Maisel and Jacobson (chap. 9) shows that, on the whole, banks appear to adjust their operations to the competitive market. Banking markets are not so overwhelmed by institutional and monopolistic practices that applications of

equilibrium theory fail. A general financial model can be usefully employed. Book rates of return and costs for classes of assets and liabilities adjust toward each other. Marginal rates received or paid for different activities tend to equalize. The correlation among returns is high, though rates of adjustment may be slow.

While our studies show that the best estimate of a bank's expected income comes from its own balance sheet and past history, two banks with the same expected future net worth may not end up in the same position. One may prosper even as the other fails. Actual incomes will differ depending on how each one's activities react to events. The degree of risk in each bank depends on both the outcome that is expected and the relationship of probable outcomes to possible events.

3.3.2 The Distribution of Possible Losses

It is because portfolios differ in these ways that an estimate of risk and capital adequacy also requires an estimate of the specific distribution function around a bank's anticipated net worth. This requires finding the possible risks in each activity it is engaged in and then combining them to form an estimate of total risk.

As noted, the general evaluations of risks can be divided into four types:

1. Unanticipated movements in the discount rates applicable to an activity's future earnings or costs are a big factor in risks. Discounts change with movements in the default-free spot interest rate; the term structure of interest rates; and the risk premiums for individual activities.

2. The risk that loans will perform poorly is a second type. Variations in the default rates of banks around their expected values have not been large, but the departure of individual banks from this average has been considerable. Thus in 1975, the worst postwar year for unanticipated loan losses, losses as a share of net earning assets for the banking system increased by 15 basis points, or from 0.27 percent to 0.42 percent. On the other hand, about 6 percent of the banks increased their loan losses by more than 50 basis points (0.5 percent) in that year.

3. In addition, a risk exists that a bank will incur large changes in its current earnings because of a shift in liabilities, unexpected operating expenses, losses from off-balance-sheet operations, or alterations in its portfolio. Such changes are measured roughly by the variations in current operating earnings before loan losses and taxes. In the 1970s the net income of banks before loan losses and income taxes averaged about 1.55 percent of net earning assets ($1.55 per $100). The range around this average was from 1.38 percent to 1.70 percent. In each year, fewer than 3 percent of banks had negative returns before loan losses. In 1975 an examination of individual banks shows that, at the 1st percentile of all banks, the decrease in net worth from this cause was about 1.5 percent of

all earning assets. At the 99th percentile, net worth increased by an amount equal to 3.7 percent of net earning assets as a result of such earnings.

More important than the level of earnings are unexpected negative shifts that cause unexpected losses in net worth. The largest drop in operating earnings for the average of all banks was 0.23 percent of net earning assets in 1971. In other years the maximum fall in this ratio was less than 10 percent (0.02) of this amount. In 1975 slightly more than 5 percent of all banks had net operating losses, including losses from loans but excluding credits. In that year, 10 percent of all banks experienced a decline in this earning ratio of 0.4 percent or more.

For some of these banks such losses would not have been unexpected but could have been predicted from their prior record. In such cases, risks could have been reduced by requiring poorly operating banks to put up more capital and to alter their operations. Dangers arise primarily from unanticipated changes in operating losses.

4. Finally, there are risks that do not seem quantifiable in the same way. Such risks include major losses due to insider abuse, fraud, or lack of diversification. These have been among the main causes of bank failures. One would normally assume that the risk of such losses would fall rapidly with size, but this has not been the case. The number of large bank failures in this category seems to be an indictment of existing methods of examination. In most cases examinations did not eliminate the risks from lack of diversification, whether of type of loan, duration, or customers. In some cases the examiners were aware of the risks but did not have the tools to deal with them.

While some degree of success has been achieved in estimating the first three types of risk, greater progress is needed. More detailed analysis and simulation of the risks of maldiversification are also vital. Furthermore, knowledge of the covariances among risks is inadequate. From individual bank data, however, it does appear, as one would expect, that the four risks are not perfectly correlated. Therefore total risk is less than would be estimated by merely totaling their separate values.

This discussion brings out rather clearly a contrast between this volume's view of how to estimate the soundness of a bank and the methods frequently used by examiners and similar evaluators. Their estimates are usually based on examinations of individual loans and measures of trends or untoward movements in book values. They fail to estimate the risks of unanticipated events. If they estimate the gap between market and book values (and they often do not), such evaluations may properly reflect future expected values. They may show problems in a bank owing to past events. Spot checks may be useful in determining that an institution has not properly reported its poor prior performance; but the need for such evaluations is a measure of poor

auditing standards. Examinations may also be useful to catch fraud or a lack of adequate diversification.

Such evaluations, however, fail to measure the actual portfolio risks. These depend upon how unexpected events may change the value of specific activities and on the weight of these activities in the bank's portfolio. To measure such risks requires modeling the way events are likely to cause unanticipated changes in values and the distribution of such movements.

3.4 The Expected Level of Earnings or Losses

Since a bank's current net worth is the present value of its expected net cash flows, projecting the expected net worth of a bank at the end of any operating period cannot be separated, in theory, from estimating the value of its capital. The same kinds of forces must be considered in each evaluation. At this point, however, we first examine the problem of estimating expected total returns or losses, then go on to the estimate of the distribution function around this projection before returning to questions concerning current capital values, which logically should come first.

As one aspect of the research for this volume, a great deal of effort was spent in attempting to examine relationships between economic events and revenues and losses in specific bank activities. We obtained individual income statements and balance sheets covering fifteen years or more for a large sample of banks. We attempted to fit both simple and complex econometric models to their earning movements. The results were inconclusive.

We found that the best explanations of movements in the net worth of individual banks could be derived most accurately by use of time series of their past actions, along with movements in a limited number of macroeconomic variables. The papers by Jacobson (chap. 11) and by Craine and Pierce (chap. 12) describe some of the positive results of these studies. The negative results of additional approaches, not reported on in detail, covered a wide variety of other sources of data, longer time periods, and more exogenous variables.

Both the theoretical and the empirical analysis indicate a strong correlation between recent net earnings and their levels in future periods. Revenues differ among banks, depending on each one's portfolio and operations. As shown by the Maisel and Jacobson paper (chap. 9), gross revenues among banks differ by more than their net revenues. Banks select a variety of techniques by which they generate interest income and their operating income and losses. Such differences and their results are mirrored in their past earning histories.

Gross revenues should, and do, include a margin to pay for expected losses. The levels of anticipated interest earnings and losses are a function

of prior earnings and loan losses. Banks with higher loss ratios need not be riskier if they charge enough to cover their higher expected losses.

The estimates of anticipated levels of net worth and the distribution function of probable fluctuations around such expected levels can be analyzed in two separate categories. First come the gains and losses from the interest rates of the assets and liabilities in the portfolio. Second come the results arising from operations, which include losses from loan underwriting.

3.4.1 Anticipated Interest Earnings

At any time, interest earnings reflect the categories of assets and liabilities and the interest rate maturities in each category selected by a bank. As the papers in part 2 show, interest rates paid and received by a bank reflect the best knowledge in financial markets with respect to movements of general (risk-free) interest rates. However, earnings from loans as well as the costs of borrowing do vary somewhat from purely market-determined interest rates. But, even so, a bank's actual returns can be expected to change roughly in conformance with whatever movements occur in market rates.

Both the theory and the results of these and other studies show that in general the market's estimate of future interest rate earnings is likely to be the best available. Furthermore, the recent earning record of the bank will reflect the relationship between its selected balance sheet and overall interest returns for both market instruments and banks as a whole. The studies show, moreover, that, for a bank away from the average in any period, a slight tendency exists for its interest earnings to regress toward the median of its size group.

3.4.2 Expected Operating Earnings

Expected net income also depends on operating expenses and loan losses in addition to net interest income. Movements in earnings, therefore, may diverge from expectations if a bank's performance in its operations or its loan underwriting does not meet anticipations. An examination of past loan and operating incomes shows that, as with interest rates, it is useful in forecasting the next period's losses to start with the assumption that they will equal those of the prior period. Estimates based on the previous year mean that a bank that is experiencing losses or low operating income will need greater capital to offset its expected poor results. Losses also rise in recessions and in the aftermath of a period of high interest rates (Hoenig and Spong 1977; Spong and Hoenig 1978).

Loan Losses

No bank knowingly takes a loan that it expects will default. Some banks may select portfolios that have higher average losses, but, unless

they change their selection process suddenly, their choice of portfolios will have been reflected in prior years' net revenues. A correlation exists between higher gross revenues and loan losses, but, since these offset each other, net revenues are not affected. Losses that are anticipated are charged for in the interest rate or fees quoted prospective borrowers. Expected losses merely increase the gap between gross and net revenues.

The ratio of losses to net earning assets also depends on the share of loans in the portfolio. Banks investing primarily in securities rather than loans have a lower percentage of loan losses compared with assets than banks with a high ratio of loans. The type of loans also influences the level of losses. They rise with the percentage of commercial and industrial and consumer loans and fall with the amount of mortgage loans. Large banks average more losses than small ones, but small banks are more likely to be at either extreme. A tendency exists for banks with larger than average losses to regress toward the median in the following year.

Changes in Operating Income before Loan Losses

Just as with loan losses, the best prediction for next year's income for individual banks is simply last year's income. It is difficult to improve upon such a prediction by adding other variables. The R^2s for regressions of the current year's income for individual banks, using last year's income as the only independent variable, are about 0.5. The only other obvious significant variables are those based on differences in liabilities held by a bank. If a bank has a higher share of demand deposits, its earnings are slightly higher; and, if its percentage of purchased liabilities is larger, its earnings are slightly lower than the average. The relationships are weak, however, with R^2 of under 0.1. More significantly, virtually no relationship exists between gross revenues before interest and expenses and net earnings. All of the increased revenues go to pay for larger interest payments, larger losses, or higher operating expenses. Net revenues are independent of the difference in gross revenues.

Differences in balance sheets also do not offer significant explanations for year-to-year movements in incomes of individual banks. As with loan losses, an assumption that year-to-year movements in income are unanticipated and follow a stochastic process among banks of the same size seems a good initial assumption in estimating risks.

The primary exception to a purely random relationship is again a slight tendency for individual banks' revenues to regress back toward the median of all banks in the next year. Furthermore, in years when revenues drop sharply, banks with higher revenues seem to be in greater danger of an above-average fall, but the R^2s are under 0.05.

The sections that follow examine why the expected earnings are likely to be more or less than anticipated. As in this section, the causes are divided into those movements dominated by market interest rates and

those due to failure of a bank to perform its operating and lending functions adequately.

3.5 Interest Rate Risk

The most important risk of insolvency or of a fall in the net worth of a bank arises from a mismatch of the term to maturity of assets and liabilities with fixed interest rates. Samuelson (1945) and later authors have used the concept of duration to study the effects of interest rate changes on financial institutions. *Duration* is a measure of the weighted average time before payments are received from interest and principal on a security or loan. The weights used in the calculation are the relative present values of the future payments.

3.5.1 The Interest Elasticity of Net Worth

Morrison and Pyle discuss in their paper (chap. 13) both the theory of interest elasticity and some models that can be used to apply the concept to specific bank assets and liabilities. They show that under the simplifying assumption that all spot and forward rates change by the same amount and that assets and liabilities remain constant, the percentage change in a bank's net worth will be proportional to the percentage change in interest rates. The proportion or actual value of such movements in capital will depend on the duration of the bank as a whole. The bank's duration is a weighted average of the duration of its individual activities. The weights are each activity's share of the present value of the portfolio.

Morrison and Pyle also show, however, that for two reasons these simplifying assumptions are unlikely to be met:

1. The discount rates for all future payments are not likely to move together. They will diverge depending upon the time until a payment is to be received or made and also because of variations in the inherent risk in each asset or liability.

When interest rates rise or fall, the term structure (the rate paid on assets of different maturities) does not move proportionately throughout. Short-term rates usually move by more than long-term rates. Both may react differently to shifts in real interest rates and to expected inflation. The lack of correlation across the structure of rates may, according to Morrison and Pyle, reduce the simpler calculation of interest rate risks by up to 25 percent or, in some cases, even more.

In addition to shifts in the term structure, discounts for risks of different classes of loans, borrowings, and securities may widen as interest rates rise. Most calculations of term structure interest movements are based on risk-free or government securities. (The Lane and Golen paper, chap. 15, introduces the broader concept in contrast to the simpler

calculations in McCulloch and in Morrison and Pyle.) Such widening of risk premiums will raise the total effect of interest movements, particularly since larger movements in risk premiums are likely to occur for loans and other nonliquid assets, which make up a large share of bank portfolios. This tendency will be heightened because added risk premiums are also likely to raise the total amount that must be paid for liabilities.

While the theory indicates that completely accurate results require that risk estimates be built up taking into account the many diverse movements arising in the term and risk structure, the empirical data seem to show that in practice modeling risks at each duration may be adequate without the need for information about the exact time path of flows. The risks caused by uneven annual returns from assets appear minor compared with those that arise from differences in the average duration of banks' assets and liabilities.

2. The second reason the simplifying assumptions fail is that not all of a bank's assets and liabilities have fixed payment streams and a well-defined maturity. Cash flows alter as the rates at which commitments are taken down change, assets are paid off more or less rapidly, and deposit liabilities shift. At the same time, interest rates paid and received on assets tied to market rates move.

The papers by both Morrison and Pyle and Nadauld (chap. 14) consider procedures by which adjustments for uneven flows may be made in the risk estimates for specific types of assets and liabilities. The empirical work makes it appear that adjustments for such movements are of a second order and not necessary for adequate risk estimates.

3.5.2 The Interest Risk Estimates

The studies do show the necessity of calculating the duration of individual activities in a bank's portfolio. The risk of an activity can then be calculated by applying to it estimates of the risk at that particular duration. The risk of the portfolio is found by combining the activities into a total using proportionate weights. Such risk estimates do not include adjustments for shifts in cash flows, for widening risk premiums, or for possible covariance among interest movements. In the studies, this latter factor more than offsets the other two. If this is generally true, the abbreviated estimates may well form an outside bound.

McCulloch in his paper (chap. 10) estimates the probability that, as a result of unanticipated interest rate movements, an asset with a specific duration will lose more than x percent of its value at some point during the year. He calculates such probable movements in the risk-free rates for assets and liabilities with maturities from three months to thirty years. He bases these estimates on the history of actual movements in the prices of government securities between 1951 and 1977. The tables and figures in

the McCulloch chapter can be used to calculate the probable interest rate risk of any portfolio, under the assumption that the probabilities evidenced by these distributions will continue.

If the dynamics of changes in the values of assets and liabilities are such that they can be modeled by diffusion processes, a variance rate for such changes will serve to measure risks. The assumption is frequently made, as in the Black-Scholes option pricing model, that changes in value owing to interest rate movements follow a log-normal distribution. McCulloch and others have argued that the distribution of the prices of interest-bearing securities is far more fat-tailed, or leptokurtic. To reflect this, McCulloch has developed an option pricing formula based on a log-symmetric stable distribution (McCulloch 1978*a*). The distribution assumes a greater probability of extreme events. The application of the more fat-tailed distribution greatly increases the estimated risk from interest rate changes. Thus, McCulloch shows that for a twenty-year par bond the risk that the price will change by 10 percent or more during a year is estimated to be covered by a fair insurance premium of 0.06 percent if a log-normal distribution is used, compared with a premium of 1.17 percent under the log-symmetric stable distribution that he has fitted to past interest rate changes.

The papers by Morrison and Pyle, Nadauld, and Lane and Golen (chaps. 13, 14, and 15) attempt to calculate the interest rate elasticity of net worth for specific model institutions. Each selects a limited number of activities and simulates their movements based on econometric models of past lending and borrowing. Possible movements in interest rates are estimated from maximum past shifts in the spot rate and the term structure.

Many bank assets are not market instruments, and as a result they lack observable market values. Market values must be imputed adjusting expected cash flows to a certainty equivalence. These adjusted flows can then be discounted at the projected default-free rate. Morrison and Pyle describe the theory behind one form of estimation of a certainty equivalence as well as a technique for performing this task. Nadauld expands upon this concept and explains the content of a computer program that can perform this task.

All these chapters present examples of actual simulations for periods in the mid-1970s. Morrison and Pyle estimate the interest elasticity for a wholesale bank that contains business loans, demand deposits, certificates of deposits, and equity capital. They utilize a range of term structures to obtain estimated interest rate elasticities and find that they are low for a bank whose portfolio consists only of commercial loans with primarily floating rates.

These papers show vast differences in interest rate risks depending upon the activities contained in the model bank. The estimates of poten-

tial interest rate risks vary considerably among the studies in this volume. The large changes in value found as probable by Nadauld in his work with savings and loan data are similar to the earlier studies. Morrison and Pyle and Lane and Golen show both low interest rate elasticities and insurance costs. These results follow directly from the specific assumptions used in their particular applications and not from the techniques. If more general assumptions were used, the results of the different techniques would come closer together.

As noted, Morrison and Pyle measure the interest rate risk of a limited part of a bank—one in which most rates move with the market. Capital losses are minor. They also find that changes in value as a result of interest induced flows in a wholesale bank are small. This latter result may well be typical of more broadly based portfolios.

Several critical factors account for the lower costs of insurance estimated by Lane and Golen, which range from 10 to 40 percent of those found by McCulloch for similar maturities and capital ratios. In practice, each would have to be adjusted to more realistic assumptions for the particular bank being evaluated. Lane and Golen assume that all funds received during the period are invested at the rate that applies at the next examination period. The effect of this assumption is to reduce the duration by a full year. In contrast, if the rollover of investments took place evenly, the diminution of duration would be only half a year. They also assume no dividends, while McCulloch assumes that all earnings are paid out. The Lane-Golen technique increases the estimated end-of-period capital.

More significantly, the period Lane and Golen picked to develop their probability distributions was one in which capital values rose as a result of declining interest rates. Thus they measure variances around an expected capital gain. Insolvency occurs only if the initial net worth plus this expected gain is exceeded by a loss. The negative parts of their estimated distributions are considerably smaller than they would be if the variances were measured around a neutral expectation of changes in value. The Lane-Golen tables make clear, as do the prior studies, how rapidly additional capital can reduce the risk of insolvency. An examination of any of the tables shows that the cost of insurance drops rapidly as the amount of capital is increased.

3.6 Risks of Poor Performance

The risks of insolvency may rise and the future net worth of a bank may fall because of poor performance of its normal functions. A variety of causes can decrease revenues or raise expenses. Loan losses or delayed payments may expand. The bank may have to increase the share of high-priced purchased money. Operating costs may jump. Decreases or

losses may occur in miscellaneous sources of income, such as from the trust department, foreign exchange or security trading, or real estate.

3.6.1 Distribution Functions Derived from Estimates of Nonperformance

The measurements of the distribution functions around expected changes in net worth arising from unanticipated movements in loan losses and operating earnings are derived from a variety of time series and cross-sectional data. The time-series data include year-to-year movements in average changes for banks as a whole, for classes of banks, and for individual large banks and bank holding companies. The cross-sectional data include movements in the levels and year-to-year changes for each bank since 1970. The data on individual banks were analyzed extensively. They are the source of knowledge concerning the relationships from one period to the next.

One form of the distribution functions used is developed from the variances of the year-to-year changes in individual bank net worths arising from loan losses and operating charges. The years used are those in which the variances were largest. The distribution functions derived from these records are based on the movements in all banks, in all large banks, and in the banks with the largest and smallest variances. The period covered is from 1965 to 1979.

As the next chapter shows, the distribution functions derived from the records of nonperformance do not indicate that these are important sources of insolvency. In a competitive economy, the average earnings for a continuing, vital industry must be high enough to maintain its ongoing performance. While variations in earnings occur with macro-events, such fluctuations are not likely to lead to insolvency in an industry with adequate capital aided by a good insurance system.

Operating revenues and loans usually do not deteriorate suddenly. It takes poor management or fraud and insider abuse to thwart normal diversification. While errors may accumulate in a bank over time, a proper analysis of the existing trends usually shows when changes in operations and capital additions are required. A failure to require that existing conditions be corrected is more likely to cause problems than is the impact of unanticipated events.

3.6.2 Are These Risk Estimates Adequate?

Because the distribution functions measuring the probabilities of poor performance do not indicate much risk in banking operations from this source, the question must be raised whether they are biased downward. For two technical reasons they may be low, but these do not appear significant. More important is the absence from the general distributions of measures of maldiversification and of the probability of fraud.

The distributions used in this study are based on years of maximum past movements and on the assumption that changes for individual banks follow a normal distribution. Both assumptions may reduce estimates of true risks. Distribution functions should be based on a complete estimate of potential events. An estimate of risks based on the maximum changes in losses or income over a fifteen-year period may not be as high as an estimate measuring risks over a longer period.

Furthermore, as with interest rates, losses and unanticipated movements do not appear to follow a completely normal pattern. The distributions, particularly among either very large or very small banks, seem skewed toward more extreme losses. They appear leptokurtic. Risk measures based on an assumption of normality may, as is shown in McCulloch's paper, understate the true values.

Nondiversification

One of the more critical questions in estimating risks is to find a logical measure of nondiversification. Theoretical concepts are quite clear. Nondiversification is measured by the correlation among individual assets and activities of possible losses in total returns from interest and capital. A portfolio in which activities are not correlated is diversified. Problems arise because, by definition, losses are unanticipated. Still, certain correlations with a resulting lack of diversification appear probable. Clearly, interest rate risks are correlated. Other classifications with high correlations also appear, such as geographic—local versus national versus international; by industry; by size of firm; by ownership.

We have examined differences among loan losses in some detail. Contrary to our initial expectations, we could not develop any general rules, perhaps because historically the rate of loss in most cases has been low. As a result, it may be possible to build a better measure of nondiversification by use of simulations rather than past data. One could assign possible distributions of loan losses and correlations to specific activities. By drawing from these distributions, one could estimate the potential costs of nondiversification in a manner similar to that used in the Lane and Golen paper (chap. 15).

Insider Abuse

Better definitions of insider abuse are also necessary. Two of the largest bank failures were related to misuse of insider positions. Congress has been legislating in this sphere. If the laws are clear enough, then protection against abuse should be a matter of proper audit. For this purpose there is little obvious reason to expect that government audits or examinations would be better than private ones. Since most of our economy and regulations are based on private auditing and accounting, it appears that those who feel it cannot work for banks ought to show what

basic differences exist and why these cause a need to treat banks differently from other corporations. While special regulations may be necessary for some purposes, it is not obvious that a need exists for a government audit.

In analyzing these other risk factors, one must not overestimate their total effect. While insider abuse or fraud has caused the failure of most banks, they tend to be the small ones. Their losses, compared with either the insurance fund or payments from it, are not large. From 1 January 1934 to 31 December 1978, the FDIC total losses, including anticipated losses on assets still held, were $345 million. This does not include forgone interest, which would increase the total losses by 50 percent or so. Of the total, by far the largest share has gone to cover the losses of banks with over $100,000,000 in deposits. Later discussions show that these various factors may make it advisable to use somewhat different techniques for measuring risks in large and small banks. However, the general approach appears suitable for both.

3.7 Measuring Net Worth

In the measurement of risk and capital adequacy, most attention has been paid to measuring possible losses in income. Yet the measurement of current and projected net worth should play a role as significant as, or even more significant than, that of possible losses. Furthermore, the difficulties of measuring net worth are as great or even greater.

A key factor in total risk is the real or economic value of a bank's capital and those forces that will cause it to differ at the next evaluation. Because many gains or losses in the value of assets and liabilities are taken into the books only over time rather than when they occur, and because many intangibles are never recorded, the economic value of capital often varies greatly from that shown on a bank's books.

We can see how great the difference is between book and economic value if we are willing to assume that the value of a bank's stock in the market reflects its true economic value. In the years 1950 through 1975, the market value of the net worth of the approximately twenty-five banks and bank holding companies carried in Standard and Poor's Bank Stock Index averaged about 135 percent of their book value. In individual years, the ratio of net worth in the market to book for all of these banks ranged from 1.87 in the highest year to 0.94. Year-to-year changes in this ratio exceeded 40 percent at times. When market-to-book ratios for individual banks are examined by years, an even wider range is found. The years 1971–73 appear not untypical. We have examined the market-to-book ratios for these years for each of 135 banks; they ranged from 3.5 for the bank with the highest ratio to 0.6 for that with the lowest, around a median of 1.25.

Capital accounts in banks consist of equity capital, surplus, undivided profits, reserves for contingencies, and other capital reserves. True economic capital may differ from this total because: (*a*) gains or losses on assets from interest rate movements are not recorded; (*b*) liabilities may be overstated when regulation Q forbids payment of market interest rates; (*c*) the value of information, customer relations, and goodwill may be considerable; (*d*) reserves for loan losses may not be accurate; (*e*) the value in use or in liquidation of fixed assets varies; (*f*) commitments for future loans or foreign exchange purchases and sales may have a positive or a negative value; (*g*) other reserves, such as those for contingencies and deferred taxes, may increase real net worth.

The paper by Sharpe (chap. 8) presents the formal analysis and precise definitions that are at the heart of our discussions of capital adequacy. Sharpe uses a state preference model to make clear the theoretical underpinning of some of the more common ideas.

The first section outlines the concept of capital adequacy for an institution whose deposits are insured by a third party. An economic balance sheet that includes the FDIC's liability to the depositors is introduced and explained. It is demonstrated that, given relevant risks, an increase in capital will reduce the per unit value of the FDIC's liability. However, the relationship is nonlinear. Each additional increment of capital will cause a small drop in the FDIC's liability. Given a specific amount of risk, some level of capital exists that will make the per unit liability equal to any preselected premium.

The second part develops the idea that with fixed insurance premiums a bank can increase its value by gaming against the FDIC; in other words, it can raise its net worth by increasing the risks in its portfolio. Furthermore, the more inadequate is the initial capital (the larger the FDIC's liability), the more will a given increase in risk raise the value of net worth. The model also shows that the total increase in the stockholder's net worth or in the FDIC's liability depends upon how changes influence liabilities as well as assets. As is stressed throughout our discussion, results depend upon the covariances among the balance sheet items as well as upon their individual relationships to events.

In the course of the analysis, another example is presented of why, in complete financial markets with an assumption of no bankruptcy and no gain from the FDIC, the mix of deposits and capital should be irrelevant. No matter what mix of deposits and stock it elected to employ, an uninsured bank could raise just enough capital to pay the market value for its assets.

3.7.1 Use of Common Stock Prices

One method of measuring the value of a bank's capital is to look at the stock market's estimate of its net worth. To believers in the efficiency of

financial markets, this is the only sensible way. In an efficient market, prices reflect the usable relevant information on the present value of future dividends and net worth. They summarize all the pertinent facts of the balance sheet and intangible assets.

However, serious problems arise in estimating capital from stock market data. In the first place, well-operating markets exist for stocks of only 1 to 2 percent of all banks. While these are the largest, containing the majority of all assets, a substitute technique must be found for the others. Furthermore, though the market may be efficient in projecting its own future estimate of net worth, this may differ from actual values. The market swings widely in estimates. It must consider earnings far into the future, not the resources available for payments on a given day.

While efficient in the narrow sense, the market's record of projections, both on an individual and an aggregate basis, is not good. If the market's estimates were accepted, the amount of capital would fluctuate widely. This could affect lending decisions and output. Even if public policy increased to some degree the risks assumed by the FDIC, it might be good policy if it smoothed the swings and discouraged procyclical lending. Finally, because the market is so heavily influenced by government regulations and actions, there is no reason to expect it to be estimating the true market values desirable for public policy as against the value of regulations to the individual owners.

Poor Information

Financial theory tells us that it is difficult to improve upon the market's judgment as to the value of a bank's capital—because anyone who could consistently improve upon the market would make large profits and drive the price toward equilibrium. Still, in the case of many banks, the information available to the market has been inadequate for making the best judgments. Some data have not been gathered, and some have been suppressed. Because they fear that disclosure could lead to runs from ill-informed depositors, regulators have opposed disclosure of a broad range of information, such as on poor loans and investments, misconduct, source of deposits, and similar data.

Perhaps as a result, in critical cases the market's judgment has been demonstrably poor. The stock of several of the large banks that failed in recent years sold at high levels until well after insolvency was already a highly probable outcome. Few large depositors or lenders spent time or money in attempting to judge their banks' risk, because the depositors made the correct assumption that, even though most of their loans to the banks were not covered by FDIC insurance, there was a de facto guarantee.

Based on poor experience both for stockholders and for the insuring agency, however, and as a result of pressure from the Securities and

Exchange Commission, regulators are increasing the flow of information. The justifications for withholding information have decreased. Small depositors did not withdraw their funds on receiving adverse news. They trusted the FDIC. On the other hand, stockholders and lenders on debentures suffered large losses because of a conflict of interest between the regulators' desire to keep the banks open and their duties as security regulators.

Even with added requirements, however, managements may still hide critical information. Creative accounting is not uncommon. Furthermore, even with adequate information the market fails to anticipate many events. Its forecasting record is not good.

Private versus Social Values

We also do not know how much of estimated net worth at any time reflects divergence between private and social valuations of risks and future earnings. By taking excess risks or reducing their capital below the level that would be set in a competitive informed market for an uninsured, nonregulated firm, bankers may raise the market's valuation of their net worth. The expectations of earnings might disappear if current insurance operations were altered to charge fair premiums. Similarly, some of the bank's returns and its estimated economic capital may reflect noncompetitive features in the system that should be removed.

The Market Price of Risk

Rather than requiring added capital or insurance each time the market reduces its estimate of the net worth of banks as a whole, it may be worthwhile for a public insurer to share certain risks. To avoid large variances in estimated capital, for example, the FDIC or other regulators using capital estimates on market valuations might prefer to use a moving average of some sort to iron out the effect of the largest fluctuations in overall stock prices.

Decisions on how often and how much to counter market estimates are difficult. Some movements reflect real drops in economic value. Thus banks as a whole lose net worth when interest rates rise or major industries face potential defaults. Furthermore, each bank reacts uniquely to such macro events, depending on how it has constructed its own portfolio. Changes in net worth owing to such events are a necessary part of risk calculations and should not be neglected.

On the other hand, some movements in capital values, as evidenced in tables 5.2 and 5.3, reflect the market's shifting evaluation of risk as a whole. Fluctuations occur because of rapid shifts from optimistic to pessimistic expectations of future earnings. For administrative and other reasons, it may be advantageous to smooth out some of these overall movements even if it increases the insurer's risk. Even though future

movements in the market may be random and not predictable, the FDIC can assume different risks than can individuals or firms. It can afford to average out over cycles, even though this might be unprofitable for individuals.

A willingness to average market estimates of value may make additional sense because, if regulators or insurers bring added pressure on banks to increase their capital based on cyclical fluctuations, they may create difficulties both for the bank and for the economy. In recessions, equity capital is expensive and difficult to raise. Furthermore, in recessions macro conditions will improve faster if businesses can borrow money to invest. If banks are restricted in their lending because the market value of their capital has fallen, recovery will be delayed. Market values reflect a general pessimism and poor expectations. Attempts to force banks to increase capital in order to offset the market's reactions will increase the overall pressure on the economy (Orgler and Wolkowitz 1976).

3.7.2 Use of Market Related Data

Since the actual use of specific stock market data for calculating net worth is possible for only about 100 or 200 of the 14,400 banks, other techniques are necessary for the rest. One procedure is to estimate separately the present value of the individual activities in the banks from related information taken from financial markets. The individual parts can then be summed. Thus the present value of securities held, of the loan function, of the deposit function, and of miscellaneous operations can be valued separately and the bank's total net worth calculated.

The direct valuation of a bank's assets and liabilities can start with estimates taken from financial markets. For actively traded securities, marking to market is no problem. Since market quotations for equivalent assets exist, a direct estimate of any discrepancies between book and market is possible. In fact, bank annual reports currently carry such calculations. However, they appear as footnotes or appendixes to the report, not as corrections to the book capital. The market can also be used to value other liabilities and related assets such as federal funds, repurchase agreements, owned acceptances, and certificates of deposits.

The Maisel and Jacobson paper (chap. 9) shows that valuation is possible but more difficult for demand and savings deposits where neither on an explicit nor an implicit basis are market returns paid, for loan accounts where accrued information among lending officers can increase returns, and for miscellaneous income such as from trust departments.

The value of deposits, other information, and miscellaneous income can be estimated from the market for premiums paid for such assets, including goodwill. Unfortunately, the market for selling banks or their deposits is not an active one. Premiums paid vary greatly depending on

how badly a firm or individual wants to enter a specific market. For these reasons, other techniques must be employed that use information from a variety of sources.

A large difference between market and book values is likely to arise from the effect of interest rate changes on the loan account. These can be corrected for by using recent lending rates—say over the past month or quarter. These rates can be used to discount the portfolio of previously existing loans after their maturity has been estimated.

Estimates are available for expected average net returns from deposits and from other activities for all banks. Such expected rates of return can be applied to specific banks, with necessary adjustments if they seem out of line. These expected returns for the individual bank can be capitalized. A faster, less rigorous procedure may be used by capitalizing overall returns through market price/earnings ratios of similar banks. While these are not rigorous methods, the degree of effort worth using in this valuation depends upon the significance of these other sources of income.

Such estimates of capital owing to a more realistic estimate of the firm as an operating entity must be added to those changes arising from the differences in the market value of assets. In most cases, returns from intangibles will be in the range of 10 to 30 percent of the total. Therefore, an error of even 20 percent in estimating them will change the total estimated capital by only 5 or 6 percent.

Would such ad hoc procedures improve on the use of either stock prices or book? The answer seems to be yes. Since capital enters into the risk calculations in a nonlinear form, even minor improvements in estimates may be important in certain critical ranges. In the same way, some adjustment for expected growth in a portfolio relative to net worth may also be worthwhile. Although the record of sophisticated attempts to project individual balance sheets is not good, in a dynamic situation rough approximations of the future are likely to be better than an assumption of no change.

3.8 Models of Risk and Capital Adequacy

The final step in the procedure for measuring capital adequacy is to derive from the separate measures of a portfolio's current and expected net worth and its distribution function a measure of its total risk or capital adequacy. Such measures either can show the fair insurance premium that would have to be paid to offset the portfolio's risk or can estimate the probability that a negative net worth will occur in a designated period.

The papers in this volume use three separate approaches to the measurement problem. In some cases the approaches are applied to actual or prototype banks. In other cases, only certain functions or certain kinds of risks are modeled. These studies develop theories while

illustrating their application by specific examples. The results of such examples show how banks can avoid major risks. However, to measure complete risks and capital adequacy, more detailed information concerning the individual bank must be inserted into the models.

The first approach estimates risks through the theory of contingent claims, using variances derived from past movements of returns in the interest rate market, in loan losses, and in operating earnings. The second constructs simulation models of future net worth and failure probabilities. The distributions of risks are based on past experience or on assumptions as to extreme possibilities of movements in a period. The final approach predicts risks from regressions of measures of bank asset and liability characteristics, other annual report data, and past behavior of total stock market returns of banks.

3.8.1 Conditional Claims

Merton (1974, 1977*a*) has shown that many types of conditional financial claims can be analyzed in terms of option pricing theory (Black and Scholes 1973; Cox, Ross, and Rubenstein 1979). McCulloch in his paper (chap. 10) and in related work measures the variance of past interest rate movements. Both he and Merton (1977*a*) show that the value of deposit insurance (the risk of loss from insolvency) is equivalent to a promise by a third party guarantor to take over the assets and pay deposits in full if the value of a bank's assets falls below the amount it has promised to pay on deposits.

At a given date, a firm has a particular sum of assets and has promised to pay a given amount to liability holders. The difference is its net worth. Its liabilities at the time of the next examination are already a fixed sum based on promised interest rates, but the future value of its assets and its net worth will depend on what events occur in the interim. An insurer guarantees that, if the assets are worth less than the liabilities, it will pay them off at their face value and accept the assets as its recompense.

The insurer is offering a guarantee that is equivalent to a "put option." In an option market, the seller of the option agrees to accept shares of stock at a fixed (exercise) price set at the time of the sale. His risk depends on the probability distribution over which stock prices may range at the expiration date. His potential losses depend on the probabilities that the stock will be selling below the exercise price and how far below in each such case. If we chart his risk, the curve will be similar to that of figure 2.1.

Option pricing theory shows that the value of the put option or its equivalent, the fair insurance premium, depends only on the risk-free interest rate, the amount of liabilities at the date of next examination, the time until the examination, the current value of the firm's assets (the difference between the current values of its assets and its liabilities being its net worth), and the variance rate per unit time for the logarithmic change in the value of assets.

3.8.2 Simulations

A second approach to measuring risk is through simulations. The papers by Morrison and Pyle, Nadauld, and Lane and Golen (chaps. 13, 14, and 15) contain approaches of this type. They also discuss the underlying theories behind these and related techniques. Simulations enable one to relate the risk in particular portfolios either to a forecast of exogenous variables available from other sources or to a distribution of probable events based upon past relationships.

Morrison and Pyle, for example, model a few particular activities of a bank. They show how to measure the magnitude of interest rate risks in a particular combination of activities. In a bank that can move its lending rates promptly after the risk-free rate changes, the remaining risks—primarily those of movements in risk premiums and disintermediation—are not large.

Nadauld develops a computer model to make measurements of the Morrison and Pyle type in a more general form. His model is developed to measure probable changes in net worth that may arise from movements in interest rates. He accounts for resulting movements in both discount rates and induced changes in loan payments. Although Nadauld uses mortgages for his particular examples, the program can be applied to all types of loans and investments.

The paper by Lane and Golen develops this approach further. It shows how simulations can be used to estimate risks in more complex situations. The authors simulate the probability distributions needed for the estimation of risks, drawing from distributions based either on time-series forecasts or on past movements. The simulations use knowledge of recent events as well as history. The probability distributions that result are related to a variety of capital/asset ratios in order to measure the interaction between risks, capital, and fair insurance premiums. Specific results depend upon the initial conditions for the simulations.

As in the Morrison and Pyle paper, the activities of the bank are limited, and only interest rate risks are measured. Liabilities, on average, are assumed to cost the bank sums equivalent to the six-month Treasury bill rate. The particular period used for these simulations shows rather low risks for these activities in comparison with those estimated from the option pricing model.

3.8.3 Fundamental Risk Determinants

The third approach, in the paper by Rosenberg and Perry (chap. 16), models risk by using regression techniques. It determines prediction rules for the systematic and residual risk experienced in the market for the bank's common stock. It aims at measuring the predictive significance of a large number of variables as an indicator of risk, and hence as a target for regulation.

Using the COMPUSTAT data base, prediction rules have been developed for two aspects of risk: systematic risk (risk that is related to covariance with the market portfolio) and residual risk (the aggregate of specific risk and extramarket covariance). For each type of risk, several models have been estimated: one model employs only measures of the bank's asset and liability characteristics; a second employs these characteristics and other data taken from annual reports; a third model adds the history of the behavior of the price of the bank's common stock. The central conclusion of the study is that systematic and residual risk in banks can be predicted from predetermined data. Prediction rules estimated in this way can serve a useful function in monitoring bank risk.

3.9 Can General Financial Theory Really Be Applied?

The measures of risk and capital are based upon models derived from modern financial theory. Numerous arguments arise about whether the concepts that have been developed and tested largely in more perfect markets, such as that for bonds and common stocks, can be applied to a specialized industry and individual institutions. Banking markets do vary from those of the theory, but how significant is this in overall results?

One of the strengths of the theories arises from the fact that only a few assumptions are necessary to obtain robust empirical results even when deviations from the assumptions occur. However, since the markets for financial intermediaries deviate from the assumptions of a perfect, efficient market in many ways, as a minimum, qualitative differences will exist between actuality and the predictions of the theoretical analysis.

The following important simplifying assumptions of models have been worked out in theories:

1. Perfect capital markets exist. This means that securities are infinitely divisible; information is available to all at no cost; there are no costs for transactions, and pure competition exists among borrowers and lenders.
2. There are no legal or institutional restrictions on borrowers or lenders.
3. Taxation costs are zero.
4. Bankruptcy costs are zero.
5. Those engaged in the market attempt rationally to maximize.
6. Homogeneous expectations exist, and future earnings can be represented by a subjective random variable.
7. Lending and borrowing can be accomplished by individuals and corporations at the risk-free rate.
8. Hedging and arbitrage, including short sales, are possible in any security.

Critical for the models is the idea that financial markets are efficient and utilize available information effectively to project and value future

cash flows. Based on these projections, accurate and rational prices are established for securities. These can be traded costlessly, allowing arbitrage to work. Perfect substitutes will not sell at different prices in the same market.

Arbitrage will be at work in three ways. It will tend to ensure that loans and investments with similar characteristics will have roughly equal returns. It should cause managers and bank executives to be paid what they are worth, since otherwise they can move elsewhere. It will cause substitutions of holdings among bank stocks so that a bank's value will depend upon its choice of activities.

3.9.1 Significant Differences

There are a number of ways the banking market fails to meet the assumptions. Regulations restrict competition and the free choice of portfolios. Taxes and bankruptcy costs are not zero. Information and transaction costs are important.

Regulation and Competition

Most significant variations exist with respect to competition and legal or institutional restrictions. Financial institutions do not operate in purely competitive markets. Administered prices apply to both their borrowing and their lending. Nonprice competition is not sufficient to remove distortions.

If their markets were to be classified, as are those of manufacturing or commercial firms, some banks would appear to operate in fairly competitive oligopolistic markets. Others, especially those in small, one-bank towns, have much tighter monopolies for many services. Competition is restricted by the need for a charter and permission from the regulatory authorities to open new branches. Neither type of permission is easily obtained.

There are numerous regulations over interest rates, with respect to both the amount that can be paid on different classes of deposits and the amount that can be charged on loans.

The composition of portfolios is regulated, and the assets an institution can hold are limited. These restrictions exist partly as an attempt to control risks (though it might be noted that their effect, by decreasing diversification and limiting better choices, is probably to increase risks) and partly to allocate credit that may be available to the institutions in accordance with certain priorities set by the government.

Taxes and Bankruptcy Costs

Basic differences arise in the theories of leverage and corporation finance when taxes are taken into account. Effects become less certain because of the complexities of our tax system. Some taxes push in one direction, some in the opposite.

Bankruptcy costs can also be significant. Legal and court costs rapidly diminish the value of a firm in bankruptcy. Economically illogical decisions may be made because of the need to protect the conflicting rights of numerous claimants to the estate. However, in many cases of banking insolvency, costs can be considerably reduced because of the ability of the regulators and the FDIC to move rapidly and logically. Mergers can be aided and expedited.

Information and Borrowing Costs

Other significant factors are costs of information and of issuing securities and trading assets. They influence the efficiency of the market for raising capital and for lending. They are also among the critical factors in bankruptcies. Rapid progress is being made in developing an economic theory of information. However, its numerous potential effects and the need to alter concepts when lack of information is taken into account are still only unfolding. When insiders in a firm have greater information than does the public, a moral hazard arises. It is hard for the market to devise procedures to protect lenders and investors from insiders (Ross, 1977).

There are many other informational deficiencies in the lending sphere. Many loans are small. It is not profitable to spend large sums on gathering information. As one might expect, the amount of information available rises with the size of loans. A good deal of information is specific to each existing borrowing-lending relationship. For example, on consumer loans most profits arise only from second or later loans to a customer. The need to gather information and the risk of error greatly reduce the value of an initial loan. Success increases with time and with knowledge.

Because information about the customer's past payments and ability to pay are so important, loans in many cases can be sold only at large discounts. When part of a portfolio of loans is offered in the market, the threat of adverse selection is always present. Many of the significant costs of transactions in bankruptcies seem to be related to the cost of gathering information. Factors such as the loss of existing relationships, cost in establishing new relationships, and adverse selection raise the cost of marketing loans. In turn, transaction and bankruptcy costs increase risks. They also may make some added leverage profitable.

Individuals and firms frequently lack the assumed ability to arbitrage, to create hedges, to lay off risks, or to sell short. As a result, the rates at which they borrow and lend may vary by a great deal.

There also may be considerable irrationality, or, as important, the cost of attempting to operate rationally in the market may be great. When costs of shopping the markets and of making decisions are high, actual market rates will diverge. There can be tied relationships, with a resulting sluggish response to outside action or shocks.

Even if the market is efficient, its knowledge of the future may be slight. Much of our later analysis is based on the fact that returns are stochastic. Forecasts of the future in the financial markets are usually, or at least frequently, wrong. The data in the Maisel and Jacobson paper illustrate the fact that ex post results can differ for long periods from those that probably were thought to exist at the time of lending and investment.

Transaction Costs

Another sphere in which important divergences from the theoretical assumptions appear is transaction costs. Much of the analysis assumes that necessary assets and liabilities of the type held by the bank can be sold for value in a well-operating market. While this is true for many assets, sales of commercial, farm, and foreign loans may entail sizable losses. High transaction costs may occur because of loss of information or liquidity squeezes. In the foreign sphere liquidation costs may be extreme because political forces may make it impossible to shift loans and raise funds.

As a result, loans with high potential transaction costs require maintaining liquidity through other assets. They may also require an additional risk premium that takes into account that their rates of return are not symmetrical. Because of forces external to the particular bank, their rate of loss may rise sharply at times when sales of such loans become necessary.

It is possible to estimate how expensive it would be to liquidate a portfolio. Transaction costs will vary. Government securities will have a broad market. Most municipals will be salable also, although some may be local names that can be liquidated only with extra time and effort. Confusions have arisen because at times securities can be sold only with large losses. Losses based on the difference between book and market values must be differentiated from transaction costs. While a firm may obtain far less than book value in a weak market, these losses do not reflect additional liquidation costs. The market will pay only current values, not book values; but such losses follow from prior interest rate movements.

National business loans will normally have a fairly active market, particularly if the bank has only a share of a loan, as is true for most national companies. Real estate loans of a permanent type on single-family homes also are readily salable. Permanent loans on other real properties will be slightly less liquid, but in these cases an estimate of the cost of brokerage or obtaining information sufficient to sell the loans is easily obtained from charges for this type of service by mortgage brokers. Loans to financial institutions and for carrying securities are also readily sold. In all these cases, liquidity problems or selling in a period of tight

credit must be separated from the transaction-information cost of a loan sale.

Consumer loans have somewhat higher transaction costs because information is more vital. With-recourse sales of such loans create only slight problems. Without recourse, buyers will have more trouble evaluating risks.

Three spheres with high transaction costs are construction loans, commercial and farm loans to local borrowers, and foreign loans. In the first two cases, information is the key. A new lender will have to redevelop information and charge for it, as well as charging a premium for probable adverse selection. Foreign loans either to a single country or in toto are likely to go bad because of balance-of-payment difficulties, for political reasons, war, or international economic upheaval. If they do, their market will disappear. No real diversification among foreign loans is possible for losses brought on by major international stress.

In most of these cases, even if a contract calls for variable rates and short maturities, firms usually cannot pay off loans and probably cannot increase interest rates at times of economic stress. Risks on such loans are greater because, in a liquidity squeeze, chances rise rapidly that the loans will default and that costs of sales to others will become much higher.

3.9.2 Excess Profitability

One obvious question that immediately occurs to most observers is, Why, if the market works and is fairly effective, do some banks seem so much more profitable than others? Aren't the divergence in profitability and the large differences in market valuations of capital indications that the theories are wrong? When we examine average rates of return on banks' earning assets, we find numerous reasons why these should differ.

Some higher returns reflect earnings on the bank's own capital. The amount employed in earning assets depends not only on capital as reported on the bank's books, but also on a complicated relationship among nonearning assets, reserves, and intangible capital. The earnings on intangible capital will include earnings from such items as information and customer relationships developed in the past.

Other important returns may arise from oligopolistic powers. Banks have obtained such power because of limited entry into the banking business and because of the prohibition of payments of market interest rates on deposits.

Some managements may be more efficient, more innovative, or better forecasters. In a competitive market, however, greater efficiency and innovations of managers should be competed away. In addition, a better forecaster or a more efficient individual ought to be paid nearly what he is worth. It is not too difficult for one bank to hire away good managers from others, and such changes occur fairly often.

If a set of assets seems to be returning above-normal amounts, this may simply reflect luck or the fact that possible but not highly probable unfortunate events have not yet occurred. Values are based on expected returns. For periods such as this past decade, these can be badly off in either a favorable or an unfavorable direction. But over time in an efficient market, no class of assets should have returns that diverge significantly from returns for similar assets.

The most important way for a firm to alter its returns is by increasing the risks it assumes. By selecting assets, firms can determine both the return they will earn and their basic level of systematic risks. Firms can err in their operations if they improperly measure the risk of a loan and accept too low a rate of return, or if they fail to properly diversify their risks.

The amount a firm receives from any asset or class of asset depends upon the systematic or nondiversifiable risks in the asset. On the other hand, the risk in the firm's portfolio depends upon its ability to diversify and therefore upon the nondiversified risk it retains. Thus the danger of insolvency will rise to the extent that a firm increases the risks in its portfolio in a nonsystematic manner.

It is possible that a firm with proper skills can pick nondiversifiable assets so well that it can increase its expected returns corrected for risks. However, historical and anecdotal evidence from bank failures and problem banks indicate that firms attempting to specialize and not diversify are likely to underestimate the actual risks they take and to overestimate their risk-corrected returns.

Banks that are earning a good deal less than the average tend to do so either because they have not properly controlled their expenses, or because they have failed to properly underwrite their loans and are in danger of taking large loan losses, or because their forecasts have been poor and their portfolio choices react poorly to unexpected events. Those who earn less than the market because their expense controls or underwriting are bad tend to stand out. On the whole, such trends can be observed, risks can be reduced, and insolvency can be prevented by taking the necessary action to increase their capital and shake up the management.

3.10 Concordance with Concepts: Large and Small Banks

Our empirical work and theoretical developments seem to show that, while qualitative and individual differences between theories and institutional facts must be considered, analysis built upon the theories can be extremely useful. In this as in other spheres, the theories appear to give robust empirical results even when deviations from the assumptions occur.

Returns—particularly on a book basis—for categories of loans among banks do tend to equalize. Even though their task is complicated by problems of information and transaction costs, bankers do make logical choices.

While excess returns may be earned in some categories such as demand and saving deposits because of ceilings and a lack of competition, returns to these activities are far less than they appear to those, for example, who believe that the prohibition against paying interest on demand deposits makes them a free good to banks. Competition does not reduce excess returns to zero, but costs of deposits do move with market interest rates.

However, the degree to which the theories fit the facts and their usefulness for policy may differ between large and small banks. As in many parts of our economy, banking is divided into a small number of large firms, which control the bulk of the assets, and a large number of relatively small firms.

In 1980 there were approximately 175 banks with assets of over one billion dollars. These accounted for more than 60 percent of all assets. One might define small in various ways. Of the 14,400 banks in the United States, slightly more than 3,000 had assets below $10,000,000 and accounted for about 2 percent of all assets. About 8,000 banks with assets of between $10 and $50 million accounted for about 11 percent of all assets. The 1,800 between $50 million and $100 million held about 7 percent of the assets. The 1,400 banks between $100,000,000 and $1 billion held 20 percent. All together, the 1,600 largest banks held well over 80 percent of all bank assets, or over $1.5 trillion.

The problems of operation, of regulation, and of examination differ a great deal depending on size. The skills of the managers, the degree of diversification, the degree of market pressure and segmentation vary greatly.

All banks have a number of widely traded investments, returns on which are completely competitive. At the other extreme, there are neighborhood depositors and borrowers who do not shop for better prices because the importance of convenience and goodwill is so great. Returns from these customers can have a noncompetitive factor. A higher proportion of the portfolios of the larger banks will be market dominated; they will have a much smaller percentage of depositors or borrowers tied primarily because of convenience. Small banks are more likely to fail because of fraud, insider abuse, and lack of diversification, but when they fail, the average loss is not large.

Because the size of banks makes such a difference in their conformance to the basic concepts of theory, in the effect that existing forms of regulation will have on their efficiency, and in the impact of a failure on the economy and on the insurance fund, it may be sensible to separate out small banks in determining the most effective forms of regulation.

The next two chapters show the results of applying the measurement procedures to specific uses and types of risks. They describe in greater detail some of the difficulties found in actual applications. They are based on the theories and some of the specific results contained in the more detailed papers of part 2.